



Multi-Agent Systems

Slides adapted from Prof. Jörg Denzinger's MAS Course
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CPSC 433
Winter 2007



Motivation

- Systems with higher efficiency, faster answers, better solutions.
- Synergy! The whole is more than the sum of its parts
- Modeling behaviors
- Better software design
- Better interaction with humans



Basic Problems (I)

- Modeling Agents
 - Degree of Autonomy
 - Degree of Willingness to Collaborate
 - Degree of Intelligence
 - Complexity



Basic Problems (2)

- Construction of Community
 - Organization
 - Communication
 - Control
 - Roles
 - Division and Assignments of Tasks
 - Distribution of Resources



Basic Problems (3)

- Using a community of agents
 - Environment
 - Constraints/Conditions to fulfill
 - Efficiency
 - Reuse of Components



Basic Solutions (I)

- Adaptation of human organizations
 - Political Structures
 - Business Structures
 - Societal Structures



Basic Solutions (2)

- Negotiations
 - Detection of conflicts
 - Determining the scope of conflicts
 - Protocol for resolving conflicts



Basic Solutions (3)

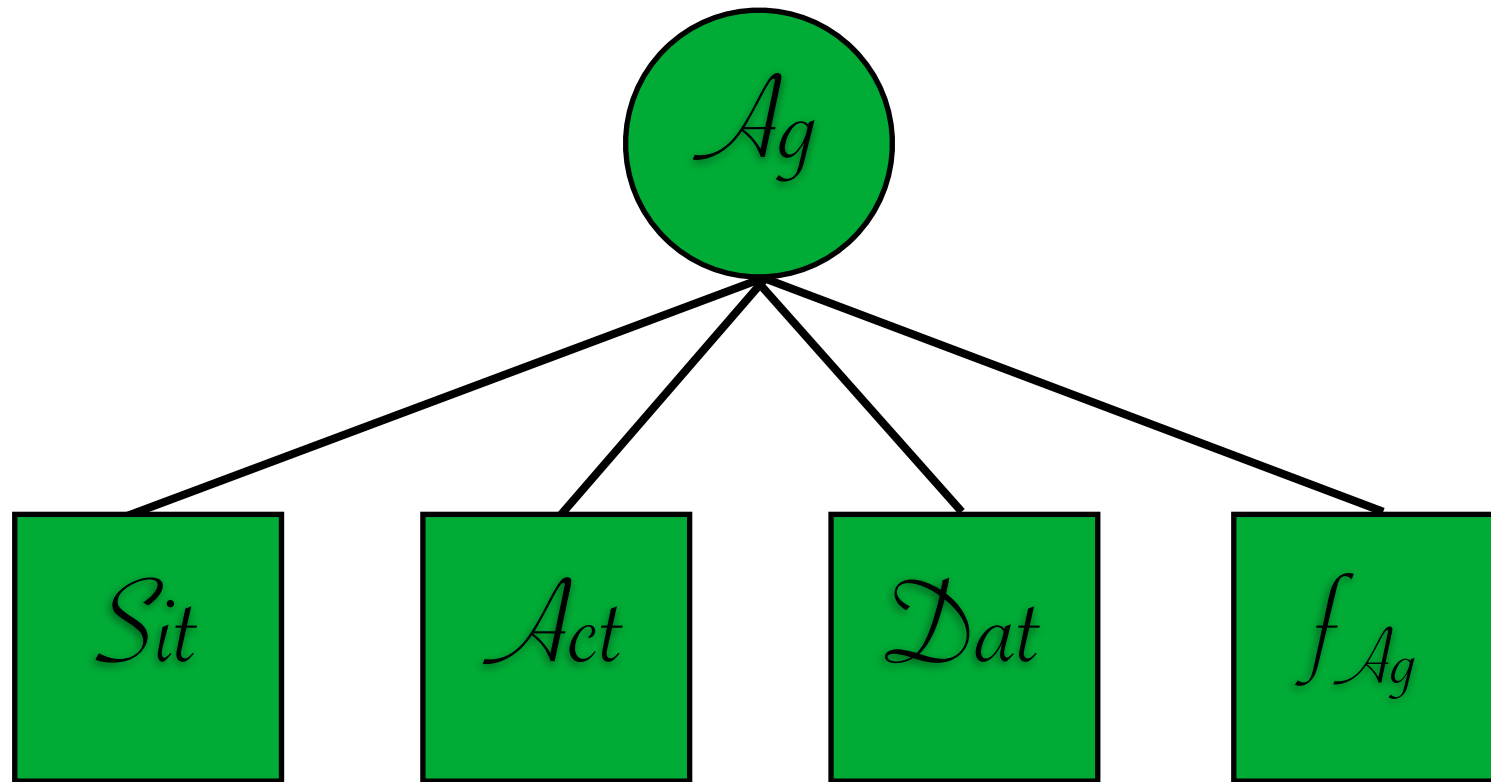
- Agent Models
 - Modal Logics
 - State Automata
 - Rule Based Modeling



Basic Solutions (4)

- Tools for realizing MAS
 - MAS languages
 - Test beds (OLEMAS, ARES)
- Game Theory
 - Payoff Matrixes
- Knowledge representation techniques
 - FIPA or KIF

An Agent



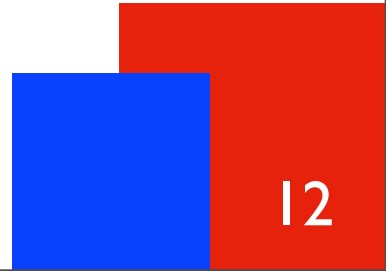
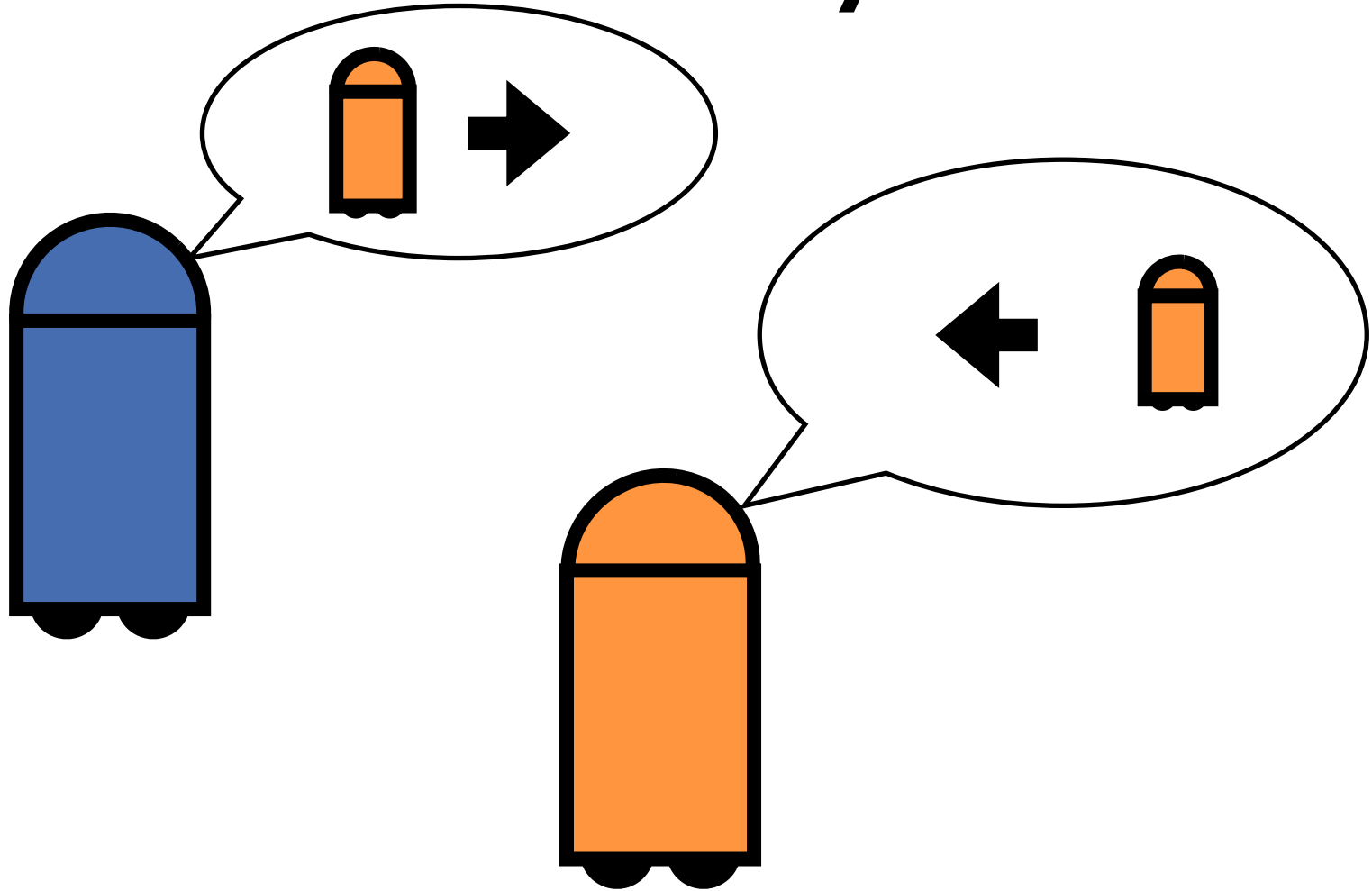


An Agent

- Sit - the set describing all possible situations the agent can be in
- Act - the set describing all possible actions the agent can take
- Dat - the internal data area of the Agent
- f_{Act} - the function that chooses the action based on the situation and the internal data of the agent
 - $f_{Act} : Sit \times Dat \rightarrow Act$




Autonomy





Agent Models

- Situation-Action Pairs
- Rule Based
- State Based
- Object Oriented (from the Actor Model)
- Role Based
- BDI (Beleif, Desire, Intention)



Cooperation

- Cooperation by making (selected) information available
- Negations
- Master-Slave Relationships
- Voting
- Auctions
- Blackboards



Competition

- Agents 'undoing' the achievements of others
- Agents 'blocking' other agents
- Lying
 - About Identity
 - About the World
 - About Others
- Trying to get protected information



Semi-Cooperation

- Agents cooperating to solve problems
 - Each agent has a secret goal
 - Has to search for the optimal global solution, that also satisfies a local function
- Example: Land-use planning



Distributed Search

- Search Problems can be spread out among agents to solve problems better or faster
- Agents can cooperate by sharing information
- Specialist agents can be brought in to solve subproblems that are difficult to handle in other ways



Distribution Paradigms

- Improvements on the Competition Approach
- Dividing the problem instance into sub-problem instances
- Accessing a common search-state
 - Real state in shared memory
 - Distributed state among agents

Going to Many Agents

