Introduction to Belief Desire Intention Agents

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BDI (Belief Desire Intention) agents have been used in many successful applications in complex environments.
Belief Desire Intention Model of Agency

• BDI is a framework for describing the behaviour of rational agents.

• Based on work in the philosophy of mind:

  Intentional systems: “[..] whose behavior can be predicted by the method of attributing belief, desires and rational acumen.”

  Practical reasoning: “[..] a matter of weighing conflicting considerations [..] provided by what the agent desires [and] believes.”

• Human practical reasoning consists of two activities:
  • Deliberation: deciding what to do i.e., form intentions.
  • Means-ends Reasoning: deciding how to do it i.e., form plans.
A plan is a *programmed* recipe for achieving a goal in some situation. A BDI execution engine selects from a plan library, based on the situation.
• A plan typically has a number of (sub)goal steps.
• Each sub-goal generates an (internal) event which has some relevant plans.
• So the plan library can be seen as a set of goal-plan trees.
• At each goal node a plan must be selected (OR).
• At each plan node the goals must be accomplished (AND).
BDI Agent-Oriented Programming

- BDI Agent-Oriented Programming provides abstraction at the level of mental attitudes to explain the operation of a system. Beliefs, Desires, Intentions.

- The modularity of plans makes it easy to develop complexity incrementally.

- The goal oriented approach makes it suitable for use in dynamic environments.

- Many efficient and powerful development environments available. JACK, Jadex, Jason, PRS, 2APL, ...

- BDI agent programs are fast to develop. A 2006 study showed:
  - Gain compared to Java programming 500%.
Example Plan Structure

- **goal**: RespondBushfire
- **plan**:
  - **Action**
  - **M:msg**

**ObtainTransport**
- GetCar
- ArrangeLift
- NoTransport

**AssembleMembers**
- HouseAssemble
- DistAssemble

**MoveSafeLoc**
- WalkToLoc
- DriveToLoc
- WaitPickUp

**DetermineLoc**
- Walk(L)
- Drive(L)

**EvacHouse**
- Stay&Defend

**Walk(Door)**
- M:toDoor

**GetFromRadio**

**LocalShelter**

**LeaveTown**
A plan is a sequence of steps
A step can be a **goal**, an **action**, a **message** to another agent, or some computation.
Example Plan Structure

A goal may have different plans, for achieving it in different situations.
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A goal may have **different plans**, for achieving it in **different situations**.
Example Plan Structure

For a goal to succeed one of the plans must succeed. If one fails try another.
Example Plan Structure

For a plan to succeed, all steps must succeed.
Example Plan Structure

If things fail, recovery happens as locally as possible
Plan selection **responsive** to changing environment.
Advantages

• Intuitive representation

• Late selection: situation aware...

• Plan failure - retry new plan. Committed to choices, like humans.

• Agent is responsive to environmental changes.

• Huge number of options possible - over 2 million for modest tree. (Subgoal steps 4, Choices 2, Depth 3)