

Agent Based Systems

Communication

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- We have considered mechanisms for agents to interact – mechanisms such as auction protocols or negotiation protocols allow agents to hopefully reach an agreement.
- In order to do so, agents need to be able to communicate in an expressive manner

- Many approaches to communication in (multi-)agent systems are inspired by Austin's work in speech act theory (1962)
- Speech act theories are pragmatic theories of language; theories of how language is used to achieve goals and/or intentions

Speech Act Theory

- Austin argued that many utterances are similar to 'physical actions' in that they bring about a change to the state of the world
- Example: "You're fired"
- More generally, things humans utter are done so with the intention/goal of satisfying some goal
- Examples: asking a question, answering a question, making a request
- A theory of how utterances are used to achieve intentions is a speech act theory

Searle's Classification of Speech Acts

John Searle (1969) classified types of speech acts:

- 1 representatives**
such as informing, e.g., 'It is cold'
- 2 directives**
attempts to get the listener to do something e.g., 'please pass the beer'
- 3 commissives**
which commit the speaker to doing something, e.g., 'I promise to pay...'
- 4 expressives**
whereby a speaker expresses a mental state, e.g., 'thank you!'
- 5 declarations**
such as declaring war

Components of a Speech Act

We can view a speech act as having two components:

- 1 a performative verb: (e.g., request, inform, promise, ...)
- 2 propositional content: (e.g., “the light is on”)

Same Content, Different Meanings

We can have the same content but the meaning is different depending on the performative. Consider “turn on the light”

- performative = request
content = “*the light is on*”
speech act = “please turn on the light”
- performative = inform
content = “*the light is on*”
speech act = “the light is on!”
- performative = inquire
content = “*the light is on*”
speech act = “is the light on?”

Semantics of Speech Acts

- Questions arise as to how to define the semantics of a speech act.
- The semantics of speech acts can be formalized using a set of pre-conditions and post-conditions
- For example, when considering a “request” speech act there are certain things that should be true prior to the request and a set of things that should be true following the request

Semantics of a Request

Here is the semantics for request:

request(a, b, X) (i.e. agent a asks agent b to do X)

The pre-conditions are:

- a believes b can do X
- a believes b believes b can do X
- a believes a wants X

The post-conditions are:

- b believes a believes a wants X

Agent Communication Languages (ACLs)

- There have been several attempts to create agent communication languages (ACLs) based on speech act theory (e.g., KQML, FIPA ACL)
- KQML comprises two parts:
 - the knowledge query and manipulation language (KQML)
 - the knowledge interchange format (KIF)

KQML Performatives

KQML allows one to define various acceptable 'communicative verbs', or performatives. Examples include:

- ask-if ('is it true that...')
- perform ('please perform the following action...')
- tell ('it is true that...')
- reply ('the response is...')

KIF is a language for expressing the content of the messages

FIPA allows inform and request as basic primitives

(inform

:sender agent1

:receiver agent2

:content (price item3 250)

:language scheme

:ontology art-auction

)

Discussion Questions

- 1 Consider the Dutch auction we discussed last week. Identify the communication primitives (speech acts) needed.
- 2 Consider a more complicated negotiation model where two agents are negotiating the rental of a house. One agent has a set of houses to rent (with price, number of rooms); the other has a utility function to rank the houses. What communication primitives might be required to allow negotiation?

Recap: Agent Systems

- decentralized control - increased robustness
- autonomy - able to deal with unseen cases/scenarios
- need means to ensure societal fitness among competing agents - game theory used to reason
- need means for coordination - auctions, negotiation - and many others

Agent Systems - Impact and Research

- Led to new paradigms in software engineering and design
- Interesting questions arise in balancing autonomy with control of the system
- There has been much study in questions pertaining to emergent phenomena
- Many of these fundamental questions - decentralized computation and representation, emergence are studied in the field of Artificial Life