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Motivations as an abstraction of meta-level reasoning

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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

$$f_i(Beliefs) = \begin{cases} over(P, bay1) \wedge batt(10) \rightarrow 2 \\ occupied(agent) \rightarrow -1 \end{cases}$$

Goal Generation Function

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

$$f_g(Beliefs) = \{over(Packet, bay1) \rightarrow +!sort(Packet)$$

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

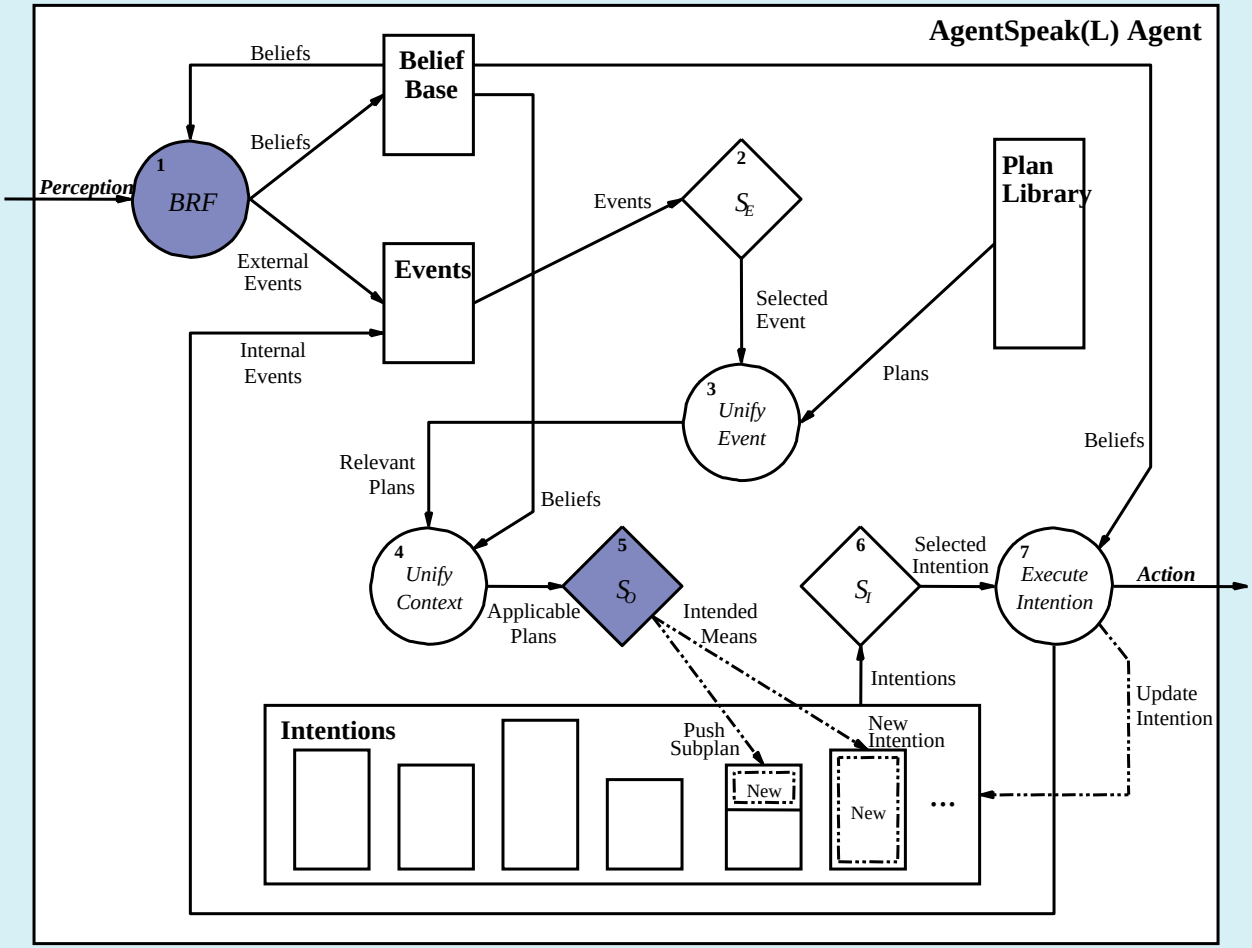
select a plan for the most motivated new goal and adopt it;

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;

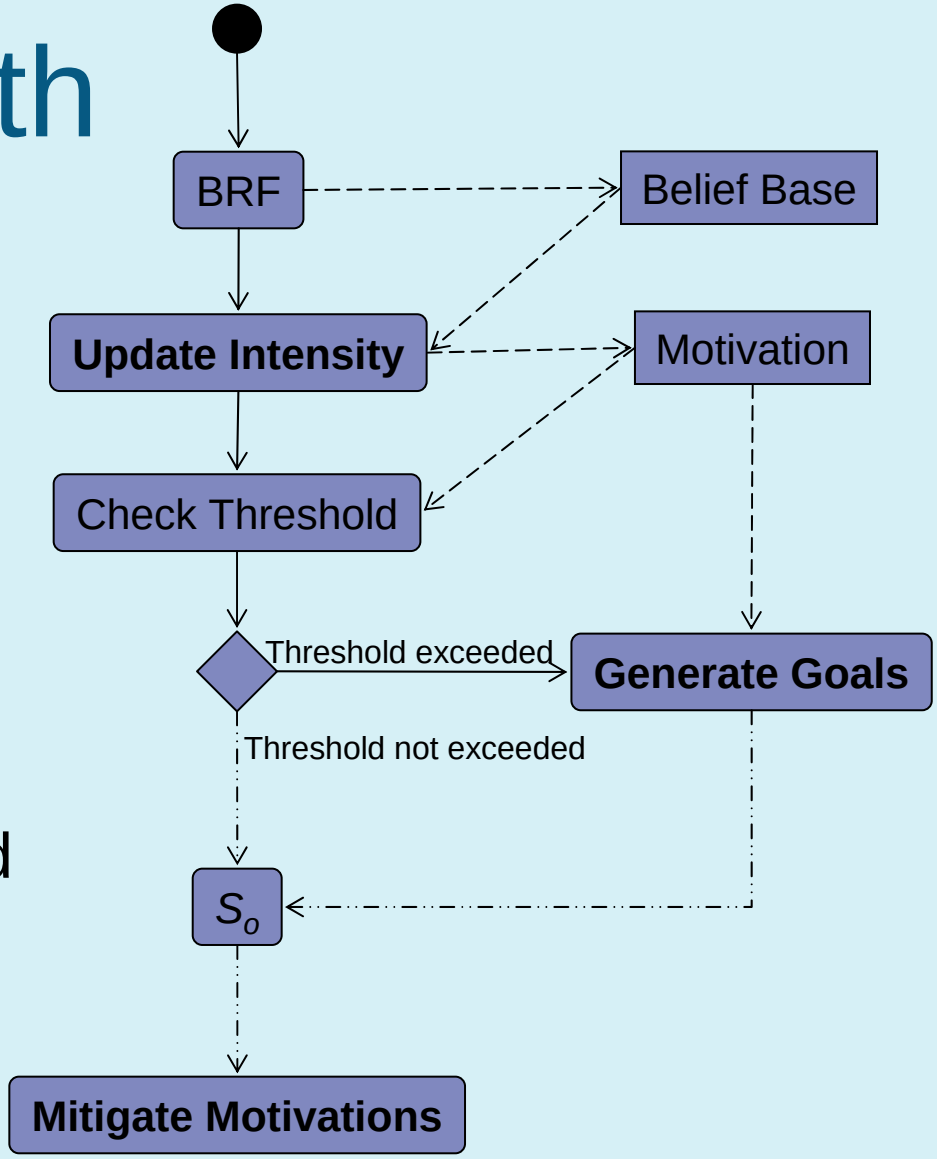
end loop

AgentSpeak Control Cycle



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



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;
   }
}
```

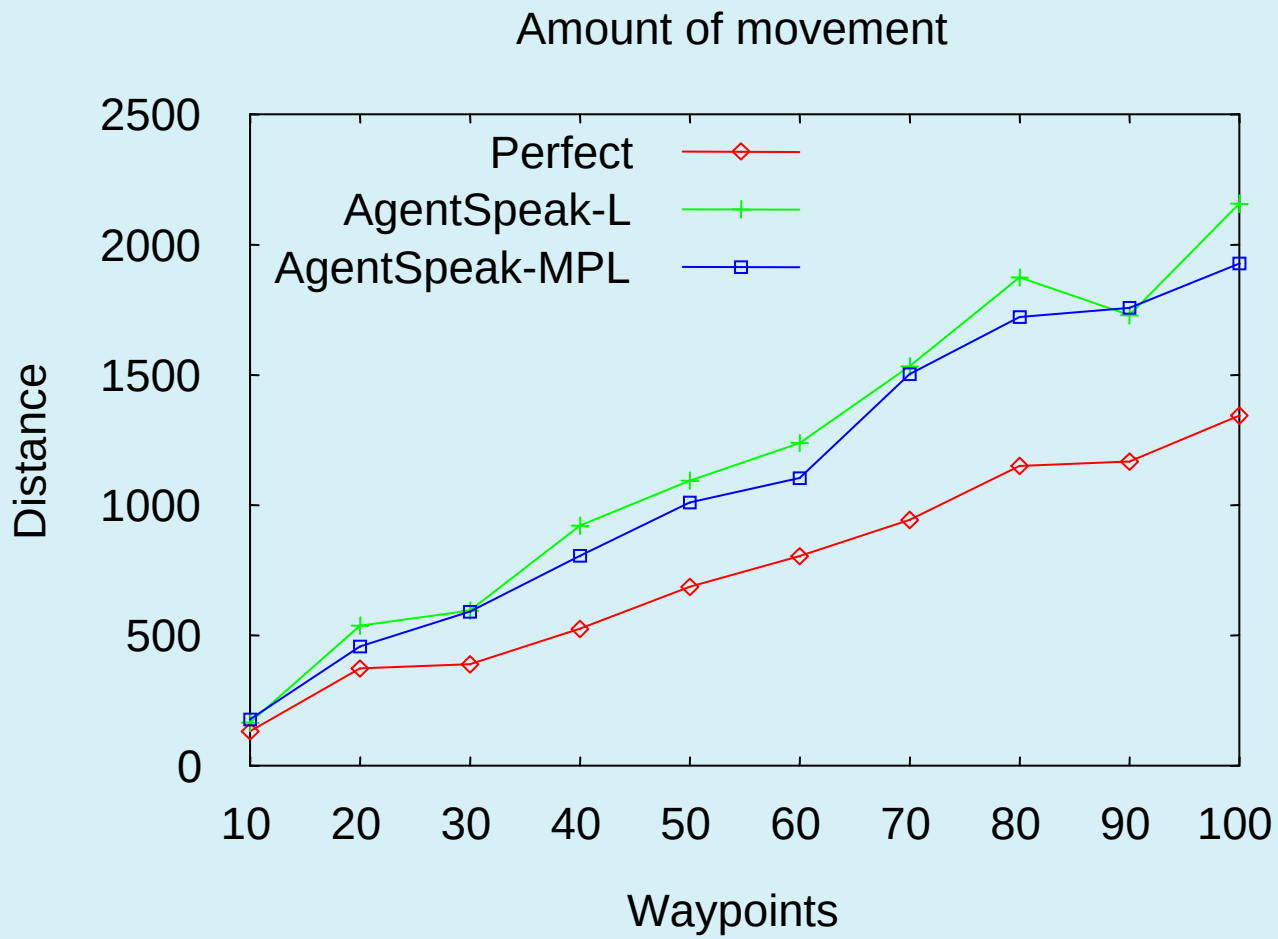
Experiment – Mars Rover

- 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

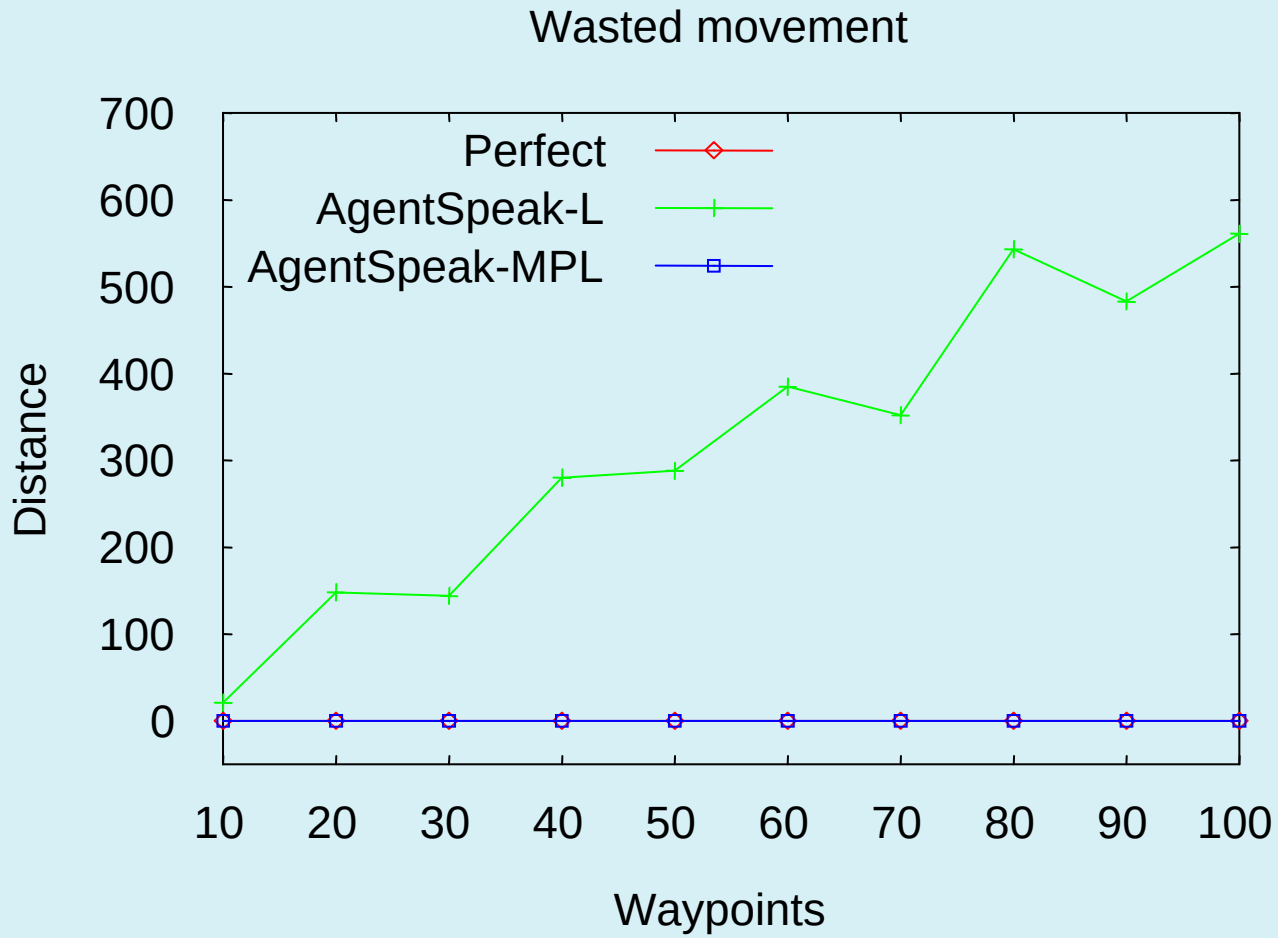
Mars Rover – Results

- Traditional AgentSpeak agent
  - Reacts when battery is critical
  - Wastes movement when dropping intentions
- Motivated agent
  - Proactively decides when to recharge
  - No wasted movement

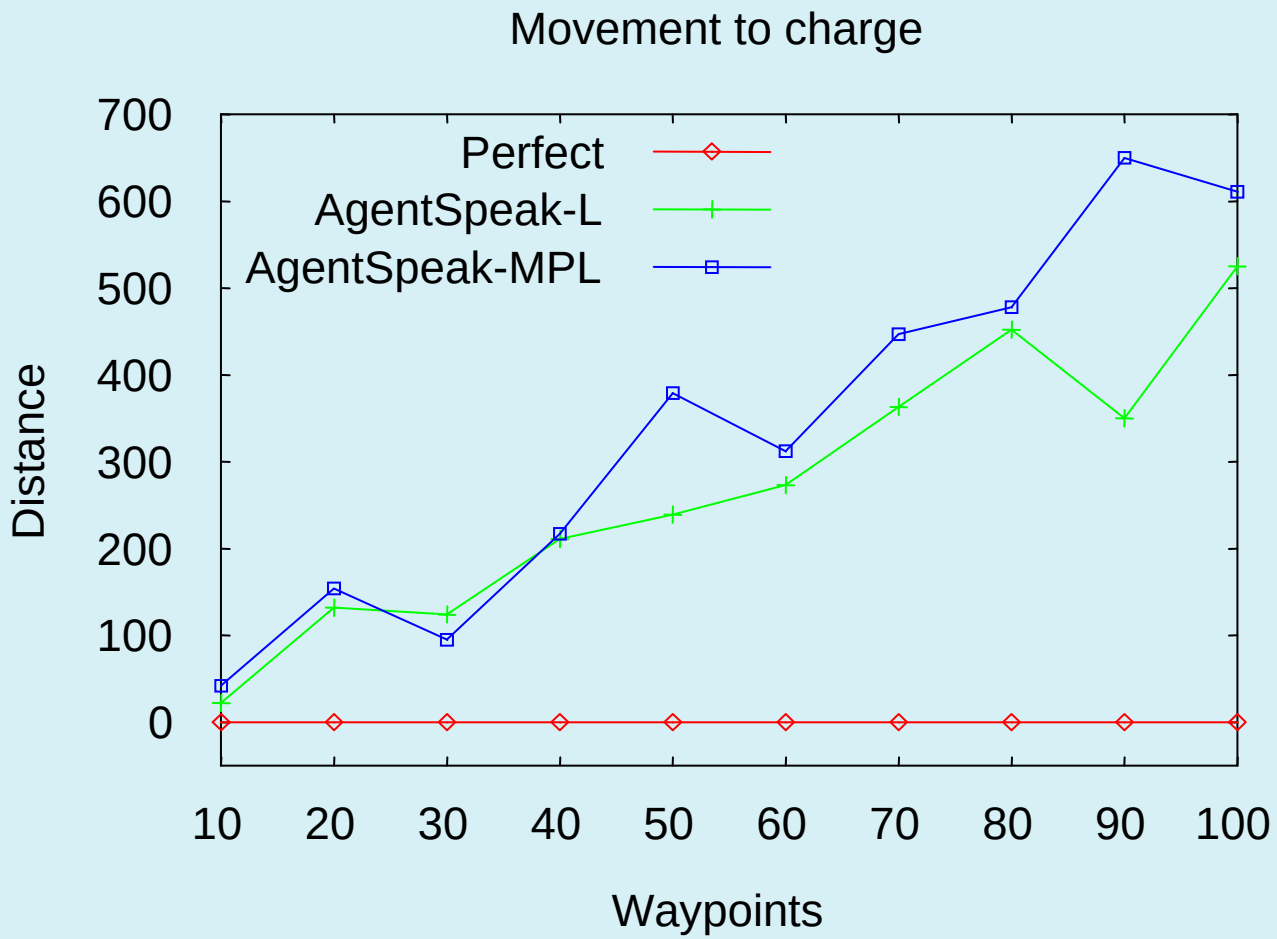
Rover – Distance covered



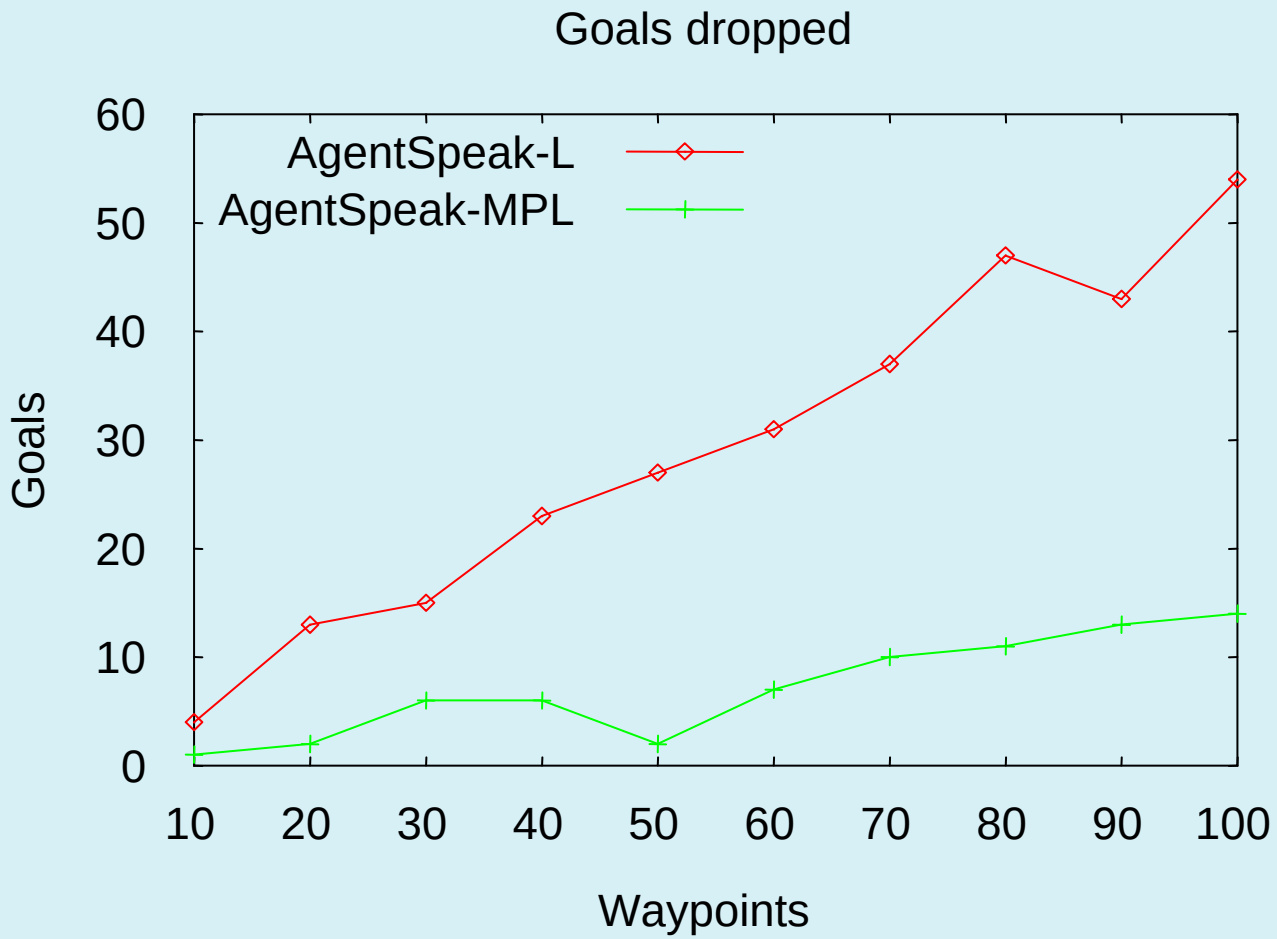
Rover – Wasted movement



Rover – Charge movement



Rover – Goals dropped



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:

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