# “Méta-modèle d’agent pour la generation de comportements variables induits par des modèles cognitifs modulaires”

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   - Etat de l'art
   - Approche
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   - Caractéristique
   - Percept
   - Action
   - Opération
3. **Conclusions & perspectives**

## Entrainement

## Equipe en situation de crise


## Comportement variés

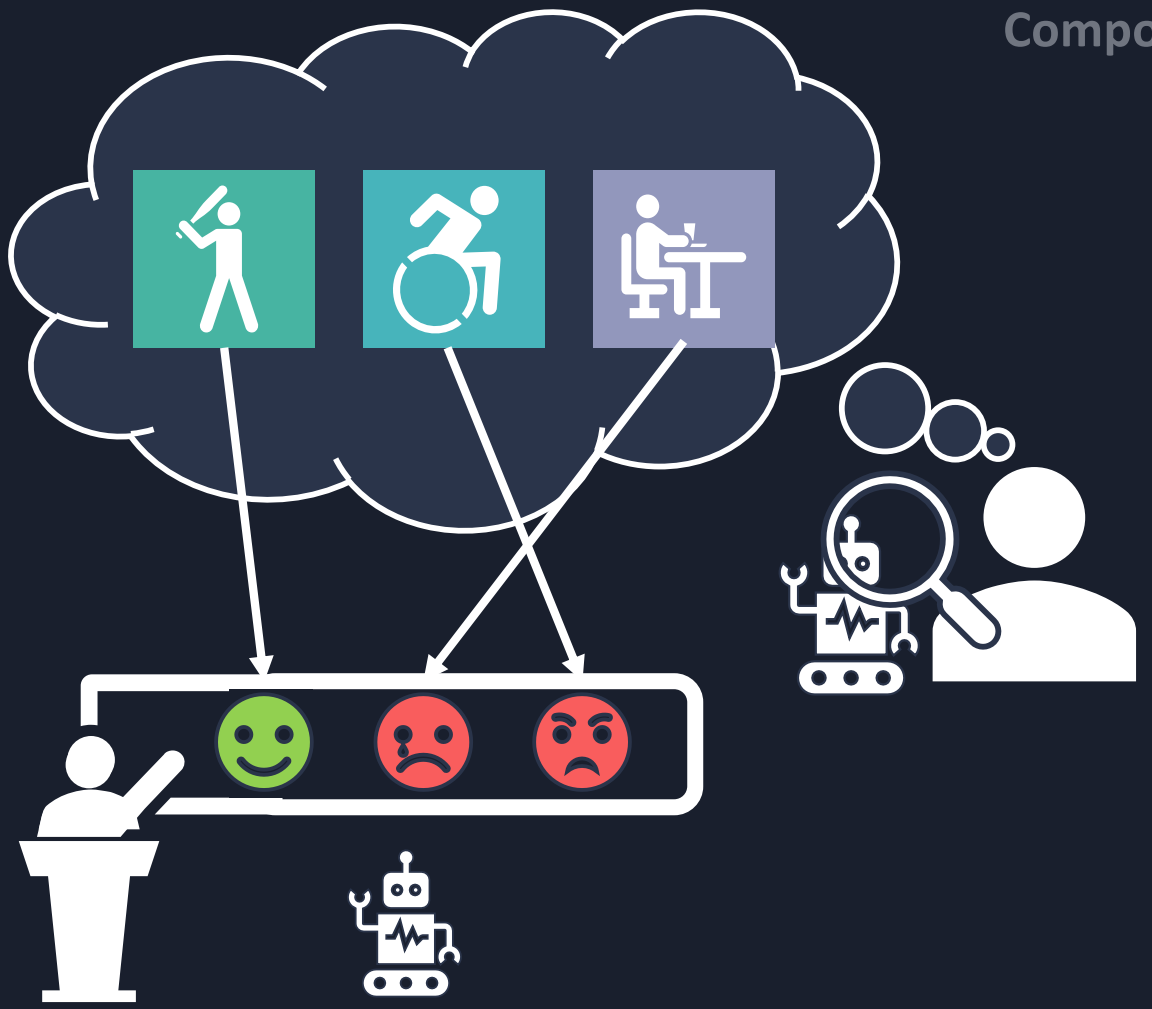
*Travaux similaires :*

- ***VICTEAMS*** *(Huguet, Lourdeaux, et Sabouret 2016)*
- ***Silverman*** *(Silverman et al. 2012)*
- ***V3S*** *(Barot et al. 2013)*

# Contexte

## Comportements

- Représentatifs
- Intelligibles
- Explicables



# Introduction

## Modèle cognitif

Modélisation simplifiée d'un ensemble de **processus psychologiques et/ou intellectuelles**

Processus cognitif

**➔ Induire des comportements intelligibles et explicables**

Modèle Cognitif Demary → Pro-Actif / Passif ; Communicant / Non-com.

**Demary, 2018:** *Évaluation cognitive du leader dans une dyade hiérarchique*

Modèle Cognitif Fadier → Activités limites tolérées par l'usage

**Fadier, 2003:** *Safe design and human activity : construction of a theoretical framework from an analysis of a printing sector.*

Modèle Cognitif Driskell → Vision tunnel ; Erreur exe. ; Réduction communication ; …

**Driskell, 2018:** *Teams in extreme environment*

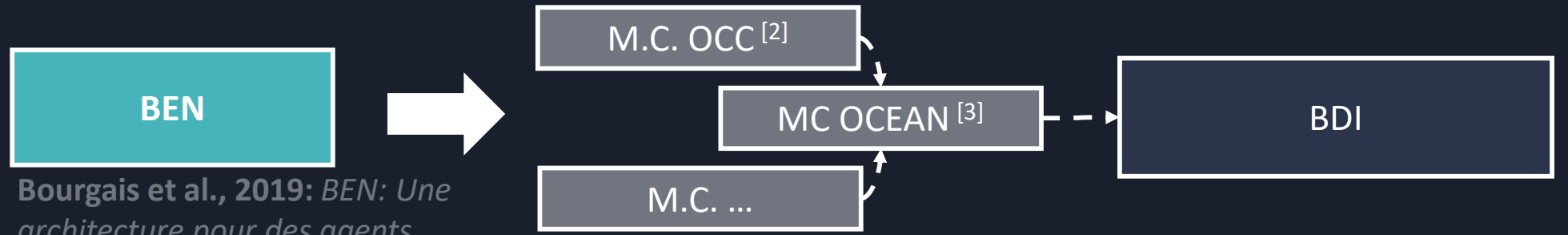
# Introduction

## Modèle d'agent

### Modèle d'agent hybride


**Huguet, Lourdeaux, et Sabouret, 2016 :** *Moteur de sélection de tâches*

### Modèle d'agent BDI[1]




**Bourgais et al., 2019:** *BEN: Une architecture pour des agents cognitifs […]*

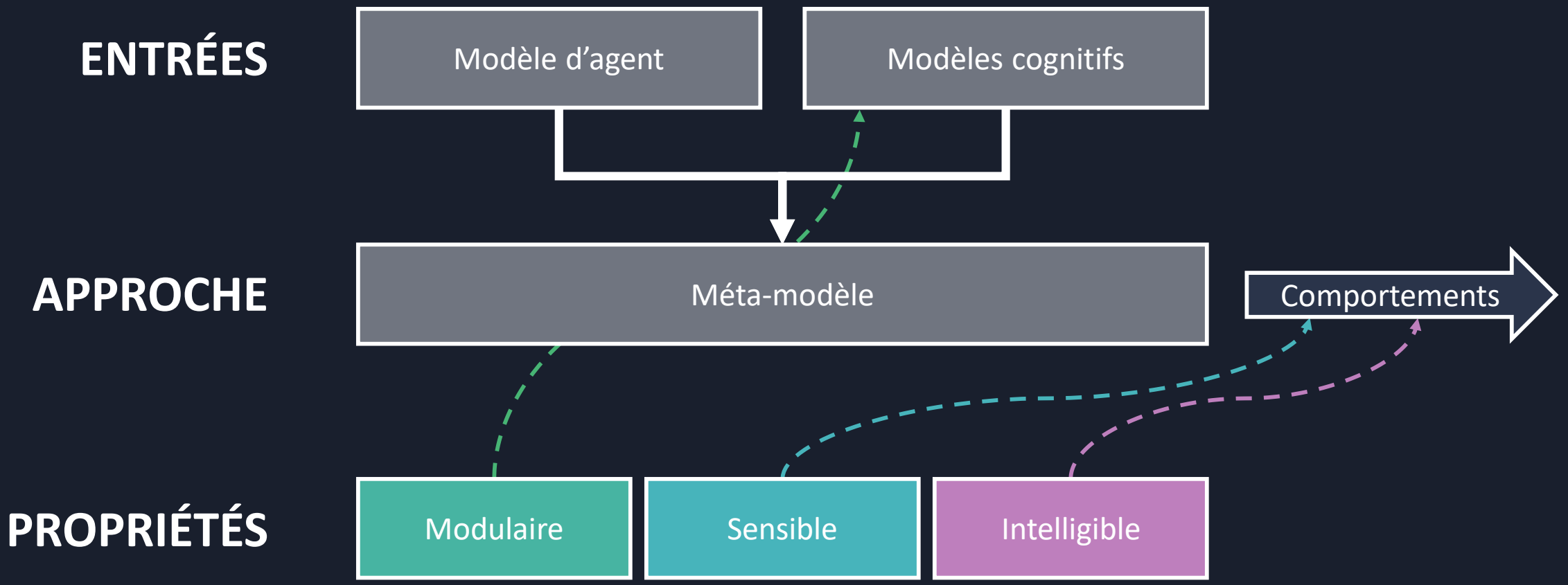
### Architecture cognitif

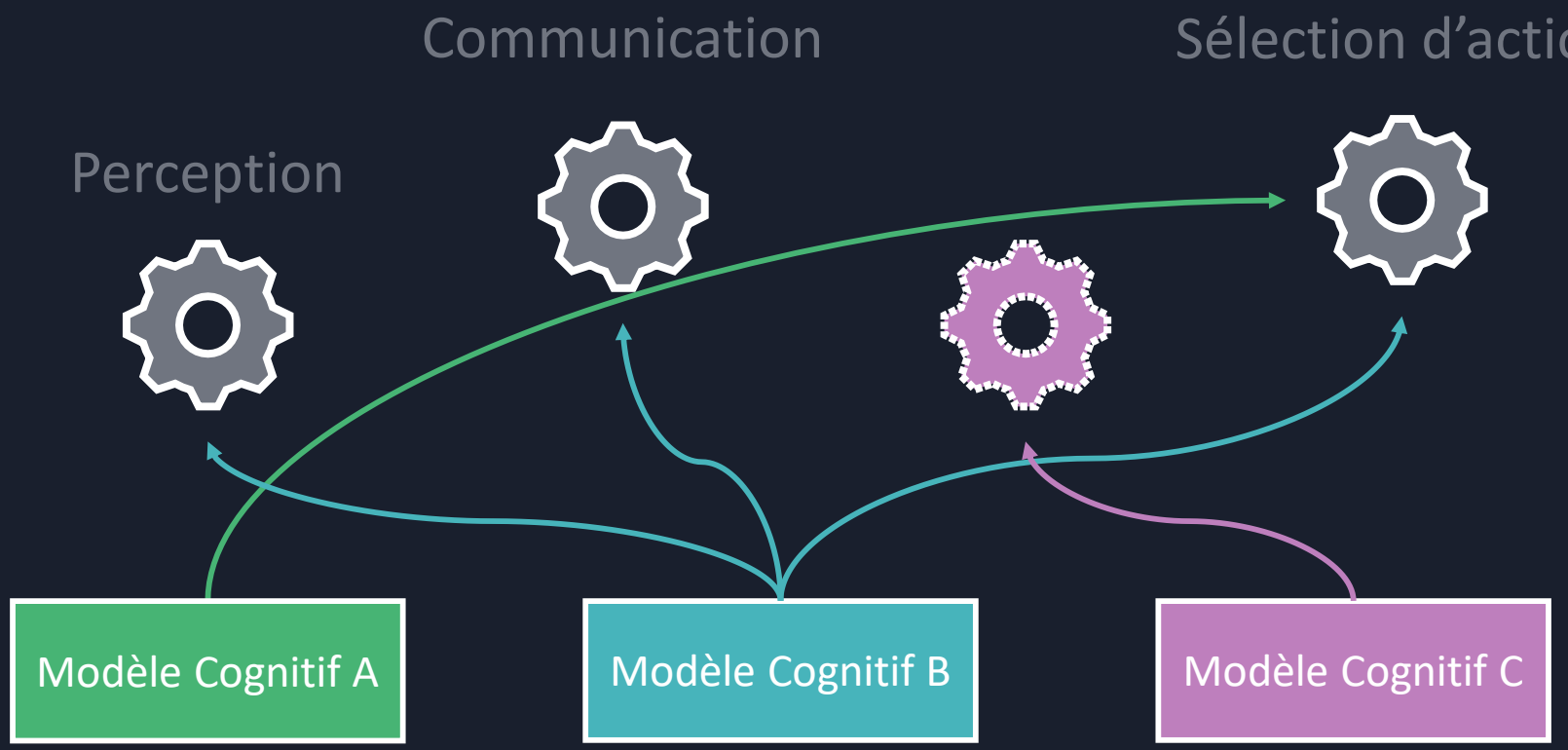

**Gratch & Marsella, 2004:** *A domain-independent framework for modeling emotion.*

**[1] Bratman 1987 :** *Intentions, Plans and Practical Reason […]*
**[2] Costa Jr. & McCrae, 2008 :** *The Revised NEO Personality Inventory (NEO-PI-R).*
[…]

*"All models are wrong but some are useful"*

*George Box - 1979*



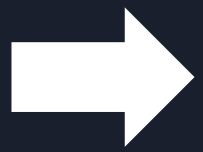



**Difficulté de généraliser l'intégration de modèles cognitifs en raison de la nature variée de leurs impacts**

# OPACK

## Originalité

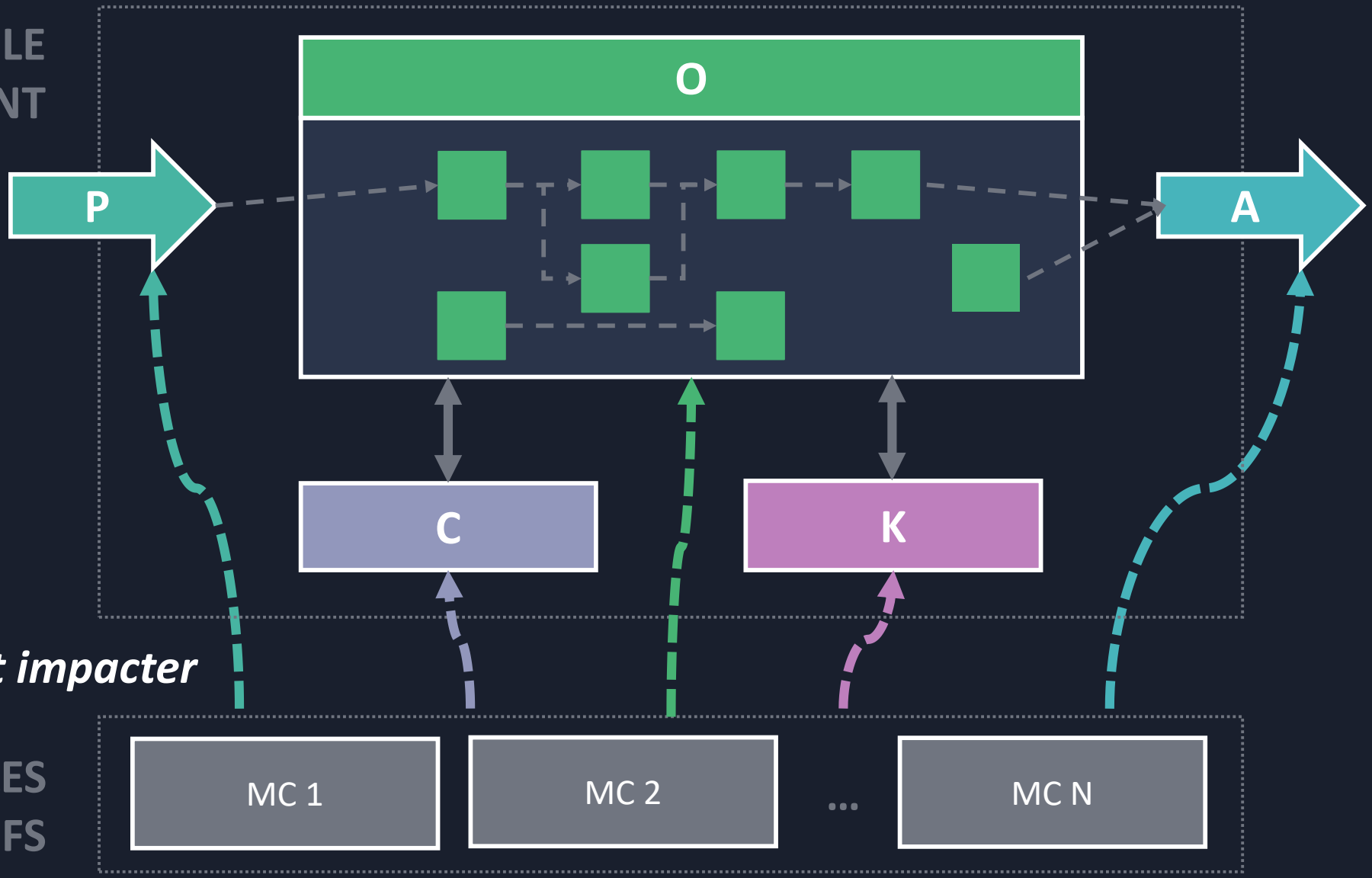
Les modèles cognitifs peuvent impacter modulairement



- **O** Opération
- **P** Percept
- **A** Actions
- **C** Caractéristiques
- **K** Connaissances

# OPACK

## Vue générale



**Monde**


```
#include <opack/core.hpp>
using namespace opack;
int main()
{
    auto sim = Simulation();
}
```

# OPACK

## Population de la simulation

```
auto agent    = agent(sim);
auto bathtub = artefact(sim);
auto patient = artefact(sim);
```

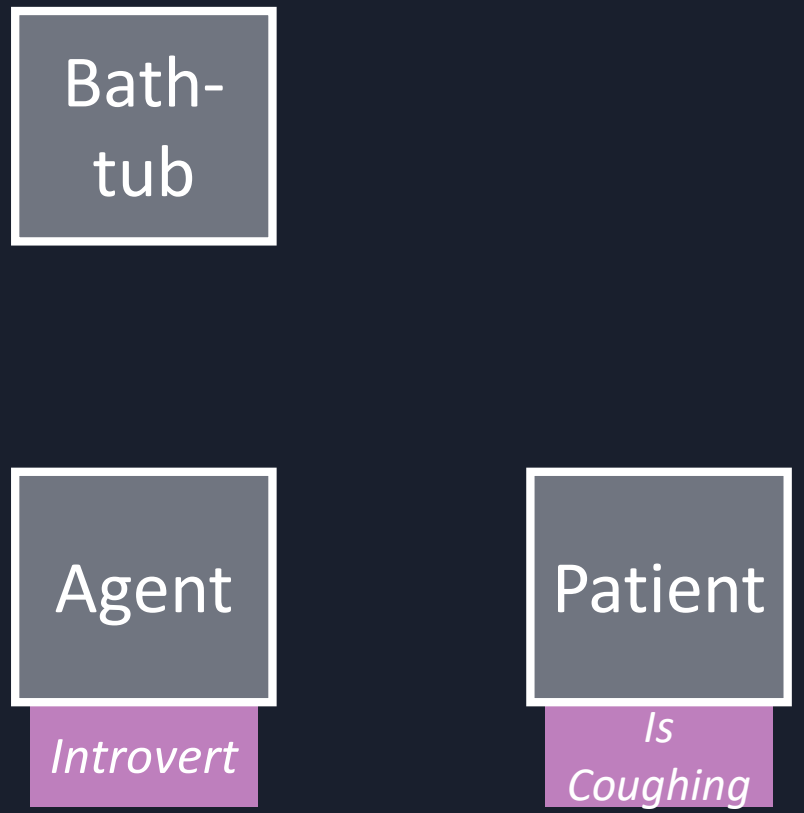
Bath-tub

Agent

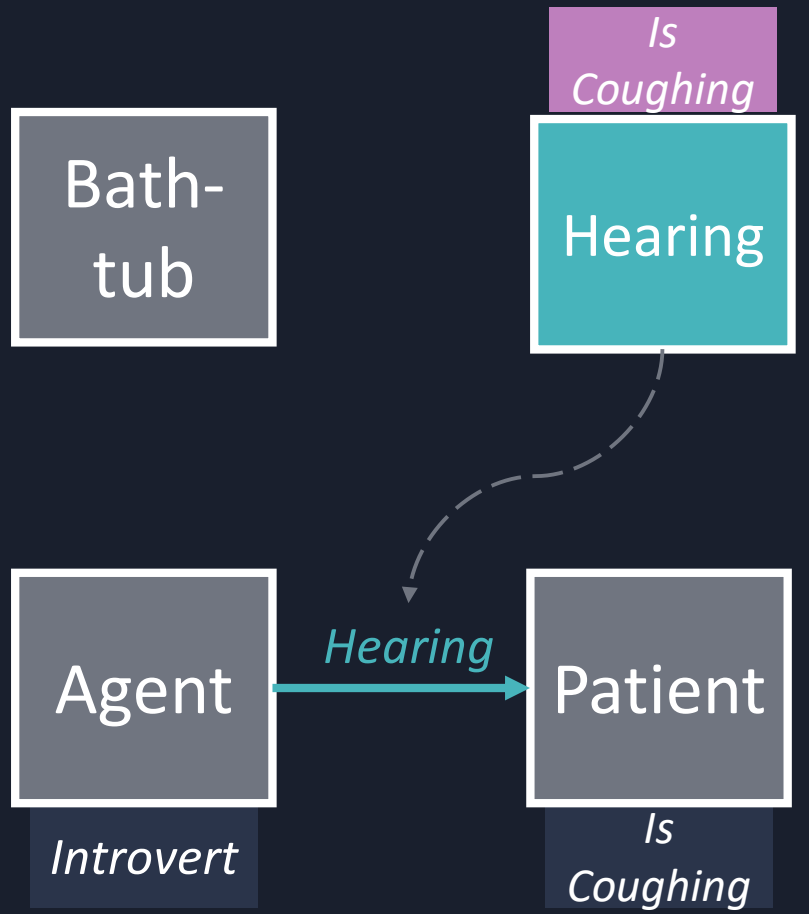
Patient

# C Caractéristiques

```
struct Introvert : {};
struct IsCoughing : {};

agent.add<Introvert>();
patient.add<IsCoughing>();
```

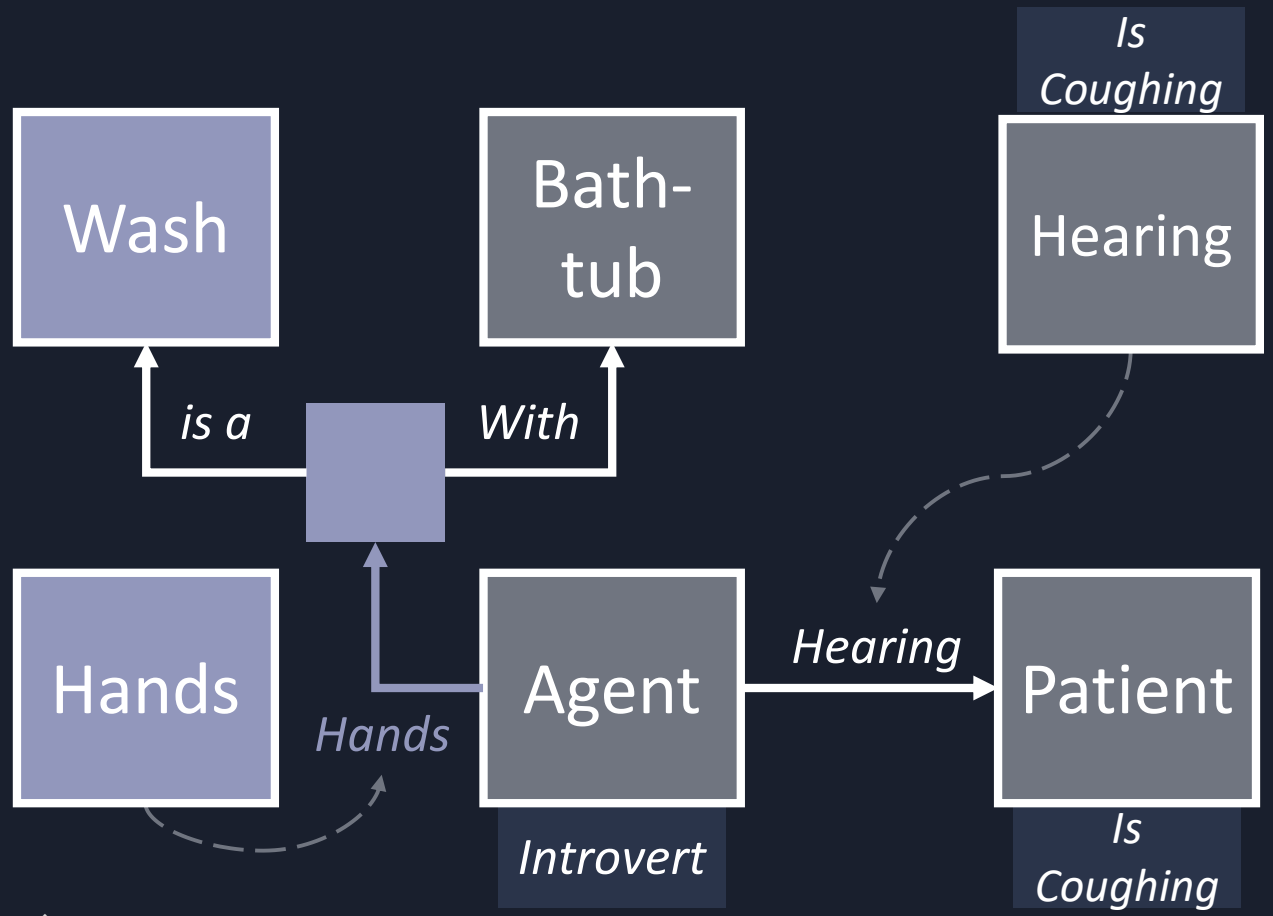


# P Percept



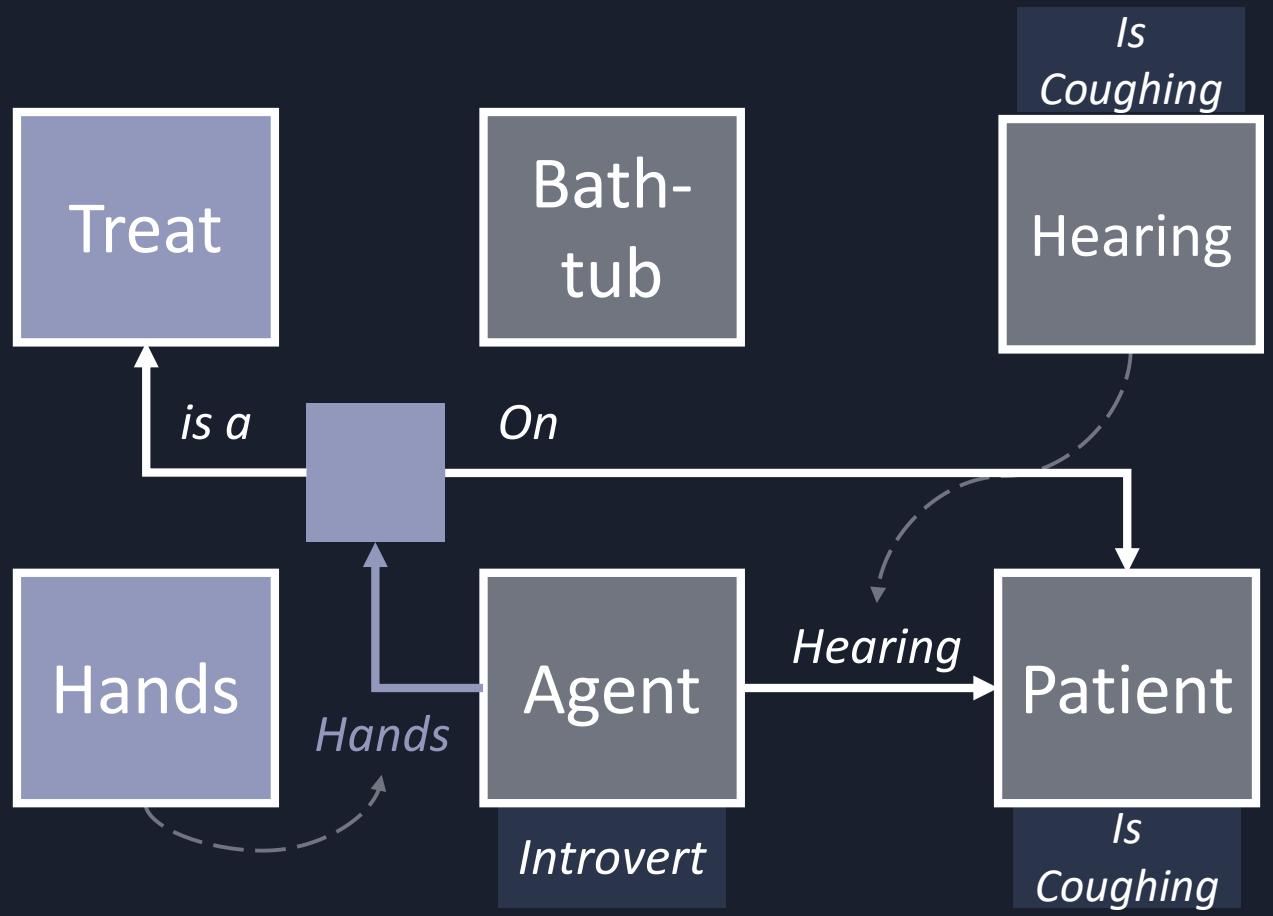

```
struct Hearing : Sense{};
reg<Hearing>(sim);
perceive<Hearing, IsCoughing>(sim);
perceive<Hearing>(agent, patient);
does_perceive<IsCoughing>(agent, patient); // true
does_perceive<IsCoughing>(agent, sink); // false
```

# A Action




```
struct Hands : Actuator{};
struct Wash  : Action{};
reg<Hands, Wash>(sim);
auto action = action<Wash>(sim)
                .add<With>(lavabo);
act<Hands>(agent, action);
```

# A Action

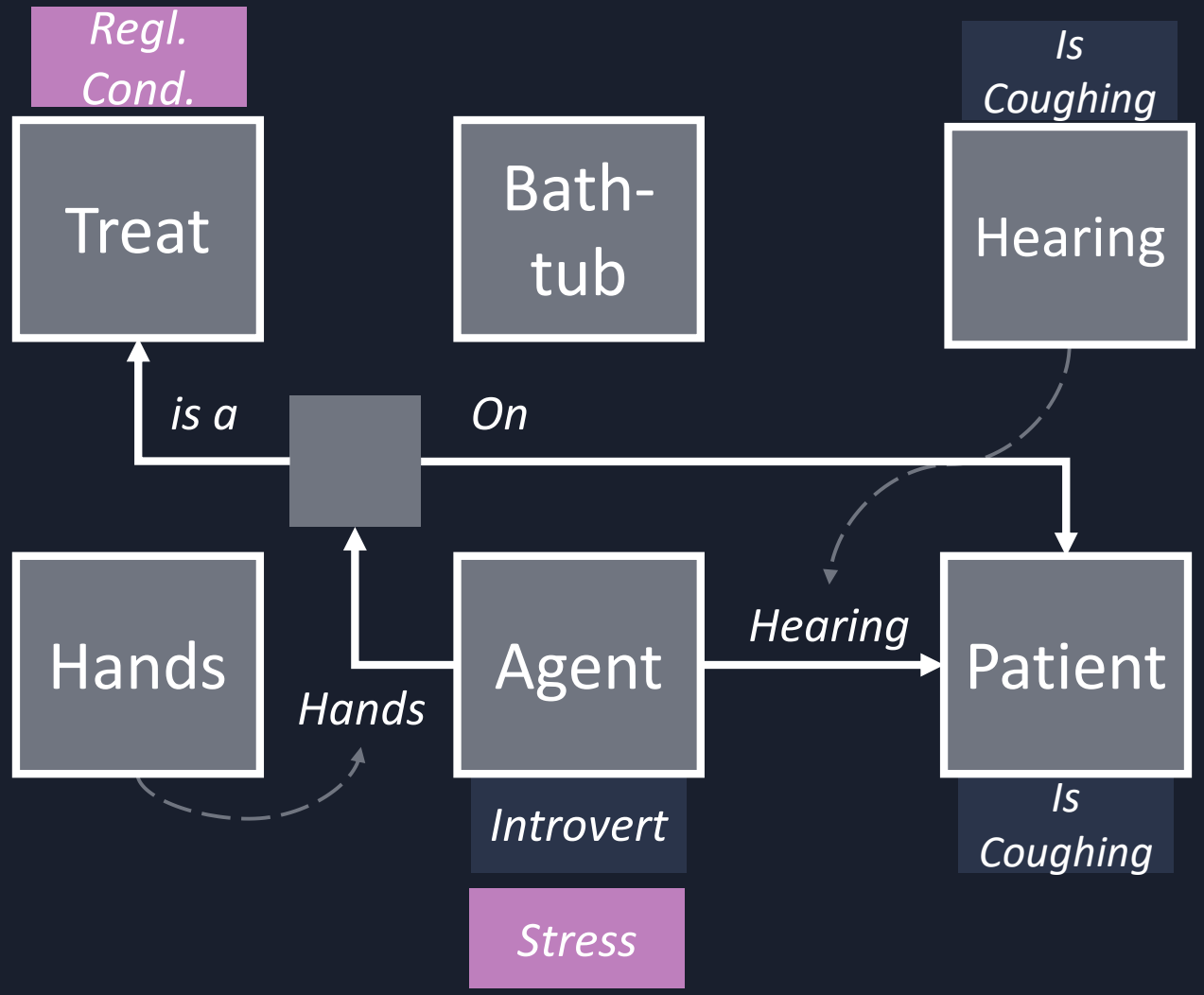



```
auto action = action<Treat>(sim)
                  .add<On>(patient);
act<Hands>(agent, action);
```

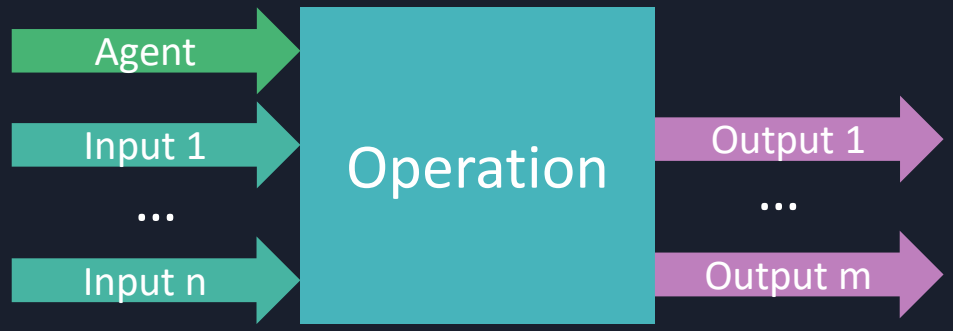
# OPACK

## Ajout de modèles cognitifs

```
struct Stress : {float value; };
agent.add<Stress>();

struct ReglementaryCond : {/*…*/};
action.add<ReglementaryCond>();
```



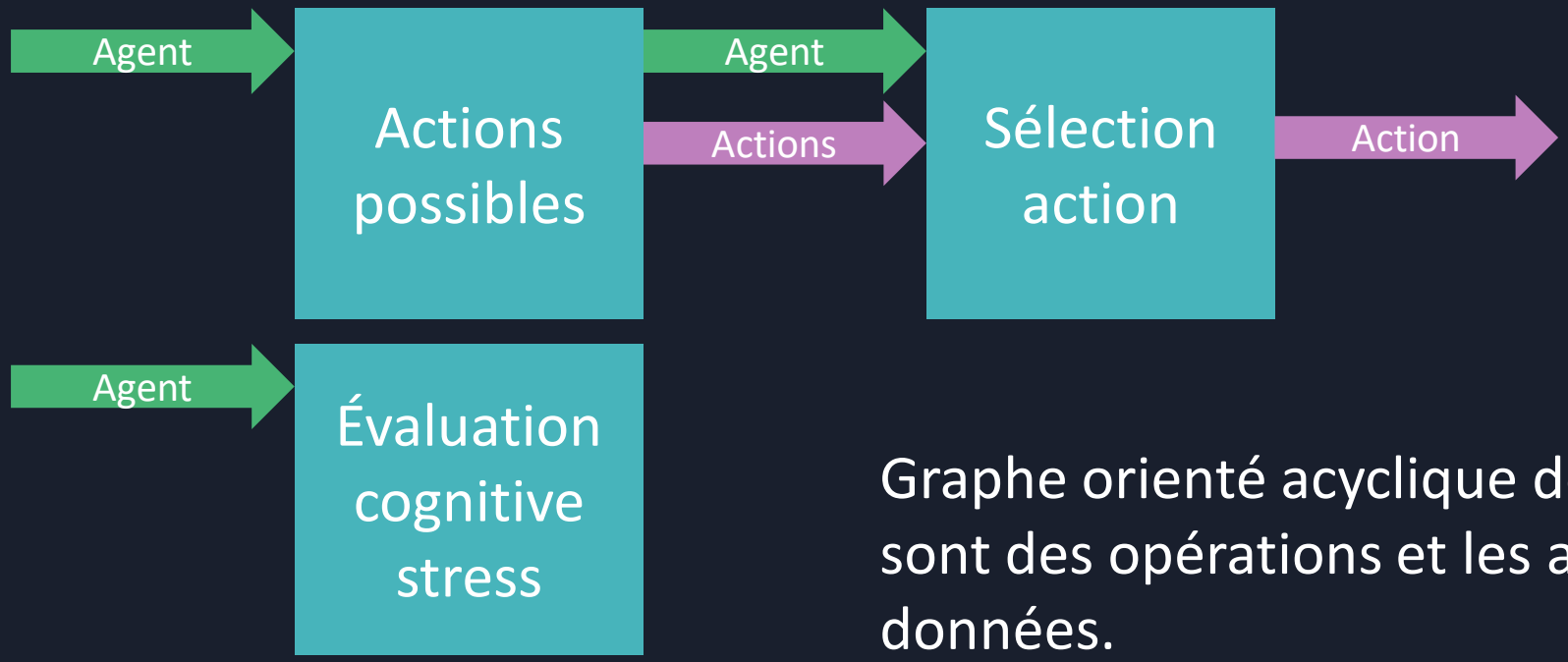
# O Operation




Une opération est une **fonction** avec des entrées et des sorties.

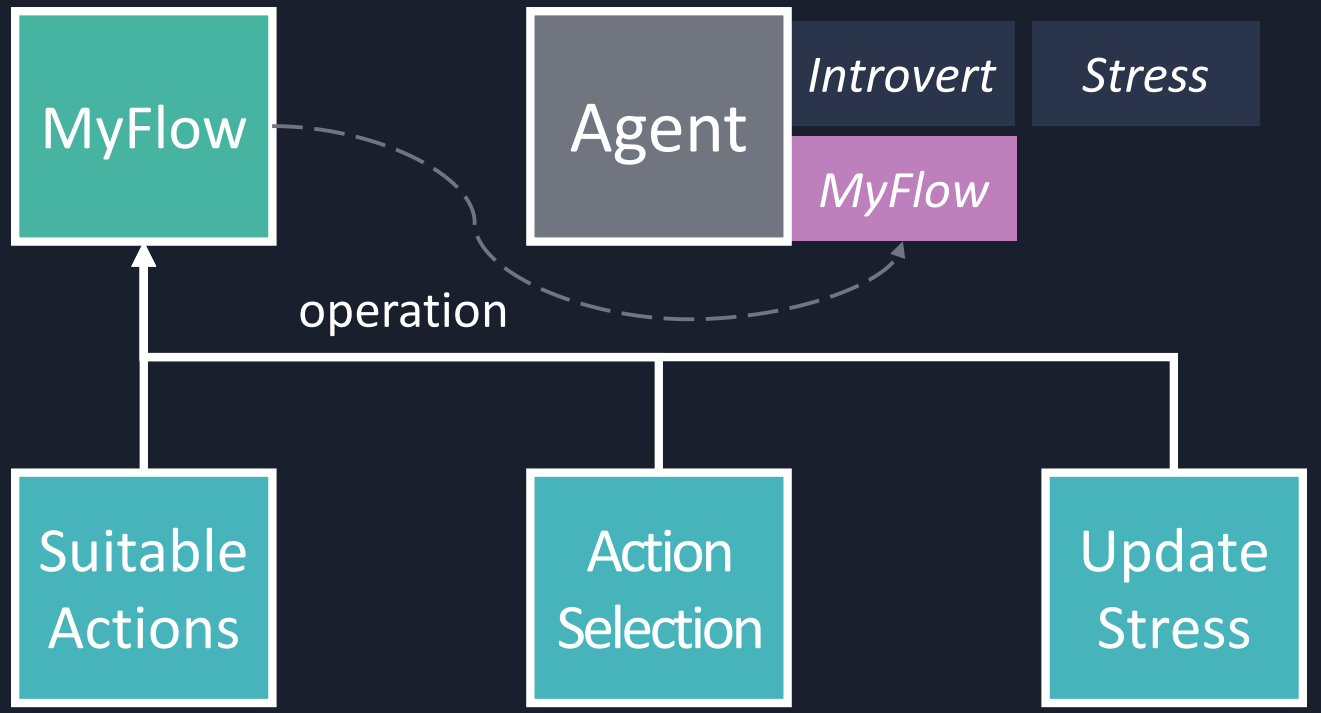
- Toujours accès à l'état de l'agent (**P**, **A**, **C** et **K**)
- $O$ … $*$ entrée(s) (issues d'autres opérations)
- $O$ … $*$ sortie(s)

# O Operation




Graphe orienté acyclique dont les sommets sont des opérations et les arcs des flux de données.

# O Operation

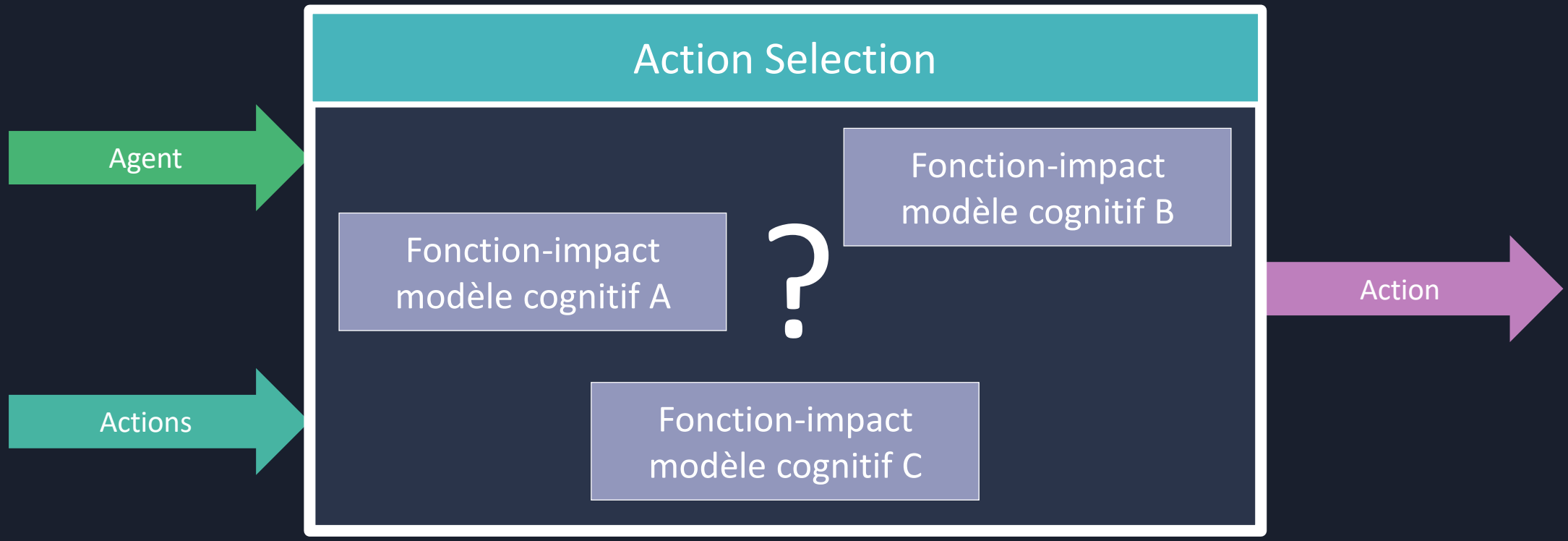



```
struct MyFlow : Flow {};

flow<MyFlow>(sim);
operation<MyFlow, SuitableActions, ActionSelection>(sim);
agent.add<MyFlow>();

operation<MyFlow, UpdateStress>(sim);
```

# O Operation

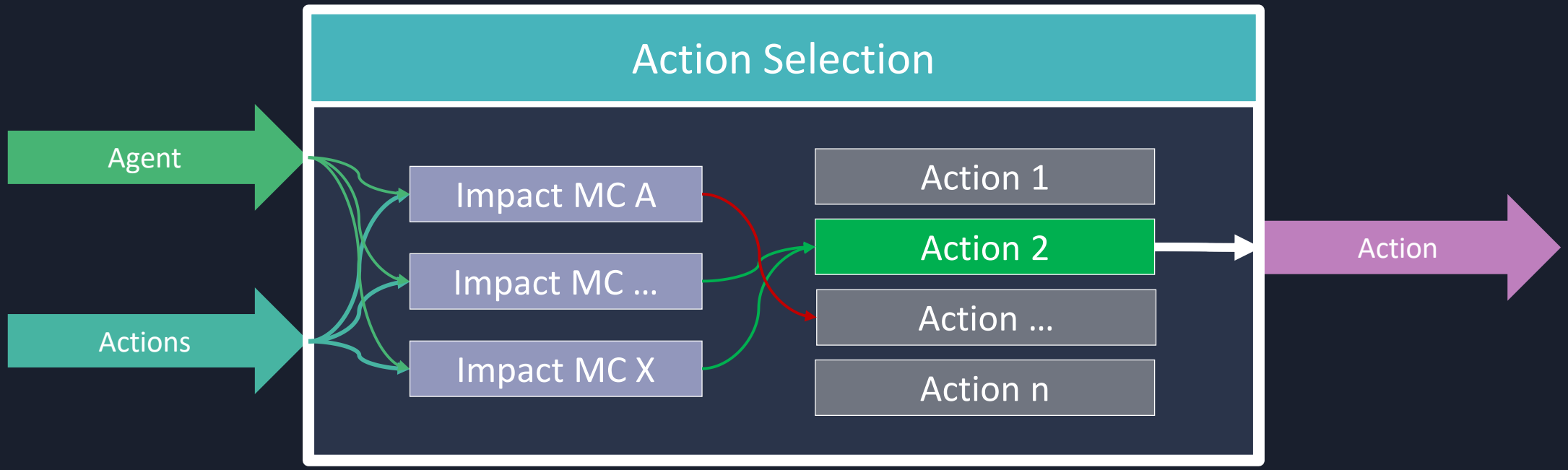

Comment modifier modulairement le fonctionnement d'une opération ?

# O Operation



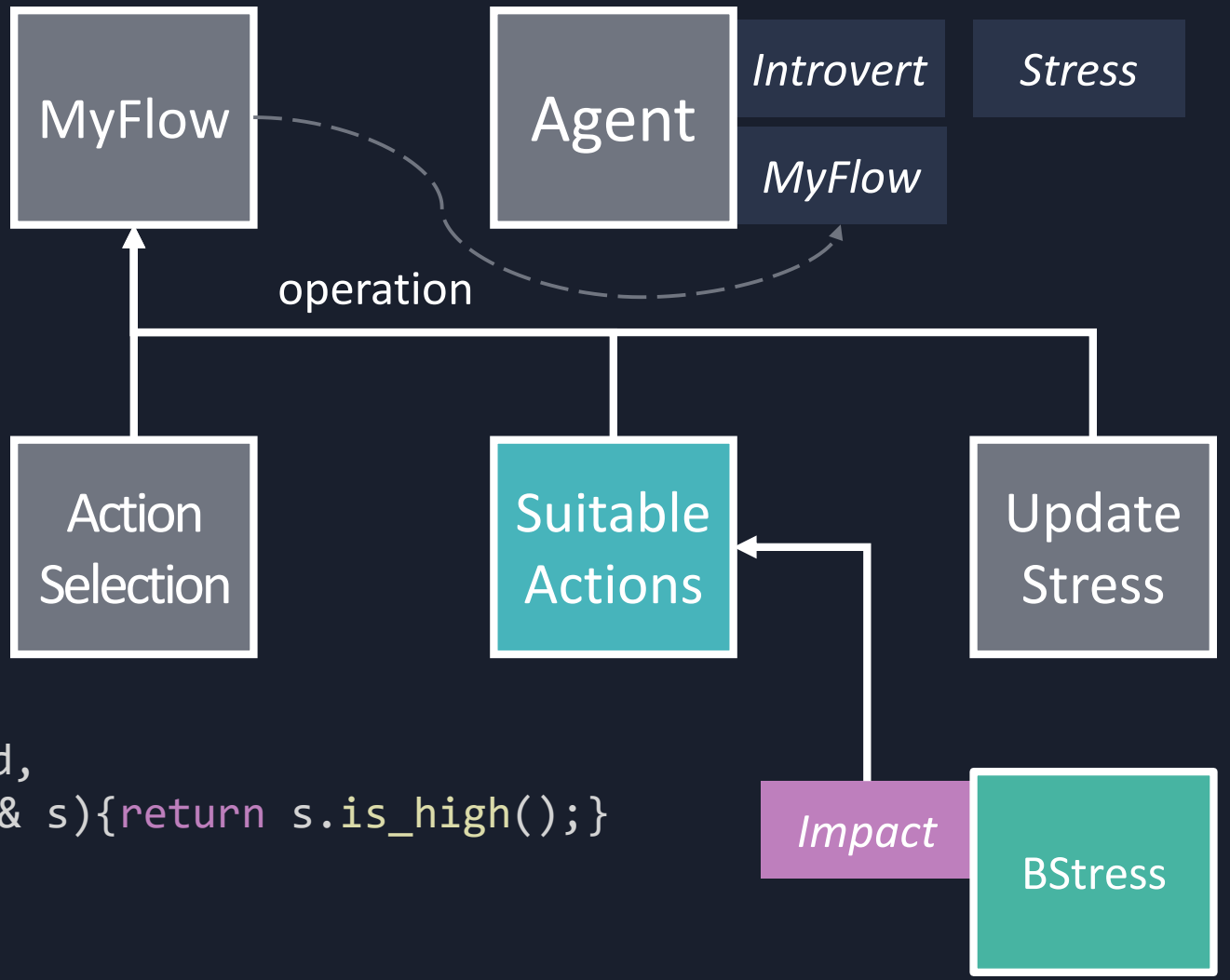

Une stratégie indique comment un ensemble de fonction-impacts est pris en compte

# O Operation




```
impact<ActionSelection, BStress>(sim,
    [](Agent_t agent, typename ActionSelection ::inputs& inputs){
        auto& actions = ActionSelection::get_choices(inputs);
        auto& graph   = ActionSelection::get_graph(inputs);
        for (auto& a : actions){ //… }
        return opack::make_outputs<ActionSelection>();});
```

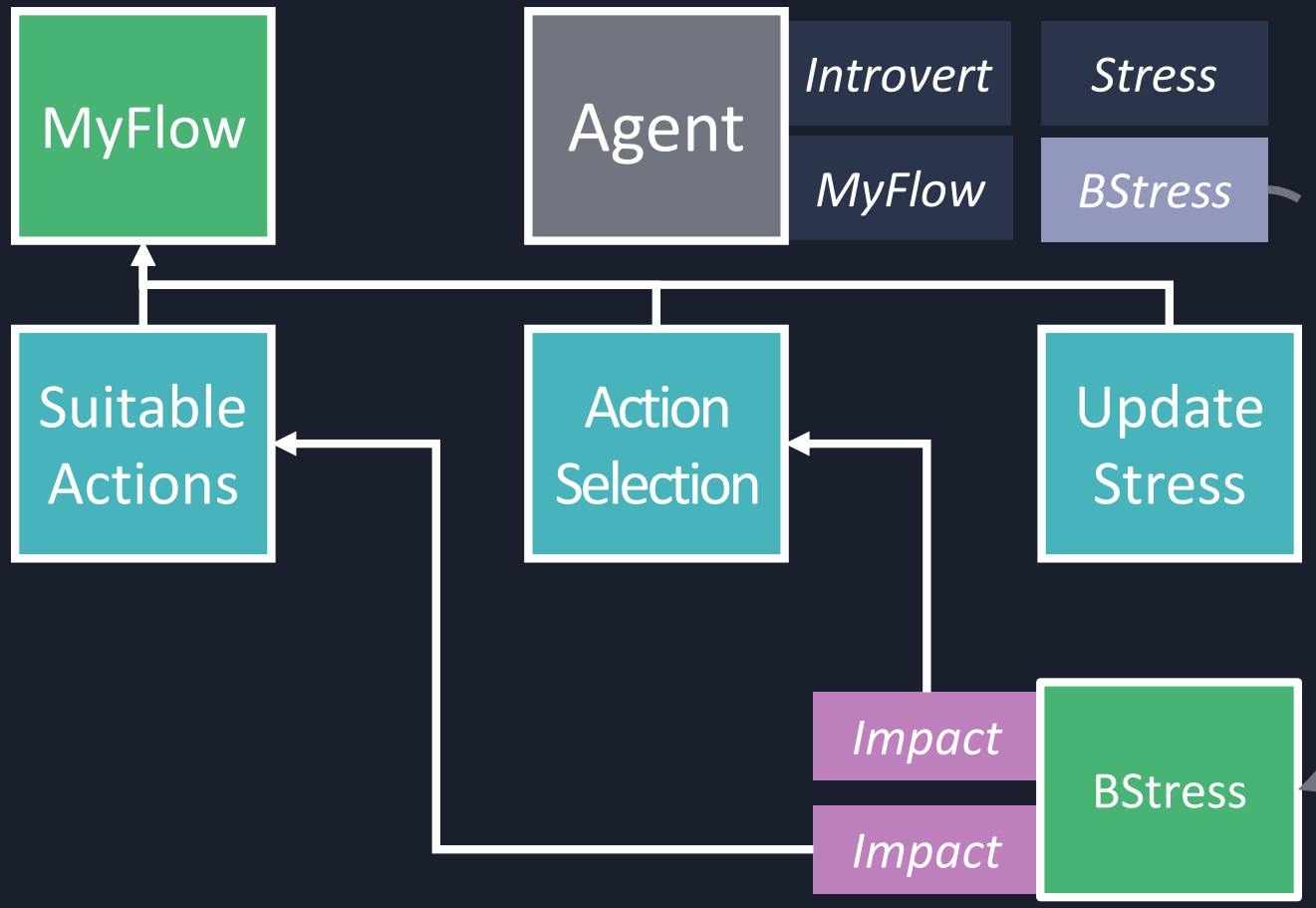
# O Operation




```
struct BStress : Behaviour {};

behaviour<Bstress, Stress>(world,
        [](Agent_t, const Stress& s){return s.is_high();}
);
```

# O Operation

```
//Passage de T à T+Δt
sim.step();
```

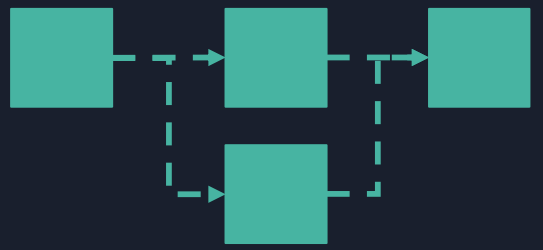



## Méta-modèle OPACK

- Génération de comportements induites par des modèles cognitifs modulaires
  - **Operation** : fonctionnement opération + composition d'un flux
  - **Percept** : définition de sens + capacités perceptives
  - **Action** : définition des actuateurs et des actions
  - **Caracteristics** : composition des entités
  - **Knowledge** : libre (e.g composition d'arbre d'activités)
- **Minimum d'hypothèses sur le modèle d'agent et les modèles cognitifs**
- Evaluation préliminaire de la sensibilité montrant la sensibilité de la selection d'action à l'ajout de modèles cognitifs (voir article).

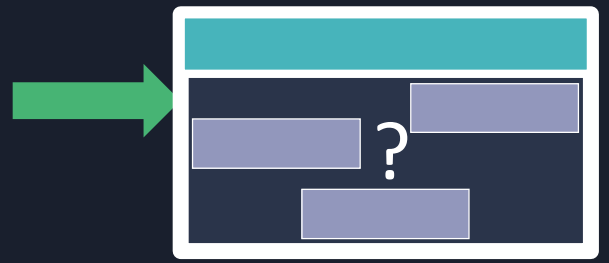
# Perspectives

- Evaluer la sensibilité avec un modèle d'agent complet



- Evaluer auprès d'experts l'intelligibilité des comportements générés sur un cas d'application d'entrainement

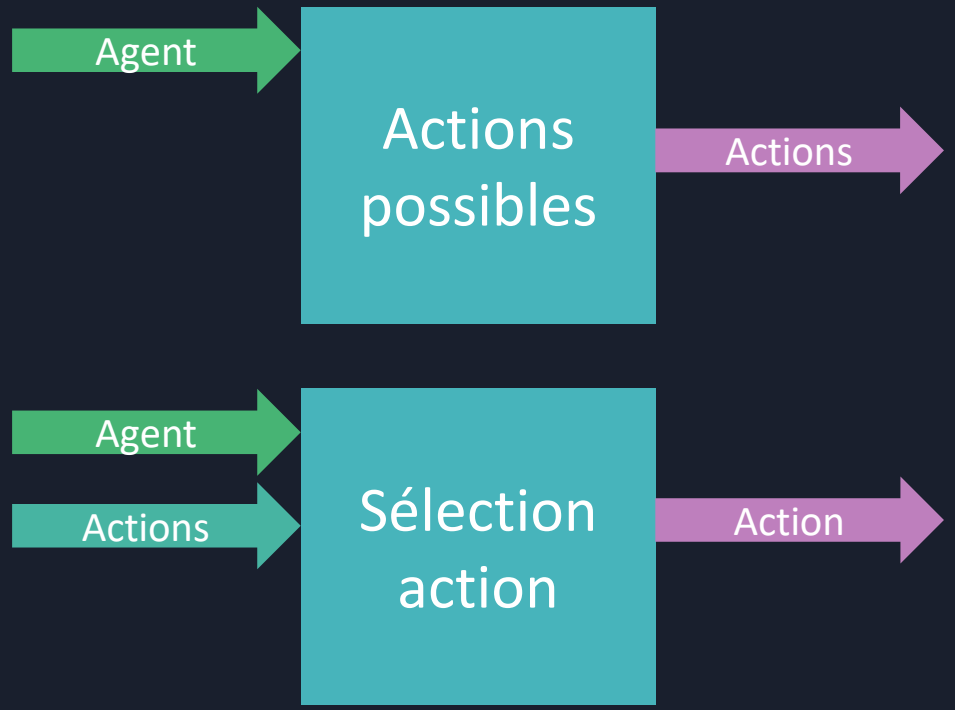
- Préciser d'autres stratégies en fonction des rôles



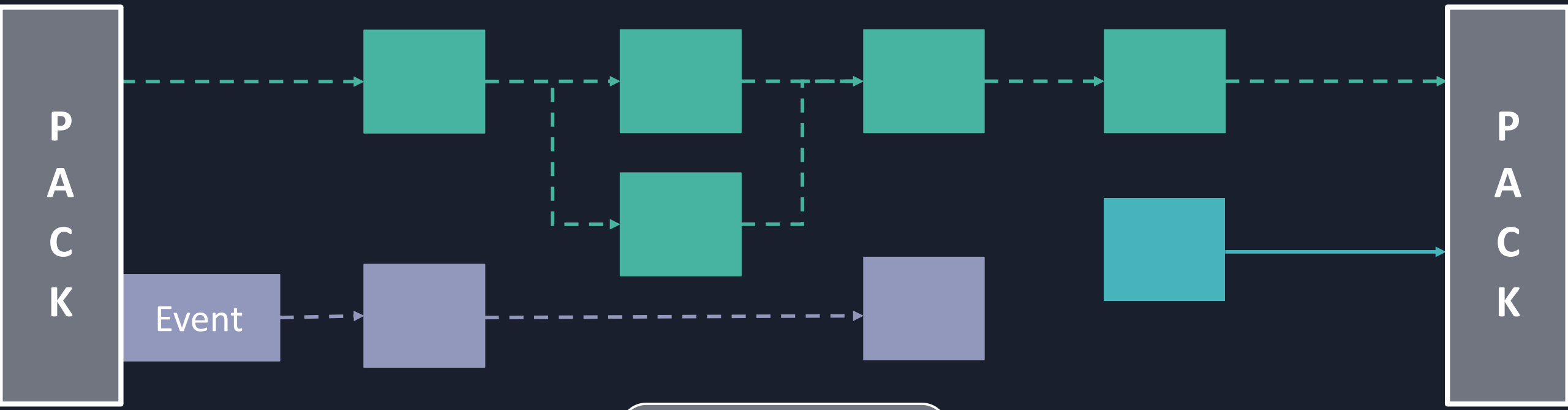
# Thank you for your attention

# O Operation

```
struct SuitableActions :
operations::Union<Action_t> {};

struct ActionSelection :
operations::SelectionByIGraph<SuitableActions>{};
```



# O Operation




T

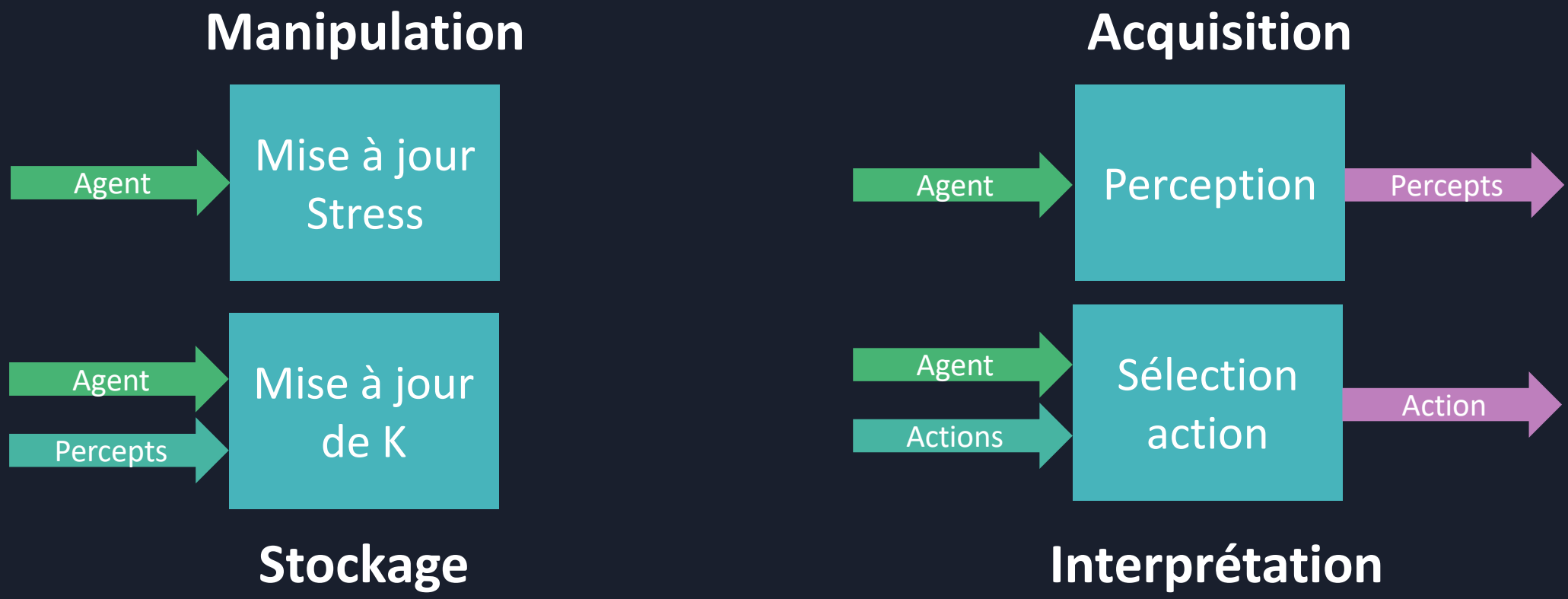
```
//Passage de T à T+Δt
sim.step();
```


Temps de simulation

T
+ Δt

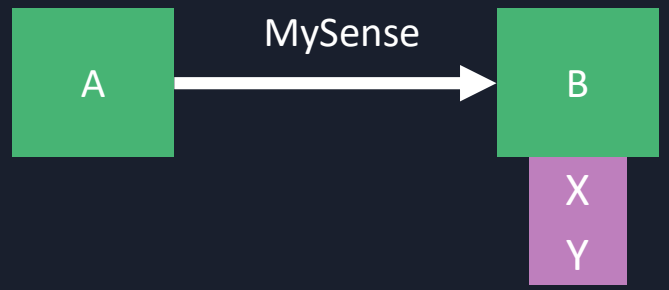
# O Operation

En fonction du rôle d'une opération, différentes stratégies sont envisageables. Un rôle dépend de la signature d'une opération



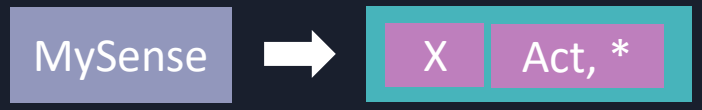

[1] American Psychological Association (APA) : Dictionary of Psychology

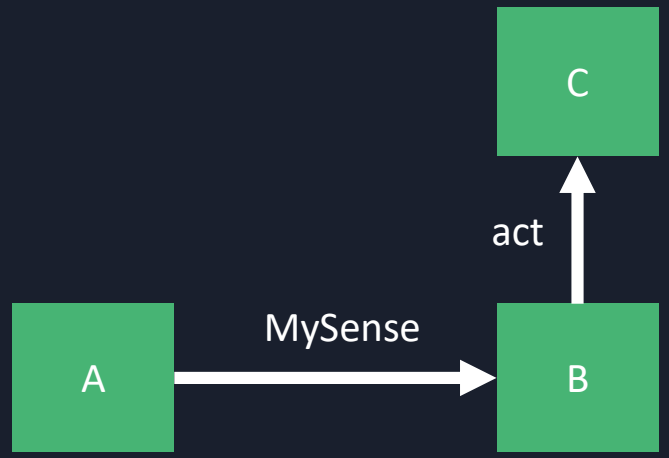
# P Percept


1

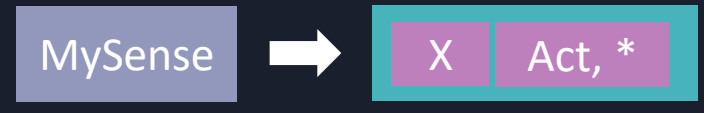
A perceive X(B) == True
A perceive Y(B) == False

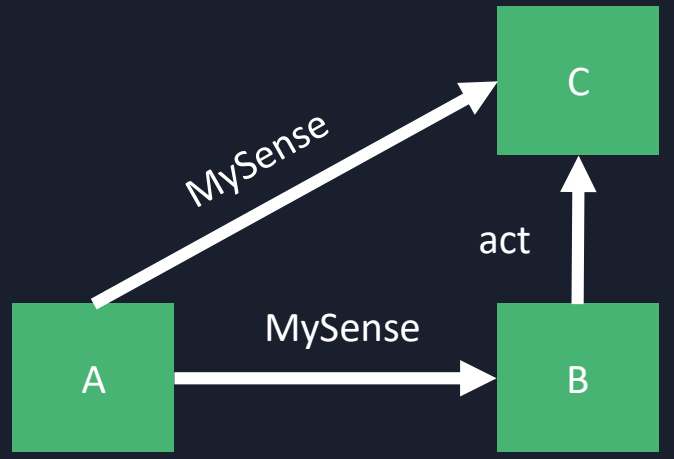



2

A perceive act(B, *) == True
A perceive C == False
A perceive act(B, C) == False



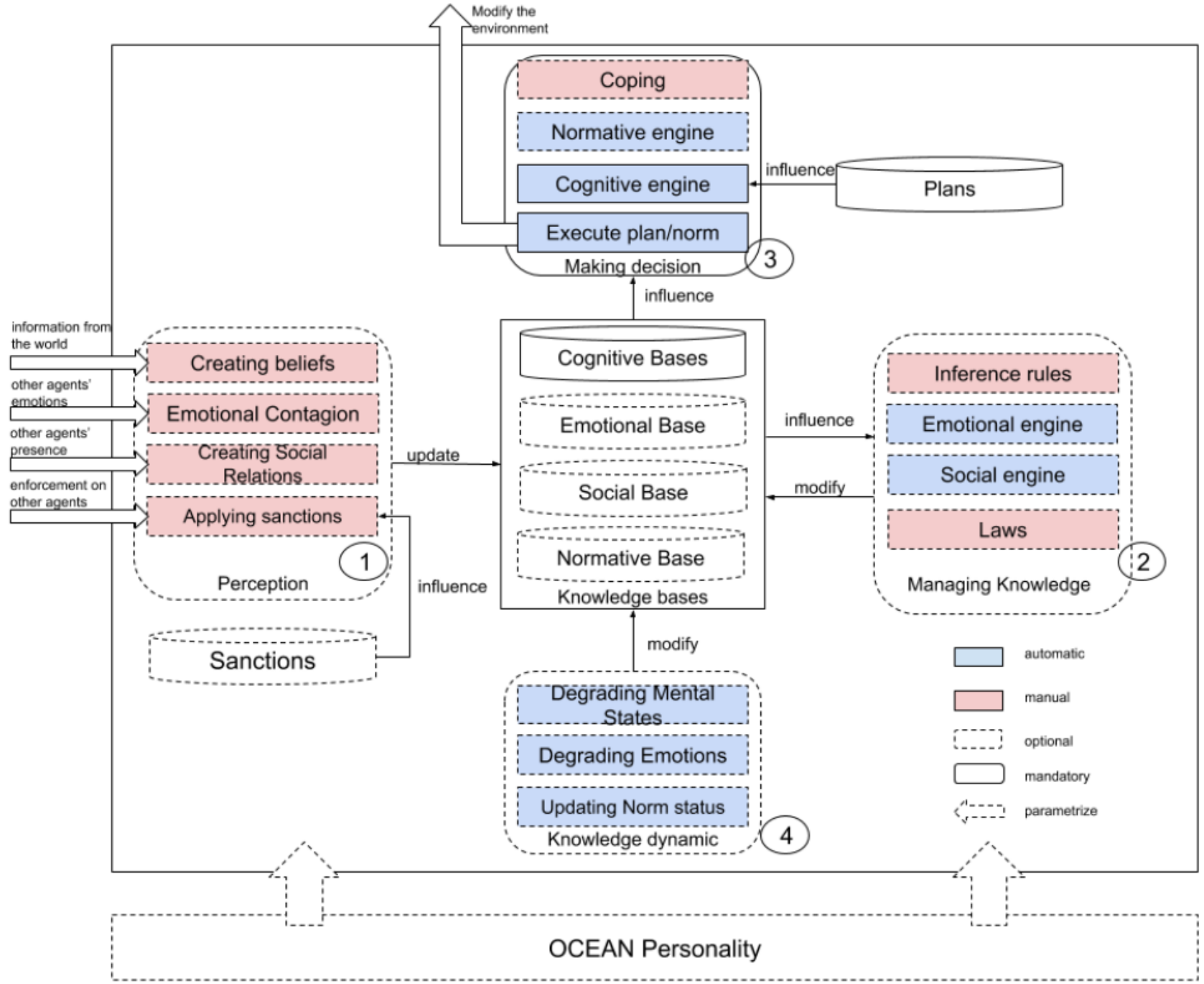




3

A perceive act(B, *) == True
A perceive C == True
A perceive act(B, C) == True

# BEN

**Bourgais et al., 2019:** *BEN: Une architecture pour des agents cognitifs [...]*



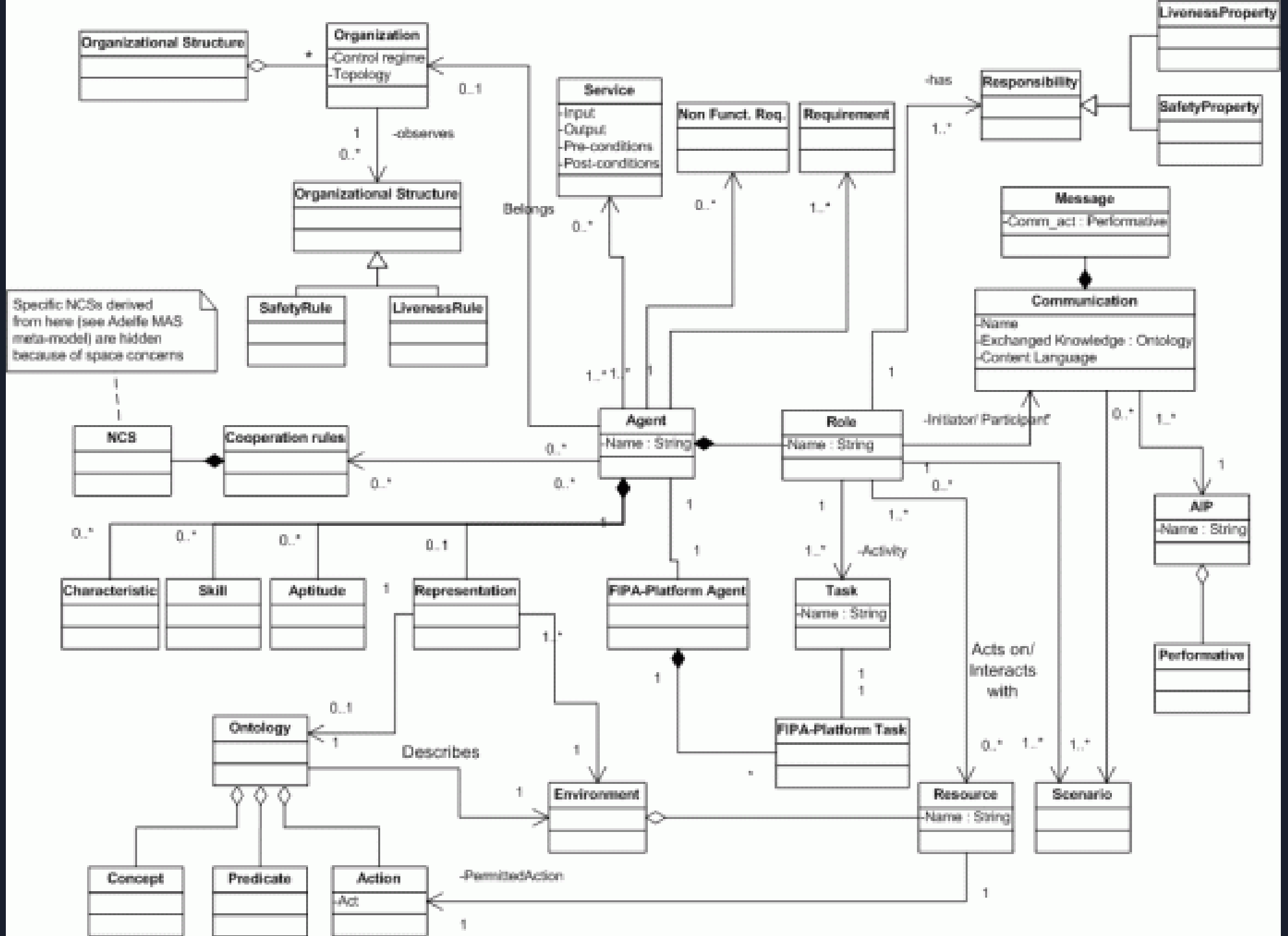
# BEN

**Bourgais et al., 2019:** *BEN: Une architecture pour des agents cognitifs […]*

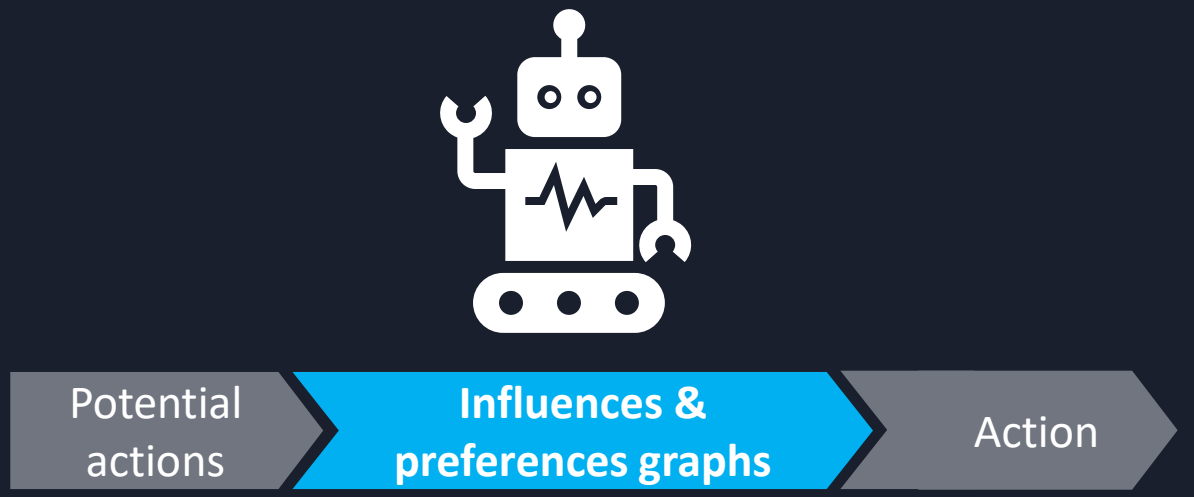
# Unifying meta-model

Bernon et al. - 2005 - A Study of Some Multi-agent Meta-models

ADELFE, GAIA & PASSI

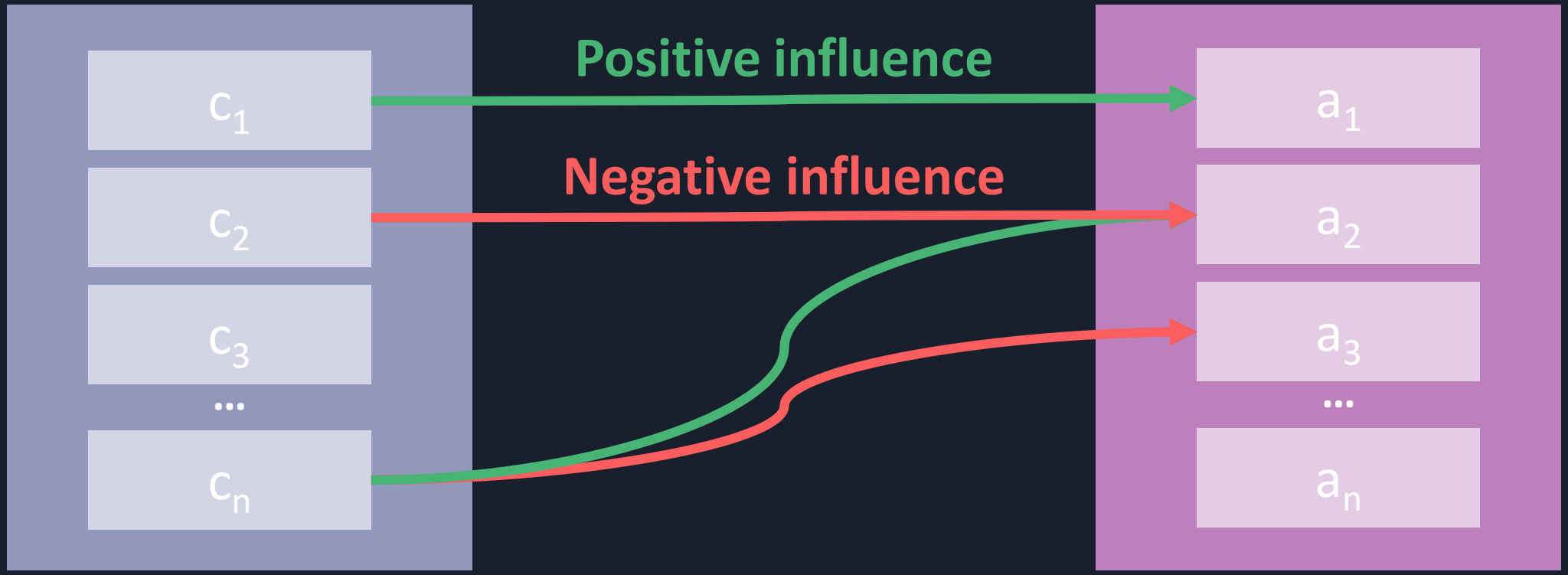


# Our approach …



# Influences graph

## Formalism 1/2




**C**

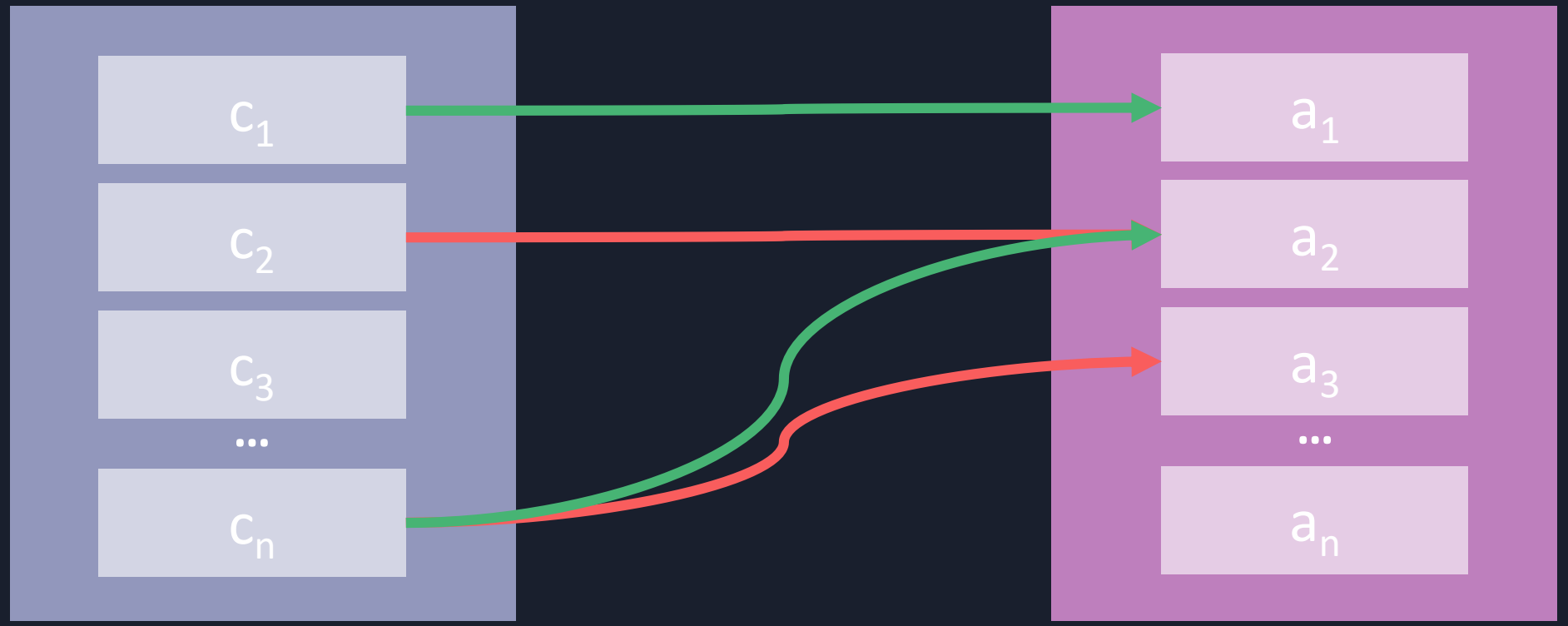
**Set of behaviours**

**A**

**Set of actions**

# Influences graph

## Formalism 2/2




**C**

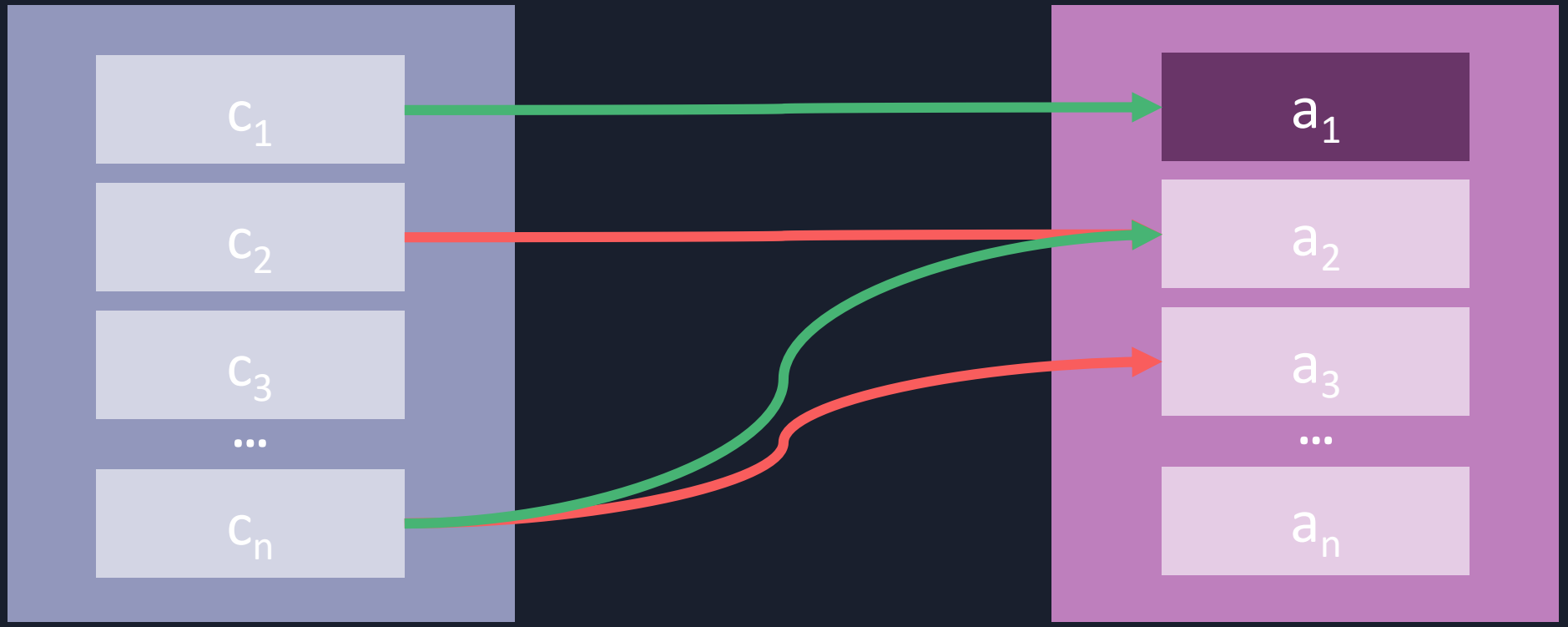
**Set of behaviours**

**A**

**Set of actions**

# Influences graph

## Formalism 2/2




Selected

C

Set of behaviours

A

Set of actions

# Example

Inputs

## C Set of behaviours

− passive actions
+ ordered actions

**Proactive followership**[1]

− Not mastered actions
+ Shortest active actions

**Stressed** [2]

+ regulatory actions

**Regulatory** [3]


[1] **Demary, 2018:** *Évaluation cognitive du leader dans une dyade hiérarchique*
[2] **Driskell, 2018 :** *Teams in extreme environment*
[3] **Fadier, 2003 :** *"Safe design and human activity : construction of a theoretical framework from an analysis of a printing sector"*

# A Set of actions

Each action is defined by the following indicators :

$C_B$ : base cost

$C_R$ : regulatory cost

Tags : a set of symbols

Shown as : $\{C_B, C_R\}$ [Tags]

| Do nothing | A1 | A2 | A3 | A4 |
|---|---|---|---|---|
| {0, 0}<br>[] | {3, 0}<br>[SC3] | {2, 0}<br>[SC1, Ordered] | {4, 0}<br>[SC3] | {2, 5}<br>[SC2] |

# Agent state and parameters

Our agent :

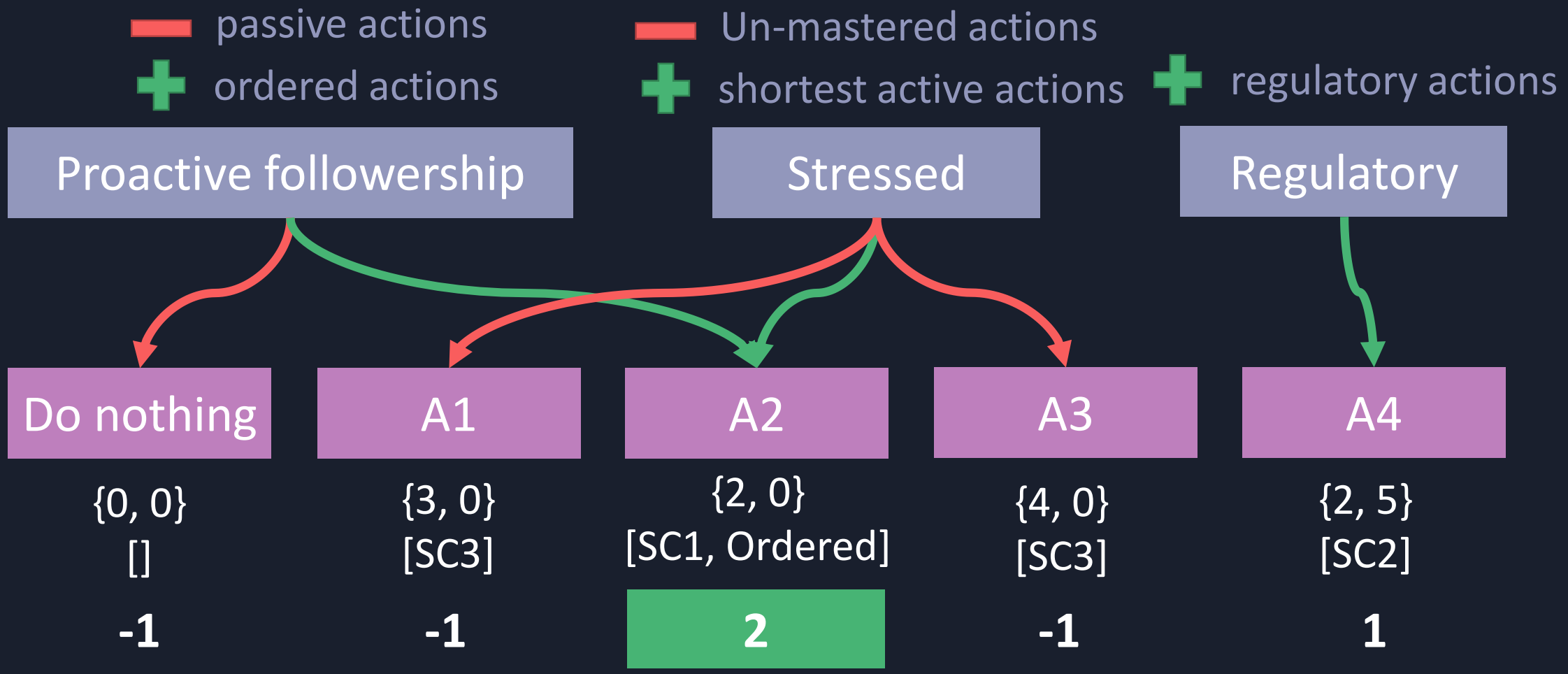
- Is stressed or not S : {true, false}
- Is proactive or not P : {true, false}
- Is regulatory or not R : {true, false}
- Has a level of qualification {SC1, SC2, SC3}
  - Either SC1, SC2 or SC3

As stated before, depending on this, some behaviours will not be taken into account

# Example

S : true | P : true | R : true | SC2

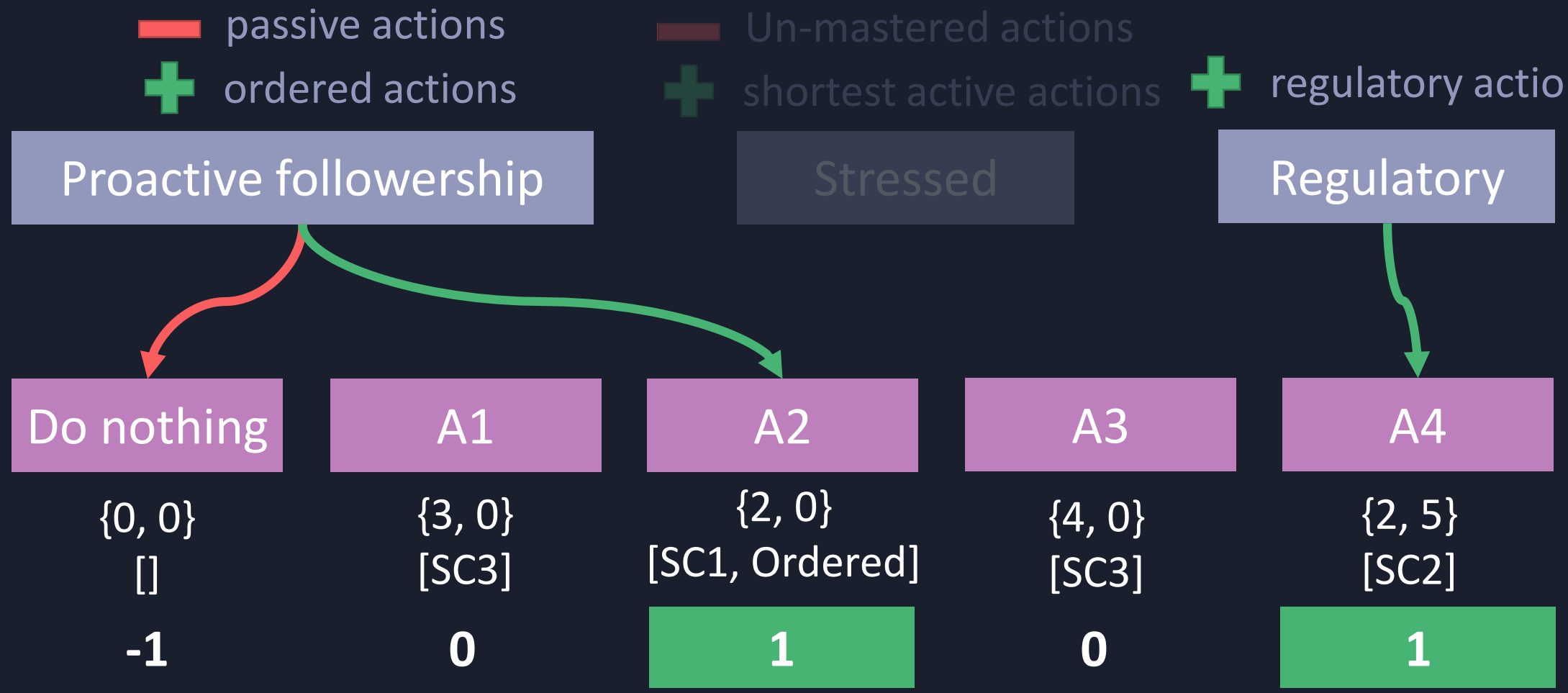
Case 1 : A proactive, stressed and regulatory agent



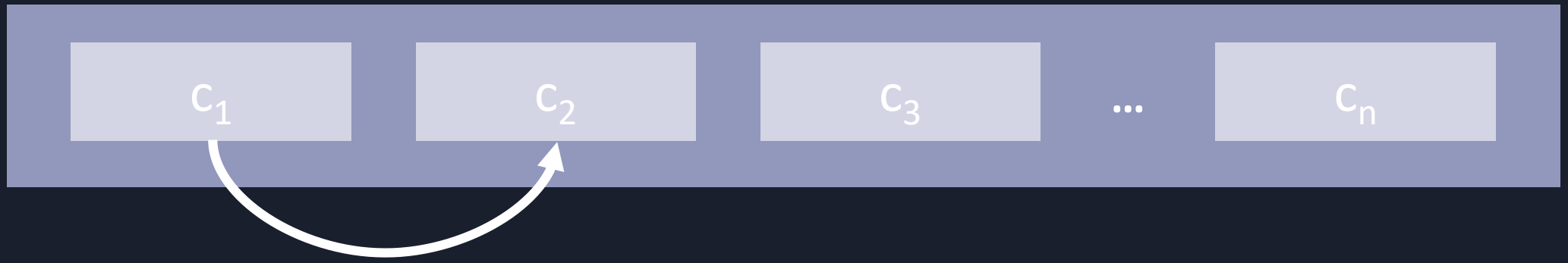
# Example

S : false | P : true | R : true | SC2

Case 2 : A proactive and regulatory agent



# Preferences graph




A preference is a relation between two behaviours.

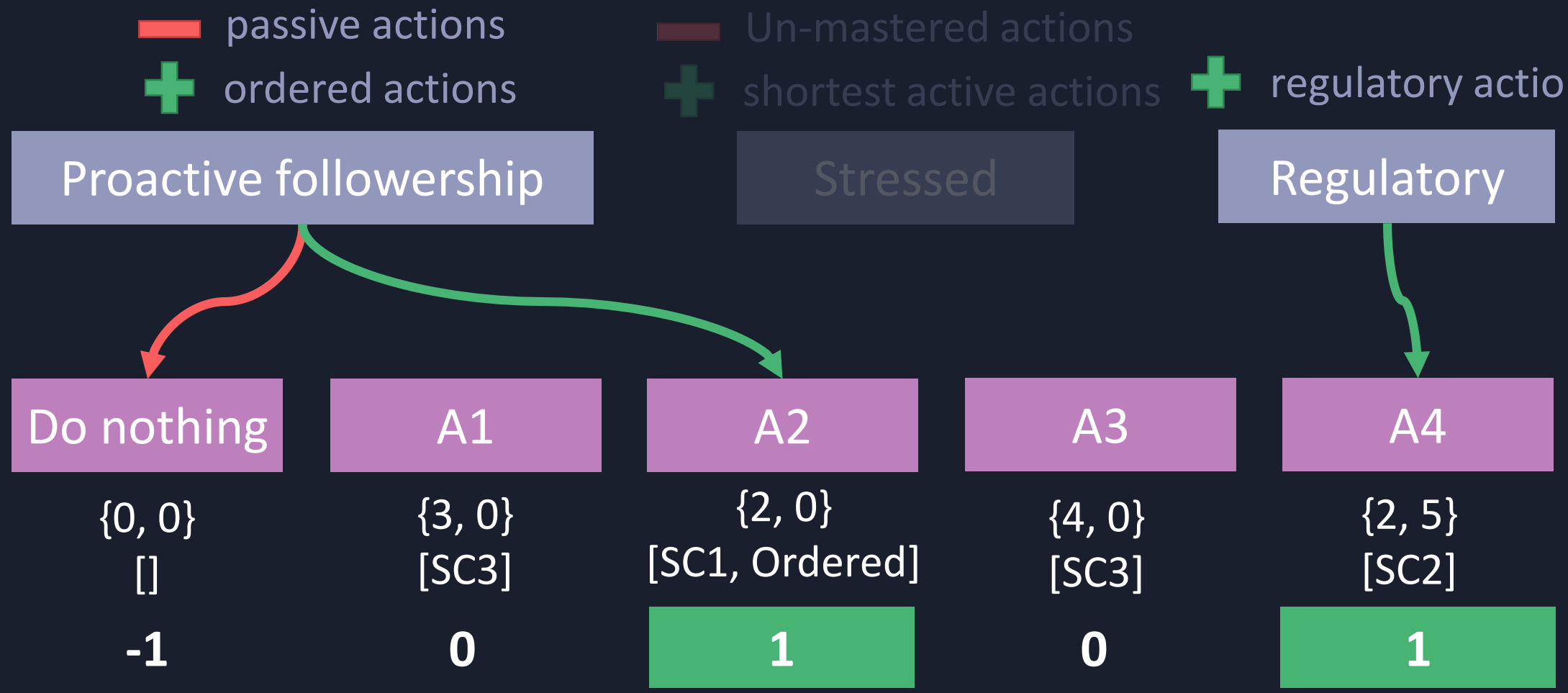
*Actions positively influenced by $c_1$ will be prefered*

Used when several actions are selectable.

# Example

S : false | P : true | R : true | SC2

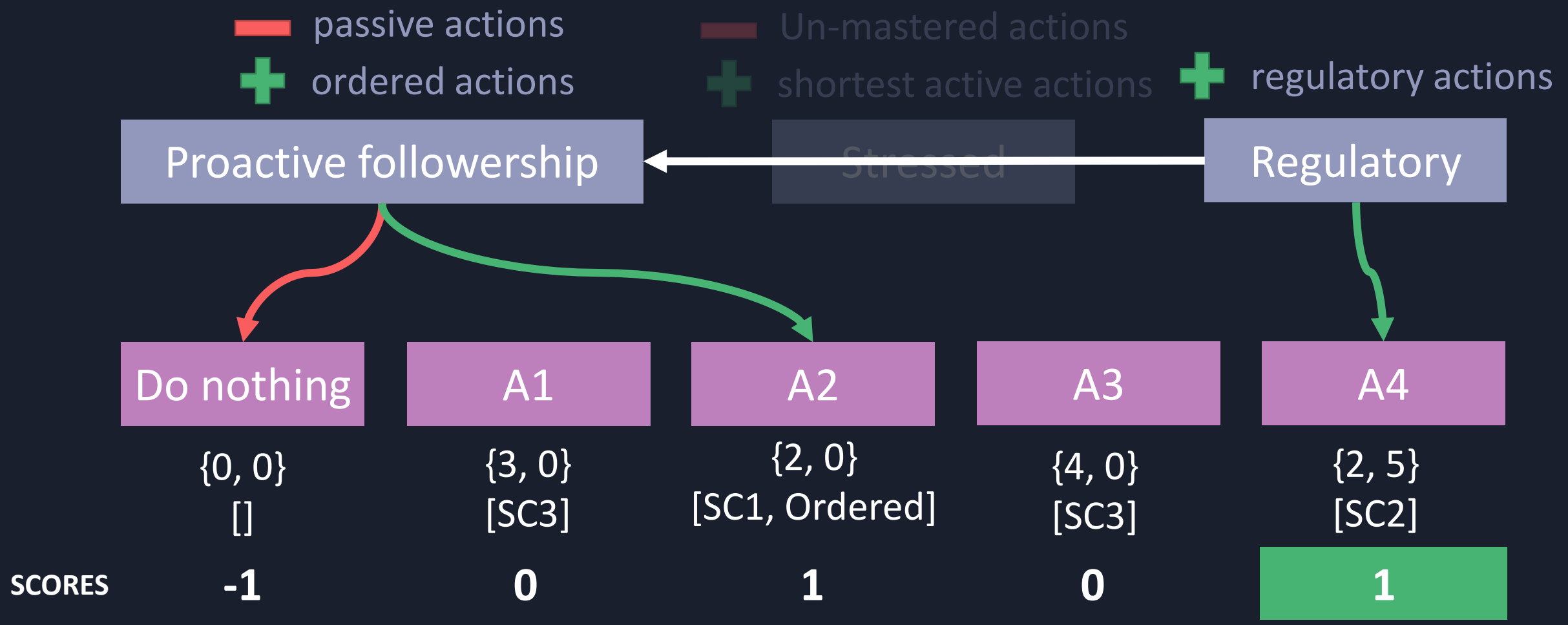
Case 2 : A proactive and regulatory agent



# Example

S : false | P : true | R : true | SC2

Case 3 : A proactive and regulatory agent w/ pref.



## Influences and preferences graphs

- Integrate modular behaviours for action selection
- Sensitivity and Intelligibility
- Preliminary evaluation of intelligibility

## Perspectives

- Extend to other dimensions (perception, beliefs update, …)
- Evaluate sensitivity and intelligibility in a training context.

# Thank you for your attention

# O Operation

```
//Passage de T à T+Δt
sim.step();
```