MAS #1 Tutorial:
Organization, Agent architectures & BDI

Tuesday, 14:30 - 16:00, 16:15-17:45

Organization

- Attendance
- Assignments
    - Programming in Jason -- max **9 points**
        - handed-out: 7. 10
        - deadline: 26. 10. 2014, 3:59 AM
    - Solving EFG -- max **17 points**
        - handed-out: TBA
        - deadline: 23. 11. 2014, 3:59 AM
    - DCSPs -- max **14 points**
        - handed-out: TBA
        - deadline: 2. 1. 2015, 3:59 AM

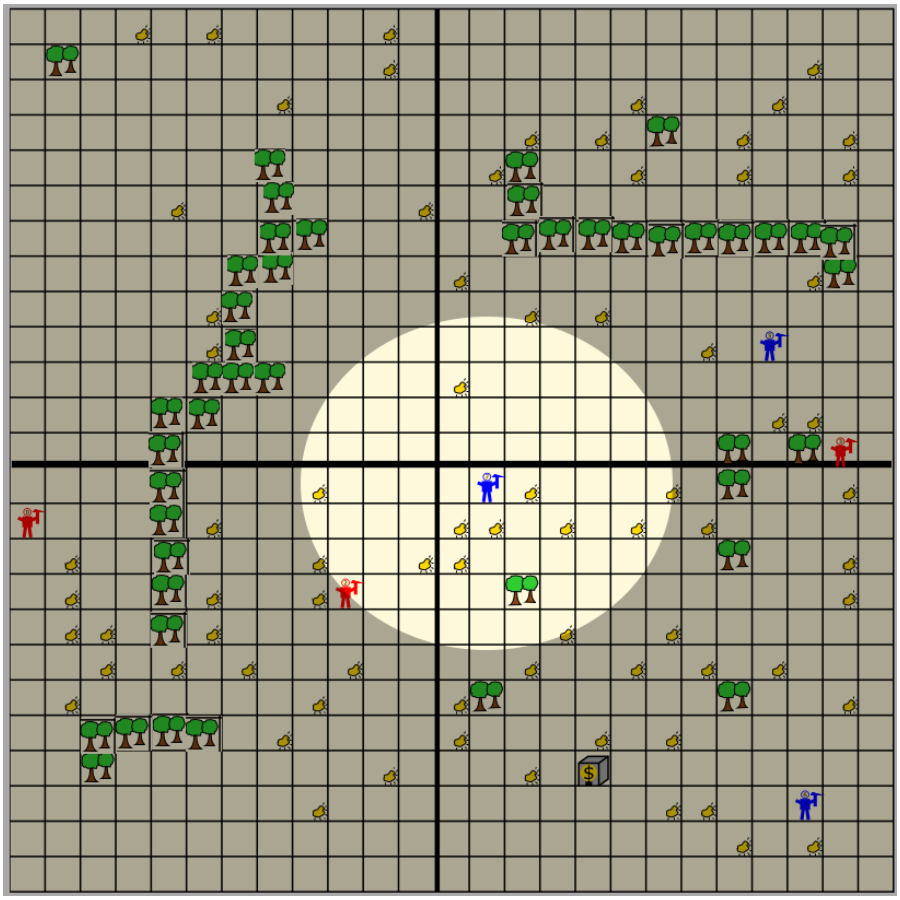
  Any conflicts with other assignments?

- Discussion Forum
    - https://cw.felk.cvut.cz/forum/forum-893.html

Running example

Goldminers:

Imagine 3 agents in a partially observable environment that looks like this:



Percepts:

1. p = (x,y) agent's current position
2. G = {(x,y)} locations of gold stones the agent sees
3. A = {(x,y)} locations of other agents that the agent sees
4. F = {(x,y)} locations of forests the agent sees
5. d = (x,y) the location of the depot if the agents sees it
6. c the boolean flag determining whether the agent is carrying a gold stone

Actions:

{north, south, east, west, grab, drop, skip}

Rules:

- 1 point for each piece of gold carried to the depot

- trees and depot stay static, gold disappears if any of the agents grabs the gold
- agent cannot pass cells with forest, agent cannot pass cells occupied by other agents
- 1% of the actions will fail and end up with random effect

Implementing agents

Agent function:
Specifies the behavior of the agent: for each sequence of percepts, chooses an action
f: P* -> A

Rational agent:
Given some performance measure a rational agent always performs the action that maximizes its performance measure.

Question: are humans rational?

Perceive-Deliberate-Act cycle:

1. Perceive
2. Deliberate
3. Act

Agent architectures:

(According to Norvig and Russell)

1. Reflex (Reactive) Agent
    - choses action based on its current percepts
    - (only consider the part of the world that is currently visible)
    - typically in form of if-then-rules

   Tasks: In pseudocode, write reflex/reactive agent for our gold mining scenario

2. Model-based Reflex Agent
    - builds model of the world that contains the expected state of the world that is currently unobserved
    - choses action based on the current model of the world

   Tasks: In pseudocode, write model-based agent for our gold-mining scenario

3. Model-based Goal-based Agent
    - the agent has a declaratively specified goal
    - performs actions that pursue the goal
    - Techniques:
        i. Classical planning (sequence of actions)
        ii. Planning with Uncertainty (policy)
        iii. Adversarial planning (policy)
        iv. Belief-Desire-Intention architecture (reactive planning -- can be used when full planning is not tractable)

4. Model-based Utility-based Agent
    - Each state of the world has a certain utility for the agent
    - Find sequence of actions (in deterministic env.) or policy (in non-deterministic env.) that maximizes the utility gathered over time
    - Techniques
        i. sequential decision making: MDP, POMDP (non-adversarial)
        ii. sequential games, imperfect information games (adversarial)

5. Learning-based Agent
    - The agent function is learnt through the interaction with the environment
    - Typically involves both learning the model and optimal policy
    - Techniques
        i. Reinforcement learning
            - agent receives percepts (observations) together with reward / penalty
            - learns transition table and Q-values: state X action -> R
            -

Belief-Desire-Intention Architecture

Story:

- Programming rooted in psychology. Inspired by folk psychology (how people think other people think).
- Gave rise to specialized BDI languages such as Jason, 3APL, 2APL, GOAL, which however never really took off. Still not comparable to the mainstream languages in the comfort of use.
- Could be implemented in any language
- Hoped to provide more computationally tractable way to compute intelligent behavior than full-scale planning, the behaviour is easier to understand to human and it is relatively easy to incorporate human expertise into the agent

- Many flavours, different authors, different opinions on why is BDI good and why is not
- Similar to behavior trees

Main components (internal state divided into):

- Beliefs - what do I believe to hold in the world (model of the world)
- Desires - what would I like the world to look like (my goals)
- Intention - what goals am I committed to pursue
    - Unlike desires, intentions should satisfy some properties:
        - Agent should not intent something that he believes to be true
        - Agent should not intent something that he believes is unachievable
        - Agent should not intent something that is not desired
        - Intention should be **consistent**
        - Question: how long should an intention persist?
            - blind commitment: also referred to as fanatical commitment, the agent is intending the intention until it believes that it has been achieved (persistent intention)
            - single-minded commitment: besides above it intends the intention until it believes that it is no longer possible to achieve the goal
            - open-minded commitment: besides above it intends the intention as long as it is sure that the intention is achievable

Typical BDI Deliberation cycle

* Process percepts / communication
* Deliberate about intentions/goals; drop the achieved ones
* Pursue intentions / apply rules

Tasks: In pseudocode, write a BDI agent for our gold mining scenario

Next tutorial: Programming in Jason, bring your own computers.