Autonomous Multiagent Systems

Peter Stone

Week 8, Thursday (10/17)

Any Questions?

- unbounded? (p. 3)
- "integer" in RHS in table (p. 4)
- how is entropy justified?

Motivation from real insects

- Ant colonies exhibit remarkably complex behaviors
  - Food gathering
  - Burial
  - Nest building
  - Reproduction
- Individual ants aren't smart
  - They're easily fooled out of their element (Feinman)

$\boxed{\text{Model the ant, not the colony}}$

Overview of the Readings

Go to the Ant: A manifesto

Blazing a Trail: A robotic application

Pheromone Robotics: Another

Go to the Ant

- Complex system behavior from many simple agents
- Complexity comes from interactions, the environment

Agent Definition

$\boxed{\text{Agents tied to environment}}$

- $Agent = <State, Input, Output, Process>$
- $Environment = <State, Process>$

$\boxed{\text{Note: supports hierarchical agents}}$

Examples from Nature

- Ants: path planning
- Ants: brood sorting
- Termites: nest building
- Wasps: task differentiation
- Birds and Fish: flocking
- Wolves: surrounding prey

Principles

- Try to avoid functional decomposition
- Simple agents (small, forgetful, local)
- Decentralized control
- System performance from interactions of many
- Diversity important: randomness, repulsion
- Embrace risk (expendability) and redundancy
- Agents should be able to share information
- Mix planning with execution
- Provide an "entropy leak"

Blazing a Trail

- Multiagent resource transportation
- Move randomly 'til an agent gets to resource
- Communicate path to other robots
- Somewhat restrictive
  - Seems to rely on corridors
  - No method to improve paths
- But it's on *real robots*

Pheromone Robotics

- Find a victim and display path for humans
- Set up descending hop-count trail
- Fairly complex messages for pheromones
- What if the robots keep moving?
- Again, *real robots*

Propose an ant-based algorithm to...

- ...Sort a dynamic set of items
  - Each item has a key and a rank
  - Goal: keep the ranks in ascending order of the keys

Propose an ant-based algorithm to...

- ...Sort a dynamic set of items
  - Each item has a key and a rank
  - Goal: keep the ranks in ascending order of the keys

- ...Create ant cemeteries
  - Goal: dead ants should all be piled in the same place
  - (it doesn't matter where)

Propose an ant-based algorithm to…

- …Sort a dynamic set of items
  - Each item has a key and a rank
  - Goal: keep the ranks in ascending order of the keys

- …Create ant cemeteries
  - Goal: dead ants should all be piled in the same place
  - (it doesn't matter where)

- …Do network routing
  - build routing table mapping destinations to links at each node
  - Goal: minimal transit time for packets

Other ant-based research

- AntNet – Network routing solution
  - Randomized algorithm (packets sent probabilistically)
- Holland – picking up pucks
  - Goal: robot putting pucks in a pile
  - Rules: move randomly, drop if you have 3
  - Analogy: ant burial
- Balch – ant tracking
  - Computer vision success
- Missionaries and Cannibals – An optimization problem

Next Week's Readings – Applications

- Air traffic control
- Elevator control
- Meeting scheduling

Department of Computer Sciences
The University of Texas at Austin