Logics for agents

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Agents

- agents act in some environment
- agents have beliefs and goals
- agent program determines what to do, given beliefs, in order to achieve goals

Agent programming languages and logic

- specialised agent programming languages: SimAgent, AgentSpeak (Georgeff/Rao), 2APL (people in Utrecht...)
- programming languages usually declarative, often rule-based or Prolog-like
- some of the research questions:
  - how to design a programming language which implements an agent architecture formalised in logic (e.g. a logical axiom: things which are believed to be true, cannot be chosen as goals)
  - how to verify agent programs (one way is to design a logic of agent programs)

Our work in this area

- how to ascribe beliefs to agents
- modelling various rule application strategies in logic
- modal logic to reason about rule-based agents (Mark Jago's PhD)
- logic to reason about 2APL agents (in progress, joint with Mehdi Dastani and John-Jules Meyer from Utrecht)
- various logics for bounded memory reasoners (joint work with people from Trento) - including rule-based agents, but also arbitrary reasoners

Resource limitations

- we are especially interested in verifying properties like:
  - how much time will it take the agents to achive the goal
  - can an agent with memory of size m achieve the goal
  - how many messages do the agents need to exchange to achive the goals
- and any trade-offs between time, memory and communication resources

Resource limitations for logical reasoners

- if agents reason in logic, resource limitations above relate to questions in proof complexity
- Proof complexity: a logic is given by a set of inference rules (e.g. resolution).
  - Time complexity: if a formula ϕ is derivable from a finite set of premises Γ, how long can the proof get (as a function of the size of Γ and ϕ)
  - Space complexity: if all the agent can to do is read premises into memory, apply inference rules to formulas in memory, erase some formulas from memory; how large a memory does it need to derive ϕ from Γ (as a function of the size of Γ and ϕ)

Other things we do

- Efficient belief revision for rule-based agents (with Mark Jago), its implementation in AgentSpeak (with Rafael Bordini)
- Modal logic, in particular modal logic to reason about path constraints, intuitionistic modal logic (Dima Shkatov's PhD)
- Epistemic logics for resource-bounded reasoners (on our own, also with Thomas Ågotnes, recently started working with Johan van Benthem and Fenrong Liu)