

Providing Foundation for User Feedback Concepts by Extending a Communication Ontology

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Abstract. The term user feedback is becoming widely used in requirements engineering (RE) research to refer to the comments and evaluations that users express upon having experienced the use of a software application or service. This explicit feedback takes place in virtual spaces (e.g., issue tracking systems, app stores), aiming, for instance, at reporting on discovered bugs or requesting new features. Founding the notion of explicit user feedback with the use of an ontology may support a deep understanding of the feedback nature, as well as contribute to the development of tool-components for its analysis at use of requirements analysts. In this paper, we present a user feedback ontology as an extension of an existing communication ontology. We describe how we built it, along with a set of competency questions, and illustrate its applicability on an example taken from a collaborative communication related to RE for software evolution.

Keywords: User Feedback, Communication Ontology, Requirements Engineering

1 Introduction

More and more, software users make use of social media to express their comments about a software service or to rate applications they often use. This information, which is easily accessible via the Internet, is considered an invaluable asset for software developers and service providers, to help them understand how to improve their software application or service, and get inspiration for new functionalities and products [1, 2]. This information deliberately provided by the users is generally called *explicit user feedback* and can be used as a complement to *implicit user feedback*, i.e. information collected by means of observing the user behaviour through logs.

In [3] it is stated, “Feedback is one of the primary results of introducing the implemented software system into the real world. There is an immediate response to the system from those affected by it”. This definition leads us to recognise user feedback both as an artefact and as a process. Taking the perspective of user feedback as an artefact, we revise the previous definition and propose the following one: “User feedback is a reaction of the user upon her experience in using a software service or application. Explicit user feedback could be based on multi-modal communication, such as natural language text, images, emoticons, etc.”. Taking the perspective of the communication

process, we claim that the roles of sender and receiver are essential to make clear the purpose of explicit feedback.

In our research, we focus on explicit user feedback, with the ultimate goal of defining methods and techniques to support software system maintenance, as well as collaborative RE tasks as described in a recent paper [4]. We consider issues related to collecting and analysing user feedback. Indeed, different techniques may be needed for collection and for analysis, depending on the feedback type, and on the volume of the corresponding data. On one hand, structured feedback is collected according to a predefined input template. Consequently, in this case the analysis is driven by the schema underlying the template itself. On the other hand, unstructured user feedback is collected freely, without the aid of any predefined structure. Thus, the analysis in this case may require data mining and natural language processing (NLP) techniques to discover, retrieve, and extract information and opinions from huge textual information [5].

In this paper we present an ontology of user feedback, key for a deep understanding of the explicit user feedback and its further exploitation. To build the *user feedback* ontology we adopt a goal-oriented methodology that guide us in specifying the main stakeholders, including the users of our ontology (e.g. designers of feedback collector tools and analysts), and a set of competency questions (CQs) that the resulting ontology will answer [6]. For example, the following CQs emerged from the analysis of the goals of feedback analysts: (a) what are the types of user feedback presentation formats?; (b) how can user feedback be classified?; (c) and what are the speech acts commonly expressed by users in their explicit feedback?

Since feedback collection is seen as a communication process, we develop our ontology as an extension of a well-founded existing communication ontology [7]. Besides this, we consider users' feedback expressed in natural language (NL), therefore we take into account the speech act theory (SAT) of Searle [8, 9].

The rest of the paper is organised as follows. Section 2 presents the concepts we borrow from pre-existing ontologies and SAT theory. Section 3 describes the user feedback ontology and the concepts that it involves. Related work is recalled in Section 4. Finally we draw some conclusions and point out future work in Section 5.

2 Baseline

Collecting *user feedback* basically consists in a process of communication between the developers and the users of existing software systems. We build on an existing Communication ontology [7] and extend it including *user feedback* concepts. This Communication ontology is especially attractive because it is grounded on a foundational ontology, namely the Unified Foundational Ontology (UFO) [10], which has been successfully applied to provide real-world semantics for ontologies in different fields. In the following we briefly recall the concepts that we reuse from UFO and from the Communication ontology.

UFO distinguishes between endurants and perdurants. **Endurants** do not have temporal parts, and persist in time while keeping their identity (e.g. a person and the colour of an apple). A **Perdurant** (also referred to as **event**), conversely, is composed of temporal parts (e.g. storm, heart attack, trip). **Substantials** are existentially independent endurants (e.g. a person or a car). **Moments**, in contrast, are endurants that are ex-

intentionally dependent on other endurants or events, inhering in these individuals (e.g. someone's headache and the cost of a trip). Moments can be intrinsic or relational. **Intrinsic Moments** are those that depend on one single individual in which they inhere. A **Relator** is a relational moment, i.e. a moment that inheres simultaneously in multiple individuals. **Agents** are substantials that can perceive events, perform action contributions and bear special kinds of intrinsic moments, named **Intentional Moments** (examples of agents are person, student and software developer). **Action contributions** are intentional participations of agents within an event (e.g. saying something to someone, writing a letter). An **Intention** is a type of intentional moment (other examples of intentional moments are belief and desire) that represents an internal commitment of the agent to act towards that goal and, therefore, causes the agent to perform action contributions.

The communication ontology considers sender and receiver as the central agents in the communication process. The **Sender** is an agent that sends a message through a communicative act. A **Communicative Act** is an action contribution that carries out the information exchanged in the communication process. This communicative act corresponds to what Searle names illocutionary act [8]. The exchanged information is here captured as a **Message**, which is the propositional content of the communicative act. A **Receiver** is an agent that perceives the communicated message. As the communicative act, a **Perception** is an action contribution that consists in the reception of the exchanged information (thus, also having a message as propositional content). A **Communicative Interaction** is a complex action composed of exactly one communicative act and one or more perceptions. In other words, in a communicative interaction, there is one sender agent and at least one receiver agent. Moreover, the communicative act and the perceptions involved in a communicative interaction have the same message as propositional content. Thus, this message is also said to be the propositional content of the communicative interaction.

In addition, due to the gathering of feedback is seen as a communication process, we extend the communication ontology with concepts coming from the literature about the characterisation, elaboration and use of user feedback. Specifically, we look at the feedback expressed in NL, hence, we rely on the linguistic theory of SAT [8, 9].

3 User Feedback Ontology

In this section we explain the concepts of our ontology. Let's start with the concepts of the baseline, which are illustrated with a dark grey colour in Fig. 1. We have distinguished three key concepts of the communication ontology to be extended. These concepts are intention, message and communicative act.

We extend the concept of **Intention** into communicative intention and reflexive intention. The **Communicative Intention** refers to the internal commitment of a sender of conveying an information to a receiver or an audience, regardless of having this information understood. While a **Reflexive Intention**, according to H.P. Grice, as quoted in [9], refers to the sender's intention that is formulated and transmitted with the purpose of being recognised or understood by a receiver.

A message *bears* a given **Topic**, in UFO a topic is an intrinsic moment (i.e. a property of the message), that becomes the subject of conversation between agents. The last

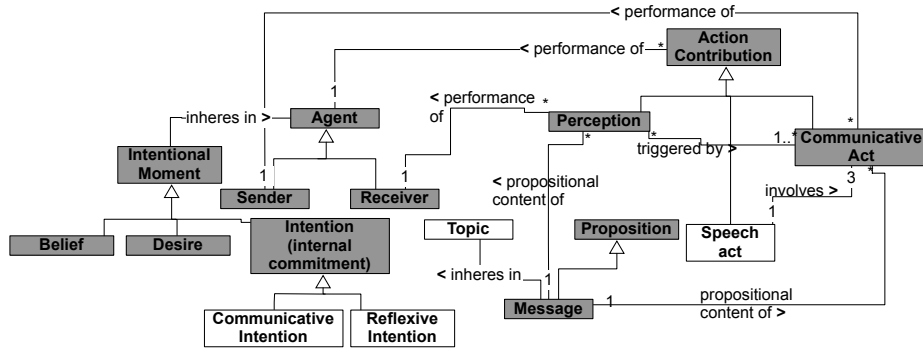


Fig. 1. Concepts extending the communication ontology. Baseline concepts in dark grey, new concepts extending the ontology in white.

concept that is added and central in our ontology is the concept **Speech Act** that is per-se an action, i.e. an action contribution, and is the basic unit in a linguistic communication.

Communication ontology and SAT concepts. A speech act *involves* three communicative acts, namely, locutionary, illocutionary and perlocutionary act that we consider specialisations of a communicative act. These acts are visualised in Fig. 2, in which we refine the relation between speech act and communicative act and connect the speech act directly to each one of the acts. A **Locutionary Act** is the act of “saying something” (production of words), an **Illocutionary Act** makes reference to the way in which the locutions are used and in which sense (intention to motivate the production of words), and a **Perlocutionary Act** is the effect the sender wants to accomplish on the receiver or audience. Let’s consider the utterance “*Is there any example code I could look at?*”, the locutionary act corresponds to the utterance of this sentence, the illocutionary act corresponds to the speaker’s intention to make the audience aware that she has a request, and the effect, i.e. the perlocutionary act, is that the speaker got the audience to handle her request. A speech act involves at least one act, what we mean is that someone could utter a senseless phrase (e.g., “one the snow”), accomplishing the locutionary act, but the illocutionary and perlocutionary acts are not present. The **Performative verb** refers to the verb that *classifies* the illocutionary act into five categories that were introduced by Searle, and later revised by Bach and Harnish [9].

An intention *inheres in* the sender, in this case the reflexive intention that *causes* the illocutionary act. Then, this illocutionary act *triggers* the execution of a locutionary act through the utterance of specific words that will reify such a reflexive intention. The *consequence of* the illocutionary act is the sender’s perlocutionary act that the receiver will *perceive* as the overall *effect of* a speech act. We need to clarify that the relation *consequence of* between the illocutionary and perlocutionary act is a type of indirect causation, i.e. if the communication is successful, the receiver will perform the action intended by the sender. Finally, a speech act is successful if the intention that the sender expresses is *identified* by the receiver by means of recognising such a sender’s intention.

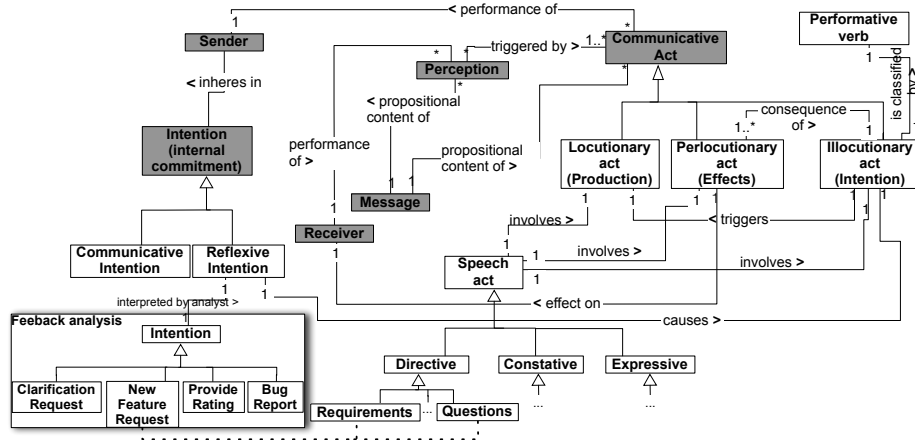


Fig. 2. Communicative acts involved in each speech act.

SAT concepts. Our *user feedback* ontology builds on a revised taxonomy of speech acts proposed in a previous work [11], which considers speech acts commonly used in online discussions of an open source project. We grouped the selected speech acts in three main categories: constative, directive, and expressive. We are currently consolidating the part of the ontology that considers concepts that are specific to feedback collection and analysis. An excerpt may be found in [6]. For reasons of space we only show the connection of the reflexive intention to the intention interpreted by a software requirements analyst. Once the analysis of the speech acts is performed, different results can be presented. For example, the categorisation of the feedback according to the user’s reflexive intention. As can be found in the recent literature on feedback from software users, possible intentions for a user to send a feedback are Clarification Request, New Feature Request, Bug Report and Provide Rating. For instance, Bug Report is inspired on corrective or negative feedback [12, 13] as in this case, the user feedback refers to information that should be used to correct the software, which means that this information has a negative connotation. The encouraging [14] and positive [13] feedback have been turned into Rating (e.g. stars in the AppStore) [2]. Strategic behaviour [14] in our ontology refers to a New Feature Request while Clarification means that the feedback contains questions or extra information (such as critical details), to make something clearer. These terms are indeed used in different works and our feedback ontology attempts at unifying all the different concepts in a single classification.

3.1 Illustrative Example

The following example, see Fig. 3, illustrates how the ontology may support the analysis of user feedback. We take an excerpt of an e-mail⁴ sent by a user of a software application called XWiki⁵. Note that the ontological concepts are highlighted with a

⁴ Source: <http://lists.xwiki.org/pipermail/users/attachments/20080220/748039cc/attachment.html>

⁵ <http://www.xwiki.org/xwiki/bin/view/Main/WebHome>

different font type to facilitate the understanding. This e-mail represents an instance of unstructured user feedback. The fields *Subject:* and *From:* are the concepts **Topic** and **Sender**, respectively, of our ontology. In the body of the e-mail we can distinguish different types of speech acts. In this example we find that the first speech act expresses the user’s reflexive intention of making questions to be answered. After some other messages, we find the intention *suppose*, referring to the speech acts suppositives. The followed two speech acts requirement and question are also expressed.

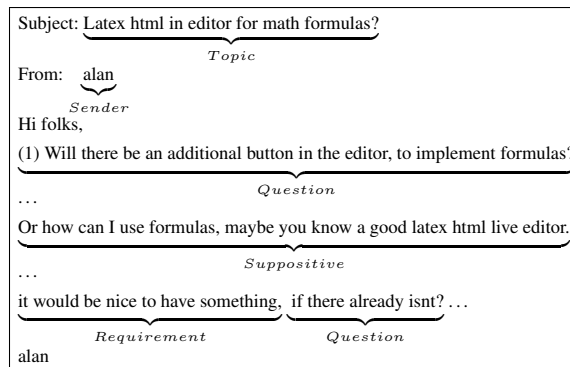


Fig. 3. Example of unstructured user feedback in the XWiki mailing list.

Now let’s see a detailed explanation of the analysis performed. Taking the previous example we first see the **Message (1)** is the *propositional content* of a **Communicative Act**. As highlighted before, this message *bears* the **Topic** “*Latex html in editor for math formulas?*” and the **Sender** is *alan*. The **Reflexive Intention** –*Make a question*– *inheres in alan* that *causes* the **Illocutionary act** *Quest*. This act produces an effect, i.e. **Perlocutionary act** that is a *consequence of* the **Illocutionary act**, which together with the **Locutionary act** *Elaborate a question* are the three acts involved in the **Speech Act** –*Question*. The ontology supports the understanding of such an intention expressed by a sender that must be recognised by a receiver. In this example the understanding that the sender is expressing a question is that of producing the **Perlocutionary act** –*Answer*– that will have the effect on the receiver, i.e. *XWiki community*, who through the **Perception** –*Reading*–, which is *triggered by* the communicative act, will eventually answer the posed question. However, the other speech acts (i.e. **Suppositives**, **Requirements**, and **Questions**) may provide to the analyst indicators for identifying a **Feature Request** in this feedback.

3.2 Discussion

At this stage of development the ontology is intended to clarify concepts useful to understand the nature of explicit feedback elaborated by software’s users and to support requirements analysts when performing feedback analysis. Due to space limits, we only discuss one of the proposed CQs, namely (c) what are the speech acts commonly expressed by users in their explicit feedback? This CQ is answered by querying the part

of the ontology where the concept speech act is specialised into the different sub-kinds (see Fig. 2, bottom-centre). Answers to this question are taken into account in tool-supported analysis technique for explicit unstructured *user feedback*, which exploits NLP tools. This tool supports the classification of phrases as instances of concepts representing speech acts that commonly appear in user feedback [11]. The ontology allows us to identify the relation between the types of speech acts (or their combination) to the type of user feedback (see Fig. 2, left-corner at the bottom). For example if the speech acts used in the feedback under analysis are classified as Suppositive, Requirement, and Questions, this may be interpreted as indicators for the analyst towards identifying a Feature Request.

Other capabilities of the proposed ontology, which can not be illustrated here due to space limits, concern the support for the identification of analysis techniques, based on the presentation format of the feedback, i.e. visual, audio and textual, or as a composition of linguistic and non-linguistic act (e.g. attachment, emoticons). Concerning the scope of application of the proposed ontology, by construction we consider software requirements analysis and design of feedback collection techniques as application areas. Since we are building the *user feedback* ontology extending a foundational ontology we believe that it can help understand the nature of user feedback. Regarding the current status and known limitations of the work, we are consolidating the ontology and a proper validation along all the CQs considered so far, is to be performed.

4 Related Work

We briefly recall work addressing the problem that motivates our research, namely how to collect and analyse explicit user feedback for the purpose of collaborative RE in software evolution and maintenance. Worth mentioning are tools, which enable users to give feedback in situ, based on semi-structured collection, e.g. [15, 16]. Focusing on works that investigate how explicit, indirect user feedback analysis can support software maintenance and evolution tasks, the following approaches are worth to be mentioned: [17] presents an approach based on statistical analysis, to exploit explicit, indirect feedback by power users, reporting about software defects through the open bug reporting in the Mozilla project. Statistical analysis is applied by [2] to answer questions about how and when users provide feedback in the AppStore.

There is a vast literature about the application of ontologies in RE, but it is out of the scope of this paper to mention all that work. As examples in the case of requirements elicitation, we can mention [18] that presents an approach to build a domain ontology used to guide the analyst on domain concepts used for the elicitation of requirements. Our work differs from it because our ontology aims at supporting designers of feedback collector tools and requirements analysts to understand why and how *user feedback* is provided, as a previous step before determining the requirements.

5 Conclusion

In this paper we introduced a user feedback ontology that we are developing, which considers feedback as an artefact and as a special type of communication process. We

described how we are building it by extending and integrating existing ontologies, borrowing concepts from different theories, including SAT. As future work, we intend to validate it systematically against the whole set of competency questions that it is built for. The ontology will provide foundation to our ongoing work on conversation analysis based on the automatic extraction of speech acts [11].

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