

# The AORTA Architecture

Integrating Organizational Reasoning in *Jason*

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# Motivation

- Programming organization-aware agents
- Integration
  - Agent platforms
  - Organizational models
- Should allow focus on *agent* programming
  - Reusability - across platforms and models
  - Automation

# Organizations in MAS

- Regulates agents in a society
- Abstract description of expectations
- Examples include Moise+ and OperA
- AORTA uses a meta-model based on roles and objectives

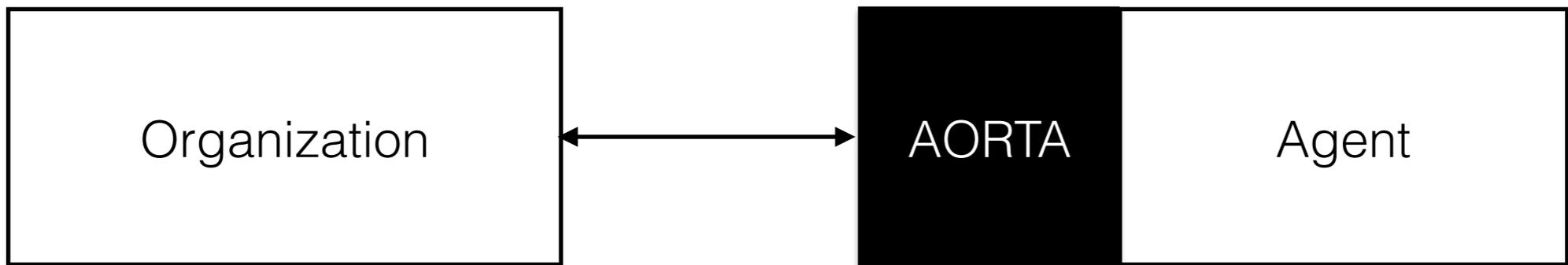
# **AORTA:** **A**dding **O**rganizational **R**easoning **t**o **A**gents

- Provides agents with organizational reasoning capabilities
- Not tied to specific organizational model
- Formalized using structural operational semantics
- Each agent has an AORTA program with reasoning rules

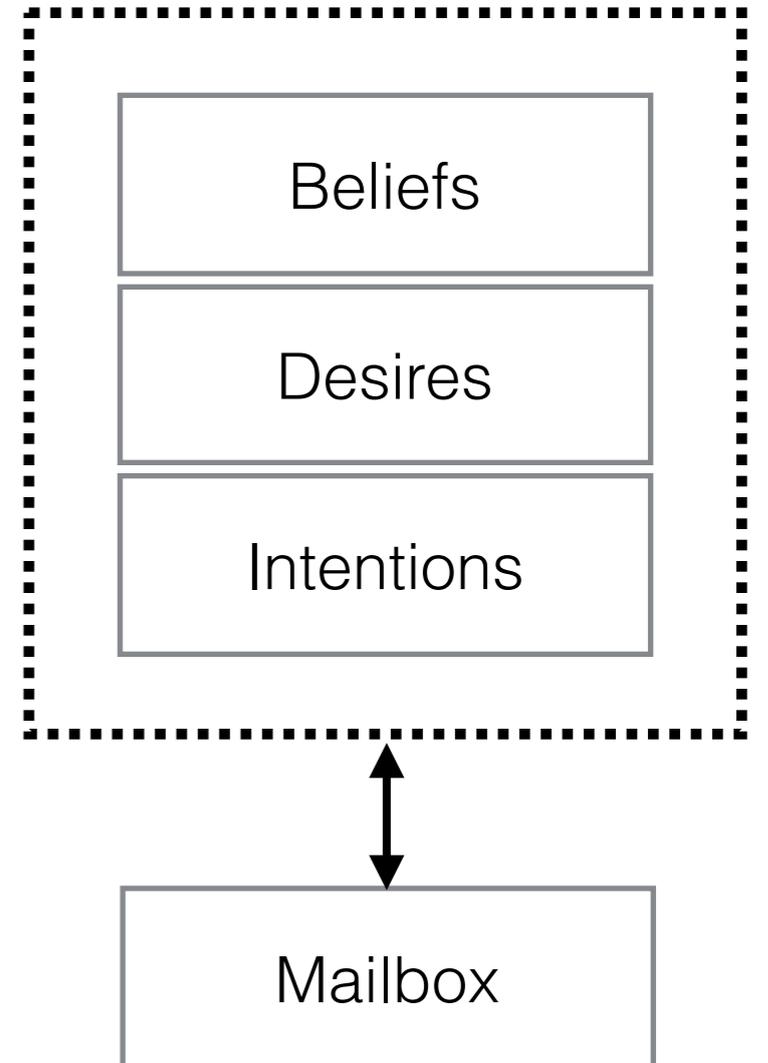


Organization

Agent

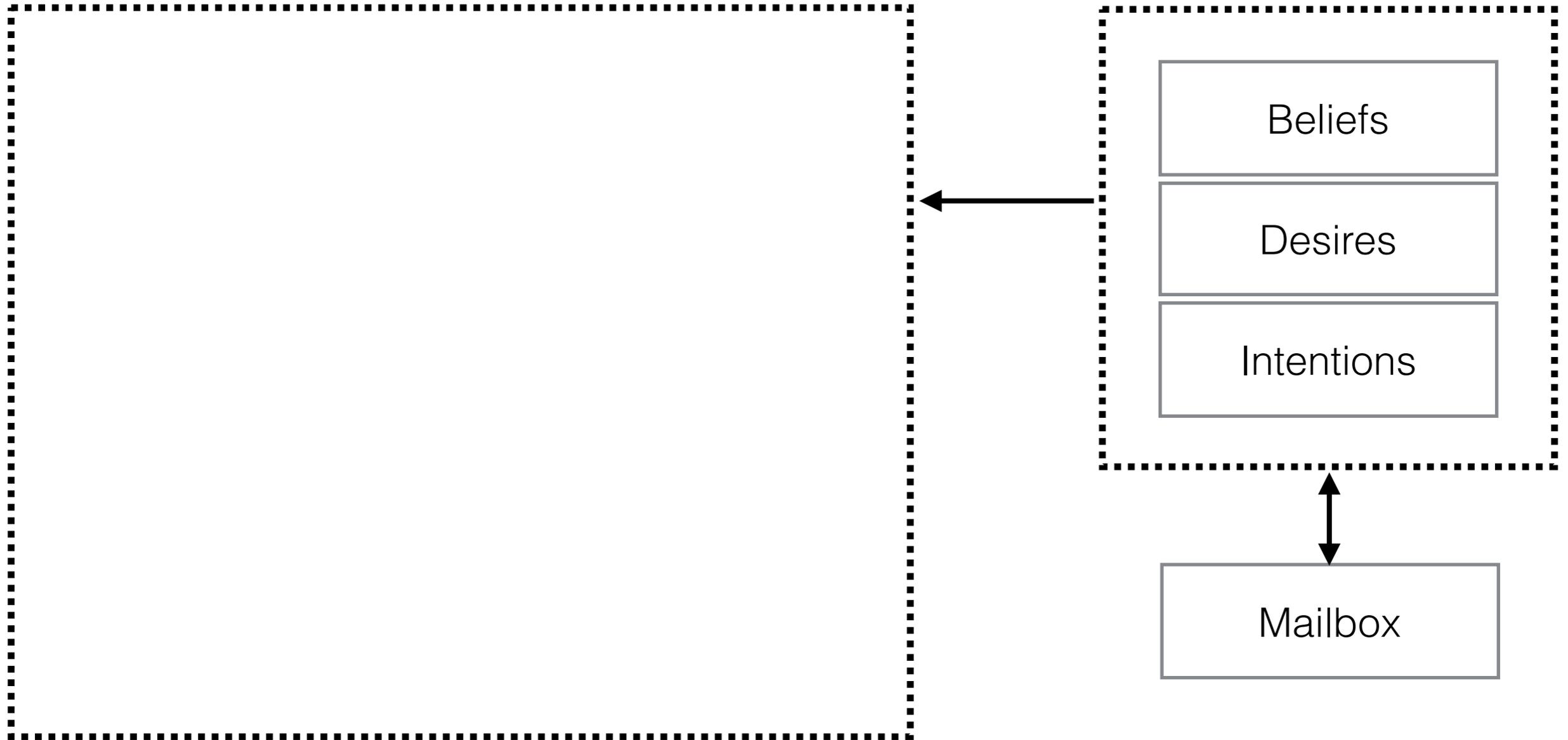


# BDI agent



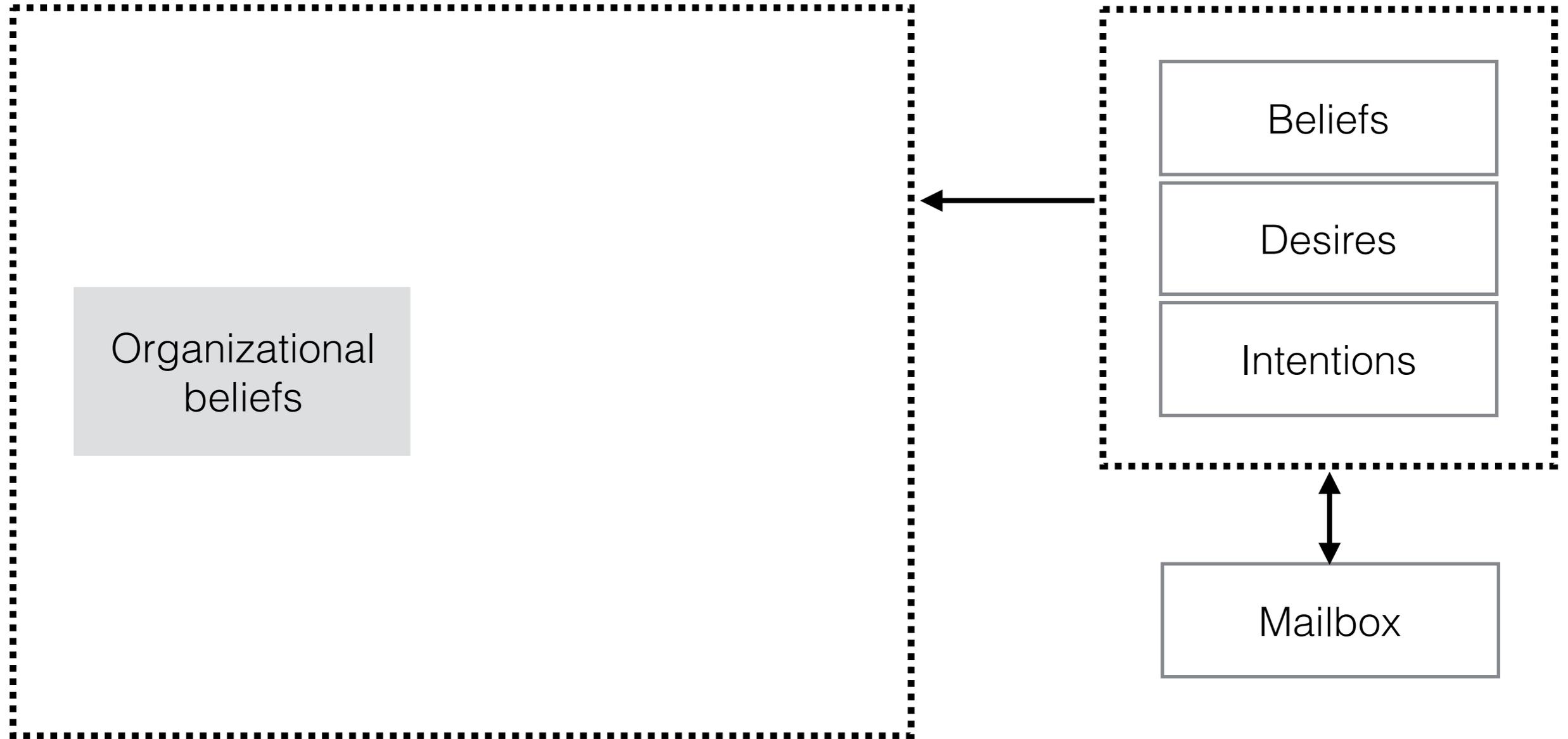
AORTA reasoning component

BDI agent



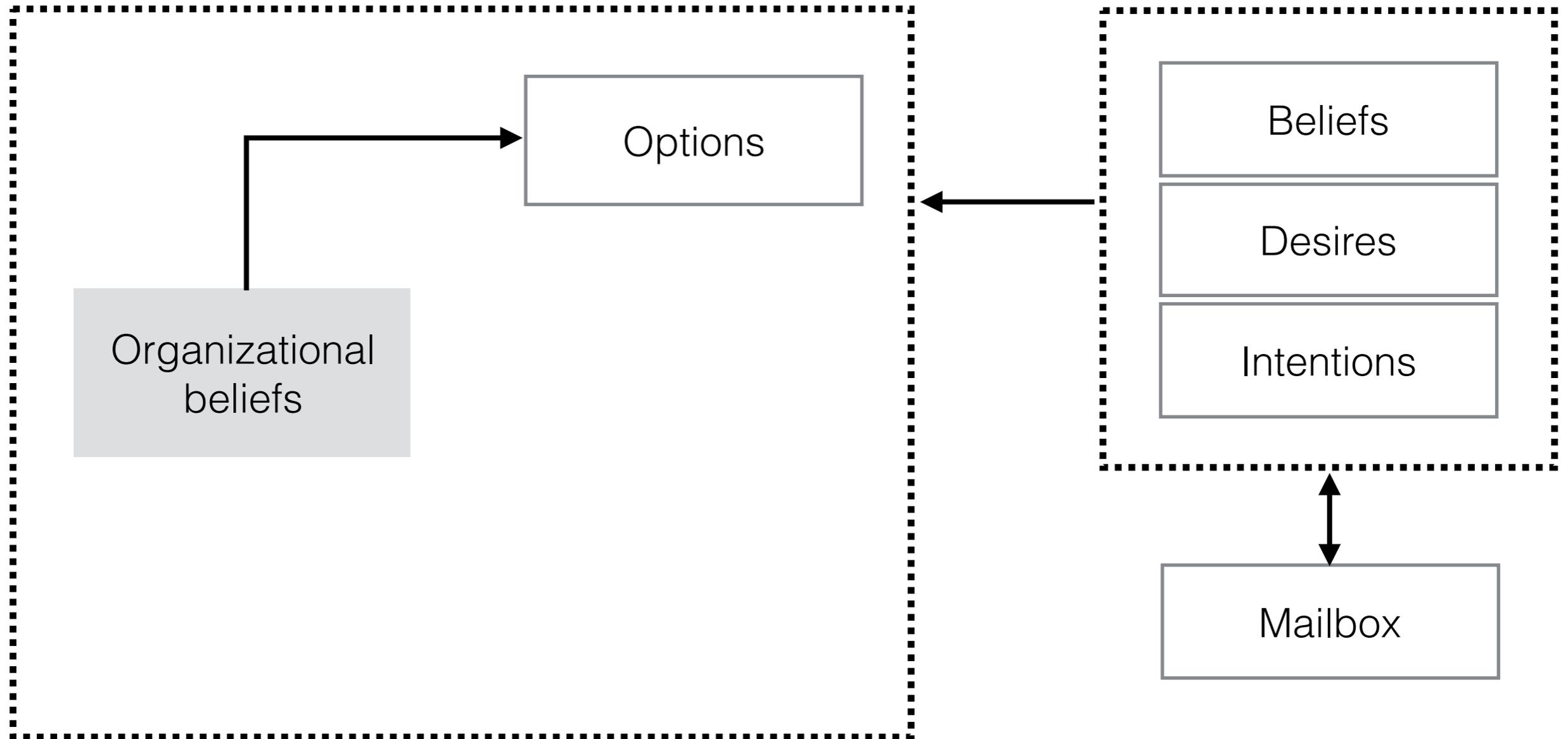
# AORTA reasoning component

# BDI agent



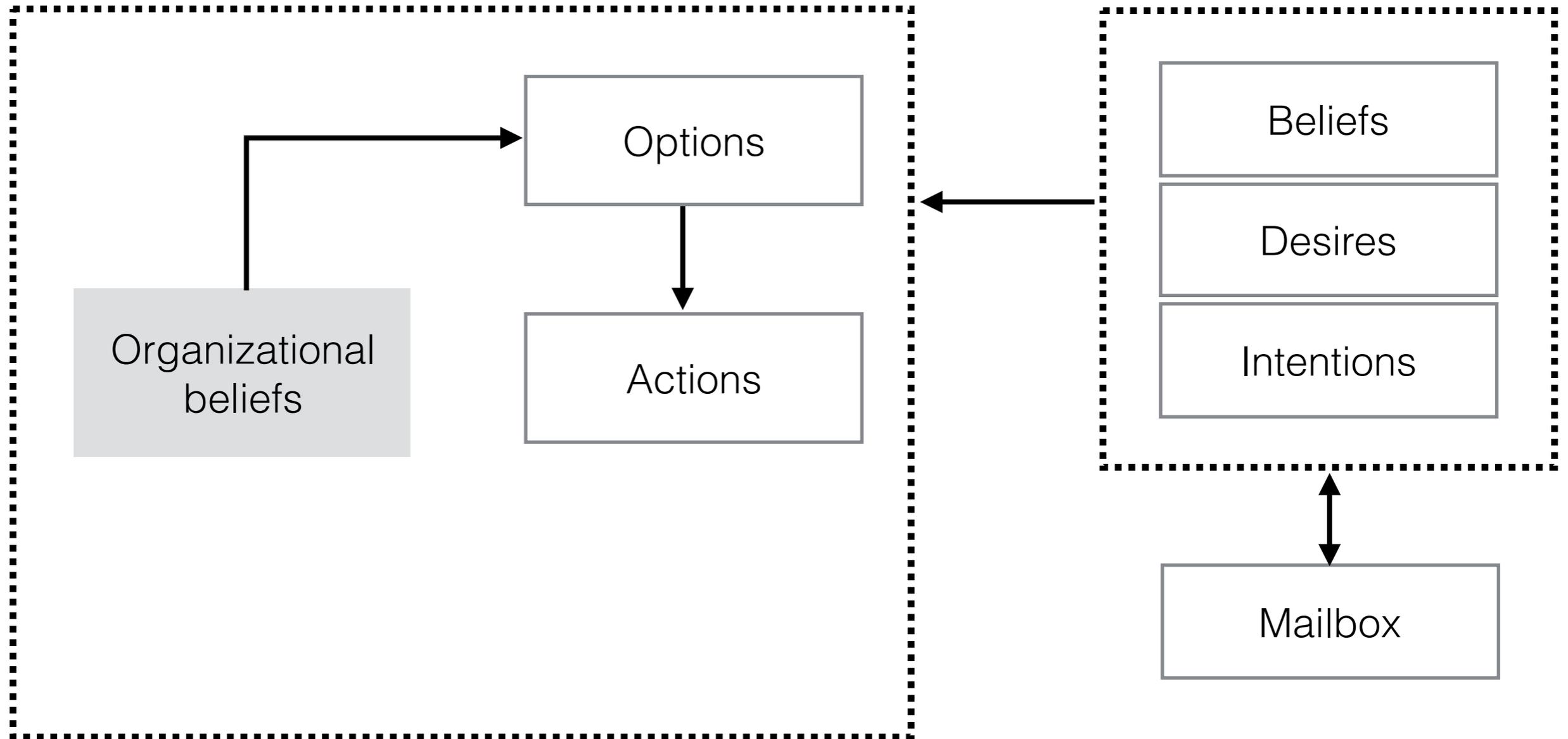
# AORTA reasoning component

# BDI agent



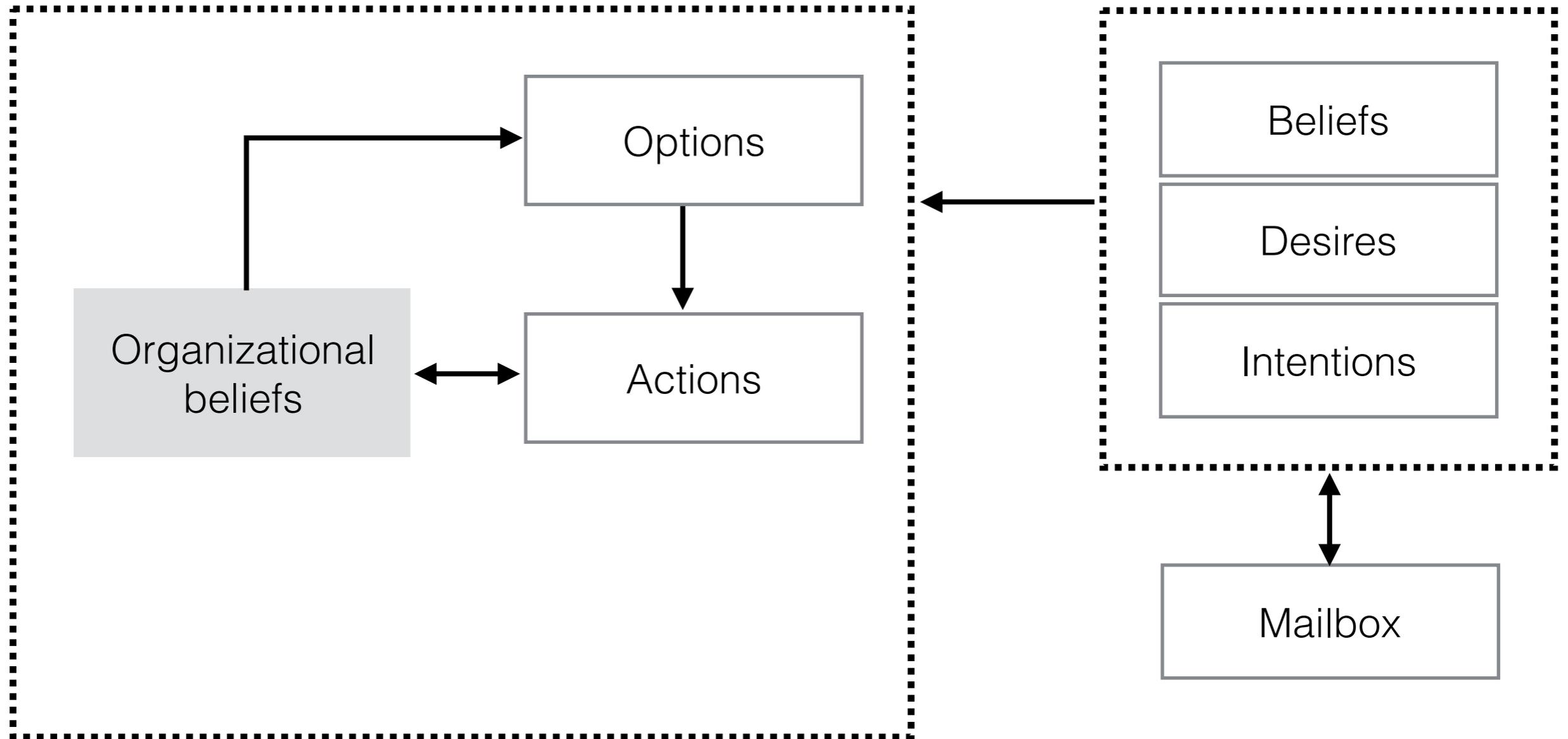
# AORTA reasoning component

# BDI agent



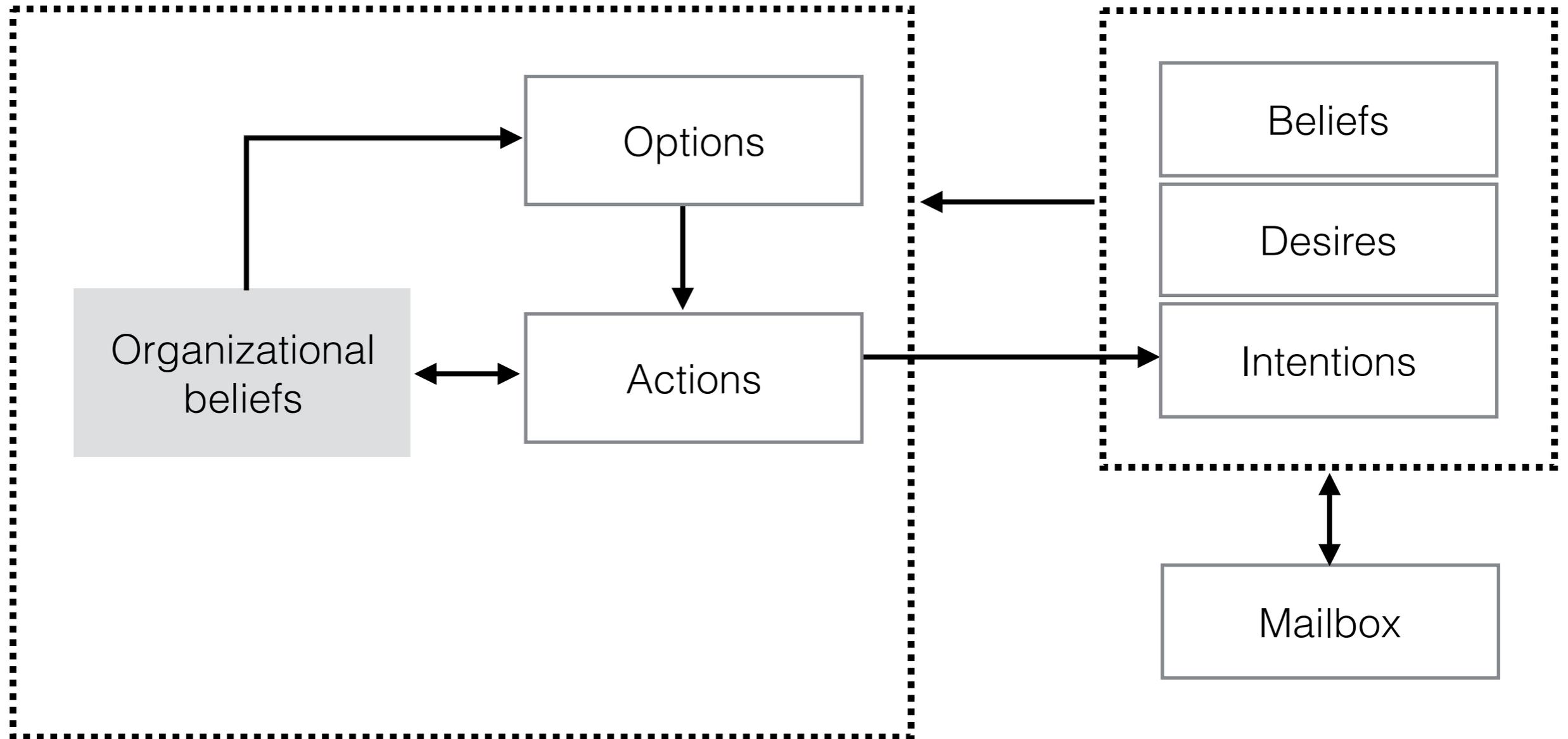
# AORTA reasoning component

# BDI agent



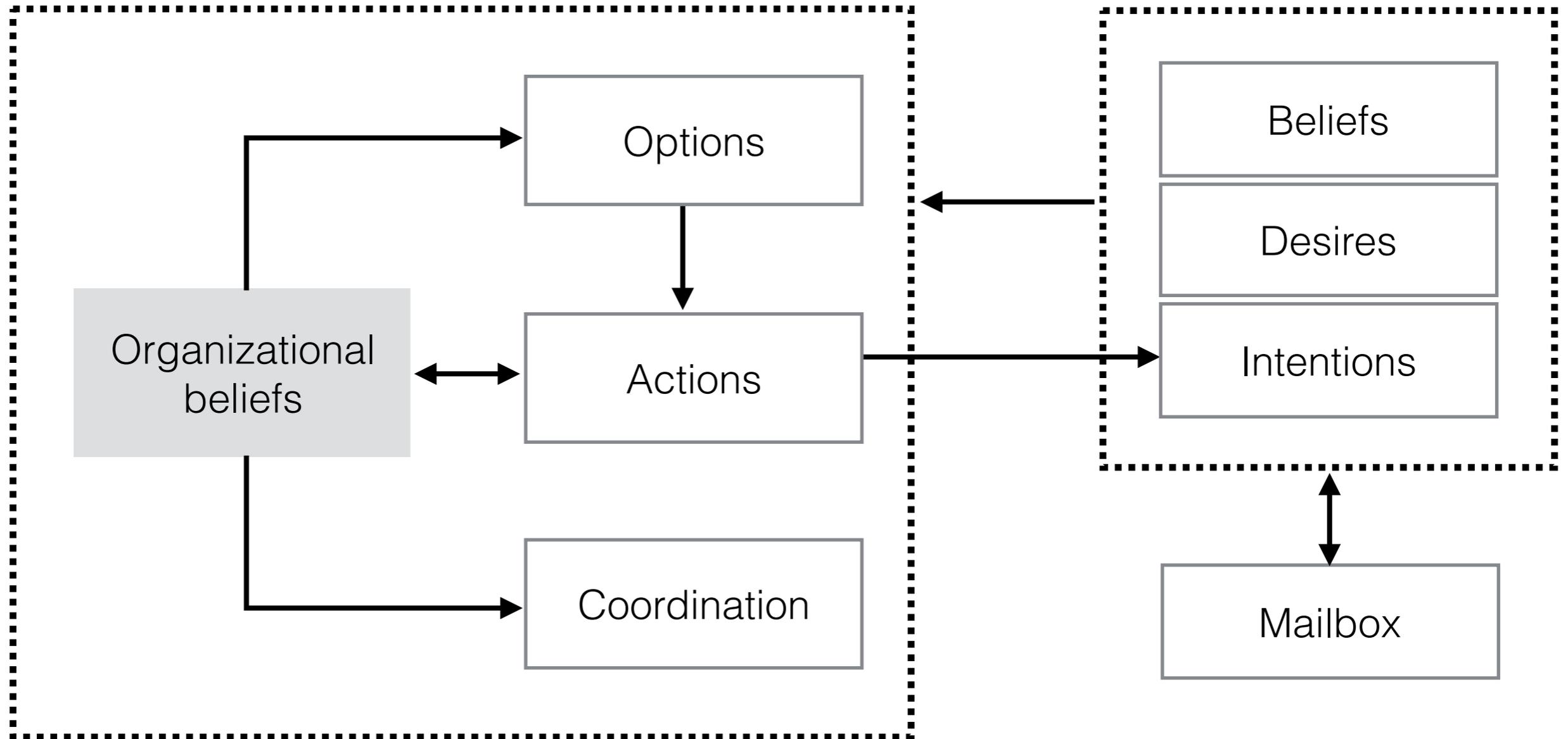
# AORTA reasoning component

# BDI agent



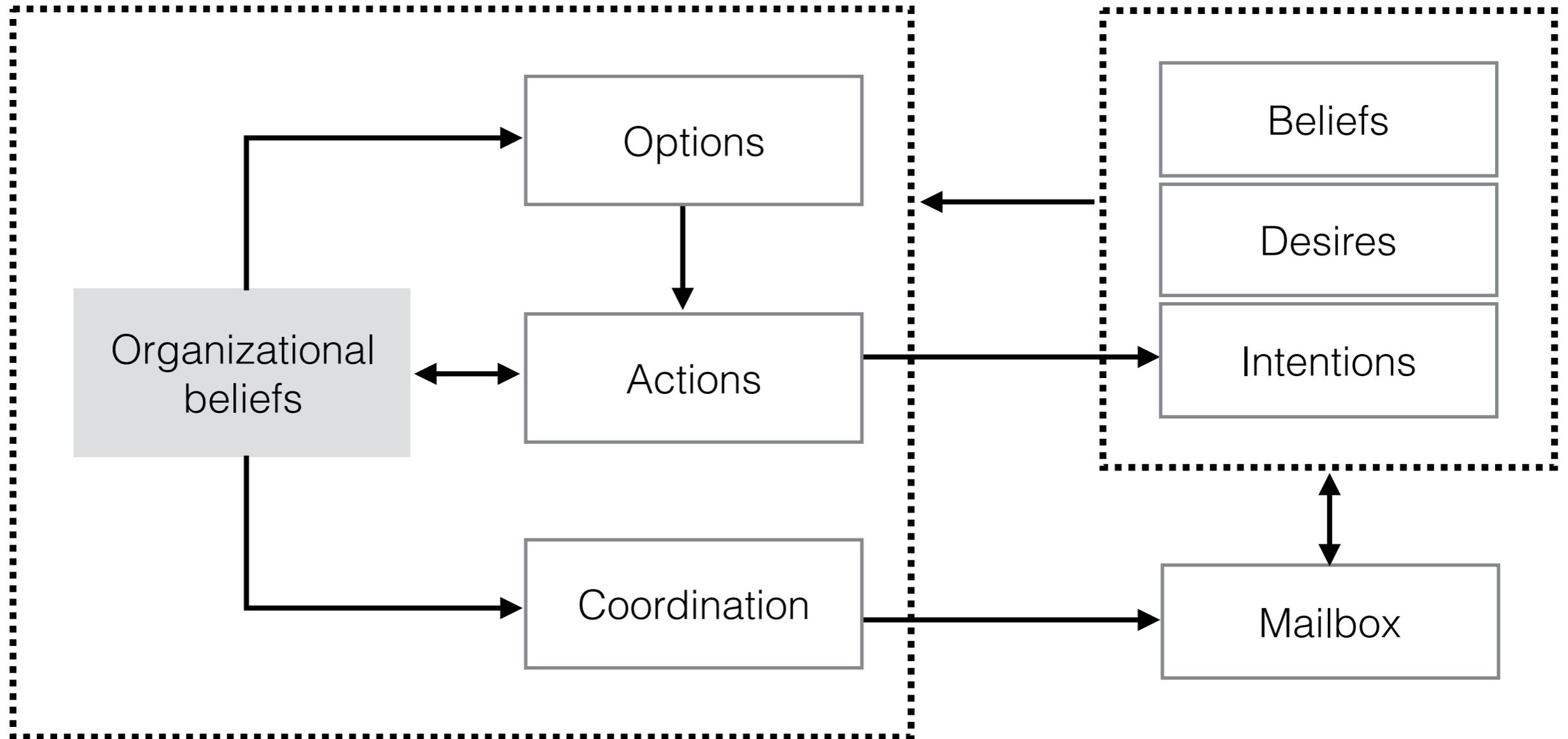
# AORTA reasoning component

# BDI agent



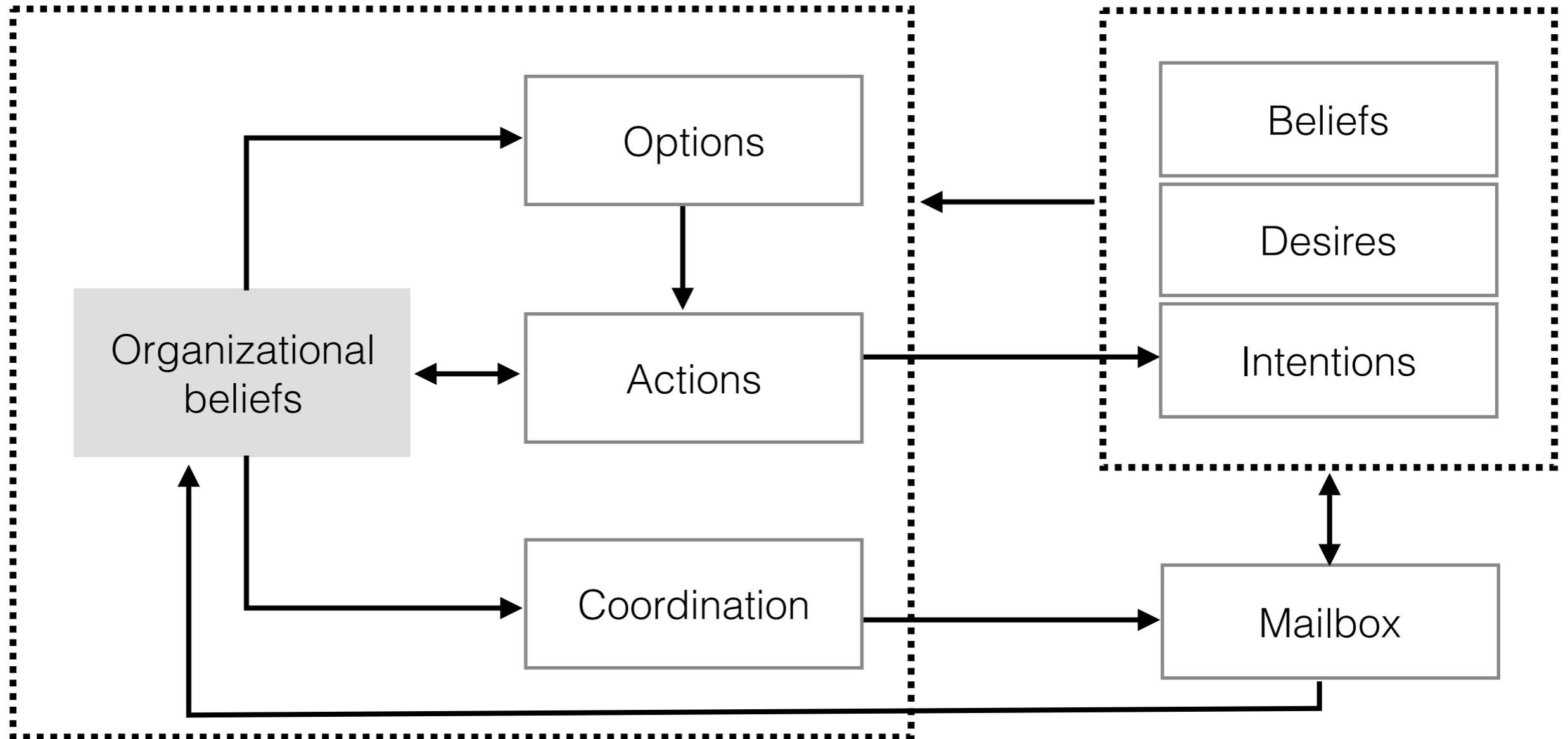
# AORTA reasoning component

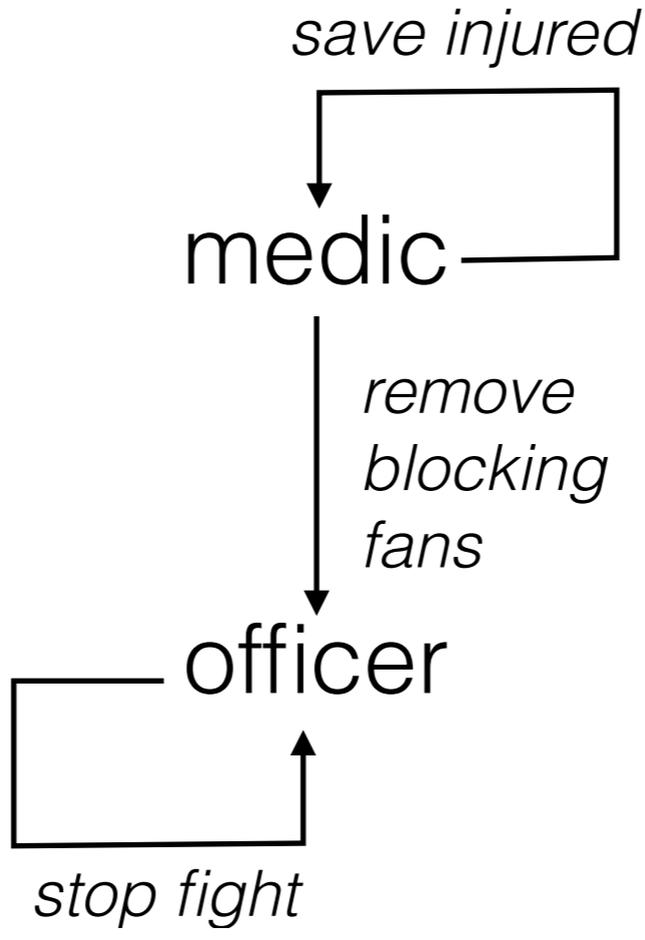
# BDI agent



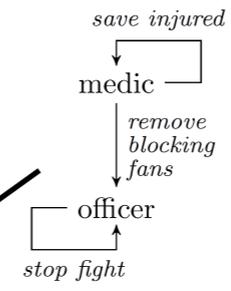
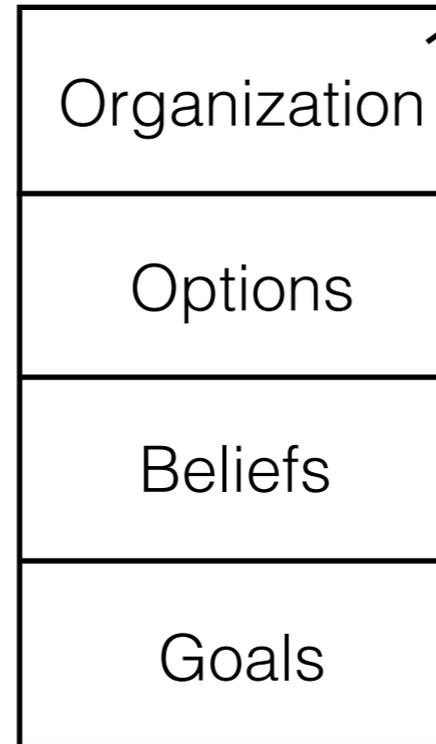
# AORTA reasoning component

# BDI agent

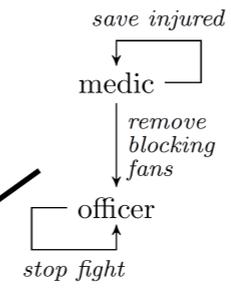
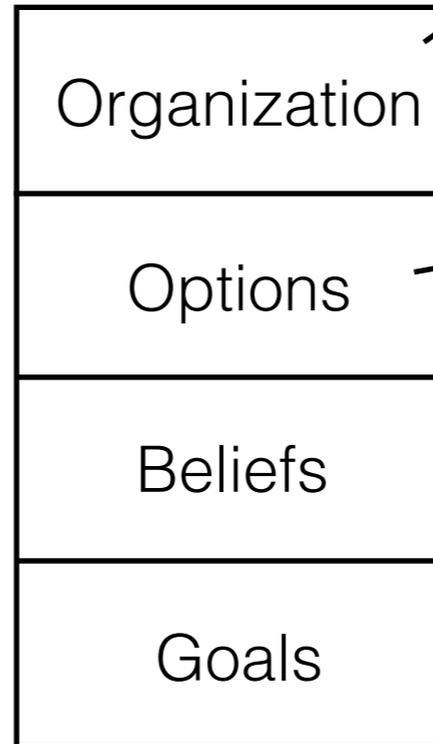




# Bob



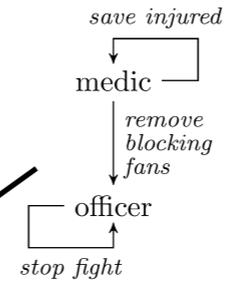
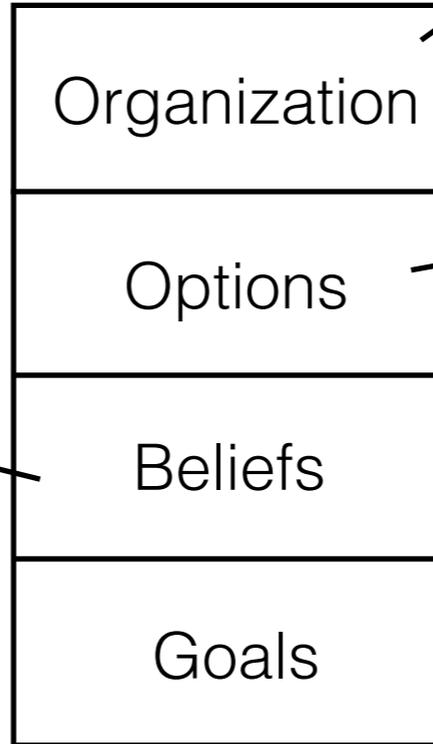
# Bob



$rea(bob, officer)$

$rea(bob, medic)$

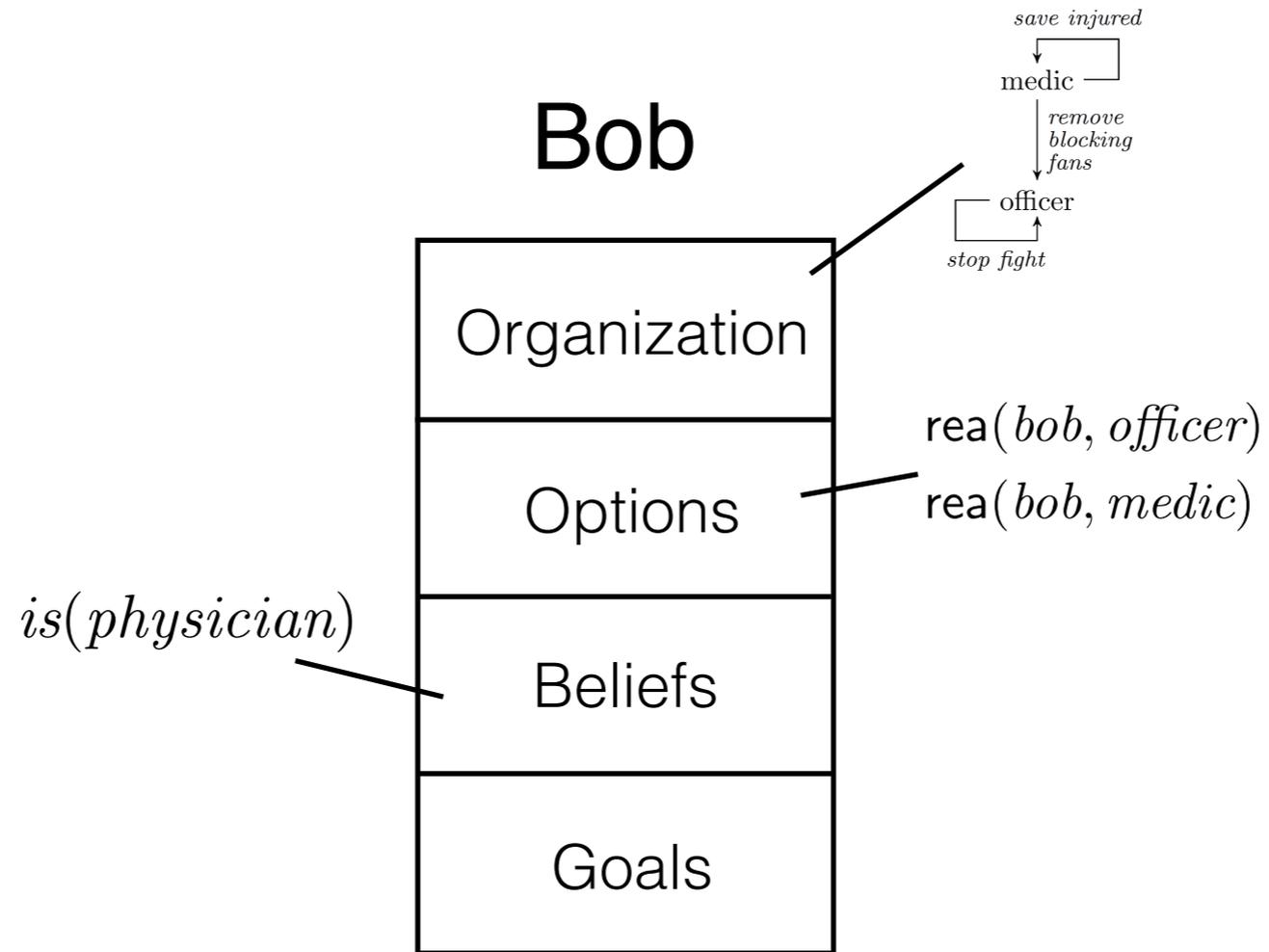
# Bob



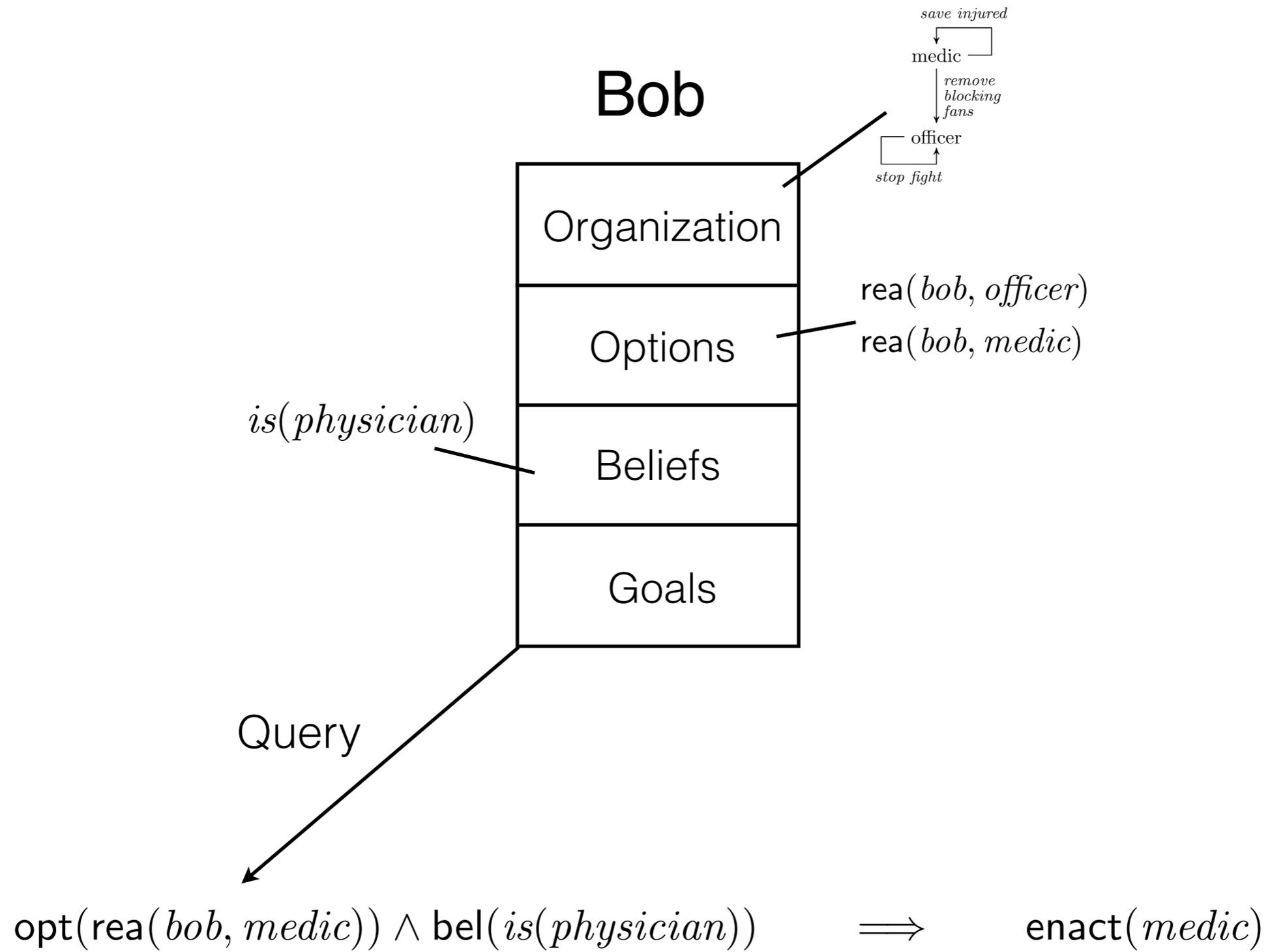
*is(physician)*

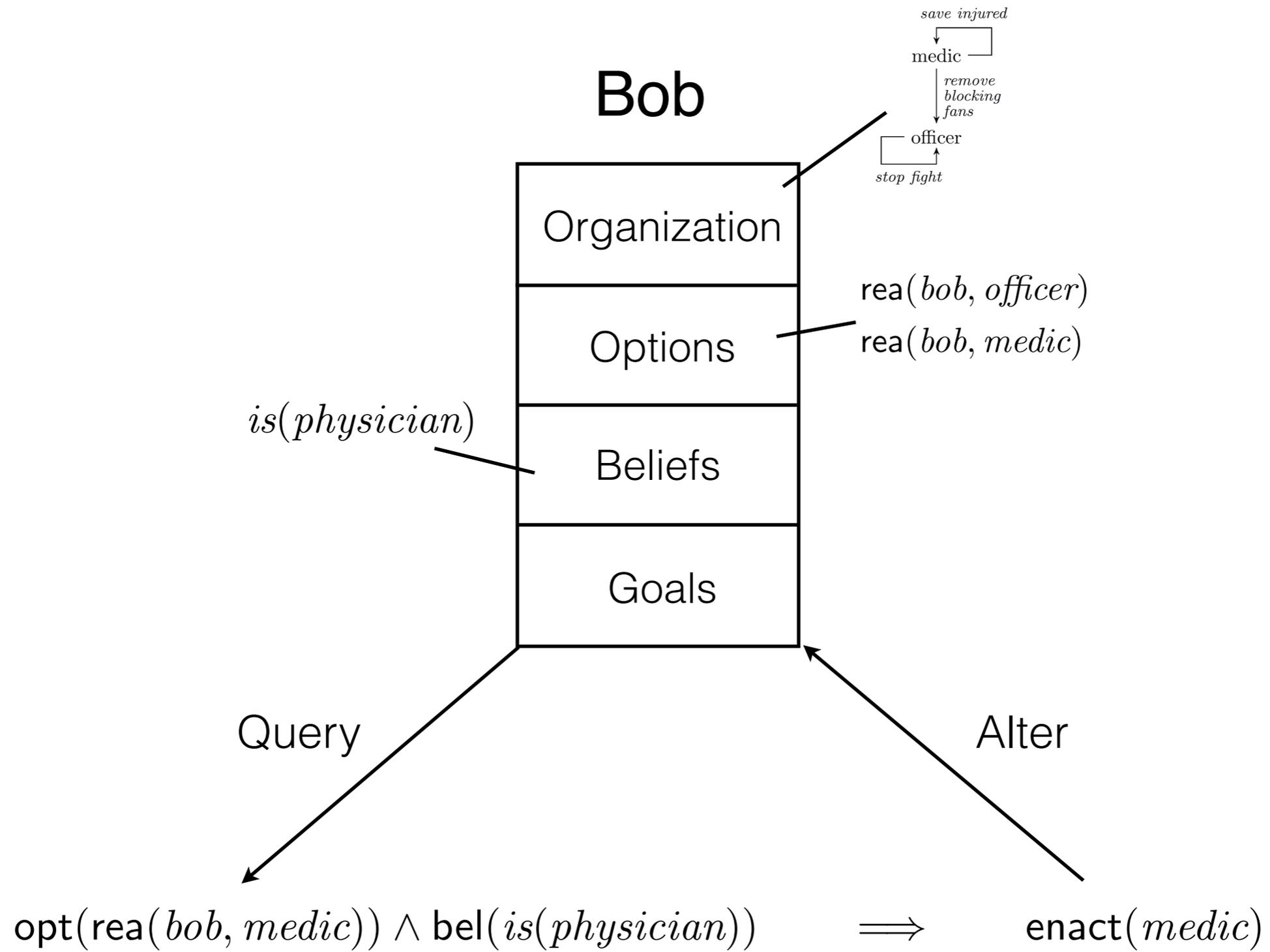
*rea(bob, officer)*

*rea(bob, medic)*



$$\text{opt}(\text{rea}(\text{bob}, \text{medic})) \wedge \text{bel}(\text{is}(\text{physician})) \implies \text{enact}(\text{medic})$$





# Mental state

- AORTA keeps a copy of the agent's mental state
  - Query language independent of agent platform
  - Requires synchronization

AORTA



*Jason*



AORTA



Bridge

*Jason*



AORTA



*commit(objective)*



*Jason*



AORTA



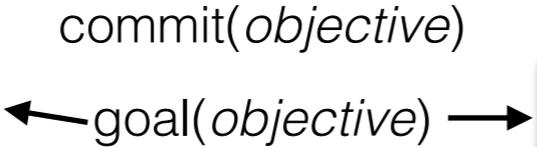
commit(*objective*)  
← goal(*objective*)

Bridge

*Jason*



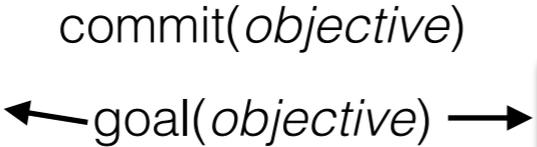
AORTA



*Jason*



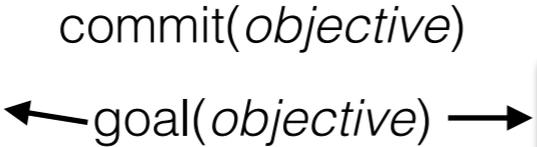
AORTA



*Jason*



AORTA



*Jason*



AORTA



Bridge

*Jason*



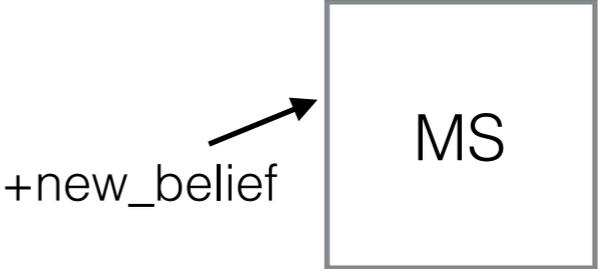
AORTA



Bridge



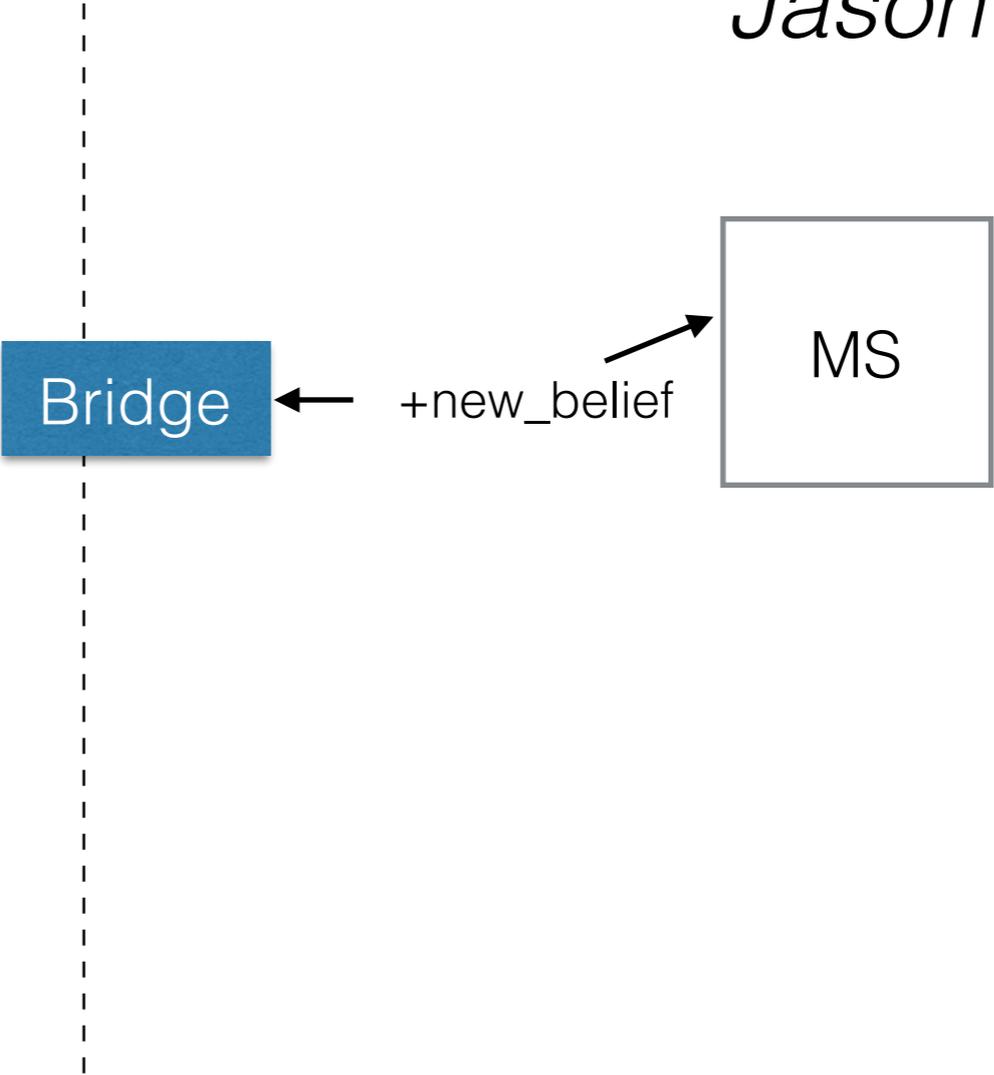
*Jason*



AORTA



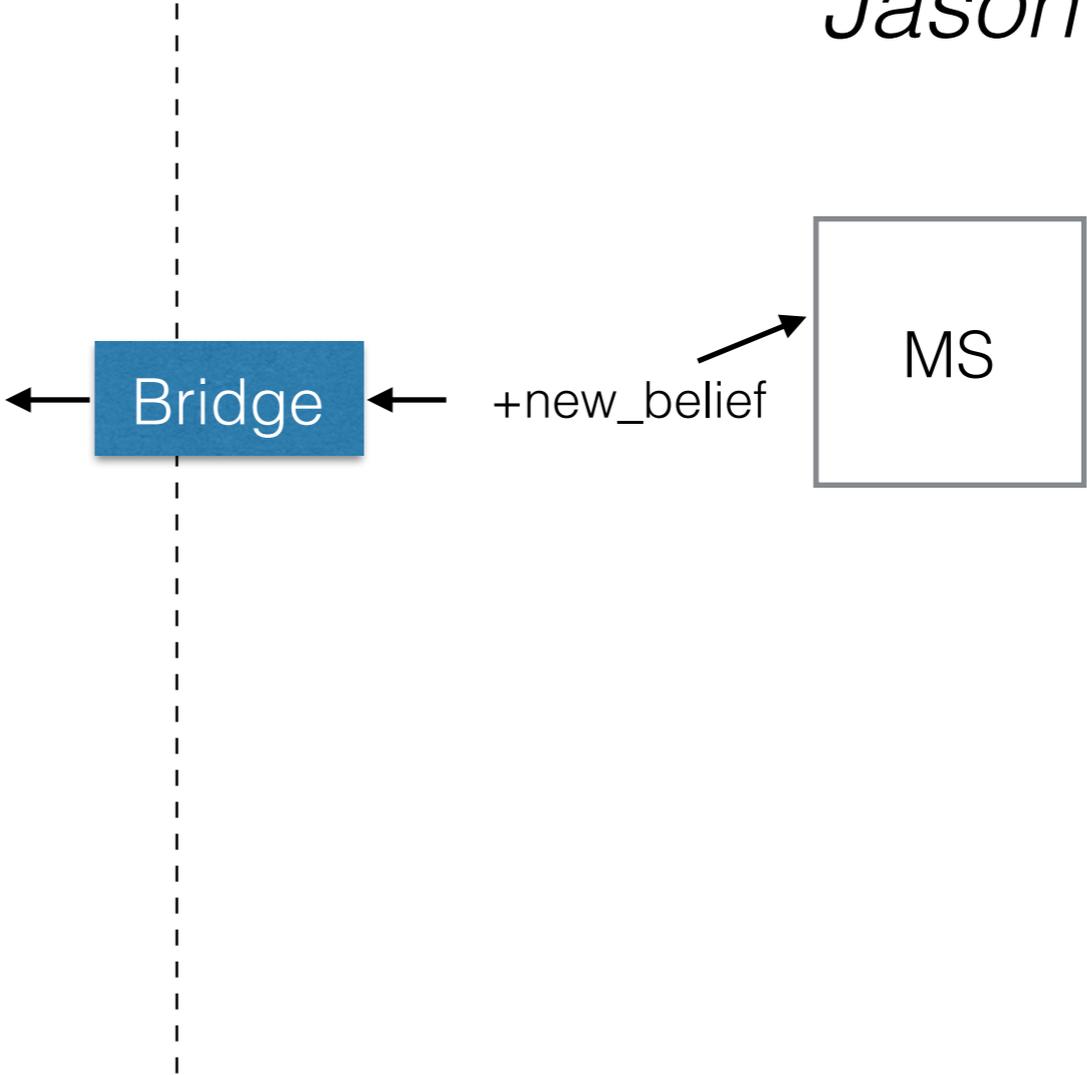
*Jason*



AORTA



*Jason*



AORTA

*Jason*



← *bel(new\_belief)*

← *+new\_belief* →



```
+!injuredFound : room(R) & not(visited(R)) <- !visited(R).  
+!injuredFound <- +injuredFound.  
  
+!visited(R) : in(R) <- +visited(R).  
+!visited(R) : not(state(traveling)) <- goTo(R); !visited(R).
```

```
+!injuredFound : room(R) & not(visited(R)) <- !visited(R).
+!injuredFound <- +injuredFound.

+!visited(R) : in(R) <- +visited(R).
+!visited(R) : not(state(traveling)) <- goTo(R); !visited(R).

options {
    [org(role(R,Os), rea(bob,R), member(O,Os), active(O))]
        => consider(objective(O)).
}

actions {
    [opt(objective(O))] => commit(O).
}
```

```
+!injuredFound : room(R) & not(visited(R)) <- !visited(R).
+!injuredFound <- +injuredFound.

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+!visited(R) : not(state(traveling)) <- goTo(R); !visited(R).

options {
    [org(role(R,Os), rea(bob,R), member(O,Os), active(O))]
        => consider(objective(O)).
}

actions {
    [opt(objective(O))] => commit(O).
}
```

Bob has already enacted the medic role.

AORTA

*Jason*

commit(*injuredFound*)

AORTA

*Jason*

commit(*injuredFound*)



goal(*injuredFound*)

AORTA

*Jason*

commit(*injuredFound*)



goal(*injuredFound*)



*+!injuredFound*

AORTA

*Jason*

commit(*injuredFound*)



goal(*injuredFound*)



*+!injuredFound*



*+!visited(room1)*

AORTA

*Jason*

commit(*injuredFound*)



goal(*injuredFound*)



*+!injuredFound*



goal(*visited(room1)*)



*+!visited(room1)*

AORTA

*Jason*

commit(*injuredFound*)



goal(*injuredFound*)



*+!injuredFound*



goal(*visited(room1)*)



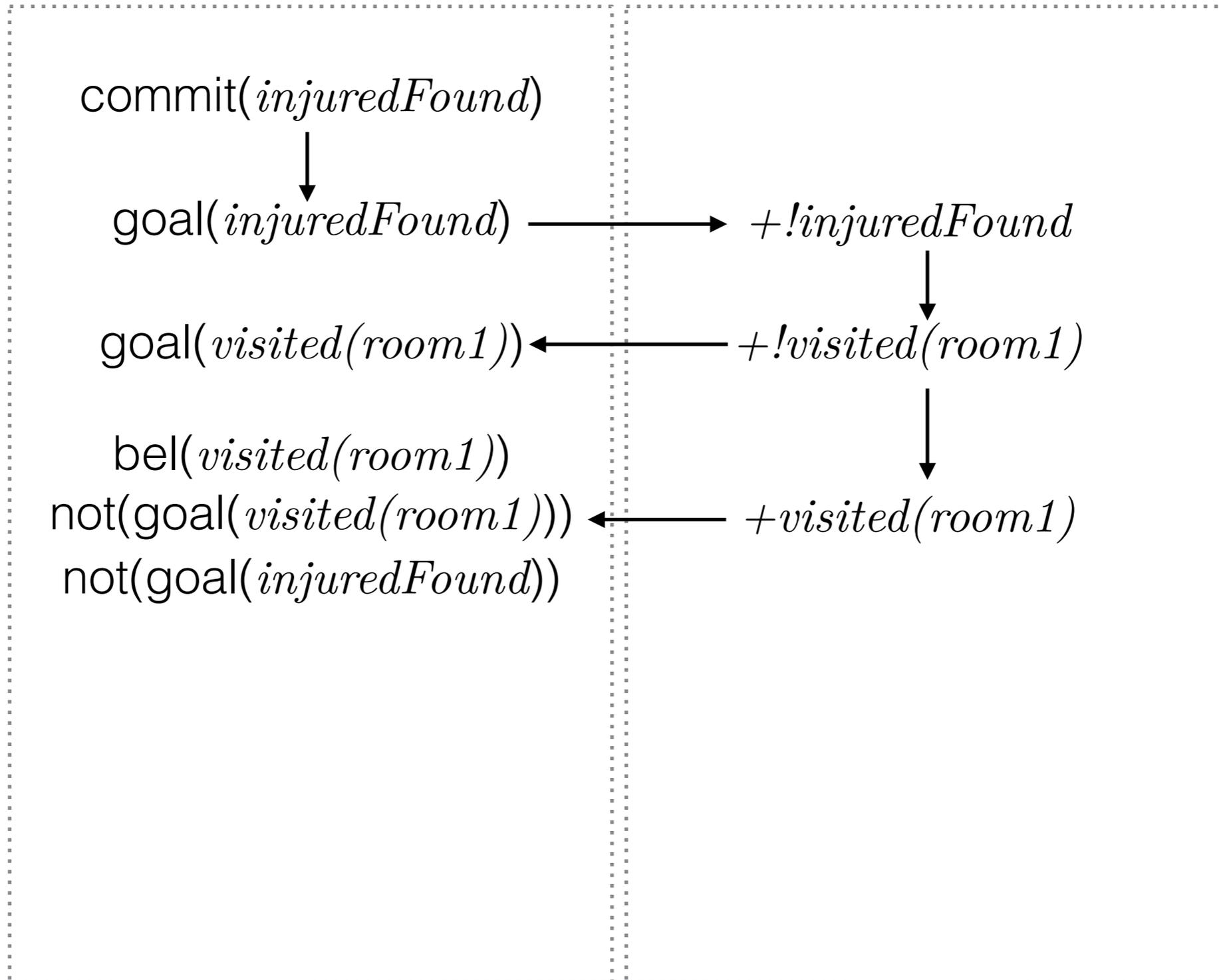
*+!visited(room1)*



*+visited(room1)*

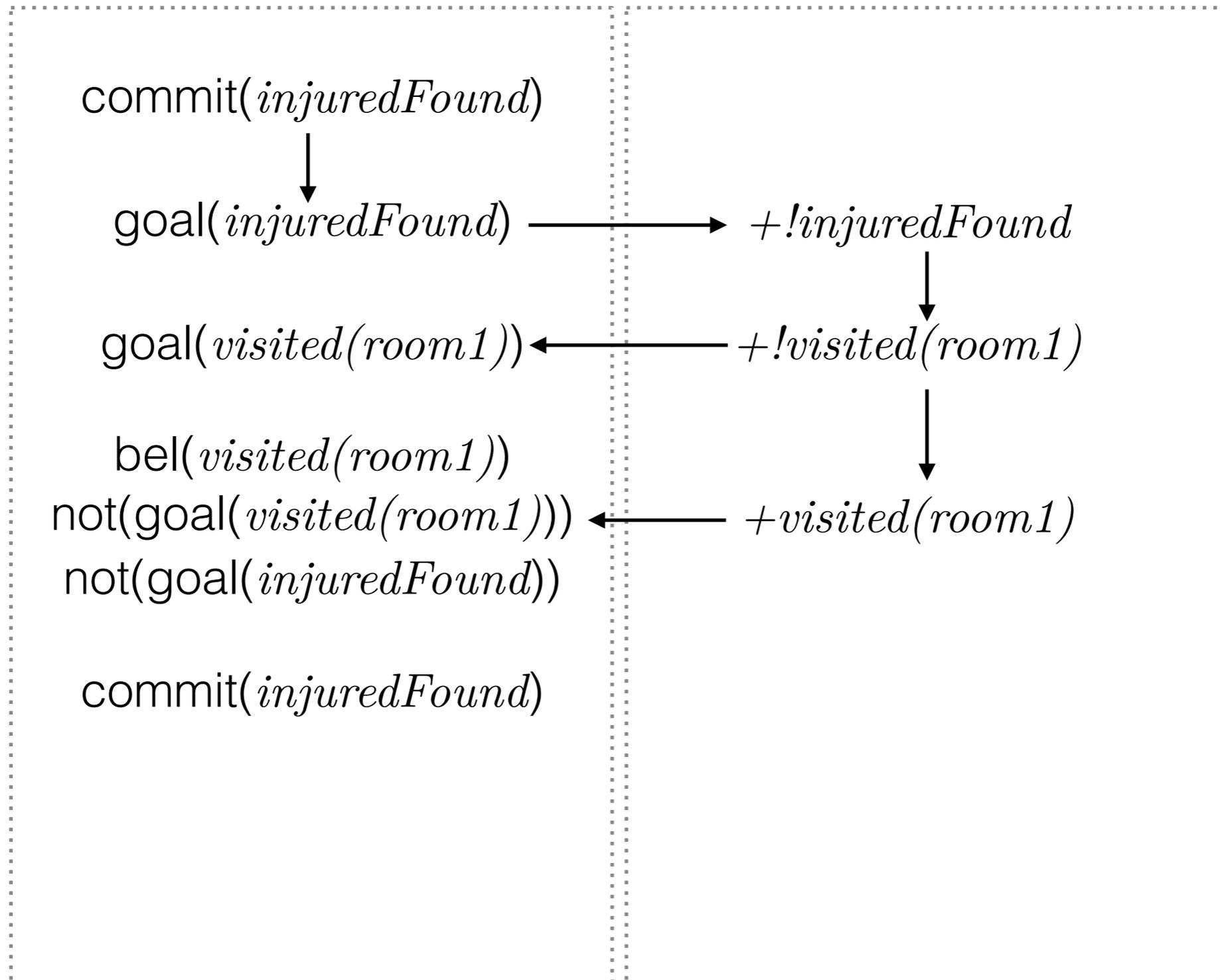
AORTA

*Jason*



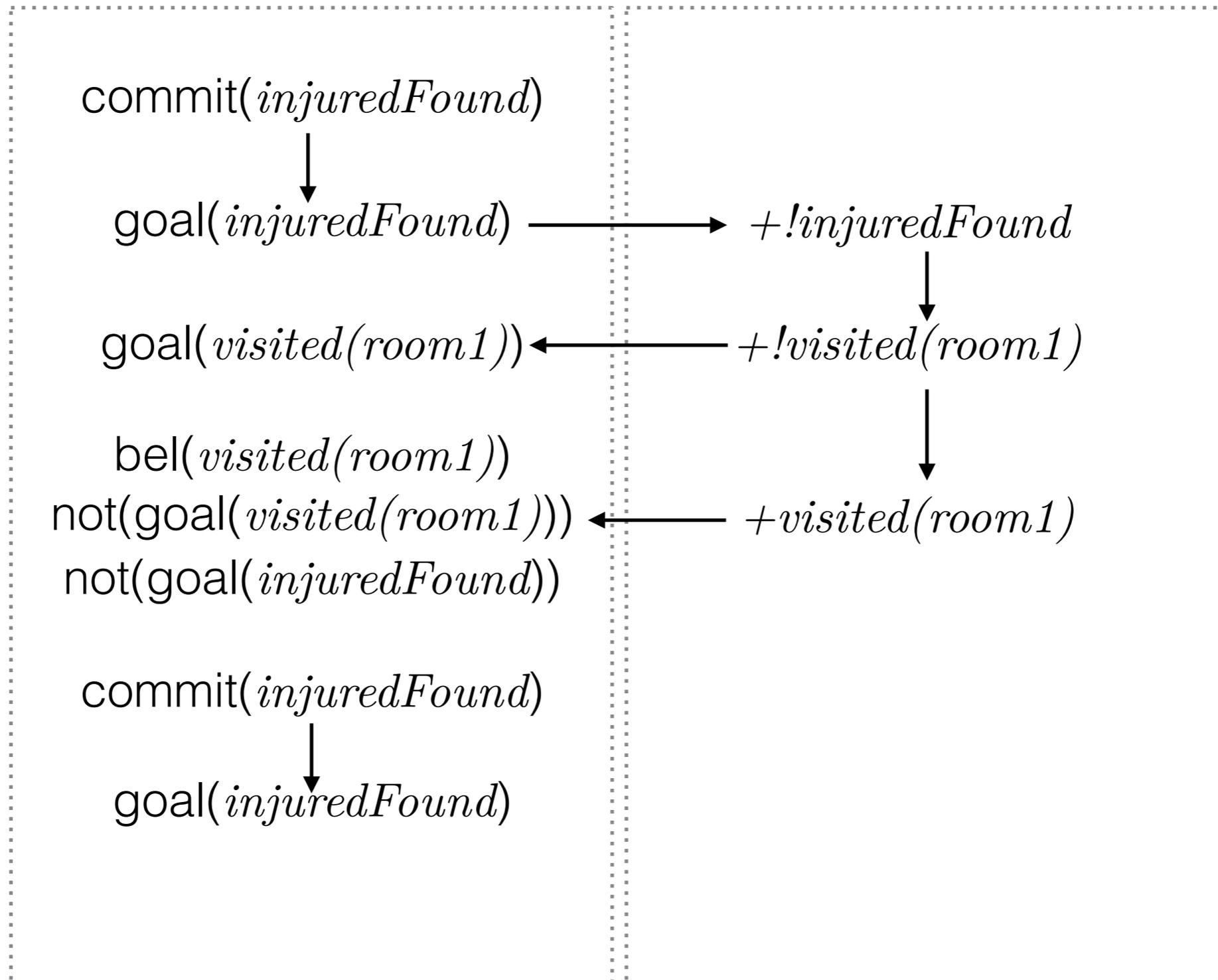
AORTA

*Jason*



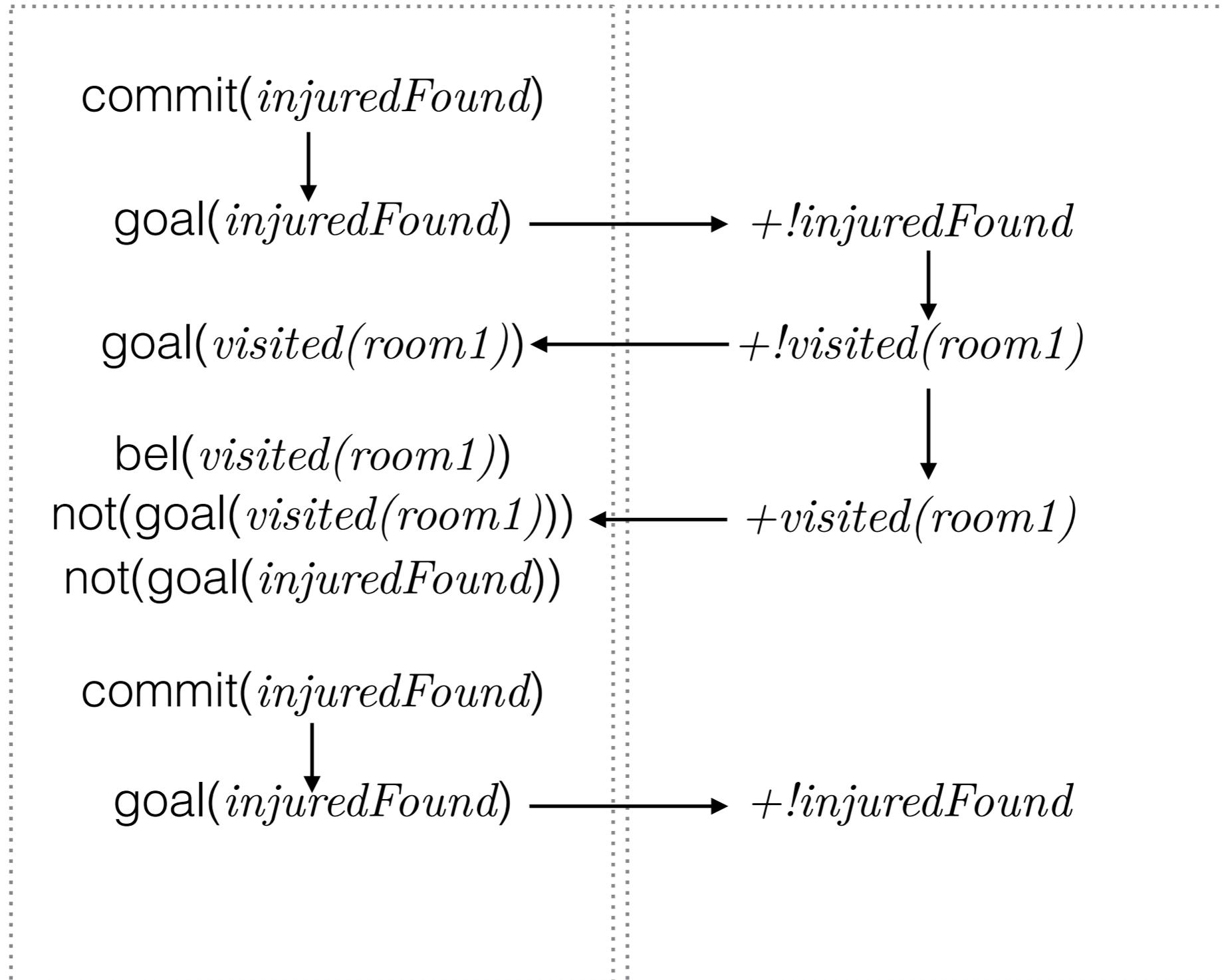
AORTA

Jason



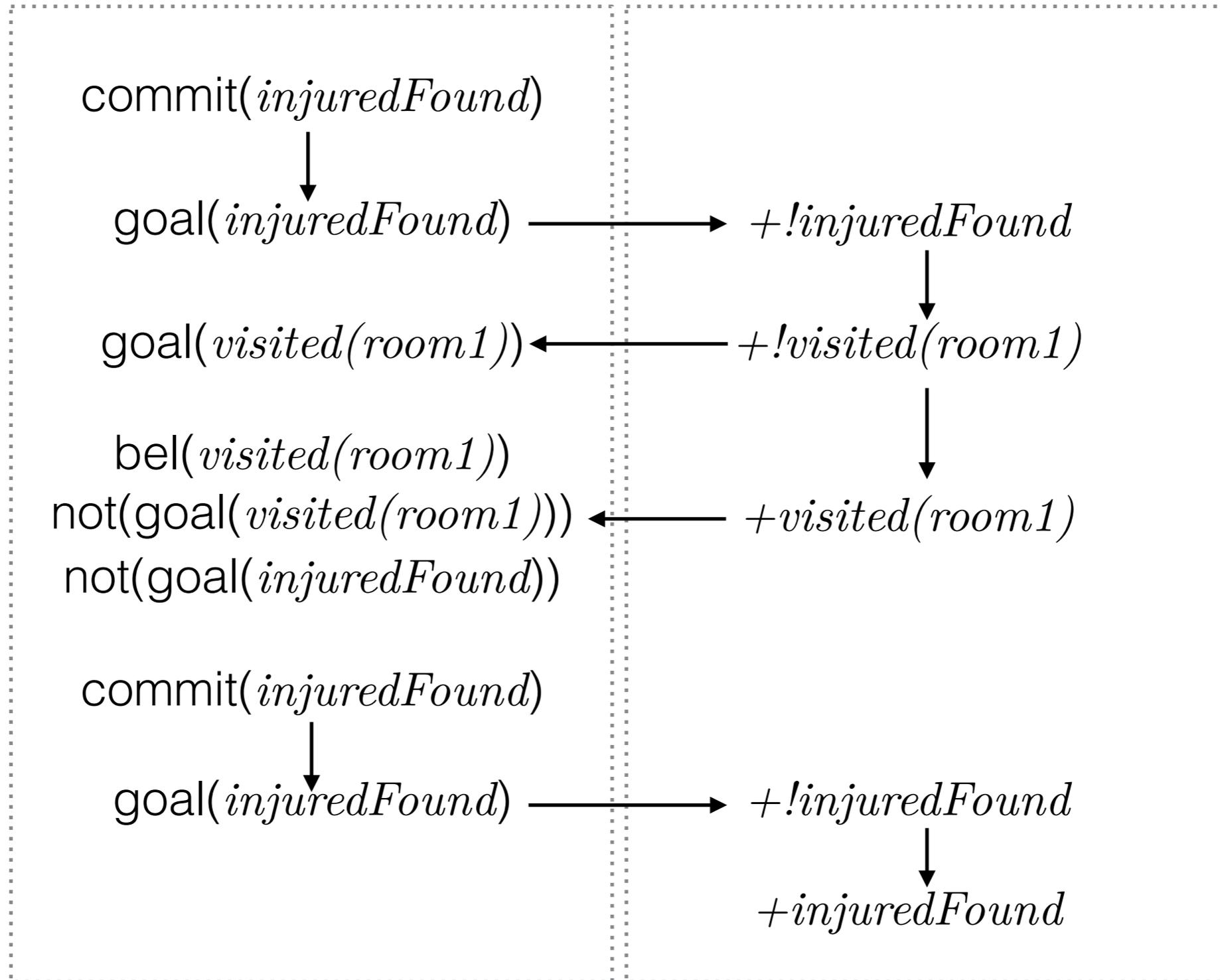
AORTA

Jason



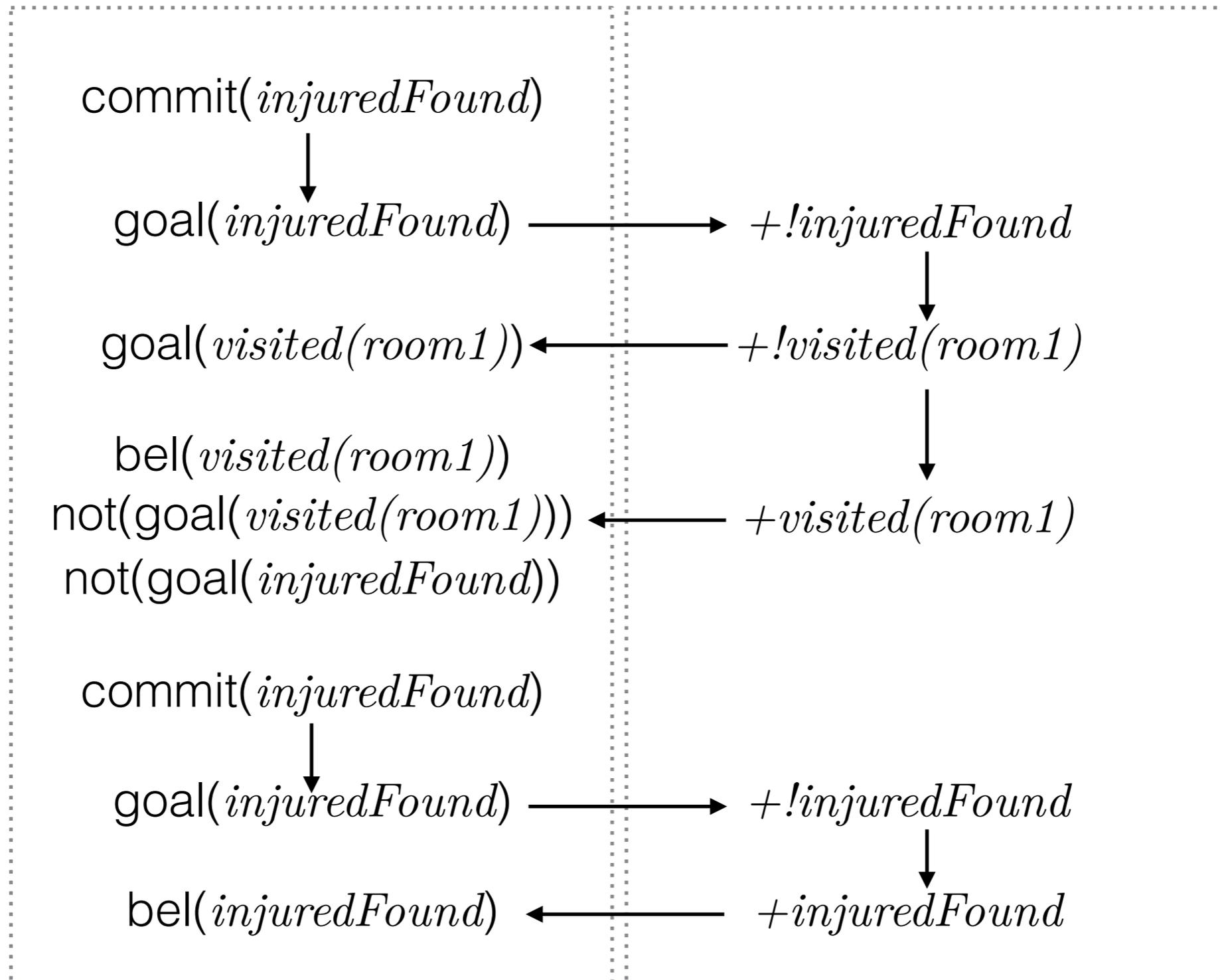
AORTA

Jason



AORTA

Jason



# Conclusion

- Organizational reasoning capabilities
  - Integrated with BDI agents
  - Independent from organization
- Integrated into the *Jason* platform
- Decentralized organization

# Future work

- Integration with other platforms
- Support for norms
- Centralization of certain aspects
  - Shared organization component
  - Inspired by artifacts

Thank you