Autonomous Multiagent Systems

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Week 6, Tuesday (10/1)

Midterm Surveys

- 6 received so far
- Keep ’em coming!

Any Questions?

Overview of the Readings

- Joint intentions – theory
- STEAM – implementation

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Joint Intentions – Setting

How agents **form and disband** teams

- Agents in dynamic multiagent world
- Neither complete nor correct beliefs
- Changeable goals, fallible actions
- Don't know others' beliefs/goals

Convoy example

Starting Point – Individuals

Persistent goal: relative to q to achieve p

- p false, but desired true
- p will keep being desired unless:
  - p true
  - p impossible
  - q false

Intention: persistent goal, belief throughout that it's being done

- What's the role of q?

- What's the difference between goal, intention?

2 proposals for teams

Joint commitment not just intention where agent is team

Weak: Joint intention $\equiv$ mutually known intention: each intend to do their part of collective action

Strong: Same, except mutual knowledge persists until mutually known that activity is over

Why too weak and too strong?

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Joint Commitment

Weak achievement goal (WAG): relative to q *with respect to a team* to achieve p

- Individually wants p

  OR

- Believes p true, impossible, or irrelevant, AND has a goal of team knowing it.

$\boxed{\text{4 cases}}$

Joint Commitment

Joint Persistent Goal (JPG): relative to q to achieve p

- mutually believe p false, but mutually know all desire p true
- mutually believe that each have WAG p until
  - mutually believe p true
  - mutually believe p impossible
  - mutually believe q false

Intention: joint persistent goal, mutual belief throughout that it's being done

- Intend own action, commited to others'

- Overhead: automatic goal to communicate status

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Establishing JPGs

- Communication (basis for KQML)
- Observation (requires co-presence)
- Any other way?

STEAM

- An implementation/extension of joint intentions
- Goals
  - Anticipate teamwork failures
  - Flexibility and re-use
- Joint intentions doesn't do it all, though
  - Coherence: all using same plan – commitment protocols
  - Communication cost – decision theoretic
  - Replanning – role dependencies

Team Operators

- Have preconditions, effects, termination rules
- Automatically establish joint intentions
- To establish, “all team members must simultaneously select” a team operator to establish a joint intention
- Agents maintain “team state:” model of team’s mutual beliefs

How should teams be formed initially?

Domains

- Attack:
  - Fly to holding point
  - Send out scouts
  - Shoot at enemy
- Transport:
  - Escorts protect transports
- RoboCup

Observed Problems

- Commander returns to home alone after failing, others stayed
- Scout never returned, others got into infinite loop
- One got orders first and went ahead alone
- All out of ammunition, but failed to realize unachievable

Solved generally with STEAM

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Evaluation

- Used in 3 domains with different characteristics
- STEAM rules can be re-used
- Flexibility: solves initial problems, can deal with small changes to environment
- Communication efficiency
- Encoding and modification effort

Student-led discussion

Teamwork : *cooperative effort by multiple agents to achieve a common goal*

- Is joint intentions always necessary for teamwork?

- Are there cases where a team, as defined above, can be implemented without joint intentions?

Follow-up

- Are there cases where a team would be better implemented without joint intentions?

  OR

- For what multiagent tasks is it desirable to use joint intentions?

Next Week's Readings – RoboCup case studies

- Application rather than theory
- Focus on learning approaches
- Choose 2 of 7