

## CHAPTER 7: COMMUNICATING

### An Introduction to Multiagent Systems

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

#### Agent Communication

- 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.

## Speech Acts

- 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*.

## Speech Acts: Austin

- Austin noticed that some utterances are rather like 'physical actions' that appear to *change the state of the world*.
- Paradigm example – declaring war.
- 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.

## Speech Acts: Searle

- 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.

- 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”)

- 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?”

### 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 & Perrault (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.

## Plan-based Semantics for Request

$request(s, h, \phi)$

pre:

- $s$  believes  $h$  can do  $\phi$
- $s$  believe  $h$  believe  $h$  can do  $\phi$
- $s$  believe  $s$  want  $\phi$

post:

- $h$  believe  $s$  believe  $s$  want  $\phi$

## 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).

- 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*.

### Example KQML/KIF dialogue (A)

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

### Example KQML/KIF dialogue (B)

```
(stream-about
  :sender      A
  :receiver   B
  :language   KIF
  :ontology   motors
  :reply-with q1
  :content    m1
)

(tell
  :sender      B
  :receiver   A
  :in-reply-to q1
  :content
    (= (torque m1) (scalar 12 kgf))
)
```

### Example KQML/KIF dialogue (B continued)

```
(tell
  :sender      B
  :receiver   A
  :in-reply-to q1
  :content
    (= (status m1) normal)
)

(eos
  :sender      B
  :receiver   A
  :in-reply-to q1
)
```

## 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 performative in FIPA.
  - *housekeeping*;  
e.g., sender etc.
  - *content*  
the actual content of the message.

## • Example

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



performative	passing info	requesting info	negotiation	performing actions	error handling
accept-proposal			x		
agree				x	
cancel		x		x	
cfp			x		
confirm	x				
disconfirm	x				
failure					x
inform	x				
inform-if	x				
inform-ref	x				
not-understood					x
propose			x		
query-if		x			
query-ref		x			
refuse				x	
reject-proposal			x		
request				x	
request-when				x	
request-whenever				x	
subscribe		x			

### “Inform” and “Request”

- “Inform” and “Request” are the two basic performatives in FIPA. 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.

## FIPA “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.

## FIPA “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.