

LECTURE 8: AGENT COMMUNICATION

An Introduction to Multiagent Systems

<http://www.csc.liv.ac.uk/~mjlw/pubs/imas/>

- Most treatments of communication in (multi-)agent systems borrow their inspiration from *speech act theory*.
- Speech act theories are *pragmatic* theories of language, i.e., theories of language *use*: they attempt to account for how language is used by people every day to achieve their goals and intentions.
- The origin of speech act theories are usually traced to Austin's 1962 book, *How to Do Things with Words*.

2 Speech Acts

- In this lecture, we cover *macro-aspects* of intelligent agent technology: those issues relating to the agent *society*, rather than the individual:
 - *communication*: speech acts; KQML & KIF; FIPA ACL.
 - *cooperation*: what is cooperation; prisoner's dilemma; cooperative *versus* non-cooperative encounters; the contract net.

1 Agent Communication

- Austin noticed that some utterances are rather like 'physical actions' that appear to *change the state of the world*.
 - Paradigm examples would be:
 - declaring war;
 - christening;
 - 'I now pronounce you man and wife' :-)
 - But more generally, *everything* we utter is uttered with the intention of satisfying some goal or intention.
 - A theory of how utterances are used to achieve intentions is a speech act theory.

3 Plan Based Semantics

- How does one define the semantics of speech acts? When can one say someone has uttered, e.g., a request or an inform?
- Cohen & Ferrait (1979) defined semantics of speech acts using the *precondition-delete-add* list formalism of planning research.
- Note that a speaker cannot (generally) *force* a hearer to accept some desired mental state.

- Consider:
 - performative = request
 - content = "the door is closed"
 - speech act = "please close the door"
 - performative = inform
 - content = "the door is closed"
 - speech act = "the door is closed!"
 - performative = inquire
 - content = "the door is closed"
 - speech act = "is the door closed?"

- There is some debate about whether this (or any!) typology of speech acts is appropriate.
- In general, a speech act can be seen to have two components:
 - a *performative verb*: (e.g., request, inform, ...)
 - *propositional content*: (e.g., "the door is closed")

- Searle (1969) identified various different types of speech act:
 - *representatives*: such as *informing*, e.g., 'it is raining'
 - *directives*: attempts to get the hearer to do something e.g., 'please make the tea'
 - *commissives*: which commit the speaker to doing something, e.g., 'I promise to...'
 - *expressives*: whereby a speaker expresses a mental state, e.g., 'thank you!'
 - *declarations*: such as declaring war or christening.

4 KQML and KIF

- We now consider *agent communication languages* (ACLs) — standard formats for the exchange of messages.
 - The best known ACL is KQML, developed by the ARPA knowledge sharing initiative.
- KQML is comprised of two parts:
- the knowledge query and manipulation language (KQML); and
 - the knowledge interchange format (KIF).

- In order to be able to communicate, agents must have agreed a common set of terms.
- A formal specification of a set of terms is known as a *ontology*.
- The knowledge sharing effort has associated with it a large effort at defining common ontologies — software tools like *ontolingua* for this purpose.
- Example KQML/KIF dialogue...

```
A to B: (ask-if
        (< (size chip1) (size chip2)))
B to A: (reply true)
B to A: (inform (= (size chip1) 20))
B to A: (inform (= (size chip2) 18))
```

- Here is their semantics for *request*:

$request(s, h, \phi)$

pre:

– s believes h can do ϕ

(you don't ask someone to do something unless you think they can do it)

– s believe h believe h can do ϕ

(you don't ask someone unless they believe they can do it)

– s believe s want ϕ

(you don't ask someone unless you want it!)

post:

– h believe s believe s want ϕ

(the effect is to make them aware of your desire)

- KQML is an 'outer' language, that defines various acceptable 'communicative verbs', or *performatives*.
- Example performatives:

– *ask-if* ('is it true that...')

– *perform* ('please perform the following action...')

– *tell* ('it is true that...')

– *reply* ('the answer is...')

- KIF is a language for expressing message *content*:

5 "Inform" and "Request"

- "Inform" and "Request" are the two basic performatives in FIPA. All others are *macro* definitions, defined in terms of these.
- The meaning of inform and request is defined in two parts:
 - pre-condition
 - what must be true in order for the speech act to succeed.
 - "rational effect"

what the sender of the message hopes to bring about.

performative	info	requesting info	negotiation	performing actions	error handling
concept-proposal			x		
cancel		x		x	
fp			x		
confirm	x				
disconfirm	x				
failure					
inform	x				
inform-if	x				
inform-rel					
not-understood	x				
propose		x			
refuse					
request		x			
request-when					
request-whenever					
describe					

• Example

```
(inform
  sender agent1
  receiver agent5
  content (price good200 150)
  language sl
  ontology hpl-auction)
```

FIPA

- More recently, the Foundation for Intelligent Physical Agents (FIPA) started work on a program of agent standards — the centrepiece is an ACL.
- Basic structure is quite similar to KQML:
 - *performative*;
 - 20 performatives in FIPA, e.g., sender etc.
 - *housekeeping*;
 - *content*

the actual content of the message.

- For the “request” performative...

The content is an *action*.

Pre-condition is that sender:

- intends action content to be performed;
- believes recipient is capable of performing this action;
- does not believe that sender already intends to perform action.

<http://www.csc.liv.ac.uk/~mjlw/pubs/imas/>

- For the “inform” performative...

The content is a *statement*.

Pre-condition is that sender:

- holds that the content is true;
- intends that the recipient believe the content;
- does not already believe that the recipient is aware of whether content is true or not.

<http://www.csc.liv.ac.uk/~mjlw/pubs/imas/>