

3.3.3 Coalitions

Usually, different agents do not have totally different goals, instead they share some goals while disagreeing in others.

Shared goals should be used to achieve cooperation between agents (even without any enforcements from the environment)! But how can this be put into a MAS and into its organisational structure?

☞ By allowing for coalitions

The following slides are based on the results of the CPSC 601.79 course of Kaye Mason

Definitions

Game theory:

Coalition: two or more players reach agreement based on specific terms and conditions

MAS:

Various definitions, depending on the problems to be solved, resp. the desired results

Our definition:

A group of agents that act together as a single agent in a larger system form a coalition

Why coalitions?

Basic idea:

The individual agent trades a loss in autonomy versus a gain in utility

Examples:

- Form a buyer coalition to get mass discounts
- Form voting coalition to get majority for the combination of all individual goals
- etc.

Basic problems to solve

- How, resp. when to form a coalition
- How, resp. when to dissolve a coalition
- What does an agent in a coalition give up and what does it gain?
- How to measure the success of using coalitions
- How to deal (resp. allow) membership in multiple coalitions

Forming coalitions (I)

- Top-down approaches:
 - Usually inspired by game theory
 - Often require NP-complete algorithms to be generated
 - Search for the perfect (or at least a very good) coalition structure for a problem (i.e. maximal combined utility)
 - Examples:
 - Precalculated coalitions
 - Distributed utility search algorithms

Forming coalitions (II)

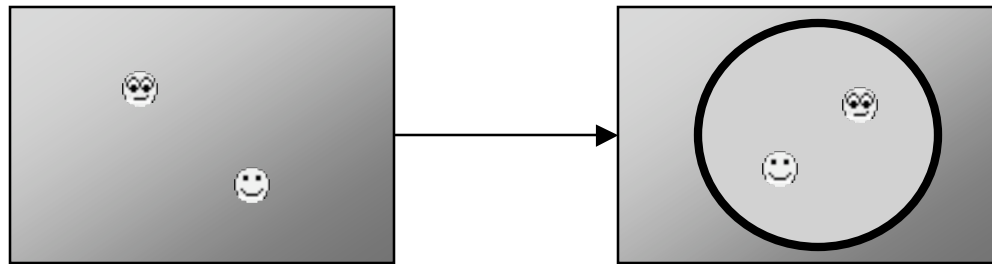
- Bottom-up approaches:
 - Selfish agents realize advantages by entering coalitions
 - Allow for dynamic organization structure
 - Examples:
 - Form coalition to break deadlocks
 - Encounter-based coalition formation

Dissolving coalitions

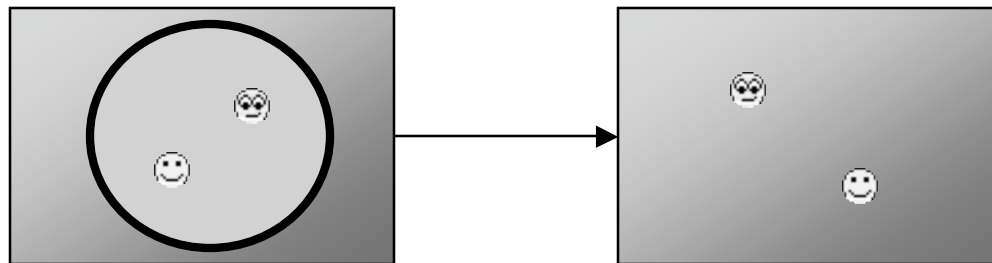
- Decision is made
 - By a single entity to leave (and then whole coalition has to reform differently)
 - By the coalition as a whole
 - By the coalition "leader"
 - On the system level outside of the coalition

Primitive operations

■ form

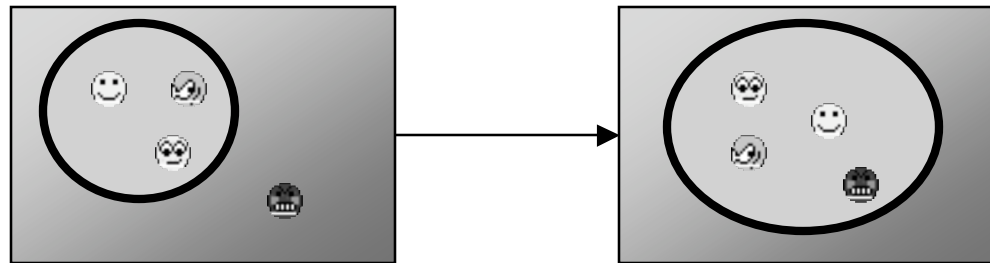


■ dissolve

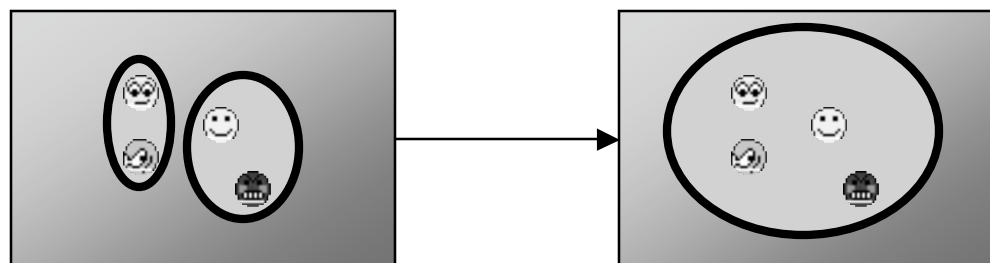


Advanced operations (I)

- Become member (= dissolve + form)

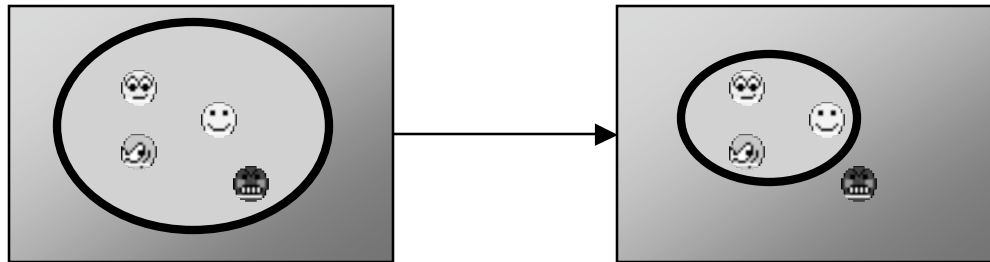


- Merge (= 2 x dissolve + form)

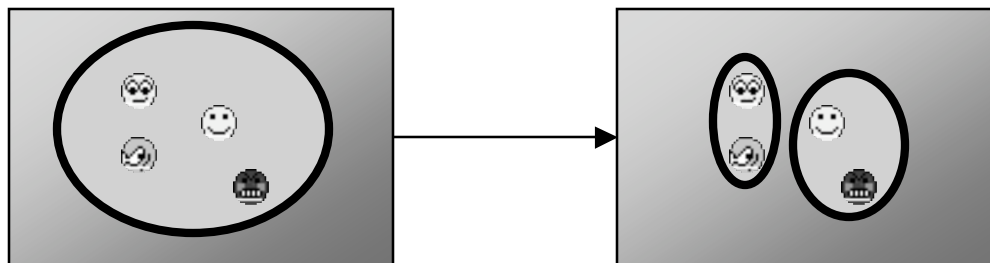


Advanced operations (II)

- Reject member (= dissolve + form)

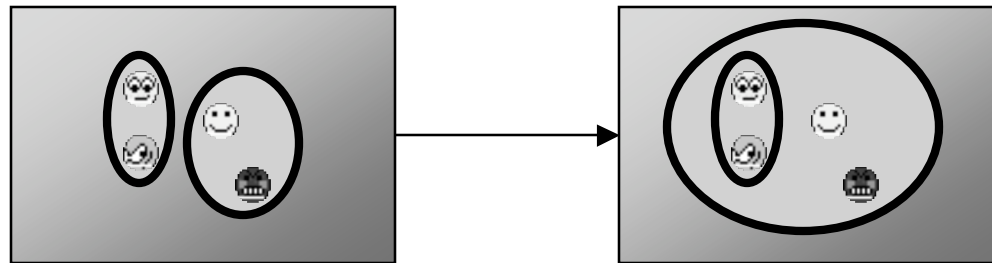


- Split (= dissolve + 2 x form)



Advanced operations (III)

- Absorb (= dissolve one coalition + form)



- Plus many more (depending on particular application)

Control in a coalition

Coalition acts within larger system as one agent (with more abilities, more efficiency, more resources)

- One agent is directing
- Agents are voting on every issue
- Agents follow rules that guide what to do and when and what to vote on

Issues:

- Open for new members vs closed membership
- Ability to depose members

Agents in a coalition

- Usually have to give up some control
 - To leader
 - To majority in votes
- What can/should stay in control of agent
 - Decision to follow individual rules
(usually difficult to implement)
 - Decision to play honestly
(usually assumed to be followed)
 - Decision to leave or stay

Measuring success

- Literature does not agree on this
- Levels of measuring
 - Agent
 - Coalition
 - Whole world
- Candidates for criteria to measure
 - Resource usage (maximize or minimize)
 - Time spent on tasks (minimize)
 - Utility

Problems with multiple memberships

Most approaches to coalitions in MAS forbid membership of an agent in several coalitions due to conflict of interests.

But: this is not the reality in our live!

Potential positive things: see Craig's blackboards

Potential negative things:

spy agents, saboteurs, etc

Seems to be an interesting research area for the future!