Cognitive agents with non-monotonic reasoning

(dissertation research overview)

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Cognitive agents

Knowledge intensive/cognitive agents

- knowledge - state of environment, attitudes $\rightsquigarrow$ mental state
- body - sensors/effectors $\rightsquigarrow$ environment
- system dynamics - performing actions $\rightsquigarrow$ behaviours

Niche:

- logic-based KR for modelling knowledge $\rightsquigarrow$ NMR/ASP
- dynamic & unstructured environments $\rightsquigarrow$ DyLP

State of the art (BDI):

- fixed KR technology $\rightsquigarrow$ simple Prolog-based
- complex semantics bound to KR
  $\rightsquigarrow$ engineering? larger case-studies?

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Thesis: scope & outline

Driving question

Can non-monotonic reasoning be practically used as a KR technology in non-trivial cognitive agent systems?

1. theoretical basis: agent programming language
   - heterogeneous KRs vs. behaviours $\rightsquigarrow$ hybrid architectures
2. evaluation: case studies $\rightsquigarrow$ single agent, non-critical
   - videogames & virtual spaces
   - entertainment robotics
3. methodology guidelines

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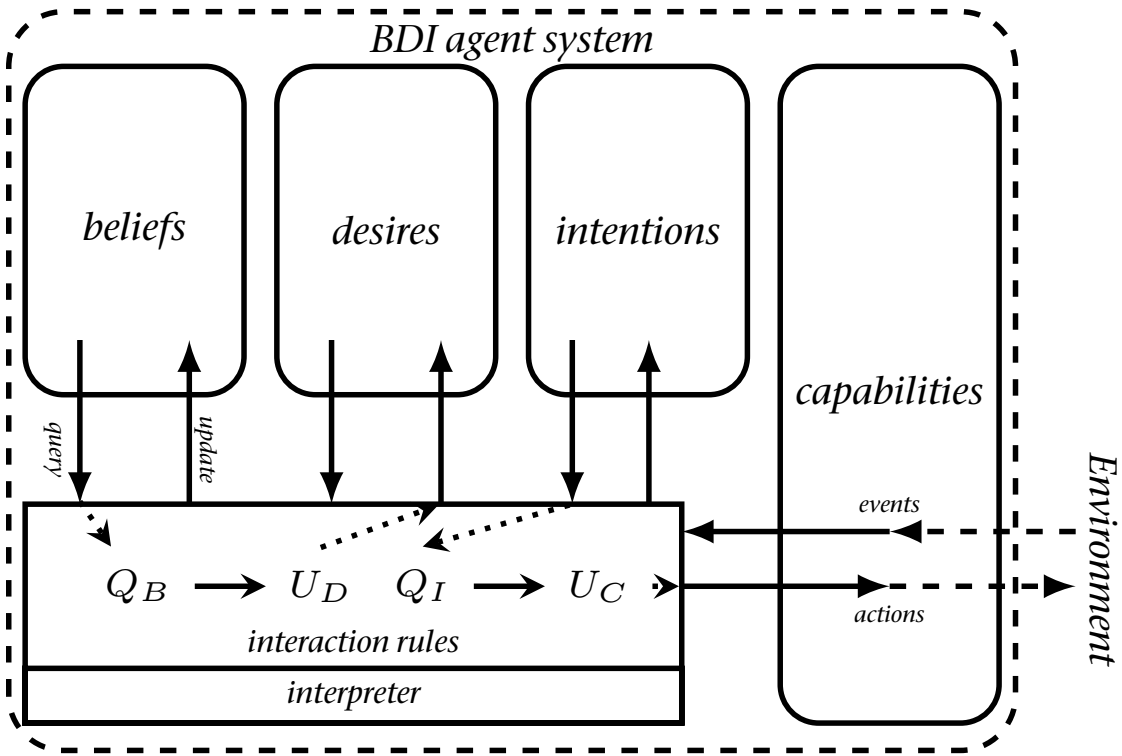
Behavioural State Machines/Jazzyk

core concept: KR module $\mathcal{M} = (\mathcal{L}, \mathcal{Q}, \mathcal{U})$

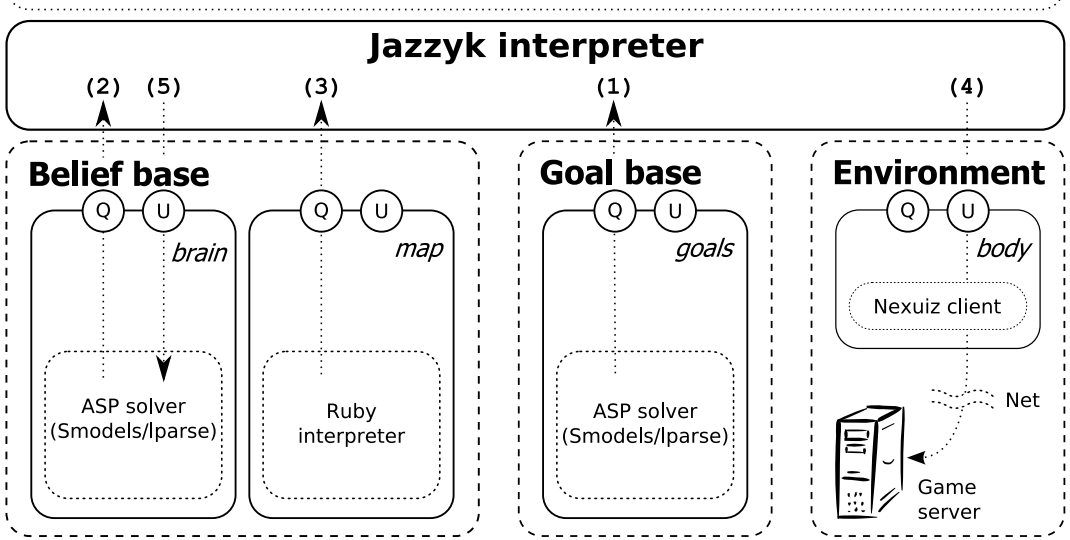
- $\mathcal{L}$ - a KR language,
- $\mathcal{Q}$ - a set of query operators $\models: \mathcal{S} \times \mathcal{L} \rightarrow \{\top, \bot\}$,
- $\mathcal{U}$ - set of update operators $\oplus : \mathcal{S} \times \mathcal{L} \rightarrow \mathcal{S}$.



Case-studies: Jazzbot

1. Jazzbot - softbot in a simulated 3D world
2. Agent Contest 2009 - small MAS/coordination
   - ⇝ inter-agent communication
3. simulated robots?

```
Agent program:
when believes goals(Obj) [{find(Obj)}] and                          (1)
     believes brain(Obj) [{see(Obj)}] and                           (2)
     query map(Object, Dist) [{Dist=get_distance_of(Obj)}]          (3)
then {
     act body(Dist) [{move forward Dist}] ,                         (4)
     update brain(Obj) [{keeps(Obj)}]                               (5)
}
```



Using BSM & Jazzyk

Goal-Oriented Behaviours:

- semi-formal design specification
  - higher level syntactic/semantic constructs
  - code templates: perceptions, goals, interruption handlers, re-usable behaviours, modules, ...
  - logic for BSM
    - ⇝ annotations (FOL, the language of beliefs)

... towards **design guidelines**.

- Jazzyk BSM = an intermediate/assembly language
  - enforces explicit control cycle ⇝ comparison platform
  - compiling BDI languages to BSM (GOAL)

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Summary & contributions

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A more abstract computational model is needed to enable a practical use of heterogeneous KRs (NMR/ASP) in non-trivial cognitive agents. ⇝ BSM is a suitable model for this task!

- *Behavioural State Machines* (AAMAS'06, ProMAS'07, AAAI-SS08/AITA) ✓✓✓
- *Jazzyk* (ProMAS'08, `http://jazzyk.sourceforge.net/`) ✓✓✓
- *Jazzbot* original application of ASP (ProMAS'08) ✓✓✗
- further case studies ✗✗
- BSM as an intermediate language (submitted) ✓
- design guidelines/methodology (first steps - submitted) ✓✗✗

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Thank you for your attention.

Questions

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