CS344M
Autonomous Multiagent Systems

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Good Afternoon, Colleagues

Are there any questions?
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- Why have ACL?
- How is a conversation policy implemented?
- Standards for communication today?
- How is second paper relevant to RoboCup?
- How does second paper deal with subgoaling?
- Do teams try and understand other team’s messages?
- Can you interrupt other team’s communication?
Logistics

- Programming assignment 4 - any questions?
Logistics

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- Week 5 readings – choose 2 papers and one team description paper
Soccer server communication

- Only one agent from a team can speak at a time (or at least be heard at a time)

- Communication limited to 50 meters

- Limited bandwidth (both number of characters and allowed characters)
  - How to have only one agent to speak at a time?
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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
Starting Point – Individuals

**Persistent goal:** relative to \( q \) to achieve \( p \)
Starting Point – Individuals

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- $p$ false, but desired true
- $p$ 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 $q$?
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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
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
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

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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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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.”
Beliefs, Desires, Intentions

- Beliefs: What the agent thinks to be true
- Desires: What it wants to be true
- Intentions: What it plans to do
"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
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• 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
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- 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

- Commander returns to home alone after failing, others stayed
- Scout never returned, others got into infinite loop
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• All out of ammunition, but failed to realize unachievable
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- One got orders first and went ahead alone
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Solved generally with STEAM
Work on learning languages

- Evolving language for predator-prey domain (Jim and Giles)

- Work by Luc Steels group
Activity: Sort yourselves alphabetically by last name

- No verbal or written language is allowed (including typing something).
- Any form of gesturing is OK, except for “skywriting” or writing with one’s finger.
- Other ways of conveying characters are OK.
- All other forms of communication are allowed, be creative.