Motivations as an abstraction of meta-level reasoning

Felipe Meneguzzi & Michael Luck
King’s College London
Overview

• Motivations
• AgentSpeak(L)
• AgentSpeak-MPL
  – Motivation Model
  – Motivation Functions
  – Integration with AgentSpeak
  – Experiment
• Conclusions and Future Work
Motivations

• Root cause of future-directed behaviour
• Studied by a number of other disciplines
  – Orientation towards particular goals
  – Associated with *drives* and *incentives*
  – Controls focus of attention
• In our work: 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 library
  – Plans encode procedures
  – Plans are characterised by trigger and context conditions
  – Goals are implicit in the plans
AgentSpeak-MPL

• AgentSpeak(L) + Motivations
  – Standard AgentSpeak(L) language
  – 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
• Mapping of beliefs to intensity values

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

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

\[ f_g(Beliefs) = \{ \text{over}(Packet, bay1) \rightarrow +!\text{sort}(Packet) \} \]
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
2. Belief Base
3. Events
4. Unify Context
5. Unify Event
6. Selected Intention
7. Execute Intention

AgentSpeak(L) Agent

Plan Library

Events
Selected Event
Plans
Intended Means
Intended
Intentions
Intention
New
New
Push Subplan
New
...

Beliefs
External Events
Internal Events
Relevant Plans
Applicable Plans
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

www.dcs.kcl.ac.uk/pg/meneguzzi/
Motivation Description

Motivation processBay1 {
    Threshold = 10;
    IntensityUpdate org.kcl.IUFunctionImpl {
        over(packet1,bay1) -> 1;
    }
    GoalGeneration org.kcl.GGFunctionImpl {
        ~over(packet1, pigeonHoles) -> +!sort(packet1);
    }
    Mitigation org.kcl.MFunctionImpl {
        over(packet1, pigeonHoles) -> -20;
    }
}
Experiment – Mars Rover

- Rover moving about a 2D environment
  - Movement consumes batteries
  - Rover recharges on the mother ship
- Goal is to explore a set of waypoints
- Rover must not run out of batteries
- Minimise wasted movement
Mars Rover – Results

• Traditional AgentSpeak agent
  – Reacts when battery is critical
  – Wastes movement when dropping intentions

• Motivated agent
  – Proactively decides when to recharge
  – No wasted movement
Rover – Distance covered

Amount of movement

Distance

Waypoints

Perfect
AgentSpeak-L
AgentSpeak-MPL

www.dcs.kcl.ac.uk/pg/meneguzzi/
Rover – Wasted movement

Wasted movement

Distance

Waypoints

Perfect

AgentSpeak-L

AgentSpeak-MPL

www.dcs.kcl.ac.uk/pg/meneguzzi/
Rover – Charge movement

Movement to charge

Distance

Waypoints

Perfect
AgentSpeak-L
AgentSpeak-MPL
Rover – Goals dropped

Goals dropped

AgentSpeak-L
AgentSpeak-MPL

Goals

Waypoints

www.dcs.kcl.ac.uk/pg/meneguzzi/
Future Work

• Reasoning about third-party motivations
• Refine the motivation language
Conclusions

• Architecture easily integrated to BDI-like languages
• Provides an intuitive abstraction for meta-level reasoning
• Separates meta-reasoning from action-directed plans
Questions?

• Implementation available on request: felipe.meneguzzi@kcl.ac.uk