Normative Social Applications

User-centered Models for Sharing Location
in the Family Life Domain

Normative Social Applications

User-centered Models for Sharing Location
in the Family Life Domain

Proefschrift

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus prof. ir. K.C.A.M. Luyben,
voorzitter van het College voor Promoties,
in het openbaar te verdedigen op woensdag 27 september 2017 om 15:00 uur

door

Abdullah KAYAL

Masters of Science in Interactive Systems Engineering,
Royal Institute of Technology (KTH), Stockholm, Sweden,
geboren te Latakia, Syrië.

Dit proefschrift is goedgekeurd door de

promotor: prof. dr. M. A. Neerincx
copromotor: dr. M.B. van Riemsdijk
copromotor: dr. ir. W.P. Brinkman

Samenstelling promotiecommissie:

Rector Magnificus,	voorzitter
Prof. dr. M. A. Neerincx,	Technische Universiteit Delft
Dr. M. B. van Riemsdijk,	Technische Universiteit Delft
Dr. ir. W.P. Brinkman,	Technische Universiteit Delft
Onafhankelijke leden:	
Prof. dr. Pınar Yolum,	Boğaziçi University, Turkije
Dr. C. Hauff,	Technische Universiteit Delft
Prof. dr. D. K. J. Heylen,	Universiteit Twente
Dr. M. V. Dignum,	Technische Universiteit Delft
Prof. dr. C. M. Jonker,	Technische Universiteit Delft
Prof. dr. ir. G-J. P. M. Houben,	Technische Universiteit Delft, reservelid

SIKS Dissertation Series No. 2017-38.
The research reported in this thesis has been carried out under the auspices of SIKS, the Dutch Research School for Information and Knowledge Systems.

An electronic version of this dissertation is available at
http://repository.tudelft.nl/.

Contents

Summary

Social media platforms are used by a massive, growing number of users, who use these platforms to share content such as text, photos, videos, and location information. As the spread of social media is playing an increasingly important role in our world, literature has shown that while aiming to promote a number of human values (e.g. friendship, social recognition, and safety), this type of technology may pose risk to other values (e.g. privacy and independence), creating what has been defined as value tensions.

This thesis proposes the norm-based, Social Commitment (SC) models as a solution that could potentially provide tailored support for user values. As research shows that norms can fulfill (or pose risks to) values, SC models could utilize their normative core to as well as their ability to contain key relevant information that complement the missing features in social applications' preference settings, to give users a rich, flexible, and adaptive structure that improves their social application experience.

Location sharing in the family life (i.e. within families with children in the elementary school age) was selected as an application domain, as it provided potential use cases that are abundant with value tensions (e.g. a child's safety vs. their independence), while embodying the essential elements of data sharing using social platforms. The research followed a Situated Cognitive Engineering approach, and an exploratory investigation into the social context of the application domain was conducted: focus groups and cultural probing studies with parents and children, and the collected data was analyzed using grounded theory. The result was a grounded model that showed (1) how activities, concerns, and limitations related to family life are connected through specific user values, and (2) that norms can support these values by promoting activities, alleviating concerns and overcoming limitations.

Further on, a conceptual model was built, and subsequently a SC grammar (and a semantic lifecycle) were developed for this domain: the SC-model allowed users to construct commitments amongst each other for sharing and receiving social data, harmonized to their values via normative statements. A location-sharing application was developed so that, in addition to location-sharing features found in familiar commercial platforms, it also contained an implementation of our SC grammar.

The SC model's expressivity was validated through a qualitative user study with parents and children, where nearly all participants' normative statements were found to be expressible through the proposed model. The SC grammar's usefulness (within the application domain) as well as its ease of use were validated through a crowd-sourced, online user study. The SC model's ability to provide improved human value support was validated through a user study conducted with elementary school children using the location-sharing application we developed, as well as a questionnaire constructed to measure fulfillment of

children's values relevant to the domain. Results demonstrated that enhancing the app with the SC model has improved its support a number of children's values while posing no risk to the remaining measured values in the process.

In the thesis's final user study, we demonstrated that using contextual information (e.g. a user's value profile) as well as commitment attributes (e.g. recency and norm type), can be used to create predictive models that are capable of automatically resolving the vast majority of conflicts that may occur amongst location-sharing commitments.

In conclusion, this thesis demonstrates that SC models possess the potential to provide an easy to use, flexible tool that allows social applications to work better in users' favor, supporting intended user values while posing minimal risk to other values as a side effect.

Samenvatting

Socialmediaplatformen worden gebruikt door een enorm, groeiend aantal gebruikers, die deze platformen gebruiken om inhoud te delen zoals teksten, foto's, video's en locatiegegevens. Het bereik van social media speelt een steeds belangrijkere rol in onze wereld, en literatuur heeft aangetoond dat, in het streven naar het promoten van een aantal menselijke waarden (zoals vriendschap, sociale erkenning en veiligheid), dit soort technologie risico's met zich mee kan brengen voor andere waarden (zoals privacy en onafhankelijkheid), waardoor zogenaamde waardespanningen worden gecreëerd.

Deze scriptie benoemt de norm-gebaseerde Social Commitment (SC) modellen als oplossing die mogelijk ondersteuning op maat kunnen bieden voor gebruikerswaarden. Omdat onderzoek aantoont dat normen waarden kunnen vervullen (of risico's kunnen vormen), kunnen SC-modellen gebruikmaken van de normatieve kern, evenals het vermogen om belangrijke relevante informatie te bevatten die ontbrekende functies in de voorkeursinstellingen van socialapplicaties kunnen aanvullen, om gebruikers een rijke, flexibele en adaptieve structuur te bieden ter verbetering hun ervaring met social applicaties.

Location sharing (locatie delen) binnen het gezinsleven (d.w.z. binnen gezinnen met kinderen van middelbareschoolleftijd) werd als applicatiedomein gekozen, aangezien het potentiële use cases biedt die rijk zijn aan value tensions (bijv. de veiligheid van een kind vs. zijn onafhankelijkheid), terwijl de essentiële elementen van het delen van gegevens worden geïmplementeerd met behulp van social platforms. Voor het onderzoek werd gebruik gemaakt van de Situated Cognitive Engineering-benadering, en een exploratieonderzoek naar de sociale context van het applicatiedomein werd uitgevoerd: focusgroepen en culturele onderzoeken met ouders en kinderen en de verzamelde gegevens werden geanalyseerd met behulp van grounded theory. Het resultaat was een grounded model dat aantoonde (1) hoe activiteiten, zorgen en beperkingen in verbinding staan met specifieke gebruikerswaarden, en (2) de normen die deze waarden kunnen ondersteunen door activiteiten te bevorderen, zorgen weg te nemen en beperkingen te overwinnen.

Daarnaast werd een conceptueel model gebouwd, en vervolgens werden SC-grammatica (en een semantische levenscyclus) ontwikkeld voor dit domein: het SC-model stelt gebruikers in staat om onderlinge verbintenissen op te zetten voor het delen en ontvangen van sociale data, geharmoniseerd naar hun waarden via normatieve uitspraken. Een location-sharingapplicatie is ontwikkeld zodat het, bovenop de location-sharingkenmerken van bekende commerciële platformen, ook een implementatie van onze SC-grammatica bevat.

De expressiviteit van het SC-model werd gevalideerd door middel van een kwalitatieve gebruikersstudie met ouders en kinderen, waarbij de normatieve uitspraken van bijna alle deelnemers uit te drukken waren via het voorgestelde model. Het nut van SC-grammatica (bin-

nen het applicatiedomein) evenals het gebruiksgemak werden gevalideerd door middel van een crowd-sourced online gebruikersstudie. Het vermogen van het SC-model om verbeterde human value support te bieden werd gevalideerd door middel van een gebruikersstudie, uitgevoerd met basisschoolkinderen met gebruik van de location-sharingapplicatie die wij hebben ontworpen, evenals een samengestelde vragenlijst voor het meten van de vervulling van de waarden van kinderen relevant aan het domein. De resultaten toonden aan dat het versterken van de app met het SC-model de ondersteuning van een aantal waarden van kinderen heeft verbeterd, terwijl het geen risico met zich meebrengt voor de resterende gemeten waarden in het proces.

In de eindgebruikersstudie van de scriptie hebben wij aangetoond dat het gebruik van contextuele informatie (bijvoorbeeld een gebruikerswaardeprofiel) evenals commitmentattributen (zoals recency en normtype) kunnen worden gebruikt om predictieve modellen te creëren die in staat zijn om automatisch de overgrote meerderheid van conflicten die kunnen voorkomen tijdens location sharing commitments op te lossen.

Ten slotte blijkt uit deze scriptie dat SC-modellen het potentieel hebben om een gemakkelijk te gebruiken, flexibel hulpmiddel te bieden waarmee socialapplicaties beter werken ten gunste van de gebruikers, waarbij beoogde gebruikerswaarden worden ondersteund terwijl als bijwerking een minimaal risico optreedt voor de overige waarden.

1

Introduction

1.1. Motivation

Social media platforms have gained a massive number of users in the recent years[1], and have recently become an integral part of our day-to-day interaction– Platforms such as Facebook, Twitter, and Instagram are consistently gaining new users, who use these platforms to share content such as text, photos, videos, and location information. The prevalence of social media has prompted individuals and organizations alike to use these platforms in both recreational as well as critical (Abel et al., 2012) settings for sharing and receiving data.

While social media is spreading and becoming more accessible, its role in our world becomes more important as well. Social media has transformed the manner in which people communicate themselves to the world, connect with others, or create new social and business opportunities. However, the benefits of this technology may come at a cost: while social media may be used with the intention of promoting certain human values such as friendship, social recognition and safety, it may also negatively impact equally important values such as freedom, responsibility and privacy. These trade-offs are known as value-tensions (Miller et al., 2007) in the research area of Value-Sensitive Design, an area concerned with accounting for human values in software development (Friedman, 1996).

We hypothesize that these value tensions in currently available social and location sharing platforms are related to the limited control that these platforms offer over sharing and receiving of data. In particular, these platforms are limited in their ability to incorporate (situational, social, or temporal) context in decision making on whether to share or receive data. This observation is in line with research in philosophy of privacy, which argues for the importance of incorporating context information in sharing data (Nissenbaum, 2010).

For example, Twitter allows users to either protect or make public their tweets, while newsfeed rules are based on following and unfollowing other users. Hence Twitter lacks the ability to take into account context information pertaining to the reason a Twitter account is followed. Facebook's newsfeed does not show stories ordered by time, and hence lacks the ability to take into account the temporal context. Neither Facebook nor Twitter allow the

[1] At the time of writing, Facebook had 1.86 billion active users, while Twitter had 319 million active users.

adoption of sharing or receiving rules coming from a user's friend or family member, and hence they lack the ability to take into account the social context. Some applications like Apple's FindMyFriends allow for conditional sharing rules, e.g. user x gets a notification every time user y is at a certain geographical location. However, these rules are always executed, and there is no possibility for the application to violate these rules in exceptional circumstances. Therefore, even though almost every social platform provides its users with some control over sharing and receiving data, limitations exist regarding the expressive power of the control concepts and implementations of this control. The lack of a standard framework that encompasses a variety of ways to exercise control means that preferences in social applications will inevitably give rise to value tensions, posing threats to a number of user values while aiming to promote others.

This thesis investigates this issue in the domain of location sharing within the family life. A number of existing social apps (e.g. Glympse[2] and Life360[3]) and wearable gadgets (e.g. LG's KizON[4]) already provide location sharing functionality, with the aim of assisting children in exploring their environment by helping them stay safe, go to school or visit friends on their own, make new friends, or explore their neighborhood. Value tensions clearly surface in this domain (Czeskis et al., 2010). For example, this type of technology is primarily used by parents with the intention of promoting safety through monitoring the location of their children, yet it negatively impact the values of responsibility and privacy for these children as a consequence of this constant monitoring (Nihlen-Fahlquist, 2013; Sahadat, 2016). Similarly, Facebook and Foursquare's feeds that include people's check-ins may promote social recognition, while relaxed (Debatin et al., 2009) and ineffective (Benisch et al., 2011) privacy policies negatively impact the values of privacy and safety. Some of the more recent social applications are taking steps to explicitly address these value tensions. For example, Snapchat[5] is trying to promote social connectedness through photo sharing while posing less risk to people's privacy through removing a photo after a one-time view.

This thesis aims for development of a generic model that allows location sharing applications to take into account contextual information in deciding whether to share and receive data, thereby alleviating value tensions as arising in existing location sharing platforms.

1.2. Proposed solution

Research in philosophy and normative systems (Bench-Capon, 2003; van der Weide, 2011; Hansson, 1991) proposed the idea that values can be promoted and demoted, i.e. be fulfilled and placed at risk, respectively, by norms. The idea is that an *action* changes an old situation into a new situation, and if the new situation is better or worse than the old one with respect to a certain value, we say that the action respectively promotes or demotes that value. Since norms are *action guiding* statements (obligating or prohibiting actions), norms can be used to influence a person or an agent's behavior in order to promote or demote certain human values. To make that idea more explicit, we can say that within a specific social context S, to promote value V, agent A should adopt norm N that obliges or prohibits action Ac,

[2] http://www.glympse.com/
[3] http://www.life360.com/
[4] http://www.lgnewsroom.com/newsroom/contents/64572
[5] http://www.snapchat.com/

which changes the situation in favor of V.

In particular, this thesis investigates the use of a type of norm called *Social Commitments* (SCs) for governing sharing and receiving of data. SCs were proposed by Singh (Singh, 1999) as norm-based structures that describe an agreement between two parties in socio-technical systems (Chopra and Singh, 2012). The parties involved in a social commitment are called the *creditor*, who creates the commitment and the *debtor*, who is committed towards the creditor for bringing about (or maintain) a certain proposition (the consequent) when a certain antecedent comes to hold (Chopra and Singh, 2012). SCs embody a normative element (i.e. an obligation or a prohibition of an action), as well as important contextual information, such as the parties involved, and the conditions under which fulfillment of the obligation or prohibition is required. SCs can also be further extended to represent concepts like deadlines, expiry conditions, roles and relationships amongst the parties involved, and more.

SC models therefore have the potential to provide tailored support for user values through their normative core, as well as through expressing relevant context information that complements the missing features in social applications' preference settings. This thesis investigates the use of SCs to govern sharing and receiving of data in location sharing platforms.

1.2.1. Terms used in this thesis

Throughout this thesis we rely heavily on the notion of norms, values, and social commitments. As these terms cover a wide scope in the English language, clarification is required at this point to define the scope and meaning of each of these terms within the context of this thesis. Andrighetto et al. (2013) provides definitions for norms in multi-agent systems, starting from their social nature– "customary rules of behaviour that coordinate the interactions in groups and societies". It states a common view of norms as "regulatory" mechanisms, and in this thesis we exclusively use the deontic notion of regulatory norms, including obligations and prohibitions. The notion of values in this thesis refers to human values, relies on the Cambridge dictionary definition of values, i.e. "the importance or worth of something to someone" as well as value (and value types) listed in the surveys in Rokeach (1973); Schwartz (2012), and the role of values in design Friedman (1996). Andrighetto et al. (2013) highlights the relationship between norms and values, stating that norms usually promote or support a value or value preference. Social commitments as discussed in this thesis rely on the original work in Singh (1999) and its subsequent social commitment research, and we make a distinction between the notion of norms and social commitments in this thesis with social commitments representing an agreement between (two) parties that involves a norm (obligation or a prohibition), conditions, and consequences.

1.3. Research question and hypotheses

A significant amount of research has been done on how to (formally) represent and reason about norms and SCs, and how to use these for modelling and governing multi-agent systems (Andrighetto et al., 2013). However, to the best of our knowledge, researchers have only recently started exploring the use of these concepts from normative systems research in governing the behavior of social applications (Koster et al., 2013; Such and Criado, 2016).

Translating concepts derived from work on norms and social commitments into directly usable social platforms requires investigation of how these concepts can be employed effectively in these platforms and of the usability of the resulting frameworks. Moreover, the validity of claims regarding the extent to which these applications provide better support for user values will have to be investigated. These issues are studied in the context of location sharing in family life, leading to the main research question of this thesis:

In the family life domain, in what manner can social commitments offer a usable solution that complements the user preferences of location-sharing platforms, and improve the platforms' overall support for human values?

To answer this, the main question was separated into four components– two research questions and two hypotheses. The two research questions were exploratory in nature, utilizing qualitative research methods to establish an understanding of the domain (Marshall, 1996), as well as a foundation, i.e. a proposed solution stemming from the requirements of the application domain and available literature. The aim of the two hypotheses was to empirically evaluate this proposed solution in terms of the improvement it provides to human values support.

The first component addresses understanding the application domain– location sharing in family life. What are the elements that make up the social context in family life, and how are they related to norms and values? And what type of application must be built if we want to investigate the usability and value support of a normative structure such as SCs? The relationship between norms and values has been highlighted in philosophy literature (Hansson, 1991), decision theory (van der Weide, 2011), as well as in software design (van de Poel, 2013). Thus the majority of research in this component focused on finding the link between human values and the elements of family life. In this way it establishes a model that outlines how normative statements within a location sharing application can influence family life through providing support for human values. With the establishment of a model that links values to norms on one hand, and values to elements of the social context of family life on the other, this value-based model (and this research component overall) can be seen a foundation step on top of which the remaining three components can build.

The second component investigated the transition between the conceptual, generic idea of the norm-based SC models, as available in literature (Singh, 1999), into a form that is usable within a location-sharing application. First, the research investigated how to tailor the SC framework as available in the literature to the specific needs of the domain. It identified elements that are currently lacking in existing location sharing applications, and analyzed whether to include or exclude components of the SC framework for our purposes. Second, the framework was conceptually refined for the domain of location sharing.

The third component relates to the main position argued for in this thesis. Aforementioned research in philosophy and normative systems (Hansson, 1991), argumentation (Bench-Capon, 2003; van der Weide, 2011), and value-sensitive design (van de Poel, 2013) showed that human values can be promoted, i.e. further fulfilled, and demoted, i.e. placed at risk, by norms. Moreover, as earlier discussed, social platforms (including location sharing apps) suffer from value tension issues, i.e. demoting important values while trying to

promote others. We hypothesize that augmenting a social platform, e.g. a location sharing app, with a normative structure that allows its users to create agreements regarding the sharing and receiving of location data will lead to a more socially adaptive behavior tailored for the social context in which it is functioning, and hence improve that application's overall support to human values.

The fourth and last component concerns how to address conflicts between commitments. This is a challenge inherent to the use of normative models: a user can subscribe to multiple commitments which can, under certain conditions, give rise to opposing requirements regarding sharing and receiving of data. As research in context-aware recommender systems suggests, user profiling has been established as a method to provide better recommendations and a better user experience (Panniello and Gorgoglione, 2012; Fernández-Tobías et al., 2016; Panniello et al., 2012; Knijnenburg et al., 2012). Building on that idea as well as on the already established link between values and norms, we hypothesize that knowledge of user profiles based on the ranking of their values, as well as how they believe the commitments they create support these values, will improve a system's ability to predict users' preferred resolutions if conflicts between commitments were to occur.

To conclude this section, from the main research question and the constituent components that described above, it is now possible to formulate the following two sub-research questions and two hypotheses that are tested in this thesis:

- Research question 1: how can the use of norms in a social platform influence the social context of family life?

- Research question 2: how can a social commitment model be tailored to a usable implementation to govern sharing and receiving of data in a location sharing platform?

- Hypothesis 1: a location sharing application augmented with a social commitment model provides better support for children's values than the same application without a social commitment model.

- Hypothesis 2: people's values are predictors of people's preferred resolutions to conflicts between commitments.

1.4. Approach and thesis structure

This thesis investigated the research question from a domain-specific perspective, namely family life. Therefore, *situated Cognitive Engineering* (sCE) was selected as the general framework for development (Neerincx and Lindenberg, 2008)– an iterative process based on Cognitive Engineering, with a situated approach that allows for better addressing of the human factors, central to the understanding of specific application domains.

To answer the first research question, qualitative, exploratory user studies were conducted with a sample of the target group, six children 6-8 years of age and six of their parents. These studies included a three-week cultural probing study (Gaver et al., 1999) and three focus group sessions (Kreuger and Casey, 2008). The material obtained in these studies included transcribed audio, photos, annotated maps, and post-its notes amongst others. Analysis of the obtained material was conducted using qualitative analysis methods,

namely grounded theory (Strauss and Corbin, 1998)– a bottom-up approach where a theoretical model was derived from qualitative data. The result of the analysis was a grounded model that established a link between norms and human values on one side, and human values and the elements of the social context of family life on the other– accounting for (and only for) the foundation step in sCE on top of which following specification and evaluation can be built. Details are described in Chapter 2.

To answer the second research question, a domain-specific SC model was built and evaluated in two iterations. The first iteration conceptually refined the generic SC model by Singh (Singh, 1999) based on data from user requirements, and through analysis of shortcomings in location sharing platforms. This process resulted in a modular concept that was evaluated for expressivity using co-constructing stories (Ozcelik Buskermolen and Terken, 2012), a qualitative, group-interview method particularly suited for the evaluation of technology that is still in the conception phase. Four children aged 7-9 and four of their parents participated in that study. The study generated in-depth qualitative, transcribed feedback, which was analyzed using qualitative methods. In the second iteration the transformation of the SC concept was resumed through conceptual reasoning as well as the user feedback generated through co-constructing stories, the transformation aimed at reaching a form that was ready to be implemented within a location-sharing platform. The transformation process resulted in (1) a SC grammar specifically intended for location sharing in the family life, and (2) semantics comprising a commitment lifecycle describing the creation and resolution of commitments. A web-menu implementation of the SC grammar was evaluated for usability and domain contribution through an online, scenario-based user study with 416 participants. Details of the studies, analysis, grammar, lifecycle, and web-menu implementation can be found in Chapter 3.

To test the first hypothesis, a location sharing application was developed. The application had two versions: one with only basic check-in functionality allowing user to share their location with a predefined list of people when they choose to do so; and one that added an implementation of the SC model. That feature allowed users to create commitments amongst each other regarding the sharing and receiving of location data. Thirty-four children aged 7-11 tested the application through a within-subject, counter balanced user study. Children tested usage of the application(s) though a mission-based interactive game in which they had to perform application-related tasks simulating real life situations. At the end of every session, children answered a 31-item questionnaire developed to measure fulfillment of children's values and validated though a panel of experts. Details of the application, study, questionnaire, analysis, and results are presented in Chapter 4.

To test the second hypothesis, an online, scenario-based user study with 396 participants was conducted. Participants' value profiles were first obtained, for a select set of five values relevant in the domain. Participants were then instructed to solve scenario problems by creating location sharing commitments– some of which created potential normative conflicts. Upon a potential conflict's detection, participants were asked to indicate their preference for the resolution of that conflict. Participants were also instructed to indicate how every commitment they created supported the selected set of values in the study. A mathematical predictive model based on user and commitment value profiles was developed, aiming to predict user preference for conflict resolution through the proximity of commitment value profiles to user value profiles. Details of the predictive model, study, analysis, and results

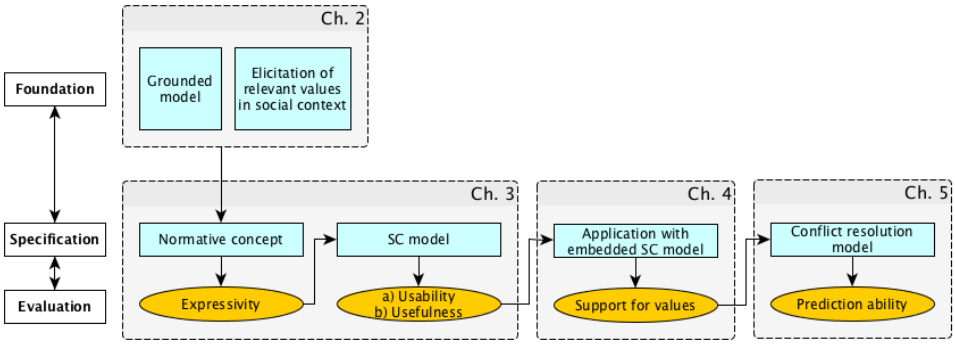

Figure 1.1: A step-by-step diagram highlighting this thesis's research and contributions.

are described in Chapter 5.

Conclusions that can be drawn from the findings in this thesis are discussed in Chapter 6, including the main contributions of this research, limitations, and suggestions for future research. Figure 1.1 shows a step-by-step diagram highlighting this thesis's research and contributions, tying every element to its corresponding chapter as well as to one of sCE's three phases, foundation, specification, and evaluation.

2

A value-centric model to ground norms and requirements for ePartners of children

Children as they grow up start to discover their neighborhood and surrounding areas and get increasingly involved in social interaction. We aim to support this process through a system of so-called electronic partners (ePartners) that function as teammates to their users. These ePartners should adapt their behavior to norms that govern the social contexts (e.g., the family or school) in which they are functioning. We argue that the envisaged normative framework for ePartners for children should be based on an understanding of the target domain that is grounded in user studies. It is the aim of this chapter to provide such understanding, in particular answering the following questions: 1) what are the main elements that make up the social context of the target domain (family life), and how are they related?*, and* 2) what are the relationships between these elements of the social context and the normative framework in which we envision the ePartners to operate? *To answer these questions we conducted focus groups sessions and a cultural probe study with parents and children. The transcripts from these sessions were analyzed using grounded theory, which has resulted in a grounded model that shows that 1) activities, concerns, and limitations related to family life are the main elements of the social context of this user group, and that all three elements are connected through the central concept of user* values*, and 2) norms can support these values by promoting activities, alleviating concerns and overcoming limitations. In this way the model provides the foundation for developing a normative framework to govern the behavior of ePartners for children, identifying user values as the starting point.*

This chapter is based on "A value-centric model to ground norms and requirements for ePartners of children", in Coordination, Organizations, Institutions, and Norms in Agent Systems IX, ©Springer-Verlag 2014.

2.1. Introduction

Children as they grow up start to discover their neighborhood and surrounding areas (and more so unsupervised the older they are), and get increasingly involved in social interaction (e.g. at school or sports clubs). It is our aim to support this process with intelligent technology to enable children to feel more socially connected, safe, and secure. We call this *socio-geographical support*. Such support can for example concern a child's safety as he/she is learning to explore its surroundings or learning to cycle to school, as well as the organization of children events in the community, birthday parties, and assistance in arranging play dates. We focus on *elementary school children* (between 6 and 12 years old) as our target group, as well as important people in their social environment such as their parents and teachers. We choose this target group as this is the age where they begin to explore their social and geographical environment on their own.

Our proposed solution for providing socio-geographical support is to create a system of so-called *electronic partners* (ePartners), that function as teammates to their human users as they navigate through their socio-geographical environment. ePartners in this setting may take the form of an application on a smartphone or another hand-held device. ePartners have already been investigated in various domains, e.g., within control systems (Arciszewski et al., 2009), robots (Hindriks et al., 2011), and applications that promote positive lifestyle changes (Henkemans et al., 2009).

Existing work on ePartners focuses on the bilateral relation between a single human and his/her ePartner. We propose that for our target domain it is also important to take into account the *social context* in which ePartners are functioning to enable them to adapt their support accordingly. For example, if a family normally allows a child to wander around the neighbourhood alone, the ePartner of the child might only notify the parents in case the child has left the area considered familiar or secure. On the other hand, if a family lives in an unsafe area they might not allow the child to do this, in which case the ePartner of the child could send a warning to the parents if the distance between child and parents has crossed a certain limit. We propose to model these different requirements for the behavior of the ePartner as *norms* (Andrighetto et al., 2013) that govern the respective social contexts. New norms may arise at run-time due to changing circumstances and social contexts. The idea is that the ePartner will be able to adapt its behavior accordingly to provide tailored support.

It is our view that development of interactive, human-centred automation such as ePartners for socio-geographical support should be built on empirical research to ensure that the provided support aligns with the context of use (see also Norman and Draper (1986); Fogli and Guida (2013)). Thus we argue that the development of the ePartner for socio-geographical support and the normative framework on which it is based should be *grounded in user studies* that provide an understanding of the target domain and the ePartner's supportive role in it in a systematic way. To achieve such understanding, in this chapter we answer the following questions: *1) what are the main elements that make up the social context of the target domain (family life) in relation to socio-geographical support, and how are they related?*, and *2) what are the relationships between these elements of the social context and the normative framework in which we envision the ePartners to operate?* We aim for a grounded model that concisely describes these elements and their relations. This model is the main scientific contribution of this chapter, and is anticipated to help guide future development of normative models suited for specifying behavioral requirements of

an ePartner for socio-geographical support within a family life context.

To answer our research questions we applied a situated cognitive engineering methodology (Neerincx and Lindenberg, 2008), described in Section 2.3. In particular, we conducted focus group sessions (Kreuger and Casey, 2008) and a cultural probe study (Gaver et al., 1999) with parents and children (Section 2.4). Transcripts from these sessions were analyzed using grounded theory (Strauss and Corbin, 1998), Section 2.5. The resulting grounded model (Section 2.6) identifies the main elements and their relations in the social context of family life concerning socio-geographical support, and it shows how these are related to norms for the ePartner. In this way our model provides the foundation for developing a normative framework to govern the behavior of ePartners for children. We discuss related work that forms the background of our research in Section 2.2 and conclude the chapter in Section 2.7. To the best of our knowledge, this is the first time that situated cognitive engineering has been used in normative systems research.

2.2. Background

In this section we give more background on important elements of our research, namely ePartners (Section 2.2.1) and normative and organisational frameworks (Section 2.2.2).

2.2.1. ePartners

ePartners are defined as computerized entities that partner with a human (development of a relationship) and share tasks, activities, and experiences (de Greef, 2012). In that sense, as automation becomes sophisticated, ePartners will function less like tools and more like teammates (Breazeal et al., 2004). They follow a paradigm shift from automation extending human capabilities to automation partnering with a human (de Greef, 2012). Examples of ePartners can be seen in various domains: critical domains such as space missions (van Diggelen and Neerincx, 2010), naval command and control (Arciszewski et al., 2009), and virtual reality exposure therapy (VRET) (Paping et al., 2010), as well as other, less critical domains such as socio-cognitive robotics (Hindriks et al., 2011), and personal digital assistants (Myers and Yorke-Smith, 2005; Henkemans et al., 2009).

The notion of ePartner fits very well with the role that we envisage intelligent technology to play in socio-geographical support, namely as an intelligent entity able to partner with people. ePartners can form individual agreements (contracts) with their users and can take the initiative to act in specific situations. ePartners have not yet been investigated in the context of socio-geographical support nor with the emphasis on the social role that they are playing and the ensuing need for adaptation to norms in their social contexts.

2.2.2. Normative and organizational frameworks

In recent years, an increasing amount of research has proposed to assign an organization or a set of norms to a multi-agent system (MAS) with the aim of organizing and regulating it (see Dignum (2004); Hübner et al. (2007); López y López et al. (2006); Uszok et al. (2004); Vázquez-Salceda and Dignum (2003) and the overview in Andrighetto et al. (2013)), similar to the way social norms and conventions organize and regulate people's behavior in society (López y López et al., 2006). This should make agents more effective in attaining their purpose, or prevent undesired behavior from occurring. Organizational frameworks

often incorporate norms as an element of the specification of an organization (see Hübner et al. (2010); Dignum (2004)). Research in this area has yielded a wide range of frameworks and languages for expressing organizations and norms.

We aim to build on this work by using norms to allow people to define requirements of social contexts in which ePartners should function. To ensure that the normative framework allows to express those aspects that are important for people in the context of socio-geographical support of children, we perform user studies to obtain an understanding of this social context and the role that norms could play in governing the ePartner's functioning.

The use of normative systems as the basis for supporting collaboration between humans and artificial teammates has been investigated only to a limited extent. KAoS (Uszok et al., 2004), which is a framework that allows to specify policies for human-agent/robot teamwork, takes steps in this direction. To the best of our knowledge, the requirements for their policy framework are however not elicited based on user studies to understand the context in which these agents or robots should function, but rather on a general analysis of aspects of human-agent teamwork. The work in Ali et al. (2012) proposes that software adaptation be achieved through allowing users to modify the system at runtime through feedback, though the work does not propose the use of norms.

2.3. Methodology

In this section we describe the methodology we are using to develop ePartners as socially supportive applications that understand and adapt to user's social contexts. In Section 2.3.1 we introduce *situated Cognitive Engineering* (sCE), the general framework we will use for development, and in Section 2.3.2, we describe the methods we used for data collection and analysis within the sCE framework.

2.3.1. Situated cognitive engineering

As a principle stance in the development of ePartner that can adapt to its social context, we reject the notion of a generic, context independent normative model, suitable for any social context. Instead we argue for the need of normative models specifically tailored for their social context, in our case family life. Situational dependency is also core to the situated cognition theory (Brown et al., 1989) which posits that cognition can not be separated from its context. Therefore, this study uses *situated Cognitive Engineering* (sCE) as the general framework for development (Neerincx and Lindenberg, 2008). sCE describes an iterative process based on *Cognitive Engineering* (CE) approaches (Hollnagel and Woods, 1983) whereby practical theories and methods are developed that are *situated* in the domain. Using a situated approach allows for better addressing of the human factors (i.e. human characteristics that influence their behavior in a certain environment), which in turn leads to a better human-machine collaboration design. sCE is composed of three main phases:

1. *Foundation:* understanding the domain, human factors, and technology involved;

2. *Specification:* the specification of the requirements and the corresponding use cases (the steps that define the interaction between a user and a system) and claims (what the developer proposes the system to be capable of doing).

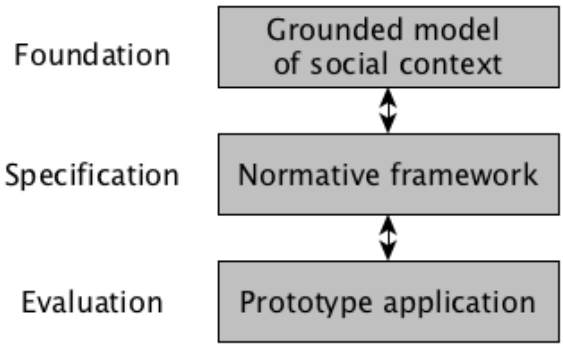

Figure 2.1: The three phases of sCE and how they align with the phases of our research

3. *Evaluation:* validating these claims through development of a prototype application that is tested in the field.

We use this methodology for the development of ePartners for socio-geographical support by instantiating the three phases in the following way (Figure 2.1):

1. *Foundation:* understanding our users' social context;

2. *Specification:* developing an expressive normative framework tailored to the target domain of socio-geographical support, to allow users to communicate their social requirements to the ePartner;

3. *Evaluation:* creation of a prototype ePartner for socio-geographical support according to the specification and iteratively evaluating it in the field.

In this chapter we address the first phase (understanding social context). That is, we leave development of a normative framework and a prototype application for future work.

2.3.2. Research methods

As explained in the previous subsection, we aim in the first phase to get an understanding of the important elements in the social contexts in which the ePartner will function. Therefore we need to collect data that describes the attributes, properties, and characteristics of the content of these social contexts. That type of *descriptive* data is usually obtained using *qualitative* methods (as opposed to quantitative methods, that start with a pre-assumed concept or model of a phenomena, and set out to collect specific, often quantified data to study this concept or model).

Two established types of user studies can be used to collect such descriptive data from the target environment: the first type is *cultural probing* (CP), a methodology initiated by Gaver (Gaver et al., 1999). It consists of providing users with packages of postcards, maps, disposable cameras, post-it notes, and other material for them to use to record spontaneous

data related to their lives. No explicit usage instructions on exactly how to use the material are provided. Users collect data over a period of several days or weeks (for examples on works involving cultural probes, see Schmehl et al. (2011); Bernhaupt et al. (2007, 2008)). The aim of CP is not to reach a comprehensive view of the user's requirements, but rather to use the collected material to inspire design. The second type of user studies we have used is *focus groups*, which can be defined as "carefully planned series of discussions designed to obtain perceptions on a defined area of interest in a permissive, non-threatening environment" (Kreuger and Casey, 2008). In a setting like focus groups, a small group (usually 5-10 participants) is gathered in one place, and then a discussion session is led by a moderator. The moderator proceeds to ask open ended questions, stimulating conversations between the participants relating to the subject of research.

We aim to obtain an understanding of the elements of the social context and the relationships among these elements, building a theoretical model on top of the collected data, or "grounded" in the data. This motivated the choice of *grounded theory* as our data analysis method: grounded theory is a bottom-up approach whereby theory is derived from data, systematically gathered and analyzed throughout the research process. Researchers do not begin the project with a preconceived theory in mind, but rather, the researcher begins with an area of study and allows the theory to emerge from the data (Strauss and Corbin, 1998).

In grounded theory, analysis comprises of four distinct steps (Creswell, 1998):

1. *Open coding*[1] where data is examined line by line in case of pieces of text (or object by object for other types of data), and portions of text and other media are "coded" under various codes that represent key points in the data.

2. *Axial coding* or the creation of categories, whereby similar codes are grouped together to highlight the presence (or emergence) of a theme or a concept.

3. *Selective coding* (or to further refine the existing set of codes), to identify themes central to the research questions and aims, and several iterations of coding and recoding of the data may take place until a satisfactory level is reached.

4. *Theory building* or the discussion and linking of emergent themes, and visual portrayal of connections that build up themes into a theoretical model.

In future work we will use the model that results from step 4 to identify requirements for a normative framework to support ePartner functioning in socio-geographical support (sCE's specification phase), which we will in turn use to build a first prototype (sCE's evaluation phase).

Grounded theory, as any qualitative analysis methods, is inherent subjective in nature and therefore vulnerable to validity threats such as researcher bias, interpretation bias, or respondent bias. This study therefore followed two strategies as proposed in the grounded theory literature (Strauss and Corbin, 1998) to minimize these intrusions. The first strategy applied was comparative thinking, i.e. comparing findings with reports in the literature, and with other data sets. In this study, we therefore collected data through both focus groups and cultural probes, noting the presence of similar themes in the analysis of both sets.

[1] Here, codes bear the meaning closer to tags in modern social applications. To code a piece of text is to tag it with a number of words or short phrases that relate to the content of that piece.

Secondly, we applied a re-evaluation strategy (MacQueen and Milstein., 2012), whereby an independent researcher was invited to re-evaluate the analysis of samples of the text, in order to investigate the degree of understandability, correctness, and completeness of the coding schema (details in 2.5.2).

2.4. User studies

In this section we describe the user studies that we have performed to get an understanding of the contexts in which ePartners for socio-geographical support are expected to function.

We have conducted three focus group sessions and one cultural probe study to investigate user requirements. The participants in these studies were parents and (some of) their children in a town of approximately 30.000 inhabitants, located in the South-West of The Netherlands. Through a small 'snowball sample' (Bernard., 1995) we requested a group of 6 parents and another group of 6 children to participate in the studies. "In snowball sampling you locate one or more key individuals and ask them to name others who would be likely candidates for your research" (Bernard., 1995). Our snowball sample started with a contact who participates in the school board, a youth centre and in a website for the local community.

The first focus group session included the six parents only. We introduced to them our project, research, and explained the aim of our user studies. To stimulate discussion, we displayed a few ePartner usage scenarios (created beforehand) and design claims (i.e. claims about a few positive and negative effects of the ePartner features within our scenarios)then asked the participants (individually) to rate to what extent they agree with our claims. After a short general discussion, we provided the parents with cultural probing kits (each kit contains a map, an instant camera, post it notes, post cards, pens, and some glue). The session ended with a brief explanation on the typical usage of the kit material.

The second session (three weeks later) included the same group as the first session. The parents brought back the material they (along with their children) collected during that period, and then proceeded (individually) to describe the data (e.g., pictures, map highlights, etc.) they collected with their kits. This process stimulated the discussion for a further 45 minutes in which many of the parents' and their children's life issues, values, and concerns were raised.

The third session included the six children only. The ages of the children ranged between six and eight years old. That session was led by an experienced elementary school teacher, and consisted of a discussion where the teacher asked the children a number of open ended questions related to their knowledge and usage of current technology, what activities they are allowed to do, how they connect with other children at school, sport clubs, and other places. All sessions were audio-taped.

2.5. Data analysis and evaluation

We transcribed the audio recordings from all three focus group sessions and imported these transcriptions and the scanned probe kit material into QSR NVivo[2] to perform qualitative analysis.

[2]http://www.qsrinternational.com/products_nvivo.aspx

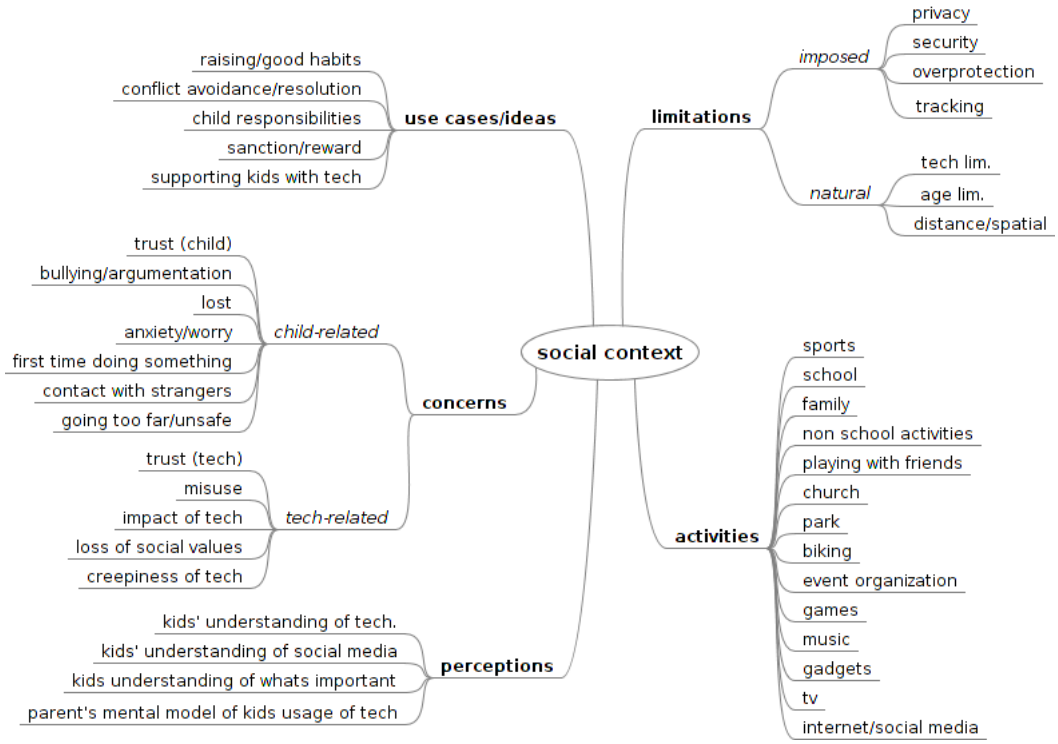

Figure 2.2: Final tree of codes

First, thorough reading of the transcriptions allowed us to derive the preliminary coding schema from the data material. In the second round of analysis, each passage of text was annotated with the appropriate codes, and the relevant codes were grouped together which resulted in a tree of codes. Afterwards, the tree of codes was further refined (e.g., codes with similar or close meaning were merged, codes under the same topic were grouped, infrequent codes were removed, etc.). Coding was then re-done according to the new tree, and portions of it were rated by another researcher.

2.5.1. Tree of codes

In this section we describe the tree of codes that has resulted from our data analysis.

The tree can be seen in Figure 2.2. The leaves of the tree represent the set of codes used in the analysis to mark relevant pieces of text in the transcriptions. Groups of codes represents the main "themes" or "elements" of the social context within our user group that we have identified in the data, created through grouping together codes that are similar or related. Two groups (limitations and concerns) were split into sub-groups (in italic) for further clarification.

Second level nodes represent groupings of codes that together represent a theme within

the participants' social context. *Activities* includes codes relevant to activities participants engage in, such as playing with friends, church, or sports. *Concerns* represent issues raised by parents (and children) that are present in their current life or are a cause for a certain worry, such as "contact with strangers" and "misuse" of technology. *Limitations* covers a rather broad theme that consists of both *imposed* (overprotection, privacy) or *natural* (spatial, age) issues that present a specific barrier towards the performance of an action (whether related to technology or not). *Perceptions* include mental models formed by an individual or a group (parents or children) of their understanding of certain concepts such as technology or social media, and *use-cases/ideas* represent suggestions that were given directly by focus group participants about ePartner features they believe to be be useful.

To explain in more detail, a few passages and their related codes taken from the data are shown below[3]:

- A: I think safety & security is important, also for the family, how do you handle this? If they can hack such an "ePartner" system, they will know everything about your child: Where they go, where they play their sports, how the routes are, and that's a lot of data. When I drew these data for the probe kit, I realized: You now know how my kid goes to the football field. Security is extremely important.

Coded under (a) limitations:imposed:security, (b) limitations:imposed:privacy, and (c) activities:internet/social media

- B: You know everything about it, and I don't feel like it, to be on something like Facebook, but I am forced to do this to follow the developments.

- C: We were wondering this week, do we have to make a Facebook account for ourselves to be prepared for when cC wants to have such an account?

Coded under (a) concerns:anxiety/worry, (b) concerns:trust:(child), (c) activities: internet/social-media, and (d) perceptions:parents' mental model of kids understanding of technology.

- cC: (about her smartphone)... and that is something on which you can play all sorts of games, and you can also chat and listen to music.

Coded under (a) activities:gadgets, (b) activities:music, (c) activities:internet/social media, and (d) perceptions:kids' understanding of technology.

[3]Names of participants are anonymized. Adults are referred to with one capital letter (for example, A or B), and children are referred to with a small c before one capital letter (for example, cA means the child of adult participant A).

2.5.2. Coding evaluation

As motivated in Section 2.3.2, randomly selected portions of the data (containing around 20% of the codes) were evaluated by a second researcher who has not been exposed to the data before. Evaluation consisted of (a) rating the codes present in the passages with "OK", "questionable" or "reject", and (b) answering a set of open-ended questions regarding the terminology used, consistency, completeness, placement and grouping of the codes.

The result of part (a) was that roughly 60% of the codes received an OK, 20% were rated as questionable and 20% were rejected. Out of the rejected 20%, we agree with the rejection in approximately half of the cases, for example:

- Coding "D: Maybe you can say: They will do things on Facebook etc., but you could let them get used to this in a controlled way".

was classified under "misuse" (which falls under the theme concerns:tech-related), but we agree with the evaluator that this text is not related directly to misuse of technology. For these cases we have adapted our codings.

We disagree with the rejection in the rest of the cases, for example:

- Coding "So, where do you have to interfere? Maybe, do you have to give children their own responsibility not to do these kind of things?"

was coded under "overprotection" (which falls under the theme limitations:imposed), because the idea of overprotection is being discussed, especially considering the overall context of that part of the discussion.

The answers to the questions in part (b) were:

- The current coding schema represents the data fairly well.
- Adding codes such as "future plans" and "playing outside" was suggested, seen to be useful in the third session with the children in specific.
- A few changes to current codes were suggested, for example splitting "bullying/argumentation" into two separate codes, changing "trust (ePartner)" into the more specific "trust (social media)", and renaming "distance/spatial limitations" to become more specific.
- No changes were suggested for the grouping (themes) of the codes.

These suggestions were taken into account to the extent that they had implications for the final tree, though not strong enough to produce prominent changes to the hierarchy and placement of codes within the tree. This suggests that the tree of codes resulting from the analysis has a good level of comprehensibility. Analyzing the evaluation as well as applying many of the suggested modifications to the codes and the tree contributed to a joint-view tree of codes in the final form.

2.6. Grounded model

With no more refining of the themes and codes in the tree to be done, the fourth and last step in grounded theory is theory building (the discussion and linking of emergent themes, and visual portrayal of connections that build up themes into a theoretical model, as discussed in Section 2.3.2).

2.6.1. Values as a central element

We queried the data material with various combinations of codes within the different themes in the tree of codes, especially codes with a high density in the text. We found that many of the passages of text that were returned as a result of queries of this type were statements from parents and children regarding certain elements that they believe to be "good" or "bad", "preferred to" or "not preferred to" a certain familial or societal issue they encounter.

Before we elaborate further on the possible significance of these types of statements, we need to briefly introduce the notion of "values" as discussed in across various academic domains. According to Cambridge Dictionary, a value is defined as "the importance or worth of something to someone".

Schroeder (2012), shows that values can be represented as phrases containing a subject matter, and a claim of "good/better/best" or "bad/worse/worst", relating the subject matter to someone or something, or in general. Examples of that can be "too much cholesterol is bad for your health", "my new can opener is better than my old one" and "pleasure is good". Though the word "value" in itself seldom appears in a sentence of this form, the existence of the varieties of "good" and "bad" in the sentence signify how the value of the subject matter is seen. In his 1973 book (Rokeach, 1973), social-psychologist Milton Rokeach published a list of values (based on a survey he conducted) that has become popular and widely used. The list included 18 terminal values (end results, or what one seek to accomplish such as happiness, freedom, and a comfortable life) and 18 instrumental values (ways of seeking and accomplishing terminal values, such as ambition, self-control and honesty).

The statements of the "good/bad" and "preferred to /not preferred to" form, which were returned as results of the queries discussed earlier, may then provide clues to the values of the person providing such statements. Often, the values they refer to align with some of the values in Rokeach's value survey.

To illustrate, querying the data for passages containing both the tree codes of "internet/social media" and "safety", would return several results, one of which is:

- "E: Often I get why-questions from children, and on the Internet you can get really strange things if you Google some words. Can you have a child-friendly Internet, that is safe and enclosed?"

Transforming this passage into the "good/bad" form returns the following value statement:

- "It is good to protect your children from the Internet's unsafe side".

Within Rokeach's value survey, we can arguably link the previous sentence to the value of "family security".

- "C: cC would really be happy if she could see that her best friend is available to play, but then I think they can already phone eachother, but such a feature would be nice for children: to see eachother's availability"

Transforming this passage into the "good/bad" form returns the following value statement:

- "It's good if children are able to use technology for coordinating their activities".

Within Rokeach's value survey, we may link the previous sentence to the values of "independence" and "social recognition".

We found that several of values in Rokeach's survey are important for this type of user groups, including family security, independence, inner harmony, true friendship and social recognition.

2.6.2. Relationship between social context and values

Highlighting values as a central concept in the user data brought forth the idea for a unifying link that can be established among three of the five themes in the social context through the values of our user group– activities, concerns, and limitations. We further explain these themes in the context of this application domain, as well as the tree of codes in Figure 2.2:

Activities: pertain to activities in which children (sometimes along with their parents) engage during their average day, e.g. going to school, visiting friends.
Concerns: pertain to (mostly) parental concerns related to their children in the general sense (e.g. being increasingly in contact with strangers) or specifically related to technology (misuse of social media).
Limitations: concerning geographical (e.g. distance) or social (e.g. privacy or security) limitations that obstruct certain societal goals both parents and children have.

To highlight the relationship between values and these elements as defined above: activities are driven by the values of our user group, concerns pose a threat to the values of that group, and limitations obstruct fulfillment of the values of that group (or in the case of imposed limitations, pose a threat to their values). This relationship is depicted in Figure 2.3.

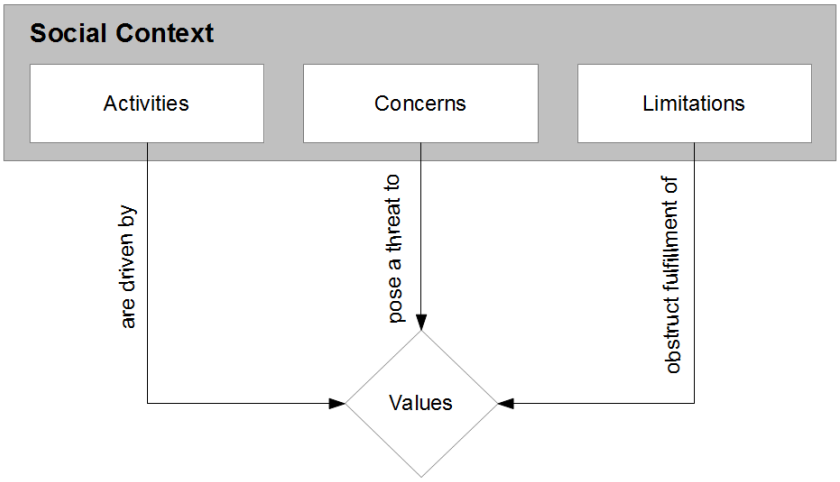

Figure 2.3: Relationship between social context and values

2.6.3. Relationship between values and norms

The second question we posed in the introduction highlighted the need to understand the relationship between the normative framework in which we envision the ePartner to operate, and the elements of the social context. Having seen how the elements of the social context are interconnected through user values, we proceeded by investigating the relationship between these values and norms. This relationship has been established in literature. For example, in Hansson (1991) it is investigated to what extent norms (obligations, permissions, and prohibitions) can be expressed in terms of value predicates (good, bad, better, etc.). In Figueiredo and Silva (2013), a method is proposed to identify conflicts between the values of an agent, and the norms to which it subscribes. In van de Poel (2013) norms represent the middle layer in a 3-layer hierarchy (Figure 2.4) which shows how design requirements can be elicited from values. Social norms (as an intermediary step in this model), can thus be derived from (or to be more specific, created to support) values– though in van de Poel (2013), these norms represent a further level of abstraction of the more concrete, deontic notion of norms, which would fall in-between this layer and the design requirements layer in this model.

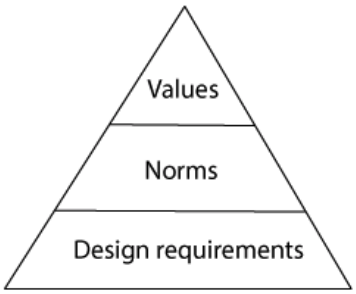

Figure 2.4: A model that shows how to move from values to design requirements (van de Poel, 2013)

Based on the previous literature examples, we propose that norms that influence the behavior of an ePartner can be created to support the values of our user group. Consider our last example of a sentence expressing a value:

- "It is good to protect your children from the Internet's unsafe side".

This means that the user believes a specific concern (misuse of technology) poses a threat to one of their values (family security).

We identify ePartner norms can support this value, for example:

- ePartner is obliged to block websites that are considered unsafe, or

- ePartner is obliged to inform parent if child is accessing unsafe websites.

By adhering to either of these norms, the ePartner alleviates this instance of the concern "misuse of technology", thereby averting its possible threat to the value "family security".

To generalize from that example, the elements of the social context (activities, concerns, limitations) affect user values positively or negatively, and though adhering to norms, ePartners can enforce a positive effect or diminish a negative one.

2.6.4. Relationship between social context, values, and norms

We have seen how the elements of the social context are related to the values of our user group, and that ePartner norms can be created to support these values. We can now "close the loop" and see how norms for the ePartner can support the elements of that social context. The resulting grounded model (Figure 2.5) shows the relationship between social context, values, and norms, answering the two research questions that we posed in the introduction (Section 2.1):

1. *Activities* that families engage in, *concerns* about and *limitations* on family life form the main elements of the social context of this user group, and these three elements are connected through the central concept of user *values* (namely, activities are driven by values, concerns pose a threat to values, and limitations obstruct fulfilment of values).

2. *Norms* can support these values by promoting activities, alleviating concerns and overcoming limitations.

In this way the model provides the foundation for developing a normative framework to govern the behavior of ePartners for children. It shows that to develop a normative framework for ePartners for socio-geographic support, user values should form the starting point. It also provides guidance on the type of prototype application and corresponding norms to be developed in the next phases of sCE, since these should be aimed at promoting activities, alleviating concerns and overcoming limitations.

2.7. Conclusion and discussion

Our contribution in this chapter is a grounded model that shows the main elements of the social context of this user group, namely the 1) activities, concerns, and limitations related to family life, and that these three elements are connected through the central concept of user *values*, and that 2) norms can support these values. In this way the model provides the foundation for developing a normative framework to govern the behavior of ePartners for children, identifying user values as the starting point.

The model we presented is grounded, meaning that it was constructed on the basis of user studies and corresponding data analysis, and it provides a coherent and concise specification– though it is imperative to note that the intention of grounded theory - as a qualitative research methodology - is to synthesize models (such as this one) that provide a foundation for empirical work which may utilize such user-rooted, synthesized concepts to test for evidence. Moreover, and despite our best efforts in accounting for researcher bias,

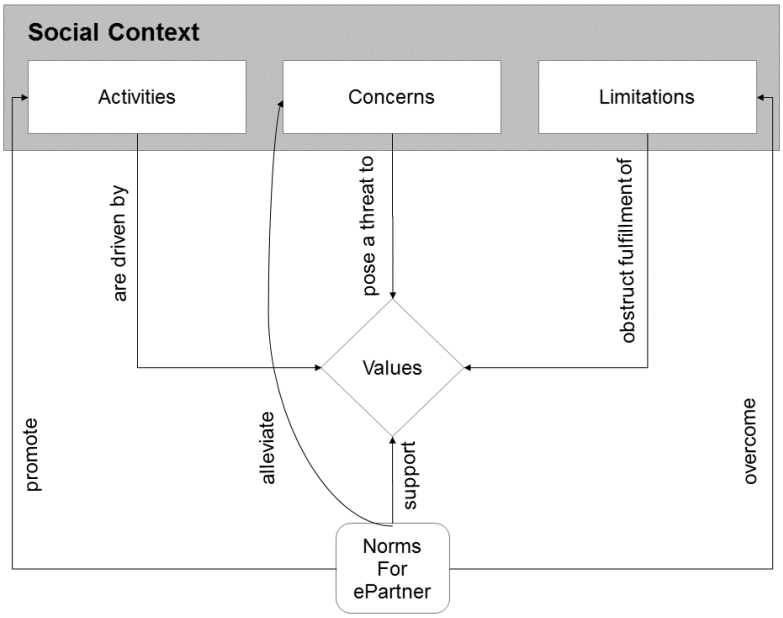

Figure 2.5: A grounded model that shows the relationship between social context, values, and norms.

the inherent subjectivity in qualitative data analysis methods cannot be entirely eliminated. But we believe that taking users into account is crucial for developing this type of interactive technology, and having done so in this chapter, the ePartner's support taken from this model onwards will align with this target group's context of use. This chapter also forms an example of how one can use user-research methods as the basis for developing a normative framework.

In future research, we will continue with the next phase of the sCE framework, building on the findings we presented in this model. Relevant research at this stage is Value-Sensitive Design (VSD), see Friedman and Kahn (2003)– an approach that seeks to design technology that accounts for human values in a principled and comprehensive manner, and investigate how values are supported or diminished by particular technological designs.

Following the development of a normative framework for socio-geographic support we will create and evaluate a first prototype on top of a mobile phone sensing platform. The prototype should allow users to express their requirements on ePartners' behavior, supported by a normative specification language. We will evaluate the prototype through user studies situated in the environment of the target group.

3

A social commitment model for location sharing applications in the family life domain

Mobile location-sharing technology is used increasingly by parents to know where their children are. It is our aim to make such technology more flexible in adapting to the particular social context in which it operates. We propose to realize this by allowing users to specify norms that govern the respective social contexts, to which the application should adapt at run-time to provide tailored support. The challenge we address in this chapter is the development of a normative model tailored for mobile applications that support location sharing in family life. The novelty of our work lies in the fact that we employ empirical user-centered design methods and techniques for developing the model in an iterative and "bottom-up" way. This results in two main contributions: 1) a normative model, specifically a social commitment model, for family life location sharing applications shown to be useful and usable, and 2) a demonstration of how user-centered design can be employed to develop a normative model for social applications.

3.1. Introduction

Social media platforms have gained a massive number of users in recent years– at the time of writing, Facebook had 1.86 billion active users, while Twitter had 319 million active users. People are spending increasing amounts of time sharing and receiving content such as text, photos, videos, and location information. In this chapter we are interested specifically in the latter. In our research we investigate the creation of a mobile, location sharing application to support families with elementary school children, usually six to twelve years of age. This application may assist children when they start exploring their environment,

This chapter is based on "A social commitment model for location sharing applications in the family life domain", currently under review.

e.g., by helping them stay safe, go to school or visit friends on their own, make new friends, or explore their neighborhood.

A number of existing social apps and wearable gadgets already provide functionality that supports location sharing in this context to some extent. For example, Foursquare and Facebook allow users to perform check-ins at certain places, and share that location content with their lists of friends. Both Facebook and Twitter allow for geographical tagging of content including photos. Glympse and Life360 are family-oriented mobile apps, where for example, a parent can view the current location of her children or other family members on a map through GPS tracking. LG has recently released KizON, a bracelet that provides real-time location information allowing parents to track their children's whereabouts in real time.

The idea that forms the starting point for our work is that such applications need to take into account their social context and adapt their support accordingly (Kayal et al., 2014a). For example, if a family normally allows a child to wander around the neighbourhood alone, the location sharing application of the child might only notify the parents in case the child has left the area considered familiar or secure. On the other hand, if a family lives in an unsafe area they might not allow the child to do this, in which case the application could send a warning to the parents if the distance between child and parents has crossed a certain limit. Following the vision outlined in van Riemsdijk et al. (2015b), we propose to model these different requirements for the behavior of the application as norms that govern the respective social contexts, to which the application should adapt at run-time to provide tailored support.

In research on normative multiagent systems a wide range of normative models and frameworks has been developed (see Andrighetto et al. (2013) for an overview). Norms are statements expressing for example obligations and prohibitions as means to regulate the behavior of autonomous agents towards achieving a better overall system performance. This concept has been inspired by the way social norms regulate people's behavior in society. The challenge we address in this chapter is the *development of a normative model tailored for mobile applications that support location sharing in family life*.

The novelty of our work lies in the fact that we employ empirical user-centered design methods and techniques for developing the model in an iterative and "bottom-up" way (Section 3.3). We start from an understanding of our user group (Section 3.2) and perform two iterations of specification and evaluation (Sections 3.4-3.7) in order to create a normative model that aligns with the context of use. This results in two main contributions: 1) a normative model for family life location sharing applications shown to be useful and usable, and 2) a demonstration of how user-centered design can be employed to develop a normative model for social applications. We discuss these results and conclude the chapter in Section 3.8.

3.2. A Value-Centric Grounded Model

The starting point of this chapter is previous research (Kayal et al., 2014a) in which we have conducted several user studies (namely, cultural probes (Gaver et al., 1999) and focus groups (Kreuger and Casey, 2008)) with a sample of our target group (6 parents, and 6 of their children) in a town of approximately 30,000 inhabitants. The aim of the study was to understand what the main elements are that make up the social context of the target do-

main (location sharing in family life) and how these are related to the envisaged normative framework.

We used a qualitative method called *grounded theory* (Strauss and Corbin, 1998) to analyze our data. In grounded theory a model is built through a bottom-up process of labelling the transcripts of interviews with increasingly abstract codes in order to identify main themes in the data and eventually identify relations between them. The resulting "grounded model" is shown in Figure 3.1.

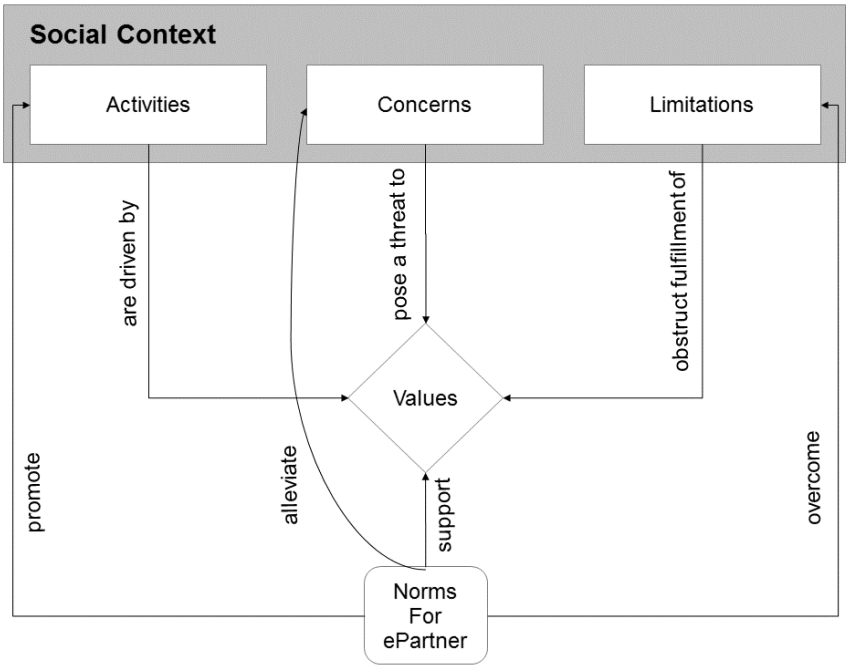

Figure 3.1: Grounded model (from Kayal et al. (2014a))

The model identifies three key elements of the social context of family life: "activities" e.g. visiting family, going to the park, playing outside; "concerns" e.g. anxiety about children going places on their own, children's exposure to the internet; and "limitations" e.g. friends living at a distance, difficulty using certain technologies. We have identified the concept of *values* as central in connecting elements of the social context to norms. According to Cambridge Dictionary, a value is defined as "the importance or worth of something to someone". In his 1973 book (Rokeach, 1973), social-psychologist Milton Rokeach published a now widely used list of values such as family security, freedom and independence, based on a survey he conducted. The connection between norms and values has already been made in philosophy and normative systems literature (Hansson, 1991; Van Wynsberghe, 2012; Manders-Huits, 2011). The idea is that values may be promoted and demoted by norms, which influence agents' choice of actions. An *action* changes an

old situation into a new situation, and if the new situation is better or worse than the old one with respect to a certain value, we say that the action respectively promotes or demotes that value (Bench-Capon, 2003; van der Weide, 2011). Since norms are *action guiding* statements, through obligating or prohibiting actions (Hansson, 1991), norms can be used to influence an agent's behavior to promote or demote certain values. Through annotating user statements in Kayal et al. (2014a) with the values from Rokeach's list which relevant to these statements, were were able to identify the values from that list which we believe are relevant to this domain. Specifically, we found that the following user values were appeared in the annotations at least more than once:

- *Family security:* parents keeping their family members safe and secure.
- *Freedom:* children expressing their desire to have less parental monitoring.
- *Independence:* parents and children expressing their desire that the children be able to do more activities on their own.
- *Friendship:* parents and children alike expressed the importance for the children to build true friendships with their peers.
- *Social recognition:* organized social activities for children (e.g. at school, playgrounds, friends', etc.). Parents and children stressed how social activities and interaction can provide a sense of social achievement or recognition for the children.
- *Inner harmony:* parents' "peace of mind", as opposed to the anxiety typically experienced with the activities that their children have to do away from their supervision.
- *Responsibility:* the importance for children to become responsible when it comes to school, homework, and free time.

3.3. Approach

In the introduction, we highlighted the need for developing social applications while ensuring user involvement throughout the stages of development. In this section we outline our approach in more detail. Our approach is based on the *situated Cognitive Engineering* (sCE) framework (Neerincx and Lindenberg, 2008). Cognitive Engineering (Hollnagel and Woods, 1983) concerns development of practical theories and methods that are *situated* in the domain. Using a situated approach allows for (1) better addressing of the human factors (i.e. human characteristics that influence people's behavior in a certain environment), which in turn leads to a better human-machine collaboration design and (2) a better understanding of the domain of operation. sCE is a Cognitive Engineering framework in which the *iterative* nature of situated user-centered development processes is emphasized.

sCE comprises three main iterative phases: *foundation* – understanding the domain and characteristics of our target group, *specification* – scenarios, technological requirements and claims about the effect of the envisaged technology in the lives of the target group, and *evaluation* of certain aspects of the introduced technology during the cycles of its implementation, such as usability and user interface tests, simulations of certain models, and field testing/evaluation of prototypes.

An overview of how we employed these phases for developing a normative model is depicted in Figure 3.2. We instantiated sCE's foundation phase through development of the grounded model and identification of values as described in Section 3.2 (Box 0). Based on this foundation, we develop the normative model through a series of iterations of specification and evaluation. In this chapter we focus on the first two iterations (Box 1): i) specification of the main elements of the normative model (which we call the *normative concept*, Section 3.4) and evaluation of its expressivity (Section 3.5), and ii) a more detailed specification of the syntax and semantics of the *normative model* (Section 3.6) and evaluation of its usability and usefulness (Section 3.7). Evaluation of the extent to which a location sharing application built on the basis of this normative model provides better support for people's values (Box 2), as well as specification and evaluation of a normative conflict resolution model (Box 3) are subject of future research.

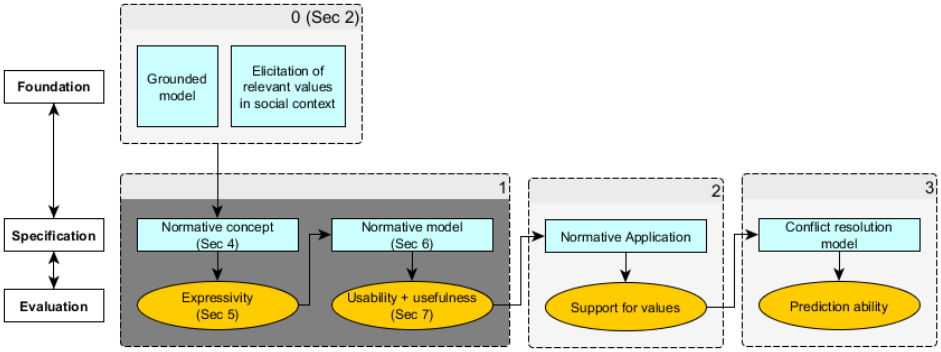

Figure 3.2: Instantiation of the three phases of the sCE framework.

3.4. Specification of the Normative Concept

In this section we present a specification of the normative concept to be used as the basis for developing the normative model. Following sCE, we perform an analysis of possible *scenarios* and corresponding technological *requirements* and *claims* about the effect of the technology. In our case this concerns identification of location sharing scenarios, requirements regarding the elements of the normative concept, and claims concerning the expected fulfillment of values in these scenarios when these requirements would be fulfilled (Section 3.4.1). This analysis is based on the data and grounded model from our previous user study (Kayal et al., 2014a) as summarized in Section 3.2. We analyze to what extent existing location sharing applications already fulfill these requirements and provide support for relevant values (Section 3.4.2). Then we identify the main components of the normative concept with the aim of providing support for values as envisaged (Section 3.4.3).

3.4.1. What should our model be capable of expressing?

We have performed an analysis of the data from our focus groups with parents and children from Kayal et al. (2014a) and identified situations (scenarios) and corresponding normative

Table 3.1: Scenarios, requirements, and claims.

No.	Scenario	Requirements	Claims
1	When a child arrives at a playground, a friend's place, or at school, a parent or friend would like to know this.	x wants y to share their location with them if they arrive at a specific location.	Promotes: *Social recognition* *Friendship* *Family security*
2	In order to keep her children safe, a mother would like to ensure that she or the children's father know when they enter a dangerous area.	x wants y to share their location with them or a third party if they enter a certain place.	Promotes: *Family security*
3	During dinner or homework a parent does not want the child to receive location information from non-family members to preserve family time and quiet time.	x wants y to stop receiving location info from non-family members during certain time periods.	Promotes: *Responsibility* *Inner harmony*
4	A parent may not want to receive location notifications from their child during a time when they are busy.	x does not want to receive too many location notifications under certain conditions.	Promotes: *Independence* *Freedom* *Inner harmony*
5	Parents do not want strangers to know where their children are.	x does not want y's location to be shared with strangers.	Promotes: *Family security*.

statements (requirements) regarding sharing and receiving location information. These requirements can be interpreted as obligations or prohibitions that govern sharing and receiving of data, and can be translated to what users believe should feature in a family location app or platform. In Table 3.1 we describe these scenarios and corresponding requirements, and we identify values they intend to promote.

From these scenarios and requirements we extract the following general elements that a normative model for location sharing applications should allow to express, according to this analysis step.

Social needs In real-life social settings, requirements regarding sharing and receiving data may originate from people in the user's social circle, i.e., from a person different from the user of the application such as a child's parent or friend.

Context Social needs regarding location sharing often concern a specific context describing when data should (not) be shared or received, such as a particular location or time of day.

Duality of data sharing Social needs in the context of location sharing applications may concern both sides of the sharing process, i.e., not only sharing but also receiving data.

Third party association Social needs regarding location sharing may concern a third party, for example a mother requesting a child to share location data with the father, or not to share data with strangers.

Obligations and prohibitions Social needs regarding location sharing can be in the form of obligations (data should be shared or received) or prohibitions (data should not be shared or received). Here we loosely interpret a request *not* to share/receive as a prohibition to share/receive, in line with Meyer (1987). Relating our normative model to formal theories investigating action negation in deontic logic (Broersen, 2004) is a topic for future research.

3.4.2. Comparison with existing applications

We now compare these elements to social and location sharing platforms that are available as of the time of writing. Existing location sharing platforms implement roughly two types of data sharing mechanisms: i) location sharing by means of *active check-ins*, where location data is shared (only) when the user actively does so, such as on Foursquare, Facebook and Twitter, and ii) location sharing by means of *GPS tracking*, where location data is continuously shared once the user agrees to do so and until it is switched off by the user, such as on Life360 and FindMyFriends.

Comparing these location sharing mechanisms with the elements we identified above, we make the following observations. Applications that feature only the possibility for user-initiated check-ins do not accommodate social location sharing needs within the application. This can demote some users' values because i) no check-in is performed at a time where they would like to know where another user is, or ii) because a check-in is performed but not shared with them. The latter can occur when users assign their contacts to custom lists and choose which of their updates are shared with which lists, such as in Facebook. Assume for example that a daughter has a list comprising family members. Then if parents would like to be notified when she is at an unsafe area, it would require the daughter to share all her check-ins with all of her family. This promotes *family security* but may demote her *freedom* because more check-ins are shared with parents than necessary and desired, as well as with other family members. Also it may demote family members' inner harmony because they receive too many check-ins (Case 4 of Section 3.4.1). Please note that in the last case, this kind of oversharing may be avoided by creating a list only consisting of parents, and switching sharing with the list on only when creating a check-in at a dangerous area. However, this is cumbersome and it does not facilitate extensions that require the application to be aware of this social need, for example a functionality that reminds the daughter to check-in or that performs an automatic check-in at a dangerous area.

On the other hand, applications that rely on GPS tracking and continuously share location data do accommodate social needs, but the data is not shared in a context-dependent manner. This may promote family security and social recognition since parents and friends can always find out where a child is (Cases 1 and 2 of Section 3.4.1), but it can demote a child's freedom and independence since their decision to go somewhere has to take into

account that someone else might see this. Some applications such as FindMyFriends do allow limited conditional location sharing, for example by giving permission to share GPS data only within a certain timeframe. Also conditional notification rules can be used to express that user x gets a notification every time user y is at a certain geographical location. However, this typically concerns a context-dependent *notification* to x based on GPS data that has already been shared, rather than context-dependent *sharing* of that data from y to x.

Moreover, existing applications typically focus on providing mechanisms to allow sharing but not receiving of location data (duality of data sharing), and to the best of our knowledge they do not allow to express prohibitions on sharing and receiving data nor third party location sharing needs. This may demote responsibility, for example when a child receives notifications when it is supposed to be doing homework (Case 3 of Section 3.4.1), or family security when a child shares location data with strangers (Case 5 of Section 3.4.1).

In summary, existing location sharing applications implement some aspects we identified, but a comprehensive location sharing model that is grounded in user values and allows to express contextualized social needs has not yet been developed. These limitations come with the risk of negatively affecting user values as a side effect of promoting others.

3.4.3. Components of the normative concept

In this section we make the requirements identified in Section 3.4.1 more concrete by translating them into components of the normative concept. We take as a starting point an existing model from the normative multi-agent systems literature whose elements correspond to some extent with those we identified based on our user study. Specifically we build on the work of Singh (Singh, 1999) on *social commitments (SCs)*. A SC describes an agreement between two parties, namely a *debtor* who is committed towards a *creditor* for bringing about a certain proposition, or a *consequent*, when a certain *antecedent* comes to hold. A commitment can be viewed as the result of an expressed social need, e.g., a parent would like to be informed when a child arrives at school (social need), which can result in a corresponding commitment from child to parent. Being a norm-based model, we use the term "agent" to denote the application that is sharing and receiving information on behalf of the user.

Creditor and debtor The creditor and debtor represent the parties involved in a social commitment, which facilitates expressing social needs. The creditor is a user that makes a request (expresses a social need) to the debtor through its agent for data to be shared or received. For example, in Case 2 of Section 3.4.1, user x is the creditor and y is the debtor.

Normative effect We introduce a deontic normative effect which is either the obligation or prohibition of a certain action. The effect achieved through obligating or prohibiting an action should aim to promote a certain value. For example, in Case 1, the normative effect is "user y is obliged to share their location with user x", and in Case 5, the normative effect is "user y is prohibited from sharing notifications". In specifiying the main elements of the normative concept we abstract from the specific action under consideration, i.e., the duality of data sharing and third party associations. This is further detailed in the specification of the normative model in Section 3.6.

Triggering and expiry conditions To represent the context in which a norm should have an effect, we introduce triggering and expiry conditions. A triggering condition, when true, detaches the normative effect of a social commitment on an agent. For example, in Case 2, if the condition "in dangerous area" is true, the norm triggers the detachment of the normative effect "user y is obliged to share location". A triggering condition is similar to the antecedent of a social commitment in Singh (1999) or the activation condition of a norm as used for example in Kollingbaum and Norman (2003). The expiry condition (Kollingbaum and Norman, 2003) deactivates the normative effect when it becomes true. While in many cases this condition will be the opposite of the triggering condition, e.g. in Case 3, the trigger condition is dinner time starting, and the expiry condition is dinner time ending, some situations may require an expiry condition is not the exact opposite, e.g. the trigger condition is dinner time starting, and expiry condition is a guest leaving the house.

In summary, a social commitment is a tuple $\langle C, D, n, t, e \rangle$ where C is the creditor, D is the debtor, n is the normative effect, t is the triggering condition, and e is the expiry condition.

3.5. Evaluation of the Normative Concept

According to the iterative sCE approach, we evaluated the developed normative concept with members of our target group. The main purpose was to evaluate already at this early stage of development the *expressivity* of the normative concept regarding its ability to express users' normative statements. In addition, we aim to form an understanding of how potential users would use future technology that is based on our concept, as a guideline for the specification phase in the following iteration.

3.5.1. Method

The method we selected for our evaluation is Co-Constructing Stories (CCS) (Ozcelik Buskermolen and Terken, 2012). This is a group interview method that is particularly suited for the evaluation of technology concepts that are still in the conception phase, through allowing potential users to make future judgments about novel design concepts by linking them to their own past or current experiences. Assuming that memories, experiences and thoughts about the future are closely linked, users could make better judgments about novel design concepts if they were able to link them to their own past experiences. Utilizing that concept, CCS aims to generate in-depth qualitative user feedback.

The method consisted of two phases: sensitization and elaboration. In the sensitization phase, users were asked whether they recognize a particular story and were invited to talk about their own experiences in this context. In the elaboration phase the researcher introduces the concept to be evaluated as an additional element to the story, and participants were then invited to tell how they believe the story would play out after the introduction of that element.

These interviews provided us with a corpus of text that could be analyzed for occurrence of normative statements in natural language that pertain to the topic, as well as key elements on how potential users may use the proposed technology.

Figure 3.3: The comic-like storyboards we used in CCS (translated).

3.5.2. Participants and material

A group of 2 boys and 2 girls, aged 8-10, and a group of 4 of their parents, were interviewed separately– the children group first, then the parents group, in a central location in their neighbourhood in a town of approximately 30,000 inhabitants. In each group, two co-constructing stories sessions were held in sequence. The scenarios of each session were identical in both groups. The scenarios were presented with the visual aid of comic-like storyboards (Figure 3.3).

We constructed two scenarios that represented cases where a location sharing application utilizing our model was envisioned to be of potential use, embodying the same values identified earlier, such as family security, social recognition, freedom.

In the first scenario, the sensitizing story was about a girl who was going to school by herself. She was told by her mother to be careful on her way to school. She arrived at school just in time. The story was elaborated to include a handheld smart device, where the mother asked the girl to check-in when she arrives to school, which the girl did.

The second scenario used a sensitizing story of a boy who is bored at home, not knowing that close by, two of his friends were playing outside. The elaborated story introduced a handheld smart device, which allowed the boy to see where his friends were, prompting him to go outside and join them.

3.5.3. Procedure

The CCS-interviews were semi-structured, meaning that interviewees could divert from the questions asked, provided they remained within the general theme of discussion. This type of interview allows for the interviewer to further gather data on users' own ideas rather than merely the specific answers to the interviewer's questions. Each group's interview lasted approximately 30 minutes, i.e. 15 minutes per scenario, in which approximately 5 minutes were spent discussing the sensitizing story, and 10 minutes were spent discussing the elaboration story. First, the sensitizing story was shown as a storyboard, then the discussion was initiated by asking the participants if they recognize that story in their lives. Their answers would lead to follow-up questions to elicit more information about the shape and variation this scenario takes individually for each participant. Afterwards, the elaborating story was introduced on the storyboard, and to stimulate the discussion participants were asked if they would find the introduced technology useful. Their answers would also lead to further questions regarding whether or not they found a certain enhancement useful, and what in specific made such an enhancement perceivably more or less useful.

Approval of the university's ethics committee was obtained before conducting the study, as well as parents' informed consent, and the entire session was audio-recorded to facilitate analysis.

3.5.4. Data analysis and results

The data collected from CCS was approximately one hour of audio discussion, and we transcribed the data for statement analysis.

We first needed to perform a validity check, i.e. verifying whether participants were able to identify with the proposed scenarios, and whether their responses– which included natural language normative statements, were relevant to the concept, domain, and research topic. In the first scenario, both parents and children groups confirmed the difficulty of children going to school without an accompanying adult, discussing possible ways to alleviate that difficulty, e.g. going with other children altogether, having to call home from school when they arrive, or having the school alert parents in case their child did not arrive within a certain period of time. In the second scenario, both the parents and children groups highlighted various ways the children arrange to meet for playdates or other events after school. They highlighted the lack of a reliable way to arrange this, e.g. sometimes they would call their friends' house, or have a parent call one of their friends' parents, or even go to that friend's house without knowing if they are there, or to the playground to see if they can find someone they know by chance.

Secondly, after the validity check, we needed to identify the user statements of a normative form that concern location sharing, and evaluate the capability of our concept model to express them. We found 12 statements of that form, 11 of which our model could express, e.g. first four statements in Table 3.2, while one statement, the last in Table 3.2, contained a triggering event that could not be expressed directly using our normative concept. It cannot be expressed directly because there is no specific triggering condition mentioned in the statement. Based on common sense knowledge one may assume that it means the school should inform the parents when the child is not in school within a certain amount of time after class starts, e.g., five minutes as in Statement 1. However, this is not what the parent expressed in the interview. This illustrates one of the challenges of representing and rea-

Table 3.2: Five out of the participants' twelve natural language statements. The first four can be expressed using our normative concept, while the fifth is inexpressible.

No.	Natural language normative statement	Expression using our concept model
1	Parent: If five minutes pass after the start of school and a child is not in class, the school should call the parents.	⟨Parent, Teacher, Obligation(call parent), Child not in school after 5 mins, Child is in school⟩
2	Parent: my daughter should call me when she reaches school, if she was going by herself.	⟨Parent, Child, Obligation(call parent), Enter school, Leave school⟩
3	Child: sometimes I ($Child_1$) want to play with someone ($Child_2$) but I don't want others to come.	⟨$Child_1$, $Child_2$, Prohibition(send a message to other children), Start playing, Stop playing⟩
4	Child: when I ($Child_1$) get a message from a friend ($Child_2$), then I know they want to play with me. I would find that to be nice.	⟨$Child_1$, $Child_2$, Obligation(send a message to me), Want to play, Stopped playing⟩
5	Parent: the school should inform parents if their child does not arrive to school.	⟨Parent, Teacher, Obligation(call parent), *trigger and expiry components cannot be expressed.*⟩

soning with people's norms in software, namely translating people's intuitive interpretation of social norms to statements that can be interpreted by the technology.

From that, we can conclude that our generic SC-based concept is powerful enough to express the large majority of potential users' behavioral requirements for a location-sharing technology in the domain. Though one of the normative statement was not fully expressible, the simplicity of the conceptual model offers a good compromise for such infrequent shortage of expressive power. Looking more in detail at what these commitments express, we make the following observations.

- *Sharing information about third party:* Statement 1 concerns a SC where the debtor (the teacher) is not the person who's location should be shared, but the commitment concerns location information *about* a third person (the creditor's child). This is different from the third party association identified in Section 3.4.1, which concerns the debtor sharing location *with* a third party. Moreover, the SC concerns information that the child is *not* in school, i.e., negative location information.

- *Triggering and expiry conditions:* A) We observe that they concern a variety of conditions: location of a third person, location of the debtor, as well as activities (playing). B) We observe that the expiry condition is the dual of the triggering condition. C)

Their interpretation can be that the normative effect is detached once as soon as the triggering condition holds (Statements 1 and 2), or that the normative effect applies continually between triggering and expiry conditions holding (Statements 3 and 4).

- *Absence of deadlines:* While deadlines are commonly studied in normative frameworks (Boella et al., 2008; Broersen et al., 2004; Hindriks and van Riemsdijk, 2013), these normative statements do not refer explicitly to deadlines for the normative effect to be achieved. Statements 1 and 2 may be interpreted to specify the deadline implicitly, namely to fulfill the obligation as soon as possible once the triggering condition holds. This can be linked to so-called *optimization norms* as introduced in Ghose and Savarimuthu (2012). Statements 3 and 4 concern continuous detachment of the normative effect inbetween triggering and expiry condition, which does not require a deadline. This can be compared to various types of goals as distinguished in the agent programming literature, for example in Dastani et al. (2011). Further exploring this connection is left for future work.

- *Commitments to oneself:* Statement 3 concerns a commitment where the creditor and debtor are the same person. Such commitments essentially express basic location sharing preferences that can be expressed with lists as in existing applications (see Section 3.4.2), namely that location data should not be shared with certain groups of people.

Additional findings in the CCS data suggested that (1) the possibility of a commitment involving a parent and someone else's child is undesirable, (2) additional communication mediums might be of little use amongst adults, since they are accustomed to using already existing means, e.g. SMS or WhatsApp, for communicating. This points to the need for including certain user *roles or relationships*, e.g. adult or minor, parent or child, to determine the choice a creditor has over creating a commitment. Structures for representing roles and relationships have been developed in work on agent organizations (Dignum, 2004).

In this iteration, we also used roles and relationships to further restrict the list of available debtors. Based on the additional findings in CCS, we removed the possibility of a commitment involving a parent and someone else's child, and restricted the list of available debtors available for adults, so that a parent will only be able to create commitments with their own children as debtors. The list of debtors available for children users included their own parents as well as all other children.

3.6. Specification of the Normative Model

In this iteration of the specification phase we aimed to refine the SC concept into a normative model with a concretely defined syntax and semantics. In Section 3.6.1 we highlight the refinements we make with respect to the normative concept based on our analysis in Section 3.4.1 and the findings from the evaluation described in Section 3.5.4. We further refine this into a definition of the syntax of the normative model (Section 3.6.2), and provide its informal semantics by means of a lifecycle specification (Section 3.6.3)[1].

[1] Providing formal semantics at this point in the research is not required in terms of the evaluation proposed for this iteration (see Section 3.7), and is left for further research

3.6.1. Refining the concept

Creditor and Debtor In the previous iteration, we borrowed the concept of creditor and debtor as the parties involved in the commitment from existing SC literature (Singh, 1999). In this iteration, we made the following two changes. Firstly, for usability reasons we dropped the explicit notion of the creditor in this iteration, since from a user perspective, the creditor is always assigned as the user creating the commitment. Secondly, we placed no restriction in the previous iteration on a user creating a commitment where they also are debtor, i.e., expressing a commitment towards oneself. However since this does not express a social need nor offers additional functionality to basic preference settings in social apps, we restricted the list of available debtors to all users other than the creditor.

Normative effect In the previous iteration, we introduced the normative effect as the core component of a social commitment. For the model to be usable, the parts that compose a normative effect must be precisely defined. Based our analysis in Section 3.4.1 and the CCS data, we define our normative effect component in three parts:

Norm type an obligation or a prohibition of an action;

Action to share or receive data, in this case location information;

Third party the user or user group with whom the location information must or must not be shared, or from whom the location information must or must not be received. The third party's role within a certain commitment is passive, i.e. content shared with them or received from them is entirely determined by the creditor and debtor.

For example, in the normative effect "share location with family", the norm type is an obligation, the action is to share, and the third party would be the user group "family". In the normative effect "not receive location from me", norm type is a prohibition, the action is to receive, and third party is "me", or the creditor themselves.

We do not include the possibility for sharing information *about* a third party for reasons of simplicity, and since we encountered only a single instance of this type in the user data. Although in general such multiuser privacy aspects are important when sharing data on social media (Murukannaiah et al., 2016), in our domain of location sharing in family life they appear to be less prominent.

Triggering and expiry conditions In the previous iteration, we introduced the triggering and expiry conditions as the conditional components of a social commitment. Since the expiry condition was found to be the dual of the triggering condition, for usability purposes we transformed trigger and expiry conditions into one conditional component. According to conditionals in the user statements in Section 3.4.1 and CCS normative statements, we allow these to be one of the following two:

1. A place conditional: triggered by entering a defined geographical area, and expires upon leaving that area.

2. A time conditional: triggered at a specific time and expires at another.

We do not include the possibility for expressing location of a third person, since we also omitted the possibility of sharing information about a third party. Moreover to simplify context recognition, we do not include activities as conditions but introduce a time conditional which may be used to indicate the time period in which an activity takes place, e.g., dinner time. Moreover, while in general one may consider various logical combinations of place and time as conditionals, we do not include this here for reasons of simplicity and since most of the user statements concern atomic conditions.

Roles and relationships Based on the findings from the CCS evaluation, we excluded the possibility of a commitment involving a parent and someone else's child, and restricted the list of available debtors available for adults, so that a parent will only be able to create commitments with their own children as debtors. The list of debtors available for children users included their own parents as well as all other children.

Validity Based on CCS normative statements we introduced two distinct commitment validity options that were found to be useful by our user group. A commitment can either be valid for one instance of normative detachment, i.e. removed after one compliance or violation of the norm, or valid-until-removed, i.e. normative effect may be triggered until commitment is explicitly removed.

3.6.2. Syntax: social commitment grammar

Based on the refinements described in Section 3.6.1, we constructed the following grammar for social location sharing commitments. The sentence in the first line expresses a social need that translates to the corresponding commitment upon acceptance by the debtor, where the creditor is the "I" who expresses the social need.

⟨*commitment*⟩ ::= '`I want`' ⟨*debtor*⟩ '`to`' ⟨*norm type*⟩ ⟨*action*⟩ '`with/from`' ⟨*third party*⟩ '`if`' ⟨*condition*⟩ '`,`' ⟨*lifespan*⟩

⟨*norm type*⟩ ::= '`not`' | ϵ

⟨*action*⟩ ::= '`share location`' | '`receive location`'

⟨*third party*⟩ ::= '`me`' | ⟨*users*⟩ | ⟨*groups*⟩

⟨*users*⟩ ::= ⟨*my parents*⟩ | ⟨*other parents*⟩ | ⟨*my children*⟩ | ⟨*other children*⟩

⟨*my parents*⟩ ::= '`Paul`' | '`Mary`' | ...

⟨*other parents*⟩ ::= '`Lisa`' | '`Peter`' | ...

⟨*my children*⟩ ::= '`Mike`' | '`Claire`' | ...

⟨*other children*⟩ ::= '`Jason`' | '`Jane`' | ...

⟨*groups*⟩ ::= '`friends`' | '`family`' | '`others`' | '`everyone`'

⟨*condition*⟩ ::= ⟨*time period*⟩ | '`he/she is at`' ⟨*place*⟩

⟨*time period*⟩ ::= ‘`between`’ ⟨*time*⟩ ‘`and`’ ⟨*time*⟩

⟨*time*⟩ ::= ‘`00:00`’ | ‘`00:01`’ | ... | ‘`23:59`’

⟨*place*⟩ ::= ‘`home`’ | ‘`school`’ | ‘`park`’ | ...

⟨*lifespan*⟩ ::= ‘`for one instance`’ | ‘`valid-until-removed`’

⟨*debtor*⟩ ::= ⟨*my children*⟩ in the case of an adult creditor

⟨*debtor*⟩ ::= ⟨*my parents*⟩ | ⟨*other children*⟩ in the case of a child creditor

3.6.3. Informal semantics: commitment lifecycle

In this section we informally detail the semantics for our SC syntax through specification of a commitment lifecycle. This lifecycle is similar to the one proposed in Singh and Telang (2012), where formal definitions of semantics can be found. We motivate how a commitment's lifecycle for social location sharing applications deviates from the one proposed by Telang and Singh.

Here we use an example commitment that could be generated with our syntax to illustrate the different states that a commitment could go through in its lifecycle (Figure 3.4): I want *Paula* to *share* her location with *me* if *she is in the park*, *valid-until-removed*. We assume the creditor is Paula's father, and make the distinction between the actions performed by users, i.e. Paula and her father, and their agents. We discuss the various states and transitions of the lifecycle step-by-step– though this discussion remains on a higher abstraction level, informally describing the these states for illustration purposes.

The commitment lifecycle consists of a constructed state (created by creditor), a received state (received by debtor), a rejected state (rejected by debtor), a conditional state (accepted by debtor but not yet triggered), a detached state (condition is met), violation and compliance states (agent complying or violating the normative action at this instance), and cancelled or released state (commitment ended by debtor or creditor). To illustrate given the aforementioned example:

Constructed state The creditor creates the proposed commitment. Since the creditor is Paula's father, Paula is available as debtor. The creditor's agent (Paula's father) sends the (requested) commitment to Paula's agent[2].

Received state Paula receives a commitment request through her agent. For illustration purposes, we assume that Paula has the choice to accept or reject the commitment. If Paula rejects, the commitment's lifecycle ends as it enters the rejected state. If Paula accepts, the commitment enters its active phase, conditional state.

[2]The creditor is permitted to create commitments only with certain debtors as per the grammar in Section 3.6.2, e.g. A parent cannot create a commitment with someone else's child. It is outside of the scope of this research to investigate the complex social dynamics in family-life situations that may impose further restrictions on which parties in terms of permissions to create commitments.

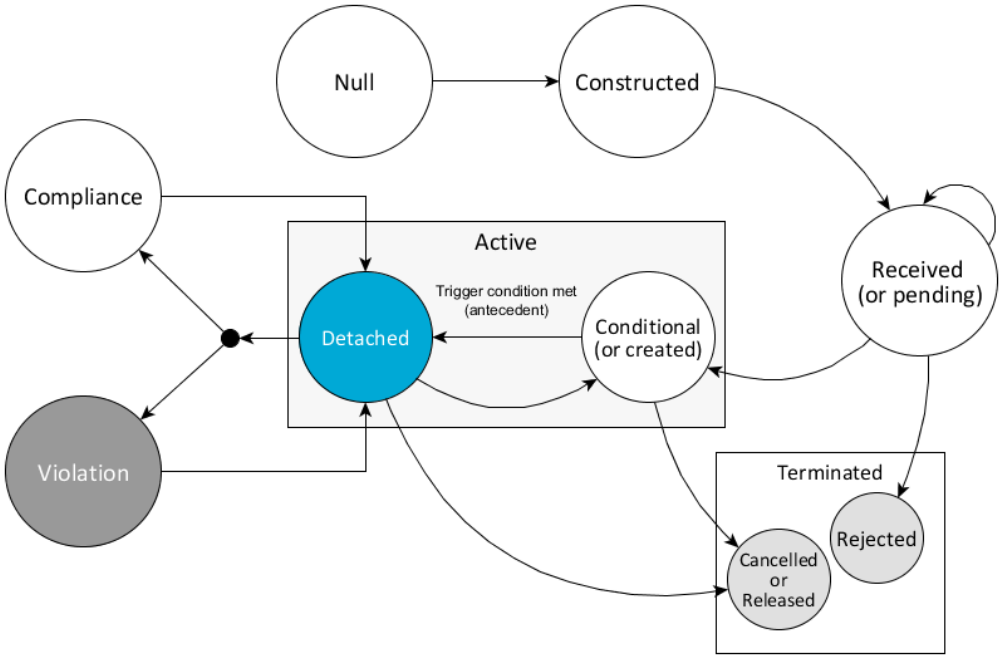

Figure 3.4: The commitment lifecycle.

The "Constructed" and "Received" states are not included in Singh and Telang (2012). Instead, in that paper a commitment transitions directly from "null" to an "Active" state, abstracting from the commitment creation process. We envisage our SC model to be used in an application that supports the process of commitment creation, i.e., where a creditor expresses a social need and the debtor can reject or accept the underlying commitment. In order to model this process, we include these states explicitly in our lifecycle.

Conditional state Without a trigger, Paula's agent is yet to be obligated or prohibited from performing any action. If Paula then enters the park, the triggering condition holds, and the normative effect is "detached" on Paula's agent, taking the commitment to the detached state. Both Paula and the creditor may remove the commitment at the conditional state, which would lead to the cancelled or released state.

Detached state To illustrate this state we need to assume a location sharing application's point of view. Creation of a location object may be automatic, e.g. as in Life360, or may still need an explicit event such as Paula actively performing a "check-in", e.g. as in Foursquare. The nature of the obligated action depends on the type of location sharing application.

If location sharing was automatic, or if Paula performed a "check-in", Paula's agent may share the location info with the creditor reaching a compliance state, or not; reaching a violation state. As this commitment is valid-until-removed, we go directly back to the de-

tached state. Since, depending on the application type, the transition between the detached state and compliance or violation states may not be automatic, Paula and the creditor may cancel the commitment at the detached state. This is a notable difference from Telang and Singh's lifecycle in Singh and Telang (2012), where, the debtor canceling the commitment after detachment constitutes a *violation*. For location sharing applications of the "check-in" type, we can see why it is necessary to distinguish between *violation* and *cancellation of the commitment at a detached state*.

Conditional state, revisited Paula leaves the park, which means that the expiry condition holds. This brings the commitment go back to the "conditional" state. If the triggering condition is met again, i.e. Paula goes back to the park, and since the commitment is valid-until-removed, the commitment would return to the detached state. It is worth noting here that in one-time commitment lifecycles like Singh and Telang (2012), it is not useful to allow the antecedent to become false after it has once become true– compliance and violation are always end states. For our case, and since commitments may be valid-until-removed, the expiry condition "Paula leaves the park" allows the antecedent to be false again without terminating the commitment's lifecycle, allowing for compliance and violation states to be reached more than once in the course of that one lifecycle.

Cancelled or released state We enter this state (1) momentarily if the commitment was good for one instance, and a state of compliance or violation has been reached, or (2) if Paula or the creditor remove the commitment at any state. We follow the terminology in Singh and Telang (2012), using the term "released" if the commitment was removed by the creditor, and "cancelled" if removed by the debtor. Once at this state, the commitment reaches the end of its lifecycle.

Violation and compliance states Preferences in existing social applications are treated as hard rules that the application cannot violate. This does not permit the application to deviate from these rules when necessary, e.g. in emergency situations, which may demote certain user values. Moreover, since commitments may originate from different people in a user's social circle, conflicts amongst commitments might arise which might require the application to choose to violate certain commitments (e.g. Ajmeri et al. (2016)).

In this chapter we do not discuss the consequences of compliance or violation for the debtor. However it is important to make the distinction between these two states in order to allow for further development on the side of the agents' choices to comply with or violate a commitment. A recorded trace of compliance and violation of certain social commitments could, for instance, have effects on future choices, e.g. a child debtor should not be violating a commitment from a parent creditor too often, the validity of the commitment, e.g. why not release a commitment with which a debtor never complies, or the restriction of the creditor's choices in creating a commitment, e.g. based on a high compliance rate from a child debtor, a parent creditor may be viewed as too imposing, etc.

In summary, the main differences between our lifecycle and that of Singh and Telang (2012) are the following:

- *Commitment creation process:* in contrast with Singh and Telang (2012) we model

explicitly the expression of a social need by the creditor and the acceptance or rejection of the corresponding social commitment by the debtor, reflected in the additional "Constructed" and "Received" states.

- *Cancellation of a detached commitment:* cancellation of a detached commitment in our model does not give rise to a violation. This is because our model allows not only one-instance commitments but also commitments that are valid-until-removed, which should be allowed to be cancelled even after their detachment. In the context of location sharing one-instance commitments are satisfied as soon as possible (see discussion on absence of deadlines in Section 3.5.4), which means that cancellation of a commitment inbetween detachment and fulfillment may be expected to occur only rarely.

- *Repeated commitment activation:* since we allow commitments to be valid-until-removed, "Compliance" and "Violation" are not end states. Rather, the commitment returns to the "Detached" state, and if the condition becomes false it returns to the "Conditional" state. In Singh and Telang (2012) these backwards transitions are not included because the authors only consider one-instance commitments.

3.7. Evaluation of the Normative Model

Now that we have a specification of our normative model, we can evaluate it. Our overall aim is to demonstrate that a location sharing application built on the basis of our normative model provides better support for people's values. However, before building such an application and evaluating this (which we leave for future work), we evaluate the normative model's *usability and usefulness*. Evaluating these aspects is important in human-centered design of information technology (Davis, 1989). It provides a baseline check on the appropriateness of the technology under development, ensuring that support for values is not hampered by basic usability and usefulness issues. In this section we describe our approach and hypotheses (Section 3.7.1), the method used to test the hypotheses (Section 3.7.2), we present our results (Section 3.7.3), and discuss to what extent these results support our hypotheses (Section 3.7.3).

3.7.1. Approach and hypotheses

The idea of the envisaged location sharing application is that users can express their social needs through the application. Therefore in order to evaluate our normative model, we created a web-style menu that allows participants to create social commitments according to the syntax presented in Section 3.6.2 (Figure 3.5). The menu allowed users to construct a commitment through selecting a debtor, a norm type and an action, a third party, and a condition. Lifespan was not considered a critical element for what was intended to be a time-constrained evaluation, and was therefore omitted to avoid unnecessary complexity.

Since refinement steps we took in the specification of the model were grounded in user data, we made the following hypotheses:

(1) The majority of users find our SC model representation to be usable.

(2) The majority of users find our SC model representation to be useful for location sharing in family life.

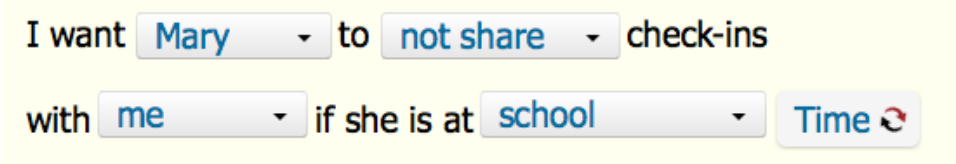

Figure 3.5: A web-style menu representation of the SC model. Commitment shown here was created by selecting debtor *Mary*, norm type *prohibition*, action *share*, third party *me, i.e. the creditor*, and a place condition *school*. The "Time" button could be used to toggle the condition type accordingly.

Additionally, we formulated the following research question:

(3) What effects do the four elements of our SC model representation have on its usability and usefulness?

3.7.2. Method

This was a within-subject, repeated measures study, i.e. participants had to perform multiple tasks dispatched from a common pool in a random order. Factors were the four elements of the web-menu representation. Each split into two subfactors as follows: norm type – obligation or prohibition, action – share or receive, third party – creditor only or any other option, and condition – place or time. This subdivision allowed us to test to what extent these factors affect usefulness and usability.

Task composition and material

To start with, participants were asked to read the text of a scenario of a familiar family life situation. These scenarios contained a location sharing problem that the participant was asked to solve using the web-menu representation. It ended with the participant rating the constructed solution's usefulness in the scenario.

Family life scenarios used in these tasks were based on the following:

(1) User stories: taken from previous qualitative data in Kayal et al. (2014a) and CCS, as well as fairly common situations within the family life domain, e.g. children going to school, a playground, parents taking their children to meet friends.

(2) The elements in the web-menu implementation: norm type, i.e. *obligation* or *prohibition*, action, i.e. *share* or *receive*, third party, i.e. *creditor only* or *any other option*, and condition, i.e. *place* or *time*.

The total number of available tasks we constructed was 16, corresponding to the 16 types of commitments that could be created using the menu. Each scenario contained a storyline from the user stories and a designated solution, i.e. what we believe to be the most suitable commitment for this scenario. The designated solutions covered all 16 commitment types. A scenario contained four to five lines of text on average. These scenarios and their designated solutions are provided in Appendix A.1.

Procedure and measurement

Before solving the tasks, participants viewed a short instructional video which explained the background of the research and the domain of location sharing in family life. Then they had to solve an example task for practicing purposes.

After that, participants solved four tasks, chosen randomly from the 16 available ones. This was done in order to limit the time participants needed to spend on the experiment. Solutions were created using the web-menu representation of our SC model. For each task, after submitting their solution participants rated how it contributed towards solving the location sharing problem in the scenario. For this they used a continuous slider (Figure 3.6), with a no contribution response indicated in the middle of the scale. In the experiment social commitments were referred to as "agreements", and the menu was referred to as the "agreement menu". The contribution rating was used to operationalize *usefulness* of the normative model.

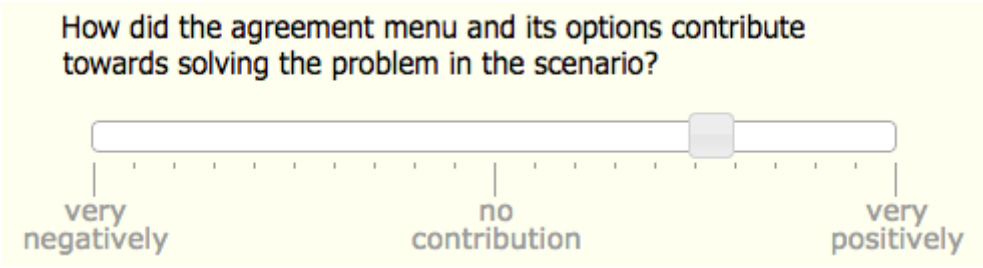

Figure 3.6: The slider used by participants to rate the commitment's contribution to solving the location sharing problem.

Finally, after the four tasks were completed, participants answered the six-item component-based usability questionnaire (CBUQ) (Brinkman et al., 2009). *Usability* was operationalized by perceived usability measured by the CBUQ and the ability for participants to find the designated commitment solution.

Participants and platform

We conducted the experiment through the online crowdsourcing platform Microworkers.com. User studies are increasingly being conducted on the web, and research has shown the web to offer an environment just as powerful as the lab, with data collected online being of at least similar quality to lab data (Gosling et al., 2004) as well as results from the two environments having high congruence (Krantz and Dalal, 2000). Four hundred and twenty participants were recruited. Since participants must be able to read and fully understand the scenarios, participating in the experiment was only open to members living in the US, Canada, UK, Australia, and New Zealand. Participants were compensated in accordance with the regulations of the crowdsourcing platform for tasks requiring a similar effort, which was less than one US dollar per participant. Permission from the ethics committee of the university was obtained prior to conducting the experiment.

To ensure the quality of the participant's responses, every task contained a quality control question, which appeared after the commitment was created. Only participants who had read the scenario in full would be able to, though simply, answer the question. Entries from participants who wrongfully answered the quality control question were omitted and participants were not compensated. Participants were informed about that in advance through our terms and conditions.

Data preparation and analysis

The responses of four participants were omitted due to incorrect answers on quality control questions. The remaining 416 participants solved four tasks each and therefore 1664 tasks in total, provided a usefulness rating after every task, and answered the CBUQ. All statistical analyses were done with SPSS version 22. Reliability analysis for the six items CBUQ showed an acceptable Cronbach's alpha of .92. Therefore the six items were combined into a single usability measure. A one-sample *t*-test with bootstrapping was conducted to compare the usability score with the benchmark value of 5.29 (Brinkman et al., 2009). Binomial tests with a test proportion of .50 were conducted on the percentage of tasks solved using the designated correct solution, across the four tasks as well as the 16 scenarios. One sample *t*-tests with a test value of 5 and bootstrapping were conducted on the average value of participants' rating of the model's usefulness, across the four tasks as well as the 16 scenarios. Generalized Estimating Equations (GEE) analyses were also conducted with both tasks correctly solved and rated usefulness as responses, the four two-level elements of the SC representation as fixed factors, and participant as a random intercept factor, using a linear probability distribution and an unstructured covariance matrix. Data is available online[3].

3.7.3. Results

In this section we present the results of the user study regarding our three hypotheses on usability (Section 3.7.3), usefulness (Section 3.7.3), and the effect of commitment elements on these aspects (Section 3.7.3).

Usability

Usability was measured through the CBUQ and the extent to which participants successfully completed the tasks. The CBUQ rating ($M = 5.75, SD = 1.1$) was significantly higher ($t(415) = 8.7, p < .01$) than the benchmark value of 5.29 established in Brinkman et al. (2009). This shows that the rating was more comparable to an easy to use standard set, than the more difficult to use standard set of interaction components of CBUQ. Results of participants' ability to complete the tasks successfully across the four tasks and the 16 scenarios are presented in Table 3.3 and Table 3.4, respectively. Binomial tests show a significant majority of participants was able to solve the tasks correctly across the four tasks ($p < .01$), and that a significant majority of participants was able to complete the tasks successfully in nine out of the 16 scenarios ($p < .01$). The percentage of correct solutions was below 50% in five of the 16 scenarios. However, none of these five scenarios were found to be significantly difficult to solve.

It must be noted that an "incorrect" solution in this context does not necessarily equal an irrelevant commitment. For example, scenario 16 asked participants to ensure their child does not get alerted with notifications during dinner time, which was given as between 6:30pm and 8:00pm. The designated solution was "I want Mary to not receive notifications from friends between 6:30pm and 8:00pm", however, the solution "I want Mary to not receive notifications from friends if she's at home", popular amongst participants and arguably still relevant to the scenario, was evaluated as incorrect in this experiment.

[3] https://doi.org/10.4121/uuid:d7978b82-a3c4-4ba1-8519-b87a8b90c883

Usefulness

The menu representation was rated as useful by participants across all four tasks (Table 3.3), and all 16 scenarios (Table 3.4), with $p < .01$ in all cases.

Table 3.3: Percentage of tasks correctly solved and rated usefulness.

	n	$Solution_{\%}$	$Mean_{RatedUsefulness}$	$SD_{RatedUsefulness}$
Task 1	416	58.7**	7.8**	2.0
Task 2	416	60.6**	7.8**	2.0
Task 3	416	65.4**	7.9**	2.0
Task 4	416	62.0**	7.9**	2.0

Note $H0_{solution}$: $\mu = 50\%$, $H0_{RatedUsefulness}$: $\mu = 5$, * < .05, ** < .01

Table 3.4: Percentage of tasks correctly solved and rating of usefulness across the 16 scenarios. *O = obligation, F = prohibition, S = share, R = receive, C = creditor only, X = other third party option, P = place, T = time.*

	n	$Solution_{\%}$	$Mean_{RatedUsefulness}$	$SD_{RatedUsefulness}$
Scenario 1 (O,S,C,P)	102	81.4**	8.2**	1.8
Scenario 2 (O,S,C,T)	111	67.6**	7.5**	1.8
Scenario 3 (O,S,X,P)	100	64.0**	8.3**	1.6
Scenario 4 (O,S,X,T)	103	52.4	7.2**	2.4
Scenario 5 (O,R,C,P)	109	79.8**	7.7**	1.8
Scenario 6 (O,R,C,T)	108	49.1	7.3**	2.4
Scenario 7 (O,R,X,P)	98	55.1	6.7**	2.4
Scenario 8 (O,R,X,T)	97	43.3	7.7**	1.6
Scenario 9 (F,S,C,P)	97	75.3**	7.7**	2.1
Scenario 10 (F,S,C,T)	93	77.4**	8.4**	1.8
Scenario 11 (F,S,X,P)	101	44.6	8.0**	1.6
Scenario 12 (F,S,X,T)	98	75.5**	8.3**	2.0
Scenario 13 (F,R,C,P)	130	68.5**	8.0**	1.8
Scenario 14 (F,R,C,T)	107	65.4**	7.8**	2.3
Scenario 15 (F,R,X,P)	95	40.0	8.0**	2.0
Scenario 16 (F,R,X,T)	115	46.1	8.4**	1.8

Note $H0_{solution}$: $\mu = 50\%$, $H0_{RatedUsefulness}$: $\mu = 5$, * < .05, ** < .01

Analysis of the effect of commitment elements on usability and usefulness

Finally, we looked into the effect of four, two-level factors of scenario types – norm type, action, third party and condition – on the user's rating of the model's usefulness. GEE analysis found that tasks involving a sharing action (540 correct and 265 incorrect solutions, or 68%) were significantly easier to complete correctly than tasks involving a receiving

action (486 correct and 373 incorrect solutions, or 57%), with $\chi^2(1) = 22.7$ and $p < .01$, and that tasks involving the creditor only as a third party (602 correct and 255 incorrect solutions, or 71%) were significantly easier to complete correctly than tasks involving other third party options (424 correct and 383 incorrect solutions, or 53%), with $\chi^2(1) = 64.0$ and $p < .01$. Combined main factors also had effects. There was an interaction between norm type and condition ($\chi^2(1) = 48.1, < .01$), action and condition ($\chi^2(1) = 5.1, p = .02$), third party and condition ($\chi^2(1) = 15.9, p < .01$) and norm type, action, third party and condition ($\chi^2 = 6.3, p = .01$)

The analysis also found that users rated the model's usefulness significantly higher in scenarios involving a prohibition ($M = 8.1, SD = 1.9$) rather than an obligation norm ($M = 7.6, SD = 2.0$), with $\chi^2(1) = 34.2$ and $p < .01$, as well as in scenarios involving a sharing ($M = 8.0, SD = 1.9$) rather than a receiving action ($M = 7.7, SD2.0$), with $\chi^2(1) = 9.8$ and $p < .01$. Combined main factors also had effects. There was an interaction between norm type and action ($\chi^2(1) = 7.0, p < .01$), norm type and third party ($\chi^2(1) = 6.9, p < .01$), norm type and condition ($\chi^2(1) = 15.3, p < .01$), action and condition($\chi^2(1) = 6.4, p = .01$), norm type, action and condition ($\chi^2(1) = 30.3, p < .01$), and action, third party, and condition ($\chi^2(1) = 9.3, p < .01$).

Revisiting the hypotheses

Our results show that a majority of participants was able to identify the designated solution across all tasks and the majority of scenarios, and found the elements of the model to be comparable to an easy to use norm set, thus confirming hypothesis 1. Same analysis also showed that users found the model to be useful in the family life location sharing domain, across all tasks and scenarios, thus confirming hypothesis 2. In terms of the third research question, GEE analysis found that constructing commitments becomes more difficult for users when more than two parties are involved, i.e. the third party involving more than just the creditor, and that users found prohibitions to be more useful than obligations within family life location sharing scenarios. The analysis also shows that commitments concerning receiving were more difficult to construct and less useful than those concerning sharing. The interaction effects amongst these factors suggest that they cannot be fully understood in isolation, and that they may have a different impact when used in combination.

3.8. Discussion and Conclusion

This chapter provides two main contributions: 1) a normative model for family life location sharing applications shown to be useful and usable, and 2) a demonstration of how user-centered design can be employed to develop a normative model for social applications. While in recent years we have seen an increase in research connecting normative models and social applications (see, e.g., Osman et al. (2013); Such and Criado (2014); Murukannaiah et al. (2016); Noriega et al. (2016); Kökciyan and Yolum (2016); Fogues et al. (2017)), to the best of our knowledge this is the first time that an iterative user-centered design process has been used to develop and evaluate a normative model for such applications.

Through this approach we have provided a comprehensive location sharing model that is grounded in user values and allows to express contextualized social needs, complementing existing location sharing platforms. The SC model comprises a grammar and a semantics in the form of a lifecycle. The model allows to express social needs in family life location

sharing settings through modelling creditor, debtor, and third party involvement, context information through conditions, and obligation and prohibitions on sharing and receiving location data. The semantics allows for norm violation to occur and accounts for one-instance as well as a valid-until-removed type of SC.

Developing such a model is important because social applications are becoming increasingly complex, and users will need to maintain a good degree of control over their sharing and receiving preferences– yet achieving such control should not be too complex. In this chapter we have shown that SC models can be harnessed to provide a usable, flexible regulatory structure that is applicable to a real-world domain, complementing theoretical work on normative multi-agent systems. This shows the potential of normative frameworks in empowering users into making social media work more to their advantage.

3.8.1. Limitations and suggested improvements

In CCS, a part of the participants overlapped with the participants in our previous work in Kayal et al. (2014a), which limits our ability to claim the expressivity of our SC model.

Due to the nature of online empirical studies, participants in the crowdsourcing study (Section 3.7) were limited to those who were subscribed to the platform, and have chosen to perform the tasks through personal interest. This limits the ability to generalize the results. Moreover, the limited time of effective user participation in such studies required avoidance of too-complex tasks. This meant that we had to refrain from enhancing the grammar in various ways which may have offered additional expressibility to the model, as well as omit lifespan SC element and therefore some aspects of the semantics in the web-menu representation. Moreover, certain demographic information (e.g. age, whether participants were themselves parents, type of area in which they live), were omitted as they do not immediately pertain to the goals of our evaluation, though they may be aspects of interest to further investigate.

However, we demonstrated that the SC representation can be utilized in social applications, and is powerful enough to be useful in its real-world application domain. To the best of our knowledge, this is the first empirical work to demonstrate such results.

Based on this discussion, we propose the following steps to increase the capabilities of the SC model and its representation:

(1) Creating composite conditions:

⟨*commitment*⟩ ::= ‘`I want`’ ⟨*debtor*⟩ ‘`to`’ ⟨*norm type*⟩ ⟨*action*⟩ ‘`with/from`’ ⟨*third party*⟩
‘`if`’ ⟨*conditions*⟩ ‘`,`’ ⟨*lifespan*⟩

⟨*conditions*⟩ ::= ⟨*condition*⟩
| ‘`(`’ ⟨*condition*⟩ ‘`or`’ ⟨*conditions*⟩ ‘`)`’
| ‘`(`’ ⟨*condition*⟩ ‘`and`’ ⟨*conditions*⟩ ‘`)`’

(2) Creating place conditionals that do not refer strictly to the debtor:

⟨*condition*⟩ ::= ⟨*time period*⟩ | ⟨*third party*⟩ is at’ ⟨*place*⟩

⟨*third party*⟩ ::= ‘`me`’ | ⟨*users*⟩ | ⟨*groups*⟩

(3) Integrating more lifecycle and semantics elements in the available menu options, e.g. both one-time and valid-until-removed lifespans, commitments which are not assumed to be accepted by the debtor, and the ability of agents to violate instances of normative detachments within accepted commitments, with the consequential sanctions and rewards.

3.8.2. Concluding remarks and future work

In this chapter we showed that SC models can potentially overcome the limitations in sharing and receiving content that are present in current social media applications, through providing a flexible and easy to use, yet powerful and useful structure that can be implemented within real-world social applications.

The findings in this chapter may lead to a number of possibilities for future work. First, an investigation of the original claim that SC models would provide better support for human values in comparison to currently available, social media preference settings is an important next step– as well as an investigation of the model's flexibility and ease of use with a user group of children. For that we propose a user study with a location sharing app with check-in capabilities, user lists, sharing and receiving preference settings, as well as an implementation of the SC model as proposed in Kayal et al. (2014b). An evaluation can concern a comparison of two versions of the app, one which includes the menu representation of the SC model and one which does not.

Second, several extension of the SC model may be considered, for example composite conditions in which logical combinations of place and time conditions can be expressed, and creating place conditionals that do not refer strictly to the debtor. Moreover, investigating more abstract conditions allowing people to express, e.g., conditions such as "when we're having dinner" or "when she's at soccer practice" may be investigated. Research has already identified frameworks where this may be possible (see Gutierrez et al. (2015)). Moreover, further steps towards a formal definition of the model's semantics could also be of value for researchers in this field.

Third, we envisage conducting an investigation of the possibilities of automatically resolving conflicts amongst commitments. Social commitments do not explicitly prohibit conflicts, and a user may be subscribed to two active commitments that detach conflicting actions. The system's ability to predict a user's preference to the resolution of such conflicts based on contextual information would increase that system's social adaptivity.

4

Socially adaptive electronic partners for improved support of children's values: an empirical study with a location-sharing mobile app

Mobile location-sharing technology is increasingly being used by parents to locate their children. Research shows that these technologies may pose risks to important user values such as privacy and responsibility, while they aim to promote others such as family security. As a solution, we proposed the use of Social Commitment (SC) models for governing the sharing and receiving of data. A social commitment represents an agreement between two people about which data should (not) be shared and received in which situation. We hypothesize that the use of SCs in mobile location sharing applications provides improved support for user values since it allows for a more flexible, context-aware location sharing. In this chapter, we present a user study to test this hypothesis. The study focuses on primary school children ($n = 34$) as the main target group, who's values may be demoted through the use of location-sharing technology. Children were provided with two versions of a mobile location sharing app: one with basic check-in functionality – the basic app – and one augmented with an SC model, which we call a Socially Adaptive Electronic Partner *(*SAEP*). Our findings suggest, among other things that the* SAEP *would provide improved support for children's values compared to the basic app.*

This chapter is based on "Socially adaptive electronic partners for improved support of children's values: an empirical study with a location-sharing mobile app", currently under review.

4.1. Introduction

4.1.1. Motivation

Social media applications have become an integral part of our interaction. Platforms such as Facebook, Twitter, and Instagram are consistently gaining new users, sharing content such as text, photos, videos, and location information. In this chapter we are specifically interested in the latter. Examples of existing location sharing mobile applications are Life360, Glympse, and wearables such as KizON. These can be used for providing what we call *socio-geographical support* for families with children in primary school age, i.e. between six and twelve years. Socio-geographical support includes assisting children in exploring their environment, through e.g. helping them go to school on their own, make new friends, and participate in neighborhood events and playdates, as well as increasing parents' awareness of the location of their children.

However, research in value-sensitive design and ethics of technology (Czeskis et al., 2010; Nihlen-Fahlquist, 2013) shows that such location sharing technology may pose risks to important user values while it aims to promote others– for example, trying to promote a child's safety through allowing parents to see where their children are at all times, may pose risks to children's privacy and independence.

This chapter builds on previous research we conducted to address this issue: an exploration of the values and social context relevant to the family life domain (Kayal et al., 2014a) and an introduction of the idea of using Social Commitment (SC) models to govern the sharing and receiving of data in mobile location sharing applications (Kayal et al., 2014b), complementing traditional social platforms' preferences. SC models were proposed by Singh (Singh, 1999, 2008) to describe a commitment between two parties in a socio-technical system, namely a *debtor* who is committed towards a *creditor* for bringing about a certain proposition, or a *consequent*, when a certain *antecedent* comes to hold. For example, a commitment between a father Bob and his daughter Alice could be that Alice should share her location with Bob when Alice is at the park. We showed how SC models can be used to create commitments for sharing and receiving data in mobile applications through a case study of location sharing in the family life domain.

We refer to such applications that can take into account commitments from people in the user's social context as *Socially Adaptive Electronic Partners* (SAEPs), following the vision outlined in van Riemsdijk et al. (2015a). Based on research in ethics of technology (Nissenbaum, 2010) we expect that SAEPs will provide improved support for user values since the use of SCs allows for a more flexible, context-aware data sharing. In this chapter we aim to test this hypothesis. In addition, inspired by research in persuasive technology (Sra and Schmandt, 2013; Fogg, 2002) we aim to evaluate the technology in two functional roles, namely as a *tool* – focusing on usability, and as a *social actor* – addressing the extent to which the technology creates a relationship with the user. The latter is especially relevant for technology that is envisaged to form a partnership or act as a teammate to its user (de Greef, 2012; Kayal et al., 2014a; Breazeal et al., 2004; Klein et al., 2004), which is the case for SAEPs. We expect that users will evaluate a SAEP more positively as a tool and as a social actor since SAEPs provide support that is more tailored to the user and the user's social context.

In this chapter we present a user study to test these hypotheses in the domain of mobile location sharing in family life. The study focuses on primary school children ($n = 34$) as

the main target group who's values may be demoted through the use of location-sharing technology. Children were provided with two versions of a mobile location sharing app: one with basic check-in functionality – the basic app (BA) – and one augmented with an SC model, the SAEP. Our results suggest that children expect (1) that the presence of a mobile location sharing app would positively support their values, and that they perceive the technology positively as a tool and as a social actor; and (2) that the SAEP would provide improved support for children's values compared to the BA, i.e., the version of the app without an SC model, and that they perceive the SAEP more positively as a tool than the BA.

In the remainder of this section we present the necessary background information in research areas related to this chapter, a domain analysis of family life, and proposed hypotheses. In Section 4.2 we describe the research method and procedure in detail, including the socio-geographical support application. We present our results and discussion in Sections 4.3 and 4.4 respectively.

4.1.2. Background

Values and Norms

A value is defined in the Cambridge Dictionary as "the importance or worth of something to someone". Within the academic world, Rokeach (Rokeach, 1973) published a surveyed list of human values that has become widely used; the list included 18 terminal values, i.e. end states of existence, such as social recognition, freedom, family security and a comfortable life, and 18 instrumental values, i.e. means of achieving terminal values, such as ambition, self-control and honesty.

Taking into account values when designing new (software) technology is necessary in order to account for what is important to different users and stakeholders (Czeskis et al., 2010; Denning et al., 2010; Yoo et al., 2013; Woelfer and Hendry, 2011; Munson et al., 2011). The research area of Value-Sensitive Design in particular has developed tools and methods for identifying stakeholders, eliciting their values, and translating these values into concrete design requirements (van de Poel, 2013; Friedman, 1996).

Research in philosophy and normative systems (Bench-Capon, 2003; van der Weide, 2011; van de Poel, 2013) as well as our previous empirical research (Kayal et al., 2014a) shows that values can be promoted, i.e. further fulfilled, and demoted, i.e. placed at risk, by norms. Norms are *action guiding* statements, i.e. obligating or prohibiting actions (Hansson, 1991), for example, one should not cross on red, or one should greet people when entering a room. An action changes an old situation into a new situation. If the new situation is better or worse than the old one with respect to a certain value, we say that the action respectively promotes or demotes that value. Therefore, norms can be used to influence behavior to promote or demote certain user values.

Socially Adaptive Electronic Partners (SAEPs)

The key idea underlying SAEPs is that this technology will be able to provide improved support for user values if it can *adapt* its behavior to people's diverse and evolving norms *at run-time* (van Riemsdijk et al., 2015a). Frameworks for representing and reasoning about norms have been extensively investigated in the area of *normative multi-agent systems* (Andrighetto et al., 2013). Norms can exist as guidelines for the behavior of humans in society, and similarly, can be used to regulate the behavior of software entities. A Social Com-

mitment (Singh, 1999, 2008) can be viewed as a kind of norm that in its representation emphasizes "directedness" in the sense that the parties involved in the commitment (i.e. debtor and creditor) are explicitly represented.

In our previous work (Kayal et al., 2014b) we have projected this research on social commitments in multi-agent systems to the context of data sharing in social platforms, with a particular focus on location sharing in the family life domain. As part of that research, we have developed a smartphone app[1] that allows users (in particular parents and children) to create commitments with one another regarding sharing and receiving of location data. The app shares and receives location data in accordance with the commitments that the user has subscribed to. The SC model and interface of this app form the basis for the research we describe in this chapter.

The development of the concept of a SAEP was also inspired by research on Electronic Partners (or *ePartners*), which are defined as "computerized entities that partner with a human and share tasks, activities, and experiences" (de Greef, 2012). An ePartner differs from traditional software in the sense that it functions not only as a tool, but also as a social actor. An ePartner can for example support its user by receiving information regarding the user's cognitive task load, and adaptively automating some of their tasks, to keep their cognitive load at an optimal level. ePartners have been investigated in various critical application domains such as simulated space missions (van Diggelen and Neerincx, 2010), naval command and control (Arciszewski et al., 2009), and virtual reality exposure therapy (Paping et al., 2010). SAEPs can be viewed as a type of ePartner that supports its user through understanding the norms that govern social interaction between human users and acting on these norms within the social context in which it operates.

4.1.3. Values in family life

In Kayal et al. (2014a), qualitative user studies and data analysis identified several categories of elements that make up the social context of the family life domain (in specific, families with children between 6-12 years of age, based in the a town of approximately 30,000 inhabitants in the Netherlands). These categories were "activities" e.g. visiting family, going to the park, playing outside, "concerns" e.g. anxiety about children going places on their own, children's exposure to the internet, and "limitations" e.g. friends living at a distance, difficulty using certain technologies, etc. The analysis also found that many of the transcribed user statements, discussing the elements of these three categories, can be directly linked to certain user values. Using Rokeach's terminology, the most relevant values and their context within the domain were identified[2] as:

- Family security: parents keeping their family members safe and secure.
- Freedom: children expressing their desire to have less parental monitoring.
- Independence: parents and children expressing their desire that children do more activities on their own.
- Friendship: parents and children alike expressing the importance for the children to build true friendships with their peers.

[1] A 3-minute tutorial video (with subtitles) can be viewed at `http://bit.do/ePartner`.
[2] see Section 3.2 for method

- Social recognition: organized social activities for children (e.g. at school, playgrounds, friends', etc.). Parents and children stressed how social activities and interaction can provide a sense of social achievement or recognition for the children.

- Inner harmony: parents' "peace of mind", as opposed to the anxiety typically experienced with the activities that their children have to do away from their supervision.

- Responsibility: the importance for children to become responsible when it comes to school, homework, and free time.

This analysis was corroborated with research findings in Czeskis et al. (2010); Nihlen-Fahlquist (2013), which highlight the importance of a similar set of values in this domain. To illustrate how location sharing commitments may promote or demote certain values, consider the following commitment:

1. Peter (Mary's father): "I want Mary to share her location with me between 7:00am and 9:00pm."

obligates a location sharing action which would arguably promote the value "family security". Moreover, the following commitment:

2. Peter: "I want Mary to not share her location with me if she's at school."

prohibits an action in a manner that would arguably lead to the promotion of the value "independence".

4.1.4. Hypotheses

Based on the research discussed in the previous subsections, we propose that the presence of a location sharing app (in general) would positively contribute to children's values, and would be perceived positively as a tool and as a social actor. Moreover, we propose that a version of the app augmented with an SC model, i.e., the SAEP, will contribute *more positively* to children's values, and be perceived more positively as a tool and a social actor than the version without an SC model, i.e., than the basic app (BA). This is formulated in the following hypotheses:

- H1: children expect that the presence of a location sharing app in their life will have a positive effect on each of their values individually.

- H2: children perceive a location sharing app positively as a tool (H2a) and as a social actor (H2b).

- H3: children expect that the SAEP will provide better support for the individual values than the BA, the location sharing app without the SC model.

- H4: children perceive the SAEP more positively as a tool (H4a) and more positively as a social actor (H4b) than the BA, the location sharing app without the SC model.

4.2. Method

4.2.1. Experimental design

The experiment had two conditions and a within-subject design. To avoid an order bias, the order was counter-balanced: in a first session, half the participants tested the app version without the SC model (BA), while the other half tested the version with the SC model (SAEP). In a second session, app versions were interchanged between the two groups. Approval for the user study was granted by the university's ethics committee.

4.2.2. Participants

Thirty-four children, six to eleven years of age ($M = 8.6, SD = 1.4$), participated in this user study. Twenty-eight of the participants were female, and six were male. Participants were found through personal connections with day-care centers (Dutch: *buitenschooolse opvang* or *BSO*) in the province of South-Holland in the Netherlands. The participants came from three different BSOs, eight, twelve, and fifteen participants from the first, second, and third BSO respectively.

4.2.3. Material

Please note that the original language of all material used by participants and described in this section is Dutch. Depictions are translated into English.

Application

The app ran on the Android platform and it permitted its users to share *check-ins* in certain locations with other users of the system, similar to applications such as Swarm and Facebook.

Two versions of the app were developed. One of the two versions included an additional feature based on the SC model representation.

Version without the SC model (BA) The BA was modeled after the behavior and capabilities of currently available social applications. In this version, participants could place other participants of the system in one of two lists (*family* or *friends*) or in neither, in which case the application would place them in the list *others*. Participants could select with which lists they share their check-ins (Figure 4.1), and from which lists they received check-ins. Participants could place or remove other users from either list, and change sharing and receiving preferences at any time. Participants could at any time see, through an event log, the last five check-ins that were visible to them.

Participants could create locations in two ways: (1) through selecting a specific point, corresponding to a GPS position on an integrated Google map, and then assigning to it a name of their choice, and (2) through detecting the current position automatically if a GPS signal was available, and then assigning a name. In both cases, a location is added to a list of available user locations, defined by a name, a GPS position, and a square area of a side length of 50 meters centered around that GPS point. Locations could be removed by the user at any time.

If a participant wanted to check-in (Figure 4.2), the list of locations that fell within a radius of 300 meters (according to the currently detected GPS position) would be displayed,

with the option of adding a location using the second method described above, in case the current location was not yet on the list. The participant could then select a location, and confirm their check-in, which would be shared with the participants that belong to the lists with which the first participant was sharing, according to their settings. Participants with whom this check-in is shared would get a pop-up with the sharer's name and location information, viewable also on an integrated Google map, assuming they had selected to receive check-ins from the list to which the sharer belongs. An "event log" was available, that showed a participant's own latest check-in information, as well as the five most recent check-ins seen from others.

Version with the SC model (SAEP) This version contained all the features in the BA, and additionally included a "commitment" menu as described in Kayal et al. (2014b), which can be represented using a grammar of the form:

⟨*commitment*⟩ ::= '`I want`' ⟨*debtor*⟩ '`to`' ⟨*norm type*⟩ ⟨*action*⟩ '`with/from`' ⟨*third party*⟩ '`if`' ⟨*condition*⟩.

A user (creditor) could create a commitment with another user (debtor) consisting of a specific normative action, i.e. to (or to not) share or receive a check-in from one or a number of users (third party), if a certain condition, based on time or geographical location, was active.

For example, Bob could create the following commitments: (1) I want Paula to share her check-ins with me if she's at the park (Figure 4.3), and (2) I want Paula to not receive check-ins from the list "friends" between 18:00 and 21:00. In commitment (1), Bob is creditor, Paula is debtor, sharing check-ins is the normative effect, and entering and leaving the park are the triggering and expiry conditions. In commitment (2), Bob is creditor, Paula is debtor, not receiving check-ins is the normative effect, and the times 18:00 and 21:00 are the triggering and expiry conditions.

When the creditor creates a commitment, it is sent to the debtor, who can either directly accept it, or "decide later". In case the latter was selected, the debtor can later decide whether to accept or reject the proposed commitment. Users can, at any time, review the list of commitments they created or received, delete commitments they created or received, and accept received commitments that are still pending. A user action such as accepting or deleting a commitment notifies the other user involved with that action.

Conflicts between basic preferences and an accepted, active commitment were solved in favor of the commitment. For example, if Bob was in Paula's family list, and Paula opted in her basic preferences to "not share check-ins with family", accepting commitment (1) above meant her check-in would be shared with Bob if she entered the park. Similarly, conflicts between two accepted, active commitments would be solved in favor of the commitment most recently accepted.

Participants could access two sub-menus for sent and received commitments respectively, which showed commitments already accepted and commitments that still required a decision, with the possibility to make a decision within these sub-menus.

Figure 4.1: Selecting which lists of users can see your check-ins (translated from Dutch).

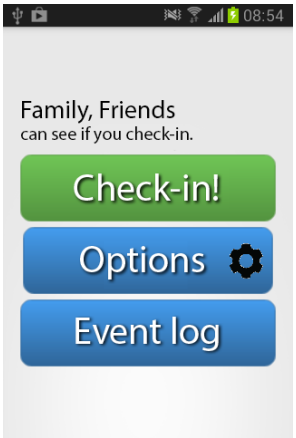

Figure 4.2: The main screen in the app, showing the check-in button (translated from Dutch).

Figure 4.3: Commitment (1) as it appears on the app (translated from Dutch).

Mobile devices

During testing sessions, every participant was in possession of a Samsung Galaxy S6310 with one of two version of the app installed. The devices were running Android version 4.1.2. All other apps were disabled.

Mission cards

To engage children with the functionalities of the apps during the time-limited test sessions, 37 "mission" cards were created (Figure 4.4). Every mission card had a unique number and contained a short, interactive task for a child to perform. The missions were categorized as follows:

- Of the 37 missions, 17 were instructional, i.e. directly asking the child to perform an action on the app(s), and the remaining 20 were simulated life situations, i.e. contained an interactive scenario where the app's usage could be of benefit.
- Of the 17 instructional missions, six tasks were created to assist children in learning to use the SC menu.
- Of the 37 missions, 21 required the child to go to a certain location within the BSO.
- Of the 37 missions, 11 required offline interaction with another child.
- Of the 37 missions, 17 could be completed similarly using both versions of the app, while the remaining 20 had additional solutions utilizing the SC menu available in the SAEP version.
- Out of 20 missions with additional SC menu solutions, five required an obligation to share, five required a prohibition to share, five required an obligation to receive, and five required a prohibition to receive. Conditions, i.e. place and time, were also distributed equally amongst the 20 missions.

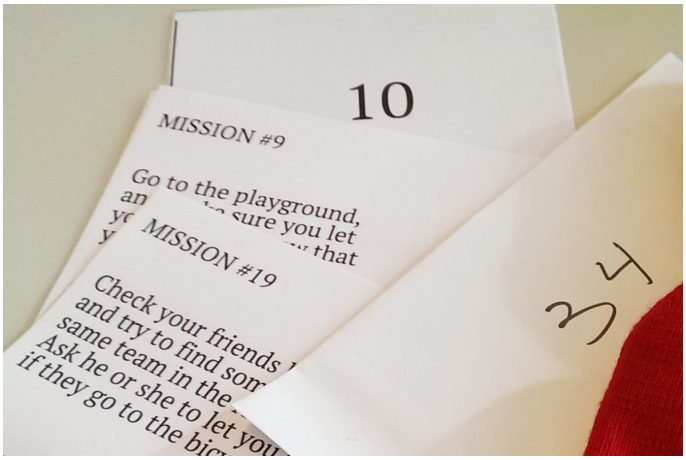

Figure 4.4: Mission cards (translated from Dutch).

The missions used in one of the BSO locations[3] can be found in Appendix A.2, translated to English from Dutch, the original language.

Instructional videos

Two instructional videos were created. The first video was an app tutorial, showing examples of all features of the version without the SC model. No mention of the SC menu was included whatsoever in this part; to avoid creating bias in the group testing the BA in the first session. The second video included instructions that help children understand and answer the post-session questionnaires.

4.2.4. Measurement

Fulfillment of domain-relevant values

To the best of our knowledge, questionnaires to measure how far certain user values are fulfilled, especially children's values, were not available for the domain. We therefore needed to design a questionnaire that could, to am extent, measure how fulfilled are the seven relevant values we identified earlier, in the lives of our user group.

Due to the aforementioned lack of literature on the subject, we initially established a list of 24 questionnaire items based on the tree nodes resulting from grounded theory analysis in Kayal et al. (2014a). These items dealt with issues such as going to school or visiting friends and family, playing with friends and playdates, self-efficacy while going to places on their own, permissions to do activities on their own, amongst others.

To determine which items would be included in the final questionnaire, a content validity analysis (CVA) (Brinkman, 2009) was performed, with the assistance of a panel of 11 experts in value-sensitive design and human-computer interaction.

Members of the panel were provided with detailed context information regarding the values and the domain. Their task included filling a table where rows represented the 24

[3]The mission cards used in the other two locations only differ in room names.

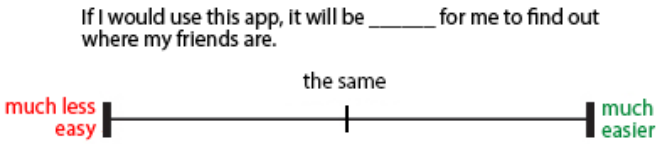

Figure 4.5: An example of one of the questionnaire items (translated from Dutch).

questionnaire items, and columns represented the seven values discussed in section 4.1.3. To fill the table, a panel member rated how useful every questionnaire item would be to measure the fulfillment of each value– the instructions provided three possibilities: "essential", i.e. that this item is essential to measure the fulfillment of that value, "useful", i.e. helpful but not necessarily essential, or "unrelated", i.e. this item cannot measure the fulfillment of that value.

All members of the panel provided their response. According to the method in Brinkman (2009), an item was added to the final questionnaire if a significant majority of the panel, including a *chance margin*, rated the item at least as "useful"– for a panel of 11 members, a significant majority with a chance margin required at least nine out of the 11 members to rate an item at least as "useful". This process resulted in 19 out of the original 24 items being included in the questionnaire. Every one of the seven values had a least one related item in the questionnaire: five items scored sufficiently to measure social recognition, four for freedom, seven for friendship, 11 for independence, two for family security, two for responsibility, and one for inner harmony.

These 19 items were then re-written in a form that would allow children to determine, on a continuous scale, the expected effect of the app on their values were they to use it in the future. For example, the item

"I can easily find out where my friends are".

was re-written as

"If I would use this app, It will be [blank space] to find out where my friends are".

Followed by a continuous line below, labelled "much less easy" on the left end, "much more easy" on the right end, and "the same" in the middle, see figure 4.5.

The fulfillment of each value was measured through taking the average score of the items that measure its fulfillment according to the panel.

Influence as a tool and a social actor

Influence as a tool was measured in two ways: (1) perceived usability, using two items from the System Usability Scale (Brooke, 1996), and (2) behavioral sampling, i.e. recording the codes of body posture and engagement of participants at regular intervals. The codes used were divided into negative and positive. The negative codes (i.e. passive, bored, frustrated, sad) were obtained using a part of the coding scheme used by Markopoulos et al. (2008). The scheme does not include positive codes, therefore the antonyms of the negative codes (i.e. engaged, excited, confident, happy) were used for the positive part of the scheme.

Influence as a social actor was measured using the average of four constructs based on a formal model of social relations for artificial companions (Pecune et al., 2013), namely (1) liking, (2) trust, (3) dominance (reversed) and (4) intimacy. Liking was operationalized

using three items from the attitude section in the original Unified Theory of Acceptance and Use of Technology model (Venkatesh et al., 2003). Trust was operationalized using five items from the same model's enhanced edition, with "trust" included (Gefen et al., 2003). We then created one item for dominance and one item for intimacy. When needed, items were written or reworded in a manner suited to the age of participants.

Similar to the values part of the questionnaire, every item in the tool and social actorship part was followed with a continuous line with a negative caption on the left end, a positive caption on the right end, and a neutral one in the middle. For the entire questionnaire, the assigned numerical values ranged from zero for the most negative to ten for the most positive, and five for the neutral, halfway point. The full questionnaire can be found in Appendix A.3, translated to English from Dutch, the original language.

4.2.5. Procedure

Earlier preparation

A pilot study with two children aged seven and eight, including testing the app as well as answering the questionnaire was conducted to assess the ability of similarly aged children in effectively using the app as well as understanding and answering the questionnaire items. The pilot consisted of a short usability study where children successfully performed tasks such as check-ins, adding a user to the friends or family list, creating a location on the Google map, and creating one sharing and one receiving commitment with another user. Later, both children (and their parents) used the app (installed on a mobile device we provided) at home for two weeks. At the end of the two week period, children successfully answered the questionnaire we developed with little or no assistance from their parents. The outcome of this pilot study corroborated the data analysis in our earlier work in Kayal et al. (2014a), validating the ability of children of this age to perform the tasks required for this user study.

Introductory session and preparation

For every BSO, a short introductory session was held one week before the first testing session. During the introductory session, the researchers were introduced to the participating children, and the tutorial video was played. All questions regarding the video and the app's functionalities in general were answered. The children's nicknames and age data was collected, as well as the location names within the BSO. Finally, the signed parental consent forms earlier distributed to the parents through the BSO's employees were collected. Usernames for the participating children and six location objects were created after the end of the session, to be available in the app for the testing sessions. Participating children were split into two groups, each testing a different version of the app and switching the following session as earlier discussed. Children had only members of their own group available in the user list, because children testing the SAEP must not be able to create commitments with children testing the BA.

Testing sessions 1 and 2

A testing sessions lasted approximately one hour, with a period of one week between the two sessions. This procedure was conducted similarly during both testing sessions. First, the researchers distributed the mobile devices to the children. Numbered hats of two different colors were distributed, making it easier for the children to distinguish the members

of each group, and for the behavioral sampling observer to identify the participant. The 17 instructional mission cards were placed in a box. Every child picked one of the cards, attempted to perform the task, and returned to replace the card with another one. These relatively simple missions were dispatched first to alleviate the learning curve, including the usage of the SC menu for the relevant group, a feature that was not explained in the introductory session. Fifteen minutes into the testing, the remaining 20 missions were added to the pile. At approximately one hour of testing time, the cards were collected from the children and no new cards were handed out. Children were shown the video which contained instructions on answering the questionnaires. Children filled the questionnaires and handed them to the researchers. Researchers were available to assist participating children with technical issues relevant to the app when present, and to explain any questionnaire item children found difficult. During a testing session, one of the researchers recorded, at regular intervals of approximately seven minutes, the behavior of every child at the designated six locations within the BSO[4]. At the end of each session, mobile phones, hats, and mission cards were collected by the researchers.

4.2.6. Data preparation and pre-analysis

Thirty-one out of the 34 children participated in both testing sessions. The value of each questionnaire item was measured with a ruler (continuous scale with zero on the extreme left to ten on the extreme right, and a granularity of 0.1), and was digitally stored. Values of the items that had negative captions were reversed. The behavioral sampling data from all 34 children, including the three who participated in only one session, was also digitally stored in longitudinal form, and the codes were enumerated into 1 for positive codes, and -1 for negative codes

The "numerical value" of each of the seven user values earlier identified (i.e. family security, freedom, independence, friendship, social recognition, inner harmony, and responsibility) was calculated for every participant, using the average of the related questionnaire items. That numerical value was calculated once for the BA version and once for the SAEP version. The average of both versions for each of the seven values was also calculated.

The values "social recognition" and "freedom" were measured by sets of items entirely contained within the sets of items measuring "friendship" and "independence", respectively. We therefore decided to drop the notion of "social recognition" and "freedom" as separate values. The values "inner harmony" and "responsibility" were measured with only one item, and were subsequently dropped from the list of values. Three values remained, namely "friendship", "independence", and "family security". Family security was split into its two items, i.e. the child's beliefs about (1) parents worrying about their child going to school on their own (FamSec 1), and (2), how well can parents know exactly where they are (FamSec 2).

All of the following statistical analyses were done using R version 3.2.1. An internal reliability analysis was conducted on values and social actorship factors that were measured by more than three items. If Cronbach's α was unsatisfactory for one or both of the two versions, we iteratively removed the least correlating item, until an acceptable α was reached for both versions. Table 4.1 shows the number of items and α values before items were

[4]This time interval was selected as the researcher required approximately seven minutes to perform one round of observation within a BSO.

removed, and table 4.2 shows the number of items and α values after the final iteration. Items which were removed during this process are highlighted in Appendix A.3.

Table 4.1: Internal reliability analysis before items were removed.

Item	α	
	BA ($WithoutSC$)	SAEP ($WithSC$)
Values		
Friendship (7 items)	.86	.75
Independence (11 items)	.7	.4
Social actorship		
Trust (5 items)	.75	.61

Table 4.2: Internal reliability analysis after items were removed.

Item	α	
	BA ($WithoutSC$)	SAEP ($WithSC$)
Values		
Friendship (7 items)	.86	.75
Independence (7 items)	.73	.69
Social actorship		
Trust (3 items)	.86	.77

To examine the app's effect on values, value items, perceived usability, and its influence as a social actor, one-sample t-tests with $\mu = 5$ were conducted on the averages of individual values (and value items), perceived usability, individual social actorship factors, and social actorship overall. To compare the two versions (i.e. the BA and the SAEP), in terms of their effect on values, value items, perceived usability, and their influences as social actors, paired t-tests were conducted for individual values (and value items), perceived usability, individual social actorship factors, and social actorship overall.

To examine the app's effect on children's body posture and engagement, overall as well as between the two versions, two linear mixed-effects (LME) models were created in R using the *nlme* (Pinheiro et al., 2015) package:

(1) A baseline model $Model_{baseline}$, with behavioral sample as a response variable, random intercepts for BSO and participants (a nested structure, participant inside BSO), using an AR1 correlation matrix and maximum likelihood (ML) as an estimation method.

(2) An updated model $Model_{updated}$, which includes a fixed effect of the app version as an add-on to $Model_{baseline}$.

4.3. Results

Table 4.3 suggests that the app significantly supports all individual values and value items measured: friendship, independence, and FamSec 1 and 2. In all these cases, the value was rated above the neutral cutoff point of 5 of the scale (Figure 4.5). Similarly, table 4.4 suggests that the app's perceived usability and social actorship were significantly positive, as well as the social actorship items of liking, and trust, while dominance was significantly below the neutral cutoff point.

Table 4.5 suggests that the SAEP supported the values friendship and independence significantly better than the BA, while no significant difference was found for FamSec 1 and 2.

Table 4.6 suggests that the perceived usability of the SAEP was significantly higher than the BA, but no significant difference was found for social actorship nor individual social actorship items.

Table 4.7 shows the frequency of positive and negative behavioral codes for each version.

$Model_{baseline}$ showed that the fixed intercept was significantly above 0, ($b = .76, p < .001$), suggesting that on average, the body language and engagement observed were more often positive than negative.

Comparing $Model_{baseline}$ with $Model_{updated}$, which included the app's version as fixed effect, suggests that adding the app's version as a predictor had a significant effect, with $\chi^2(1) = 49.0, p < .001$ and $R^2 = .2$.

Table 4.3: Mean and SD for individual values for the app in general, i.e. average of the BA and the SAEP.

	$M(SD)$
Friendship	7.1(1.4)**
Independence	6.4(1.4)**
Family security	
FamSec 1	6.3(1.8)**
FamSec 2	7.7(2.1)**

Note $H0: \mu = 5$, * $p < .05$, ** $p < .01$

4.4. Discussion and conclusion

4.4.1. Hypotheses

The analysis suggested that children in this experiment expect the presence of a location sharing app to positively contribute to their values of friendship, independence, and family security (confirming H1), and that they perceive the app positively both as a tool (confirming H2a) and a social actor (confirming H2b). Analysis also suggested that children in this experiment expect a version of the location sharing app enhanced with the SC model, the SAEP, to provide significantly better support for their values of friendship and independence than the BA, but no significance was found for family security items (partially confirming

Table 4.4: Mean and SD for perceived usability, individual social actorship factors, and social actorship overall, for the app in general, i.e. the average of the BA and the SAEP.

	$M(SD)$
Usability	7.7(1.7)**
Social actorship	7.4(1.3)**
Liking	8.6(1.3)**
Dominance	1.9(2.3)**
Trust	6.6(3.2)**
Intimacy	6.1(3.1)

Note $H0 : \mu = 5$, * $p < .05$, ** $p < .01$

Table 4.5: Mean and SD for individual values, for each of the two versions.

	$M(SD)$	
	BA ($WithoutSC$)	SAEP ($WithSC$)
Friendship	6.8(1.7)	7.4(1.4)*
Independence	6.2(1.4)	6.6(1.5)*
Family security		
FamSec 1	6.0(2.6)	6.5(2.9)
FamSec 2	8.0(2.0)	7.5(2.6)

Note: * $p < .05$, ** $p < .01$

Table 4.6: Mean and SD for perceived usability, individual social actorship factors, and social actorship overall, for each of the two versions.

	$M(SD)$	
	BA ($WithoutSC$)	SAEP ($WithSC$)
Usability	7.3(2.2)	8.2(1.8)*
Social actorship	7.5(1.6)	7.5(1.3)
Liking	8.7(1.3)	8.4(1.8)
Dominance	1.5(2.1)	2.2(3.0)
Trust	6.7(3.3)	6.5(3.0)
Intimacy	5.7(3.8)	6.5(3.5)

Note: * $p < .05$, ** $p < .01$

Table 4.7: Frequency of positive and negative behavioral codes for each version.

	BA ($WithoutSC$)	SAEP ($WithSC$)
Positive	97	158
Negative	72	9

H3), and that they perceive the SAEP more positively as a tool than the BA (confirming H4a), but no significance was found for social actorship (not confirming H4b).

4.4.2. Contributions and implications

We implemented and evaluated a location sharing application that encompassed a normative regulatory structure, namely an SC model. Results suggested that the addition of the SC model could provide a significant improvement in the application's support for several of the user's values. Further, since questionnaire items stem from our user group's activities, concerns, and limitations, this outcome in part solidifies the link made between values and these three elements of the social context of our domain as shown in the model in Figure 2.5. Moreover, this is the first study that provides empirical evidence for the argument underlying the vision of SAEPs (van Riemsdijk et al., 2015a) that social adaptivity in supportive technologies will provide improved support for user values. Moreover, to the best of our knowledge, SC models have not yet been implemented within mobile applications, and for direct user manipulation e.g. through a menu. Additionally, the study brought forth a questionnaire capable, to an extent, of evaluating how certain user values in the family life domain are fulfilled. This questionnaire can be used in future user studies in similar research areas, and be further enhanced upon more frequent usage.

Results also suggest that the SAEP provides improved perceived usability, and according to the behavioral sampling users sjpwed a positive attitude towards the technology. This provides evidence to counter a possible critique that manual creation of commitments may be too difficult or cumbersome. Although research suggests that the simpler the interaction, the more the technology is likely to be accepted (Venkatesh et al., 2003), we conjecture that the importance, benefit, and daily routine compatibility of the use of location sharing commitments outweigh the required effort for their creation. That is, people are used to asking others explicitly, for example, to let them know that they got home safely, and acquiring this information is typically important to their peace of mind. Although in future work we may also study how to derive commitments automatically, ensuring transparency and trust in the system's behavior will still require user interaction.

We did not find a significant difference for the value of family security between the BA and the SAEP. It will be interesting to conduct a similar study where parents are involved. Possibly, this value is specifically salient for parents with regards to their children. This may mean that the ability to make commitments with their children on what (not) to share with whom may have a more of a (positive) effect on how *parents* perceive fulfillment of this value in comparison to how it is perceived by children.

Moreover, we did not find a significant difference between the BA and the SAEP for perception as a social actor. It would be interesting to further investigate how the social

adaptivity of SAEPs affects social actorship factors such as trust. In particular, the aspect of (perceived) control over the SAEP behavior from the perspective of the supported person may be relevant here. In the BA one could say that the child is in full control, without influence from others: check-ins are only shared when the child explicitly does so. In the SAEP, there is some outside influence since others can propose commitments regarding location sharing that may differ from what the child would normally do. Nevertheless the child does have the freedom to decide whether or not to accept a commitment, and commitments can be made specifically for those contexts where data sharing is desired by the two parties. In applications such as Life360 on the other hand, one might say that parents have full control as the app allows them to see where their children are at all times. Further studies will have to be conducted to investigate the relation between social adaptivity and perception of social actorship.

4.4.3. Limitations

Conducting user studies involving children in the primary school age can be a challenging task (Fails et al., 2013). Because evaluating a location-sharing app with social adaptivity required the simultaneous engagement of multiple users, we conducted our user studies within day-care centers– simulating real life situations with a game of "missions". This setup allowed us to test the app with groups of children as the main target group, but we could not test for parents-children interaction. Moreover, the study tested the app only in a simulated setting. A follow up step would be to extend the evaluation to involve children as well as parents in a real life setting for a prolonged period of time. This would also help rule out the novelty effect of the app, which may have influenced the children's perception and attitude towards the technology, as well as their behavior during the user studies.

The list of values used for the evaluation was distilled from qualitative user data and was further curtailed in the data pre-processing stage. Thus the resulting list of values we tested for is by no means a representative of all relevant user values in the domain.

Further, the experiment was setup through creating a situation where the presence of an SC model was itself of benefit to the usage of the mobile app– i.e. the tasks provided an opportunity for the SC model to show its capabilities. In less ideal situations, no significant difference (or even a significant opposite effect) may be found. Therefore, future research is needed: this experiment only shows that at least under these conditions the SC model made a positive contribution.

Had the results of the analysis, however, shown that the BA provided a significantly better support for any of the measured values than the SAEP, this would have provided grounds for us to reject hypotheses H3 and H4.

Moreover, we used opportunity sampling, i.e. children who were able to obtain permission from their legal guardians to participate. This limits our ability to generalize our findings.

Furthermore, a questionnaire that measures fulfillment of user values for children was, to the best of our knowledge, unavailable. We therefore developed and validated the content of our own questionnaire for that purpose. Some of the items of the questionnaire suffered from low reliability, and a confirmatory factor analysis would have proven ineffective with a small sample size of 31 (Gorsuch, 1983), as well as below threshold subject-to-variable ratio of 31/19 (Hair et al., 1995). Furthermore, the behavioral sampling data was collected

by a single observer and thus is subject to bias, and it may be difficult to determine how the sampling approach affected our findings. Also, though the observer was not informed which group was testing which version, this could have been inferred through observing how certain participants interacted with the SC menu, which may have added to the observer's bias.

However, and to the best of our knowledge, we were the first to conduct a user study of simulated real-life tasks with primary school children within a day-care environment using measurement tools specifically created for human values. The novelty of the methods and tools used within this user study could prove very useful for researchers conducting studies with similar target groups.

4.4.4. Future work

An interesting next step would be to investigate possible conflict resolution policies, which would allow the SAEP to automatically determine the precedence of active social commitments in case of conflicts. Such policies may rely on contextual data (e.g. location, time, motion), and users' value profiles.

Moreover, the SC model which was used in this study was developed specifically for location sharing apps in the family life domain, and was kept simple enough to be used by children of primary school age. Interesting future work could include (1) testing the validity of our findings on social apps that share more than just location information, e.g. text, photos, and videos, and (2) increasing the expressivity of the syntax involved to fit such wide range of applications and users, while maintaining its usability. It would also be interesting to embed such SC models in the specifications of even more complex socio-technical systems, and investigate the type of conflicts that may occur as a result of multiple stakeholders with different requirements, as well as the solutions for such conflicts.

4.4.5. Final remarks

As the findings suggest, the presence of a location-sharing app such as the one presented in this paper can provide support to children's values on average, as well as a positive influence as a tool and social actor. The findings also show the potential that the normative, SC models have in allowing location-sharing applications, and potentially other social media applications, to play a more positive role in the lives of their users.

5

Automatic resolution of normative conflicts in supportive technology based on user values

Social Commitments (SCs) provide a flexible, norm-based, governance structure for sharing and receiving data. However, users of data sharing applications can subscribe to multiple SCs, possibly producing opposing sharing and receiving requirements. We propose resolving such conflicts automatically through a conflict resolution model based on relevant user values such as privacy and safety. The model predicts a user's preferred resolution by choosing the commitment that best supports the user's values. We show through an empirical user study ($n = 396$) that values, as well as recency and norm type, significantly improve a system's ability to predict user preference in location-sharing conflicts.

5.1. Introduction

Supportive technology such as personal assistant agents, virtual coaches, location sharing systems, and smart homes have the potential to make our lives more connected, healthy, efficient and safe. However, research in value-sensitive design and philosophy of technology shows this may come with the risk of demoting other important user values such as privacy and responsibility (Czeskis et al., 2010; Nihlen-Fahlquist, 2013; Nissenbaum, 2010). A value is defined in the Cambridge Dictionary as "the importance or worth of something to someone". Many different values can be distinguished. In particular, Rokeach (1973) published a surveyed list of human values that has become widely used, including for example, friendship, happiness, and freedom.

Research in philosophy and normative systems (Bench-Capon, 2003; van der Weide, 2011; van de Poel, 2013) as well as our previous empirical research (Kayal et al., 2014a) observes that values can be promoted and demoted by (regulatory) norms, i.e., *action guiding*

This chapter is based on "Automatic resolution of normative conflicts in supportive technology based on user values", currently under review.

statements obligating or prohibiting actions (Hansson, 1991). Inspired by this observation, we have put forward the vision that in order to provide improved support for user values, supportive technology should be able to understand and adapt its behaviour to diverse and evolving norms of people at run-time, i.e., it should be *socially adaptive* (van Riemsdijk et al., 2015b). This is in contrast with existing supportive technology in which norms are hardwired.

An important challenge that needs to be addressed when making software socially adaptive, is dealing with *conflicts between norms*. New norms can be introduced at run-time, and a situation may arise in which these norms cannot be fulfilled simultaneously. Various methods for detecting, reasoning about, and resolving normative conflicts have already been proposed in the literature (Vasconcelos et al., 2009; Criado et al., 2015; Such and Criado, 2014; Oren et al., 2008; Ajmeri et al., 2016; Meneguzzi et al., 2015), e.g. scope curtailment (limiting the scope of influence of norms in conflict) and norm ranking, and policies for defining preferences between norms, e.g. lex superior (the norm imposed by the higher power takes precedence) or lex posterior (the most recent norm takes precedence).

Since in the context of socially adaptive supportive technology *norms originate from users of the system* with the aim of guiding the system to provide better support to these users, we argue that the technology should be able to resolve normative conflicts in a way that is aligned with these *users' preferences*. As a step towards creating technology that can resolve normative conflicts on users' behalf based on their preferences, we study factors that may influence these preferences. Since the underlying motivation for creating this technology is its envisaged improved support for people's values, in this chapter we specifically focus on how we may use information about people's values to predict their conflict resolution preferences.

The idea we propose in this chapter is that based on information about 1) how a user ranks the importance of a number of relevant human values within the application domain, and 2) the extent to which specific norms promote these values, the system can resolve the conflict by choosing the norm that best supports fulfillment of the user's values. We call a user ranking of the importance of a set of values a *value profile*.

Taking this idea as the starting point, we provide two main contributions in this chapter. First, we develop a normative conflict resolution model based on value profiles (Section 5.3). Second, we show in Sections 5.4 and 5.5 through an empirical user study in the domain of mobile location sharing in family life (described in Section 5.2) that this model can significantly improve a system's ability to predict user preference for resolution of normative conflicts. In addition, we found that other variables, namely recency and norm type (obligation or prohibition), can improve prediction more than user value profiles, and that a combination of all three variables provides the best prediction of user preference. We discuss these findings in Section 5.6.

5.2. Case Study

We have selected social data sharing applications, in particular mobile location sharing for families, as our application domain for developing and studying prediction models for user preferences of normative conflict resolution. Allowing parents and children to share their location through mobile technology can support children in exploring their environment, through, e.g., helping them go to school on their own, making new friends, participating in

neighborhood events and play dates, as well as increasing parents' awareness of the location of their children. We have chosen this domain since it is well known from the literature that its use can give rise to value tensions (Czeskis et al., 2010; Nihlen-Fahlquist, 2013; Vasalou et al., 2012; Hasinoff, 2017), i.e., where promoting certain values comes at the expense of demoting others. Moreover, more and more applications of this type of data sharing and surveillance technology are developed and used.[1] This makes the investigation of location sharing technology for families not only a means for realizing our broader aim but also relevant for its own sake.

The starting point for the research presented in this chapter is our previous work (Kayal et al., 2014b), in which we have developed a smartphone app[2] for family life location sharing based on an exploratory user study (Kayal et al., 2014a). We introduced the idea that Social Commitment (SC) models – as a specific type of normative model – provide a flexible yet easy to use structure to govern sharing and receiving of (location) data. SC models were proposed by Singh (Singh, 1999, 2008) to describe a commitment between two parties in a socio-technical system, namely a *debtor* who is committed towards a *creditor* for bringing about a certain proposition, or a *consequent*, when a certain *antecedent* comes to hold.

Our app comes with an interface that allows users to create commitments expressing in which situation which data should and should not be shared and received. For example, a commitment that can be created between a father Bob and his daughter Alice through the app is that Alice should share her location with Bob when Alice is at the park. Once a commitment is created, its behaviour follows – broadly speaking – the commitment lifecycle as detailed in Singh and Telang (2012). This means that the app shares and receives location data (if possible) in accordance with the commitments to which the user has subscribed.

Conflicts between commitments may occur (see also Ajmeri et al. (2016)) when a user subscribes simultaneously to a number of commitments that may obligate and prohibit the same action (this is called a "prohibition conflict" in van Riemsdijk et al. (2015a)). For example, when one commitment between user A and B specifies that location data from A should be shared with B when A is at the park (e.g., to promote the value safety), and another commitment specifies that this data should not be shared between 3pm and 5pm (e.g., to promote the values privacy and independence), then a conflict occurs when A is at the park between 3pm and 5pm. If this occurs, the app needs to be able to make a decision on which of the two conflicting commitments to satisfy, at the expense of violating the other. The mobile application currently resolves conflicts by selecting the most recent commitment. In this chapter we investigate the use of information about users' values for selecting which of two commitments to satisfy.

5.3. Conflict Resolution Model

In this section we present our automatic conflict resolution model for social commitments that govern sharing and receiving of data in social platforms. We define a language for

[1] Examples of existing location sharing applications are Life360, Glympse, and wearables such as KizON. Use of these technologies seems to differ across countries. Results from a survey among 920 parents in the UK indicate that the use of location tracking was not prevalent (Vasalou et al., 2012). However, in the United States the app Life360 is being used by more than thirty-four million families according to the company (Hasinoff, 2017).

[2] A 3-minute tutorial video (with subtitles) can be seen at `http://bit.do/ePartner`.

creating requests regarding sharing or receiving of location data, and we define the notion of conflict used in this study in Section 5.3.1. The conflict resolution model is based on the concept of value profiles which we define in Section 5.3.2, and we present the model for predicting user preference in resolving conflicts in Section 5.3.3.

5.3.1. SC Request Language and Conflict Definition

Commitments can be created through the location sharing app described in Section 5.2 in the following way. The prospective creditor specifies a location sharing request, for example, a parent wants a child to share or not share location in a certain situation, through the graphical interface of the app. This request is sent to the prospective debtor (the child in this example), who can decide to accept or decline the request. If the debtor accepts, a commitment is created with the corresponding debtor and creditor, as well as the condition under which data should be shared or received as specified in the request. Below we provide the grammar of this language for expressing location sharing requests.

⟨*request*⟩ ::= '`I want`' ⟨*debtor*⟩ '`to`' ⟨*normType*⟩ ⟨*action*⟩ '`with/from`' ⟨*thirdParty*⟩ '`if`' ⟨*condition*⟩

⟨*debtor*⟩ ::= ⟨*individual*⟩
⟨*normType*⟩ ::= '`not`' | ϵ
⟨*action*⟩ ::= '`share location`' | '`receive location`'
⟨*thirdParty*⟩ ::= ⟨*individual*⟩ | friends | family | others | everyone
⟨*condition*⟩ ::= '`he/she is at`' ⟨*location*⟩ | '`within`' ⟨*timePeriod*⟩

where *debtor* is an individual who forms the target of the commitment that is to be created, *norm type* resolves to either an obligation (empty) or a prohibition (not) of an *action*, that is either to share or receive location information, *third party* is either an individual (e.g., the creator of the request, also known as *creditor* and referred to as "I" in the grammar) or a group of users, i.e., friends, family members, others, or everyone (i.e., all listed users), and *condition*, is either a location or a time period. If the debtor accepts the request, a commitment is created where debtor and creditor are as indicated above, the antecedent is the condition, and the consequent is the combination of norm type, action and third party – the latter can be viewed as the parameter of the action. With some abuse of language, in the following we will sometimes use the term "commitment" to refer to the commitment that is intended to be created through a request.

In the literature on social commitments the consequent typically represents a proposition that the debtor is committed to bringing about. In our case the consequent represents a sharing or receiving action that should or should not be executed. In line with literature on norms (Balke et al., 2013) we refer to the former as obligations and the latter as prohibitions, which can also be referred to as obligations *not* to do the action. Furthermore, actions and conditions in our case are specific to the domain of location sharing. We introduce a third party to specify with/from whom data is shared or received, which can be viewed as a parameter of the specified action.

The definition of conflict as introduced below underlies the implementation of conflict detection in the application we employed in the user study presented in this chapter. Informally, a conflict can occur when two commitments refer to the same debtor, have opposing

norm types (i.e., one is an obligation and one is a prohibition), concern the same action (with overlapping third party), and have an overlapping condition. Two conditions overlap when either 1) one is a location condition and the other is a time condition (because a person may be at that location at that time), or 2) both are location conditions and they are the same[3], or 3) both are time conditions with overlapping timespan (e.g., 'between 8am and 10am' overlaps with 'between 9am and 5pm'), denoted as *TimespanOverlap(timespan1,timespan2)*. We use the notation $C.debtor$ to refer to the grammar element "debtor" of commitment C, in correspondence with the grammar defined above.

Before we define the notion of conflicting commitments formally, we define what we mean by third party overlap and overlapping conditions. We use $C.condition.type$ to refer to the type of the condition of commitment C, i.e., either place or time period.

Definition 1 (Third party overlap)**.** Let $C1$ and $C2$ be commitments, and let M be the intersection of the set of third parties of $C1$ and $C2$, i.e., $M = C1.thirdParty \cap C2.thirdParty$. We define that $C1$ and $C2$ have a third party overlap, denoted as $Overlap(C1.thirdParty, C2.thirdParty)$, iff $M \neq \emptyset$.

Definition 2 (Overlapping conditions)**.** Let $C1$ and $C2$ be commitments. We define that $C1$ and $C2$ have a condition overlap, denoted as $Overlap(C1.condition, C2.condition)$, if one of the following two conditions hold:

(1) $C1.condition.type \neq C2.condition.type$, or
(2) $C1.condition.type = C2.condition.type$, and
  (2a) $C1.condition.type = location$ and $C1.condition = C2.condition$, or
  (2b) $C1.condition.type = timePeriod$ and
    $TimespanOverlap(C1.condition, C2.condition)$.

Definition 3 (Conflict)**.** Let $C1$ and $C2$ be commitments. We define that $C1$ and $C2$ are in conflict iff the following conditions hold:

(1) $C1.debtor = C2.debtor$
(2) $C1.normType \neq C2.normType$
(3) $C1.action = C2.action$
(4) $Overlap(C1.thirdParty, C2.thirdParty)$
(5) $Overlap(C1.condition, C2.condition)$

5.3.2. Value profiles

Employing users' contextual information has already been established as a viable method to provide more relevant recommendations and a better user experience (Panniello and Gorgoglione, 2012; Fernández-Tobías et al., 2016; Panniello et al., 2012; Knijnenburg et al., 2012). This, in addition to the link between user values and norms, brought forth the idea of using users' ranking of importance of a number of domain-relevant values as contextual information– to predict their preferred solution if a normative conflict is to occur.

We define a value profile as a user ranking of the importance of a set of values that are relevant in the domain under consideration, which in our case is location sharing in

[3] In this study we assume that locations with different names are geographically different locations.

family life. In Kayal et al. (2014a) we have identified a number of values from Rokeach's survey (Rokeach, 1973) as particularly relevant in this domain, namely: friendship, family security (here renamed as safety), independence, social recognition and inner harmony. In this domain social recognition takes shape mainly in the form of friendship, and inner harmony concerns in particular family security. Therefore, and in order to limit the number of values that users have to rank, in this study we omit social recognition and inner harmony. Moreover, we add the values of responsibility and privacy, since these have been identified in Nihlen-Fahlquist (2013); Czeskis et al. (2010) as important in this domain and in data sharing in general (Nissenbaum, 2010).

We define these values as follows, adapted from Merriam-Webster's dictionary:

- Friendship ($Frnd$): for you, or your family members to build friendships, a social life, and be recognized amongst others in the social circle.
- Privacy ($Priv$): for you, or your family members to be free from unwanted outside intrusion, and undesirably shared information.
- Safety (Saf): for you, or your family members to be free from dangers or harm.
- Independence (Ind): for you, or your family members to be capable of doing what they need to do without other's control or support.
- Responsibility (Res): for you, or your family members to know and be able to do the tasks they are expected to do.

To predict users' preference in the resolution of two conflicting commitments, we introduce two types of value profiles: one that provides information about the user's ranking of the importance of a set of values *in general*, and one that provides information about the extent to which a specific commitment promotes these values. We call the first a *General Value Profile* (VP_g) and the second a *Commitment Value Profile* (VP_c). By comparing each of the VP_c of two conflicting commitments with the VP_g of a user, one can determine which of the two commitments' profiles is closer to the user's values in the general sense. The idea is then that the commitment closest to the user's VP_g is the commitment that the user would prefer to fulfill in case of conflict.

These two types of value profiles are thus defined as follows, where the domain-relevant values in our case are the five values listed above:

- A user's General Value Profile (VP_g): a ranking of the importance of a set of domain-relevant values in the general sense, without any additional context.
- A Commitment Value Profile (VP_c): a ranking of how a social commitment promotes a set of domain-relevant values.

  In practical terms, i.e. when an application that embodies this conflict resolution model is in use, a user's general value profile will be created as part of the initialization process of the mobile app, while commitment value profiles are created by the user every time a request is accepted by the debtor.

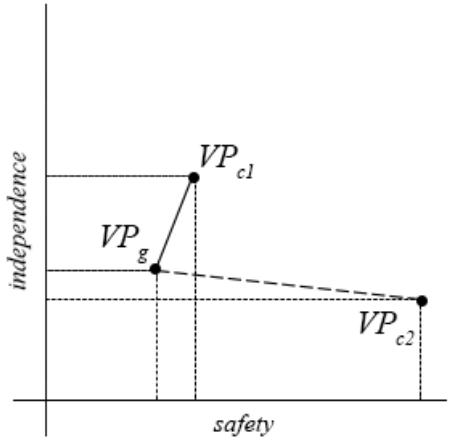

Figure 5.1: A 2-dimensional representation of safety and independence in VP_g, VP_{c1}, and VP_{c2}.

5.3.3. Preference Prediction Model

Our model for predicting which of two conflicting commitments a user will prefer is based on calculating the distance between the value profiles of each of these two commitments and the user's general value profile. The commitment that is closest to the user's general value profile is predicted to be the user's preferred solution for resolving the conflict.

We represent value profiles numerically as vectors. Each element of the vector corresponds to the importance of a particular value, i.e., the higher the number, the more important a value is within that profile. For normalization purposes, the sum of the elements of the vector should add up to 1. Thus a value profile in our case is a 5-dimensional vector, representing the relative importance of each of the identified five values relevant in this domain:

$VP = \langle Frnd, Priv, Saf, Ind, Res \rangle$
where $Frnd + Priv + Saf + Ind + Res = 1$

To illustrate how the model defines the distance between value profiles, consider the values *Safety* and *Independence*. Let C_1 and C_2 be two commitments and let VP_g, VP_{c1}, VP_{c2} represent the general value profile, and the value profiles for C_1 and C_2, respectively. Figure 5.1 illustrates a partial projection of of VP_g, VP_{c1}, VP_{c2} on 2-dimensional plane, showing how close each commitment value profile is to the general value profile. According to this illustration, the safety component in C_1 is closer to its counterpart in the user's VP_g than the safety component of C_2, i.e., $|Saf_{c1} - Saf_g| < |Saf_{c2} - Saf_g|$. This means that with respect to *Safety*, the model predicts that C_1 would be favored over C_2 in case of a conflict. Using the same argument, we can see that according to the value *Independence*, C_2 would instead be favored over C_1.

In this way we calculate for each of the five values the distance between the general value profile and the value profile of the commitment, defined formally as $|(VP_c - VP_g)|$. We do this for each of two commitments, and take the difference between the resulting two vectors to obtain a prediction vector $Pred$:

$Pred_{c1,c2} = (|(VP_{c2} - VP_g)| - |(VP_{c1} - VP_g)|)$
i.e. a vector containing five predictive components:

$Pred_{c1,c2} = \langle Frnd_p, Priv_p, Saf_p, Ind_p, Res_p \rangle$

Each component of this prediction vector represents how close the importance of a certain value in each of C_1 and C_2 is to its importance within the user's value profile. This number thus reflects how much the user is predicted to prefer C_1 over C_2 in a potential conflict with respect to that value. This number can be positive or negative (a negative number means a preference for C_2 over C_1)[4].

5.4. User study

We designed and performed a user study to determine the usefulness of our value-based conflict resolution model for predicting user preferences in resolving conflicts between commitments. The design of the user study was made relatively simple in order to allow non-experts on the subject of social commitments to perform the required tasks. In this user study participants were provided with a number of location sharing scenarios in the family life domain. Each of these scenarios ended with a location sharing challenge that required a solution to be created using the SC request language of Section 5.3.1. The study was designed so that participants were confronted with conflicts between commitments if they were to provide the expected solutions in the scenarios. As part of the study we elicited users' value profiles as well as their preferred solution when a conflict occurred. Our aim was to use our conflict resolution model to predict users' preference using information available in their value profiles, and compare that prediction with the preference they reported. In this section we present our hypotheses and research questions and describe the user study in more detail.

Permission from the ethics committee of the university was obtained prior to conducting this user study.

5.4.1. Hypotheses and research questions

Based on the background material and our value profile-based predictive model, we propose the following hypotheses and research questions:

- H1: people have a preferred resolution when confronted with a conflict between commitments.
- H2: knowledge of people's general value profiles and commitment value profiles can be used to predict people's preferred resolutions to conflicts between commitments.
- RQ3: which information within a commitment's grammatical structure can be used to predict people's preferred resolutions to conflicts between commitments?

[4] In the of case equal VP_{c1} and VP_{c2} , the model will predict an equal user preference for the two conflicting commitments. Within the dataset obtained in the user study related to this work, no such case of an equal prediction was found– while technically possible, it was very unlikely because of the fine-grained and multi-dimensional method we used for input (see Section 5.4.3). A reduced grain/dimensionality of the input method would increase the likelihood of equal commitment value profiles happening.

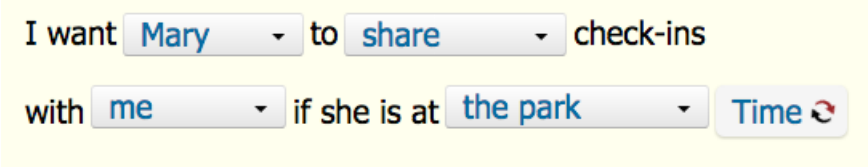

Figure 5.2: A web-style menu representation of the SC request grammar.

5.4.2. Material

Research has shown that the web offers an environment just as powerful as the lab for conducting user studies, with data collected online being of at least similar quality to lab data (Gosling et al., 2004). Results from the two environments have been shown to have high congruence (Krantz and Dalal, 2000). An advantage of using the web is that large numbers of participants can be recruited relatively easily through crowdsourcing platforms. Following this approach, we implemented a website containing the tasks participants had to perform. Participants were recruited through `Microworkers.com`, and were redirected via a link to our user study website.

We have developed a web-style menu representation of the SC request language to allow participants to create social commitments (Figure 5.2). The menu reflects the user interface of the corresponding smartphone app (see Section 5.2).

Scenarios and conflicts

Sixteen scenarios were used in the study, describing fairly common situations within the family life domain, e.g. children going to school, children playing at a playground, parents taking their children to meet friends. Origin of these scenarios is rooted in focus group data with members of the target group conducted in Kayal et al. (2014a). A location sharing challenge was presented at the end of each scenario, which participants were asked to solve by creating a data sharing request using the SC request language through the menu in Figure 5.2. Every scenario was assigned a *designated solution*, i.e. a specific commitment we deem to be correct. Scenarios were created such that the commitments forming the designated solutions for each of the 16 scenarios were distributed over 16 the possible combinations of norm type i.e. *obligation* or *prohibition*, action i.e. *share* or *receive*, third party i.e. *creditor only* or *any other user or any group*, and condition i.e. *place* or *time*.

These 16 scenarios were created such that they gave rise to eight conflicting pairs of scenarios. A conflicting pair consisted of two scenarios where the commitments forming its two designated solutions would cause a potential conflict according to the definition of conflict of Section 5.3.1. An example of a pair of scenarios with two designated solutions bearing a potential conflict can be found (in addition to the remaining scenario pairs) in Appendix A.4.

Roles

In each of the 16 scenarios, participants had to assume the role of one of the characters in the scenario– the character is meant to solve the problem in the scenario through creating a commitment with other characters. In eight of these the participant assumed roles

of parents, and in the remaining eight, participants assumed the roles of eight-year old primary school children. A participant assumed a fixed role that did not change throughout their participation. This means that in the scenarios that we used, each conflicting pair of commitments was created by the same creditor as impersonated by the participant of the study.

Instructional videos

Two instructional videos (narrated in English) were created for this user study. The first video provided information regarding the domain, SC request menu, an example task, and the required participant input in case of a normative conflict. Video instructions were customized depending on a participant's assumed role, i.e. parent or child[5]. The second video explained how to operate the values pie chart, the measurement tool we used for elicitation of user values[6] (see Section 5.4.3).

5.4.3. Measurement

Though obtaining the relative importance of a mental construct such as human values may be difficult, (Carenini and Loyd, 2004; Pommeranz et al., 2011; Huldtgren et al., 2014) provide a number of methods for the visual elicitation of the ranking of a fixed number of user values.

Participants' VP_g's and VP_c's were obtained using a colored pie chart with resizable slices, and a legend relating every slice to a specific value of the five values discussed in Section 5.3.2 (Figure 5.3 shows an example of what a pie chart may look like next to the legend). The larger the slice that referred to a certain value, the more important a participant thought this value was in comparison to others, considering the role they were instructed to play.

If a participant created two successive solutions using the SC request menu who's corresponding commitments were in conflict, a pop-up window showed up at the end of the second scenario. This window displayed information related to the two conflicting solutions. It asked the participant to indicate, from the perspective of their character in the scenario, i.e., the creditor of both commitments, how much they favor one commitment[7] over the other using a continuous slider (Figure 5.4).

Note that this setup allowed us to study the conflict resolution preferences of the (same) *creditor* of two conflicting commitments. This setup was chosen since it concerns the most "direct" relation between values and conflict resolution preferences. This is because the commitments originate from the creditor in order to promote the creditor's values, and we resolve the conflict by comparing these commitments' value profiles with the general value profile of the same creditor. Studying how values can be used to predict a debtor's conflict resolution preferences may require taking into account the debtor's perspective on the creditors' value profiles, as well as authority relations between debtor and creditor if commitments arise from different creditors. Since this is our first study in this direction, we chose a simple setup.

[5] Videos available at `https://www.youtube.com/watch?v=BfcCvUyPPOg` and `https://www.youtube.com/watch?v=X68WUhNzL9o`

[6] Video available at `https://www.youtube.com/watch?v=hqToNby4in4`

[7] We used the term "agreement" instead of "commitment" during the experiment for clarity.

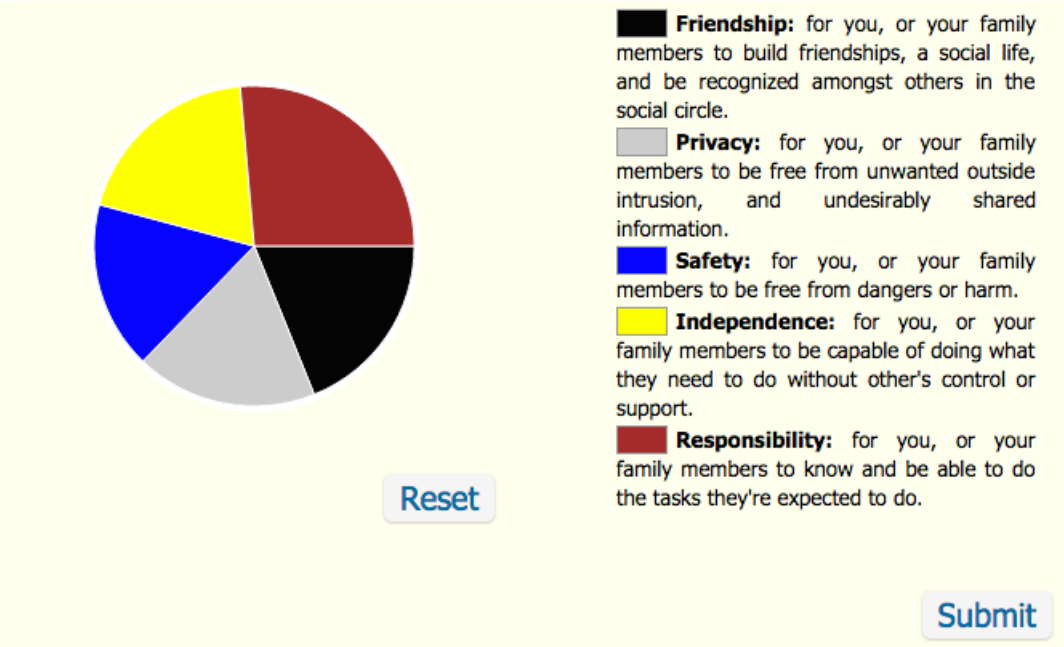

Figure 5.3: Values pie chart and legend.

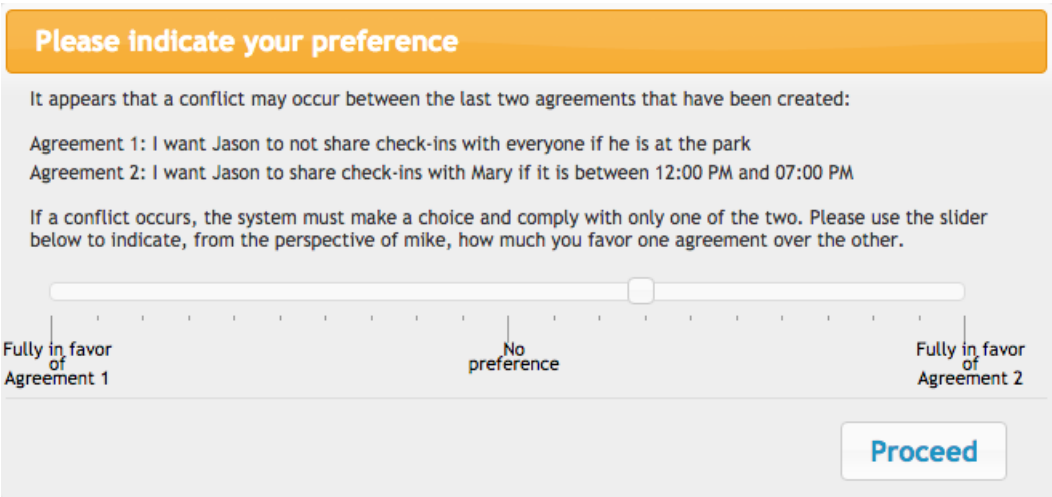

Figure 5.4: A pop-up asking the participant to indicate their preference, using a slider.

5.4.4. Participants

Four hundred participants were recruited through Microworkers.com. Participation was open to members living in English-speaking countries, i.e. the US, Canada, UK, Australia, and New Zealand. Every participant was compensated with one US Dollar, in accordance with the regulations of the crowdsourcing platform.

To ensure the quality of the participant's contributions, every task contained a quality control question. Only participants who read the task text in full would be able to answer this question correctly. Participants were informed through our terms and conditions that wrong answers to the quality control questions would result in their compensation being cancelled and their contribution omitted from the study. Four of the participants did not comply with these regulations, which resulted in a final number of 396 contributing participants. Of these participants, 202 were male and were 194 female, with an age mean of 31.2 and SD of 10.8, while 156 participants indicated being legal guardians of one or more children.

5.4.5. Procedure

Upon reaching the website's landing page participants were instructed to view the first instructional video, customized based on their randomly assigned role. After watching the video, participants were asked to enter demographic information, i.e. age, gender, and whether they were the legal guardian of one or more children.

Following the landing page, participants were directed to a practice page, where a dummy scenario, a practice SC request menu, a practice values pie chart and colored legend along with the second instructional video, were presented. Following the practice page, participants were directed to a page that contained the values pie chart and the colored legend. Participants were instructed to "indicate, in the general sense, [their] preference for these five human values" using the pie chart, and to do this "from the perspective of [their] role", i.e. either a parent or a child, and within the context of family life. This yielded the participant's VP_g.

Next, participants were directed to the scenario pages. In a scenario page, participants could read the scenario text, and attempt to solve the location sharing problem in the scenario using the SC request menu. After that, participants indicated how much the solution, namely the request they created, supports each of the five human values if it were accepted using a similar values pie chart, within the context of the scenario and from the perspective of their character in the scenario. This yielded the corresponding commitment's VP_c. Every participant had to solve eight such tasks, dispatched as conflicting pairs but in random order. This meant that every two consecutive scenarios had designated solutions generating a potential conflict, which participants had to manually resolve using the continuous slider in Figure 5.4.

Finally, after the end of the eighth scenario, participants were directed to a page containing a second value pie chart with a legend, and participants were instructed to indicate, once more, their preference for these five human values in the general sense assuming their role and within the context of family life (i.e. their VP_g).

5.4.6. Data preparation and pre-analysis

R version 3.2.1 was used for all statistics. Participant demographic data, VP_g (pre and post), assumed role, order of dispatched scenarios, solution to every task, commitments' VP_c, and users' preferences for every conflict resolution were stored.

First, a reliability analysis was conducted for values within VP_g (pre and post) amongst participants, to determine if there was significant change to merit using the average of profiles in further analysis. Results showed a satisfactory[8] Cronbach's α (Table 5.1): this means that we can assume consistency among pre- and post-experiment measurements. Therefore, for further analysis, only the pre-measurement value of VP_g was used.

Table 5.1: Reliability analysis for VP_g's.

	α
Frnd	0.75
Priv	0.52
Saf	0.63
Ind	0.70
Res	0.65

We also analyzed to what extent there is agreement among participants regarding how they viewed a commitment's impact on the five values. For this purpose we performed a reliability analysis amongst participants for values within VP_cs per scenario, and split across roles (Table 5.2). Results suggest a high level of consistency between participants in how they viewed a commitment's impact on the five values. This means that it may not be necessary to use the commitment value profiles of individual users, but instead it may suffice to use the average of a number of users' commitment values profiles to predict the preferred solution to a conflict. Relying on consensus data would require less elicitation of users' input. To investigate this, for each commitment that formed a designated solution to a particular scenario, the average of the VP_cs was calculated for all participants. This created a value profile consisting of the average of all value profiles created for the commitment in that scenario. We call these consensus value profiles or $VP_{con}s$.

Since participants performed multiple tasks, data was transformed to longitudinal form, with two tasks (i.e. one potential conflict between two designated solutions) per row. This way, every row in the data represents a potential conflict and resolution. This generated 396*(8/2)=1584 rows. In 517 rows no conflict between commitments was created, i.e. a participant failed to create two conflicting designated solutions. These rows were then dropped, leaving a total of 1067 rows out of the original 1584.

To calculate predictions of user preference for conflict resolution (as per the model introduced in Section 5.3, two different prediction vectors were used. The first one was a *fully*

[8] As an internal reliability measure, Loewenthal (2001) suggests a Chronbach's α of .7 as a threshold for acceptable reliability. However, in a scale of a low (i.e. below 10) number of items (in the case of this chapter, two: before and after), one may not be able to obtain an acceptable value of α, and thus the threshold may be reduced to .6. In our case, still, one value (privacy) is still considerably below that, however, an average of reliability for all values would still exceed .6.

Table 5.2: Reliability analysis for VP_c's per scenario, across roles.

	α	
	$Role_{Parent}$	$Role_{Child}$
Frnd	0.97	0.97
Priv	0.99	0.99
Saf	0.99	0.98
Ind	0.94	0.98
Res	0.97	0.91

personalized prediction, using a user's VP_gs and the VP_cs they created for every commitment:

(1) $Pred_{FP} = (|(VP_{c2} - VP_g)| - |(VP_{c1} - VP_g)|)$

While the second was a *semi-personalized* prediction, using a user's VP_gs but replacing their VP_cs with the VP_{con}s. As explained, the latter represents a consensus of opinions rather than users' own opinion of a commitment's impact on values (and hence semi-personalized).

(2) $Pred_{SP} = (|(VP_{con2} - VP_g)| - |(VP_{con1} - VP_g)|)$

Figure 5.5 represents a visualization of all participant's slider values (Figure 5.4) when presented with a conflict, showing the distribution of users' preference for one commitment over another: the closer to the left (right), the more they preferred C1 (C2) respectively, and the closer to the center, the more "indifferent" they were regarding that conflict. The data shows that participants deviated from the neutral, "no preference" point. This means that people have a preferred resolution when confronted with a conflict between commitments (H1).

For the purpose of analysis and creating prediction models, we translated the slider data into binomial form with the neutral "no preference" as the cutoff point. That is, measurements <0 are taken as a preference for the first of two conflicting commitments, and measurements ≥0 are taken as preference for the second. The translation to binomial form was performed because resolving an instance of conflict between two commitments means complying with one commitment and violating the other[9]. The data shows that participants were more likely to favor the second commitment they created (65.5% of total) in case of a conflict, regardless of the content. This means that the order in which commitments were created appears to influence users' preference in case of a conflict. Interestingly, this confirms empirically the relevance of the *lex posterior* policy (see Section 5.1) for resolving conflicts between norms in the context of supportive technology.

Moreover, the data showed that participants were more likely to favor the commitment

[9]The choice for obtaining user input via a continuous slider would allow to test for H1, then H2 through translating that input into a binomial form. We opted out of using a 3-choice input (i.e. C1, no preference, C2) as it may lead to a more salient choice for "no preference" for participants with a weak preference.

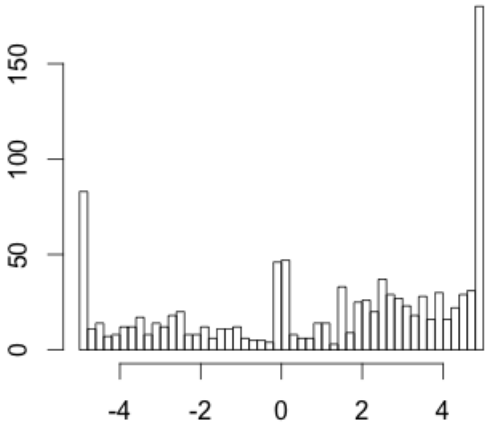

Figure 5.5: Histogram of slider data for all participants

created at a scenario where the designated solution contained an *obligation* norm type (62.9% of total). This means that the norm type of a commitment appears to influence users' preference in case of a conflict (RQ3).

In summary, we consider three main factors as possible predictors for user preference in conflict resolution: (1) order, (2) norm type, and (3) user value profiles. For the latter, we consider two options: the fully and the semi-personalized commitment value profile. The order is always taken into account in the prediction models as it cannot be considered in isolation. This means that we have a total of $2^3 = 8$ possible combinations of predictive factors.

Correspondingly, eight multi-level, Linear Mixed Effects models (LME) were constructed using the *nlme* package (Pinheiro et al., 2015) of R. Linear models describe relationships in our data between predictive factors and the outcome, in terms of a linear formula. Linear mixed effects models contain two types of factors: fixed effects and random effects. Fixed effects are the predictive factors that are within experimental control, in our case norm type and value profiles. Random effects are factors that are outside experimental control, in particular unknown participant-specific factors. Accounting for these in the model is important in case of a repeated measures study, with multiple measurements per participant as in our case. These measurements are not independent: they are influenced by participant-specific factors which are unknown to the experimenter at the time of the measurement. This could introduce a bias to measurements from an individual participant. A random effects component is added to the model to account for this idiosyncratic variation due to individual differences. This type of model containing both fixed and random effects is referred to as a mixed model. Testing the significance of a fixed factor was done by examining the improvement in the model's fit on user preference in the conflict resolution data if the model was extended with this fixed effect. For more elaborate introductory explanation we refer the reader to Winter (2013) as well as Field et al. (2012) for more of a general overview of statistical modeling techniques.

Composition of the models is as follows: in all eight models, the binomial user preference was used as a response (i.e., the output of the prediction), $participant$ as a random effect, with an unstructured covariance matrix (i.e. making no assumptions of any relationship between the variances in intra-participant measurments). Fixed effects (i.e., the predictive factors) used in each of the eight models are shown in Table 5.3. The intercept concerns the order in which commitments were created, norm type refers to the type of the norm in a commitment (i.e. obligation or prohibition), and the term "Group" used in the table refers to the fact that $Pred_{FP}$ and $Pred_{SP}$ are each a *set* of predictive values rather than a single one. Table 5.4 shows the fixed effect coefficients for the eight LME models.

Table 5.3: Fixed effects used in each of the eight LME models.

	M_0	M_1	$M_{2.1}$	$M_{2.2}$	$M_{2.3}$	$M_{3.1}$	$M_{3.2}$	$M_{3.3}$
Intercept	x	x	x	x	x	x	x	x
Norm type		x				x	x	x
Group								
Pred_{FP}			x		x	x		x
Pred_{SP}				x	x		x	x

To determine whether the improvement that a model provides over another model is significant, log-likelihood comparison tests were conducted. Log-likelihood is a measure of fitness of a statistical model. In themselves, log-likelihoods are uninterpretable, however, the difference between the log-likelihood for two models is interpretable as it follows χ^2 distribution, which is a standard measure of difference between expected and observed outcomes. And this can be compared with random differences, which means we can see whether the observed difference is beyond "random chance", and hence significant.

Using log-likelihood comparison tests, a base model can be compared to another model in which fixed effects are *added* in comparison to the base model, i.e., not all models can be compared in this way. To determine the improvement that each model provided over the base model $M0$, seven log-likelihood comparison tests were conducted with $M0$ and each of the other seven models. To determine the effect of adding value-profile predictors over a model containing the norm type predictor, three log-likelihood comparison tests were conducted with $M1$ and each of the $M3.x$ models. To determine whether fully personalized value predictors provided an improvement over the semi-personalized, with and without the presence of the norm type predictor, four log-likelihood comparison tests were conducted, with ($M2.1, M2.3$), ($M2.2, M2.3$), ($M3.1, M3.3$), and ($M3.2, M2.3$). R^2 values were obtained through comparing all of the above pairs.

To understand the magnitude (i.e. effect size) of the improvement of one model over another in its ability to explain the data, we also report the pseudo-R^2 (hereafter abbreviated as R^2) values as suggested by Finch et al. (2014). The R^2 value is the percentage of variance in the data that can be explained more by one model than by the other, e.g., R^2 = .1 (or 10%) means a model can explain 10% more of the observed outcome than the other model. Cohen (1988) classifies effect size of R for social sciences as small when R=.1, medium when R=.3, and large when R=.5. For R^2 this means a value of .01 can be seen as small effect size, .09 as medium, and .25 as large. Table 5.5 shows the results of the log-likelihood

comparison tests and the R^2 values. An explanation (and choice) of the statistical methods used in this analysis can be found in Finch et al. (2014).

5.5. Results

Table 5.4: Fixed effect coefficients for the eight LME models.

	$estM0$	$estM1$	$estM2.1$	$estM2.2$	$estM2.3$	$estM3.1$	$estM3.2$	$estM3.3$
Intercept	.655**	.526**	.658**	.653**	.657**	.541**	.550**	.556**
Norm type		.247**				.226**	.201**	.198**
Pred_{FP}								
Frnd_{FP}			.001**		.001**	.001*		.001*
Priv_{FP}			.000		.000	-.001		-.000
Saf_{FP}			.002**		.001	.001*		.000
Ind_{FP}			.000		.000	-.000		.000
Res_{FP}			.001		.000	.000		.000
Pred_{SP}								
Frnd_{SP}				.001	.000		.001	.000
Priv_{SP}				-.000	-.000		-.001	-.001
Saf_{SP}				.004**	.003**		.002**	.002*
Ind_{SP}				.001	.001		-.000	-.000
Res_{SP}				.003*	.003*		.001	.001
$\%_{Prediction}$	68.4	77.6	72.3	74.4	75.1	77.8	77.0	77.9

Note: * $p < .05$, ** $p < .01$

In Table 5.4, numbers inside the cells (aside from intercept) are the fixed effect coefficients of the linear model, in other words, in column $estM1$, the slope of .247 represents the norm type's effect on model $M1$'s ability to explain user preference. The intercept is the constant in the linear formula. Since the formula's 0 to 1 outcome represents our annotated recency of a commitment (i.e. 0 for the first commitment in the conflicting pair, and 1 for the second), the intercept on its own here represents a prediction based on recency without any additional predictive factors.

The double asterisk next to that number represent a p value below .01 (see table notes), and thus norm type is considered very significant in this model. Based on this analysis, we can see that column $estM0$ shows that the baseline model (i.e. knowledge of commitment order and participant ID alone) can significantly predict user preference, with 68.4% predicted correctly. Column $estM1$ shows that a significant improvement in prediction can be obtained when adding norm type to the model, with 77.6% of user preferences predicted correctly. Columns $estM2.1$ to $estM2.3$ show that knowledge of users' value profiles can significantly improve prediction over knowledge of commitment order and participant ID alone, with best prediction out of these three obtained using both $Pred_{FP}$ and $Pred_{SP}$ with 75.1% of the predictions correct. Columns $estM3.1$ to $estM3.3$ show that knowledge of both norm type and users' value profiles can significantly improve prediction over knowl-

Table 5.5: Results of the log-likelihood tests and the R^2 values.

	$\chi^2(R^2)$						
	$M1$	$M2.1$	$M2.2$	$M2.3$	$M3.1$	$M3.2$	$M3.3$
$M0$	75.0(.07)**	40.5(.04)**	57.6(.05)**	67.5(.06)**	88.8(.08)**	89.2(.08)**	97.0(.09)**
$M1$					13.8(.01)*	14.2(.01)*	22.0(.02)*
$M2.1$				27.0(.03)**			
$M2.2$				9.9(.01)			
$M3.1$							8.3(.01)
$M3.2$							7.9(.01)

Note: * $p < .05$, ** $p < .01$

edge of commitment order and participant ID alone, with best prediction out of these three obtained using all of norm type, $Pred_{FP}$, and $Pred_{SP}$ with 77.9% of the predictions correct.

In Table 5.5, the numbers in every cell shows the result of a comparison between two models. For example, the values in uppermost left cell show that additional predictors in $M1$ (namely norm type) affected the ability to explain user preference relatively well ($\chi^2 = 75.0$), with a small to medium effect size ($R^2 = .07$). The double asterisk next to that number represent a p value below .01 (see table notes), and thus the change in prediction ability between $M0$ and $M1$ is very significant. Following this analysis, row $M0$ confirms each of the seven models with fixed effects provide an improved explanation of user preferences over the base model, particularly with R^2 values suggesting small to a medium medium effect size (depending on model). Row $M1$ shows that adding value profile predictors to a model containing norm type would have little yet significant improvement in explaining user preferences. Rows $M2.1$ and $M2.2$ show that adding a semi personalized prediction to a model containing a fully personalized prediction would offer little but significant improvement, if norm type was not included as a predictor. Rows $M2.1$ and $M2.2$ also show that the reverse, i.e. adding a fully personalized prediction to a semi personalized prediction, would not offer any improvement in prediction. Rows $M3.1$ and $M3.2$ show that no improvement was found in both cases when norm type was included.

5.6. Discussion

5.6.1. Hypotheses and research questions

In terms of hypothesis H1, pre-analysis in Section 5.4.6 has shown that participants were strongly in favor of a resolution for conflicts, as opposed to having no preference for one commitment over another, confirming this hypothesis. The results in table 5.4 showed that the most accurate predictors of user preference are certain commitment-relevant information. Within its grammatical structure, norm type was found to be a significant predictor (thus answering RQ3). The table also shows that a commitment's recency was also found to be significant. Value profiles provided a slight (yet significant) improvement over recency and norm type, with the highest prediction accuracy was achieved when using commitment order, norm type, and value profiles altogether (thus confirming hypothesis H2). Last, the

results of model comparison in table 5.5 show that fully personalized value profile predictors do not offer more predictive power than the semi personalized ones.

5.6.2. Contributions

The main contributions of this chapter are 1) development of a conflict resolution model for social commitments based on knowledge of user values, and 2) a user study that shows that this value-based model can be used to automatically solve data sharing conflicts in location sharing platforms. Aside from value profiles, our analysis revealed powerful yet simple and easy-to-obtain information, i.e., order and norm type, that can be used to significantly increase automatic conflict resolution prediction accuracy. To the best of our knowledge, we are the first to develop a normative conflict resolution model based on user information, in particular user value profiles.

5.6.3. Limitations

For our user study, we have selected five human values relevant to the domain of location-sharing in family life to make up the components of value profiles. A more comprehensive list of human values could be used to provide a wider perspective on the values users find important, and relevant to location-sharing commitments. In the user study we used 16 scenarios and fixed conflicting commitment pairs. These scenarios and conflicts were based on common family life situations as well as rooted in previously collected focus group data (Kayal et al., 2014a). Yet despite our best efforts in selecting and pairing scenarios, and the consistency in results across conflicts, more research is needed to investigate generalizability of our findings to other location sharing scenarios and social data sharing domains. Moreover, the study was conducted online using a crowd sourcing platform. This means that the conflicts and resolutions were simulated, and participants were in essence actors who simulated both parental and children roles within given scenarios. We therefore cannot immediately assume that real-life location-sharing scenarios would generate the same results. Nevertheless, research (Borlund and Schneider, 2010) suggests that simulated work tasks produce results that are comparable with real world behavior. Moreover, working with real world data has to be balanced against an efficient research approach and ethics justification. Obtaining such data would require the development of entire application as well as asking participants to use application of long period of time, all that to evaluate only one element of the system. Using therefore a gamification mechanism known as “abstractions” (Kapp, 2012) was therefore more justified. With abstractions participants were only exposed to a simplification of the situation by removing less relevant factors (e.g. a parent actually going to their office) while also making cause and effect clearer with time being sped up (e.g. participants did not wait the period of a school day for the second scenario). The advantage of conducting a study in this controlled type of setting is a strong internal validity. Because we have control over the variables (Robson, 2002), we are in good position to attribute the observed effects to our manipulations, instead of potential biases that may come from confounding variables in a field study. Though field studies have higher external validity, confounding variables (i.e. variables outside of experimental control) would make findings less generalizable– thus we opted for a setup with a strong internal validity, with a view of conducting further research in a field setup. Also, using a crowd sourcing platform limited participation to those who chose to perform that task out of personal interest. This

limits the generalizability of our findings beyond interested parties for the time being. Furthermore, the label referring to the more recent commitment made was always displayed on the right side of the slider, leaving our findings in regard to recency vulnerable to visual bias– though the effect of recency is more document in literature (Howard and Kahana, 2002).

Moreover, and since we needed to ensure participants were able to fully understand our scenarios, participation was limited to English-speaking countries only, i.e. primarily "western" cultures. Different cultures may, on average, rank their values differently. At a first glance, this would not affect how the prediction model works– the model uses a user's value profile(s), and sometimes community value profiles, to generate a prediction for that specific user. Different users within one community rank their values differently as well, and there is no reason to expect that the model will be less capable of predicting individual user preferences if it uses user value profiles and community value profiles from another culture that is equally as homogeneous as western culture. However, if we were to collect community profiles from various cultures and use their average in the semi-personalized prediction, then this may negatively affect the prediction accuracy for semi-personalized predictions.

Finally, we must note the conflict detection algorithm in Section 5.3 is not intended to detect all possible conflicts within social commitments– it is geared specifically towards detecting commitments created by our grammar, and by the same creditor (as in our case), for which it is fully sufficient.

5.6.4. Proposed future work

The main finding from this chapter forming the basis for future work in this direction is that our results provide evidence that values are a relevant factor influencing users' preferences regarding normative conflict resolution. This is important in light of our overall aim of creating supportive technology that better supports people's values by adapting to their norms, for two main reasons: 1) it provides empirical evidence for the link between norms and values which underlies our vision of socially adaptive supportive technology, and 2) if we can improve our understanding of the relation between values and normative conflict resolution preferences through further research, this may allow us to improve the predictive power of our conflict resolution models, leading to supportive technology that better supports people's values.

Improving our understanding of the relation between values and normative conflict resolution preferences involves also studying other factors that are (potentially) relevant for conflict resolution, and their interaction with values. In this study we have already identified two other factors (recency and norm type). We expect that a third important factor is the nature of the relation between debtor and creditor (e.g., an authority relation).[10] This is particularly relevant when considering a debtor's conflict resolution preferences in case of conflicting commitments towards different creditors. Among other things it will be interesting to investigate if for these other factors we can also identify accompanying values as the underlying factor. For example, in cases where authority plays a role, an underlying value may be respect for authority. Moreover, more research is required to investigate more involved interplay between values of different users, e.g., debtors may take into account

[10] We thank one of the anonymous reviewers for highlighting this.

their own values as well as their perception of the values of creditors in establishing conflict resolution preferences.

In support of efforts to acquire a better understanding between values and normative conflict resolution preferences, we feel that an interesting next step would be to investigate other ways of obtaining value profile information. In this study we asked participants to provide this information directly via a pie chart, and it would be interesting to obtain that profile indirectly, e.g., through behavioral information or sensor data to investigate if such information can lead to better predictions. Furthermore, in our study the starting point was a predetermined set of relevant values. It would be interesting to integrate and further develop value elicitation techniques, i.e., techniques for eliciting which values are important in the context of particular applications (Pommeranz et al., 2011).

Finally, this user study was conducted in a simulated setting with all-adult actors who simulated both parental and children roles within given scenarios in the location sharing domain. Conducting this research in a field setting with both parents and children with a location-sharing mobile app would be necessary to confirm that our findings carry over to use of the technology in real life. An important challenge to consider when performing a field study with technology that automatically takes decisions on users' behalf as in our case, is how to balance automatic decision making and user control over the application's behavior. Though our predictive models have good accuracy, this does not necessarily mean that users will easily accept an application that automatically resolves their conflicts. Moreover, it will be interesting to investigate the generalizability of our results to other social data sharing settings. If we obtain evidence that this is the case, it supports our broader vision of developing socially adaptive supportive technology.

6

Discussion and Conclusion

This thesis investigated the use of norm-based, social commitment (SC) models to enhance social platforms in supporting human values. As its application domain the thesis focuses on location-sharing applications. It considers the elicitation of the requirements for SC models within this domain, builds a grammar and a visual representation for SC models, investigates SC's model's support for human values, and uses value-profiles to predict users' preferred resolutions for SC conflicts. The thesis aims to answer the following research questions:

In the family life domain, in what manner can social commitments offer a usable solution that complements the user preferences of location-sharing platforms, and improves the platforms' overall support for human values?

Two sub-research questions and two hypotheses were formulated to answer the main research question:

- *Research Question 1 (RQ1)*: how can the use of norms in a social platform influence the social context of family life?
- *Research Question 2 (RQ2)*: how can a social commitment model be tailored into a usable implementation within a domain-specific, location-sharing application?
- *Hypothesis 1 (H1)*: a location sharing application augmented with a social commitment model provides a better support for children's values than the same application without a social commitment model.
- *Hypothesis 2 (H2)*: knowledge of people's general value profiles as well as commitment value profiles can be used as a predictor of their preferred resolutions to conflicts between these commitments.

The research followed a cognitive engineering (Hollnagel and Woods, 1983) approach at the beginning, starting with an exploration of the application domain, requirements, and

technology. The outcome of that exploration was used to formulate hypotheses which were then empirically tested with user studies. The results presented in this thesis demonstrate how to elicit the requirements and develop, for a specific domain, a SC model that is usable within a location-sharing app. The results also demonstrate that enhancing the app with the SC model has improved its support for user's values, and that users' value profiles can be used to predict users' preferred resolution for SC conflicts.

Relationship between values, norms, and elements of the social context (RQ1) The second chapter of this thesis followed an exploratory approach to understand the application domain and the target group through a number of qualitative user studies, namely cultural probes (Gaver et al., 1999) and focus groups (Kreuger and Casey, 2008). The analysis of the collected data brought forth a grounded model that highlighted the relationship of the social context of the target user group with the concept of values, and how regulatory norms can support these values. In that way the model showed how norms can influence the social context of that domain, i.e. through human values. The model also provided a foundation for developing a norm-based framework, e.g. a SC model, to govern the interaction of a system of agent-based social applications.

Tailoring a SC model for use within a location-sharing application in the family life domain (RQ2) The third chapter of this thesis continued the exploratory approach and identified certain missing elements in social applications' data sharing and receiving settings, which make their support for human values suboptimal. Based on these missing elements, as well as data collected in pervious user studies, a concept of a normative language was developed and evaluated for expressivity through a user study. Afterwards, the research focused on making that concept more concrete, through developing a grammar and a life-cycle for a SC model grounded in the family domain. The grammar (and lifecycle) accounted for the social aspects, allowed for expressing a temporal dimension, and for violation of commitments. The chapter also showed, through an empirical study, that users found the SC model easy to use, and of positive contribution to the family life, location sharing domain. The research and design steps taken in this chapter showed how to build and tailor SC models to be embedded and directly usable within domain-specific social applications.

SC models support for children's values within a location-sharing application (H1) Support for H1 was established through an empirical study described in Chapter 4. Thirty-four children participated in a within-subject, counter balanced user test for two models of a location sharing app, one which included the SC model, and one which did not. Children answered questionnaires at the end of every test, which were developed specifically to measure the fulfillment of important values in children's lives, e.g. friendship, independence, and family security. Observations of children's behavior were also sampled at fixed intervals. The analysis shows that children expect the version of the app enhanced with the SC model to provide significantly better support for their values of friendship and independence than a version without the SC model, and no difference was found for the value of family security. The analysis also showed that children expect the version with the SC model to be a better tool than the version without the SC model, though no difference was

found for social actorship. Averaging results of both versions showed that the presence of a location sharing app in children's lives improves support for their values, and has a positive influence both as a tool and social actor.

Predicting users' preferred resolution of conflicts using value profiles (H2) Support for H2 was established through an empirical study described in Chapter 5. Three hundred and ninety-six people participated in a study conducted online. In that study, participants had to provide their value profiles. They did this by ranking the importance of a set of relevant values in the general sense, and indicating their preferred resolution to SC conflicts they generated, through trying to solve a number of intentionally conflicting family scenarios we provided. Participants also provided value profiles that relate to every solution they created. The analysis showed that mathematical models that utilize different combinations of value profiles can be used to predict user preferences for resolving conflicts in location sharing commitments. It also revealed other relevant commitment information that can be used to improve prediction accuracy– namely recency and the commitment's norm type. The analysis also showed that using averages of general-sense value profiles e.g. from historical data, offer similar predictive abilities when compared with value profiles elicited user-by-user.

6.1. Limitations

Application domain Though the research aimed to investigate the issue of value tension in social platforms, the empirical part of the research focused on a specific application domain, i.e. location sharing applications in the family life. This limits the ability to generalize findings to other domains within social platforms. For example, location information maybe considered more sensitive for the value of privacy than limited-size text posts or links to news items. Moreover, the value of safety arguably plays a more important role in the domain of family life than e.g. event organization or political discussions over social media.

User studies conducted online Two of the empirical studies in this thesis were conducted online through a crowd sourcing platform. That limited the ability to generalize findings beyond those who chose to perform the tasks out of personal interest. The limited time of effective user participation in such studies meant that we had to avoid very complex scenarios, as well as omit a few of the grammar's rules and semantic aspects in our testable implementation, which may have given participants additional expression abilities. Moreover, scenarios, conflicts, and resolutions were simulated, and we cannot immediately assume that real-life location-sharing scenarios would generate the same results– though research (Borlund and Schneider, 2010) suggests that simulated work tasks produce results that are comparable with real world behavior.

User studies involving children Conducting user studies involving children in the primary school age can be a challenging task (Fails et al., 2013). In this thesis we have taken a first step towards evaluating the effect a SC-enhanced location-sharing app on children's values. To do this was difficult as children could only be exposed to the app for a lim-

ited time and at a specific location. In the study presented in chapter 4, we simulated real life situations with games of "missions", with every game session lasting approximately an hour. Ideally, long term evaluation of the app, as well as social commitments' effect on family-life values should be present, involving both children and parents in a real life setting. However, this user study provides a unique example of an alternative that reasonably alleviates the limitations associated with that type of studies.

6.2. Contributions

To investigate the research questions and test the hypotheses proposed in this thesis, a number of models, a grammar, an application, and a measurement tool had to be created. The following paragraphs highlight this thesis's contributions.

6.2.1. Scientific contributions

Models This thesis brought forth three models. In chapter two, the main contribution was a grounded model that outlines the relationship between a normative framework for a social application and the elements of the social context in a certain application domain, through the linking element of human values. The model represented a projection of situated Cognitive Engineering (Neerincx and Lindenberg, 2008) on the application domain, that is grounded in that domain's requirements. In chapter three, a SC model with a lifecycle for location sharing applications in the family life domain was developed. This model provides a clear specification for implementing SC-components within a location-sharing platform. It represents the normative component in the grounded model presented in chapter 2, and its lifecycle is a concretization of the generic SC lifecycle (Singh and Telang, 2012). In chapter five, a model to predict user preference in resolving location sharing commitments conflicts was created, based on users' value profiles. Overall, these models can serve as blueprints for researchers in practical aspects of normative systems: in (1) understanding the normative application domain, embedding a normative model within an application, and (2) automatically resolving normative conflicts created through the application.

Measurement tools The study in chapter four also brought forward a questionnaire for measuring a number of children values, within the location sharing context. The content of the questionnaire was validated through a panel of experts in Value-Sensitive Design and Human-Computer Interaction. Aside from this questionnaire, and to the best of our knowledge, no other tools that can quantitatively measure the fulfillment of children's values (or human values in general) are available. Therefore, this questionnaire can be of benefit for researchers in the field of value-sensitive design, as a validation tool for research concepts and designs.

Understanding conflict resolution preferences The study in chapter five brought forth insights in how humans would potentially resolve data sharing conflicts on social platforms. The two predictors in the model that performed the best did not, in fact, relate to the value profile of the participant, but were rather generic: recency and norm type. This can provide a valuable insight on how to further develop automatic conflict resolution strategies that would comply with the habits of most users of social platforms.

6.2.2. Practical contributions

Aside from its contribution to the scientific community, many groups can benefit from the work presented in this thesis's in a practical manner. Below we list our research's contributions for each of these groups:

End users In chapter four, we have implemented and evaluated a location sharing application for the family life domain that uses an implementation of the SC model. The implementation allowed users of the app to create agreements regarding the sharing and receiving of location data.

The main beneficiary from using an app as such would be the research's main target group, i.e. families with children in the primary school age, with a number of value-tensions clearly present within such group (Czeskis et al., 2010). This application would allow parents and children alike to share their location for many intended purposes: staying safe, exploring the neighborhood, playdates, events, etc., while maintaining a tailored support for human values that is higher than what is offered in commercial platforms.

Developers To the best of our knowledge, SC models have not been yet implemented within mobile applications or within a form that is directly accessible to end users. The application overall can benefit developers of social applications as a prototype or testbed for research ideas involving agents, norms or SCs. More specifically, the web-menu representation of the SC model showcases a user interface that can be embedded in web and mobile applications.

Computer Linguists In chapter three, a grammar for creating social commitments for location sharing in the family life domain was developed, grounded in user data. This grammar could serve as the core for the development of a more expressive, general-purpose grammar for sharing and receiving content on social platforms. The end of chapter three already highlights possible starting points for this development.

User experience designers User experience designers continuously look for new methods to gain insights into user behavior in a cost and time efficient manner. Unfortunately that is not always possible, as certain target groups impose limitations on user studies that greatly increase the required time, cost, and effort. The work in this thesis presented a method, based on simulated work tasks (Borlund and Schneider, 2010) and user research for children (Markopoulos et al., 2008) to alleviate this difficulty for a specific target group, i.e. children in the primary school age– though the principle behind the method, i.e. the simulated "missions", can reasonably be applied to other types of users as well.

Moreover, throughout the numerous user studies carried out for this thesis, we have overcome various obstacles during preparation and experiment design that were not explicitly mentioned in the descriptions of these experiments, yet useful to mention nonetheless. For user studies including children, it was essential to (1) have an experienced school teacher lead the discussion if a discussion was needed, (2) ensure children understood the basic function of a device or a piece of software before an interaction evaluation is in process, (3) consider all limitations of the user study environment (e.g. reachability, size, signal strength or WiFi if needed), and parental requirements (e.g. some children arrive

late or are picked up early), and (4) ensure awareness of all assumptions related to children (e.g. children by age x can read and write perfectly, children before age x do not own mobile devices). For user studies conducted online, running a pilot with a limited number of users was essential to discover experiment design flaws that might have severely affected the quality of obtained data. Quality control questions had to be created so that it would take approximately enough effort to cheat on a certain task as it would to perform the task as intended, thus lowering the risk of undesirable user contributed data. Lastly, platform-related regulations must always be considered before running a study (e.g. redirecting to external websites, payment methods and regulations, ethical treatment of workers).

6.3. Future work

The work presented is thesis aimed towards improving social applications' support for human values through normative frameworks. To build up on this work means further transitioning towards truly adaptive social platforms that are capable of understanding people's norms and values. This could open up many possibilities for new research spanning the areas of agent systems, norms, human-computer interaction, value-sensitive design and data science. A current vision for follow up research (van Riemsdijk et al., 2015a) suggests three areas for potential development, namely:

Interaction The SC grammar developed in this thesis was kept relatively simple to allow for an efficient evaluation, and tailored to a specific social application domain, i.e. location sharing. This grammar can be further developed to allow for additional expressivity. Possible developments include adding multiple (or nested) conditionals, and conditionals relative to the creditor or third party. Moreover, and though our automatic conflict resolution algorithm scored fairly high, people's acceptance of automatic resolution of conflicts, as opposed to presenting the conflict to users for manual resolution, still requires investigation. This can be done, for example, through evaluating users' acceptance to automatic conflict resolution using the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh et al., 2003). A related challenge concerns automatic identification of norms and commitments through analyzing user behavior, for example using data from social media (Bocconi et al., 2015), verbal and non-verbal social signals (Vinciarelli et al., 2012), or usage data of the application itself.

Reasoning Though a SC model governs the location sharing app, the app itself does not, in its current implementation, reason on whether to comply or violate an active, accepted commitment, or similarly resolve a normative conflict. The study presented in the fifth chapter took an important first step in providing insights on how users would prefer to resolve location sharing conflicts, however, further research is needed for reasoning on commitment acceptance and compliance based on information derived from users' social context. Such reasoning will make socially adaptive applications more resilient to situations where a commitment cannot be complied with. This can be the case due to external circumstances (e.g., loss of network connection), or due to user behavior (e.g., forgetting to take the phone when going out). Generic reasoning mechanisms are required to allow applications to flexibly handle such situations in a principled manner.

Ethics Though human values arguably pertain to ethical considerations, possible unethical uses of this type of norm-governed application were not explicitly addressed within the scope of this work. The main challenge in this area remains as the proper definition of ethical boundaries, while avoiding ethical abuse that may be possible due to the runtime adoption of norms (van Riemsdijk et al., 2015a). Moreover, an interesting direction of research is developing ethical and philosophical foundations for the concept of socially adaptive electronic partners SAEPs. In some respects SAEPs may be considered to be tools, however, if they have more autonomous reasoning capabilities they may also be conceived as teammates (Klein et al., 2004; Breazeal et al., 2004) Or perhaps the concept of a SAEP as mediating connection between people by partnering with an individual is a novel type of entity that requires its own conceptual and philosophical underpinnings, for example based on mediation theory (Verbeek, 2014). Another aspect of ethics to consider in respect to autonomous reasoning is responsibility (Dignum, 2017), where agents capable of autonomously taking decisions may be accountable in case the decision taken has had harmful consequences. Agents must be able to take ethical considerations from various stakeholders into account, as well as explain (or provide a trace) of reasoning that led to that decision.

6.4. Final remarks

Social applications have been gaining massive numbers of users on a consistent basis, sharing data such as images, videos, and location information. While this technology has helped shape our world in the recent decade, research showed that it may pose a risk to a number of important user values while aiming to promote others. This thesis investigated enhancing these applications with the norm-based, social commitment (SC) models, aiming to improve their support for intended human values while minimizing the risk it poses to other values. Results of the work done in this thesis demonstrated the potential of SC models in providing an easy to use, flexible tool that allows social applications to work better in users' favor, supporting intended values while posing minimal risk to other values as a side effect.

A

Appendix

A.1. Scenarios used in online user study in Chapter 3 (with designated solutions)

1. Mary is an 8 years old child. Paul is her father. Paul wants to find out when Mary arrives at the park. She is going there on her own for the first time, and Paul is worried. You are Paul. Use the menu below to construct an agreement to find out when Mary arrives at the park.

   Designated solution (and type): I want *Mary* to *share* her check-ins with *me* if *she's at the park* (O,S,C,P).

2. Mary and Jason are both 8 years old children. Jason wants to play with Mary after school (some time between 3 and 5 pm). Jason does not know where Mary is going after school. You are Jason. Use the menu below to construct an agreement to find out where Mary is going after school.

   Designated solution (and type): I want *Mary* to *share* her check-ins with *me* if *it's between 3pm and 5pm* (O,S,C,T).

3. Mary and Jason are both 8 years old children. Lisa is Jason's mother. Jason wants to play with Mary in the park nearby her house. Jason may forget to inform Mary when he arrives at the park. You are Lisa. Use the menu below to construct an agreement to ensure Jason informs Mary of his arrival at the park.

   Designated solution (and type): I want *Jason* to *share* his check-ins with *Mary* if *he's at the park* (O,S,X,P).

4. Jason is an 8 years old child. Lisa is his mother, and Peter is his father. Jason is going to play with his friends after school (some time between 3:30pm and 6pm). Lisa is supposed to drive Jason home afterwards. The parents do not know where Jason and

his friends are going to play. You are Peter. Use the menu below to construct an agreement to ensure that Lisa finds out where Jason is going.

Designated solution (and type): I want *Jason* to *share* his check-ins with *Lisa* if *it's between 3pm and 6:30pm* (O,S,X,T).

5. Jason is an 8 years old child. Lisa is his mother. Lisa wants to drive Jason home when he's done playing at the park. Lisa wants to make sure Jason is aware when she arrives. You are Lisa. Use the menu below to construct an agreement to ensure that Jason is informed of your location while he's playing at the park.

   Designated solution (and type): I want *Jason* to *receive* check-ins from *me* if *he's at the park* (O,R,C,P).

6. Mary and Jason are both 8 years old children. Mary wants Jason to come and play with her in the afternoon (sometime between 3pm and 5pm). Mary does not know yet exactly where she is going to play. You are Mary. Use the menu below to construct an agreement to ensure that Jason knows where you're going this afternoon.

   Designated solution (and type): I want *Jason* to *receive* check-ins from *me* if *it's between 3pm and 5pm* (O,R,C,T).

7. Jason is an 8 years old child. Lisa is his mother, and Peter is his father. Peter wants to pick Jason from day care when he's done with work. Peter is going to be late, but Lisa agrees to pick Jason up instead. You are Peter. Use the menu below to construct an agreement to ensure that Jason finds out when Lisa arrives to pick him up.

   Designated solution (and type): I want *Jason* to *receive* check-ins from *Lisa* if *he's at daycare* (O,R,X,P).

8. Jason is an 8 years old child. Lisa is his mother. Lisa wants Jason to be more active in making friends in their neighborhood. Jason does not know where his friends play after school (some time between 4pm and 6pm), and therefore has not, up to now, joined them. You are Lisa. Use the menu below to construct an agreement to ensure that Jason finds out where his friends play after school.

   Designated solution (and type): I want *Jason* to *receive* check-ins from *Friends* if *it's between 4pm and 6pm* (O,R,X,T).

9. Mary is an 8 years old child. Jane is her mother. Jane does not want to be notified every time Mary comes home. But Mary checks-in and informs everybody when she comes home. You are Jane. Use the menu below to construct an agreement to ensure that Mary does not notify you when she arrives home.

   Designated solution (and type): I want *Mary* to *not share* check-ins with *me* if *she's at home* (F,S,C,P).

10. Mary is an 8 years old child. Paul is her father. Paul has a meeting between 10am and 12pm, and will be very busy during that time. But Mary checks-in frequently all day long, and shares with everybody. You are Paul. Use the menu below to construct an agreement to ensure that Mary does not notify you with her location during your meeting.

    Designated solution (and type): I want *Mary* to *not share* check-ins with *me* if *it's between 10am and 12pm* (F,S,C,T).

11. Jason is an 8 years old child. Lisa is his mother. Lisa does not want strangers to find out where her son is. But when Jason goes to the park he keeps sharing his location with everybody. You are Lisa. Use the menu below to construct an agreement to ensure that Jason does not tell strangers (as in, all people who aren't friends or family) that he's at the park.

    Designated solution (and type): I want *Jason* to *not share* check-ins with *others* if *he's at the park* (F,S,X,P).

12. Jason is an 8 years old child. Peter is his father, and Lisa is his mother. Lisa has a meeting (between 2pm and 4pm) and she does not want to be interrupted during that time. But Jason does not know that, and he might share a few check-ins with her during that time. You are Peter. Use the menu below to construct an agreement to ensure that Jason does not share his location with Lisa during her meeting.

    Designated solution (and type): I want *Jason* to *not share* check-ins with *Lisa* if *it's between 2pm and 4pm* (F,S,X,T).

13. Mary and Jason are both 8 years old children. Mary and Jason go to the same school. Jason therefore does not need to be notified if Mary arrives at school. But Mary checks in when she arrives at school every day. You are Mary. Use the menu below to construct an agreement to ensure that Jason is not notified of your check-ins if he's at school.

    Designated solution (and type): I want *Jason* to *not receive* check-ins from *me* if *he's at school* (F,R,C,P).

14. Jason is an 8 years old child. Lisa is his mother. Jason does not want to bother his mom with too much check-ins. For example, Jason is going on a school trip (between 10am and 3pm) and he is going to check-in in every place they go. You are Jason. Use the menu below to construct an agreement to ensure that Lisa is not notified of your location during that school trip.

    Designated solution (and type): I want *Lisa* to *not receive* check-ins from *me* if *it's between 10am and 3pm* (F,R,C,T).

15. Jason is an 8 years old child. Peter is his father. Peter wants Jason's grades at school to improve. Jason is easily distracted by all the notifications on his smart phone when

he's at school. You are Peter. Use the menu below to construct an agreement to ensure that Jason does not receive notifications from his friends while he's at school.

Designated solution (and type): I want *Jason* to *not receive* check-ins from *friends* if *he's at school* (F,R,X,P).

16. Mary is an 8 years old child. Jane is her mother. Jane wants Mary's grades at school to improve. But Mary is easily distracted by all the notifications on her smart phone during the time where she's supposed to do her homework (between 6:30pm and 8pm). You are Jane. Use the menu below to construct an agreement to ensure that Mary does not receive notifications from her friends during the time where she's supposed to do her homework.

    Designated solution (and type): I want *Mary* to *not receive* check-ins from *friends* if *it's between 6:30pm and 8pm* (F,R,X,T).

A.2. Mission cards

1. Go to the school yard. Make sure that your friends know you are there.
2. Go to the toddlers room. Make sure that your family knows you are there.
3. Try to make a location that isn't in the app yet (for example, the atelier).
4. Go to the inner yard. Make sure only your family knows that you are there.
5. See if you've already checked-in in all places. Check-in in the places where you haven't yet.
6. Add two children to your "other" list and two more to your "friend" list.
7. Go to the inner yard. Share your location but make sure it isn't going to be seen by "family" or "others".
8. Check which friends have shared their location already (tip: try the event log).
9. Go to the school yard. Let your friends know that you're there.
10. Go to the dining room. Let your friends know that you're there.
11. Go to the upper atelier, and let your parents know that you're there.
12. Go to the dining room. Make sure that at least someone in the toddlers room knows where you are.
13. 13 Ask a friend of yours to always share his/her check-ins with you if he/she is in the upper atelier.
14. Make sure that one friend of yours does not find out where you are from now until 6 o'clock.

15. Ask a friend of yours to always let you know if he/she is in the upper atelier.

16. Make sure that one of your friends would not let you know if he/she is in the toddlers room.

17. Ask one of your friends to not let you know where he/she is after 3 o'clock in the afternoon.

18. Go to the school yard. Make sure that you add a new friend to the app that has the same hat color. Make an agreement that if one of you is in the dining room, then the other should know.

19. Check your friends list and try to find someone from the same team who is in the upper atelier. Ask him/her to not let you know when he/she is at the upper atelier.

20. Ask one of your friends to request from you to always share your location with him/her if you're in the inner yard.

21. Ask one of your friends to request from you to always share your location with him/her if you're in the school yard.

22. Check which of your friends are outside. If your friends are outside, go to them and check-in altogether. Otherwise, go to the toddlers room and check-in.

23. You want to have something to eat, but you don't want to eat alone. Let everyone know that you're in the dining room.

24. You can see where your friends are through the event log. Make sure that one of your friends can find out where you are between now and a quarter of an hour.

25. Check where your friends are and ask someone you like to come with you to the inner yard. Check-in together.

26. Go to the upper atelier and try to ask someone to come there from the inner yard. Can you see if there are other children there? See on the map or the event log where your friends are and check-in together in the upper atelier.

27. See who's now outside. Try first to do that with the help of the app. Check-in when you're outside.

28. Check where other children are via the event log. If you can find a few, add them as friends. If you can't find anybody, check if someone is outside and see if he/she can add you as a friend.

29. You want to always know when one of your friends comes to the daycare center. Make a setting so he/she would always let you know when he/she's at the bicycle storage.

30. Ask someone to always let you know when he/she is going to the inner yard.

31. Make a setting so one of your friends would not find out if he/she is at the bicycle storage.
32. Make sure that one of your friends would not know find out where you are if he/she is at the upper atelier.
33. After 3:30 in the afternoon, you don't have to know where one of your friends is.
34. Ask someone to make sure that he/she receives your check-ins from now until half an hour later.
35. Ask someone to make sure that he/she does not receive check-ins from his/her friends from now until half an hour later.
36. Ask someone to make sure that he/she receives your check-ins from now until fifteen minutes later.
37. Ask someone to make sure that he/she does not receive check-ins from his/her friends from now until fifteen minutes later.

A.3. Questionnaire

Table A.1 shows the questionnaire part used to measure user values, and the values each item measures. Table A.2 shows the questionnaire part used usability and social actorship.

Table A.1: Questionnaire part used to measure user values, and the values each item measures (translated).

No.	Statement	labels	SR	FR	FD	ID	IH	RS	FS
1	If I would use this app, it would be [blank] for me to make appointments with friends, for example to go to the park, playground or school.	much less easy, the same, much easier	x	x	x	x			
2	If I would use this app, it would be [blank] for me to find out if my friends are playing outside.	much less easy, the same, much easier	x	x					
3	If I would use this app, it would be [blank] for me to go to the playground with friends.	much less easy, the same, much easier		x					
4	If I would use this app, it would be [blank] for me to remain in contact with my friends.	much less easy, the same, much easier	x	x					
5	If I would use this app, it would be [blank] for me to go and play at one of my friends's.	much less easy, the same, much easier	x	x		x			
6	If I would use this app, it would be [blank] for me to find out where my friends are.	much less easy, the same, much easier		x					
7	If I would use this app, it would be [blank] for me to visit family members (like my grandfather, grandmother, aunts, uncles, and cousins.	much less easy, the same, much easier			x	x			
8*	If I would use this app, the number of arguments with my parents would probably become [blank].	much less, the same, much more					x		

No.	Statement	labels	SR	FR	FD	ID	IH	RS	FS
9*	If I would use this app, it would be [blank] to go on a family visit on my own.	much less scary, the same, much scarier				x			
10*	If I would use this app, it would be [blank] to go visit a friend on my own.	much less scary, the same, much scarier				x			
11*[i]	If I would use this app, it would be [blank] to go to school on my own.	much less scary, the same, much scarier				x			
12*[i]	If I would use this app, my parents would [blank] tell me what to do, like my homework for example.	much less often, the same, much more often			x	x			
13*	If I would use this app, my parents would worry [blank] if I go to school on my own.	much less, the same, much more							x
14*[i]	If I would use this app, my parents would probably treat me [blank] like a child.	much less, the same, much more			x	x		x	
15[i]	If I would use this app, my parents would allow me [blank] to visit friends who live far from me.	much less, the same, much more				x			
16	If I would use this app, I would be [blank] to go to certain places in my neighborhood.	much less confident, the same, much more confident				x			
17	If I would use this app, my parents would allow me [blank] to go to school on my own.	much less often, the same, much more often				x			
18	If I would use this app, my father and mother would know [blank] exactly where I am.	much less often, the same, much more often							x
19	If I would use this app, my friends would know [blank] where I am.	much less often, the same, much more often	x	x					

Table A.1: Values: SR = social recognition, FR = friendship, FD = freedom, ID = independence, IH = inner harmony, RS = responsibility, FS = family security. Items with an asterisk (*) are reversed during calculations. Items marked with (i) were removed as a measure of the value “independence” during reliability analysis.

Table A.2: Questionnaire part used to measure usability and social actorship (translated).

No. & Statement	labels
Usability	
20. The app was easy to use.	no, in between, yes
21. I understand how he app works.	no, in between, yes
Social actorship	
Liking	
22. I liked using the app.	no, in between, yes
23. I would like to use the app in the future.	no, in between, yes
24. I would tell others about the app.	no, in between, yes
Dominance	
25. I feel like the app acts like a boss over me.	no, in between, yes
Trust	
26. I feel that the app does what I want it to do.	no, in between, yes
27. I think the app does nothing sneaky.	no, in between, yes
28^{t}. I think the app is honest.	no, in between, yes
29. I think the app would never tell on me.	no, in between, yes
30^{t}. I think the app can keep a secret.	no, in between, yes
Intimcy	
31. The app is a friend.	no, in between, yes

Items marked with (t) were removed as a measure of the social actorship item “trust” during reliability analysis.

A.4. Example scenario pair and conflicting designated solutions

A.4.1. Scenario A

Mary is an 8 years old child, and Paul is her father. Paul wants to find out when Mary arrives at the park. She is going there on her own for the first time, and Paul is worried. You are Paul, use the menu below to construct an agreement to find out when Mary arrives at the park.

Designated solution: I want *Mary* to *share* her location with *me* if *she's at the park*.

A.4.2. Scenario B

Mary is an 8 years old child, and Paul is her father. Paul has a meeting between 3pm and 5pm, and will be very busy during that time. But Mary checks-in frequently all day long, and shares with everybody. You are Paul, use the menu below to construct an agreement to ensure that Mary does not notify you with her location during your meeting.

Designated solution: I want *Mary* to *not share* her location with *me* if *it's between 3pm and 5pm*.

A.4.3. Conflict between designated solutions

Using the conflict detection algorithm in section 5.3.1, we can see that the two agreements have the same debtor, opposite norm types, same action, overlapping third party, and possibly overlapping conditions. We therefore conclude that a conflict may occur, e.g. to share or not to share Mary's location if she enters the park between 3pm and 5pm.

A.4.4. The remaining scenario pairs

- (A) Mary and Jason are both 8 years old children. Jason wants to play with Mary after school (some time between 3 and 5 pm). Jason does not know where Mary is going to play. You are Jason. Use the menu below to construct an agreement to find out where Mary is going to play.

  (B) Mary and Jason are both 8 years old children. Mary lives next door, and Jason does not want to be informed every time Mary comes home. You are Jason. Use the menu below to construct an agreement to ensure that Mary does not notify you when she arrives home.

- (A) Mary, Jason and Mike are all 8 years old children. Jason wants to play with Mary in the park nearby her house. Jason may forget to inform Mary when he arrives at the park. You are Mike. Use the menu below to construct an agreement to ensure Jason informs Mary of his arrival at the park.

  (B) Jason and Mike are both 8 years old children. Mike thinks that Jason should be more careful when sharing his whereabouts with others. But when Jason goes to the park he keeps sharing his location with everybody. You are Mike. Use the menu below to construct an agreement to ensure that Jason does not tell anyone that he's at the park.

- (A) Jason is an 8 years old child. Lisa is his mother, and Peter is his father. Jason is going to play with his friends after school (some time between 3:30pm and 6pm).

Lisa is supposed to drive Jason home afterwards. The parents do not know where Jason and his friends are going to play. You are Peter. Use the menu below to construct an agreement to ensure that Lisa finds out where Jason is going.

(B) Jason is an 8 years old child. Peter is his father, and Lisa is his mother. Lisa has a meeting (between 3pm and 5pm) and she does not want to be interrupted during that time. But Jason does not know that, and he might share a few check-ins with her during that time. You are Peter. Use the menu below to construct an agreement to ensure that Jason does not share his location with Lisa during her meeting.

- (A) Jason is an 8 years old child. Lisa is his mother. Lisa wants to drive Jason home when he's done playing at the park. Lisa wants to make sure Jason is aware when she arrives. You are Lisa. Use the menu below to construct an agreement to ensure that Jason is informed of your location while he's playing at the park.

  (B) Jason is an 8 years old child. Lisa is his mother. Lisa wants Jason's grades at school to improve. But Jason is easily distracted by all the notifications on his smart phone during the time where he's supposed to do his homework (between 4:30pm and 6pm). You are Lisa. Use the menu below to construct an agreement to ensure that Jason does not receive notifications from anybody during the time where he's supposed to do his homework.

- (A) Mary and Jason are both 8 years old children. Mary wants Jason to come and play with her in the afternoon (sometime between 3pm and 5pm). Mary does not know yet exactly where she is going to play. You are Mary. Use the menu below to construct an agreement to ensure that Jason knows where you're going this afternoon.

  (B) Mary and Jason are both 8 years old children. Mary does not want to bother Jason with too many notifications. For example, Mary is going on a school trip (between 11am and 4pm) and she is going to check-in at every place they visit. You are Mary. Use the menu below to construct an agreement to ensure that Jason is not notified of your location during that trip.

- (A) Jason is an 8 years old child. Lisa is his mother, and Peter is his father. Peter wants to pick Jason from school when he's done with work. Peter is going to be late, but Lisa agrees to pick Jason up instead. You are Peter. Use the menu below to construct an agreement to ensure that Jason finds out when Lisa arrives to pick him up.

  (B) Jason is an 8 years old child. Peter is his father. Peter wants Jason's grades at school to improve. Jason is easily distracted by all the notifications on his smart phone when he's at school. You are Peter. Use the menu below to construct an agreement to ensure that Jason does not receive notifications from anybody while he's at school. You are Mary. Use the menu below to construct an agreement to ensure that Jason is not notified of your location during that trip.

- (A) Mary and Jason are both 8 years old children. Mary wants Jason to meet more friends in their neighborhood. But Jason does not know where his friends play in the afternoon (some time between 4pm and 6pm), and therefore has not, up to now,

joined them. You are Mary. Use the menu below to construct an agreement to ensure that Jason finds out where his friends play in the afternoon.

(B) Mary and Jason are both 8 years old children.Mary and Jason go to the same school. Jason therefore does not need to be notified if Mary arrives at school. But Mary checks in when she arrives at school every day. You are Mary. Use the menu below to construct an agreement to ensure that Jason is not notified of your check-ins if he's at school. You are Peter. Use the menu below to construct an agreement to ensure that Jason does not share his location with Lisa during her meeting.

References

Abel, F., Hauff, C., Houben, G.-J., Stronkman, R., and Tao, K. (2012). Semantics + filtering + search = twitcident. exploring information in social web streams. In *Proceedings of the 23rd ACM Conference on Hypertext and Social Media*, HT '12, pages 285–294, New York, NY, USA. ACM.

Ajmeri, N., Jiang, J., Chirkova, R., Doyle, J., and Singh, M. P. (2016). Coco: Runtime reasoning about conflicting commitments. In *Proceedings of the Twenty-Fifth International Joint Conference on Artificial Intelligence, IJCAI 2016, New York, NY, USA, 9-15 July 2016*, pages 17–23.

Ali, R., Solís, C., Omoronyia, I., Salehie, M., and Nuseibeh, B. (2012). Social adaptation - when software gives users a voice. In *ENASE*, pages 75–84.

Andrighetto, G., Governatori, G., Noriega, P., and van der Torre, L., editors (2013). *Normative Multi-Agent Systems*, volume 4 of *Dagstuhl Follow-Ups*. Schloss Dagstuhl–Leibniz-Zentrum fuer Informatik.

Arciszewski, H., de Greef, T., and van Delft, J. (2009). Adaptive automation in a naval combat management system. *Systems, Man and Cybernetics, Part A: Systems and Humans, IEEE Transactions on*, 39(6):1188 –1199.

Balke, T., da Costa Pereira, C., Dignum, F., Lorini, E., Rotolo, A., Vasconcelos, W., and Villata, S. (2013). Norms in MAS: Definitions and related concepts. In *Normative Multi-Agent Systems*, pages 1–31.

Bench-Capon, T. (2003). Persuasion in practical argument using value-based argumentation frameworks. *J. Log. Comput.*, 13(3):429–448.

Benisch, M., Kelley, P. G., Sadeh, N., and Cranor, L. F. (2011). Capturing location-privacy preferences: Quantifying accuracy and user-burden tradeoffs. *Personal Ubiquitous Comput.*, 15(7):679–694.

Bernard., H. R. (1995). *Research Methods in Anthropology. Qualitative and Quantitative Approaches.* AltaMira Press, Walnut Creek, USA.

Bernhaupt, R., Obrist, M., Weiss, A., Beck, E., and Tscheligi, M. (2008). Trends in the living room and beyond: results from ethnographic studies using creative and playful probing. *Comput. Entertain.*, 6(1):5:1–5:23.

Bernhaupt, R., Weiss, A., Obrist, M., and Tscheligi, M. (2007). Playful probing: making probing more fun. In *Proceedings of the 11th IFIP TC 13 international conference on Human-computer interaction*, INTERACT'07, pages 606–619, Berlin, Heidelberg. Springer-Verlag.

Bocconi, S., Bozzon, A., Psyllidis, A., Bolivar, C. T., and Houben, G. (2015). Social glass: A platform for urban analytics and decision-making through heterogeneous social data. In *Proceedings of the 24th International Conference on World Wide Web Companion, WWW 2015, Florence, Italy, May 18-22, 2015 - Companion Volume*, pages 175–178.

Boella, G., Broersen, J., and van de Torre, L. (2008). Reasoning about constitutive norms, counts-as conditionals, institutions, deadlines and violations. PRIMA '08, pages 86–97, Berlin, Heidelberg. Springer-Verlag.

Borlund, P. and Schneider, J. W. (2010). Reconsideration of the simulated work task situation: A context instrument for evaluation of information retrieval interaction. In *Proceedings of the Third Symposium on Information Interaction in Context*, IIiX '10, pages 155–164, New York, NY, USA. ACM.

Breazeal, C., Gray, J., Hoffman, R. R., and Berlin, M. (2004). Social robots: Beyond tools to partners. In *13th IEEE International Workshop on Robot and Human Interactive Communication (ROMAN'04)*, pages 551–556. IEEE Press.

Brinkman, W.-P. (2009). Design of a questionnaire instrument. *Handbook of Mobile Technology Research Methods*, page 31–57.

Brinkman, W.-P., Haakma, R., and Bouwhuis, D. (2009). theoretical foundation and validity of a component-based usability questionnaire. *Behaviour and Information Technology*, 28(2):121–137.

Broersen, J. (2004). Action negation and alternative reductions for dynamic deontic logics. *Journal of Applied Logic*, 2(1):153–168.

Broersen, J., Dignum, F., Dignum, V., and Meyer, J.-J. C. (2004). Designing a deontic logic of deadlines. In *DEON*, pages 43–56.

Brooke, J. (1996). Sus: A quick and dirty usability scale.

Brown, J., Collins, A., Duguid, P., BERANEK, B., MA., N. I. C., and of Illinois at Urbana-Champaign. Center for the Study of Reading, U. (1989). *Situated Cognition and the Culture of Learning*. Report (Institute for Research on Learning). University of Illinois at Urbana-Champaign.

Carenini, G. and Loyd, J. (2004). Valuecharts: Analyzing linear models expressing preferences and evaluations. In *Proceedings of the Working Conference on Advanced Visual Interfaces*, AVI '04, pages 150–157, New York, NY, USA. ACM.

Chopra, A. and Singh, M. (2012). Interaction-oriented software engineering: Concepts and principles. *CoRR*, abs/1211.4123.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*. Lawrence Erlbaum Associates.

Creswell, J. W. (1998). *Qualitative inquiry and research design : choosing among five traditions*. Sage Publications, 1st edition.

Criado, N., Black, E., and Luck, M. (2015). A coherence maximisation process for solving normative inconsistencies. *Autonomous Agents and Multi-Agent Systems*, pages 1–41.

Czeskis, A., Dermendjieva, I., Yapit, H., Borning, A., Friedman, B., Gill, B., and Kohno, T. (2010). Parenting from the pocket: value tensions and technical directions for secure and private parent-teen mobile safety. In *Proceedings of the Sixth Symposium on Usable Privacy and Security (SOUPS'10)*, pages 15:1–15:15. ACM.

Dastani, M., van Riemsdijk, M. B., and Winikoff, M. (2011). Rich goal types in agent programming. In *Proceedings of the tenth international joint conference on autonomous agents and multiagent systems (AAMAS'11)*, pages 405–412. IFAAMAS.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Q.*, 13(3):319–340.

de Greef, T. (2012). *ePartners for dynamic task allocation and coordination*. PhD thesis, Delft University of Technology.

Debatin, B., Lovejoy, J. P., Horn, A.-K., and Hughes, B. N. (2009). Facebook and online privacy: Attitudes, behaviors, and unintended consequences. *Journal of Computer-Mediated Communication*, 15(1):83–108.

Denning, T., Borning, A., Friedman, B., Gill, B. T., Kohno, T., and Maisel, W. H. (2010). Patients, pacemakers, and implantable defibrillators: Human values and security for wireless implantable medical devices. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '10, pages 917–926, New York, NY, USA. ACM.

Dignum, V. (2004). *A Model for Organizational Interaction: Based on Agents, Founded in Logic*. PhD thesis.

Dignum, V. (2017). Responsible autonomy. In *Proceedings of the Twenty-Sixth International Joint Conference on Artificial Intelligence, IJCAI 2017, Melbourne, Australia, August 19-25, 2017*, pages 4698–4704.

Fails, J. A., Guha, M. L., and Druin, A. (2013). *Methods and Techniques for Involving Children in the Design of New Technology for Children*. Now Publishers Inc., Hanover, MA, USA.

Fernández-Tobías, I., Braunhofer, M., Elahi, M., Ricci, F., and Cantador, I. (2016). Alleviating the new user problem in collaborative filtering by exploiting personality information. *User Modeling and User-Adapted Interaction*, pages 1–35.

Field, A., Miles, J., and Field, Z. (2012). *Discovering Statistics Using R*. SAGE Publications.

Figueiredo, K. and Silva, V. (2013). Identifying conflicts between norms and values. In *Proceedings of the 15th workshop on Coordination, Organizations, Institutions, and Norms (COIN)*.

Finch, W., Bolin, J., and Kelley, K. (2014). *Multilevel Modeling Using R*. Chapman & Hall/CRC Statistics in the Social and Behavioral Sciences. Taylor & Francis.

Fogg, B. J. (2002). *Persuasive Technology: Using Computers to Change What We Think and Do*. Science & Technology Books, 1 edition.

Fogli, D. and Guida, G. (2013). Knowledge-centered design of decision support systems for emergency management. *Decis. Support Syst.*, 55(1):336–347.

Fogues, R. L., Murukannaiah, P. K., Such, J. M., and Singh, M. P. (2017). Sharing policies in multiuser privacy scenarios: Incorporating context, preferences, and arguments in decision making. *ACM Trans. Comput.-Hum. Interact.*, 24(1):5:1–5:29.

Friedman, B. (1996). Value-sensitive design. *interactions*, 3(6):16–23.

Friedman, B. and Kahn, Jr., P. H. (2003). The human-computer interaction handbook. chapter Human values, ethics, and design, pages 1177–1201. L. Erlbaum Associates Inc., Hillsdale, NJ, USA.

Gaver, B., Dunne, T., and Pacenti, E. (1999). Design: Cultural probes. *interactions*, 6(1):21–29.

Gefen, D., Karahanna, E., and Straub, D. W. (2003). Trust and tam in online shopping: An integrated model. *MIS Q.*, 27(1):51–90.

Ghose, A. and Savarimuthu, B. (2012). Norms as objectives: Revisiting compliance management in multi-agent systems. In *COIN@AAMAS*, pages 105–122.

Gorsuch, R. (1983). *Factor Analysis*. Psychology Press.

Gosling, S. D., Vazire, S., Srivastava, S., and John, O. P. (2004). Should we trust Web-based studies? A comparative analysis of six preconceptions about Internet questionnaires. *American Psychologist*, 59(2):93–104.

Gutierrez, R. L. Z., Murukannaiah, P. K., Poosamani, N., Finin, T., Joshi, A., Rhee, I., and Singh, M. P. (2015). Platys: From position to place-oriented mobile computing. *AI Magazine*, 36(2):50–62.

Hair, Jr., J. F., Anderson, R. E., Tatham, R. L., and Black, W. C. (1995). *Multivariate Data Analysis (4th Ed.): With Readings*. Prentice-Hall, Inc., Upper Saddle River, NJ, USA.

Hansson, S. (1991). Norms and values. *Crítica*, 23(67):3–13.

Hasinoff, A. A. (2017). Where are you? location tracking and the promise of child safety. *Television & New Media*, 18(6):496–512.

Henkemans, O. A. B., van der Boog, P., Lindenberg, J., van der Mast, C., Neerincx, M., and Zwetsloot-Schonk, B. J. H. M. (2009). An online lifestyle diary with a persuasive computer assistant providing feedback on self-management. *Technology & Health Care*, 17:253–257.

Hindriks, K. and van Riemsdijk, B. (2013). A real-time semantics for norms with deadlines. In *AAMAS*, pages 507–514.

Hindriks, K. V., Neerincx, M. A., and Vink, M. (2011). The icat as a natural interaction partner - playing go fish with a robot. In *Advanced Agent Technology - AAMAS 2011 Workshops, AMPLE, AOSE, ARMS, DOCM3AS, ITMAS, Taipei, Taiwan, May 2-6, 2011.*, volume 7068 of *Lecture Notes in Computer Science*, pages 212–231.

Hollnagel, E. and Woods, D. D. (1983). Cognitive systems engineering: new wine in new bottles. *Int. J. Man-Mach. Stud.*, 18(6):583–600.

Howard, M. W. and Kahana, M. J. (2002). A distributed representation of temporal context. *Journal of Mathematical Psychology*, 46(3):269 – 299.

Hübner, J., Sichman, J., and Boissier, O. (2007). Developing organised multiagent systems using the MOISE+ model: programming issues at the system and agent levels. *International Journal of Agent-Oriented Software Engineering*, 1(3/4):370–395.

Hübner, J. F., Boissier, O., and Bordini, R. H. (2010). From organisation specification to normative programming in multi-agent organisations. In *Proceedings of the 11th international conference on Computational logic in multi-agent systems*, CLIMA'10, pages 117–134, Berlin, Heidelberg. Springer-Verlag.

Huldtgren, A., Wiggers, P., and Jonker, C. M. (2014). Designing for self-reflection on values for improved life decision. *Interacting with Computers*, 26(1):27–45.

Kapp, K. M. (2012). *The Gamification of Learning and Instruction: Game-based Methods and Strategies for Training and Education*. Pfeiffer & Company, 1st edition.

Kayal, A., Brinkman, W.-P., Gouman, R., Neerincx, M. A., and van Riemsdijk, M. B. (2014a). A value-centric model to ground norms and requirements for epartners of children. In *Coordination, Organization, Institutions, and Norms in Agent Systems IX*. Springer-Verlag.

Kayal, A., Brinkman, W.-P., Zoon, H., Neerincx, M. A., and van Riemsdijk, M. B. (2014b). A value-sensitive mobile social application for families and children. In *Posters, Demos, Late-breaking Results and Workshop Proceedings of the 22nd Conference on User Modeling, Adaptation, and Personalization co-located with the 22nd Conference on User Modeling, Adaptation, and Personalization (UMAP2014), Aalborg, Denmark, July 7-11, 2014.*

Klein, G., Woods, D. D., Bradshaw, J. M., Hoffman, R. R., and Feltovich, P. J. (2004). Ten challenges for making automation a "team player" in joint human-agent activity. *IEEE Intelligent Systems*, 19(6):91–95.

Knijnenburg, B. P., Willemsen, M. C., Gantner, Z., Soncu, H., and Newell, C. (2012). Explaining the user experience of recommender systems. *User Modeling and User-Adapted Interaction*, 22(4):441–504.

Kökciyan, N. and Yolum, P. (2016). Priguard: A semantic approach to detect privacy violations in online social networks. *IEEE Trans. on Knowl. and Data Eng.*, 28(10):2724–2737.

Kollingbaum, M. and Norman, T. (2003). Norm adoption and consistency in the noa agent architecture. In Dastani, M., Dix, J., and Fallah-Seghrouchni, A. E., editors, *PROMAS*, volume 3067 of *Lecture Notes in Computer Science*, pages 169–186. Springer.

Koster, A., Madrenas, J., Osman, N., Schorlemmer, M., Sabater-Mir, J., Sierra, C., Fabregues, A., de Jonge, D., Puyol-Gruart, J., and Garcia-Calvés, P. (2013). u-help: Supporting helpful communities with information technology. In *Proceedings of the 2013 International Conference on Autonomous Agents and Multi-agent Systems*, AAMAS '13, pages 1109–1110, Richland, SC. International Foundation for Autonomous Agents and Multiagent Systems.

Krantz, J. H. and Dalal, R. (2000). Chapter 2 - validity of web-based psychological research. In Birnbaum, M. H., editor, *Psychological Experiments on the Internet*, pages 35 – 60. Academic Press, San Diego.

Kreuger, R. A. and Casey, M. (2008). *Focus Groups: A Practical Guide for Applied Research*. Pine Forge Pr., 4th edition.

Loewenthal, K. M. (2001). *An introduction to psychological tests and scales*. UCL Press, London.

López y López, F., Luck, M., and d'Inverno, M. (2006). A normative framework for agent-based systems. *Computational & Mathematical Organization Theory*, 12(2-3):227–250.

MacQueen, K., E. M.-L.-K. B. and Milstein., B. (2012). *Team-based codebook development: Structure, process, and agreement*. AltaMira, Lanham, MD.

Manders-Huits, N. (2011). What values in design? the challenge of incorporating moral values into design. *Science and Engineering Ethics*, 17(2):271–287.

Markopoulos, P., Read, J. C., MacFarlane, S., and Hoysniemi, J. (2008). *Evaluating Children's Interactive Products: Principles and Practices for Interaction Designers*. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA.

Marshall, M. N. (1996). Sampling for qualitative research. *Family Practice*, 13(6):522–526.

Meneguzzi, F., Rodrigues, O., Oren, N., Vasconcelos, W. W., and Luck, M. (2015). Bdi reasoning with normative considerations. *Eng. Appl. Artif. Intell.*, 43(C):127–146.

Meyer, J.-J. C. (1987). A different approach to deontic logic: deontic logic viewed as a variant of dynamic logic. *Notre Dame Journal of Formal Logic*, 29(1):109–136.

Miller, J. K., Friedman, B., Jancke, G., and Gill, B. (2007). Value tensions in design: The value sensitive design, development, and appropriation of a corporation's groupware system. In *Proceedings of the 2007 International ACM Conference on Supporting Group Work*, GROUP '07, pages 281–290, New York, NY, USA. ACM.

Munson, S. A., Avrahami, D., Consolvo, S., Fogarty, J., Friedman, B., and Smith, I. (2011). Attitudes toward online availability of us public records. In *Proceedings of the 12th Annual International Digital Government Research Conference: Digital Government Innovation in Challenging Times*, dg.o '11, pages 2–9, New York, NY, USA. ACM.

Murukannaiah, P. K., Ajmeri, N., and Singh, M. P. (2016). Engineering privacy in social applications. *IEEE Internet Computing*, 20(2):72–76.

Myers, K. and Yorke-Smith, N. (2005). A cognitive framework for delegation to an assistive user agent. In *Proceedings of AAAI 2005 Fall Symposium on Mixed-Initiative Problem Solving Assistants*, pages 94–99, Arlington, VA. AAAI Press.

Neerincx, M. and Lindenberg, J. (2008). Situated cognitive engineering for complex task environments. *Naturalistic Decision Making and Macrocognition*, page 373–390.

Nihlen-Fahlquist, J. (2013). Responsibility and privacy – ethical aspects of using GPS to track children. *Children & Society*.

Nissenbaum, H. (2010). *Privacy in Context: Technology, Policy and the Integrity of Social Life*. Stanford University Press, Stanford, California.

Noriega, P., Padget, J., Verhagen, H., and d'Inverno, M. (2016). A manifesto for conscientious design of hybrid online social systems. In *Proceedings of the Workshop on Coordination, Organization, Institutions, and Norms in Agent Systems (COIN@ECAI'16)*.

Norman, D. A. and Draper, S. W. (1986). *User Centered System Design; New Perspectives on Human-Computer Interaction*. L. Erlbaum Associates Inc., Hillsdale, NJ, USA.

Oren, N., Luck, M., Miles, S., and Norman, T. J. (2008). An argumentation inspired heuristic for resolving normative conflict.

Osman, N., Sierra, C., and Schorlemmer, M. (2013). Charters for self-evolving communities. In Lorini, E., editor, *11th European Workshop on Multi-agent Systems (EUMAS 2013)*, volume 1113, pages 112–123. CEUR-WS.org.

Ozcelik Buskermolen, D. and Terken, J. (2012). Co-constructing stories: a participatory design technique to elicit in-depth user feedback and suggestions about design concepts. In *Proceedings of the 12th Participatory Design Conference: Exploratory Papers, Workshop Descriptions, Industry Cases - Volume 2*, PDC '12, pages 33–36, New York, NY, USA. ACM.

Panniello, U. and Gorgoglione, M. (2012). Incorporating context into recommender systems: an empirical comparison of context-based approaches. *Electronic Commerce Research*, 12(1):1–30.

Panniello, U., Tuzhilin, A., and Gorgoglione, M. (2012). Comparing context-aware recommender systems in terms of accuracy and diversity. *User Modeling and User-Adapted Interaction*, 24(1):35–65.

Paping, C., Brinkman, W., and van der Mast, C. (2010). *An Explorative Study into a Tele-delivered Multi-patient Virtual Reality Exposure Therapy System*, page 203–219. IOS press, Amsterdam and The Netherlands.

Pecune, F., Ochs, M., and Pelachaud, C. (2013). A formal model of social relations for artificial companions. In *European Workshop on Multi-Agent Systems (EUMAS)*.

Pinheiro, J., Bates, D., DebRoy, S., Sarkar, D., and R Core Team (2015). nlme: Linear and nonlinear mixed effects models. R package version 3.1-122.

Pommeranz, A., Detweiler, C., Wiggers, P., and Jonker, C. (2011). Elicitation of situated values: need for tools to help stakeholders and designers to reflect and communicate. *Ethics and Information Technology*, 14(4):285–303.

Robson, C. (2002). *Real World Research - A Resource for Social Scientists and Practitioner-Researchers*. Blackwell Publishing, Malden, second edition.

Rokeach, M. (1973). *The nature of human values*.

Sahadat, I. (2016). Kinderen volgen met gps-trackers: paranoid parenting? *De Volkskrant*.

Schmehl, S., Deutsch, S., Schrammel, J., Paletta, L., and Tscheligi, M. (2011). Directed cultural probes: Detecting barriers in the usage of public transportation. In *Human-Computer Interaction - INTERACT 2011 - 13th IFIP TC 13 International Conference, Lisbon, Portugal, September 5-9, 2011, Proceedings, Part I*, volume 6946 of *Lecture Notes in Computer Science*, pages 404–411. Springer.

Schroeder, M. (2012). Value theory. In Zalta, E. N., editor, *The Stanford Encyclopedia of Philosophy*. Summer 2012 edition.

Schwartz, S. H. (2012). An overview of the schwartz theory of basic values. *Online Readings in Psychology and Culture*, 2(1):11.

Singh, M. (1999). An ontology for commitments in multiagent systems. *Artificial Intelligence and Law*, pages 97–113.

Singh, M. P. (2008). Semantical considerations on dialectical and practical commitments. In *Proceedings of the 23rd National Conference on Artificial Intelligence - Volume 1*, AAAI'08, pages 176–181. AAAI Press.

Singh, M. P. and Telang, P. R. (2012). Specifying and verifying cross-organizational business models: An agent-oriented approach. *IEEE Transactions on Services Computing*, 5(undefined):305–318.

Sra, M. and Schmandt, C. (2013). Spotz: A location-based approach to self-awareness. In Berkovsky, S. and Freyne, J., editors, *Persuasive Technology*, volume 7822 of *Lecture Notes in Computer Science*, pages 216–221. Springer Berlin Heidelberg.

Strauss, A. and Corbin, J. (1998). *Basics of Qualitative Research: Techniques and Procedures for developing Grounded Theory*. Sage Publications Inc.

Such, J. M. and Criado, N. (2014). Adaptive conflict resolution mechanism for multi-party privacy management in social media. In *Proceedings of the 13th Workshop on Privacy in the Electronic Society*, WPES '14, pages 69–72, New York, NY, USA. ACM.

Such, J. M. and Criado, N. (2016). Resolving multi-party privacy conflicts in social media. *IEEE Trans. Knowl. Data Eng.*, 28(7):1851–1863.

Uszok, A., Bradshaw, J. M., and Jeffers, R. (2004). Kaos: A policy and domain services framework for grid computing and semantic web services. In Jensen, C. D., Poslad, S., and Dimitrakos, T., editors, *iTrust*, volume 2995 of *Lecture Notes in Computer Science*, pages 16–26. Springer.

van de Poel, I. (2013). *Translating Values into Design Requirements*, pages 253–266. Springer Netherlands, Dordrecht.

van der Weide, T. (2011). *Arguing to motivate decisions*. PhD thesis, Utrecht University.

van Diggelen, J. and Neerincx, M. (2010). Electronic partners that diagnose and guide and mediate space crew's social and cognitive and affective processes. In *Proceedings of Measuring Behaviour 2010*, page 73–76, Wageningen and The Netherlands. Noldus InformationTechnology bv, Noldus InformationTechnology bv.

van Riemsdijk, M. B., Dennis, L., Fisher, M., and Hindriks, K. V. (2015a). A semantic framework for socially adaptive agents: Towards strong norm compliance. In *Proceedings of the 2015 International Conference on Autonomous Agents and Multiagent Systems*, AAMAS '15, pages 423–432, Richland, SC. International Foundation for Autonomous Agents and Multiagent Systems.

van Riemsdijk, M. B., Jonker, C. M., and Lesser, V. (2015b). Creating socially adaptive electronic partners: Interaction, reasoning and ethical challenges. In *Proceedings of the fourteenth international joint conference on autonomous agents and multiagent systems (AAMAS'15)*, pages 1201–1206. IFAAMAS.

Van Wynsberghe, A. (2012). *Designing robots with care: Creating an ethical framework for the future design and implementation of care robots*. Universiteit Twente.

Vasalou, A., Oostveen, A.-M., and Joinson, A. N. (2012). A case study of non-adoption: The values of location tracking in the family. In *Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work (CSCW'12)*, pages 779–788. ACM.

Vasconcelos, W. W., Kollingbaum, M. J., and Norman, T. J. (2009). Normative conflict resolution in multi-agent systems. *Autonomous Agents and Multi-Agent Systems*, 19(2):124–152.

Vázquez-Salceda, J. and Dignum, F. (2003). Modelling electronic organizations. In *Proceedings of the 3rd Central and Eastern European conference on Multi-agent systems*, CEEMAS'03, pages 584–593, Berlin, Heidelberg. Springer-Verlag.

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. (2003). User acceptance of information technology: Toward a unified view.

Verbeek, P. (2014). *Op de vleugels van Icarus: hoe techniek en moraal met elkaar meebewegen*. Lemniscaat, Uitgeverij.

Vinciarelli, A., Pantic, M., Heylen, D., Pelachaud, C., Poggi, I., D'Errico, F., and Schröder, M. (2012). Bridging the gap between social animal and unsocial machine: A survey of social signal processing. *IEEE Trans. Affective Computing*, 3(1):69–87.

Winter, B. (2013). A very basic tutorial for performing linear mixed effects analyses. *arXiv preprint arXiv:1308.5499*.

Woelfer, J. P. and Hendry, D. G. (2011). Homeless young people and technology: Ordinary interactions, extraordinary circumstances. *interactions*, 18(6):70–73.

Yoo, D., Lake, M., Nilsen, T., Utter, M. E., Alsdorf, R., Bizimana, T., Nathan, L. P., Ring, M., Utter, E. J., Utter, R. F., and Friedman, B. (2013). Envisioning across generations: A multi-lifespan information system for international justice in rwanda. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '13, pages 2527–2536, New York, NY, USA. ACM.

Acknowledgements

Conducting the necessary research to write this thesis would not have been possible without the contributions of many. Here's my attempt at remembering all of them, apologies in advance if any names were forgotten.

First of all I'd like to thank my promotor Mark Neerincx and my co-promotors Birna van Riemsdijk and Willem-Paul Brinkman, as well as the head of the Interactive Intelligence group Catholijn Jonker for their limitless support throughout the past 5 years.

Then I'd like to thank Tim Baarslag, Christian Detweiler, Tjerk de Greef, Nanja Smets, and Judith Redi for their insights on multi-agent systems, value-sensitive design, cognitive engineering and crowd sourcing.

The user studies conducted in this thesis would not have been possible without the help of many. I'd like to thank Fleur Arkesteijn, Christina Katsimerou, Frank de Jong, Thomas King, Corine Horsch, Maaike Harbers, Hanna Zoon and Rianne Gouman for being present during the sessions and assisting with all sorts of unexpected tasks.

I'd like to thank Myrthe Tielman, Ursula Beer, and Dylan Schouten for providing voice commentary over explanatory user-study videos, and helping with English to Dutch translation during times when my Dutch was quite sub-par.

Finally I'd like to thank the members of the interactive intelligence group, especially the VRET group, as well as our colleagues at TNO Soesterberg and the COMMIT/ project, my new colleagues at Exact, and the friends I have across the Randstad metropolitan area for scientific (and non-scientific) insights, and overall for good times.

List of Publications

6. **Alex Kayal, Willem-Paul Brinkman, Mark A. Neerincx, M. Birna van Riemsdijk**, *Automatic resolution of normative conflicts in supportive technology based on user values*, Under review.

5. **Alex Kayal, M. Birna van Riemsdijk, Mark A. Neerincx, Willem-Paul Brinkman**, *Socially adaptive electronic partners for improved support of children's values: an empirical study with a location-sharing mobile app*, Under review.

4. **Alex Kayal, Willem-Paul Brinkman, Mark A. Neerincx, M. Birna van Riemsdijk**, *A social commitment model for location sharing applications in the family domain*, Under review.

3. **Anita H. M. Cremers, Yvonne J. F. M. Jansen, Mark A. Neerincx, Dylan Schouten, Alex Kayal**, *Inclusive Design and Anthropological Methods to Create Technological Support for Societal Inclusion.*, HCI (4) 2014: 31-42.

2. **Alex Kayal, Willem-Paul Brinkman, Hanna Zoon, Mark A. Neerincx, M. Birna van Riemsdijk**, *A Value-Sensitive Mobile Social Application for Families and Children.*, UMAP Workshops 2014.

1. **Alex Kayal, Willem-Paul Brinkman, Rianne Gouman, Mark A. Neerincx, M. Birna van Riemsdijk**, *A Value-Centric Model to Ground Norms and Requirements for ePartners of Children.*, COIN@AAMAS/PRIMA 2013: 329-345.

SIKS Dissertation Series

2011 01 Botond Cseke (RUN), Variational Algorithms for Bayesian Inference in Latent Gaussian Models
02 Nick Tinnemeier (UU), Organizing Agent Organizations. Syntax and Operational Semantics of an Organization-Oriented Programming Language
03 Jan Martijn van der Werf (TUE), Compositional Design and Verification of Component-Based Information Systems
04 Hado van Hasselt (UU), Insights in Reinforcement Learning; Formal analysis and empirical evaluation of temporal-difference
05 Bas van der Raadt (VU), Enterprise Architecture Coming of Age - Increasing the Performance of an Emerging Discipline.
06 Yiwen Wang (TUE), Semantically-Enhanced Recommendations in Cultural Heritage
07 Yujia Cao (UT), Multimodal Information Presentation for High Load Human Computer Interaction
08 Nieske Vergunst (UU), BDI-based Generation of Robust Task-Oriented Dialogues
09 Tim de Jong (OU), Contextualised Mobile Media for Learning
10 Bart Bogaert (UvT), Cloud Content Contention
11 Dhaval Vyas (UT), Designing for Awareness: An Experience-focused HCI Perspective
12 Carmen Bratosin (TUE), Grid Architecture for Distributed Process Mining
13 Xiaoyu Mao (UvT), Airport under Control. Multiagent Scheduling for Airport Ground Handling
14 Milan Lovric (EUR), Behavioral Finance and Agent-Based Artificial Markets
15 Marijn Koolen (UvA), The Meaning of Structure: the Value of Link Evidence for Information Retrieval
16 Maarten Schadd (UM), Selective Search in Games of Different Complexity
17 Jiyin He (UVA), Exploring Topic Structure: Coherence, Diversity and Relatedness
18 Mark Ponsen (UM), Strategic Decision-Making in complex games
19 Ellen Rusman (OU), The Mind's Eye on Personal Profiles
20 Qing Gu (VU), Guiding service-oriented software engineering - A view-based approach
21 Linda Terlouw (TUD), Modularization and Specification of Service-Oriented Systems
22 Junte Zhang (UVA), System Evaluation of Archival Description and Access
23 Wouter Weerkamp (UVA), Finding People and their Utterances in Social Media
24 Herwin van Welbergen (UT), Behavior Generation for Interpersonal Coordination with Virtual Humans On Specifying, Scheduling and Realizing Multimodal Virtual Human Behavior

25 Syed Waqar ul Qounain Jaffry (VU), Analysis and Validation of Models for Trust Dynamics
26 Matthijs Aart Pontier (VU), Virtual Agents for Human Communication - Emotion Regulation and Involvement-Distance Trade-Offs in Embodied Conversational Agents and Robots
27 Aniel Bhulai (VU), Dynamic website optimization through autonomous management of design patterns
28 Rianne Kaptein (UVA), Effective Focused Retrieval by Exploiting Query Context and Document Structure
29 Faisal Kamiran (TUE), Discrimination-aware Classification
30 Egon van den Broek (UT), Affective Signal Processing (ASP): Unraveling the mystery of emotions
31 Ludo Waltman (EUR), Computational and Game-Theoretic Approaches for Modeling Bounded Rationality
32 Nees-Jan van Eck (EUR), Methodological Advances in Bibliometric Mapping of Science
33 Tom van der Weide (UU), Arguing to Motivate Decisions
34 Paolo Turrini (UU), Strategic Reasoning in Interdependence: Logical and Game-theoretical Investigations
35 Maaike Harbers (UU), Explaining Agent Behavior in Virtual Training
36 Erik van der Spek (UU), Experiments in serious game design: a cognitive approach
37 Adriana Burlutiu (RUN), Machine Learning for Pairwise Data, Applications for Preference Learning and Supervised Network Inference
38 Nyree Lemmens (UM), Bee-inspired Distributed Optimization
39 Joost Westra (UU), Organizing Adaptation using Agents in Serious Games
40 Viktor Clerc (VU), Architectural Knowledge Management in Global Software Development
41 Luan Ibraimi (UT), Cryptographically Enforced Distributed Data Access Control
42 Michal Sindlar (UU), Explaining Behavior through Mental State Attribution
43 Henk van der Schuur (UU), Process Improvement through Software Operation Knowledge
44 Boris Reuderink (UT), Robust Brain-Computer Interfaces
45 Herman Stehouwer (UvT), Statistical Language Models for Alternative Sequence Selection
46 Beibei Hu (TUD), Towards Contextualized Information Delivery: A Rule-based Architecture for the Domain of Mobile Police Work
47 Azizi Bin Ab Aziz (VU), Exploring Computational Models for Intelligent Support of Persons with Depression
48 Mark Ter Maat (UT), Response Selection and Turn-taking for a Sensitive Artificial Listening Agent
49 Andreea Niculescu (UT), Conversational interfaces for task-oriented spoken dialogues: design aspects influencing interaction quality

2012 01 Terry Kakeeto (UvT), Relationship Marketing for SMEs in Uganda
02 Muhammad Umair (VU), Adaptivity, emotion, and Rationality in Human and Ambient Agent Models

03 Adam Vanya (VU), Supporting Architecture Evolution by Mining Software Repositories
04 Jurriaan Souer (UU), Development of Content Management System-based Web Applications
05 Marijn Plomp (UU), Maturing Interorganisational Information Systems
06 Wolfgang Reinhardt (OU), Awareness Support for Knowledge Workers in Research Networks
07 Rianne van Lambalgen (VU), When the Going Gets Tough: Exploring Agent-based Models of Human Performance under Demanding Conditions
08 Gerben de Vries (UVA), Kernel Methods for Vessel Trajectories
09 Ricardo Neisse (UT), Trust and Privacy Management Support for Context-Aware Service Platforms
10 David Smits (TUE), Towards a Generic Distributed Adaptive Hypermedia Environment
11 J.C.B. Rantham Prabhakara (TUE), Process Mining in the Large: Preprocessing, Discovery, and Diagnostics
12 Kees van der Sluijs (TUE), Model Driven Design and Data Integration in Semantic Web Information Systems
13 Suleman Shahid (UvT), Fun and Face: Exploring non-verbal expressions of emotion during playful interactions
14 Evgeny Knutov (TUE), Generic Adaptation Framework for Unifying Adaptive Web-based Systems
15 Natalie van der Wal (VU), Social Agents. Agent-Based Modelling of Integrated Internal and Social Dynamics of Cognitive and Affective Processes.
16 Fiemke Both (VU), Helping people by understanding them - Ambient Agents supporting task execution and depression treatment
17 Amal Elgammal (UvT), Towards a Comprehensive Framework for Business Process Compliance
18 Eltjo Poort (VU), Improving Solution Architecting Practices
19 Helen Schonenberg (TUE), What's Next? Operational Support for Business Process Execution
20 Ali Bahramisharif (RUN), Covert Visual Spatial Attention, a Robust Paradigm for Brain-Computer Interfacing
21 Roberto Cornacchia (TUD), Querying Sparse Matrices for Information Retrieval
22 Thijs Vis (UvT), Intelligence, politie en veiligheidsdienst: verenigbare grootheden?
23 Christian Muehl (UT), Toward Affective Brain-Computer Interfaces: Exploring the Neurophysiology of Affect during Human Media Interaction
24 Laurens van der Werff (UT), Evaluation of Noisy Transcripts for Spoken Document Retrieval
25 Silja Eckartz (UT), Managing the Business Case Development in Inter-Organizational IT Projects: A Methodology and its Application
26 Emile de Maat (UVA), Making Sense of Legal Text
27 Hayrettin Gurkok (UT), Mind the Sheep! User Experience Evaluation & Brain-Computer Interface Games
28 Nancy Pascall (UvT), Engendering Technology Empowering Women
29 Almer Tigelaar (UT), Peer-to-Peer Information Retrieval

30 Alina Pommeranz (TUD), Designing Human-Centered Systems for Reflective Decision Making
31 Emily Bagarukayo (RUN), A Learning by Construction Approach for Higher Order Cognitive Skills Improvement, Building Capacity and Infrastructure
32 Wietske Visser (TUD), Qualitative multi-criteria preference representation and reasoning
33 Rory Sie (OUN), Coalitions in Cooperation Networks (COCOON)
34 Pavol Jancura (RUN), Evolutionary analysis in PPI networks and applications
35 Evert Haasdijk (VU), Never Too Old To Learn – On-line Evolution of Controllers in Swarm- and Modular Robotics
36 Denis Ssebugwawo (RUN), Analysis and Evaluation of Collaborative Modeling Processes
37 Agnes Nakakawa (RUN), A Collaboration Process for Enterprise Architecture Creation
38 Selmar Smit (VU), Parameter Tuning and Scientific Testing in Evolutionary Algorithms
39 Hassan Fatemi (UT), Risk-aware design of value and coordination networks
40 Agus Gunawan (UvT), Information Access for SMEs in Indonesia
41 Sebastian Kelle (OU), Game Design Patterns for Learning
42 Dominique Verpoorten (OU), Reflection Amplifiers in self-regulated Learning
43 Withdrawn
44 Anna Tordai (VU), On Combining Alignment Techniques
45 Benedikt Kratz (UvT), A Model and Language for Business-aware Transactions
46 Simon Carter (UVA), Exploration and Exploitation of Multilingual Data for Statistical Machine Translation
47 Manos Tsagkias (UVA), Mining Social Media: Tracking Content and Predicting Behavior
48 Jorn Bakker (TUE), Handling Abrupt Changes in Evolving Time-series Data
49 Michael Kaisers (UM), Learning against Learning - Evolutionary dynamics of reinforcement learning algorithms in strategic interactions
50 Steven van Kervel (TUD), Ontologogy driven Enterprise Information Systems Engineering
51 Jeroen de Jong (TUD), Heuristics in Dynamic Sceduling; a practical framework with a case study in elevator dispatching

2013 01 Viorel Milea (EUR), News Analytics for Financial Decision Support
02 Erietta Liarou (CWI), MonetDB/DataCell: Leveraging the Column-store Database Technology for Efficient and Scalable Stream Processing
03 Szymon Klarman (VU), Reasoning with Contexts in Description Logics
04 Chetan Yadati (TUD), Coordinating autonomous planning and scheduling
05 Dulce Pumareja (UT), Groupware Requirements Evolutions Patterns
06 Romulo Goncalves (CWI), The Data Cyclotron: Juggling Data and Queries for a Data Warehouse Audience
07 Giel van Lankveld (UvT), Quantifying Individual Player Differences
08 Robbert-Jan Merk (VU), Making enemies: cognitive modeling for opponent agents in fighter pilot simulators
09 Fabio Gori (RUN), Metagenomic Data Analysis: Computational Methods and Applications

10 Jeewanie Jayasinghe Arachchige (UvT), A Unified Modeling Framework for Service Design.
11 Evangelos Pournaras (TUD), Multi-level Reconfigurable Self-organization in Overlay Services
12 Marian Razavian (VU), Knowledge-driven Migration to Services
13 Mohammad Safiri (UT), Service Tailoring: User-centric creation of integrated IT-based homecare services to support independent living of elderly
14 Jafar Tanha (UVA), Ensemble Approaches to Semi-Supervised Learning Learning
15 Daniel Hennes (UM), Multiagent Learning - Dynamic Games and Applications
16 Eric Kok (UU), Exploring the practical benefits of argumentation in multi-agent deliberation
17 Koen Kok (VU), The PowerMatcher: Smart Coordination for the Smart Electricity Grid
18 Jeroen Janssens (UvT), Outlier Selection and One-Class Classification
19 Renze Steenhuizen (TUD), Coordinated Multi-Agent Planning and Scheduling
20 Katja Hofmann (UvA), Fast and Reliable Online Learning to Rank for Information Retrieval
21 Sander Wubben (UvT), Text-to-text generation by monolingual machine translation
22 Tom Claassen (RUN), Causal Discovery and Logic
23 Patricio de Alencar Silva (UvT), Value Activity Monitoring
24 Haitham Bou Ammar (UM), Automated Transfer in Reinforcement Learning
25 Agnieszka Anna Latoszek-Berendsen (UM), Intention-based Decision Support. A new way of representing and implementing clinical guidelines in a Decision Support System
26 Alireza Zarghami (UT), Architectural Support for Dynamic Homecare Service Provisioning
27 Mohammad Huq (UT), Inference-based Framework Managing Data Provenance
28 Frans van der Sluis (UT), When Complexity becomes Interesting: An Inquiry into the Information eXperience
29 Iwan de Kok (UT), Listening Heads
30 Joyce Nakatumba (TUE), Resource-Aware Business Process Management: Analysis and Support
31 Dinh Khoa Nguyen (UvT), Blueprint Model and Language for Engineering Cloud Applications
32 Kamakshi Rajagopal (OUN), Networking For Learning; The role of Networking in a Lifelong Learner's Professional Development
33 Qi Gao (TUD), User Modeling and Personalization in the Microblogging Sphere
34 Kien Tjin-Kam-Jet (UT), Distributed Deep Web Search
35 Abdallah El Ali (UvA), Minimal Mobile Human Computer Interaction
36 Than Lam Hoang (TUe), Pattern Mining in Data Streams
37 Dirk Börner (OUN), Ambient Learning Displays
38 Eelco den Heijer (VU), Autonomous Evolutionary Art
39 Joop de Jong (TUD), A Method for Enterprise Ontology based Design of Enterprise Information Systems

40 Pim Nijssen (UM), Monte-Carlo Tree Search for Multi-Player Games
41 Jochem Liem (UVA), Supporting the Conceptual Modelling of Dynamic Systems: A Knowledge Engineering Perspective on Qualitative Reasoning
42 Léon Planken (TUD), Algorithms for Simple Temporal Reasoning
43 Marc Bron (UVA), Exploration and Contextualization through Interaction and Concepts

2014 01 Nicola Barile (UU), Studies in Learning Monotone Models from Data
02 Fiona Tuliyano (RUN), Combining System Dynamics with a Domain Modeling Method
03 Sergio Raul Duarte Torres (UT), Information Retrieval for Children: Search Behavior and Solutions
04 Hanna Jochmann-Mannak (UT), Websites for children: search strategies and interface design - Three studies on children's search performance and evaluation
05 Jurriaan van Reijsen (UU), Knowledge Perspectives on Advancing Dynamic Capability
06 Damian Tamburri (VU), Supporting Networked Software Development
07 Arya Adriansyah (TUE), Aligning Observed and Modeled Behavior
08 Samur Araujo (TUD), Data Integration over Distributed and Heterogeneous Data Endpoints
09 Philip Jackson (UvT), Toward Human-Level Artificial Intelligence: Representation and Computation of Meaning in Natural Language
10 Ivan Salvador Razo Zapata (VU), Service Value Networks
11 Janneke van der Zwaan (TUD), An Empathic Virtual Buddy for Social Support
12 Willem van Willigen (VU), Look Ma, No Hands: Aspects of Autonomous Vehicle Control
13 Arlette van Wissen (VU), Agent-Based Support for Behavior Change: Models and Applications in Health and Safety Domains
14 Yangyang Shi (TUD), Language Models With Meta-information
15 Natalya Mogles (VU), Agent-Based Analysis and Support of Human Functioning in Complex Socio-Technical Systems: Applications in Safety and Healthcare
16 Krystyna Milian (VU), Supporting trial recruitment and design by automatically interpreting eligibility criteria
17 Kathrin Dentler (VU), Computing healthcare quality indicators automatically: Secondary Use of Patient Data and Semantic Interoperability
18 Mattijs Ghijsen (UVA), Methods and Models for the Design and Study of Dynamic Agent Organizations
19 Vinicius Ramos (TUE), Adaptive Hypermedia Courses: Qualitative and Quantitative Evaluation and Tool Support
20 Mena Habib (UT), Named Entity Extraction and Disambiguation for Informal Text: The Missing Link
21 Kassidy Clark (TUD), Negotiation and Monitoring in Open Environments
22 Marieke Peeters (UU), Personalized Educational Games - Developing agent-supported scenario-based training
23 Eleftherios Sidirourgos (UvA/CWI), Space Efficient Indexes for the Big Data Era
24 Davide Ceolin (VU), Trusting Semi-structured Web Data

25 Martijn Lappenschaar (RUN), New network models for the analysis of disease interaction
26 Tim Baarslag (TUD), What to Bid and When to Stop
27 Rui Jorge Almeida (EUR), Conditional Density Models Integrating Fuzzy and Probabilistic Representations of Uncertainty
28 Anna Chmielowiec (VU), Decentralized k-Clique Matching
29 Jaap Kabbedijk (UU), Variability in Multi-Tenant Enterprise Software
30 Peter de Cock (UvT), Anticipating Criminal Behaviour
31 Leo van Moergestel (UU), Agent Technology in Agile Multiparallel Manufacturing and Product Support
32 Naser Ayat (UvA), On Entity Resolution in Probabilistic Data
33 Tesfa Tegegne (RUN), Service Discovery in eHealth
34 Christina Manteli (VU), The Effect of Governance in Global Software Development: Analyzing Transactive Memory Systems.
35 Joost van Ooijen (UU), Cognitive Agents in Virtual Worlds: A Middleware Design Approach
36 Joos Buijs (TUE), Flexible Evolutionary Algorithms for Mining Structured Process Models
37 Maral Dadvar (UT), Experts and Machines United Against Cyberbullying
38 Danny Plass-Oude Bos (UT), Making brain-computer interfaces better: improving usability through post-processing.
39 Jasmina Maric (UvT), Web Communities, Immigration, and Social Capital
40 Walter Omona (RUN), A Framework for Knowledge Management Using ICT in Higher Education
41 Frederic Hogenboom (EUR), Automated Detection of Financial Events in News Text
42 Carsten Eijckhof (CWI/TUD), Contextual Multidimensional Relevance Models
43 Kevin Vlaanderen (UU), Supporting Process Improvement using Method Increments
44 Paulien Meesters (UvT), Intelligent Blauw. Met als ondertitel: Intelligence-gestuurde politiezorg in gebiedsgebonden eenheden.
45 Birgit Schmitz (OUN), Mobile Games for Learning: A Pattern-Based Approach
46 Ke Tao (TUD), Social Web Data Analytics: Relevance, Redundancy, Diversity
47 Shangsong Liang (UVA), Fusion and Diversification in Information Retrieval

2015 01 Niels Netten (UvA), Machine Learning for Relevance of Information in Crisis Response
02 Faiza Bukhsh (UvT), Smart auditing: Innovative Compliance Checking in Customs Controls
03 Twan van Laarhoven (RUN), Machine learning for network data
04 Howard Spoelstra (OUN), Collaborations in Open Learning Environments
05 Christoph Bösch (UT), Cryptographically Enforced Search Pattern Hiding
06 Farideh Heidari (TUD), Business Process Quality Computation - Computing Non-Functional Requirements to Improve Business Processes
07 Maria-Hendrike Peetz (UvA), Time-Aware Online Reputation Analysis
08 Jie Jiang (TUD), Organizational Compliance: An agent-based model for designing and evaluating organizational interactions

09 Randy Klaassen (UT), HCI Perspectives on Behavior Change Support Systems
10 Henry Hermans (OUN), OpenU: design of an integrated system to support lifelong learning
11 Yongming Luo (TUE), Designing algorithms for big graph datasets: A study of computing bisimulation and joins
12 Julie M. Birkholz (VU), Modi Operandi of Social Network Dynamics: The Effect of Context on Scientific Collaboration Networks
13 Giuseppe Procaccianti (VU), Energy-Efficient Software
14 Bart van Straalen (UT), A cognitive approach to modeling bad news conversations
15 Klaas Andries de Graaf (VU), Ontology-based Software Architecture Documentation
16 Changyun Wei (UT), Cognitive Coordination for Cooperative Multi-Robot Teamwork
17 André van Cleeff (UT), Physical and Digital Security Mechanisms: Properties, Combinations and Trade-offs
18 Holger Pirk (CWI), Waste Not, Want Not! - Managing Relational Data in Asymmetric Memories
19 Bernardo Tabuenca (OUN), Ubiquitous Technology for Lifelong Learners
20 Lois Vanhée (UU), Using Culture and Values to Support Flexible Coordination
21 Sibren Fetter (OUN), Using Peer-Support to Expand and Stabilize Online Learning
22 Zhemin Zhu (UT), Co-occurrence Rate Networks
23 Luit Gazendam (VU), Cataloguer Support in Cultural Heritage
24 Richard Berendsen (UVA), Finding People, Papers, and Posts: Vertical Search Algorithms and Evaluation
25 Steven Woudenberg (UU), Bayesian Tools for Early Disease Detection
26 Alexander Hogenboom (EUR), Sentiment Analysis of Text Guided by Semantics and Structure
27 Sándor Héman (CWI), Updating compressed colomn stores
28 Janet Bagorogoza (TiU), Knowledge Management and High Performance; The Uganda Financial Institutions Model for HPO
29 Hendrik Baier (UM), Monte-Carlo Tree Search Enhancements for One-Player and Two-Player Domains
30 Kiavash Bahreini (OU), Real-time Multimodal Emotion Recognition in E-Learning
31 Yakup Koç (TUD), On the robustness of Power Grids
32 Jerome Gard (UL), Corporate Venture Management in SMEs
33 Frederik Schadd (TUD), Ontology Mapping with Auxiliary Resources
34 Victor de Graaf (UT), Gesocial Recommender Systems
35 Jungxao Xu (TUD), Affective Body Language of Humanoid Robots: Perception and Effects in Human Robot Interaction

2016 01 Syed Saiden Abbas (RUN), Recognition of Shapes by Humans and Machines
02 Michiel Christiaan Meulendijk (UU), Optimizing medication reviews through decision support: prescribing a better pill to swallow
03 Maya Sappelli (RUN), Knowledge Work in Context: User Centered Knowledge Worker Support
04 Laurens Rietveld (VU), Publishing and Consuming Linked Data

05 Evgeny Sherkhonov (UVA), Expanded Acyclic Queries: Containment and an Application in Explaining Missing Answers
06 Michel Wilson (TUD), Robust scheduling in an uncertain environment
07 Jeroen de Man (VU), Measuring and modeling negative emotions for virtual training
08 Matje van de Camp (TiU), A Link to the Past: Constructing Historical Social Networks from Unstructured Data
09 Archana Nottamkandath (VU), Trusting Crowdsourced Information on Cultural Artefacts
10 George Karafotias (VUA), Parameter Control for Evolutionary Algorithms
11 Anne Schuth (UVA), Search Engines that Learn from Their Users
12 Max Knobbout (UU), Logics for Modelling and Verifying Normative Multi-Agent Systems
13 Nana Baah Gyan (VU), The Web, Speech Technologies and Rural Development in West Africa - An ICT4D Approach
14 Ravi Khadka (UU), Revisiting Legacy Software System Modernization
15 Steffen Michels (RUN), Hybrid Probabilistic Logics - Theoretical Aspects, Algorithms and Experiments
16 Guangliang Li (UVA), Socially Intelligent Autonomous Agents that Learn from Human Reward
17 Berend Weel (VU), Towards Embodied Evolution of Robot Organisms
18 Albert Meroño Peñuela (VU), Refining Statistical Data on the Web
19 Julia Efremova (Tu/e), Mining Social Structures from Genealogical Data
20 Daan Odijk (UVA), Context & Semantics in News & Web Search
21 Alejandro Moreno Célleri (UT), From Traditional to Interactive Playspaces: Automatic Analysis of Player Behavior in the Interactive Tag Playground
22 Grace Lewis (VU), Software Architecture Strategies for Cyber-Foraging Systems
23 Fei Cai (UVA), Query Auto Completion in Information Retrieval
24 Brend Wanders (UT), Repurposing and Probabilistic Integration of Data; An Iterative and data model independent approach
25 Julia Kiseleva (TU/e), Using Contextual Information to Understand Searching and Browsing Behavior
26 Dilhan Thilakarathne (VU), In or Out of Control: Exploring Computational Models to Study the Role of Human Awareness and Control in Behavioural Choices, with Applications in Aviation and Energy Management Domains
27 Wen Li (TUD), Understanding Geo-spatial Information on Social Media
28 Mingxin Zhang (TUD), Large-scale Agent-based Social Simulation - A study on epidemic prediction and control
29 Nicolas Höning (TUD), Peak reduction in decentralised electricity systems - Markets and prices for flexible planning
30 Ruud Mattheij (UvT), The Eyes Have It
31 Mohammad Khelghati (UT), Deep web content monitoring
32 Eelco Vriezekolk (UT), Assessing Telecommunication Service Availability Risks for Crisis Organisations
33 Peter Bloem (UVA), Single Sample Statistics, exercises in learning from just one example

34 Dennis Schunselaar (TUE), Configurable Process Trees: Elicitation, Analysis, and Enactment
35 Zhaochun Ren (UVA), Monitoring Social Media: Summarization, Classification and Recommendation
36 Daphne Karreman (UT), Beyond R2D2: The design of nonverbal interaction behavior optimized for robot-specific morphologies
37 Giovanni Sileno (UvA), Aligning Law and Action - a conceptual and computational inquiry
38 Andrea Minuto (UT), Materials that Matter - Smart Materials meet Art & Interaction Design
39 Merijn Bruijnes (UT), Believable Suspect Agents; Response and Interpersonal Style Selection for an Artificial Suspect
40 Christian Detweiler (TUD), Accounting for Values in Design
41 Thomas King (TUD), Governing Governance: A Formal Framework for Analysing Institutional Design and Enactment Governance
42 Spyros Martzoukos (UVA), Combinatorial and Compositional Aspects of Bilingual Aligned Corpora
43 Saskia Koldijk (RUN), Context-Aware Support for Stress Self-Management: From Theory to Practice
44 Thibault Sellam (UVA), Automatic Assistants for Database Exploration
45 Bram van de Laar (UT), Experiencing Brain-Computer Interface Control
46 Jorge Gallego Perez (UT), Robots to Make you Happy
47 Christina Weber (UL), Real-time foresight - Preparedness for dynamic innovation networks
48 Tanja Buttler (TUD), Collecting Lessons Learned
49 Gleb Polevoy (TUD), Participation and Interaction in Projects. A Game-Theoretic Analysis
50 Yan Wang (UVT), The Bridge of Dreams: Towards a Method for Operational Performance Alignment in IT-enabled Service Supply Chains

2017 01 Jan-Jaap Oerlemans (UL), Investigating Cybercrime
02 Sjoerd Timmer (UU), Designing and Understanding Forensic Bayesian Networks using Argumentation
03 Daniël Harold Telgen (UU), Grid Manufacturing; A Cyber-Physical Approach with Autonomous Products and Reconfigurable Manufacturing Machines
04 Mrunal Gawade (CWI), Multi-core Parallelism in a Column-store
05 Mahdieh Shadi (UVA), Collaboration Behavior
06 Damir Vandic (EUR), Intelligent Information Systems for Web Product Search
07 Roel Bertens (UU), Insight in Information: from Abstract to Anomaly
08 Rob Konijn (VU) , Detecting Interesting Differences:Data Mining in Health Insurance Data using Outlier Detection and Subgroup Discovery
09 Dong Nguyen (UT), Text as Social and Cultural Data: A Computational Perspective on Variation in Text
10 Robby van Delden (UT), (Steering) Interactive Play Behavior
11 Florian Kunneman (RUN), Modelling patterns of time and emotion in Twitter #anticipointment
12 Sander Leemans (TUE), Robust Process Mining with Guarantees
13 Gijs Huisman (UT), Social Touch Technology - Extending the reach of social touch through haptic technology

14 Shoshannah Tekofsky (UvT), You Are Who You Play You Are: Modelling Player Traits from Video Game Behavior
15 Peter Berck (RUN), Memory-Based Text Correction
16 Aleksandr Chuklin (UVA), Understanding and Modeling Users of Modern Search Engines
17 Daniel Dimov (UL), Crowdsourced Online Dispute Resolution
18 Ridho Reinanda (UVA), Entity Associations for Search
19 Jeroen Vuurens (UT), Proximity of Terms, Texts and Semantic Vectors in Information Retrieval
20 Mohammadbashir Sedighi (TUD), Fostering Engagement in Knowledge Sharing: The Role of Perceived Benefits, Costs and Visibility
21 Jeroen Linssen (UT), Meta Matters in Interactive Storytelling and Serious Gaming (A Play on Worlds)
22 Sara Magliacane (VU), Logics for causal inference under uncertainty
23 David Graus (UVA), Entities of Interest — Discovery in Digital Traces
24 Chang Wang (TUD), Use of Affordances for Efficient Robot Learning
25 Veruska Zamborlini (VU), Knowledge Representation for Clinical Guidelines, with applications to Multimorbidity Analysis and Literature Search
26 Merel Jung (UT), Socially intelligent robots that understand and respond to human touch
27 Michiel Joosse (UT), Investigating Positioning and Gaze Behaviors of Social Robots: People's Preferences, Perceptions and Behaviors
28 John Klein (VU), Architecture Practices for Complex Contexts
29 Adel Alhuraibi (UvT), From IT-BusinessStrategic Alignment to Performance: A Moderated Mediation Model of Social Innovation, and Enterprise Governance of IT"
30 Wilma Latuny (UvT), The Power of Facial Expressions
31 Ben Ruijl (Uvt), Advances in computational methods for QFT calculations
32 Thaer Samar (RUN), Access to and Retrievability of Content in Web Archives
33 Brigit van Loggem (OU), Towards a Design Rationale for Software Documentation: A Model of Computer-Mediated Activity
34 Maren Scheffel (OU), The Evaluation Framework for Learning Analytics
35 Martine de Vos (VU), Interpreting natural science spreadsheets
36 Yuanhao Guo (UL), Shape Analysis for Phenotype Characterisation from High-throughput Imaging
37 Alejandro Montes Garcia (TUE), WiBAF: A Within Browser Adaptation Framework that Enables Control over Privacy