CS344M
Autonomous Multiagent Systems

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Good Afternoon, Colleagues

Are there any questions?
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- do RoboCup agents analyze ops’ comm?
- What should an agent do when comm is impossible?
- Is there research on non-verbal comm between agents?
- How/when are teams established?
- How would you compute action utility?
- How do you resolve conflicts in joint commitments (beliefs)?
- Alternatives to BDI?
Logistics

- Programming assignment 4 - any questions?
Soccer server communication

- What is the soccer server communication protocol?
- How does it relate?
- Does an ACL make sense in the soccer server? If so, under what circumstances?

An example protocol
Joint Intentions – Setting

How agents **form and disband** teams
Joint Intentions – Setting

How agents form and disband teams

- Agents in dynamic multiagent world
- Neither complete nor correct beliefs
  - Positive introspection: know own beliefs
- Changeable goals, fallible actions
- Don’t know others’ beliefs/goals
Persistent goal: relative to $q$ to achieve $p$
Starting Point – Individuals

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- $p$ will keep being desired unless:
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**Intention:** persistent goal, belief throughout that it’s being done
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- What’s the role of $q$?
Starting Point – Individuals

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**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
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**Weak**: Joint intention $\equiv$ mutually known intention: each intend to do their part of collective action
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**Strong:** Same, except mutual knowledge persists until mutually known that activity is over
2 proposals for teams

Joint commitment not just intention where agent is team

Weak: Joint intention \equiv\text{ 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?
Joint Commitment

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

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- Individually wants $p$
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.

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
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- Intend own action, commited to others’
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Intention: joint persistent goal, mutual belief throughout that it’s being done

- Intend own action, committed to others’
- Overhead: automatic goal to communicate status
Establishing JPGs

- Communication (basis for KQML)
- Observation (requires co-presence)
Establishing JPGs

- Communication (basis for KQML)
- Observation (requires co-presence)
- Any other way?
Locution: What is said (physical)
Locution: What is said (physical)
Illocution: What is meant
Locution: What is said (physical)

Illocution: What is meant

Perlocution: Intended effects
Locution: What is said (physical)

Illocution: What is meant

Perlocution: Intended effects

Example: “Please close the window.”
“Capabilities for teamwork cannot be patched on, but must be designed in from the start.” (Grosz, 1996)
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- Agree or disagree?
STEAM

- An implementation/extension of joint intentions

- Goals
  - Anticipate teamwork failures
  - Flexibility and re-use
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- Joint intentions doesn’t do it all, though
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 use same plan, commitment protocols
  – Communication cost — decision theoretic
  – Replanning — role dependencies
Team Operators

- Have preconditions, effects, termination rules
- Automatically establish joint intentions
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
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
Observed Problems

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- Scout never returned, others got into infinite loop
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Solved generally with STEAM
Evaluation

- Used in 3 domains with different characteristics
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
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
• Attempt to program common sense
CYC – Doug Lenat

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• > 1 million rules
  – “Trees are usually outdoors.”
  – “Once people die they stop buying things.”
  – “Glasses of liquid should be carried rightside-up.”
CYC – Doug Lenat

● Attempt to program common sense

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• Potential applications?
CYC – Doug Lenat

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• Potential applications?
  – Some listed on their web site
  – Question answering, retrieval of captioned information, machine translation, speech recognition, semantic data mining, . . .