MAS – Making Collective Decisions

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Jonathan Hudson, Ph.D
Associate Professor (Teaching)
Department of Computer Science
University of Calgary

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Making Collective Decisions

Teamwork

If we see the goal of cooperation as using results of others to perform the own tasks better or faster, then the most simple way of achieving cooperation is to make results (or information) available to other agents.

- Simple concept, no conflict handling necessary
- Existing search systems can be used
- Can lead to huge synergy effects

- Cannot be applied in conflict situations

- Can be rather communication intensive (big amounts of data can be sent around), if the two basic questions are not answered well

Negotiations

Negotiations are used to handle and resolve conflicts. Conflicts occur during cooperative problem solving

Starting point of negotiations is always a cooperation action (message) of one agent providing one or several other agents with a piece of information that is in conflict with their individual data. The goal of negotiations is to resolve such conflicts by changing the data areas (usually of all involved agents)

Rather general mechanism that can be used in almost all cases

- Very similar to human behavior.

- Can be rather communication intensive (many, rather small messages to many agents).

- Some movement in goals of agents is necessary in order to guarantee a compromise

- Cycle detection can become an issue

Leader-Follower

Leader-follower (Master-Slave) Relationships between agents aim at making extensive communication unnecessary by avoiding conflicts or by establishing clear priorities.

Can always exist/can be temporary/may be one to many

- Amount of communication rather low
- Well suited for hierarchical forms of organization

- In many applications, conflicts can simply not be avoided

- Masters can become bottlenecks (if they have too many slaves) or they might be idle (if the task distribution among agents is not good)

Self-directed systems

Self-X Started as IBM's (and now others) code for learning/adaptive systems

General goal: make systems easier to configure, maintain ai adapt to usage

Design individual agents as autonomous

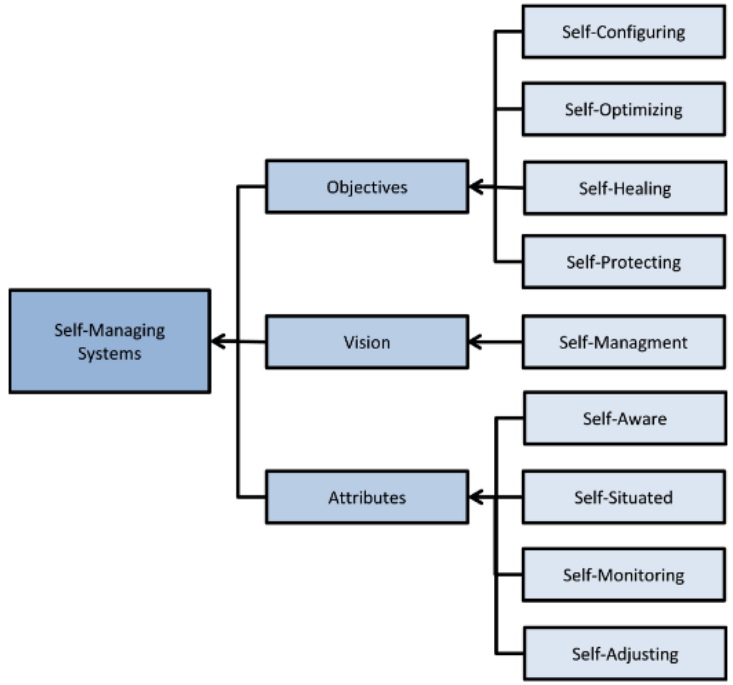


Figure 2.2: Self-Management Properties Tree

- Amount of communication can be really local or non-existant
- Well-suited for non-hierarchical organizations

- Lack knowledge of the global problem, can result in many ineffiencies in eventual solution
- Individual agents need to have complexity to solve everything they need to themselves

Emergence

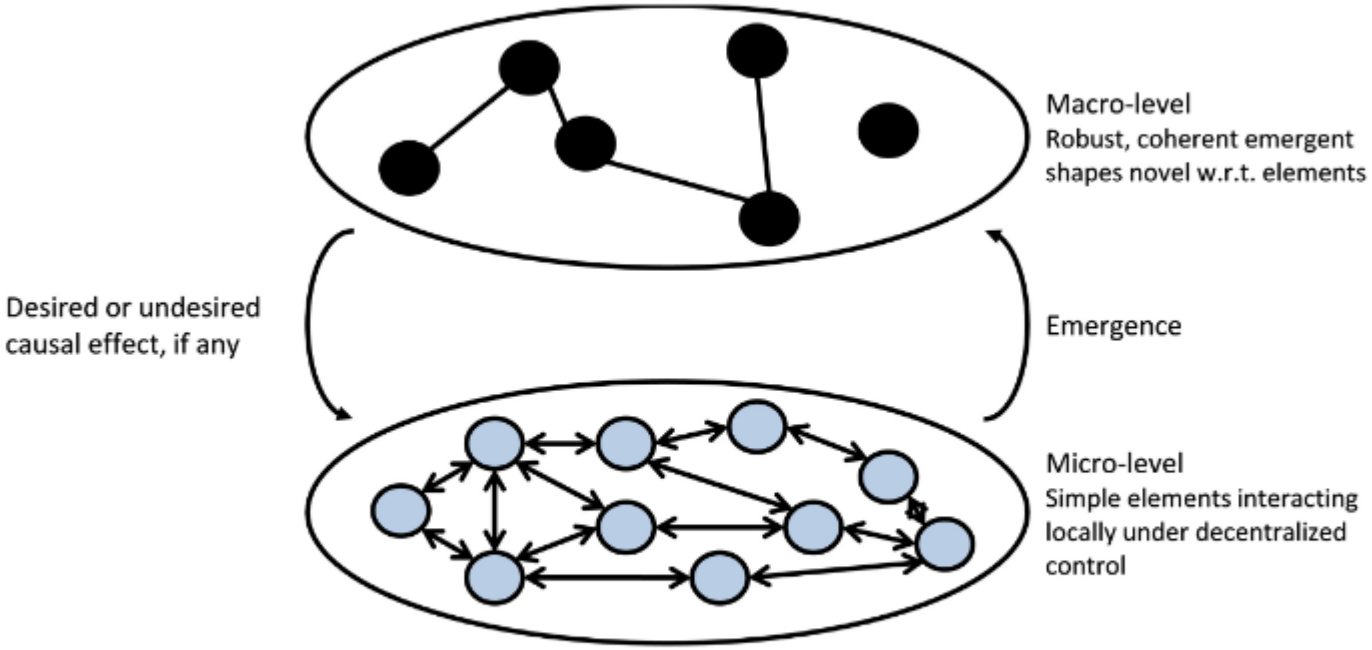
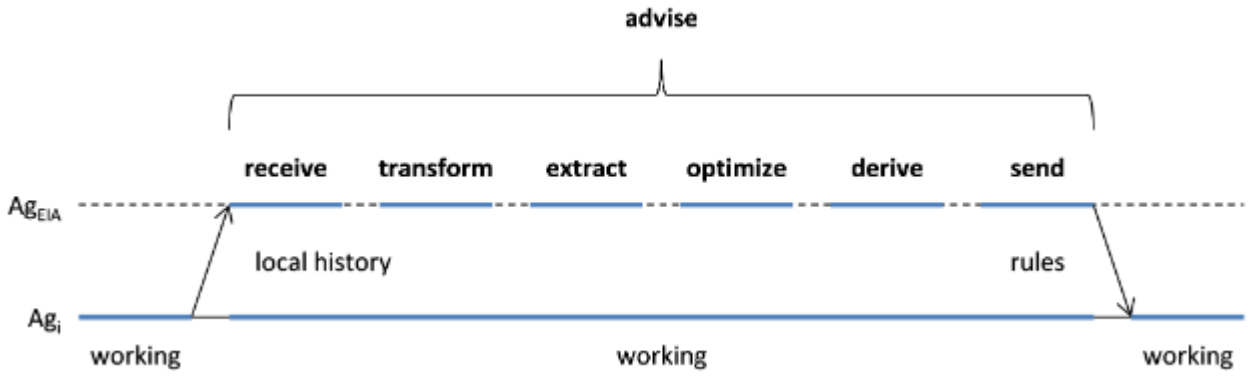


Figure 2.4: Micro-level, Macro-level, and Emergence

Advisor-Consultant

Advisor-Consultant Relationships between agents aim to reduce the centralization bottle-neck of a leader-follower relationship, while maintain the individualization of a self-directed system

Can always exist/can be temporary/may be one to many



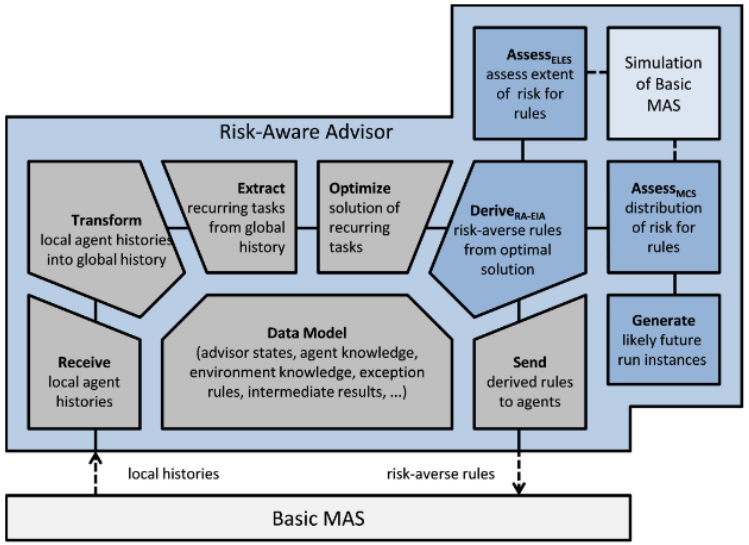


Figure 6.2: Functional Architecture of RA-EIA

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Advisor-Consultant

- Amount of communication rather low
- Well suited for organizations with separations of duty
- A well-designed advisor can help system be more globally efficient
- A consultant can be ‘hired’, assigned work, and then the work collected once finished and distributed as best fits the system (even can be ignored!)

- With loss of centralization control, the rest of system needs to be self-directed (decision makers)

- A bad design can turn this into a centralization component (while pretending it isn’t)

Voting

Voting schemes as cooperation concept are well suited for MAS, in which the knowledge of the agents is very vague and sometimes even wrong, which would lead to long negotiations to resolve conflicts.

By voting, not a compromise is generated but a solution (a fact) that is wished by most agents is accepted by all from there on.

There are no discussions, only the possible solutions to a problem (or conflict) have to be determined and made available to all agents

Voting

All agents might vote or only the ones involved in the conflict.

1. One of the agents that realized that there is a conflict has to assume the role of “master” of the voting
2. This agent informs the others about the different alternatives
3. Then it receives the votes from the others
4. Finally it informs the others about the result
5. Everyone changes its internal data to conform with the result

Voting

Alternative with the most votes wins

Alternative with absolute majority (i.e. more than 50 percent of the votes) wins

Alternative with a 2/3 majority wins

Etc…

- Provides safety with regard to Failing agents, errors
- Rather fast decisions in very complex situations with many conflicts involving many agents

- The majority can also be wrong (lemmings!)
- Agents have to be able to measure solutions to many problems
- Much redundant computation within the MAS

Auctions

Auctions are an example of market mechanisms. They are used to solve conflicts related to the distribution of resources or tasks (point a) in the cooperative problem solving process).

In contrast to negotiations, which essentially are a dialog, several agents (bidder) compete for a certain resource. Goal of an auction is to achieve optimal use of the resource, i.e. assigning it to the “best” agent.

The resource is property of on agent, the auctioneer, and it determines the definition of best use.

Auctions

English Auction

- Each bidder can bid at all the time and the other bidders are immediately informed about a new bid. If within a certain time interval no agent raises the bid, then the last bidder gets the resource for the price of the bid.
- The auctioneer achieves appr. the price the second highest bidder values the resource at.

Dutch Auction

- The auctioneer starts with a bid much higher than it thinks the value of the resource is and lowers the bid step by step until a bidder is willing to accept the bid. When a bidder accepts, it gets the resource for the price of the bid
- If no bidder knows the limits of the other bidders, the auctioneer achieves appr. the price the highest bidder values the resource. With knowing the limits this reduces to the value of the second highest bidder.

Auctions

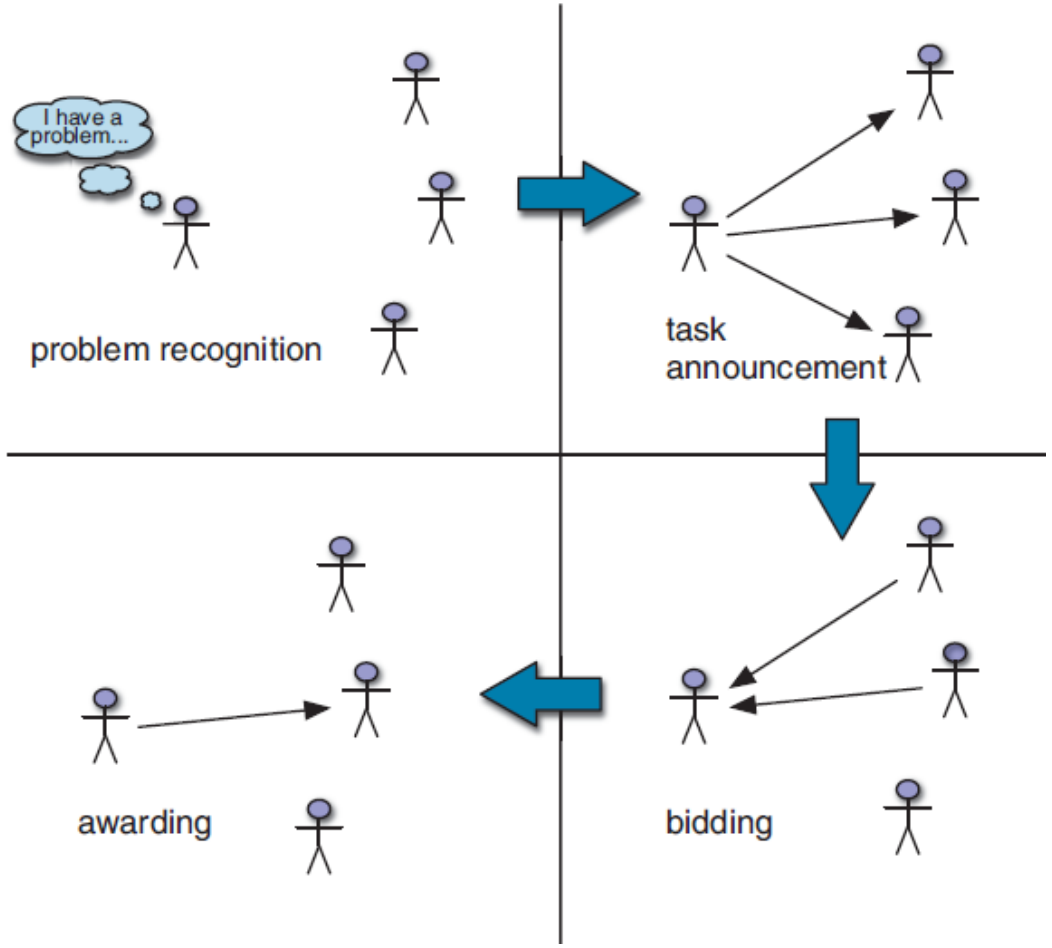
Vickrey Auction

- Each bidder hands in a bid to the auctioneer. The auctioneer hands the resource to the highest bidder for the second highest bid.
- The auctioneer achieves the price the second highest bidder values the resource at.
- Reduces bidding rounds. Also keeps bidders honest.

General

- Handles conflicts between many agents rather well.
- Allows for egoistic agents.
- Can become rather complex and time consuming
- Limited to market situations

The contract net task allocation protocol.



The contract net task allocation protocol.

Next…machine learning

Jonathan Hudson, Ph.D.
jwhudson@ucalgary.ca
https://cspages.ucalgary.ca/~jwhudson/

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