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 ia *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
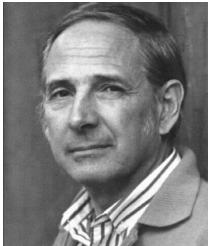
who identified various different types of speech act.

- 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'
  – *commisives*:
    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 that this. . .

- . . . but this kind of thing is required as a "transport layer" to support the kinds of thing we will talk about later.