Motivations and Goal-Directed Autonomy

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Overview

• Autonomy and Motivations
• AgentSpeak(L) and AgentSpeak(MPL)
• Motivation Model
  – Functions
  – Control Cycle
  – Integration with AgentSpeak
• Research Directions and Conclusions
Autonomy

• Here, I mean “Independence of Control”

• Features needed for autonomy:
  – Capability to generate own goals independently
  – Capability to switch between goals
  – Capability to try alternative ways to achieve a goal

• Meta-reasoning
Motivations

• Root-cause of future-directed behavior
• Studied by a number of other disciplines
  – Orientation towards particular goals
  – Associated with drives and incentives
  – Controls focus of attention
• Abstraction of meta-reasoning
  – Goal generation
  – Representation of dynamic priorities
AgentSpeak(L)

• Procedural agent language
• Based on the BDI model
• Designer specifies plans in a plan library
  – Plans encode procedures
  – Plans are characterized by trigger and context conditions
  – Goals are implicit in the plans
AgentSpeak(MPL)

- AgentSpeak(L) + Motivations
  - Standard AgentSpeak(L)
  - External motivation specification

- Motivation model for
  - Goal generation
  - Plan selection

- Motivation model based on mBDI
Motivation Model

• Tuple that includes:
  – Motivation name
  – Intensity
  – Threshold value

• Motivation functions:
  – Intensity Update
  – Goal Generation
  – Mitigation

\[<m, i, t, f_i, f_g, f_m>\]
Intensity Update Function

- Invoked when beliefs are updated
- Controls motivational intensity based on belief base updates
- Mapping of beliefs to intensity values

\[ f_i(\text{Beliefs}) = \begin{cases} 
\overline{(P, bay1)} \land \text{batt(10)} & \rightarrow 2 \\
\text{occupied(agent)} & \rightarrow -1 
\end{cases} \]
Goal Generation Function

- Invoked when threshold value is exceeded
- Posts new goal events to agent

\[ f_g(\text{Beliefs}) = \begin{cases} \text{over}(\text{Packet,bay1}) \rightarrow +!\text{sort}(\text{Packet}) \end{cases} \]
Mitigation Function

• Invoked after goals are generated
• Updates motivational intensity when a motivation is active
• Similar to Intensity Update Function
  – Also based on belief updates
mBDI Control Cycle

loop
  perceive the environment and update beliefs;
  for all motivation $m$ do
    apply $f_i$ to $m$ to update $i$;
    if $i > t$ then
      apply $f_g$ to $m$ to generate new goals;
    end if
  end for
select a plan for the most motivated new goal and adopt it;
select the most motivationally valuable intention and perform the next step in its plan;
on completion of an intention apply $f_m$ to each motivation;
end loop
AgentSpeak Control Cycle

1. **Perception**: BRF
   - External Events
   - Internal Events

2. **Belief Base**
   - Beliefs

3. **Events**
   - Events
   - Selected Event

4. **Unify Context**
   - Relevant Plans
   - Beliefs
   - Applicable Plans

5. **Unify**
   - Selected Event
   - Intended Means

6. **Execute Intention**
   - Selected Intention
   - Intentions

7. **Action**
   - Update Intention
   - New Intention

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**Intentions**

- New
- New
- New
- New
- New
- New
- New
Integration with AgentSpeak

- **Belief Revision Function** associated with motivation functions
- Motivated goals are posted as new achievement goals
- Motivation values are used in the *Option Selection Function*
Conclusions

• Architecture easily integrated to BDI-type languages
• Provides an intuitive abstraction for meta-reasoning
• Separates meta-reasoning from action-directed plans
Direction for Future Research

• Reasoning about 3rd parties through motivations
• Planning moderation
• As a reward function for normative reasoning
Questions?

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