An Introduction to Multiagent Systems

LECTURE 7: REACHING AGREEMENTS
How do agents reaching agreements when they are self-interested?

- The capabilities of negotiation and argumentation are central to mutually beneficial agreements on matters of common interest.
- In an extreme case (zero sum encounter) no agreement is possible — but in most scenarios, there is potential for mutually beneficial agreements when they are self-interested.

1 Reaching Agreements
Negotiation is governed by a particular mechanism or protocol.

Mechanism design is designing mechanisms so that they have certain desirable properties.

Given a particular protocol, how can a particular strategy be designed that individual agents can use?

Mechanisms, Protocols, and Strategies
Desirable properties of mechanisms:

- Distribution.
- Simplicity.
- Stability.
- Individual rationality.
- Pareto efficiency.
- Maximising social welfare.
- Convergence/guaranteed success.

Mechanism Design
An auction takes place between an agent known as the bid

er and a collection of agents known as the bidders.

The goal of the auction is for the auctioneer to allocate the good
to one of the bidders.

In most settings the auctioneer desires to maximise the price;
bidders desire to minimise the price.
Auction Parameters

- Goods can have private value or public/common value.
- Winner determination may be correlated value, first price, second price.
- Bids may be open cry or sealed bid.
- Bidding may be: one shot, ascending, descending.

http://www.csc.liv.ac.uk/~mjw/pubs/imas/
Most commonly known type of auction:

English Auctions

- shills
- winners curse

- Susceptible to:
- valuation, then withdraw.
  amount more than the current highest bid until it reaches thei
- Dominant strategy is for agent to successively bid a small

- ascending.
- open cry.
- first-price.
Dutch auctions are examples of open-cry descending auctions:

- Dutch auctions are examples of open-cry descending auctions:
- The auctioneer starts by good at artificially high value;
- Auctioneer lowers offer price until some agent makes a bid equal to the current offer price;
- The good is then allocated to the agent that made the offer.

http://www.csc.liv.ac.uk/~mjw/pubs/tmas/
First-price sealed-bid auctions are one-shot auctions:

- There is a single round.
- There is no communication between rounds.
- Bidders submit sealed bids for the good.
- The good is allocated to the agent that made the highest bid.
- The winner pays the price of the highest bid.

Best strategy is to bid less than true valuation.

- Submit a sealed bid that is less than your true valuation.
- The goal is to win the auction at the lowest possible cost.
Vickrey auctions are:
- second-price;
- sealed-bid.

Good is awarded to the agent that made the highest bid at the price of the second highest bid.

Vickrey auctions are susceptible to antisocial behavior.

Bidding to your true valuation is a dominant strategy in Vickrey auctions.
Negotiation usually proceeds in a series of rounds, with every agent making a proposal at every round. Negotiation is the process of reaching agreements on matters of common interest. Negotiation is the process of reaching agreements on matters of common interest.

Techniques for reaching agreement are required. Auctions are only concerned with the allocation of goods: richer

3 Negotiation

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Negotiation in Task-Oriented Domains

Imagine that you have three children, each of whom needs to be delivered to a different school. Only my neighbour or I will need to make the trip to carry out both tasks. Carrying out one of them (if obviously makes sense for both children to be taken together; and carrying out these two deliveries, or two tasks, is the same as the cost of that is, the cost of carrying out these two deliveries, or two tasks, is the same as the cost of) though, that one of my children and one of my neighbours' children both go to the same school. If you were alone, you can only benefit or do no worse (or do no worse) from your neighbour's tasks. Assume, you are no worse off than if you come to an agreement about setting up a car pool, in which case you are no worse off than if you achieve your task by yourself. The worst that can happen is that you and your neighbour won't achieve your task by yourselves. The worst that can happen is that you and your neighbour won't achieve your task by yourselves. The worst that can happen is that you and your neighbour won't achieve your task by yourselves. There is no concern about being able other's child to a shared destination, saving him the trip. There is no concern about bringing able situation, and come to an agreement that it is better for both of you (for example, by carrying the situation, and come to an agreement that it is better for both of you) you and your neighbour can discuss the each child can be modelled as an indivisible task. You and your neighbour can discuss the each morning. Your neighbour has your children, and also needs to take them to school. Delivery each morning. Your neighbour has your children, and also needs to take them to school. Delivery
A TOD is a triple

\[ \langle T \Delta, c \rangle \]

where \( T \Delta \) is a collection of tasks:

- An encounter is a collection of tasks where \( u \subseteq T \Delta \) for each \( i \in \Delta \).

\[ \langle u, \ldots, u, T \rangle \]

\( c \) defines cost of executing each subset of tasks.

- Let \( \mathcal{A} = \{ u, \ldots, u \} \) \( \forall A \subseteq \Delta \in \mathcal{A} \).
Given encounter \( T \), a deal will be an allocation of the tasks

Deals in TODS

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The Negotiation Set

The set of deals over which agents negotiate are those that are:

- pareto efficient.
- individually rational.

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The Negotiation Set Illustrated
The Monotonic Concession Protocol

Rules of this protocol are as follows...

1. Negotiation terminates, with the conflict deal.
   - If neither agent makes a concession in some round $n < 0$, then
     no agreement is reached; then negotiation proceeds to another round.

2. In round $n + 1$, no agent is allowed to make a proposal that is less preferred by the other agent than the deal it proposed at time $n$.

3. In round $n$, agents simultaneously propose a deal from the negotiation set.

4. On round $1$, agents simultaneously propose a deal from the negotiation set.

5. If neither agent makes a concession in some round $n$, then agreement is reached if one agent finds that the deal proposed by the other agent is at least as good or better than its proposal.

6. If no agreement is reached, then negotiation proceeds to another round of simultaneous proposals.

7. If neither agent makes a concession in some round $n < 0$, then negotiation proceeds to another round.

http://www.csc.liv.ac.uk/~mjw/pubs/tmms/
Three problems:

The Zeuthen Strategy

Just enough to change the balance of risk.

- If an agent concedes, then how much should it concede?
- The agent least willing to risk conflict.
- On any given round, who should concede?
- Its most preferred deal
- What should an agent's first proposal be?

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Lecture 7

http://www.csc.liv.ac.uk/~mjw/pubs/imas/
An agent will be more willing to risk conflict if the difference in utility between its current proposal and the conflict deal is low.

- You are more willing to risk conflict.
- Your proposal is now near to conflict deal.
- Suppose you have conceded a lot.

Willingness to Risk Conflict
The Zeuthen strategy is in Nash equilibrium: under the assumption that one agent is using the strategy the other can do no better than use it himself. The Zeuthen strategy is in Nash equilibrium: under the assumption that one agent is using the strategy the other can do no better than use it himself. This is of particular interest to the designer of automated agents. It does away with any need for secrecy on the part of the programmer. An agent's strategy can be publicly known, and no other agent designer can exploit the information by choosing a different strategy. In fact, it is desirable that the strategy be known, to avoid inadvertent conflicts.
Deception can benefit agents in two ways:

- **Phantom and Decoy tasks.** Pretending that you have been allocated tasks that you have not.
- **Hidden tasks.** Pretending not to have been allocated tasks that you have been.
Argumentation is the process of attempting to convince others of something. Gilbert (1994) identified 4 modes of argumentation:

• Logical mode.
  "If you accept that A and that A implies B, then you must accept that B".

• Emotional mode.
  "How would you feel if it happened to you?"

• Visceral mode.
  "Cretin!"

• Kisceral mode.
  "This is against Christian teaching!"

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Logic-based Argumentation

Basic form of logical arguments is as follows:

\[ \text{Database} \subseteq \text{Grounds}, \]

1. Sentence can be proved from Grounds.

2. Sentence is a logical formula known as the conclusion; and

Grounds is a set of logical formulae such that:

- Grounds is a set of logical formulae consistent (possibly inconsistent) set of logical formulae;
- Database is a (possibly inconsistent) set of logical formulae;

Where:

\[ \text{Database} \\vdash (\text{Sentence} \land \text{Grounds}) \]

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A rebuttal or undercut is known as an \textbf{attack}.

Let $\phi \vdash \varphi$ for some $\varphi \in \mathcal{I}_2$.

2. \textbf{Undercuts} ($\mathcal{I}_1 \vdash \mathcal{I}_2$)

$$\phi \vdash \varphi \\ \varphi \vdash \varphi$$

1. \textbf{Rebutts} ($\mathcal{I}_1 \neg \mathcal{I}_2$)

$$\phi \vdash \varphi$$

Then ($\mathcal{I}_2 \vdash \mathcal{I}_1$) can be defeated (attacked) in one of two ways:

A rebuttal or undercut is known as an \textbf{attack}.

\textbf{Attack and Defeat}

\textbf{Attack and Defeat}
Abstract Argumentation

Concerned with the overall structure of the argument rather than the internal details of arguments.

An argument is **out** if it has an undefeated attacker, and **in** if all its attackers are defeated.

An abstract argument system is a collection of arguments where we are not actually concerned as to what **x**, **y** are.

Write $x \not\Rightarrow y$ ("x is an attacker of y")

- "x is an attacker of y"
- "x is a counterexample of y"
- "argument x attacks argument y"

Where we are not actually concerned as to what x, y are.

A system of arguments

Concerned with the overall structure of the argument rather than the internal details of arguments.

Abstract Argumentation
An Example Abstract Argument System