A Multi-Agent System for Autonomous Control of Game Parameters

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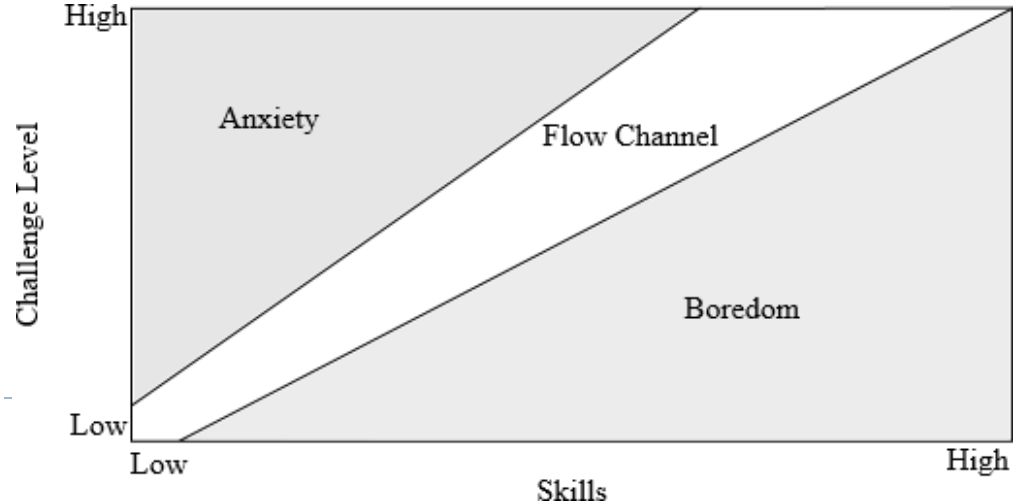
Games and Serious Games

- **Growing interest for both games and serious games**
- **The objective is either learning or entertainment**
- **The experience is effective when the player reaches the state of *flow* [Csikszentmihalyi90]**
  - *Believabilty*
  - *Adapted Challenges*



Games and Serious Games

- **Games are getting more and more complex**
  - Large number of parameters
  - Nonlinear
  - Difficult if not impossible to model

- **Players are human beings**
  - Large populations of players may involve original individuals
  - Human reasoning is unpredictable

- ***"The holy grail of game design is to make a game where […] the difficulty curve is perfect and adjusts itself to exactly our skill level."*** **Raph Koster, Theory of fun, 2004**

General Question

- **How to**
  - Adapt a game experience so it is profitable for all players?
  - Preserve the consistency and believability ?
- **Given that**
  - Potentially all players are different
  - All game engines are different
- **While keeping**
  - Real time activity
  - General concepts

How it has been done so far?

- **Machine Learning**
  - Q-Learning with Markov Decision Processes [Andrade04]
    - Needs many iterations with a static player
  - Case-Based Reasoning [Sharma07]
    - Experts need to exhaustively list cases
  - Rules Re-ordering [Spronck06]
    - Limited to plan-based agents

- **Optimization**
  - Genetic Algorithms [Zook12] & Artificial Neural Networks [Stanley05]
    - Large amounts of data needed with many iterations

Proposition

- **New paradigms to overcome complexity**
- **Use of collective intelligence**
- **(Logically) Distributed computation**
- **Bottom-up approach**

Problem Definition: A General Scenario

- **Example**

Enemy 1 health points
Enemy 2 health points
Enemy 1 robustness
Enemy 2 firepower
Player attack power
Player shooting range
…

Success percentage
Completion time
Accuracy

Tower Defense Game

Problem Definition: A General Scenario

Enemy 1 health points
Enemy 2 health points
Enemy 1 robustness
Enemy 2 firepower
Player attack power
Player shooting range
…

Tower Defense Game

Success percentage
Completion time
Accuracy

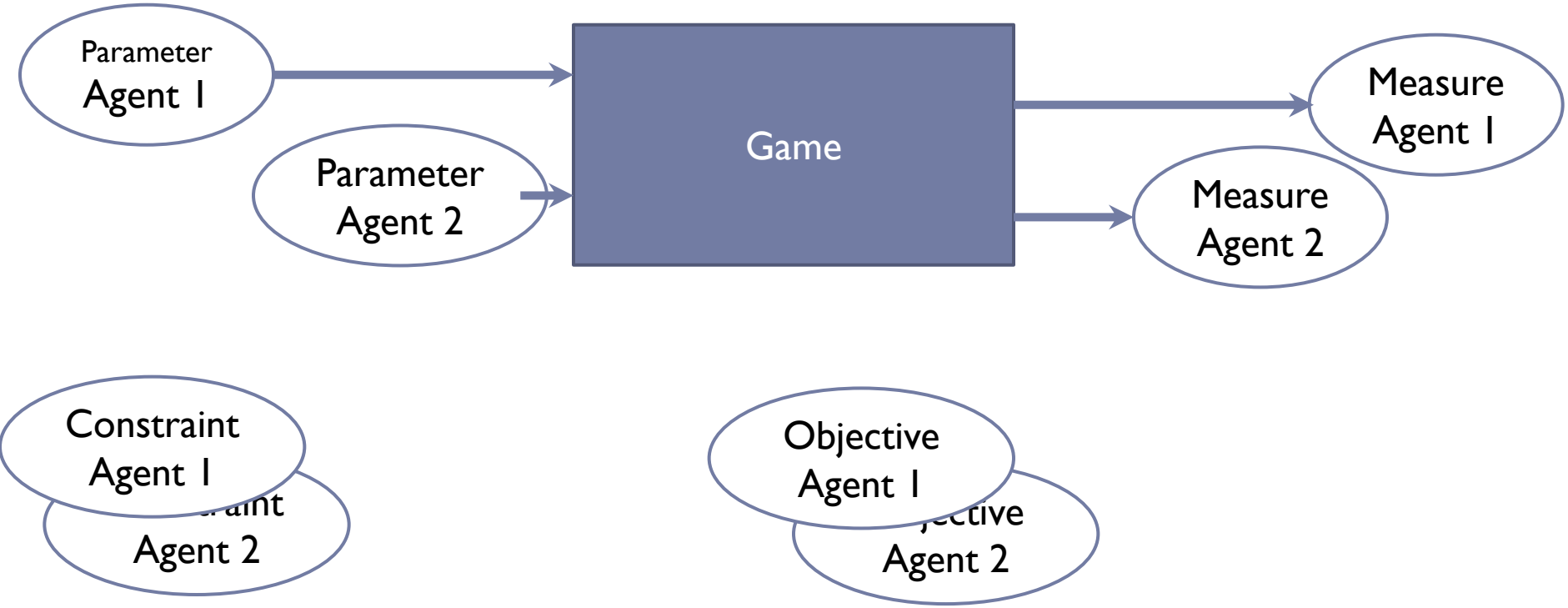
Constraints

Enemy 1 health points ∈ [5;10]
Enemy 2 health points ∈ [8; 13]
Enemy 2 hp > Enemy 1 hp
Player hp > 3 * Enemy 2 hp
Etc…

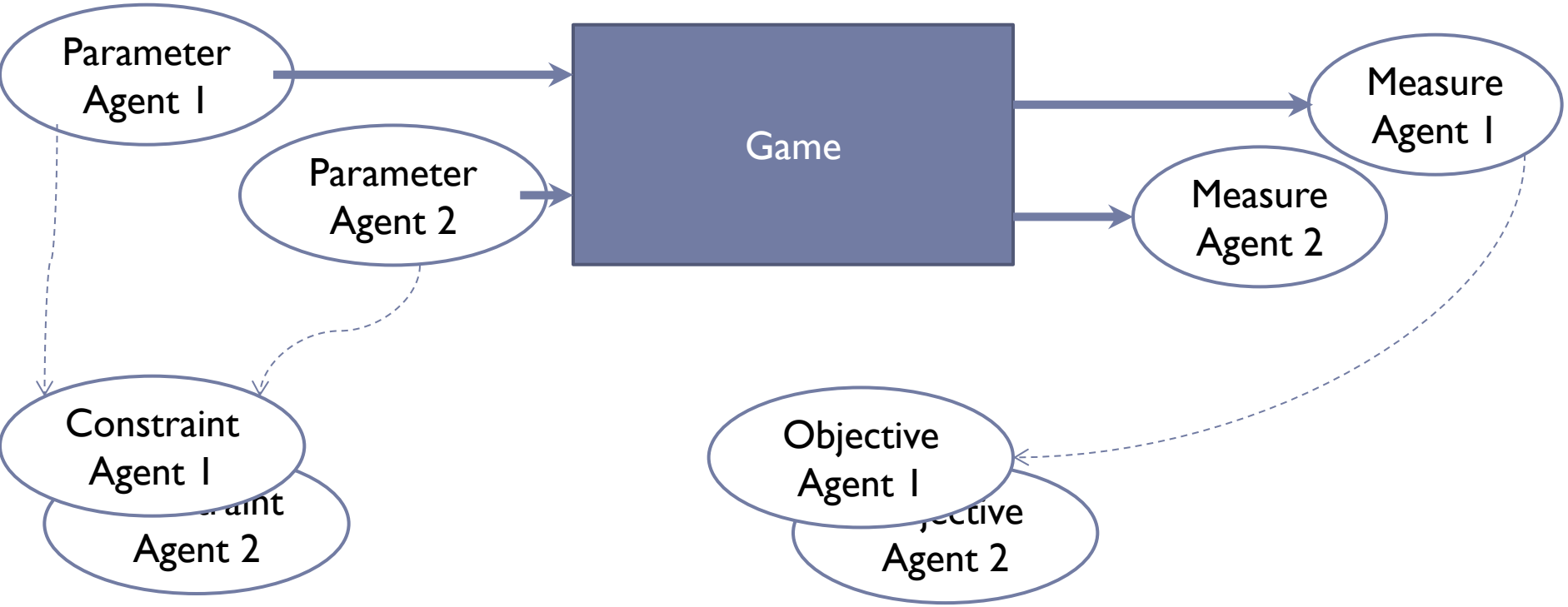
Objectives

Score ≈ 75 %
Completion time < 1min30
…

A Multi-Agent Modeling

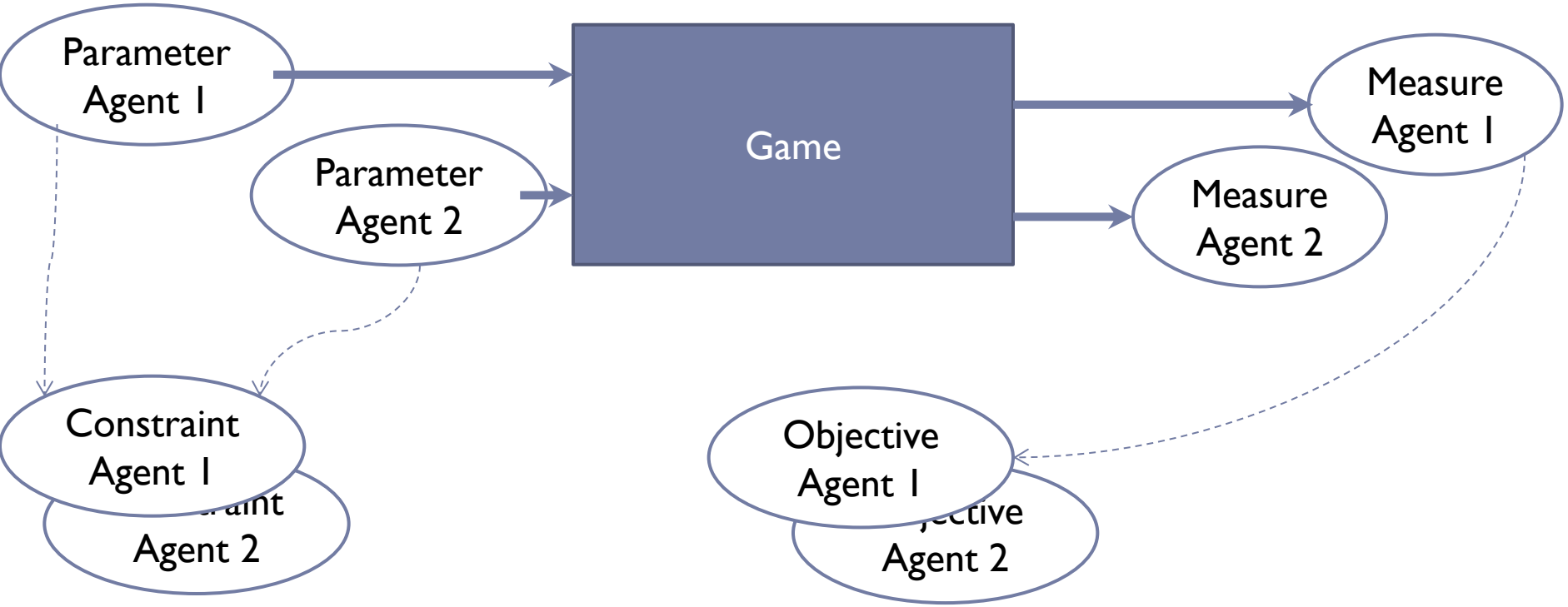


A Multi-Agent Modeling



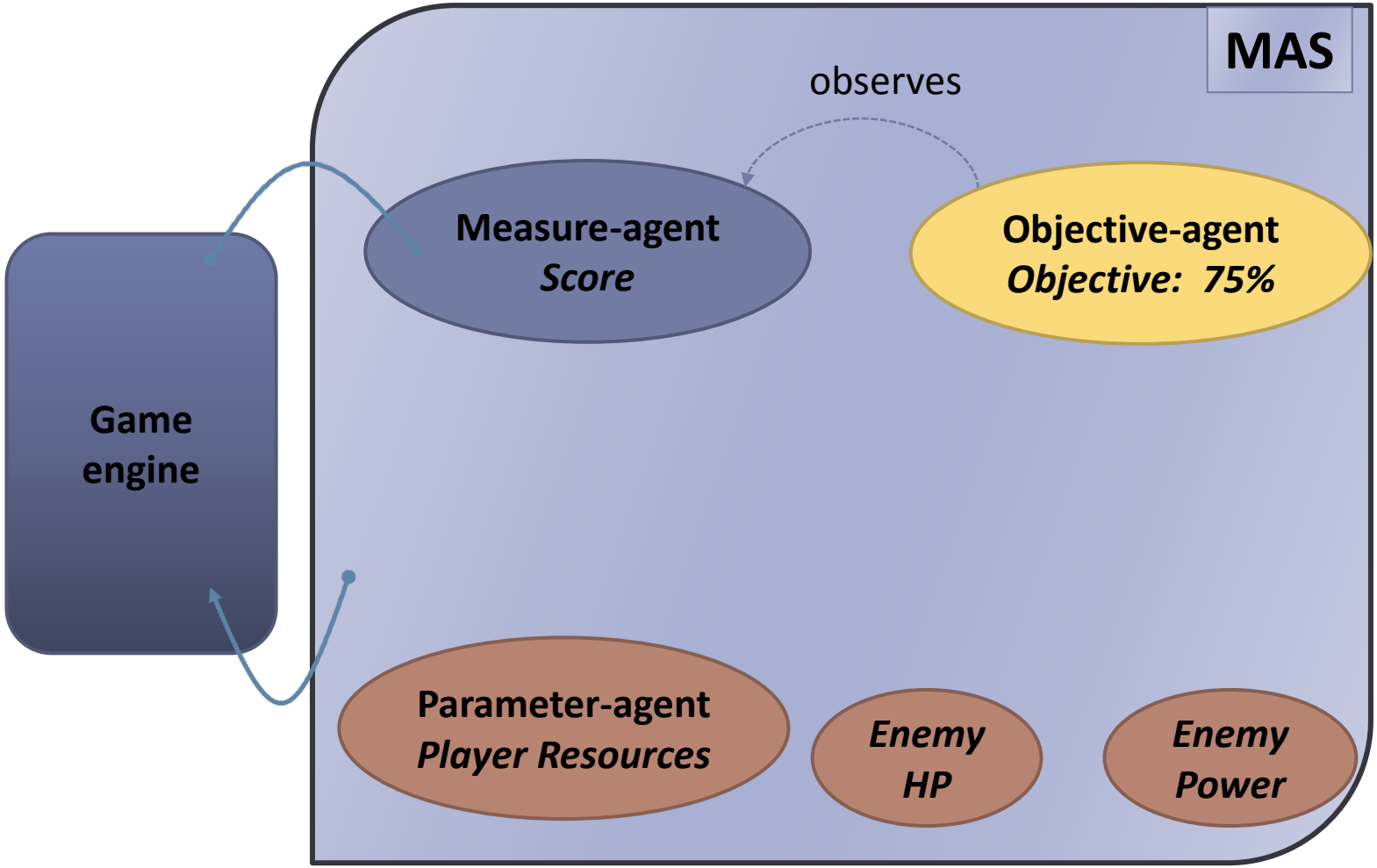
- Agents have a local perception of their environment

A Multi-Agent Modeling

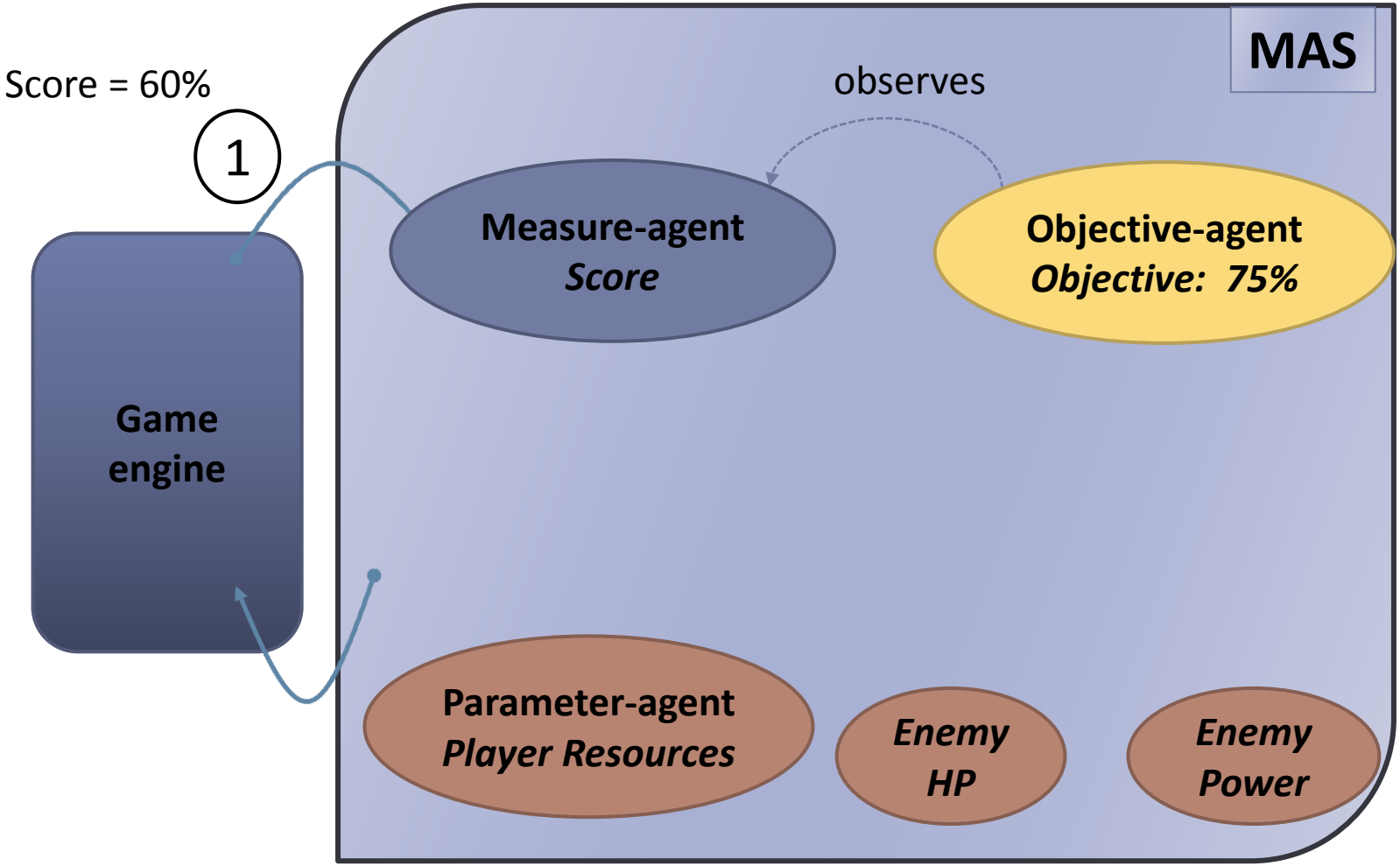


- Agents have a local perception of their environment
- Constraints and objectives compute their satisfaction level

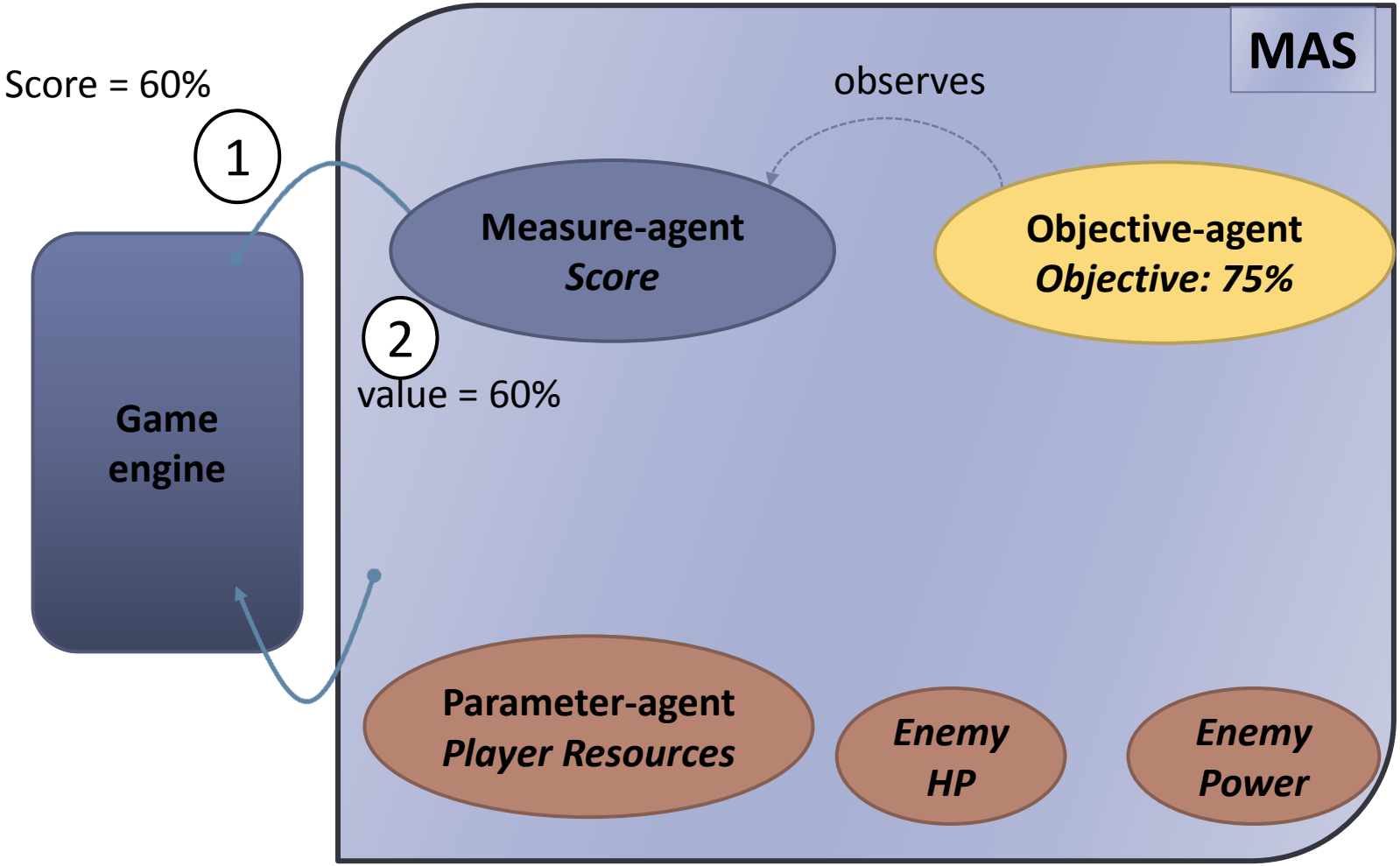
Behaviour


MAS
observes
Measure-agent
Score
Objective-agent
Objective: 75%
Game
engine
Parameter-agent
Player Resources
Enemy
HP
Enemy
Power

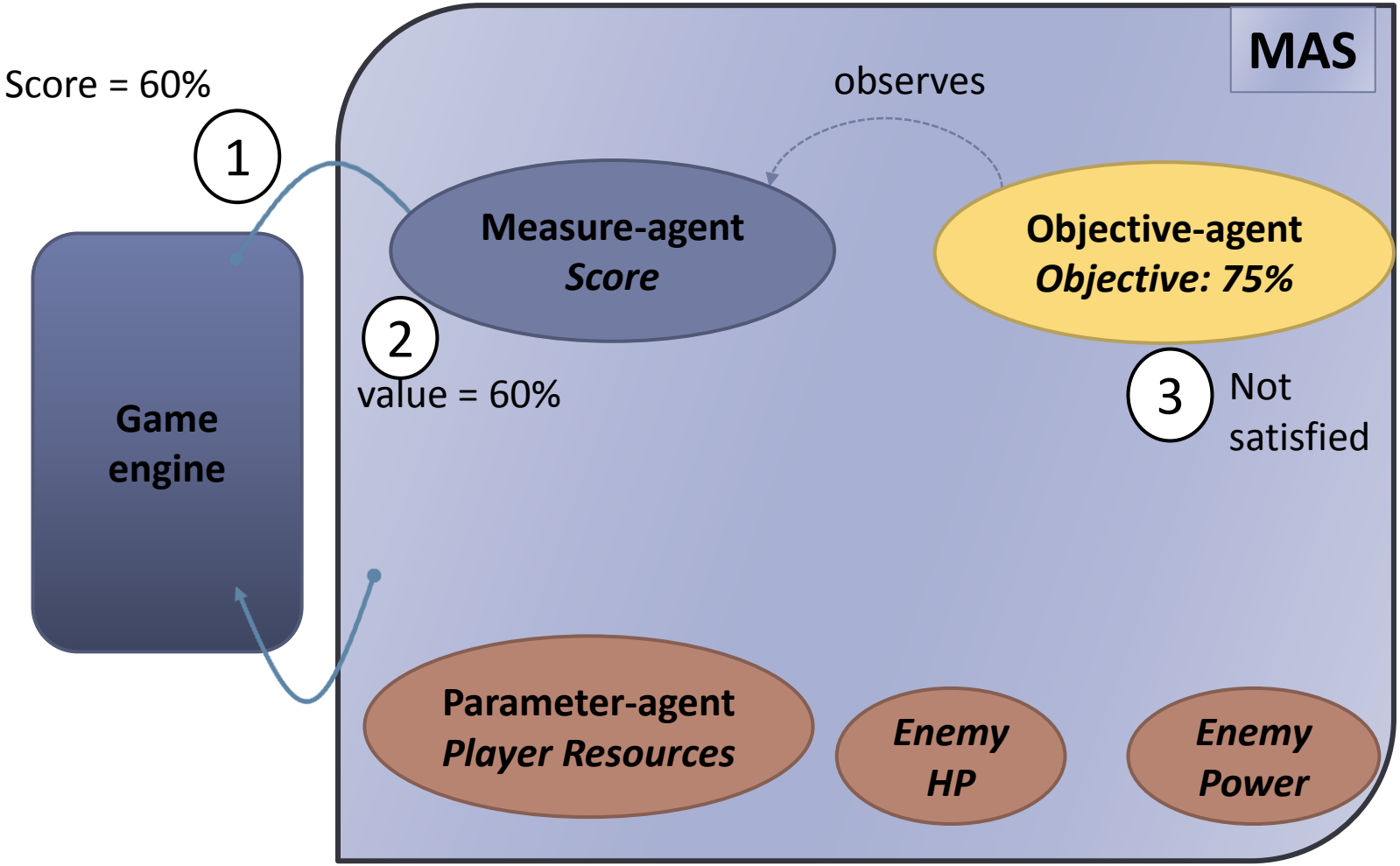
Behaviour


Score = 60%
1
Game engine
MAS
observes
Measure-agent
Score
Objective-agent
Objective: 75%
Parameter-agent
Player Resources
Enemy HP
Enemy Power

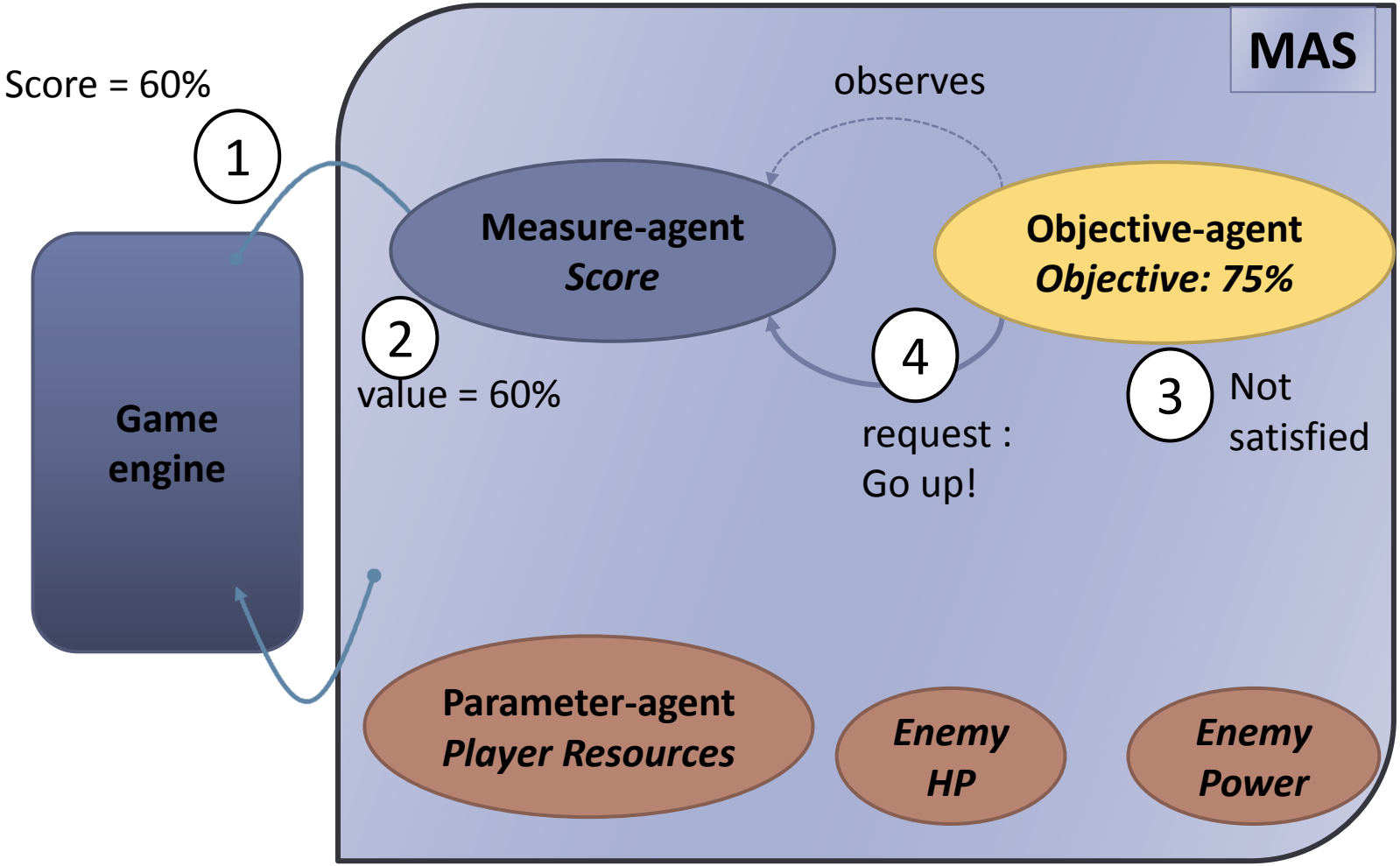
Behaviour


MAS
Score = 60%
observes
1
Measure-agent
Score
Objective-agent
Objective: 75%
2
value = 60%
Game
engine
Parameter-agent
Player Resources
Enemy
HP
Enemy
Power

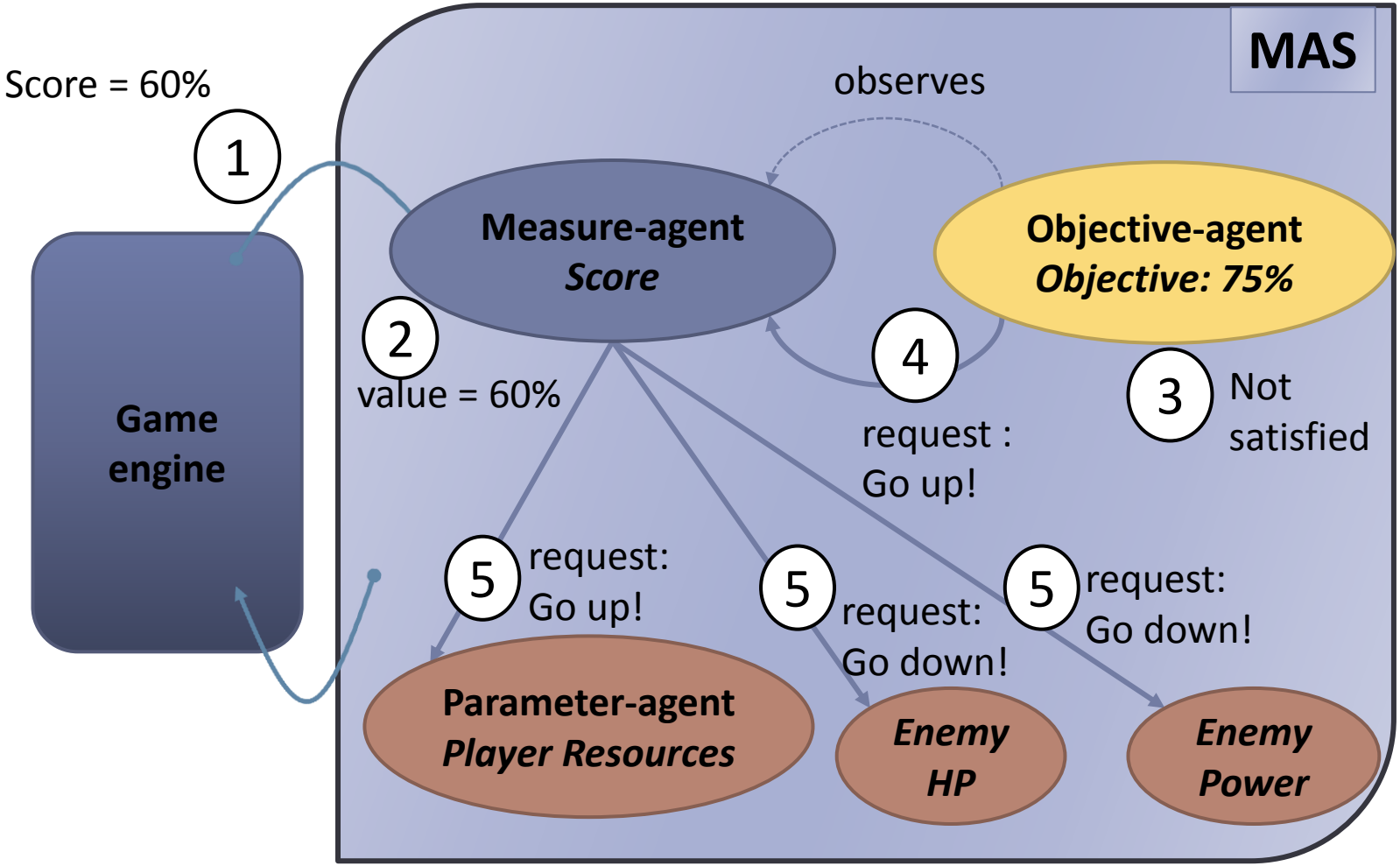
Behaviour


MAS
Score = 60%
1
observes
Measure-agent
Score
Objective-agent
Objective: 75%
2
value = 60%
3
Not satisfied
Game engine
Parameter-agent
Player Resources
Enemy HP
Enemy Power

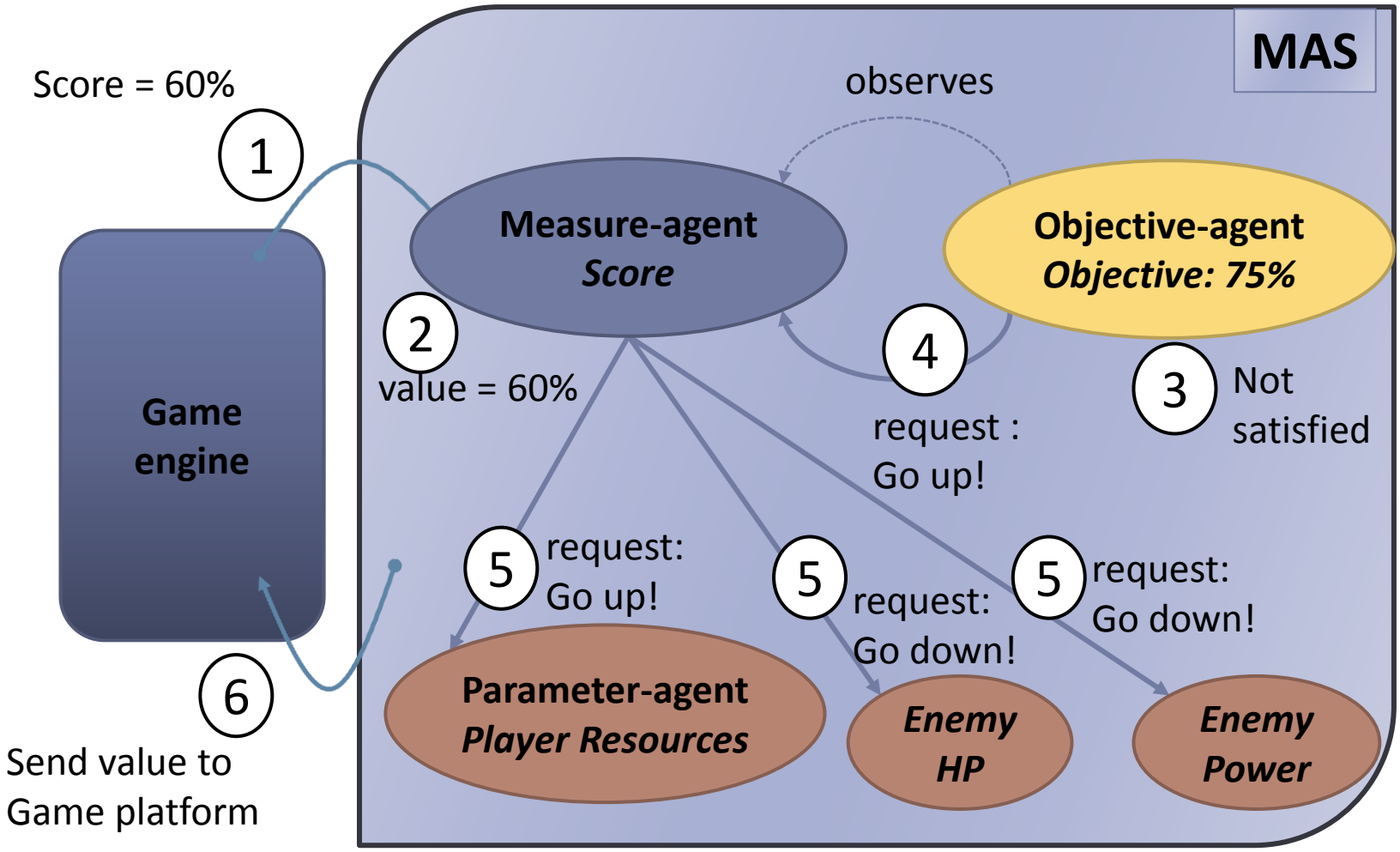
Behaviour


MAS
Score = 60%
1
observes
Measure-agent
Score
Objective-agent
Objective: 75%
2
value = 60%
4
request :
Go up!
3
Not
satisfied
Game
engine
Parameter-agent
Player Resources
Enemy
HP
Enemy
Power

Behaviour


MAS
Score = 60%
1
observes
Measure-agent
Score
Objective-agent
Objective: 75%
Game
engine
2
value = 60%
4
request :
Go up!
3
Not
satisfied
5
request:
Go up!
5
request:
Go down!
5
request:
Go down!
Parameter-agent
Player Resources
Enemy
HP
Enemy
Power

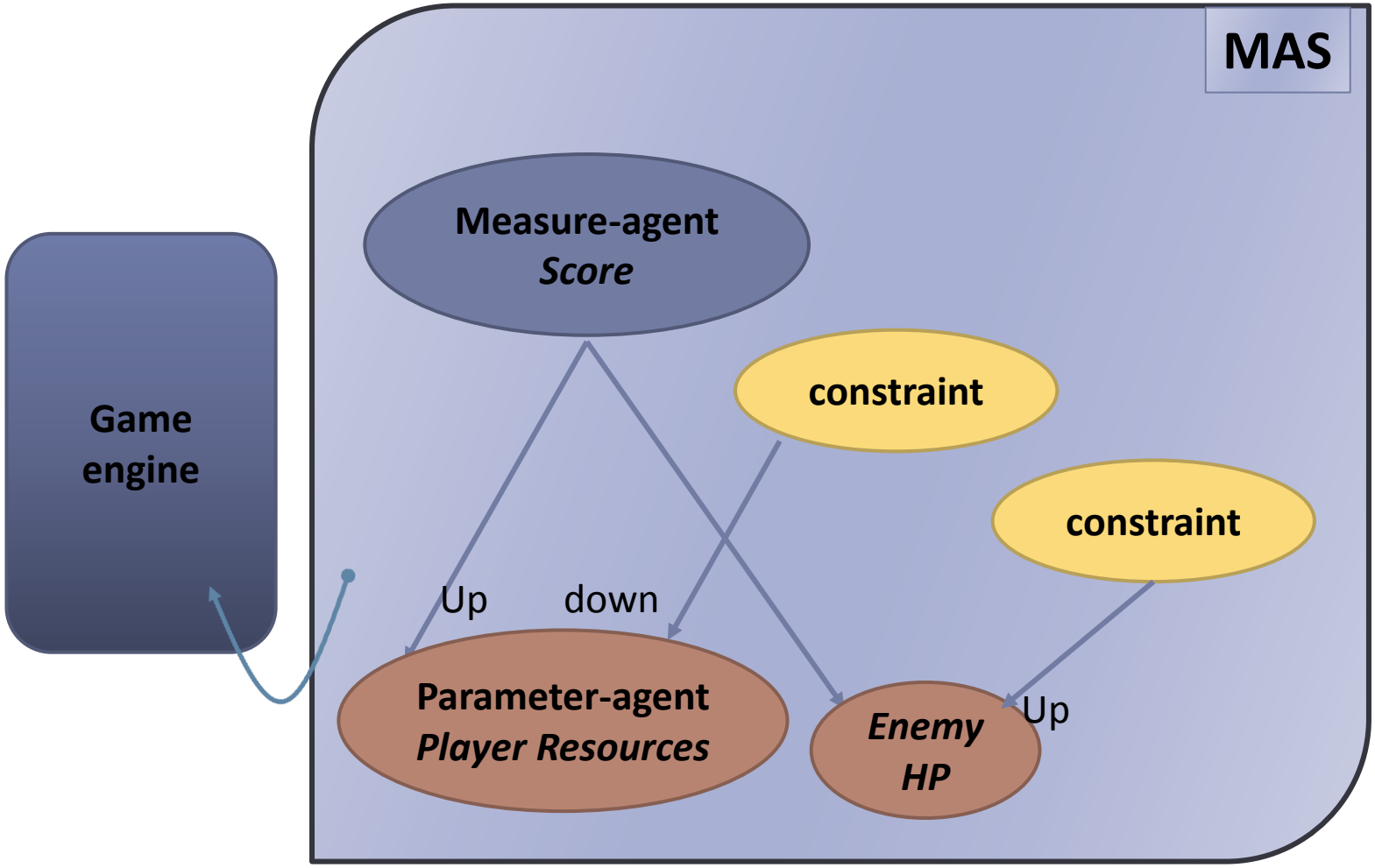
Behaviour


MAS
Score = 60%
1
observes
Measure-agent
Score
Objective-agent
Objective: 75%
Game
engine
2
value = 60%
4
request :
Go up!
3
Not
satisfied
5
request:
Go up!
5
request:
Go down!
5
request:
Go down!
Parameter-agent
Player Resources
Enemy
HP
Enemy
Power
6
Send value to
Game platform

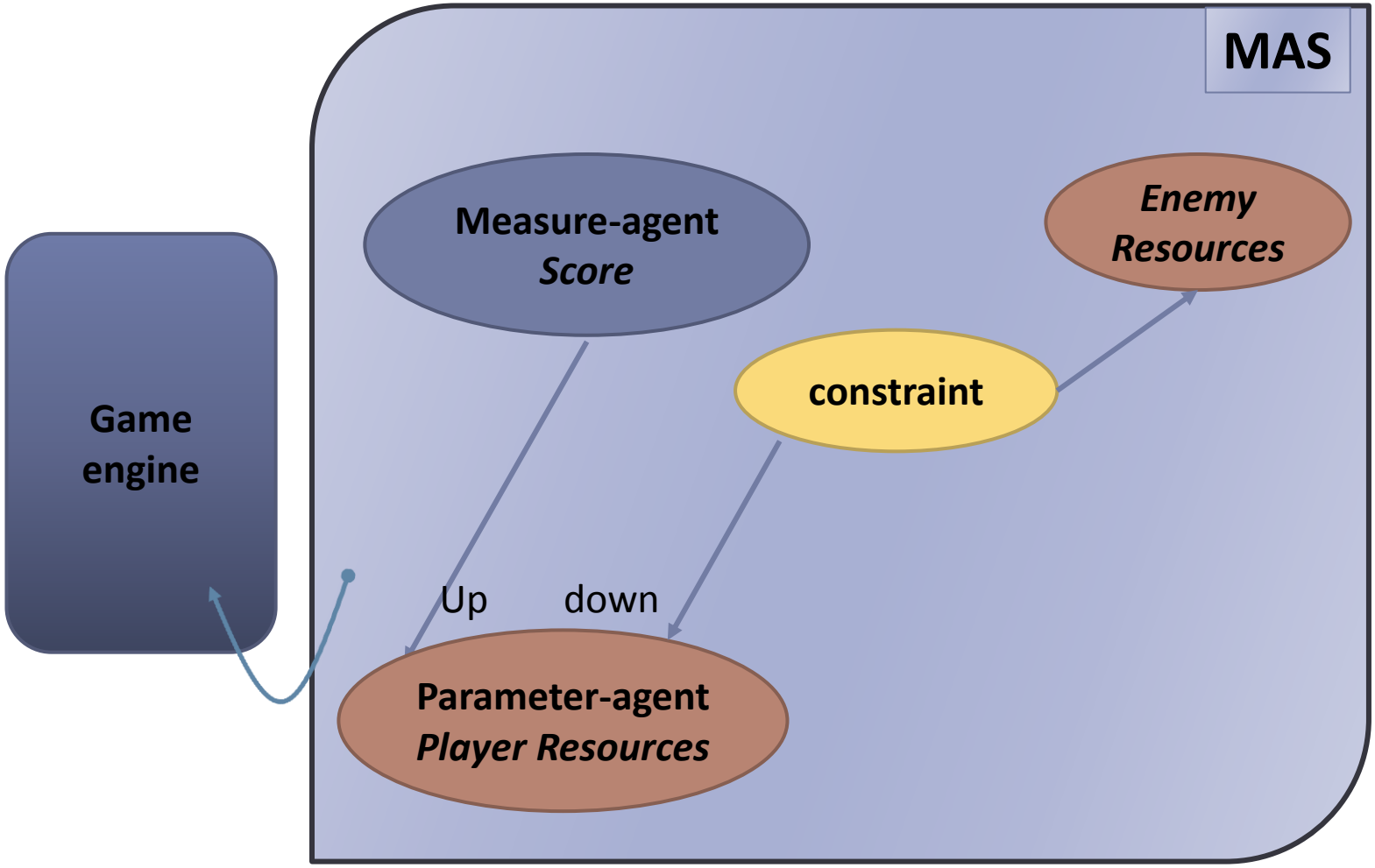
Behaviour

- **Works fine where there is no problem**
- **When a conflict occurs, behaviours need to be *cooperative***

Behaviour – Parameter Agents (1)

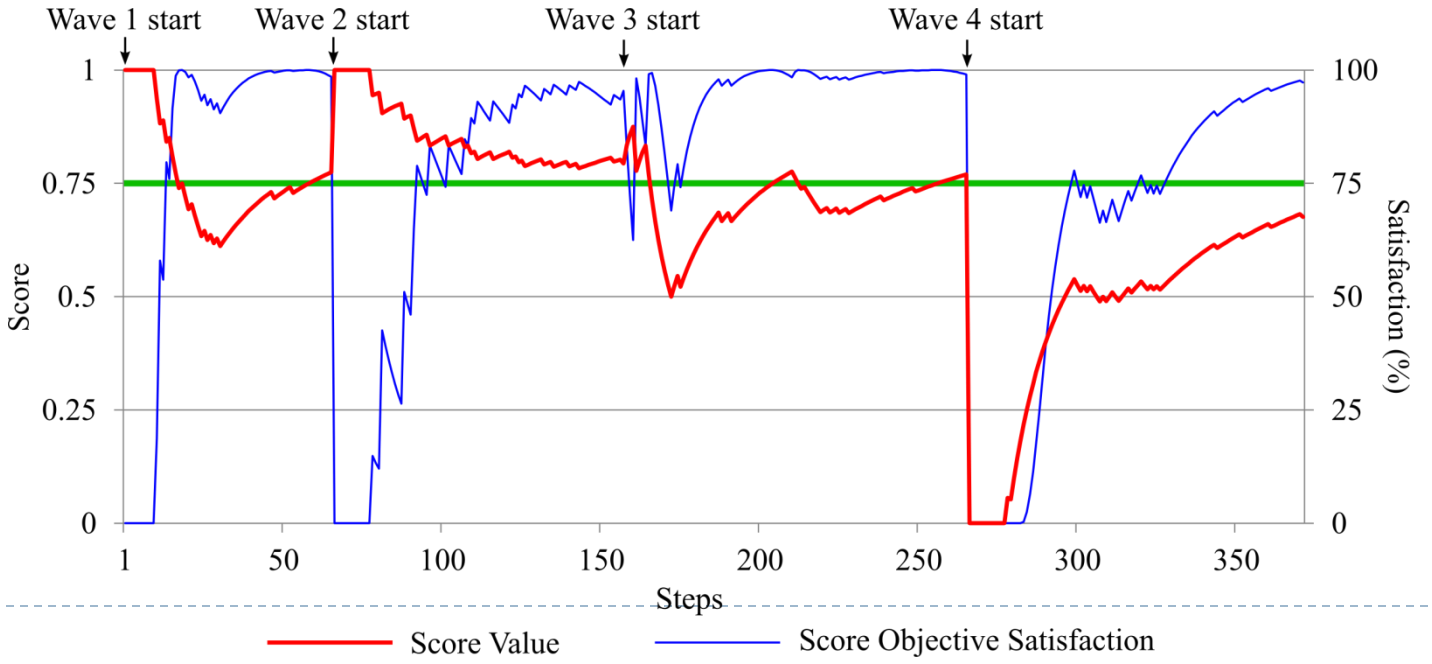


Behaviour – Parameter Agents (2)



At the Global Level

- **Local cooperative interactions lead to a global optimization of the satisfaction**
- **Successfully applied**
  - To a population equilibrium simulation
  - To a tower defense game



Conclusion

- **Real time adaptivity**
- **Minimal information from the domain is needed**
- **Concepts are general enough to be applied to various kinds of games**

Thank you

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- [Zook12] Alexander ZOOK, Stephen LEE-URBAN, Mark O. RIEDL, Heather K. HOLDEN, Robert A. SOTTILAREet Keith W. BRAWNER: Automated Scenario Generation : Toward Tailored and Optimized Military Training in Virtual Environments.Dans Proceedings of the International Conference on the Foundations of Digital Games, FDG'12, pages 164–171, 2012.

Dependencies Matrix

	Player HP	Enemy HP	Defense firepower	Enemy speed	Enemy frequency
Score	+	-	+	-	-
Completion time				+	+

Adaptive Value Tracker

CurrentFB / *LastFB*	↗	↘
↗	$\Delta = \Delta \bullet 2$ $v = v + \Delta$	$\Delta = \Delta / 2$ $v = v - \Delta$
↘	$\Delta = \Delta / 2$ $v = v + \Delta$	$\Delta = \Delta \bullet 2$ $v = v - \Delta$