

LECTURE 5: COMMUNICATING

An Introduction to Multiagent Systems

CIS 716.5, Spring 2010

Agent Communication

- In this lecture we will begin to look at *multi* agent aspects.
- The most fundamental thing that agents have to do if they want to interact is to *communicate*.
- There are some limited things that one can do with communication, but they are, well limited.
- Most work on multiagent systems assumes communication.
- You can think of this as a transport layer for all the things we'll talk about in future weeks.

Speech Acts

- We start with this man:



John Langshaw Austin

- In particular his 1962 book *How to Do Things with Words*.

- *How to Do Things with Words* is usually taken to be the origin of *speech acts*
- Speech act theories are *pragmatic* theories of language, that is theories of how language is *used*.
- Speech act theories attempt to account for how language is used by people every day to achieve their goals and intentions.
- Most treatments of communication in (multi-)agent systems borrow their inspiration from *speech act theory*, doubtless because the “action” part can be tied closely to existing ideas about how to model action.

- Austin noticed that some utterances are rather like ‘physical actions’ that appear to *change the state of the world*.

- For example Neville Chamberlain saying:



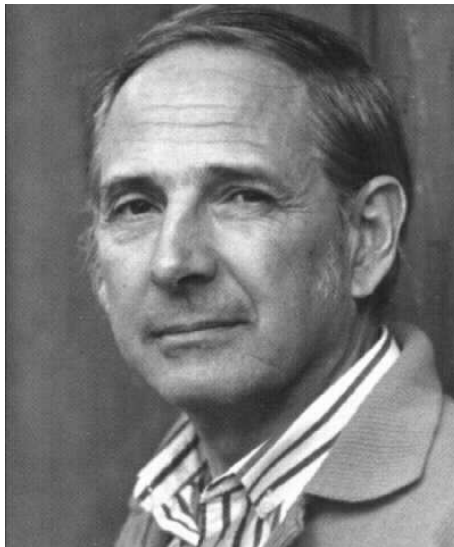
This morning the British Ambassador in Berlin handed the German Government a final note stating that, unless we hear from them by 11 o'clock that they were prepared at once to withdraw their troops from Poland, a state of war would exist between us. I have to tell you now that no such undertaking has been received, and that consequently this country is at war with Germany.

- Led to:



- Paradigm examples are:
 - declaring war;
 - naming a child;
 - “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.

- The next step was taken by John Searle



who identified various different types of speech act.

- In his 1969 book *Speech Acts: an Essay in the Philosophy of Language* he identified:
 - *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 naming.

- 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”)

- 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?”
- Several speech acts with the same propositional content.

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.

- 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 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*.

- 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.
- Chapter 6 of the book talks a lot about ontologies — we won't say any more than this.

KQML/KIF dialogue I

```
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))
```

KQML/KIF dialogue II

```
(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))
)
```

KQML/KIF dialogue II (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. 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.

- 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.
- Note that the speaker only has to *believe* that what he says is true.

- Again Chamberlain provides an example, saying, a few months before the previous example:



My good friends this is the second time in our history that there has come back from Germany to Downing Street peace with honor. I believe it is peace in our time.

- He was wrong, but he seems to have believed what he said.

- 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 recipient already intends to perform action.
- The last of these conditions captures the fact that you don’t speak if you don’t need to.

- Other performatives are:
 - propose
One agent makes a proposal to another.
 - accept-proposal
One agent states that it accepts a proposal made by another agent.
 - reject-propose
One agent rejects a proposal previously made by another agent.
- The syntax of these is similar to that of inform.

Alternative semantics

- There is a problem with the “mental state” semantics that have been proposed for the FIPA ACL.
- (This also holds for KQML).
- How do we know if an agent’s locutions conform to the specification?
- As Wooldridge pointed out, since the semantics are in terms of an agent’s internal state, we cannot *verfiy* compliance with the semantics laid down by FIPA.
- In practice, this means that we cannot be sure that a agent is being sincere.
- (Or, more importantly, we cannot detect if it is being insincere).

- This was exactly Chamberlain's problem.



- The people he was talking to lied to him.

- Singh suggested a way around this.
- Rather than define the conditions on a locution in terms of an agent's mental state, base it on something external to the agent.
- Move from a “mentalistic” semantics to a *social* semantics.
- How?
- Take an agent's utterances as *commitments*.
- But what does it mean to say that “if an agent utters an inform then it is committing to the truth of the proposition that is the subject of the utterance”?
- Doesn't stop an agent lying, but it allows you to detect when it does
 - For example when they say they want peace but then go and invade Poland.

Contestability semantics

- If an agent asserts that a proposition is true, then it is committing to *defend* that proposition.
- Any asserted proposition can be contested, and the assertor will have to provide an argument that supports it.
- If ever agent only asserts propositions for which it has an IN argument, and every agent only accepts propositions for which it is given an IN argument, then communication is *rational*.
(We will talk about argumentation in a later lecture.)
- Agents can lie, but only if they have good reasons to support the untruths they tell.
- If agents lie, they run the risk of being caught out (because they have to justify what they say).

Summary

- This lecture has discussed some aspects of communication between agents.
- It has focussed on the interpretation of locutions/performatives as speech acts, and some suggestions for what performatives one might use.
- There is much more to communication than this. . .
- . . . but this kind of thing is required as a “transport layer” to support the kinds of thing we will talk about later.