Motivations and declarative goals as cornerstones of autonomy

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Outline

→ Background: Goal types
→ AgentSpeak and Planning AgentSpeak
→ Example: Production Cell
→ Issues: Execution and Control
→ Related Work: Motivations and Decl. Goals
→ Future Work: Motivations and Planning
Background

- BDI Agents → Procedural vs. Declarative
  - Procedural → Efficient, yet inflexible
    - Predefined encapsulated behaviours
    - Designer must foresee relevant plans
  - Declarative → Expressive, not trivial
    - Desired world states
    - Requires a more complex reasoning mechanism

Perception → Desires → Beliefs → Reasoning → Intentions → Action
AgentSpeak

Based on *Procedural* Reasoning System
Agent is described in terms of a plan library

Plans are defined by:
- A *trigger* condition and a *context*
- A *body* containing the plan itself

*Events* drive the adoption of plans
Example AgentSpeak Plan

- Event is generated
- First plan with a matching trigger condition and a valid context is adopted
- If the plan fails to finish, the goal has failed

```agent
+!trigger : context
<-!subgoal1; //calls plan
    action1;  //does smth
    !subgoal2;
    action2;
+belief1; //updates bel.
-belief2.
```
Planning AgentSpeak

- Prototype developed using Jason
- Allows declarative goals to drive plan adoption
  - Goals are satisfied using planning
- Allows dynamic plan generation
  - Supported by a planning component

\[ +!\text{des}(\text{Goals}) : \text{true} \]
\[ \leftarrow \text{plan}(\text{Goals}). \]

- Where Goals is a list representing a conjunction of goals
Issues of Execution

- **Failure handling**
  - Not integral to procedural plans

- **Lookahead**
  - Agent selects and executes plans without looking at the outcome
  - Bottlenecks may cause unnecessary failures

- **Description size**
  - Increases significantly to allow flexibility
Issues of Control

- Choosing dynamic behaviours over predefined ones
  - Currently, these “decisions” are hard-coded
- Controlling the amount of time spent on planning
  - Placing reasonable bounds on planning effort
→ Production Cell
  → 4 Processing Units
  → Parts come in from the Feed Belt
  → Must be processed by certain processing units
Declarative vs Procedural

+!finish(Block) : Block = block1
<- +des([processed(Block,procUnit1),
        processed(Block,procUnit2),
        processed(Block,procUnit3), finished(Block)]).

+!finish(Block) : Block = block2
<- +des([processed(Block,procUnit2),
        processed(Block,procUnit4),
        finished(Block)]).

+!finish(Block) : Block = block3
<- +des([processed(Block,procUnit1),
        processed(Block,procUnit3),
        finished(Block)]).

+!process(Block, ProcUnit) : over(Block, ProcUnit)
<- +processed(Block, ProcUnit).

+!consume(Block) : over(Block,depositBelt)
<- -over(Block, depositBelt); +empty(depositBelt);
+finished(Block).

+!move(Block, Device1, Device2) :
  over(Block,Device1) & empty(Device2)
<- +over(Block, Device2); -over(Block, Device1);
-empty(Device2); +empty(Device1).

+!process(Block, ProcUnit) : over(Block,ProcUnit)
<- +processed(Block,ProcUnit).

+!consume(Block) : over(Block,depositBelt)
<- -over(Block, depositBelt); +empty(depositBelt);
+finished(Block).

+!move(Block, Device1, Device2) : over(Block,Device1) &
  empty(Device2)
<- +over(Block, Device2); -over(Block, Device1);
-empty(Device2); +empty(Device1).
Related Work

**Motivations**
- Often used by biological systems
- Provide a plan selection mechanism

**Declarative Goals**
- Decouple goal achievement from actions
- Means-ends reasoning link current state to desired goal
Future Work

- Planning as an enabler for declarative goals
  - Balance dynamic and static behaviours
  - Multiagent planning

- Motivations as a control mechanism for
  - Planning effort
  - Agent interaction
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