

KQML+: An Extension of KQML in order to Deal with Implicit Information and Social Relationships

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Abstract

On one hand agent-based applications require a well defined language in order to implement agent interaction protocols - KQML or FIPA are proposed for that purpose. On the other hand, industry is actively working on "conversational interfaces" which will integrate an increasing number of features found in human conversations. We show that current agent communication languages cannot be used to develop applications involving such interfaces. The languages should be extended in a way which allows an agent to manipulate indirect speech acts and to use the various kinds of speech acts found in human conversations. For that purpose, and after a careful study of speech act theory, we propose an extension of the KQML language.

Introduction

Agent technology is used more and more frequently to help users achieve various tasks in diverse domains such as network management (Skarmas and Clark 96), air-traffic control (Chu-Carroll and Carberry 95), telecommunication (Busuioc 96), or electronic commerce (Chavez and Macs 96). In most of the systems developed in those domains we can distinguish two levels of communication: agent/user interaction and interagent interactions. Agents interact with users in order to characterize their needs and to provide them with answers or solutions. Agents interact with each other in order to exchange various kinds of information. In order to successfully interact together, agents need to share a common language.

To deal with inter-agent communication, industry tries to find a standard communication language such as KQML (Finin et al. 95) or FIPA (Fipa). When it comes to agent/user communication the current technology is based on Graphical User Interfaces (GUI). However, the industry is seriously considering applications involving

"conversational interfaces": For example, "by providing support for visual personalities, Microsoft Agent facilitates a new form of user interaction known as a conversational interface. A conversational interface attempts to leverage natural aspects of human dialogue and social interaction, and makes user interfaces more appealing and approachable for a wider variety of users (Microsoft)". Although the current conversational interfaces are still simple, we can expect that they will integrate several features of human conversations in the future. More specifically, we think that future interaction languages should allow the manipulation of indirect speech acts¹ and the use of the various kinds of speech acts found in human conversations. Indeed, it can be observed that human locutors use indirect speech acts quite frequently. This can be explained by the social characteristics of these interactions (Moulin 98). In addition, speech act theory (Searle 69) indicates that speech acts found in conversations can be classified into five basic categories: assertives, directives, commissives, declaratives, and expressives. Hence, agents should be able to perform such a variety of speech acts.

Therefore, we propose in this paper an extension of KQML that (i) allows agents to exchange any kind of speech acts found in human conversations, and (ii) conveys elements that allow agents to manipulate indirect speech acts.

The rest of the paper is as follows. In section 2 we present the application domain we are working on and identify major phenomena that allow to explain indirect speech acts. In section 3 we study KQML and show why agents cannot use this kind of language in order to perform indirect speech acts and the various types of speech acts

¹ According to Vanderveken (Vanderveken 88), when a speaker performs a direct speech act (i.e. when the speaker's meaning is literal) in a context of utterance, the speaker means to perform the direct speech act expressed by the sentence that he uses in that context. For example, the speech act "I ask you to close the door" is a direct speech act expressing a request for closing the door. Instead, the speech act "Can you close the door?" is an indirect speech act expressing the same request.

found in human conversations. Finally, in section 4 we present the KQML+ language we developed as an extension of KQML.

Importance of implicit information and social relationships

Administrative correspondence is an application domain in which our extension of KQML can be applied. Large and small organizations use some kind of administrative correspondence in various forms: formal letters, informal letters, memos, notices, etc. The way those documents are written depends on the "social relationships" established between the interlocutors. Messages may be "very informal", "very polite", or "quite informal".

In the POSTAGE project, we develop software agents which manage administrative correspondence on behalf of and in cooperation with their users. Each user interacts with his own POSTAGE agent which generates messages with respect to administrative correspondence rules. A POSTAGE agent is also responsible for sending the generated message to the addressee's POSTAGE agent. Hence, our project allows users to delegate the task of administrative correspondence to interface agents

A user can formulate a message in an informal way, and the POSTAGE agent will transform this message in a way which agrees: (1) with the social relationship existing between the user and his addressee; (2) with the user's communicative intention, and (3) with the formulation rules used in that particular organization. For example the informal message "Your are laid off" would be transformed into "As general manager, I deeply regret having to announce your dismissal from our company". Moreover, a lot of administrative messages are expressed using indirect speech acts such as "Can you print this document ?" instead of using the direct speech act "Print this document".

During our study of administrative correspondence, we identified two major phenomena: the use of implicit information, and the importance of social relationships.

It is easily observed that human locutors use indirect speech acts more frequently than direct speech acts. For instance, when a manager says to his secretary "Can you print the document D45 ?", his utterance should be interpreted as a polite way of ordering her to print the document (non literal interpretation) and not as a question about her ability to print (literal interpretation). In order to take into account this conversational phenomenon, we suggested to model *implicit information* conveyed by speech acts (Bouzouba and Moulin 97). Given a speech act SA performed by locutor L1 and directed to locutor L2, we define the implicit information conveyed by SA as the information that L1 intends to transfer to L2 and which is different from SA's propositional content. For example, the implicit information associated to the question "Can you

print document D45 ?" is the request to print the document. To our knowledge, no current implementation of software agents integrates this aspect in its communication model.

In order to provide a mapping between implicit and explicit information, we use knowledge structures called *conversational schemas* which are similar to the conversational postulates that Gordon and Lakoff proposed to interpret indirect speech acts (Gordon and Lakoff 75). Conversational schemas specify conversational conventions that apply in a given socio-organizational context. A conversational schema can be used by an agent either for choosing a speech act that reflects its communicative intention, or for interpreting other agents' speech acts. For example, the conversational schema of the above example could be formulated using the following logical implication:

```
question(speaker, capacity(hearer, do(hearer, A)))  
→  
request(speaker, do(hearer, action))
```

If we want to provide agents with the ability to perform and interpret indirect speech acts, it is necessary to give them means by which they can determine if their communicative intention has been understood. In our approach, an agent A1 determines if the intention corresponding to its initial speech act has been recognized by the interlocutor agent A2, if A2's speech act matches with the expected speech act which is included in the conversational schema that A1 selected in order to perform its initial speech act.

There is little doubt that *social relationships* influence the way people interpret speech acts (Boden and Zimmerman 91). It is easily observed that locutors are aware of the roles they play and the social power they have in the organizational setting in which a conversation takes place. A soldier cannot give orders to his general without violating the power scale established in the army. We can also notice that most often social relationships are not expressed in locutors' speech acts: they remain implicit. In certain cases however, when a social relationship is violated, locutors react and may decide to invoke their social relationships: hence, they become explicit. Suppose that for whatever reason a secretary refuses to perform a task requested by her manager, the manager may strongly react saying: "I am your boss and you have to do what I order you to do".

In order to model the social context in which agents evolve, we provide them with specific mental states related to their inter-personal relationships: their roles and the social power induced by those relationships. A reasoning mechanism using those social mental states guides an agent when selecting a conversational schema and allows it to perform a speech act with respect to the power relationship established with the other agent.

In summary, a POSTAGE agent should use a communication language that allows it to express all kinds of speech acts found in correspondence messages. In addition, social relationships should be part of those exchanged messages.

Study of KQML

KQML is a communication language which has been designed to facilitate high-level cooperation and interoperation among software agents. KQML offers a extensible set of so-called "performatives" that specify what kinds of communication agents can have with each other. KQML's authors have borrowed the notion of performative verbs to speech act theory. Our study of KQML has outlined the following points:

1. *KQML performatives are limited to the assertive and directive categories.* There is no performative allowing agents to perform declarative, expressive, or commissive speech acts. However, without a commissive performative, it is difficult to imagine how agents could cooperate. Indeed, whenever an agent is busy and cannot immediately execute a requested action, it should send a commissive message, promising the requesting agent that the answer will be forthcoming. Hence, without the commissive performative, the requesting agent would have no way to know if it will get an answer for its request.

2. *Inappropriate choice of performatives.* For example, when an agent cannot answer to a request, it uses the performative *sorry*. But, *sorry* is not a verb as should be a performative according to speech act theory. In addition, this performative displays a psychological attitude of regret. However, the agent may have no regret when performing an act using this performative. More details about inappropriate choice of other KQML performatives can be found in (Cohen and Levesque 96).

3. *Illocutionary force and propositional content of KQML messages are independent.* However, according to speech act theory, the illocutionary force and the propositional content of a KQML message must be dependent. For example, the propositional content of a directive must describe a future situation. Due to the lack of semantics associated to KQML performatives, this dependency condition is not satisfied. As Cohen and Levesque suggested (Cohen and Levesque 96), one of the problems related to this independency property is that contradictions could arise. For instance, an agent could send a message saying that it requests another agent to perform an act, and at the same time the agent could say that it does not want the act to be done. Thus, agents could deny the sincerity conditions (Vanderveken 90) or preparatory conditions of their speech acts which is unacceptable.

4. *Different interpretations of KQML performatives.* Although KQML is supposed to be a standard language, several projects using it interpret differently certain performatives. For example, in order to announce its abilities, an InfoSleuth agent (Nodine and Unuh 97) uses *tell* while a Visitor-Hoster agent (Sycara and Zeng 96) uses the *advertise* performative.

Because of those limitations, the current version of KQML cannot be used to develop conversational interfaces, and we can not use for administrative correspondence. In the POSTAGE project, we have tried to extend KQML in order to overcome those limitations, basing our proposal on a rigorous study of speech act theory.

As a result, we propose to add new performatives and new slots in the structure of a KQML message. Interestingly, speech act theory (Vanderveken 90) proposes a classification of speech acts found in conversations and we can take advantage of that classification in order to provide a systematic interpretation of agent's speech acts. Briefly speaking, a speech act in speech act theory is represented by a propositional content and an illocutionary force. The illocutionary force is divided into six components.

KQML+: an extension of KQML

One of the main problems of KQML is the non-unique interpretation associated with certain performatives. Each performative verb should be carefully selected. Multiple interpretations of a performative can be explained by the fact that certain performative verbs used in KQML can belong to two different categories. For example, *tell* might be either an assertive or a declarative. The multiple interpretations can be also explained by the fact that illocutionary force components of some KQML performative verbs are not neutral. In order to solve this problem, we propose to select for each performative type, the corresponding primitive verb as suggested by speech act theory. In most cases, the primitive verb has only one illocutionary point and all of its illocutionary force components are neutral. For example, to perform a directive, the verb *direct* is the primitive performative verb suggested by speech act theory. The selected verbs of the other performative types are listed in table 1.

<i>Performative</i>	<i>Meaning</i>
<i>direct</i>	for a directive
<i>assert</i>	for an assertive
<i>declare</i>	for a declarative
<i>express</i>	for an expressive
<i>commit</i>	for a commissive

Table 1. primitive verbs for each performative type

For example, in the following message, agent A requests agent B to buy x and y products:

```
(direct
  :sender      agentA
  :receiver   agentB
  :content    buy (AGT (agentB),
                 OBJ (product-x, product-y))4
  :reply-with d1)
```

The performatives that we have just proposed allow agents to express a simple communicative intention. However, we are not able to represent with these primitive verbs more complex formulations such as "Would you be so kind to print that document?". Hence, the language cannot be limited to primitive verbs; other means should be found to represent more complex formulations. The illocutionary force components which have a direct influence on formulations are: the illocutionary point, the mode of achievement, the sincerity conditions, and the degree of strength. Thus, relying on those four components, in addition to the propositional content, we will propose new slots that should be added to the structure of KQML messages. This new structure will be named a KQML+ message. Let us first look at the definition of those components (Vanderveken 90).

Illocutionary point: when performing a speech act, a speaker has the intention to achieve its illocutionary point on the propositional content, because that point is the purpose which characterizes the type of speech act that he performs. *The illocutionary point could be named by using a performative verb.*

Mode of achievement: this is the component of an illocutionary force which determines how its illocutionary point must be achieved on the propositional content when the act is performed with that force. From a logical point of view, the mode of achievement restricts the conditions of achievement of its illocutionary point by requiring certain specific means or ways to achieve that point. When uttering a command for example, the speaker must invoke a position of authority over the hearer. The mode of achievement of an act of begging, which is a humble or polite attempt to get the hearer to do something, is a special mode of achievement of the directive illocutionary point. Hence, *the mode of achievement may be invoked based on a position of authority or on personality traits of the agent.*

Sincerity conditions: by performing an illocutionary act, the speaker also expresses (or exhibits) certain psychological attitudes (such as a regret or a desire) about the state of affairs represented by the propositional content.

For example, a speaker who promises something, expresses an intention to do what he promises, and a speaker who requests a hearer to do something expresses a desire that he do it. Formally, a sincerity condition is a subset of all psychological attitudes and is expressed using

an expressive verb such as "I regret that". *Sincerity conditions may be invoked by the use of an expressive performative.*

Degree of strength: psychological attitudes which are part of the sincerity conditions of speech acts are expressed with different degrees of strength depending on the illocutionary force. For example, the degree of strength of sincerity conditions of a supplication is greater than that of a request. Adverbs like 'sincerely' or 'frankly' strengthen the degree of strength of the sincerity condition. *The Degree of strength may be invoked by the use of an adverb.*

Hence, according to speech act theory, natural language expressions are not only dependent on the type of the performative verb, but also on the mode of achievement, on sincerity conditions and on the degree of strength. Thus, a way of extending KQML would be to consider those components as new slots for KQML+ messages. This is not the solution we adopted. Indeed, the proposed components don't emphasize social relationships which are necessary for an agent to manipulate indirect speech acts. Rather, basing our suggestion on those components, we propose new slots for the KQML+ structure message.

In the previous section, we associated to each performative type a primitive verb. In certain cases, the primitive verb might not be used. The verb *announce*, for example, could be used to perform a declarative speech act instead of the verb *declare*. To take into account our previous remarks about the necessary elements for manipulating indirect speech acts, we divided the mode of achievement into two new slots. In fact, the mode of achievement may be expressed either by a personality trait, such as politeness or humility, or by a social position. In general, the personality trait is associated with the performative verb used to express the speech act. For example, one can make a request in a polite way. Hence, we added to the structure of a KQML+ message, the slot *expressed-performative* which includes the performative verb actually used in the formulation and the degree associated with this performative. For a polite request, this slot will have the value *(request, polite)*. Since, the social position is a notion which is conceptually different than the personality trait, we separated the social position from the degree associated with a performative. This mainly allows agents to convey social relationships and consequently to manipulate indirect speech acts. The *expressed-social-position* is a new slot. Sincerity conditions and their degree of strength are used to express certain psychological attitudes of the speaker and are generally expressed in expressive formulations such as "It's a great pleasure" or "I deeply regret". Indeed, they strengthen the speech act. We consider that they make up a kind of "presentation packaging" of the speech act to perform. For example, "It's a great pleasure" is represented

⁴ Content is expressed using conceptual graphs (Sowa 84).

by the presentation slot and has the value (pleasure, great). Therefore, the structure we propose for a KQML+ message is:

```
(Primitive-performative
:sender ?
:receiver ?
:expressed-performative (verb, degree)
:expressed-social-relation ?
:presentation (expr, degree)
:content propositional-
content
:reply-with ?
:in-reply-to ?)
```

For example, the speech act "I thankfully ask you to send me the parcel", is represented by the following KQML+ message:

```
(direct
:sender I
:receiver You
:expressed-performative (ask, thankfully)
:content send(AGT(You),
OBJ(parcel))
:reply-with d1)
```

The speech act "As a general manager, I deeply regret having to announce your dismissal from our company" performed by A1 is transmitted to A2 using the following KQML+ message:

```
(declare
:sender A1
:receiver A2
:expressed-performative announce
:expressed-social-posit general-manager
:presentation (regret, deep)
:content dismiss(AGT(A1),
PTNT(A2)))
```

Conclusion

In this paper, we looked at interaction languages that allow agents to express any kind of speech act and take into account social relationships. We showed some limitations of the KQML language regarding the expression of the various kinds of speech acts found in human conversations. Using more carefully speech act theory, we proposed an extension to KQML. KQML+ messages have a similar representation as KQML's one but allow agents, thanks to new performatives and slots, to perform any kind of speech act and to convey social relationships which are necessary elements for the manipulation of indirect speech acts. Furthermore, the primitive KQML+ performative verbs eliminate the possibility of having different interpretations for each performative type.

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