

# BDI on Time

(“the future of BDI is in the future”)

# Big Picture

- BDI agents misses automatic reasoning about time (as opposed to SOAR, for instance)
- AI has explored past & future
  - Past (like episodic memory)
    - useful for explanation, learning, ...
  - Future (like search, planning, monte carlo, ...)
    - useful for rational decisions, goal oriented, ...

# Let's Focus on the Future



# Motivations To Consider Future & BDI

- BDI agents may do better (rational) decisions by looking ahead
- Foresee problems
- Realize better options
- ...

# Details of the Problem

- BDI deliberation is currently based on **present**
  - mostly based on beliefs (in current interpreters)
- although intentions points to the future  
[see Bratman, Choen ...]  
this characteristic of intention is not exploited **by the agent**
- the **developer** must  
reason about future  
(not the agent)

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```
when Drun  
if    not Igive_classes  
then ...
```



# Example

1. when **Dg**  
if **Bp**  
then **Aa Dh**

2. when **Dg**  
if **Bp**  
then **Ab Dh**

3. when **Dh**  
if **Bq**  
then **Ac**

# Example

1. when **Dg**  
if **Bp**  
then **Aa Dh**

agent **Bp** & **Bq** & **Dg**

consequence of **Aa** is  $\sim$ **Bq**

2. when **Dg**  
if **Bp**  
then **Ab Dh**

what plan to select for **Dg** ?

3. when **Dh**  
if **Bq**  
then **Ac**



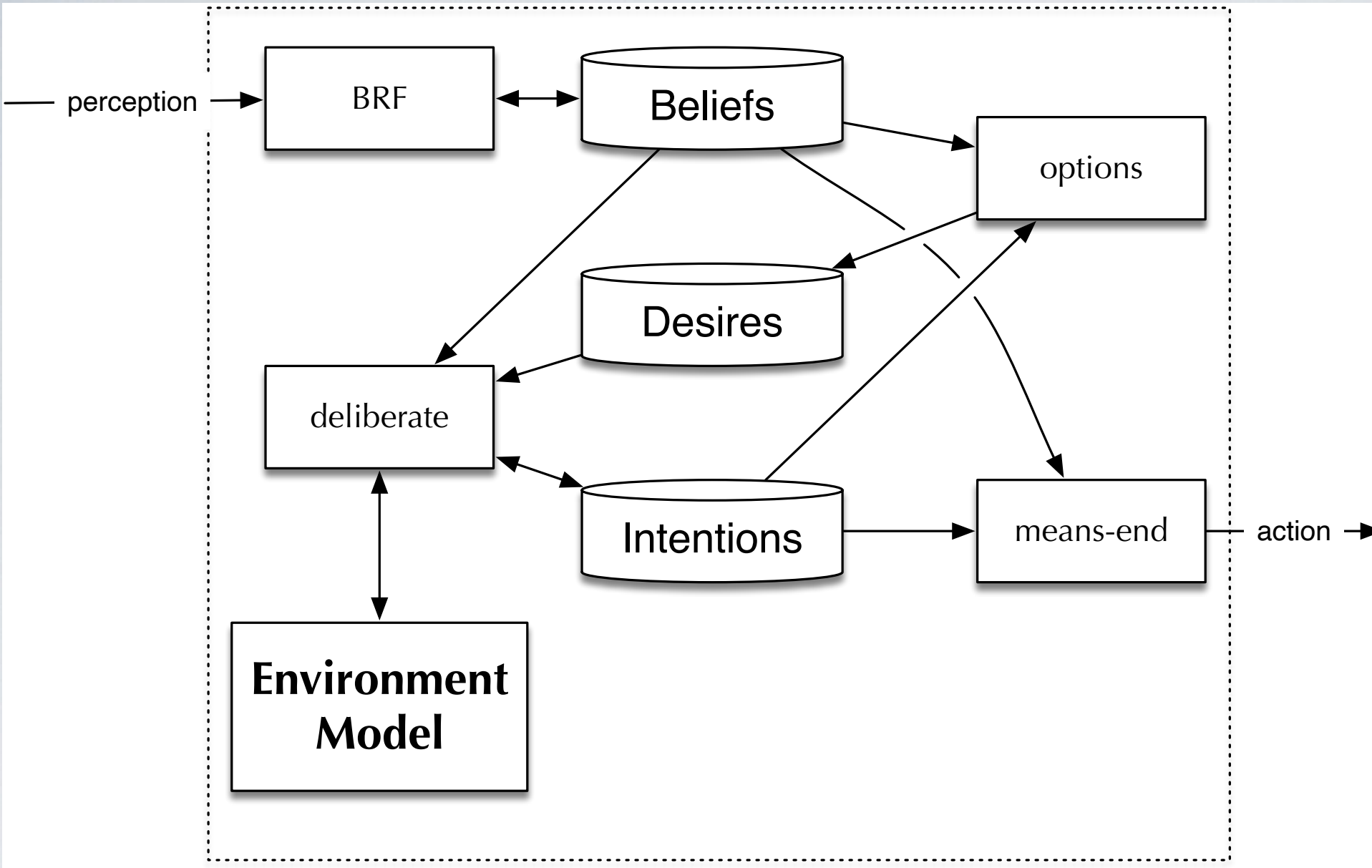
# General Proposal

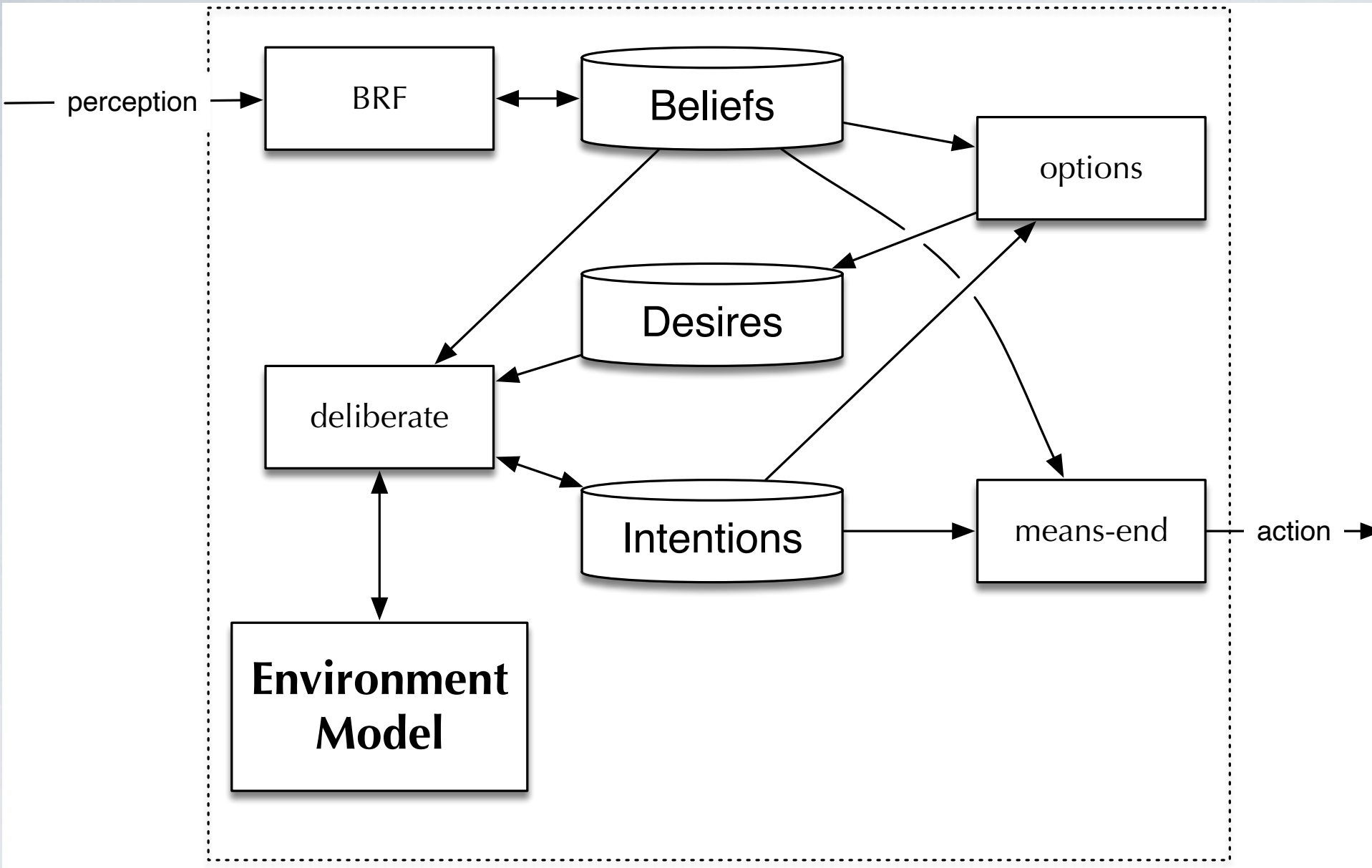
```
1 while true do
2    $B \leftarrow \text{brf}(B, \text{perception}()) ;$            // belief revision
3    $D \leftarrow \text{options}(B, I) ;$                  // desire revision
4    $I \leftarrow \text{deliberate}(B, D, I)$ 
5    $\pi \leftarrow \text{meansend}(B, I, A) ;$            // gets a plan
6   while  $\pi \neq \emptyset$  do
7      $\text{execute}(\text{head}(\pi))$ 
8      $\pi \leftarrow \text{tail}(\pi)$ 
```

Target: deliberate (not means-end)

new line 4:

$I \leftarrow \text{deliberate}(B, D, I, E)$  //  $E =$  **env model**





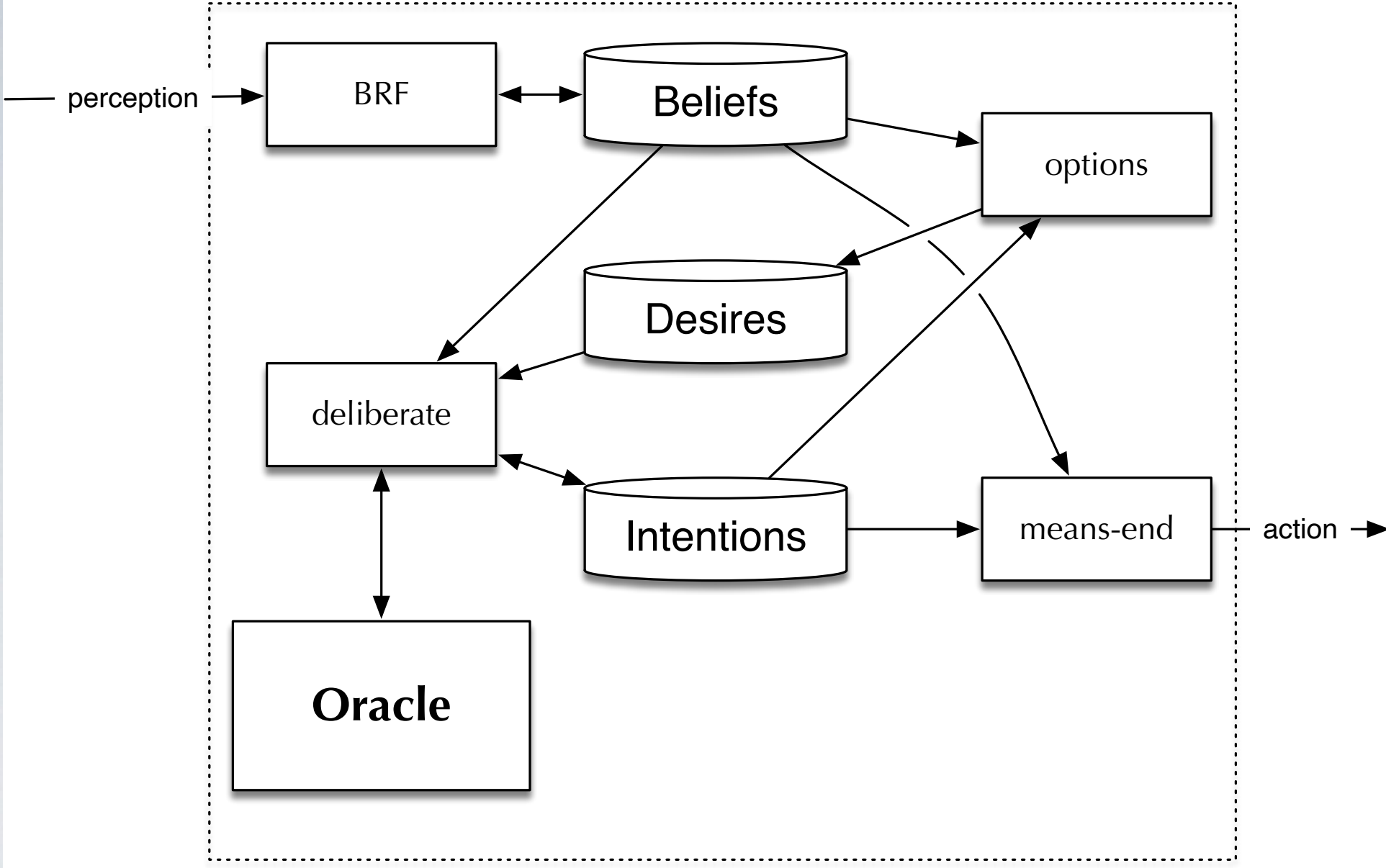
example of interaction with Env. Model:

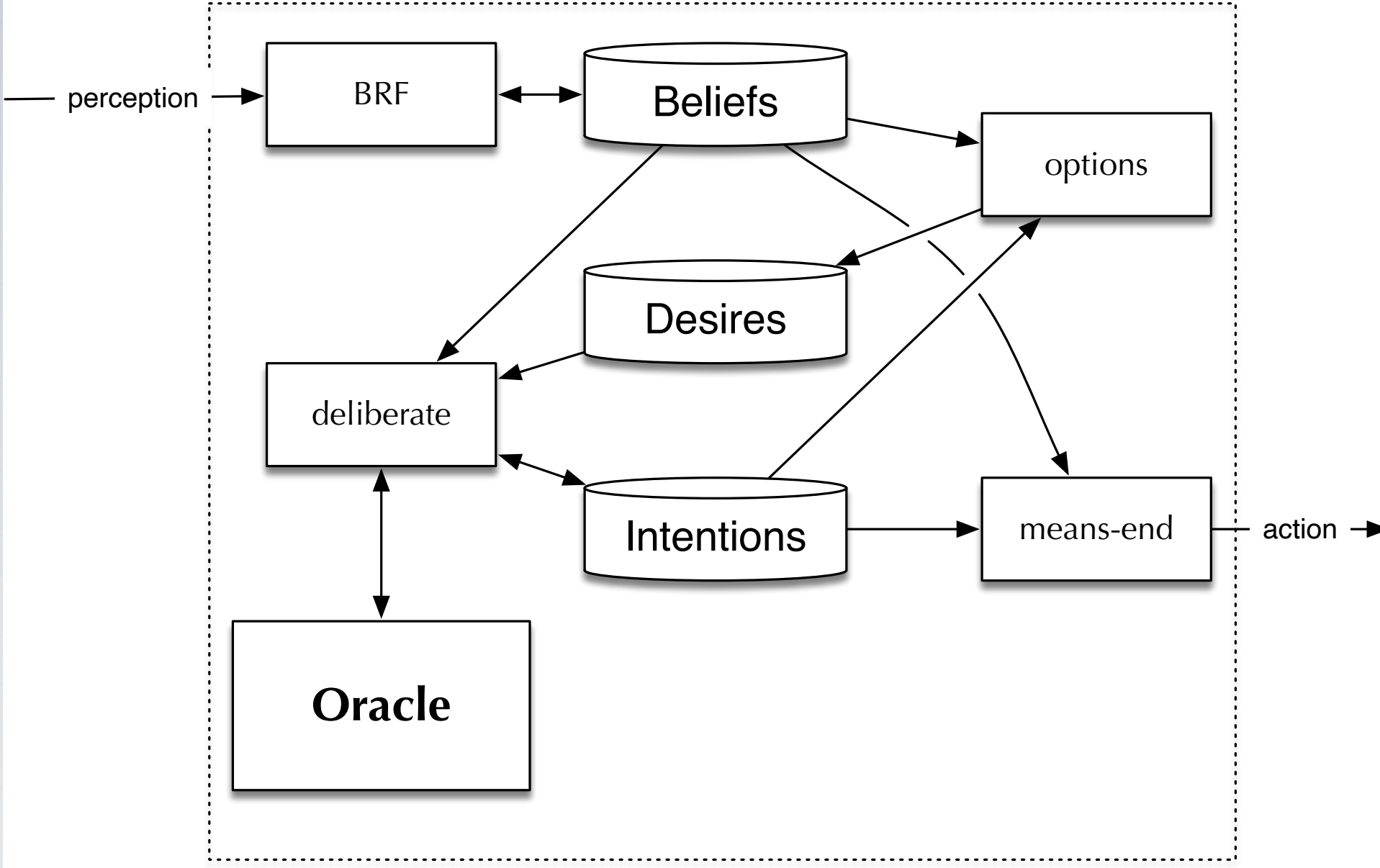
what if I **A**a?

del **B**p, add **B**q, ...

[planning like specification of actions]







example of interactions with oracle:

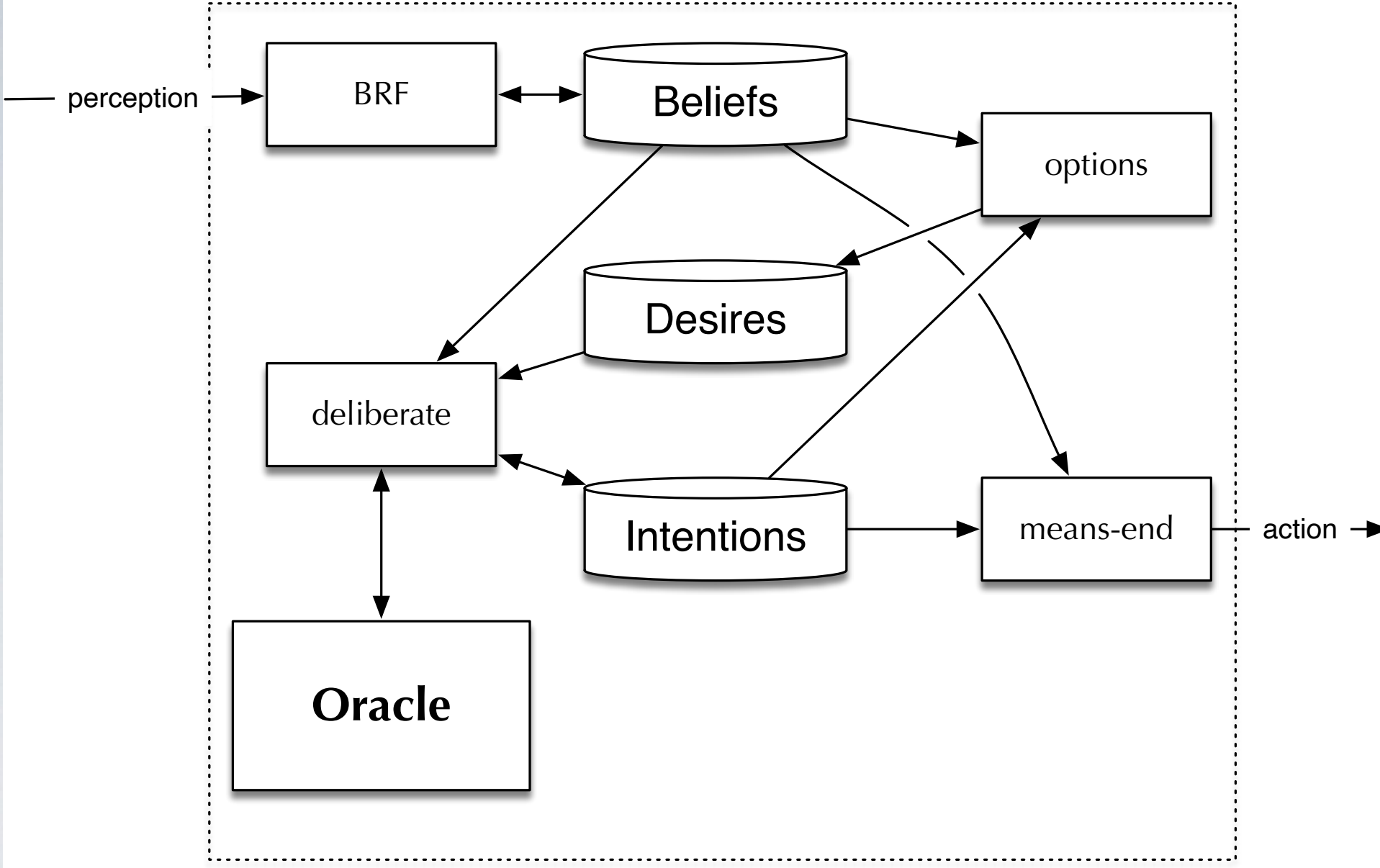
Q: what if I chose plan I?

A: you will fail in x step

A: goal g will be achieved in x steps

A: no plan option in x steps

A: you will end up killing some people



example of interactions with oracle:

Q: what if I chose plan I?

A: you will fail in x step

A: goal g will be achieved in x steps

A: no plan option in x steps

A: you will end up killing some people

Q: how the environment will be if I chose plan I?

A: in 1 step: p, q, not r

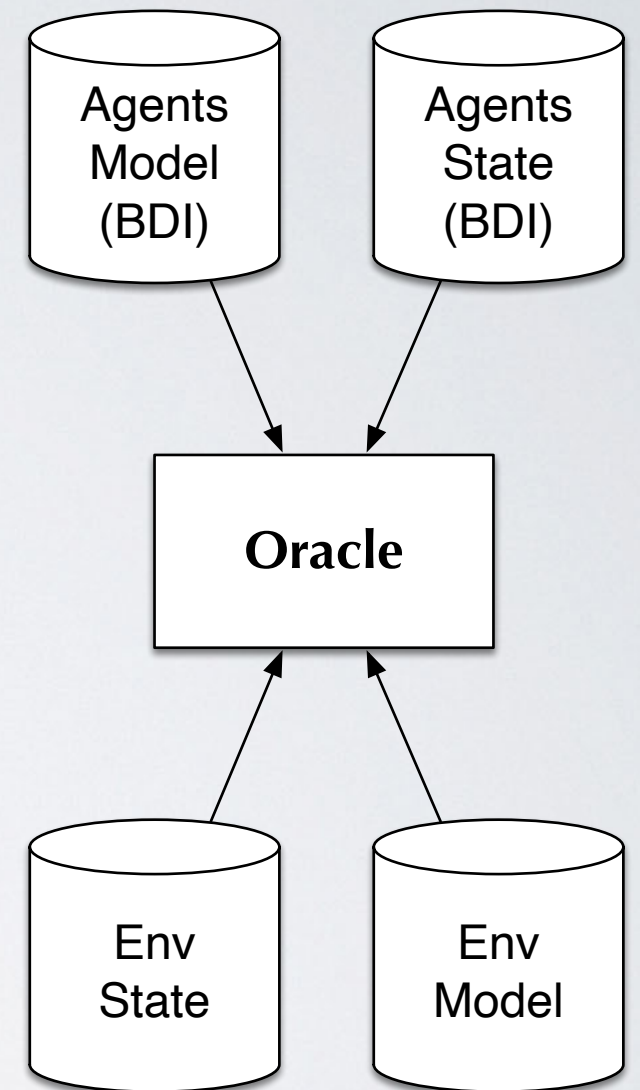
A: in 2 steps: ...

A: in 3 steps: ...



# Oracle Considerations

- look ahead based on
  - environment model, inspired by planning,  $A^*$ , monte carlo, MPC, ...
  - **agent** model (BDIly described)
- combining both is better
  - the oracle knows how the agent decides (its mental state, plans, ...), what is not the case in normal planning
  - enables “simulation” instead of branching future



# Next Steps

- Revisit BDI fundamental bibliography
- Literature review on BDI time reasoning
- Read about **AI causal models**
- Implement the oracle
- Experiment