Activity Context Representation: Techniques and Languages
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Identifying Collaborators Activities from Web-Mediated Dialogs: The Activity States Framework Approach

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Abstract

We have explored with three notions: *conceptualization, and contextualization* from situated cognition, and *psychic reflection* from activity theory for identifying activities into a method called the *activity states framework* (ASF). The purpose of our work is to build an AI system based on ASF for the identification of collaborators activities during situated context, e.g., collaborators are engaged in a tutorial activity. In this paper, we will introduce and propose how Web-mediated collaborative activities can be identified from collaborators communication exchanges by applying the ASF.

Introduction

Context plays an important role in a number of research areas since a long time, for example in the area of knowledge acquisition, machine learning, and *human-computer interaction* (i.e., HCI) (Brézillon, 1999). In HCI, it has been recognized that system design will benefit from the explicit study of context in which humans interact with artifacts during work, e.g., collaboration (Bannon,1996). There is a significant attention given within the HCI research community to use cognition theories such as situated cognition and activity theory as foundations for studying context (Nardi, 1996).

Although the importance of studying context is emphasized, there is little focus on how we may capture and represent activities (by studying context) from *human communications* on the mediated Web. In particular we are interested in the scenario of Web-mediated collaboration, i.e., collaborators chatting on the instant messaging or discussing about project on the video-conferencing system.

We have explored with three notions: *conceptualization, and contextualization* from situated cognition (Clancey, 1997, 1999), and *psychic reflection* from activity theory (Leont'ev, 1978) for identifying activities into a method called the *activity states framework* (ASF) (Binti Abdullah, 2006; Binti Abdullah et al, 2011). The purpose of our work is to build an AI system based on ASF for the identification of collaborators activities during situated context, e.g., collaborators are engaged in a tutorial activity. We foresee that the results of the work can be used to guide human-computer interaction design for Web-mediated collaborative dialogs.

In this paper, we will introduce and propose how Web-mediated collaborative activities can be identified from collaborators communication exchanges from applying the ASF. Thus the paper is organized as follows. First we will discuss the motivation and background of ASF and its major ideas and contribution. This is followed by an introduction on ASF and how we propose it can be used for identifying collaborators activity. We conclude with conclusion and future work.

Background and Motivation

In Binti Abdullah (2006), the author observed and studied a group of computer scientists collaborating on the mediated Web via social tools (i.e., instant messaging, video-conferencing system) on a scientific joint-project. The author collected and transcribed about 50,000 communication exchanges of several collaborators for the duration of 6 months. From the analyzed communication exchanges, the author found recurring breakdown situations[1] among collaborators on simple tasks such as

[1] A breakdown situation refers to the interrupted moment of our habitual,

debugging a situation of why a connected tool is not working, or using the system features for the first time. The author proposed to overcome the recurring breakdown situation by modeling heterogeneous agents that can *recognize sequence of events* that the agent is *located* (Bradshaw et al, 1996). Here the author refers to 'recognizing' as in some ways requires *learning of that event before recognizing that event as being that event*. For example, an agent recognizes that a user is "debugging" a tool, e.g., his webcam is not functioning during video-conference meeting and takes required action to overcome the situation. Therefore, the author proposed to model heterogeneous agents that can "talk" to each other in the context of collaboration on the mediated Web (Cohen et al., 2003; Singh et al., 2003). The agent modeling should enable agents able to anticipate that whenever such similar notion of debugging a tool is encountered, the agent can know what to communicate with other agent(s), or with a human agent to overcome the breakdown situation.

In order to model agents with such autonomous and interactive behavior the author emphasized on the notion of *context*. There must exist an internal structure that models how an agent *can know how to adapt to sudden changes* in their environments. For example, one way of doing it is through modeling a dynamic improvisation of fitting the actions to the context of communication in agents. In this notion of "improvisation", the author was interested in the improvisation of the states of classes[2].

The author states that such agent modeling can only be achieved if we understand precisely how people punctuate communications[3]. Thus the author proposed that one might gain insights into how we may model agent with such capabilities is by analyzing *collaborators conversations situated in his/her situated context*. Next, the analysis should be *empirically and theoretically studied and modeled* to existing *cognition theories* that *emphasizes on the notion of context.*

Thus the author did the following. About 50,000 communication exchanges were manually *converted* into formalized messages. The author referred to Fipa-Acl communicative acts specification[4] (Fipa-Acl, 2000) as a guideline in 'converting' the transcribed messages into formalized messages. The messages enabled the author to obtain preliminary findings on how people punctuate communications (Binti Abdullah et al, 2006).

The process of converting the dialogs involved extensive comprehension and application of *three specific notions on context* for *identifying collaborators activities (and speech acts[5])*: *conceptualization, and contextualization* from *situated cognition* (Clancey, 1997), and *psychic reflection* from *activity theory* (Leont'ev, 1978). During this analytical process, an innovative theoretical framework has emerged that has been called *Activity States*. The framework provides guidelines on how to convert the actual conversations into formalized messages represented with speech acts and content. It also attempts to understand and explain how the activity of reading (as an example), and comprehending the text that one reads, is in relationship to that person's activity on the web.

In this paper, we will focus on how the ASF guidelines on how to convert conversations into formalized messages may be used to guide the modeling of an AI system. Whereby the system can semi-automatically identify collaborators activities. Hence, in the next section, we review the theoretical foundation used in the ASF for *studying and modeling context* (Binti Abdullah, 2006). Then this is followed by a formal introduction of the framework and its proposed workflow.

Foundation of Activity States Framework (ASF)

In this section we will briefly discuss what context is and how it is studied from situated cognition and activity theory. In situated cognition (Clancey, 1997 & 1999) context for a person is viewed as a mental construction: its study the notions of conceptualization and contextualization.

Conceptualization is considered from both a social and neuropsychological[6] perspective. From a social psychological perspective, 'context' is explained by conceptualization i.e.: how a person conceptualizes his[7] role considering his situation, and activity - 'What I am Doing Now'. For example, a collaborator, collaborating on the mediated-Web conceptualizes his role as a scientist considers his project priorities (i.e., situations) and what he is doing now: 'discussing about new project' (i.e., activity) in constructing his behavior. From a neuropsychological perspective, the notion of conceptualization involves a composition of higher-order categorization processes at the perceptual-conceptual level that is responsible for our coordinated activity in time (Clancey, 1999). For example,

standard, comfortable "being in the world" (Winograd et al., 1986).

[2] State of classes refers to the improvisation of the classes of contexts (i.e., coordinating meeting, debugging tool) according to situations (e.g., discussion on meeting date).

[3] Punctuation refers to the ability to - knowing who to communicate with, when and how.

[4] The author specified any communicative library can be used as long as it is semantically well defined.

[5] Details will follow accordingly.

[6] Neuropsychology studies the structure and function of the brain as they relate to specific psychological processes and behaviors.

[7] We use the masculine gender to simplify the discourse: should be he/she and so forth.

at the perceptual level[8], when we are situated in a context, the way we perceive the context is always through categorizing the details in the environment (e.g., an object by its features where some details become anchored in the perception, like a recognition). These categorized details are then given a description or semantic label (e.g., the object's texture is soft). At the conceptual level, which is a higher-order categorization process – the details, which are also given descriptions, are then conceptually categorized (e.g., the texture is soft so it should be silk).

Contextualization is considered from a neuropsychological perspective. It is a notion used to describe how contexts are conceived at the conceptual-memory level. Memory is described as the product of an "active state" that is interactive and dynamic whereby past experiences are compared to information situated to context. In a nutshell, one may imagine that *conceptualization is a process coupled to contextualization* from the *perceptual to conceptual-memory processes*. Thus situated cognition studies context in the sense of:

- how a user is conceptualizing his role and activity 'What am I doing Now';
- how these social and neuropsychological processes influence a person contextualizing his/her activity at the memory level (before taking an action he considers past experiences and present information)
- in constructing his behavior.

Activity theory proposes a very specific notion of context: the *activity itself is the context* (Leont'ev, 1978). An activity is viewed as a system that is composed of objects, subject, as well as action, and operation. An object may be concrete (e.g., a table, a person) or abstract (e.g., a task, a motive), that is by definition "the objective" or "the goal" or "the purpose" of a subject (the actor of the activity), thus: its properties **do depend** from the viewpoint of the subject who acts or operates on it. A subject is defined as a person or a group engaged in an activity that includes goals such as to operate on one or more objects. Action is defined as the goal-directed process that must be undertaken to attain an object. Operation is defined as the way that actions are carried out. Therefore, in order to study context from activity theory one has to *study how people carry out their activities since activity itself is the context*.

According to activity theory, the object is operated by the subject and motivates it, thereby giving it a specific direction on how to attain the object. In the course of the subject's engagement in the activity - the object is transformed by the subject (the object is a construction by the subject). For example assume that the object of the subject is sending a file. Suppose that in the pursue of sending the file the subject is distracted by the 'presence notification' of the chat system. Now this becomes the object of the subject at that moment: the action to greet the friend. The subject sends a chat message to greet his friend instead of sending the file. Thus, the object is not viewed in the traditional sense as being 'static'. For example when a subject has as object to send an email to his colleague, he will go to his computer only to send an email. This is the traditional view of object.

However in the real world, he may have the object to send an email but after seeing an email from another colleague, he may instead read that email. Activity theory views objects as only coming into realization, becoming 'objective' when a subject makes a contact with the objective world through the mediation of artifacts in his pursue of an activity. This transformation of the object with the subject's activity is captured by the notion of 'psychic reflection' – which is the primary notion used in activity theory for studying context (Leont'ev, 1978).

Activity States Framework

In order to study the relation between *context and activity* for identifying collaborators activities – the ASF relates the notion of contextualization (Clancey, 1997) with psychic reflection (Leont'ev, 1978) by hypothesizing the following. A person pursuing an object *formulated conceptually* at first – contextualizes his 'conceptual object' in comparing the information situated on the mediated Web to his past experiences. This process will transform the subject's object to become 'objective' thus in turn influencing the subject's course of action situated to his Web-mediated activity in pursue of his 'objective'.

In simplifying this hypothesis, it is assumed that the subject's object will influence how the subject communicates, thus a subject's communication process, and action is influenced by the **'level of engagement', i.e., activity states**, in pursuing an 'objective' during his contextualization of the situated activity. Hence, the general idea of activity states framework is based on the concept of 'activity states' - *how a person conceptualizes his situation and activity*: 'What I am Doing Now' i.e., WIDN (Clancey, 1999). The concept of **activity states** is illustrated in Figure 1.

The x and y-axis denote the relation of activity states to time, situated tools and activity. The red line represents the activity states of a collaborator (i.e., the subject) – that is categorized in three levels: passive state, semi-active state and active state (see Y-axis). *Passive* means that a collaborator is just about to begin a new activity; *semi-active* signifies that a collaborator is pursuing the activity,

[8] Level here refers to 'level of analysis'. For example at the level of analyzing perception, one would study how the process of seeing an object relates to the recognition process.

while *active* signifies that the collaborator is about to reach the objective of the activity.

The squares represent an example of Web-mediated collaboration activities. For example the chat dialogs from time 10.00 am to 10.30 am between collaborator A and B is about 'coordinating a meeting' online. The two squares that overlap with one another represent that collaborating members sometimes need to multi-task their Web-mediated activities.

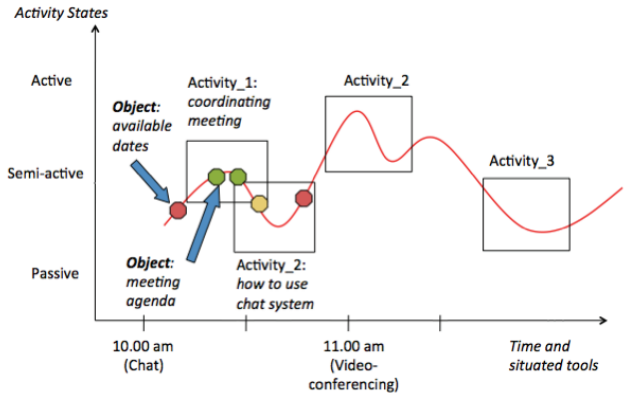


Figure 1. Activity states - capturing the level of collaborator's attention during his situated activity on the mediated-Web.

The colored circles represent objects, and a collaborator may pursue several objects during a situated activity. An assumption is made that a collaborator will always construct his communication that would help him to achieve "the objective" of his activity. This assumption is made on the basis that a collaborator, when using the Web to communicate with his collaborating colleague, will communicate with the purpose of collaborating.

We give an example of how Web-mediated communicative behavior can be represented with activity states concepts, as shown in Figure 1. Assume a collaborator that just joined the group chat that is about to start the activity of 'coordinating a meeting', *just about to be engaged* in pursuing his 'objective': he is in the passive state. The red line represents the fluctuation of the collaborator's activity states – he may be in a semi-active state in pursuing the activity of 'coordinating a meeting', however he may be in a passive state when engaged in a new multi-tasking activity with his colleague on 'how to use a chat system'.

The collaborator's object during the engagement in the activity of 'coordinating a meeting' is 'looking for available dates'. The object may result in the transformation of another object – 'discussing the meeting agenda'. How he chooses to communicate (e.g., to inform or to propose either on the chat system or via email) will thus be contextualized with respect to his situated activity.

How do we apply and model activity states analysis to *communication exchanges for identifying collaborators activities* (as illustrated in Figure 1)? ASF proposes the following (i) adapting the notion of the transformation of object and subject from psychic reflection in activity theory (Leont'ev, 1978) and (ii) applying the communicative act specification by Fipa-Acl. The notion of object and subject is used to infer the activity states, and to give a label to the activity (i.e., coordinating meeting). While the communicative act specification is used to represent the activity states and keep track of the activities (explanation follows in the next section).

To implement the notion of transformation of object, and subject to a set of utterances, let's consider the following. A collaborator on a chat system will communicate with a set of utterances, e.g., when are you available? Hence the *utterance will always be a construction from the subject*. When a collaborator is constructing his utterance at that moment, *he will form a conception of what he wants to communicate about*.

Thus in ASF, an object is defined as a conception. Conception in the ASF refers to implicit information such as abstract thoughts that might be inferred as a goal. *A reference (i.e., information) that is constructed in relation to the conception* will only become a realization when the collaborator is interacting at that next moment mediated by the located tools. Thus, subject which refers to as a person in activity theory has been defined as the reference to the conception in ASF (the example will be illustrated in the next section)[9].

Fipa-Acl communicative acts (i.e., speech acts), e.g., inform, are specified with a message content and description (see Appendix A for an example). Speech acts denote intentions when performing some actions – such as requesting a file, or informing that a specific action is being taken. The communicative acts that can best represent the activity states are grouped together. As an example, '*inform*', and 'query-ref' (i.e., asking how a person is) are grouped together to belong to the *passive state* (see Appendix B for an excerpt). Some communicative acts such as '*inform in reference*' (i.e., informing in reference to a content), may be commonly used to represent that an individual is informing about his/her status (i.e., pursuing a new activity, about to complete an activity). Thus, they may belong to both the passive, and semi-active states.

The proposed workflow

We have introduced the foundation of ASF that represents a model for analysis but not yet a framework. In this

[9] When a theory is applied to a new area, it must be adapted to fit the nature of the data or needs of the new area.

section we will introduce the ASF workflow, in Figure 2 below. The workflow provides high-level description of a control flow for an algorithm transforming the ASF model into a computer-based framework.

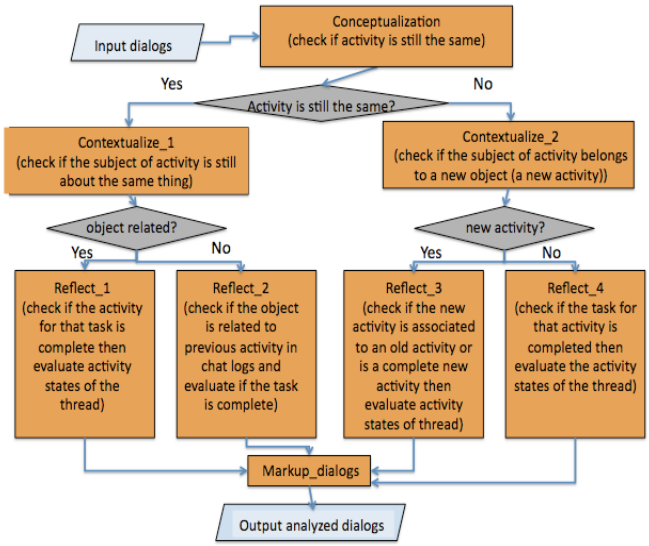


Figure 2. ASF workflow- a step-by-step guide on how to analyze Web-mediated communication exchanges to identify collaborators activities.

Refer to Figure 2. The three notions: conceptualization, contextualization and physic reflection are modeled as processes in the ASF workflow (see the orange colored boxes). Thus the notions are referred to as processes hereafter. The purpose of the process *Conceptualize* (i.e., What I am Doing Right Now) is to identify if the activity of the collaborator at that moment is the same as the one at the previous moment. The processes *Contextualize_1,* and *_2* are to check if the activity is still the same or if the speaker's activity is a new activity. The processes *Reflect_1, _2*, *_3,* and *_4* aim to evaluate the activity states by relating the speaker's current activity with the past activities.

The process *Markup_dialogs* is meant to give a representation of intentions in the analyzed dialogs with communicative acts, and with a label to the activity (e.g., activity coordinating a meeting). The workflow works incrementally to accumulate specific information during each situated activity. The information that is accumulated at each process is used for the next process (i.e., comparing the information with previously collected information).

We will go through each step of the workflow. The input to the workflow are utterances. Each utterance, for example 'just need 5 minutes' is referred to as 'activity' in the workflow. The workflow starts with the process *Conceptualize*. During this process, the model should compare the present and previous utterance in order to get information whether the activity is similar. As an example: if the currently analyzed utterance is 'just need 5 minutes', and the previous utterance is 'hang on, I should be able to push this' by the same speaker, then the two utterances are about the same activity- the collaborators are still in the activity of writing an article together, then the computer model should go to the next process, *Contextualize_1*.

At *Contextualize_1* the model would check whether the subject of the activity is still about the same thing - the object is to write a paper together, and the subject is still about sending a file. Recall that object in ASF is defined as conception, and subject is defined as reference to conception. Thus at this step it requires to identify which part of the utterance is an object, and a subject. To achieve this, if the model encounters a nominal proposition, the following utterances would be segmented[10] as a subject.

Respectively, if the model encounters a verbal proposition the utterance is segmented as *object*. For example 'just need' is segmented as the object part since it indicates that the speaker's purpose is informing a particular action to the listener: it is a verbal proposition. Thus '5 minutes', is segmented as the subject part since it indicates that the particular action (the reference to the object) is for the listener a reference to give the speaker 5 minutes: it is a nominal proposition.

At *Reflect_1*, the computer model must check if the object of the activity is completed and then evaluate the 'activity states' of the utterance in order to capture the actions appropriately. If we refer to our example, 'just need 5 minutes' indicates that the object of the activity that is to send the file has not yet been completed. Since the subject has been introduced (i.e., the file is a scientific paper) in the previous utterance, the value is increased from passive to a semi-active state.

At *Markup_Dialogs*, the computer model will search for the appropriate communicative acts to capture and model the activity states. Here the model would refer to a library of activity states' categories of communicative acts (see Appendix B). The computer model would look into the list of the communicative acts that belong to the semi-active category (which had been identified at the process Reflect). Then, the model compares the meaning of the object, and subject of the analyzed dialog to the Fipa-Acl communicative act specifications.

In our example, the communicative act 'request when' is specified with action and proposition that describes that the speaker desires that the listener performs a certain action as soon as he believes in the proposition (See Appendix A). Here the object 'just need' represents an action, and the subject '5 minutes' represents the information about the action. Hence the utterance 'just need 5 minutes' is labeled

[10] Segmented is a synonym of classified object and subject regrouped as utterances. An utterance is a data structure holding the object and its complementing subject if there is any.

with 'request when' since the object and subject of 'just need 5 minutes' corresponds to the 'request when' communicative act specification. The following format is used to represent the analyzed utterances: *speaker A listener B communicative act X: content (object (subject))*.

Thus we have the analyzed utterance represented as: *speaker A listener B request when: content: (just need (5 minutes)),* and labeled the context as *'activity sending file'*. Equational logic[11] (Gries, 2000) is used for representing the content part of the analyzed utterance(s).

Discussions – The Implications of ASF

The ASF has been experimented in a prototypical computer model on two datasets: requirements meeting during an industrial software development project, and a normal chat dialog during a scientific project collaboration. The datasets in total consists of 300 lines of dialogs. We show an excerpt of the output:

(TOP (X (INTJ (UH hello))(, ,)(SBAR (WHADVP (WRB how))(S (VP (VBP are)(NP (PRP you)))))(. ?)))[12]

(Greet
:sender "m"
:content "hello()"
:conversation "")
(Query-Ref
:sender "m"
:content "how_are (you)"
:conversation "")

At the moment, the prototypical computer model is not able yet to automatically categorize and label the activity of the utterances. However *it can perform the analysis into activity states.* Readers may refer to Appendix C for the input of chat dialogs, and Appendix D to view the rest of the output correspondingly. The prototypical computer model has been designed with a graphical user interface following Figure 1. What the ASF prototypical model has explored in detail is the transformation notion of object-subject. Nonetheless, the ASF cannot yet model prototypical contextualization - which refers to the conceptual-memory process. Most importantly, the ASF model is not making any claims on the theory of communication.

What the ASF model *highlights* is *how to exploit the notion of object, and subject* at the *moment-by-moment activity of a person* on a situated Web in order to understand *communication exchanges*. It presupposes that *object, and subject transformation* is *part of the contextualization process* – comparing current information to previous experiences. It furthermore presupposes that the chain-of-events in dialog is influenced by the situated tools that we use to convey our intention, and knowledge. This changes how we would coordinate our communicative behavior (in action) considering the current context in attaining our object.

Conclusion and Future Work

After the adoption of elements from situated cognition and activity theory, we have developed our own model and its corresponding computer-based framework. ASF exploits the interplay of the *conceptualization, contextualization* and *psychic reflection* processes by linking them to *intentions in speech acts* and *levels of activities* as above outlined. This framework has been instantiated within a semi-automatic process flow of analysis for goal-oriented conversations on the Web. Our long term purpose has been to analyze, understand and forecast human communicative behavior situated within the Web.

The results highlight that the most valuable influence of context is the *recurrent, moment-by-moment transformation of object and subject during the dialog process,* considering tools and activities in pursue of an object. The transformation process highlights mental processes *akin to an in-between process of comprehending the text that one reads and coordinating the thoughts (i.e., intentions) and actions*.

Our future work will focus on implementing an engineered version of ASF, in order to deepen pragmatically our analysis, and modeling within new experimental scenarios. While considering how will the information (i.e., dialogs) come from in practice.

Acknowledgments

We would like to thank William J. Clancey from Florida Institute of Human and Machine Cognition, and NASA Ames Center for his constructive comments and contributions to the theoretical foundation of our Activity States Framework.

APPENDIX A

Fipa-Acl communicative act	Message content and description
Request-when	Message content: A tuple of an action description and a proposition. Description: Request-when allows an agent to inform another agent that a certain action should be performed as soon as a given precondition, expressed as a proposition, becomes true.

[11] Equational logic emphasis on substitutions of equals for equals instead of modus ponens. It sits between propositional logic and first-order logic.
[12] This is the output from the parser generated at run-time. In this paper we do not go into the details of the implementation.

APPENDIX B

Activity states categories	Communicative acts
Passive	Greet, express, inform, query-ref..
Semi-active	Query-if, request when, inform-ref…
Active	Agree, inform-if, inform-ref..

APPENDIX C

(Chat logs)

<m> hello, how are you?
<p> currently writing an article for ITS to due on Monday
<m> Would you be interested in using a version of that map I showed in Barcelona
<p> indeed
<m> hang on, I should be able to push it to the entire consortium here on BD
<m> just need 5 minutes
<p> Please Q, could you explain to me how I can chat with somebody already registered in BuddySpace but not yet in Elegi ?
<m> ok gonna first publish the map
<m> sorry had phone call
<m> just publishing now
<p> I am on the phone too, sorry
<m> heh ok, I have just published the map
<m> ok go on the menu to Maps... Get published maps...

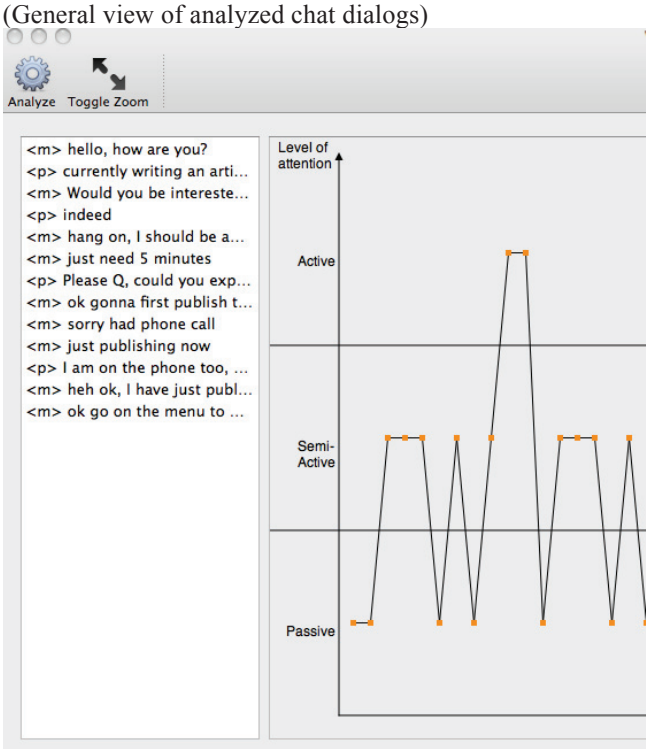
APPENDIX D

(Run-time view results of chat dialogs)

```
INFO: Installing dictionary
net.didion.jwnl.dictionary.FileBackedDictionary@110c424
Socket up and running
(TOP (X (INTJ (UH hello))(, ,)(SBAR (WHADVP (WRB
how))(S (VP (VBP are)(NP (PRP you)))))(. ?)))
(Greet
    :sender "m"
    :content "hello()"
    :conversation "")
(Query-Ref
    :sender "m"
    :content "how_are(you)"
    :conversation "")
(TOP (S (ADVP (RB currently))(VP (VBG writing)(NP (NP (DT
an)(NN article))(PP (IN for)(NP (NP (NNP ITS))(SBAR (S (VP
(TO to)(VP (JJ due)(PP (IN on)(NP (NNP Monday))))))))))))
(Inform-Ref
    :sender "p"
    :content "currently_writing(an, article)"
    :conversation "")
(Inform-Ref
    :sender "p"
    :content "for(ITS)"
    :conversation "")
(Inform-Ref
    :sender "p"
    :content "to_due_on(Monday)"
    :conversation "")
(TOP (SQ (MD Would)(NP (PRP you))(VP (VB be)(ADJP (JJ
interested)(PP (IN in)(S (VP (VBG using)(NP (NP (DT a)(NN
version))(PP (IN of)(NP (DT that)(NN map)))))))))(S (NP (PRP
I))(VP (VBD showed)(PP (IN in)(NP (NNP Barcelona)))))))
```

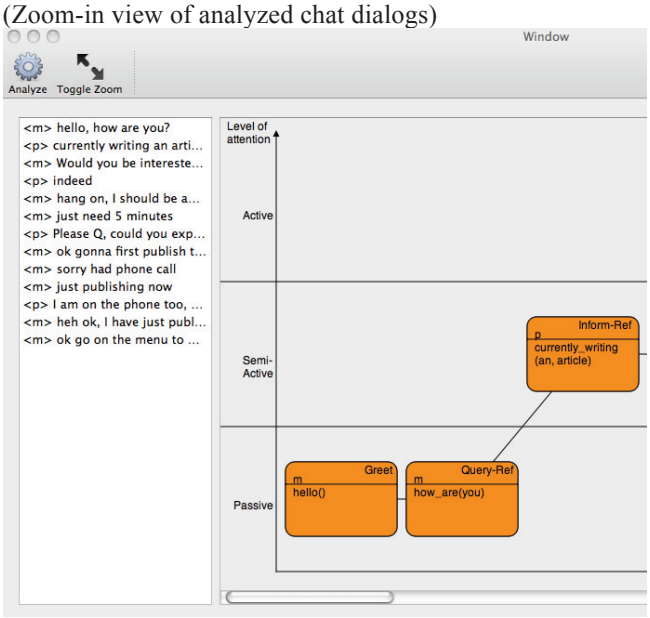
APPENDIX E

(General view of analyzed chat dialogs)



APPENDIX F

(Zoom-in view of analyzed chat dialogs)



APPENDIX G

(Excerpted requirements meeting)

<K> well that's the kind of question, is this something that should be treated as a production
<M> oh absolutely yeah
<K> and in that case are we gonna actually getting working by

Friday
<M> at the moment it's not production level we need to have something to show by Friday that they can start to use, and then we can productionized it and sell
<A> so when you start to use... what... what they are gonna do from let say next week onwards... they are gonna expect a running demo instances with this portal on... well... we've got on that one I guess
[edited]
<A> but do we need any code in there?
<M> to be honest I think we need to worry less about the graphic aspect of it... the only thing we do at production line we go through the line of business, we should not worry too much about the graphic we need to think about what content is... we do need 8 content management system of some sort...
<P> the code is real mess
…[edited]

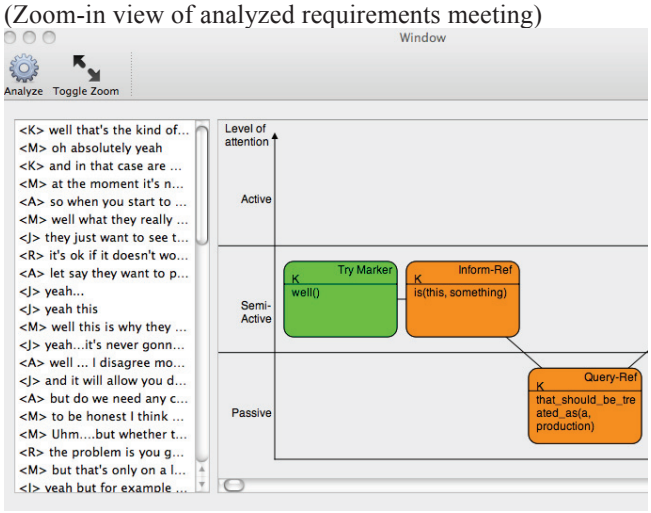
APPENDIX H

(Run-time view of requirements meeting - excerpted)

```
(Inform-Ref | Disagree
   :sender "K"
   :content "not(fake, working, software)"
   :conversation "")
(Query-Ref
   :sender "K"
   :content "could_get(you)"
   :conversation "")
(Query-Ref
   :sender "K"
   :content "money_to_write(real, working, software)"
   :conversation "")
(TOP (S (S (NP (DT the)(NN price))(VP (VBZ is)))(, ,)(: ...)(, ,)(CC but)(S (NP (PRP I))(VP (VBP guess)(SBAR (S (NP (PRP we))(VP (VBP do)(RB n't)(VP (VB have)(NP (DT a)(NN choice))(PP (IN with)(NP (PRP it)))))))))))
```

APPENDIX I

(Zoom-in view of analyzed requirements meeting)



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