Expression of Behaviors in Assistant Agents as Influences on Rational Execution of Plans

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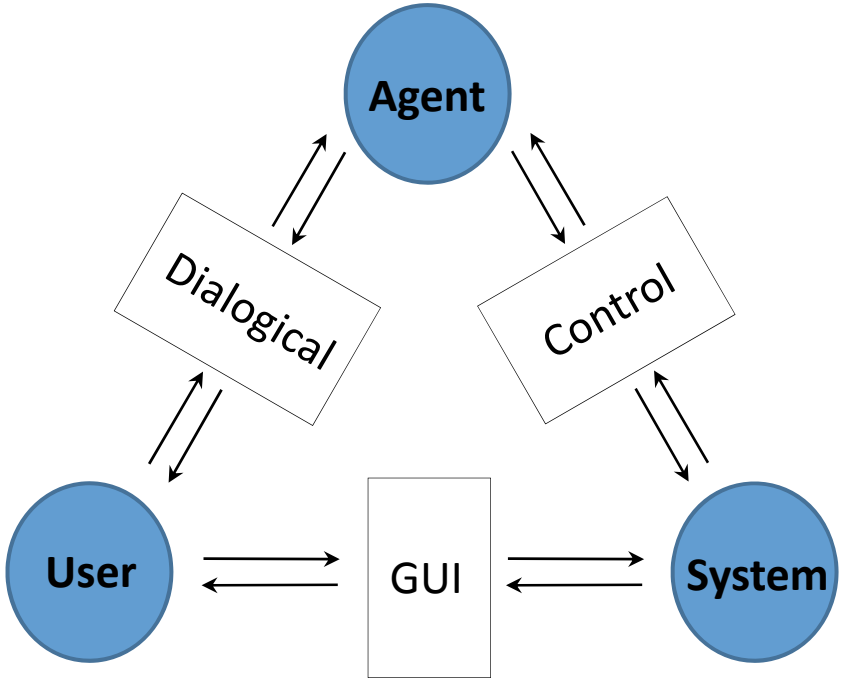
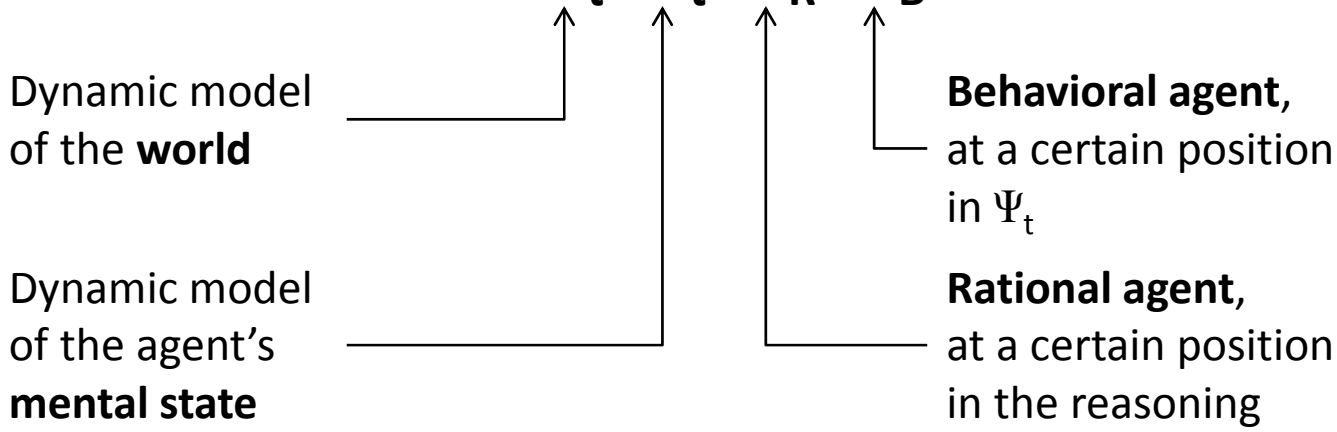
Conversational Assistant Agents

- **UAS situation** [Maes, 1994]
  - Numerous different situations
  - Variation over the leading/intrusive **role** of A
- **Control:** rational agent [Russell & Norvig, 2009]
  - Symbolic model
  - Rational reasoning capacity
- **Dialogue:** behavioral agent
  - Conversational (multimodal) interface
  - Input: user's request
  - Output: factual reply to request
  - Expression of agent's personality **varying according to its role**



Rational & Behavioral agents

- At time t, agent A = $<\Phi_t, \Psi_t, A_R, A_B>$



- Links between rationality and psychology?
  - Execution of action α_i in plan π_i toward goal γ_i has an impact on $\Psi_t \rightarrow \Psi_{t+1}$ *emotions, arousal, appraisal, coping…*
  - A_B in state Ψ_t can influence execution of current action α_i, plan π_i or evolution toward goal γ_i

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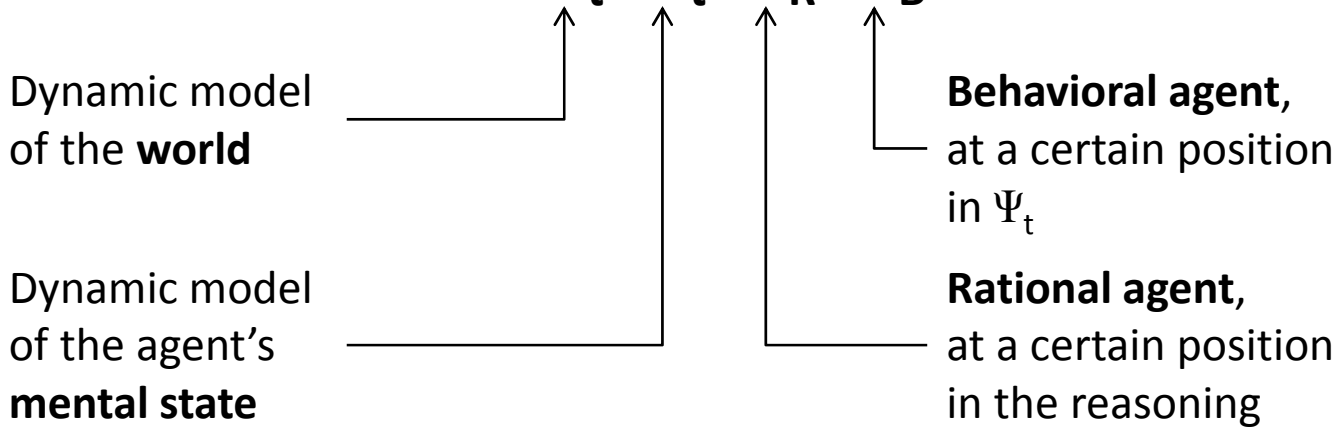

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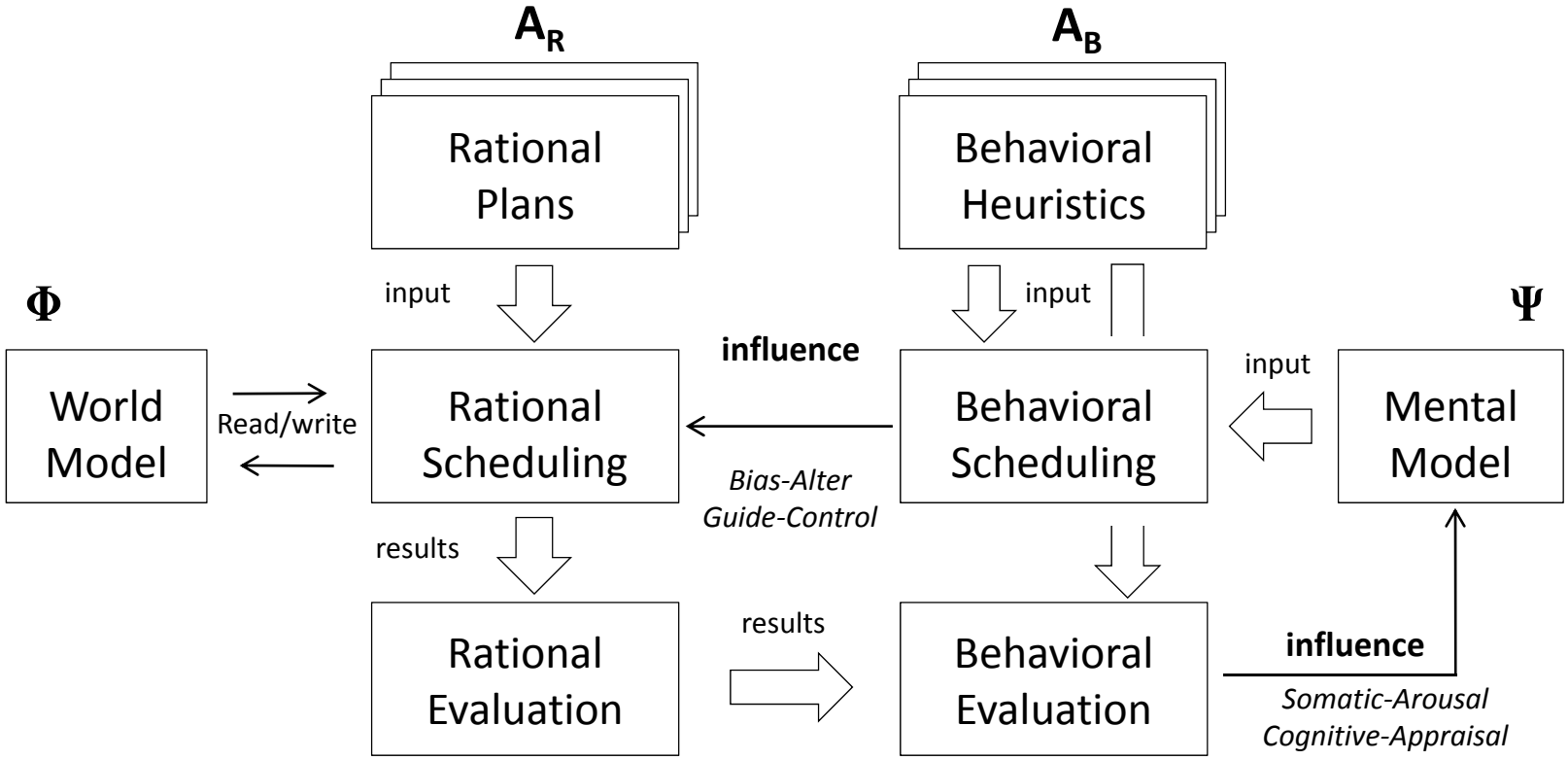
General R&B framework



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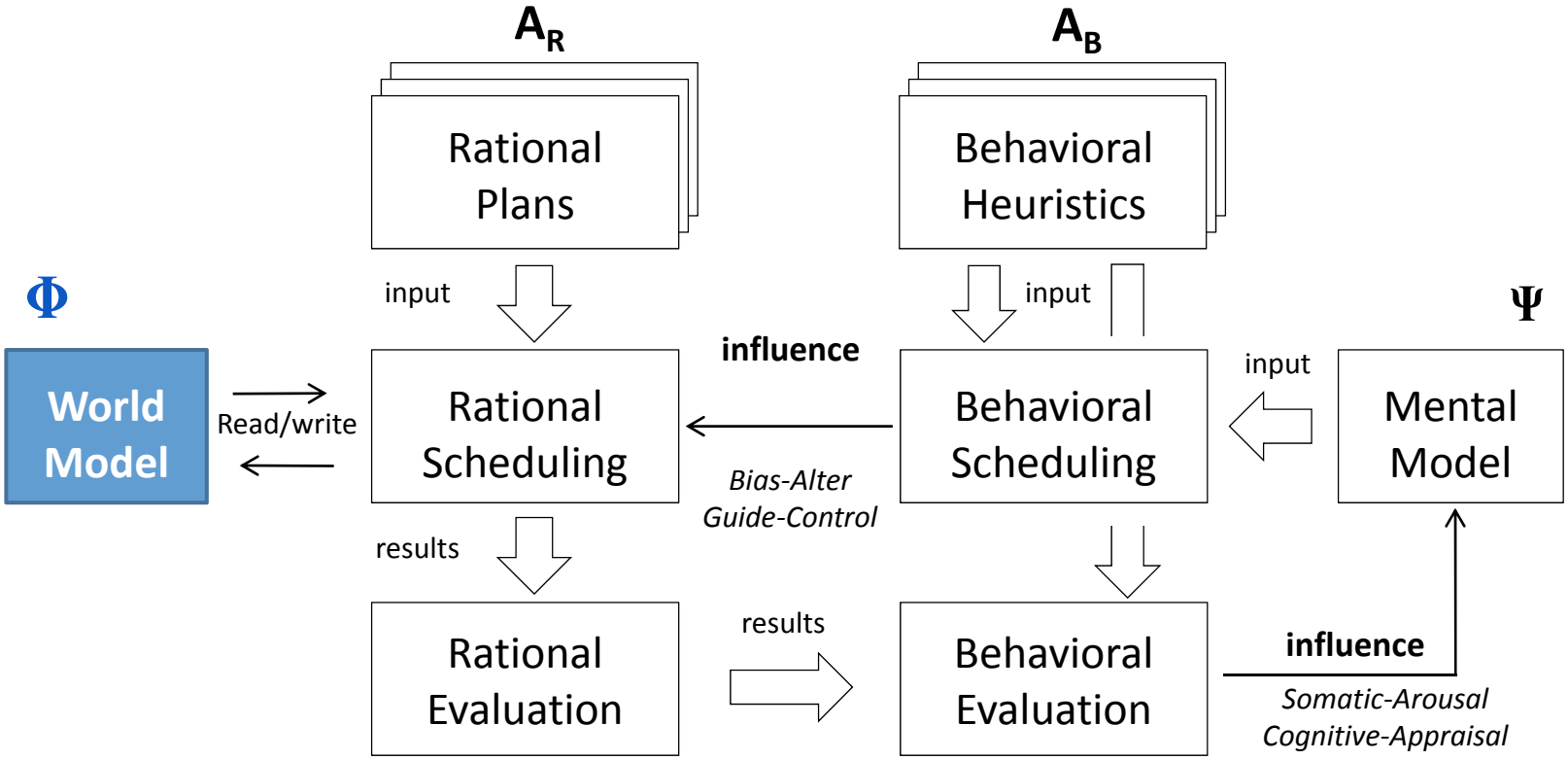
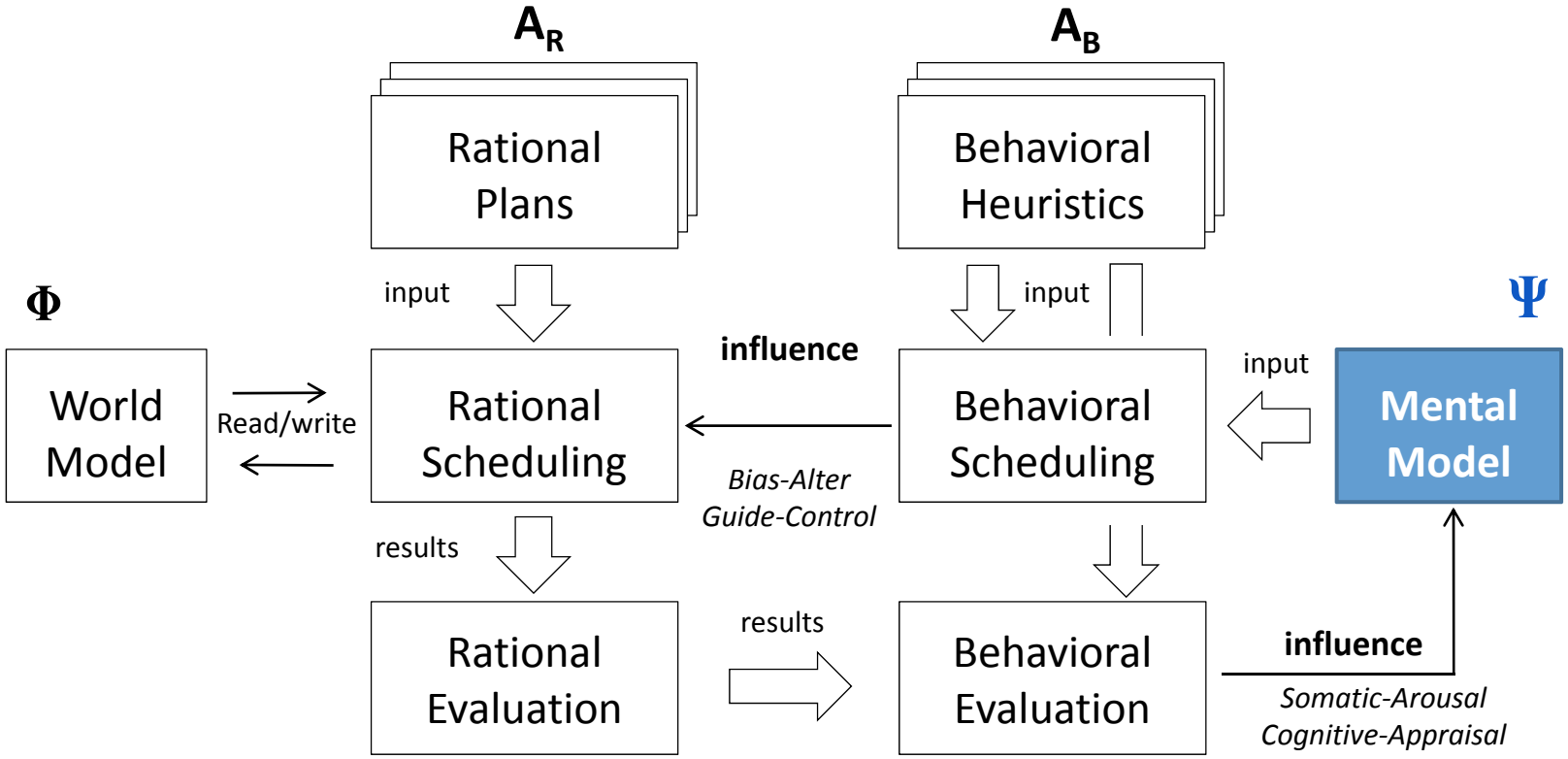


- Structure of the application
- Objects of the application
- Actions that can be performed on objects

[Bouchet & Sansonnet, 2009]

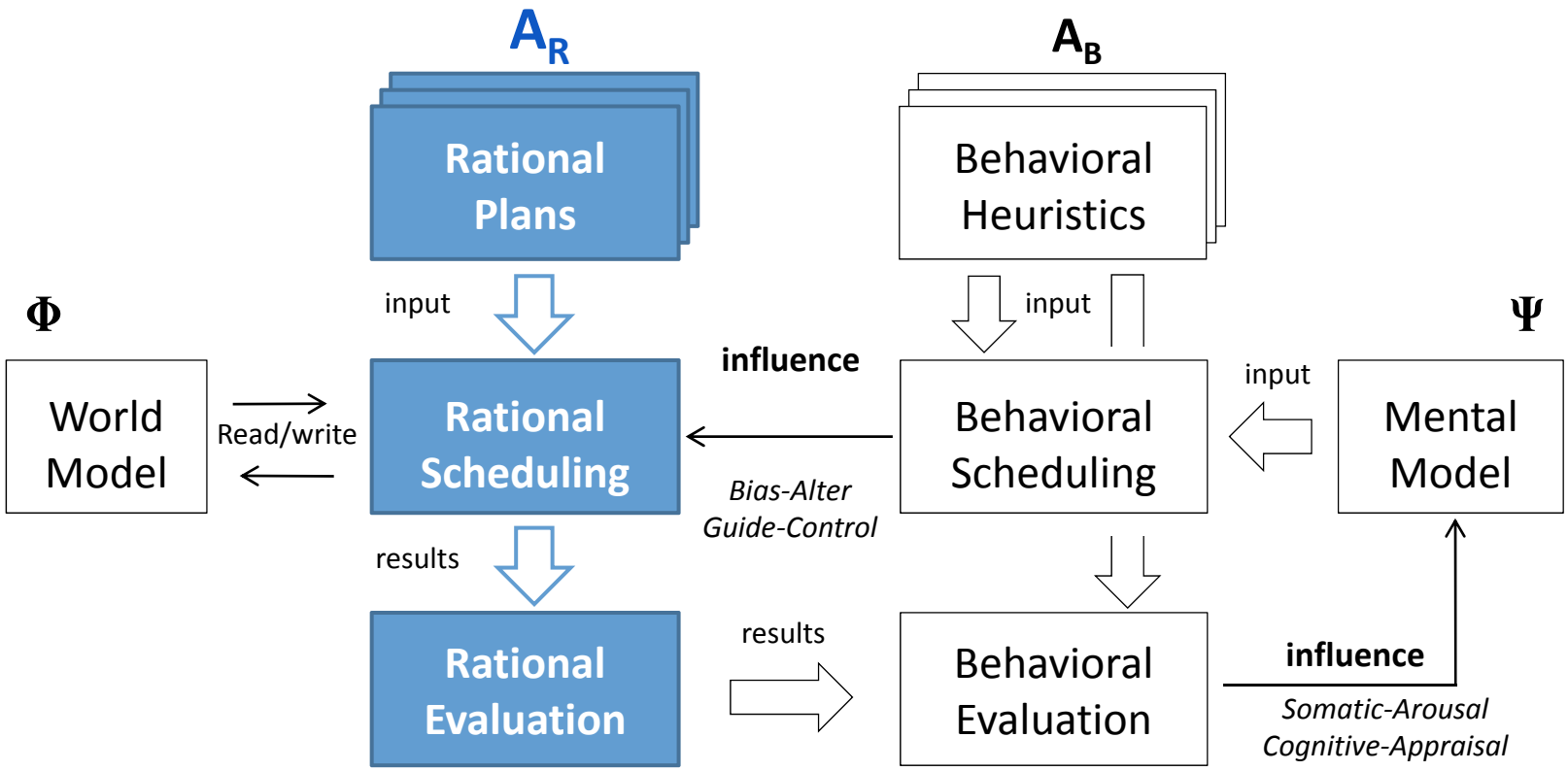
General R&B framework



- Symbolic representation
- Some static and dynamic parameters
- Same formalism as Φ

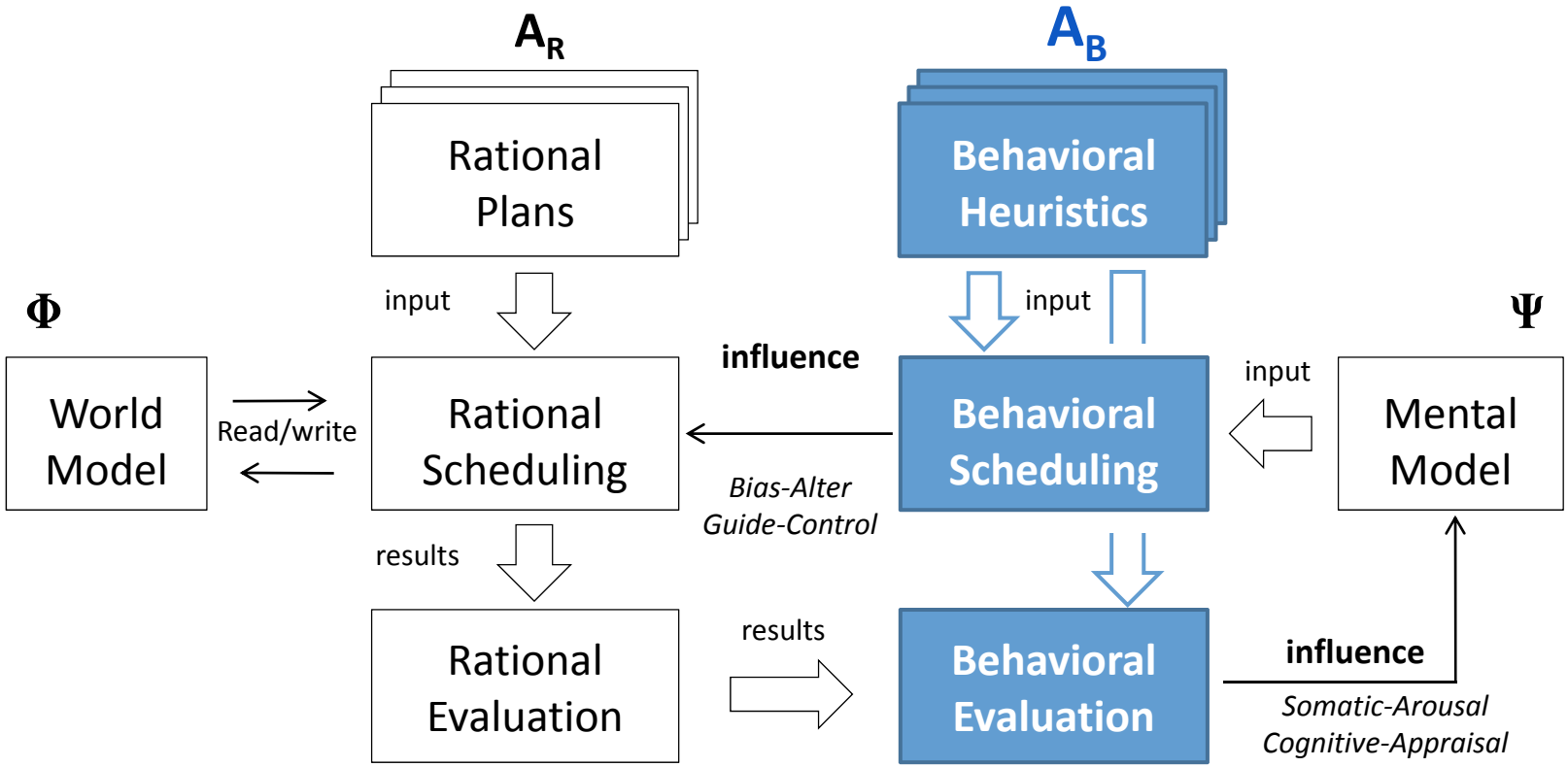
[Bouchet & Sansonnet, 2009]

General R&B framework



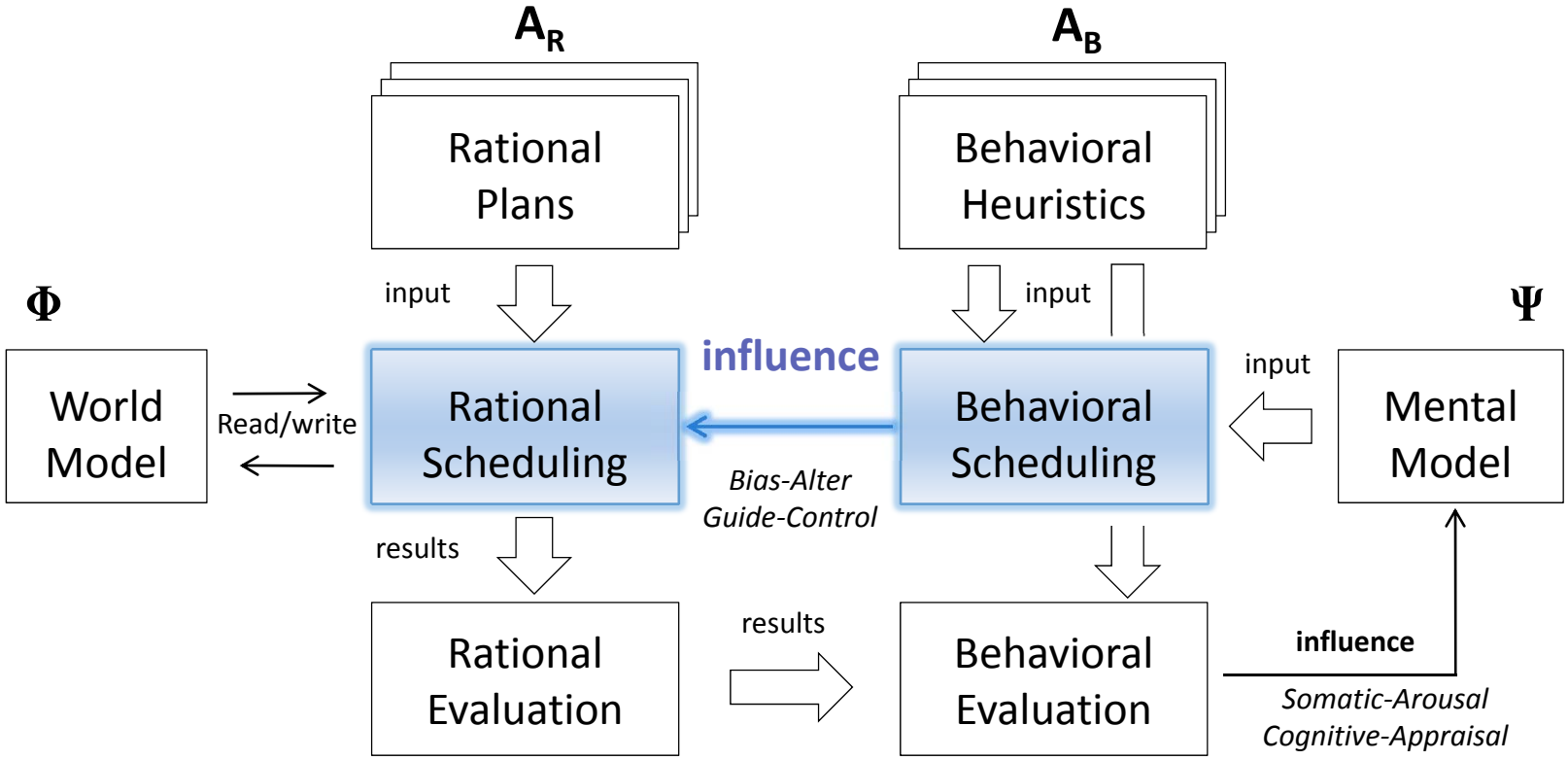
- A_R builds, chooses and executes plans π
- S_R selects actions in current plan π_i to execute on Φ
- E_R evaluates the results of the chosen action α_i to update scheduling

General R&B framework



- A_B executes heuristics h according to the current mental model Φ
- S_B **influences** the selection process of actions in current plan π_i
- E_B **influences** the evaluation of the execution of α_i and updates Ψ

General R&B framework



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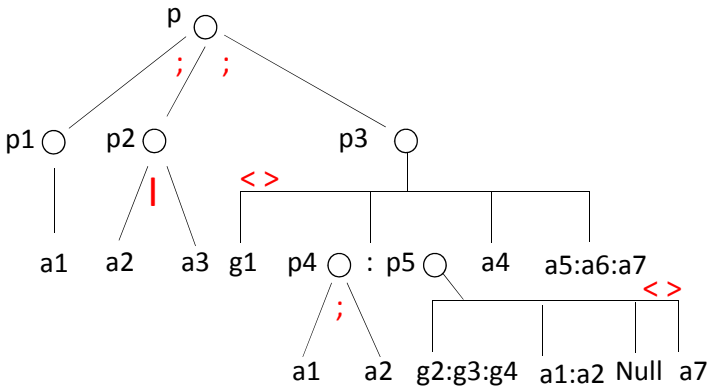
Actions and plans in the R&B framework

Traditionally, a plan π_i = tree structure [Allen et al., 1991], where nodes are:

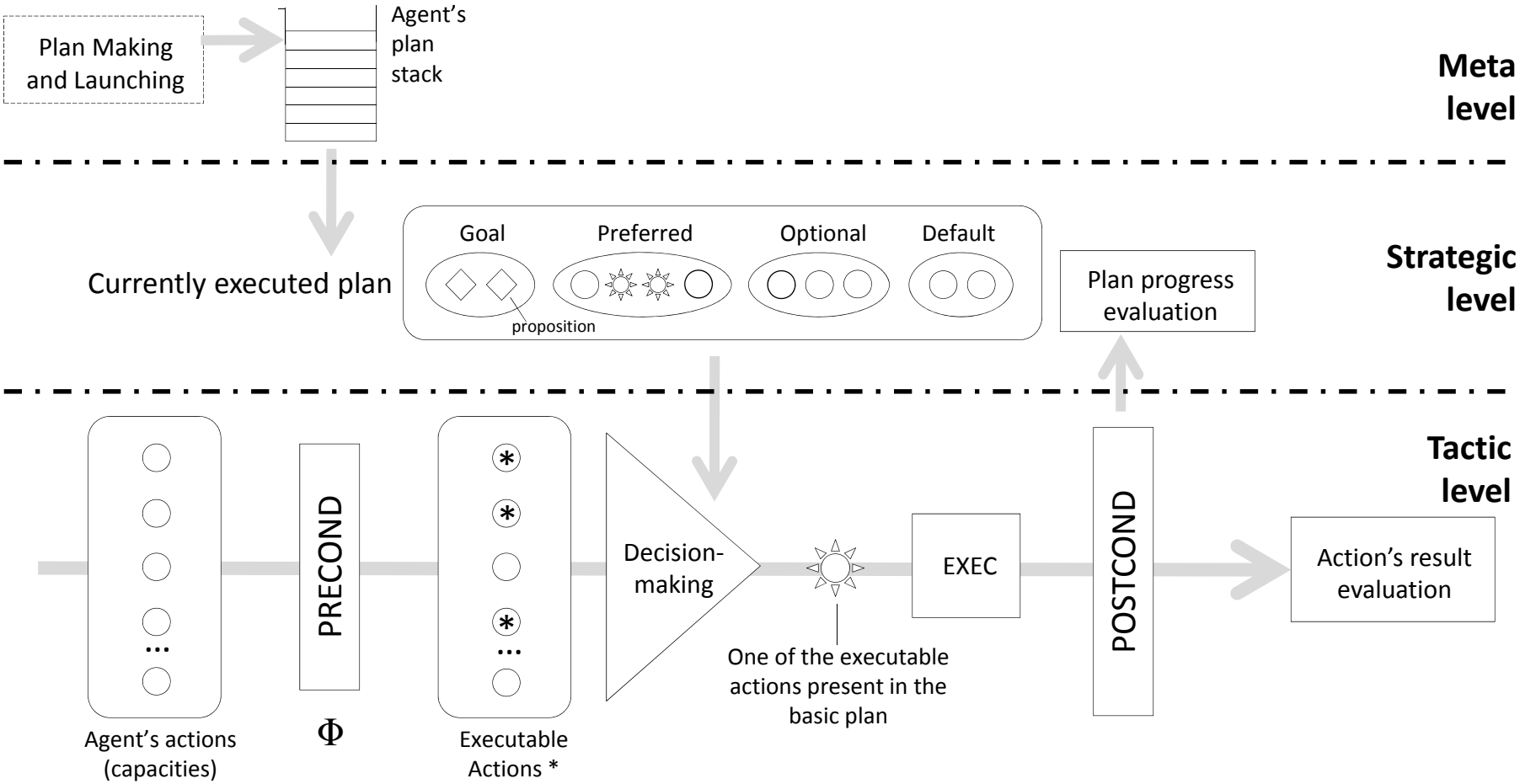
- An **identifier** p_i of an existing plan
- A **procedural** operator:
  - **Seq** $a_1;a_2$ = do a_2 when a_1 is done
  - **Alt** $a_1|a_2$ = only a_1 or a_2
  - **Par** $a_1||a_2 = (a_1; a_2)|(a_2; a_1)$
  - **Case** precond→a_1 = a_1 if precond
- A **declarative** plan $<S_g, S_p, S_o, S_d>$:
  - S_g = set of **goals**
  - S_p = **prefered** subplans
  - S_o = **optional** subplans
  - S_d = **default** subplans

p = p1;p2;p3 // sequence of subplans p1,p2,p3
p1 = a1 // terminal action
p2 = a2|a3 // random choice between a2, a3
p3 = <g1, p4:p5, a4, a5:a6:a7> // a declarative plan
p4 = a1;a2
p5 = <g2:g3:g4, a1:a2, Null, a7>

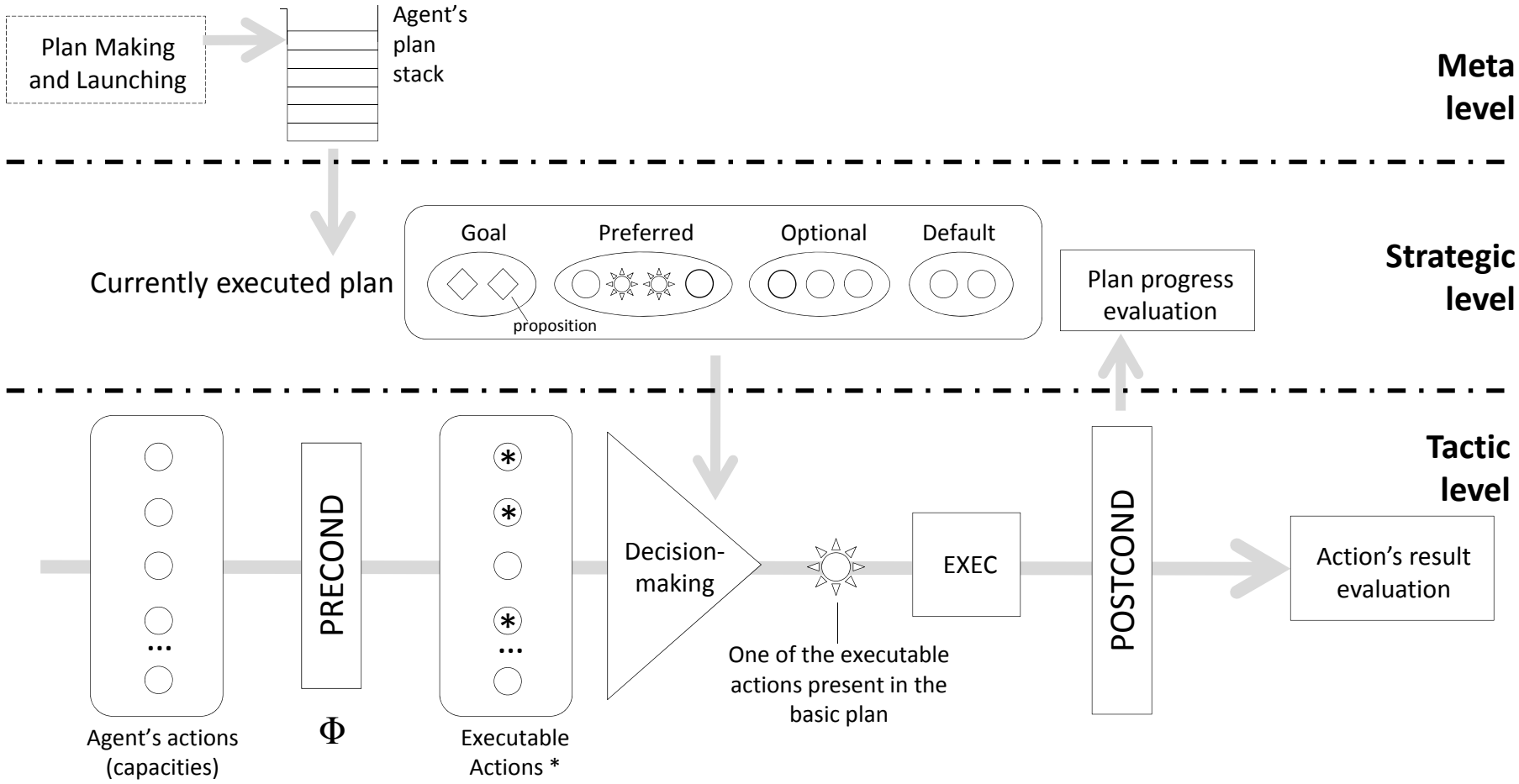


p = a1;a2|a3; <g1, a1;a2:<g2:g3:g4, a1:a2, Null,a7>, a5:a6:a7>

Rational execution of a plan



Possible influences operators

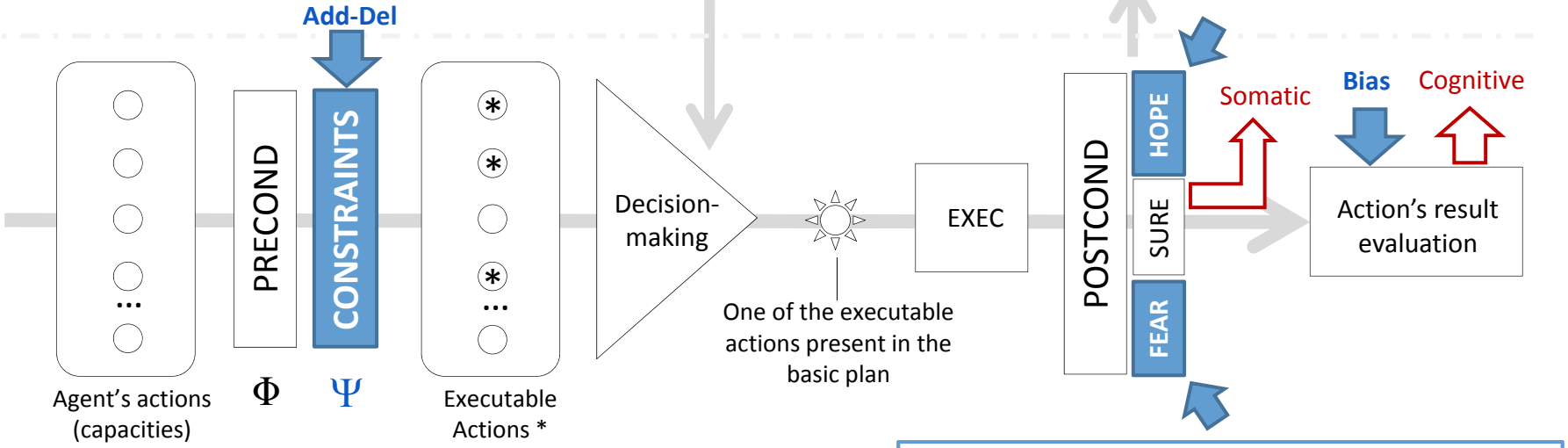


Constraint over influence operators: not to alter rationality (e.g. no deletion of a goal)
Influence operators are possible at the three levels

Tactic influences operators

1. Adding psychological or social pre-constraints
(e.g. « do not kill another agent, even if possible »)

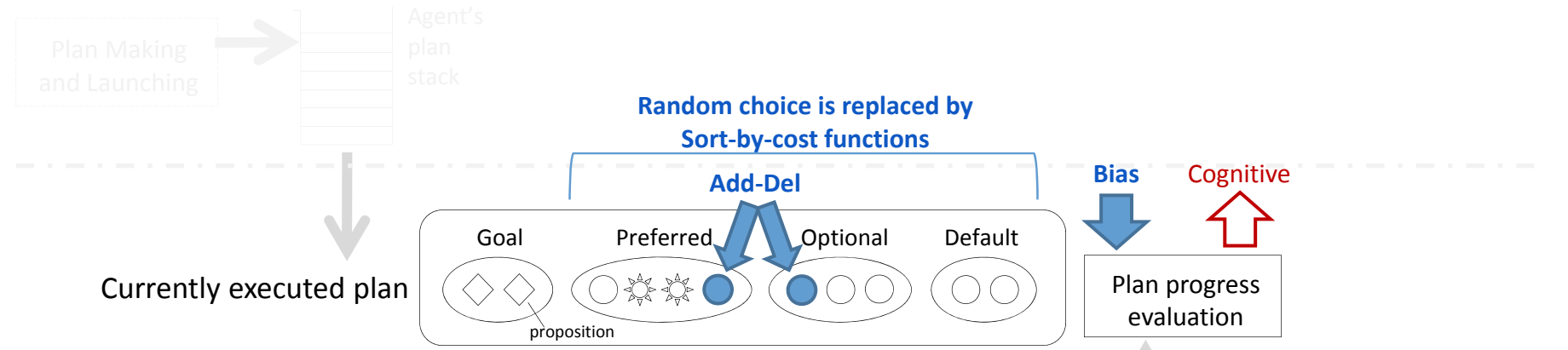
2. Annotating postconditions
α_i have certain postconditions (SURE) that are rational, but also some potential positive (HOPE) or negative (FEAR) ones



3. Reacting to postconditions
Can depend of the current psychological state Ψ_t or modify it (e.g. arousal can bias the evaluation)

Tactic level = current action

Strategic influences operators



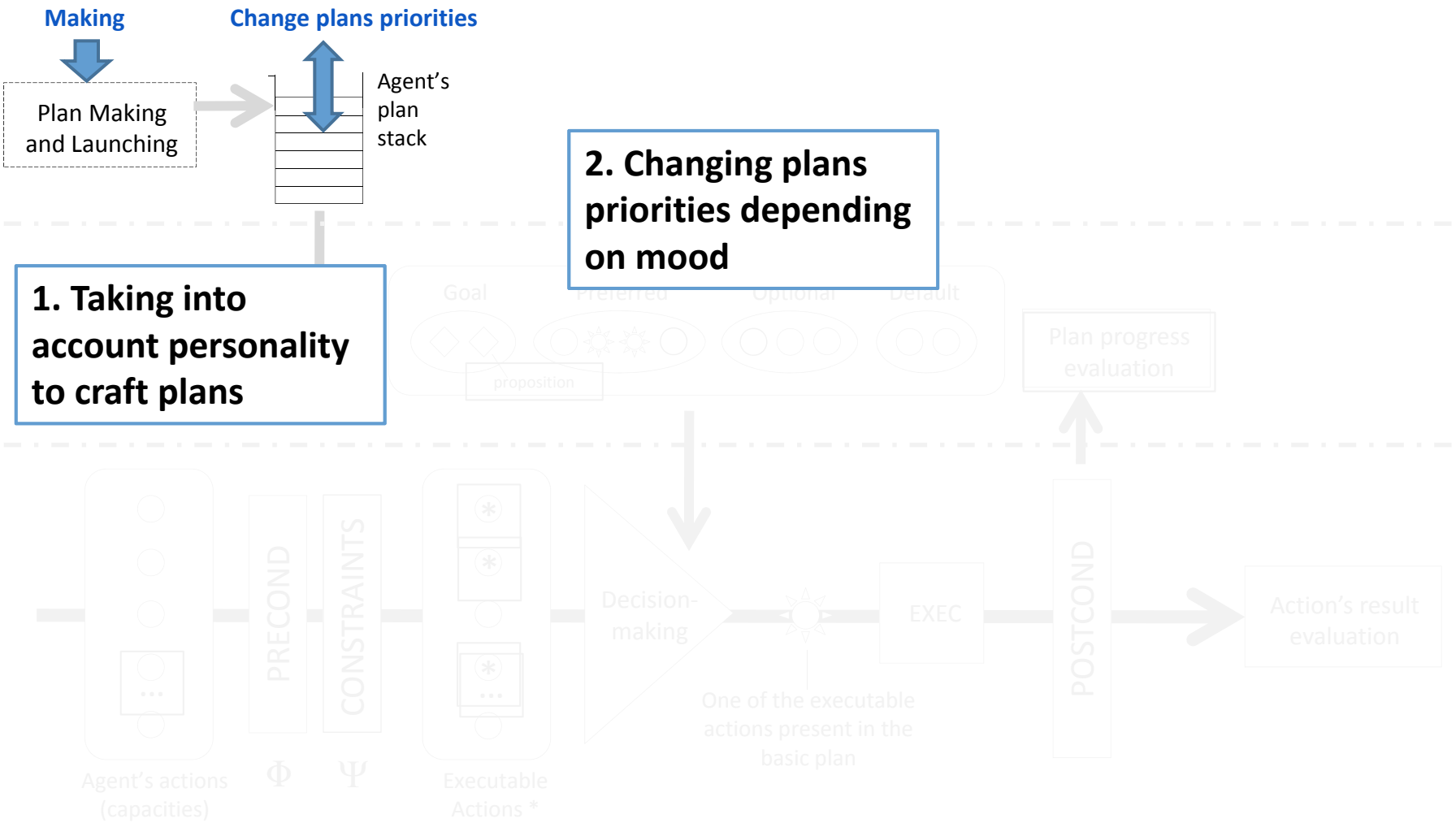
1. Replacing random choices
(e.g. procedural operators like alt and par)

2. Adding/deleting actions in S_p, S_o or S_d
(e.g. « sing a happy tune when action is done », « delete a disliked action »…)

3. Reacting psychologically to plan progression
Depending on current state Ψ_t

Strategic level = control and evaluation of plan execution

Meta influences operators



Meta level = plan making and priority between plans

Example: preferences and desires

- **Preferences:**
  - **Definition:** static or dynamic relationship leading to the choice of an action/plan/entity over another.
  - **Implementation:**
    - no alteration of plan static structure
    - use underdetermination of plans when alternatives are considered as equal
    - Ranking function of equivalent elements in the current plan

- **Desires:**
  - **Definition:** will of the agent to change the world, often implicit (the agent isn't aware of them) and impossible to refrain.
  - **Implementation:**
    - alteration of the plan static structure and dynamic execution
    - see [Bouchet & Sansonnet, 2009] for the particular case of « cognitive biases »

We considered here only the tactic influence operator consisting in annotating postconditions

Conclusion and further work

- **Formal framework** allowing to study the relationship between rational and behavioral processes
- **Influence operators** exist at different levels and offer a different way to implement classical concepts (e.g. preferences and desires)
- A **software toolkit** (implemented with *Wolfram Mathematica*) currently implements the full rational agent and the behavioral evaluator. Freely accessible at:

  `http://www.limsi.fr/~jps/research/rnb/rnb.htm`

- **Further work:**
  - Development of the behavioral scheduler for the toolkit
  - Implementation of some classical personality traits
  - Experimentation with human subjects to validate implemented behaviors