



Changing the Game: Measuring and Influencing Player Emotions Through Meta AI

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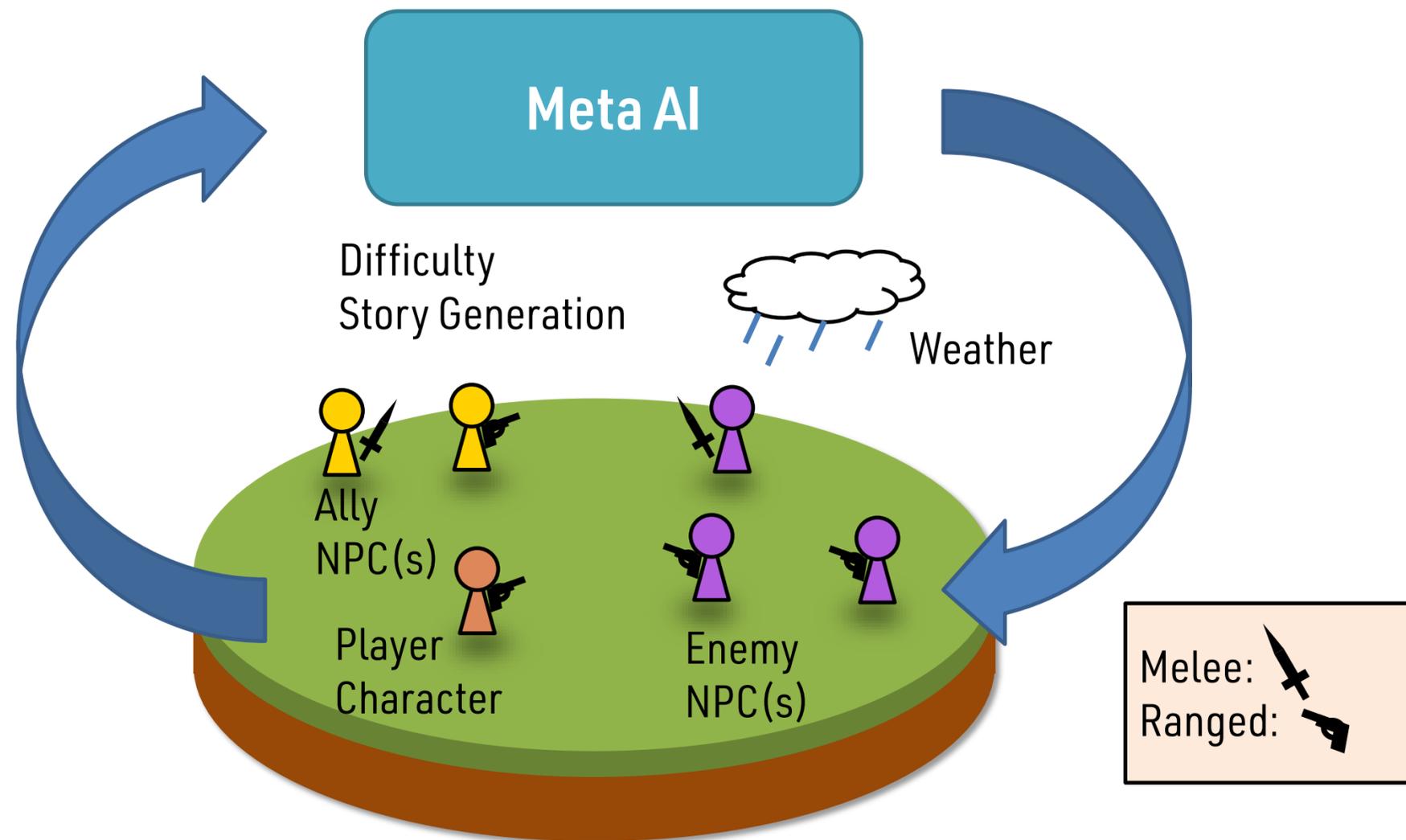
GDC

GAME DEVELOPERS CONFERENCE

MARCH 18-22, 2019 | #GDC19

Meta AI example

Meta AI (AI Director) controls the whole game...



Meta AI example

Meta AI (AI Director) controls the whole game...

e.g. weather, enemies, difficulty, story generation...

Left 4 Dead – “From COUNTER-STRIKE to LEFT 4 DEAD: Creating Replayable Cooperative Experiences” (Booth, GDC2009)

TOTAL WAR - “Battle AI in TOTAL WAR: SHOGUN 2 and Lessons Learned” (Gudmundsson, PGAI 2011)

WARFRAME - “Space Ninjas with Machineguns!” (Brewer, GDC2013)

Far Cry 4 - “Far Cry’s AI: A manifesto for systemic and emergent game-play and open world ” (Varnier, GAIC2014)

Assassin’s Creed Origins - “Virtual Insanity: Meta AI on 'Assassin's Creed: Origins'” (Lefebvre, GDC2018)

Final Fantasy XV - “Eos is Alive: The AI Systems of 'Final Fantasy XV'” (Miyake, GDC2018)

-> Meta AI is becoming more necessary

Why?

Let's start by asking "Why?"

Why do you make games?

Why?

Why do we need to try?

Why do you try **to make your games the best?**

Why?

Why do we need to make the game best?

For me, the reason why:

Games are NOT necessary

Games are not necessary, So...

What will happen if games are not necessary?

GAME = NOT necessary

Not needed for living... food/sleep/reproduction

Games are not necessary, So...

What will happen if games are not necessary?

GAME = NOT necessary

Not needed for living... food/sleep/reproduction

Easy to avoid to buy

Games are not necessary, So...

What will happen if games are not necessary?

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Easy to avoid to buy

Easy to quit

Games are not necessary, So...

What will happen if games are not necessary?

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Not needed for living... food/sleep/reproduction

Easy to avoid to buy Easy to quit

Why are we working so hard?

Games are not necessary, So...

What will happen if games are not necessary?

GAME = NOT necessary

Not needed for living... food/sleep/reproduction

Easy to avoid to buy Easy to quit

But it makes me excited!

What should we do?

If it's not necessary, people judge very severely.

Games are NOT necessary

So, we must **compel** people to play

What is needed?

If it's not necessary, people judge very severely.

Games are NOT necessary

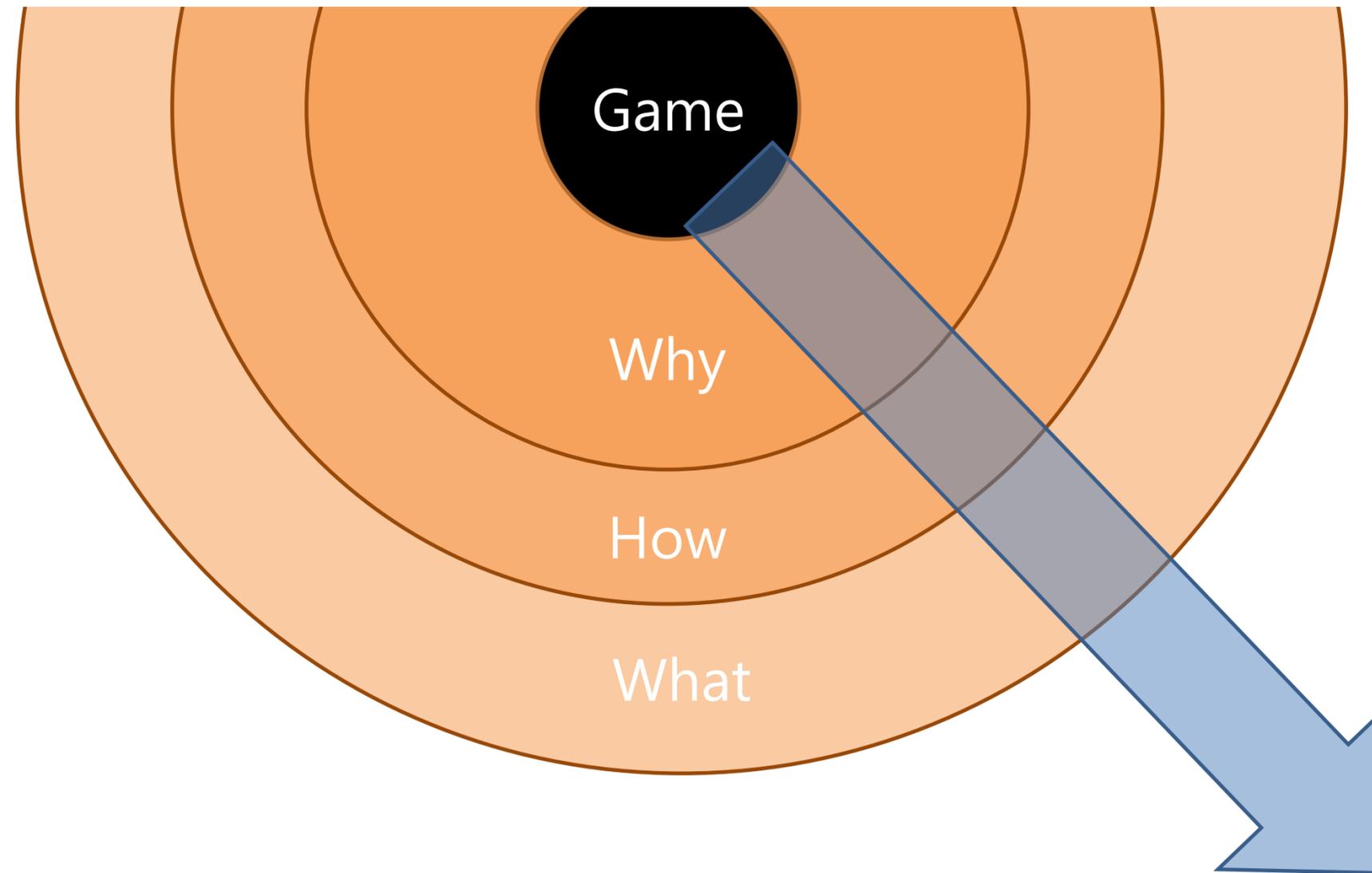
Good game is NOT enough

Better game is still NOT enough

BEST game is the only one way

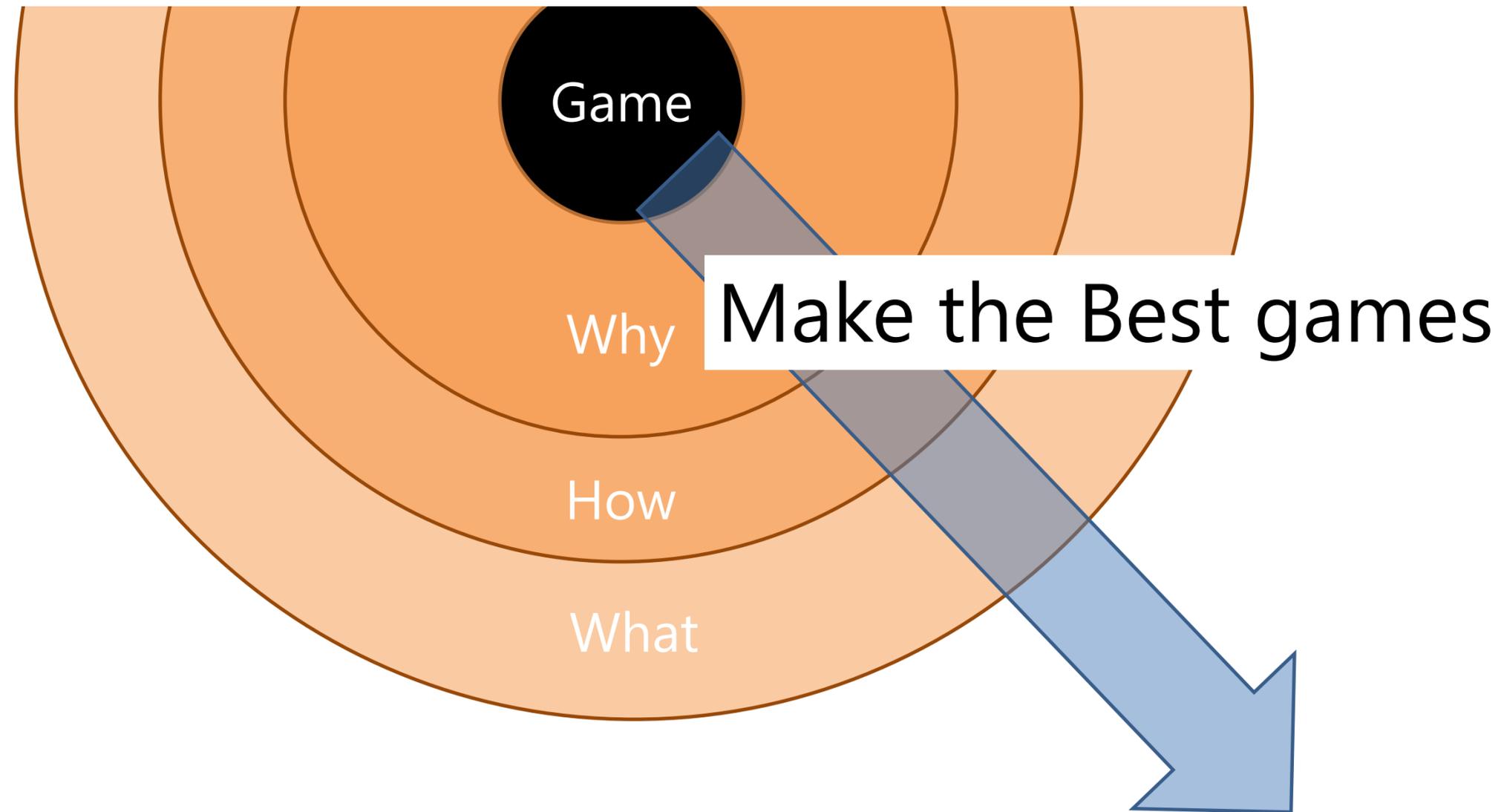
Why, How, What about game

The way to make the best game is...



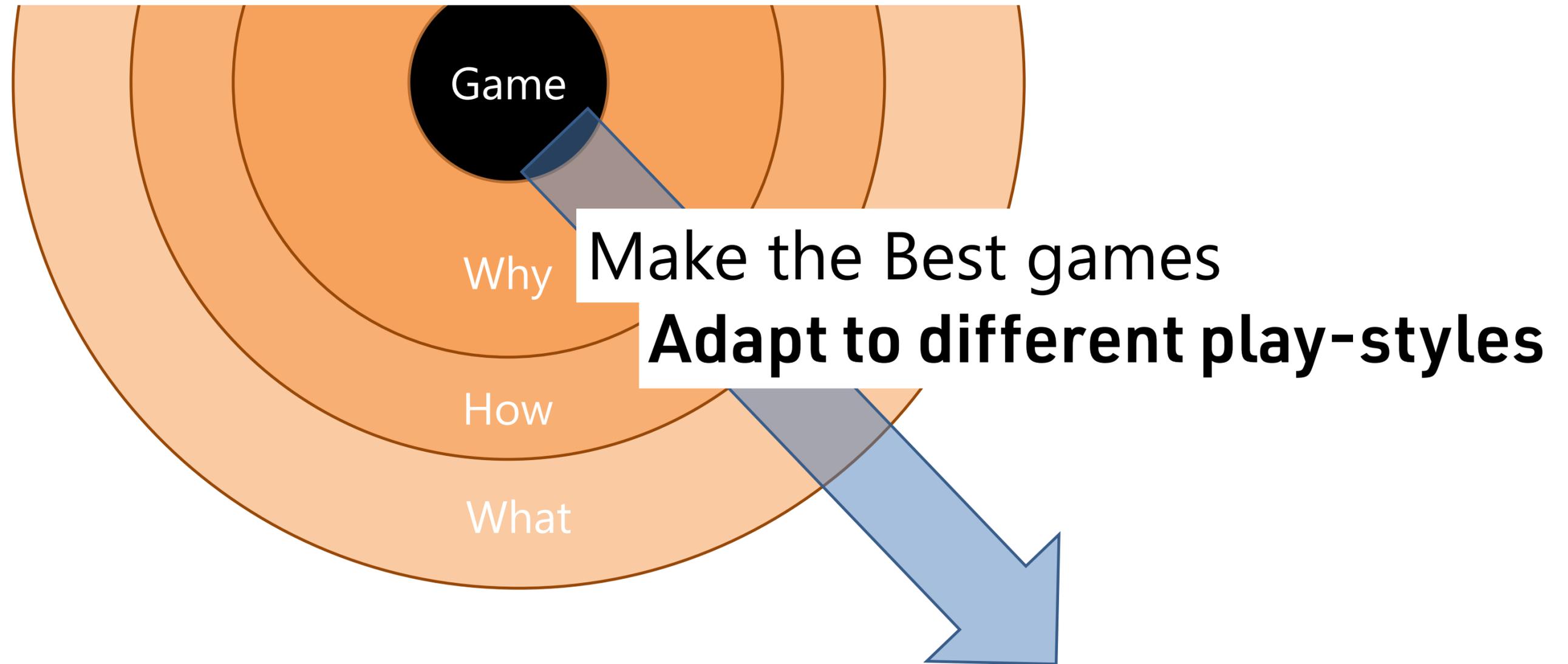
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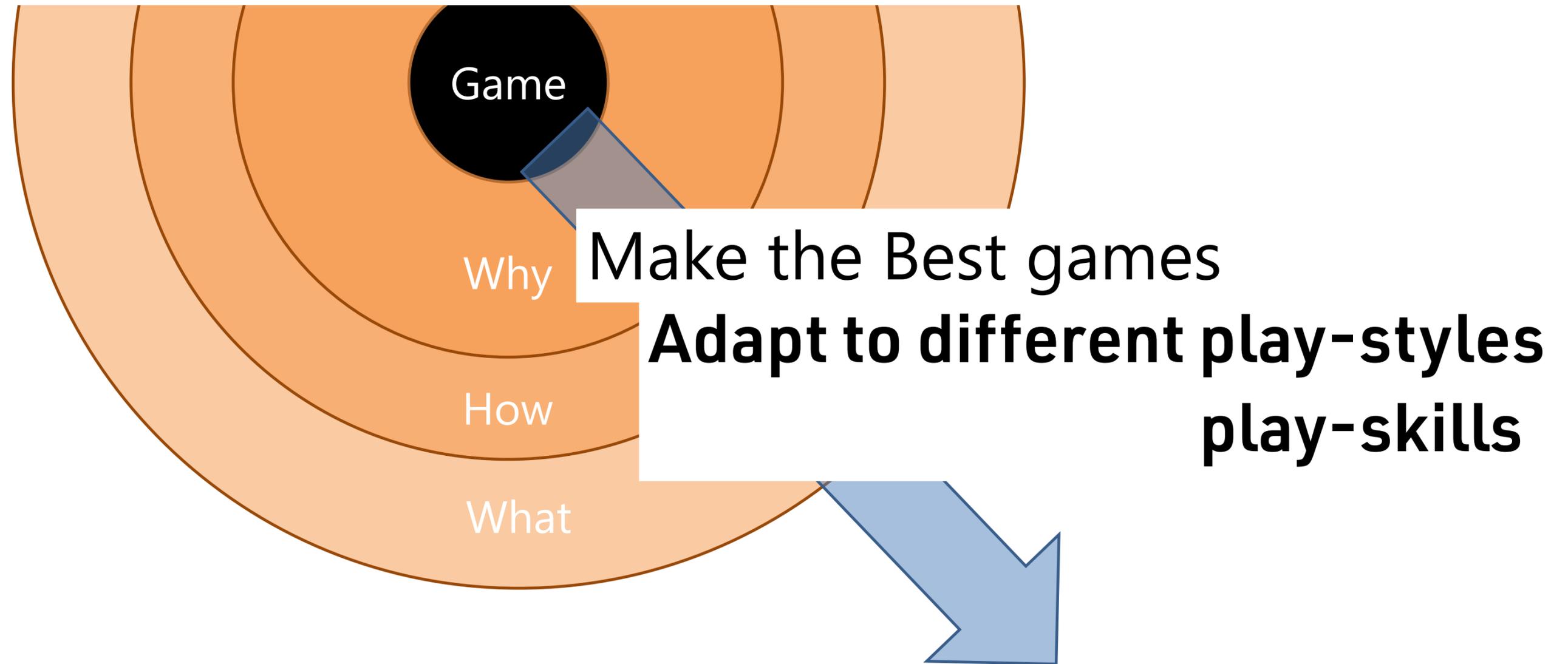
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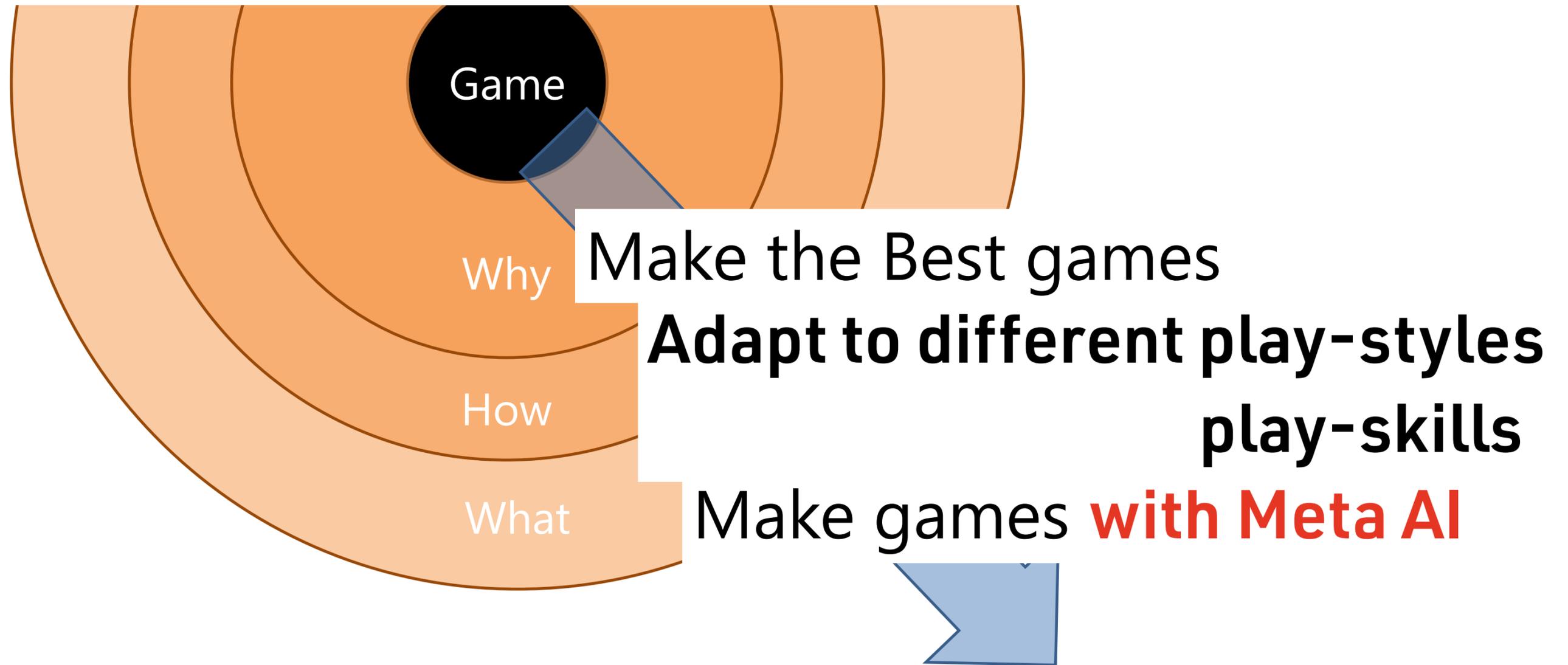
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Why, How, What about game

The way to make the best game is...



Introduction

- **Yuta Mizuno**
 - AI technical Game Designer
 - Meta AI research, Advocating and Consulting Meta AI to Products
 - The Meta AI General design
- **Daiki Satoi, Ph.D.**
 - AI researcher
 - R&D on Meta AI, Game Play Analysis, Character AI
 - The 2D Emotion-based Meta AI

Summary

- **Meta AI overview**
 - Why Meta AI
 - What is Meta AI

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 - Why Meta AI
 - What is Meta AI
- **Meta AI General Design**
 - How to make Meta AI
 - What can Game Designer do for Meta AI

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- **Meta AI overview**
 - Why Meta AI
 - What is Meta AI
- **Meta AI General Design**
 - How to make Meta AI
 - What can Game Designer do for Meta AI
- **Meta AI Practical Model**
 - Emotion-based Meta AI
 - Visualization for Meta AI

Takeaways

- Usefulness of Meta AI General Design
- Using Ru-I-Di-ism with fellow game designers
- Measuring and influencing player's emotion
- Benefits of 2D Emotion-based Meta AI
- Importance of Visualizing gameplay and emotion

Summary

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 - Why Meta AI?

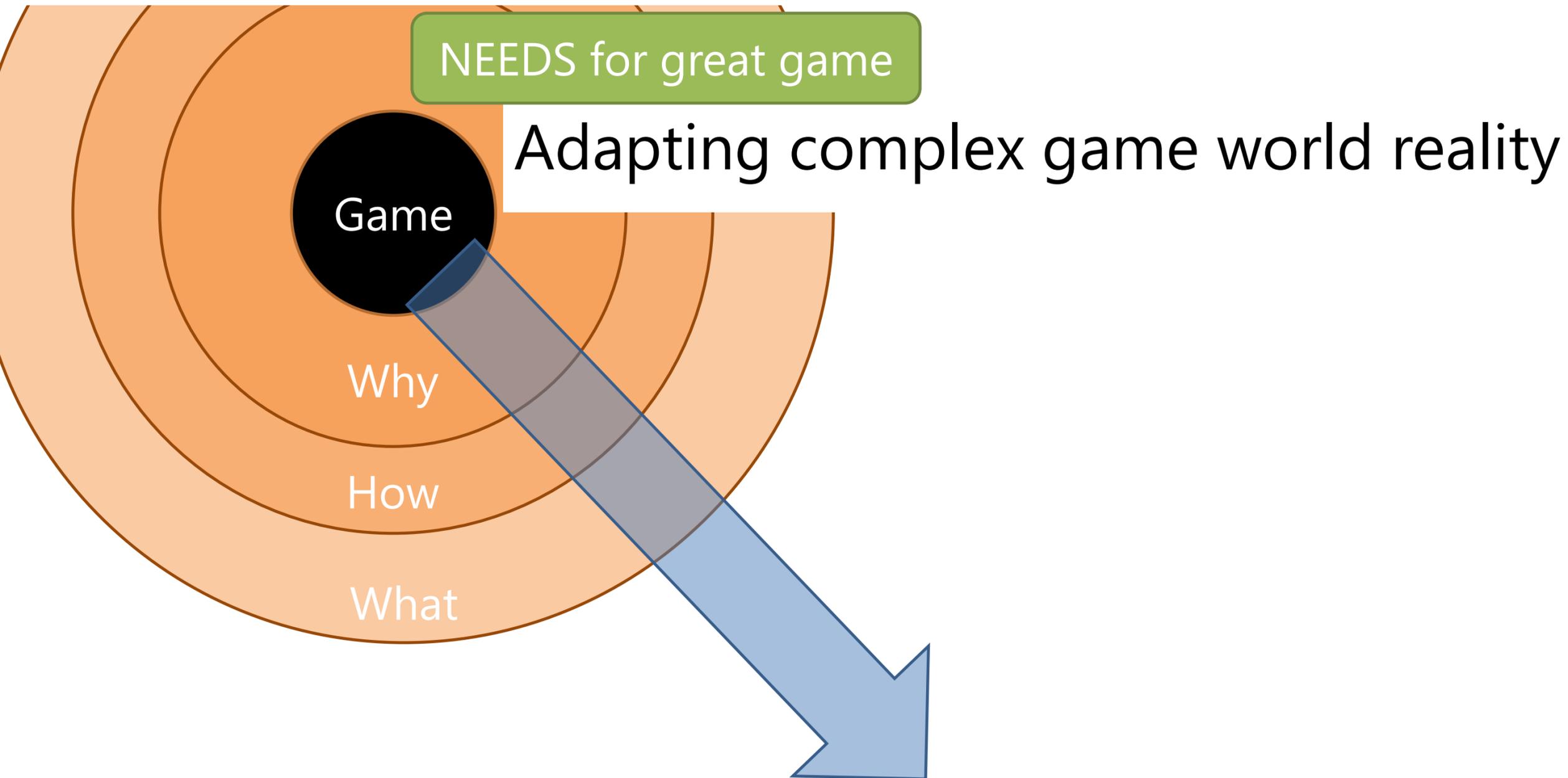
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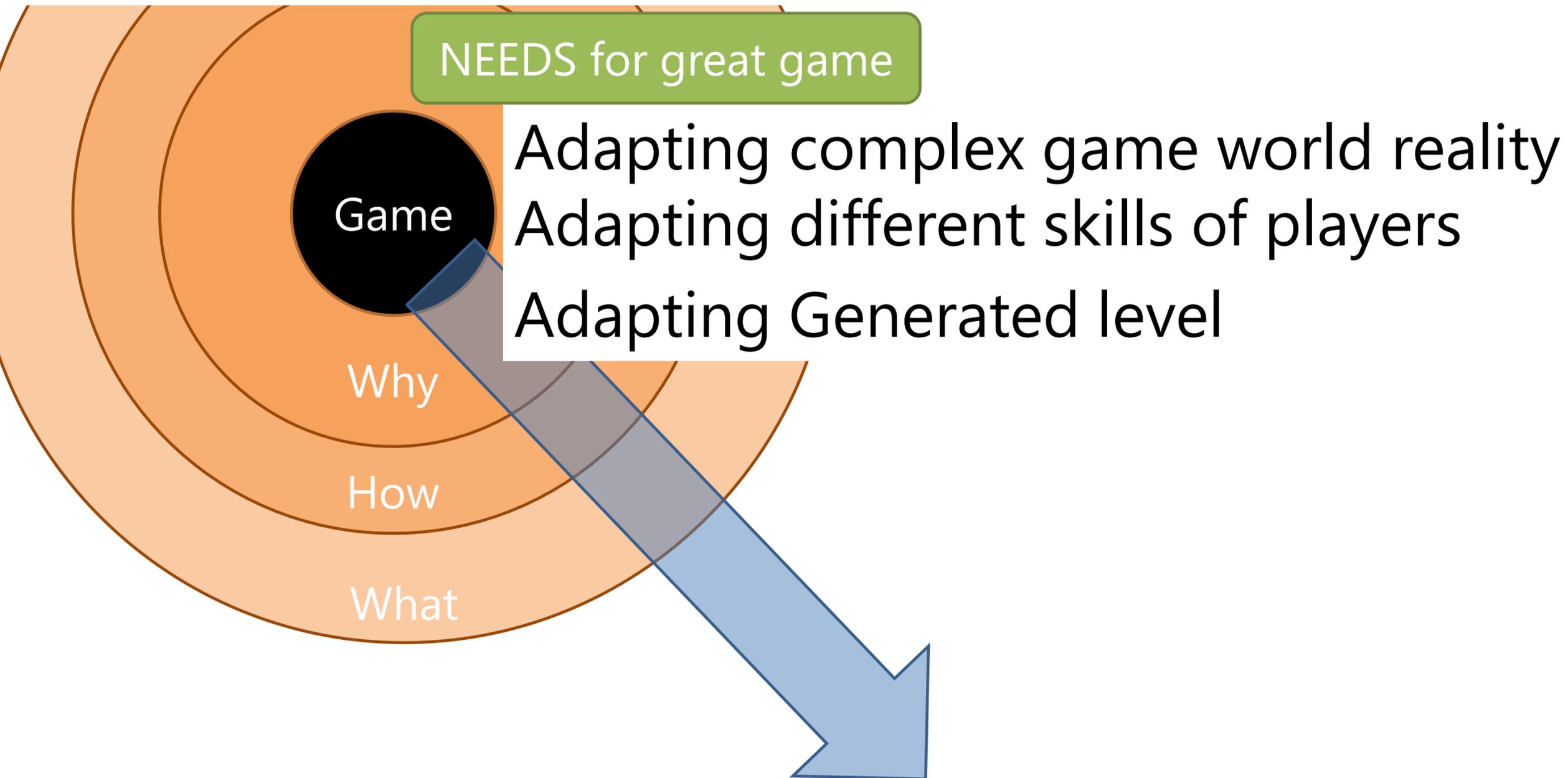
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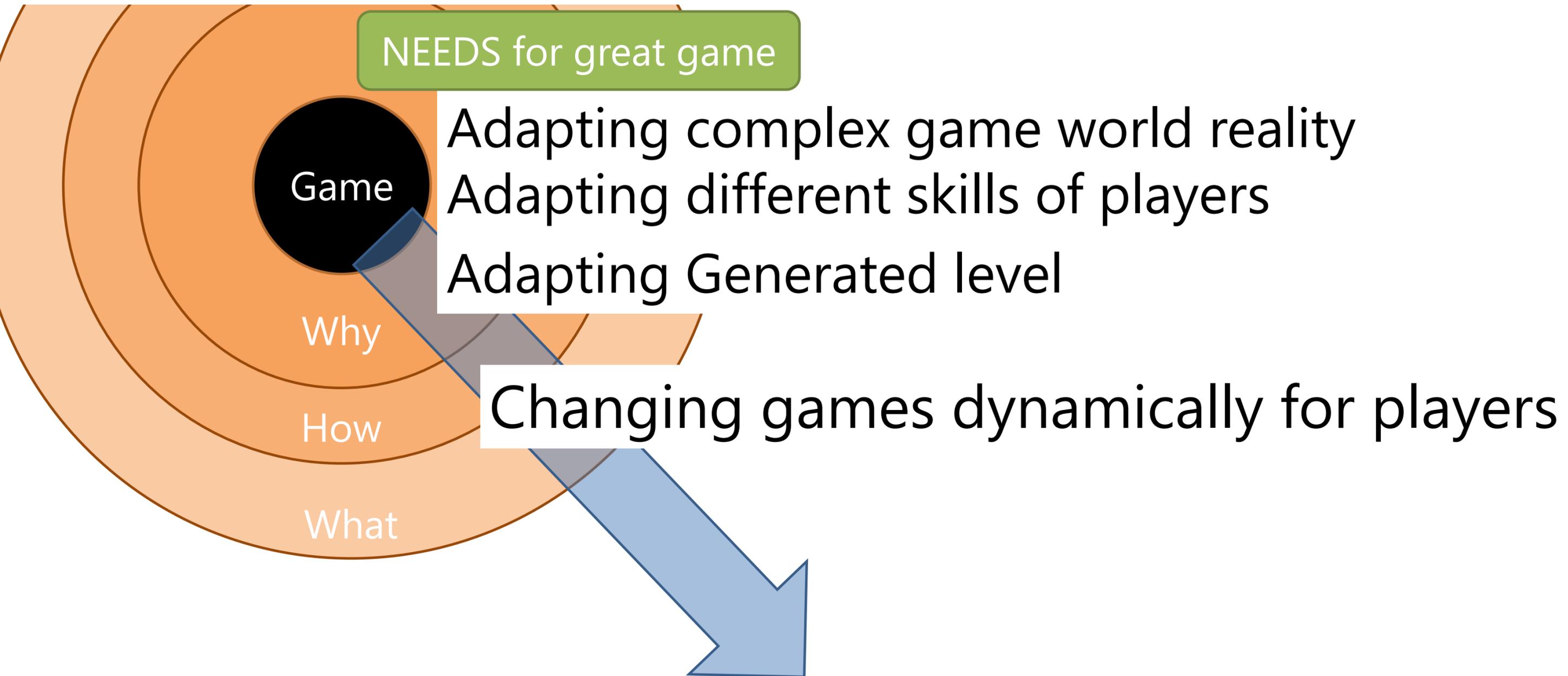
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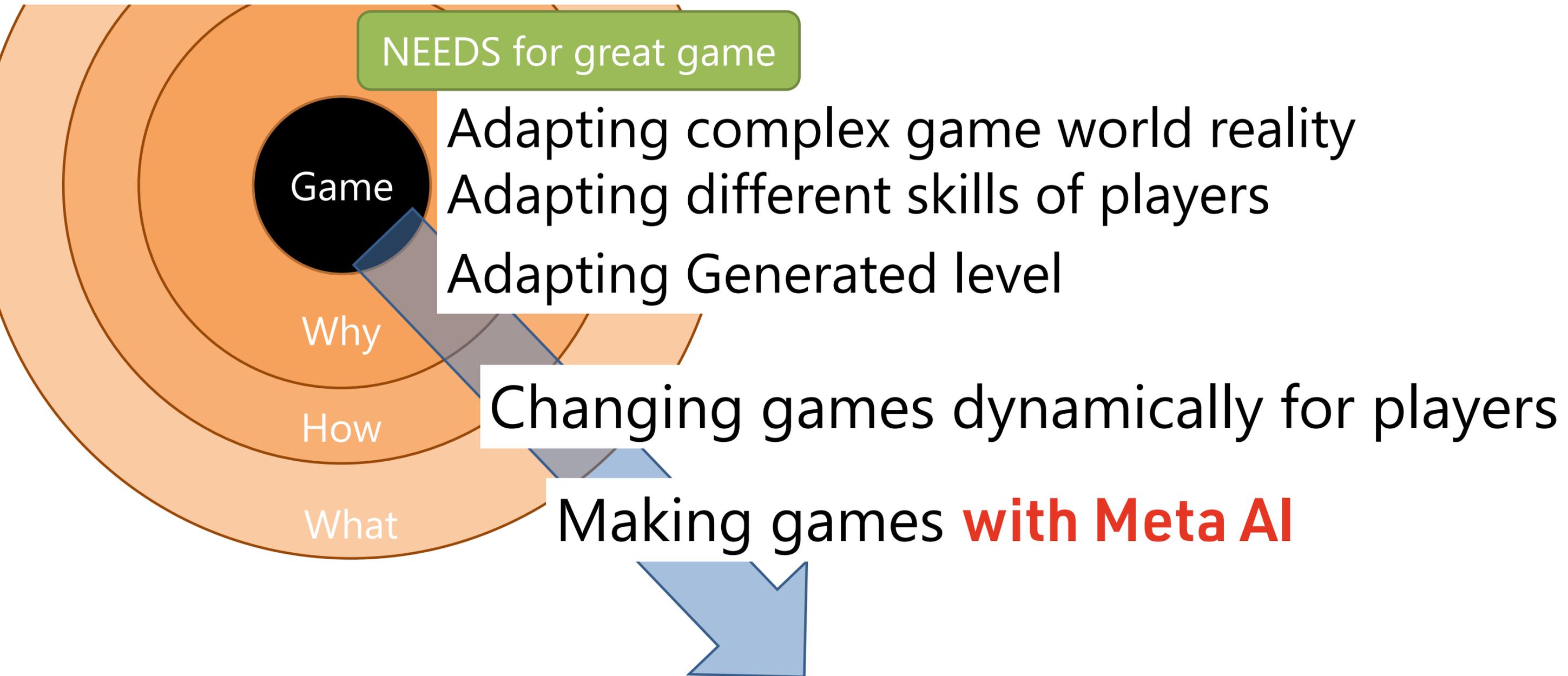
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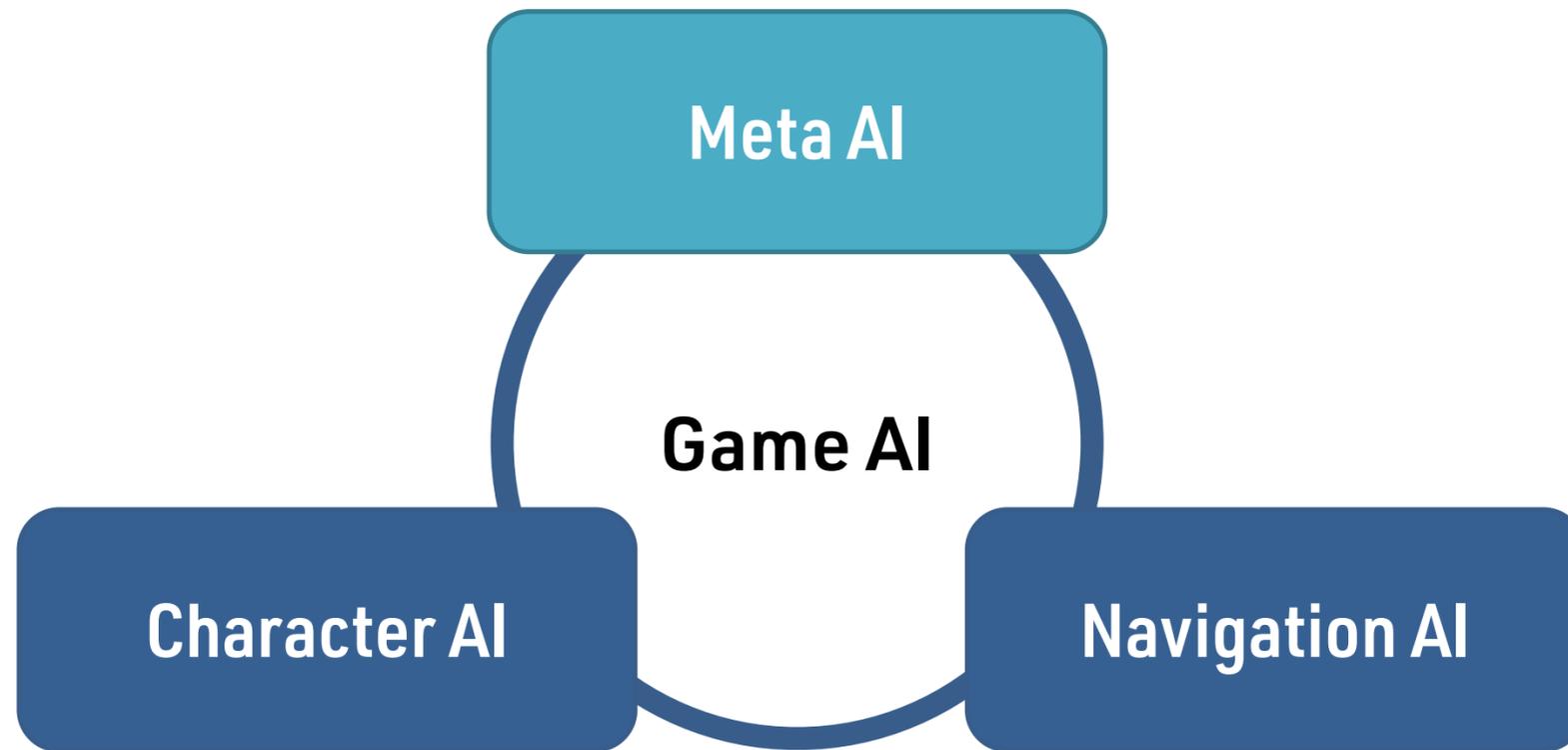


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 - **What is Meta AI**

What is Meta AI?

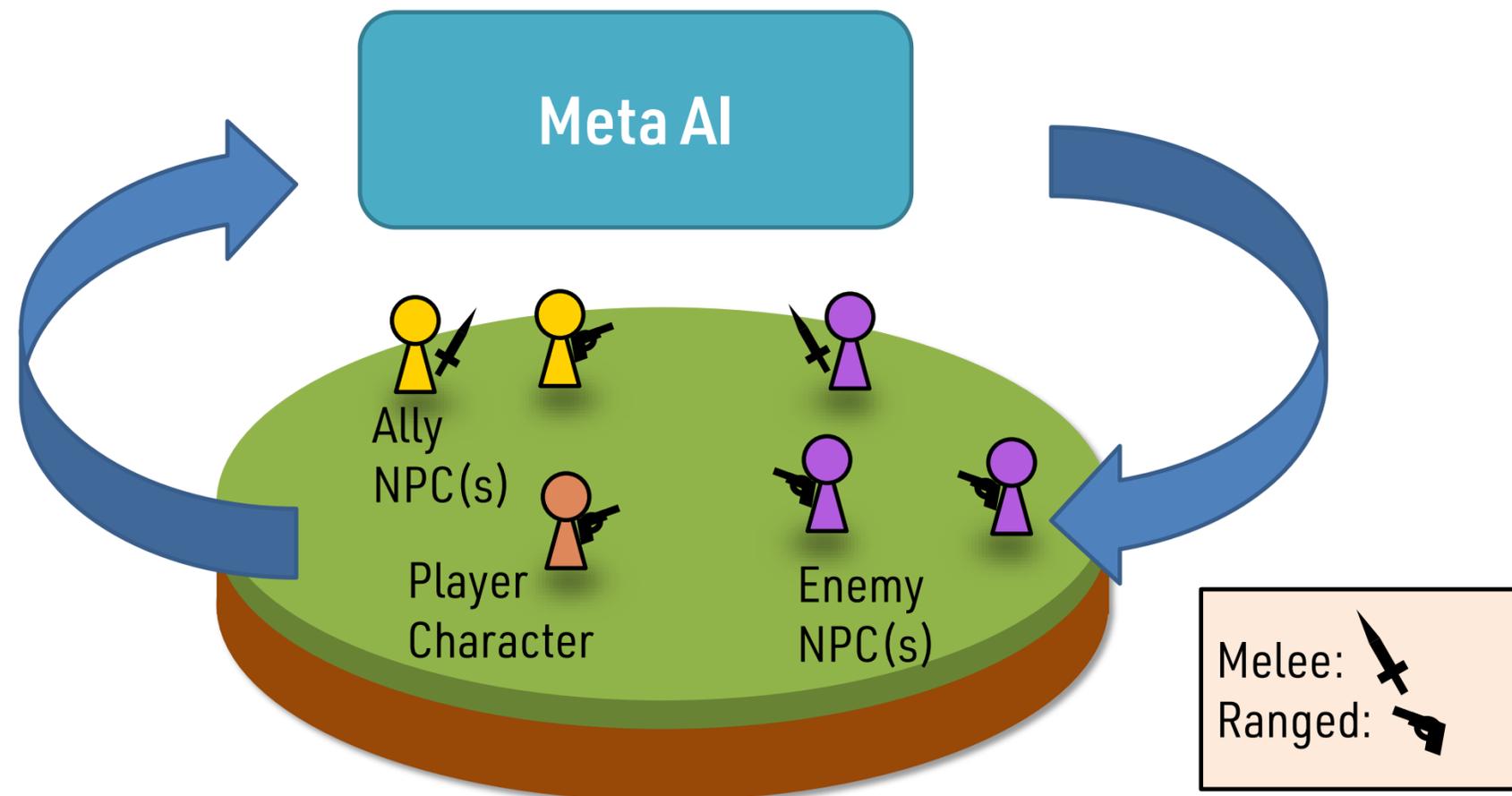
Meta AI is one type of Game AIs



What is Meta AI?

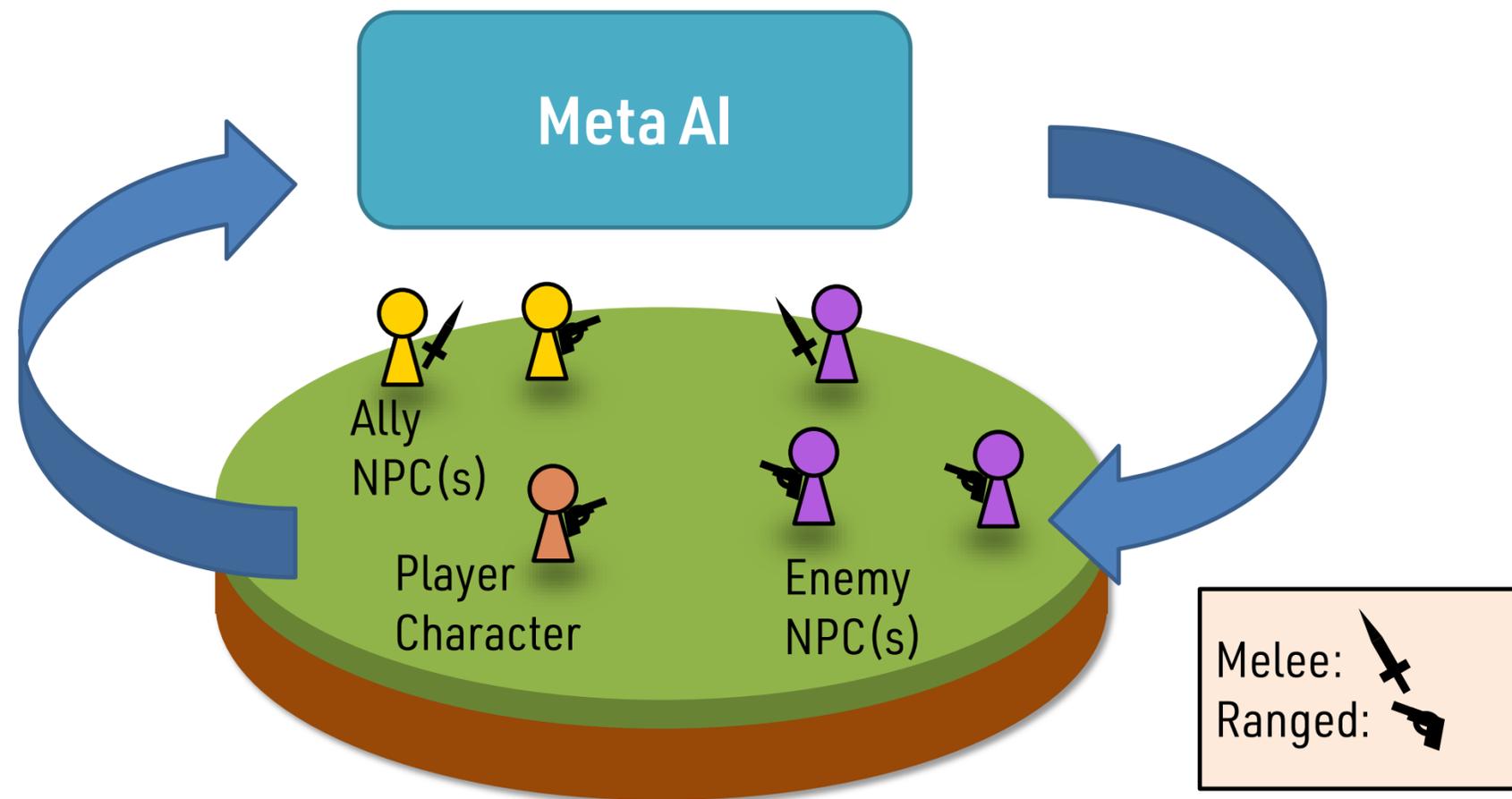
Meta AI is ...

- **Senses** the whole Game World
- Dynamically **controls the whole** game



What is Meta AI?

- Senses the whole Game World
- Dynamically controls the whole game



→ How to implement
Meta AI?

Summary

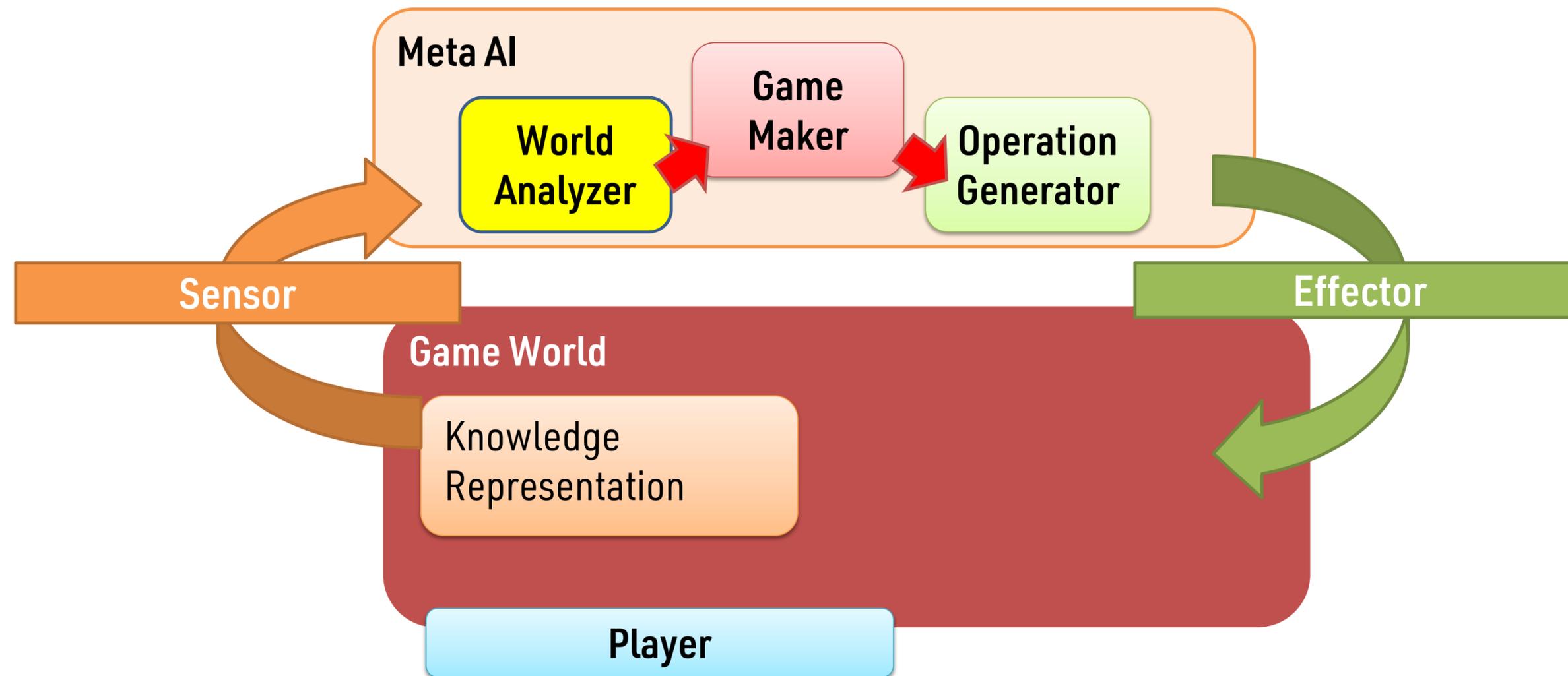
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 - Why Meta AI
 - What is Meta AI
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- **Meta AI General Design**
 - **How to make Meta AI**

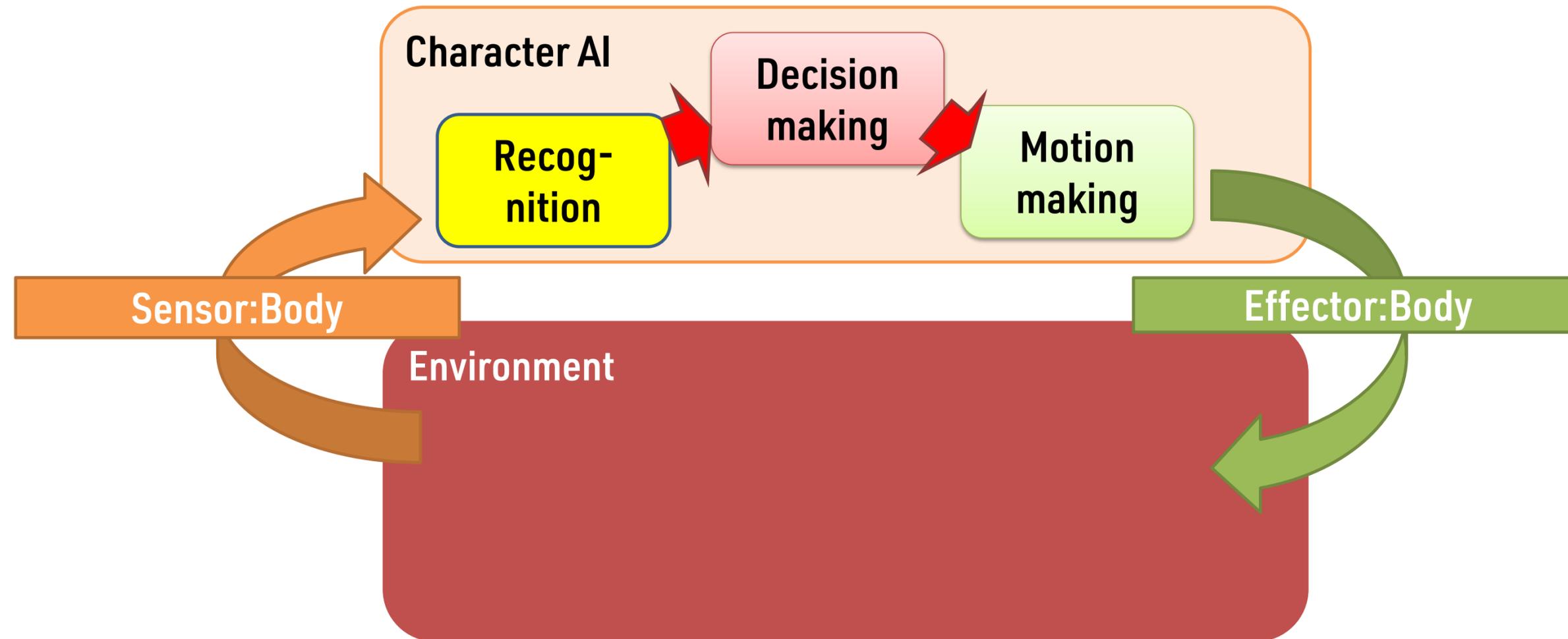
General Design Of Meta AI

This is a general design of Meta AI.



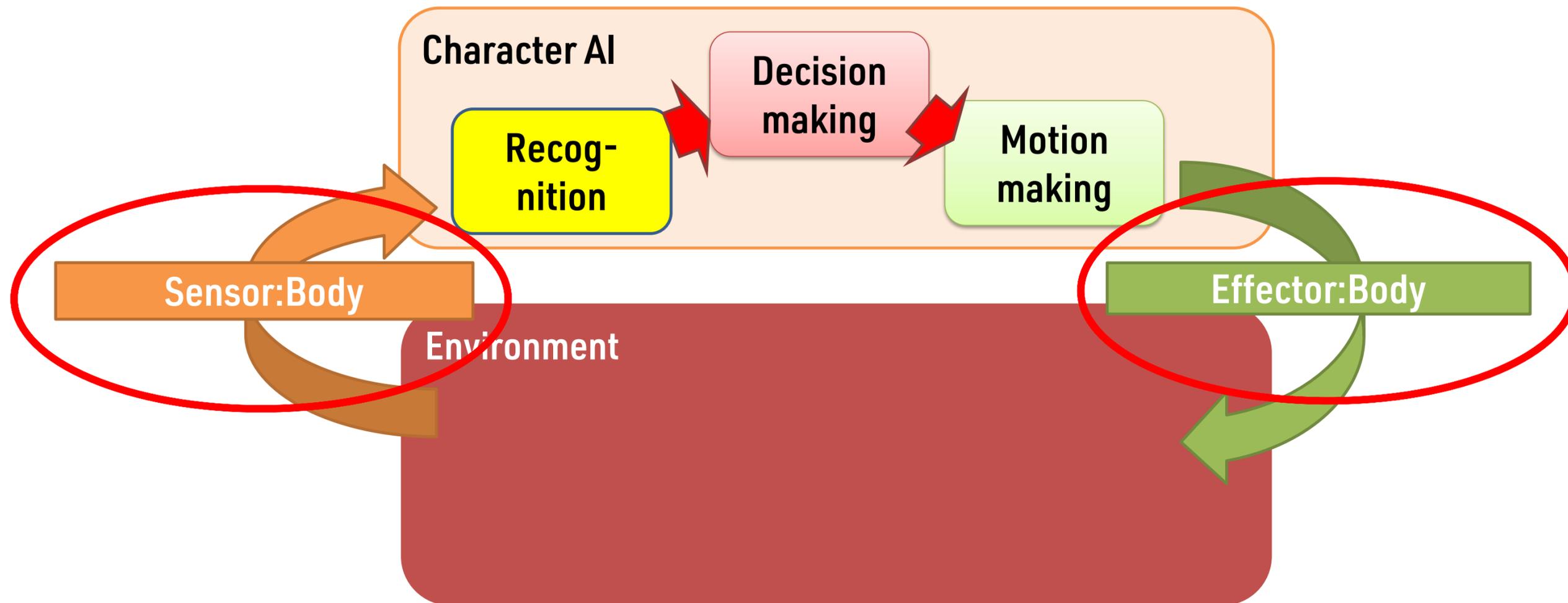
Start From An Agent Architecture

At the beginning, consider an agent architecture, well known in the robotics field.



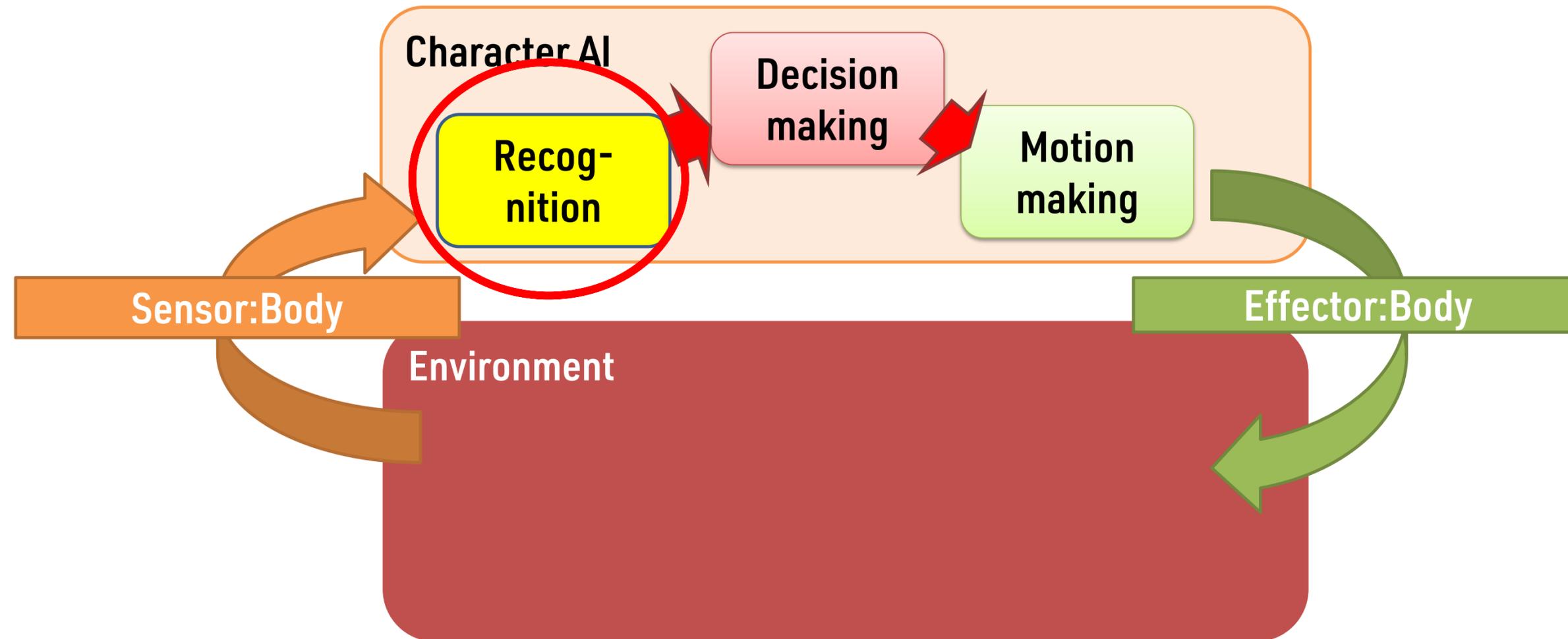
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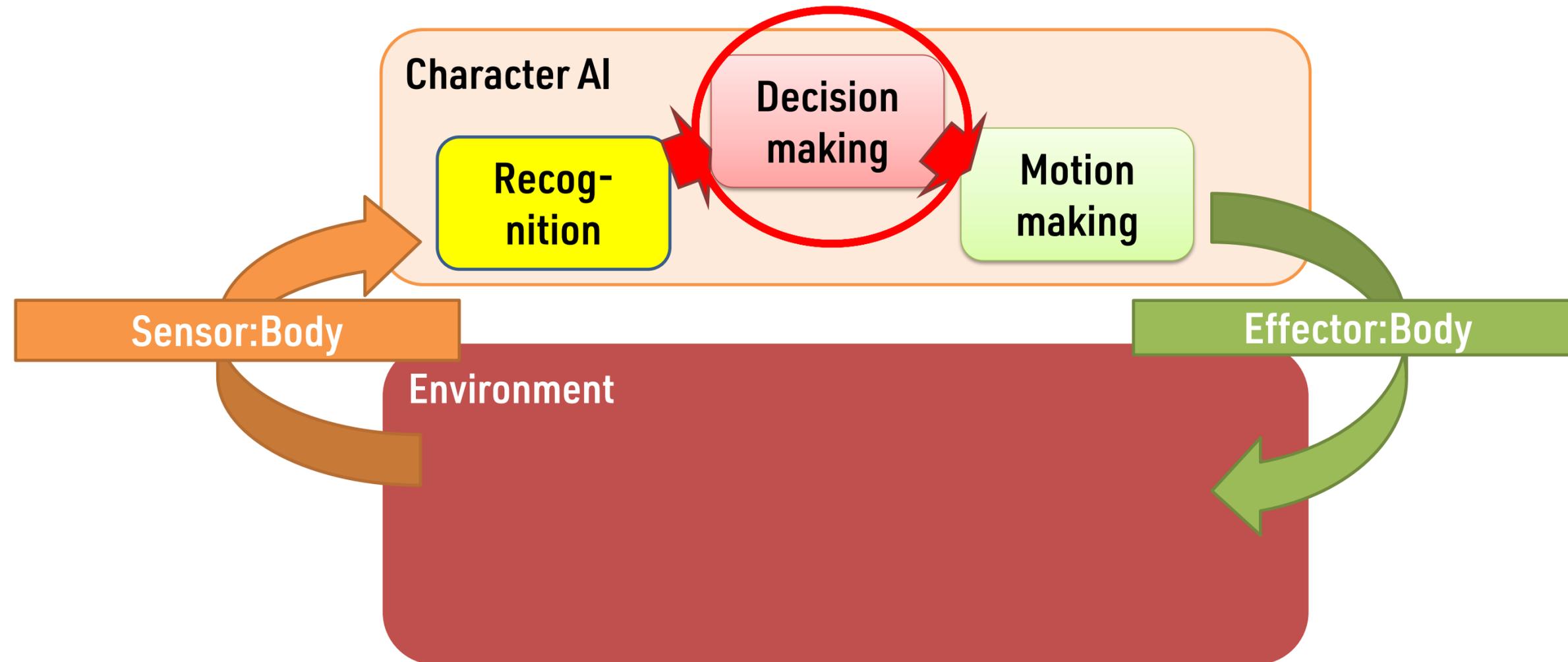
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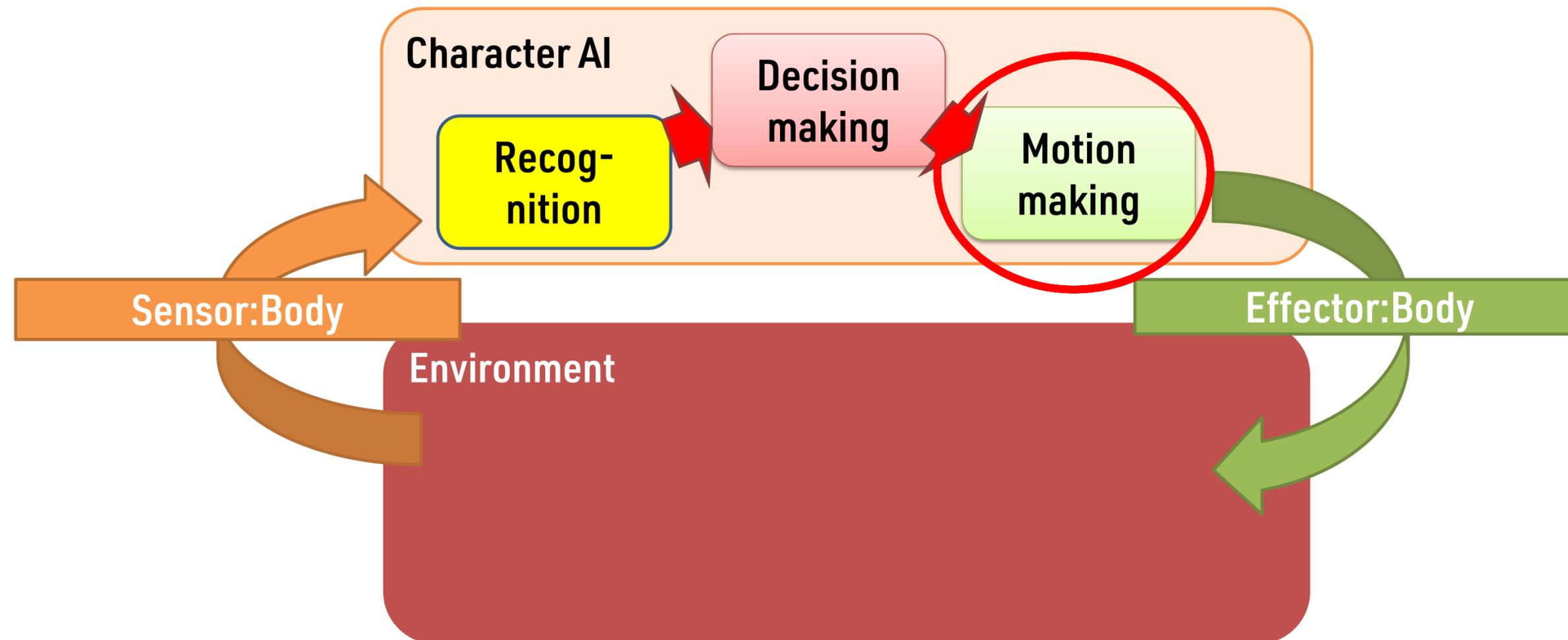
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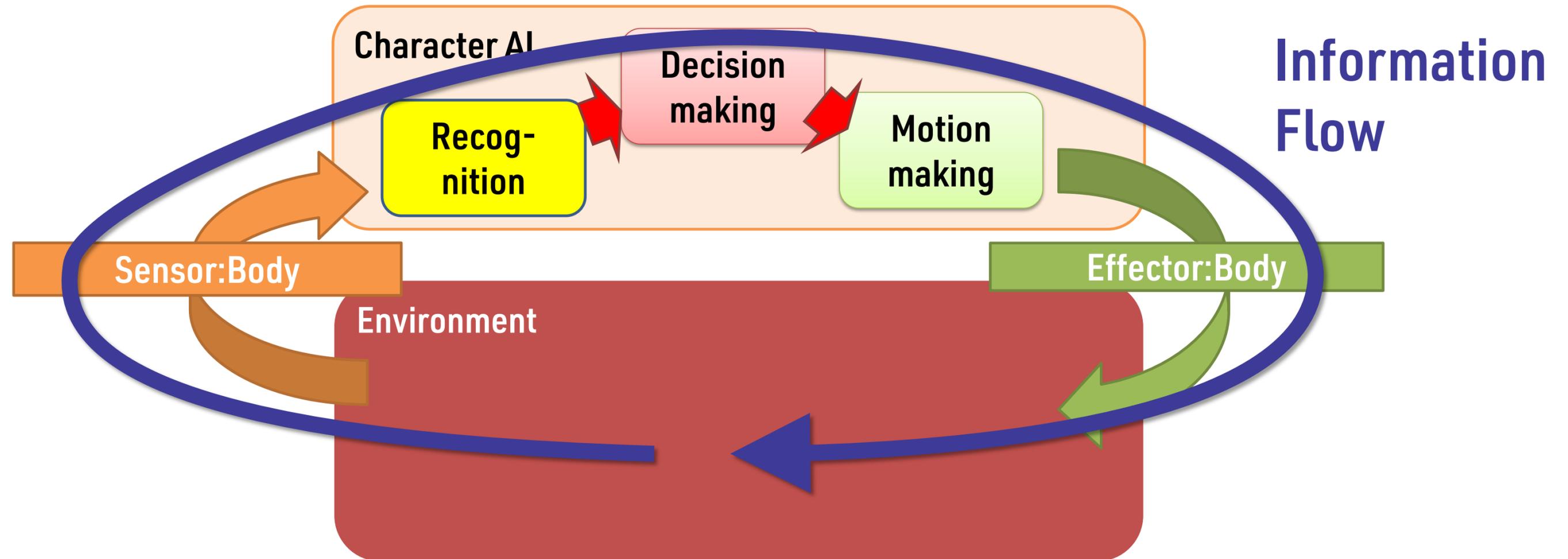
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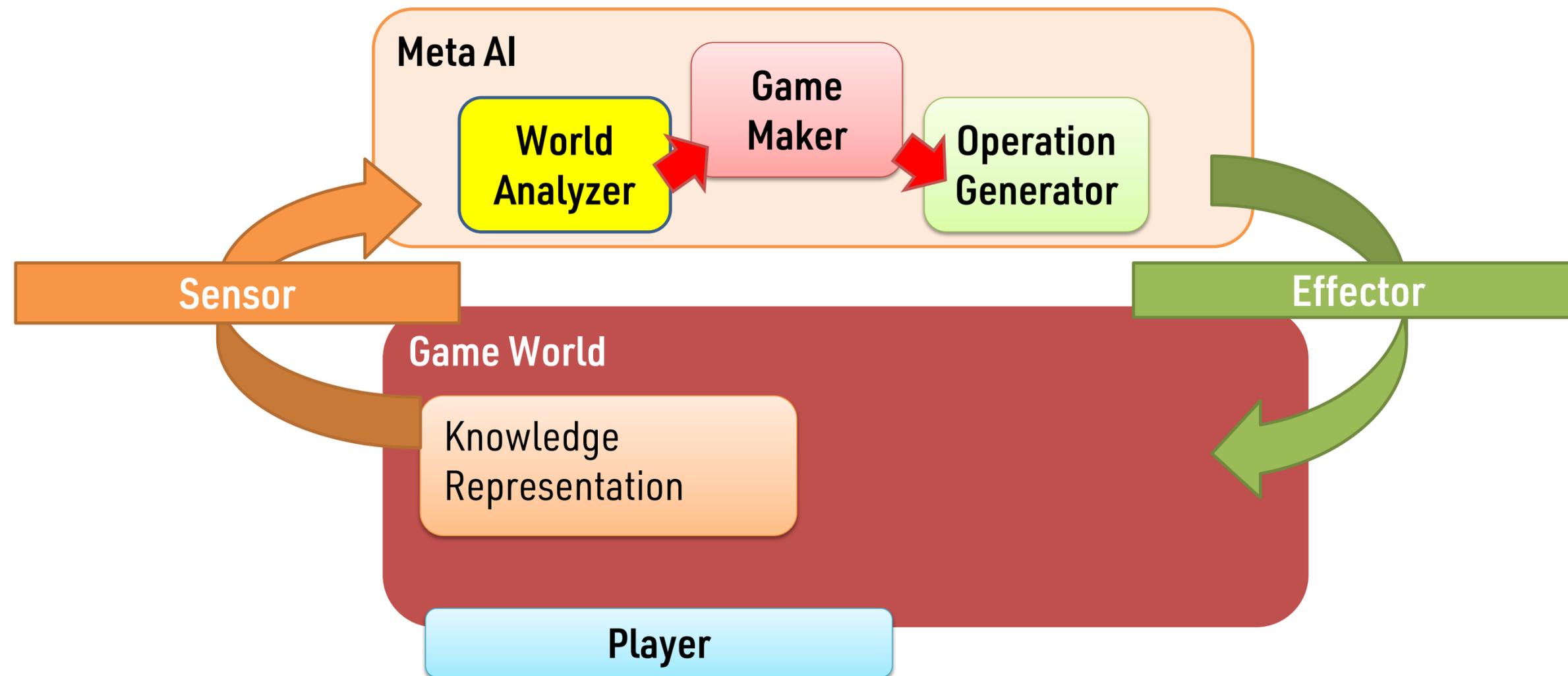
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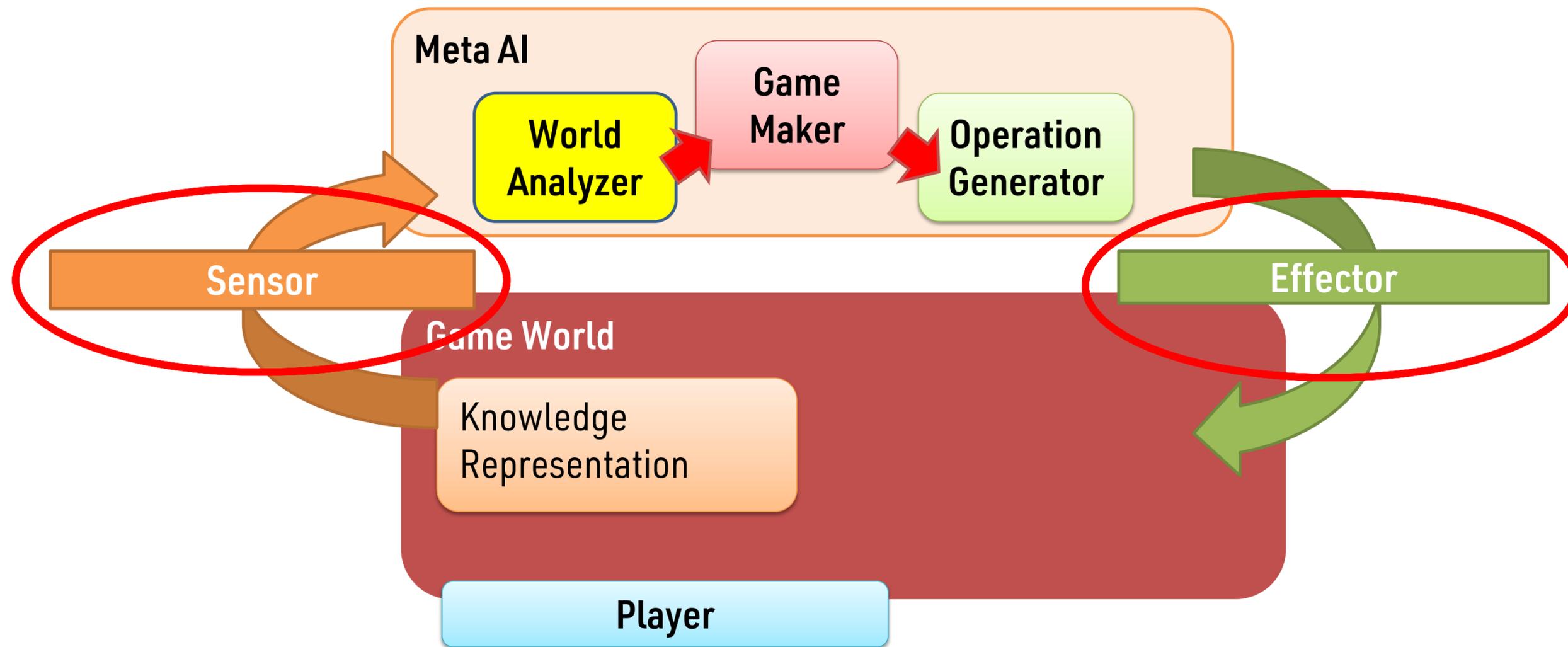
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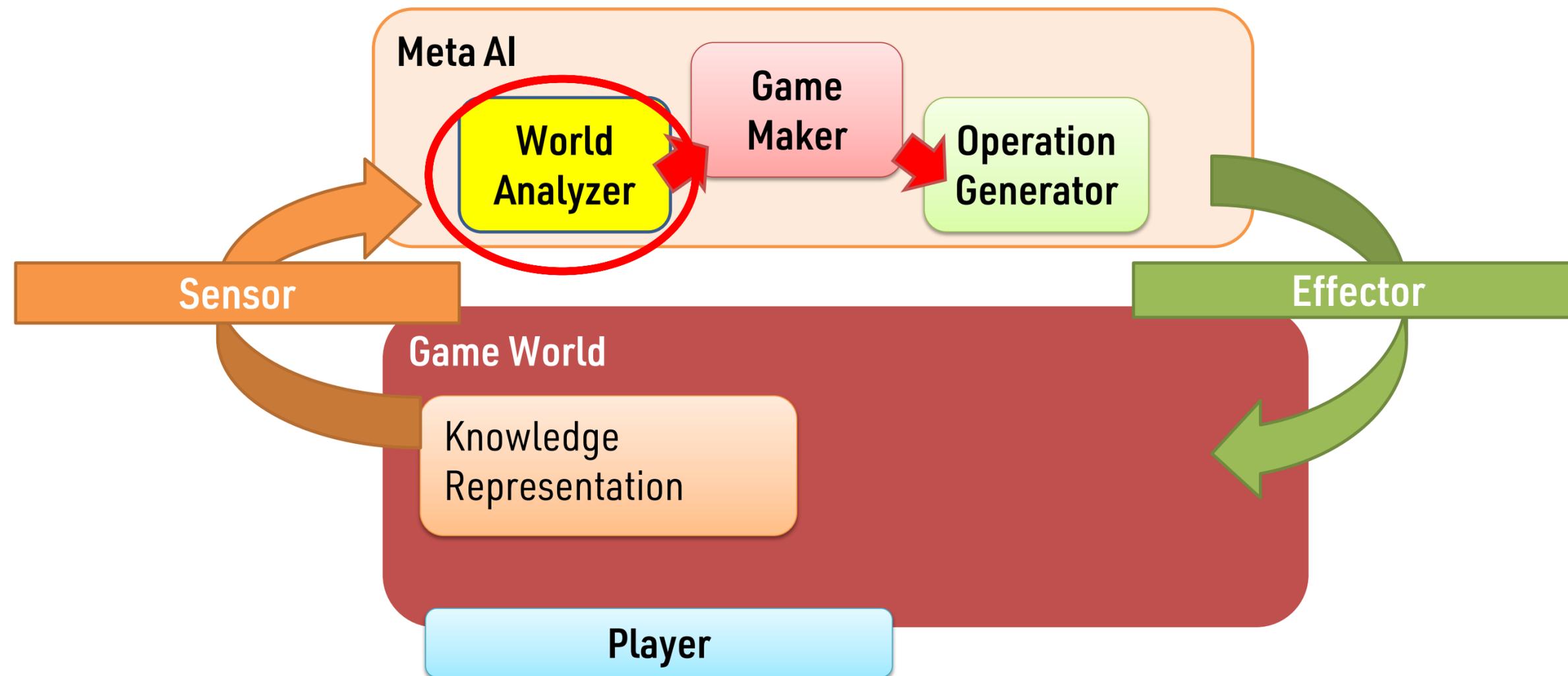
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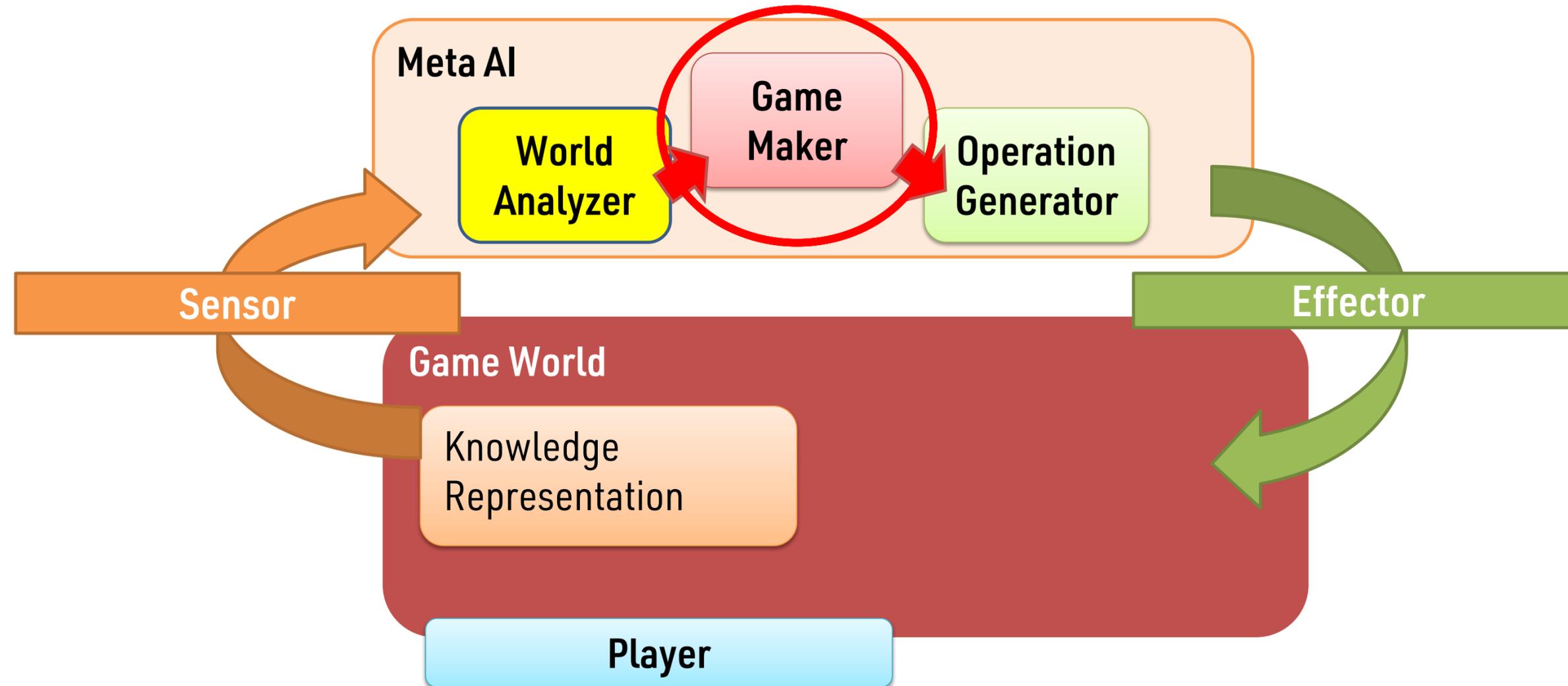
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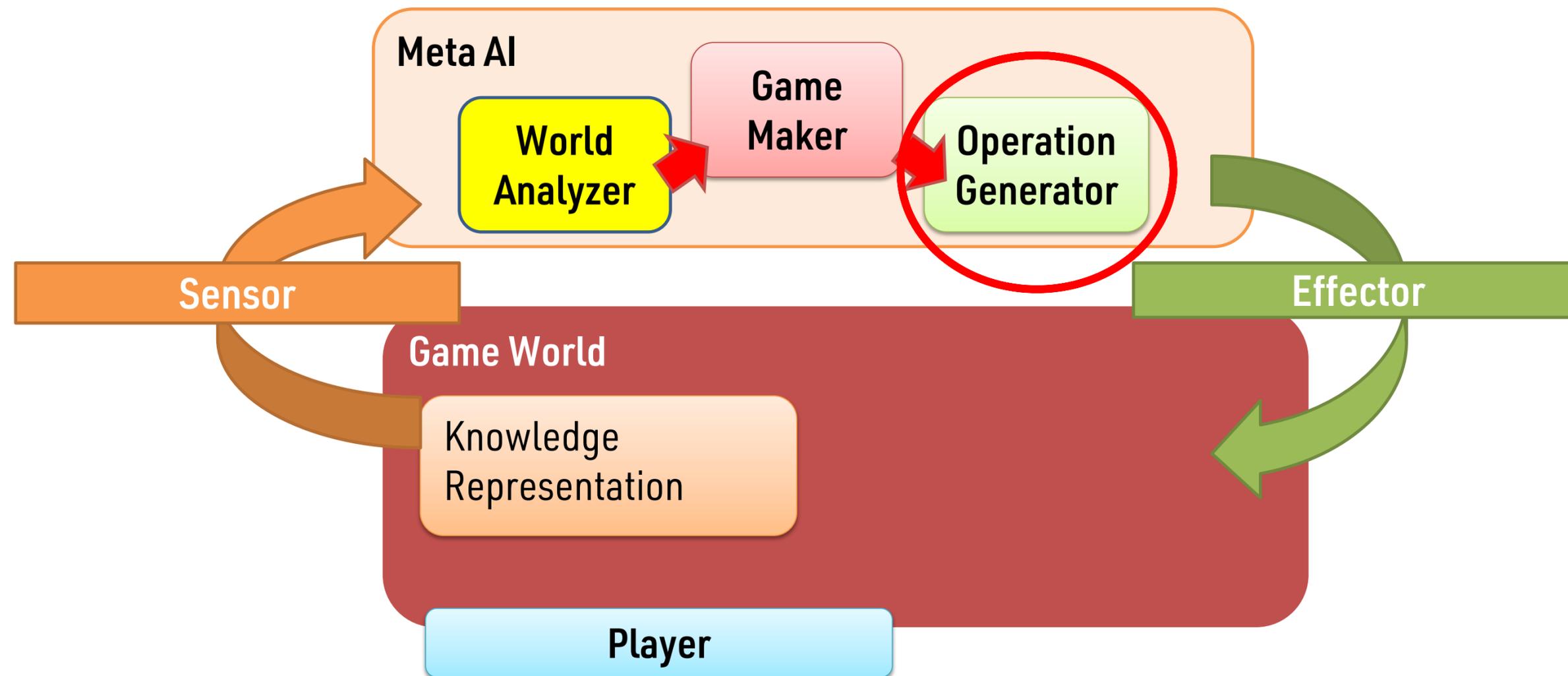
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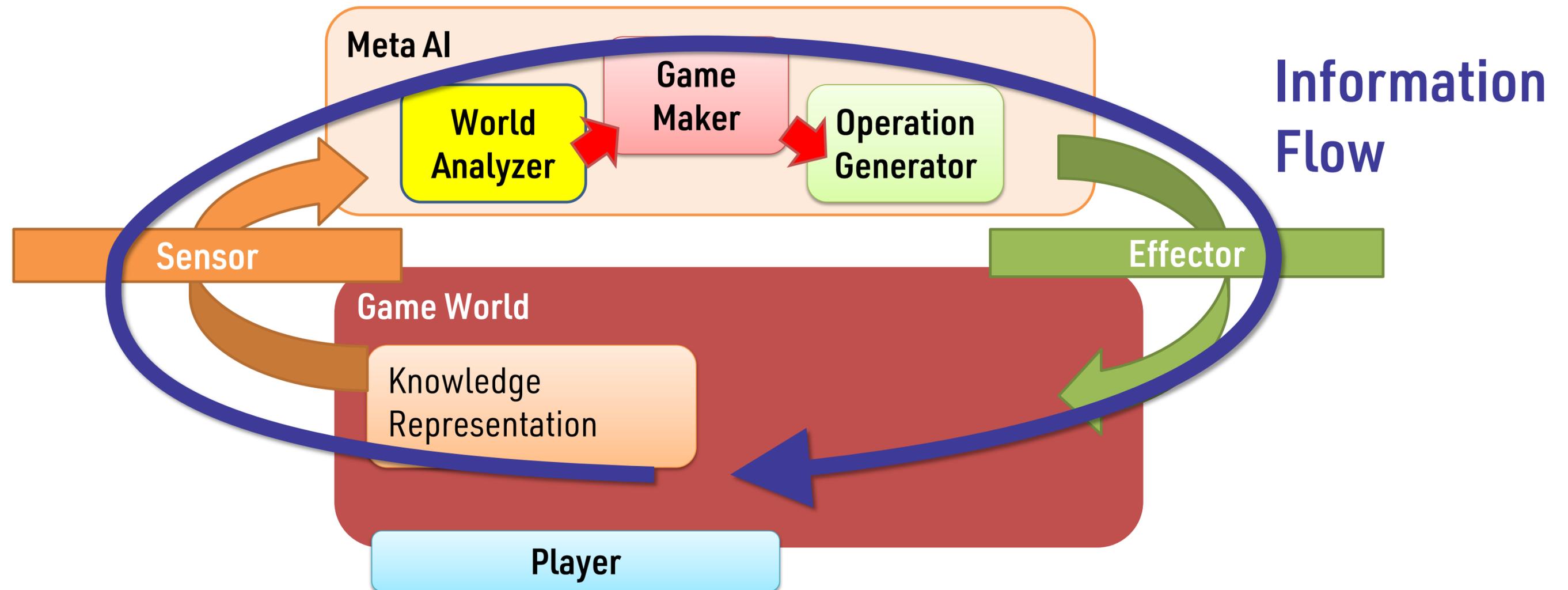
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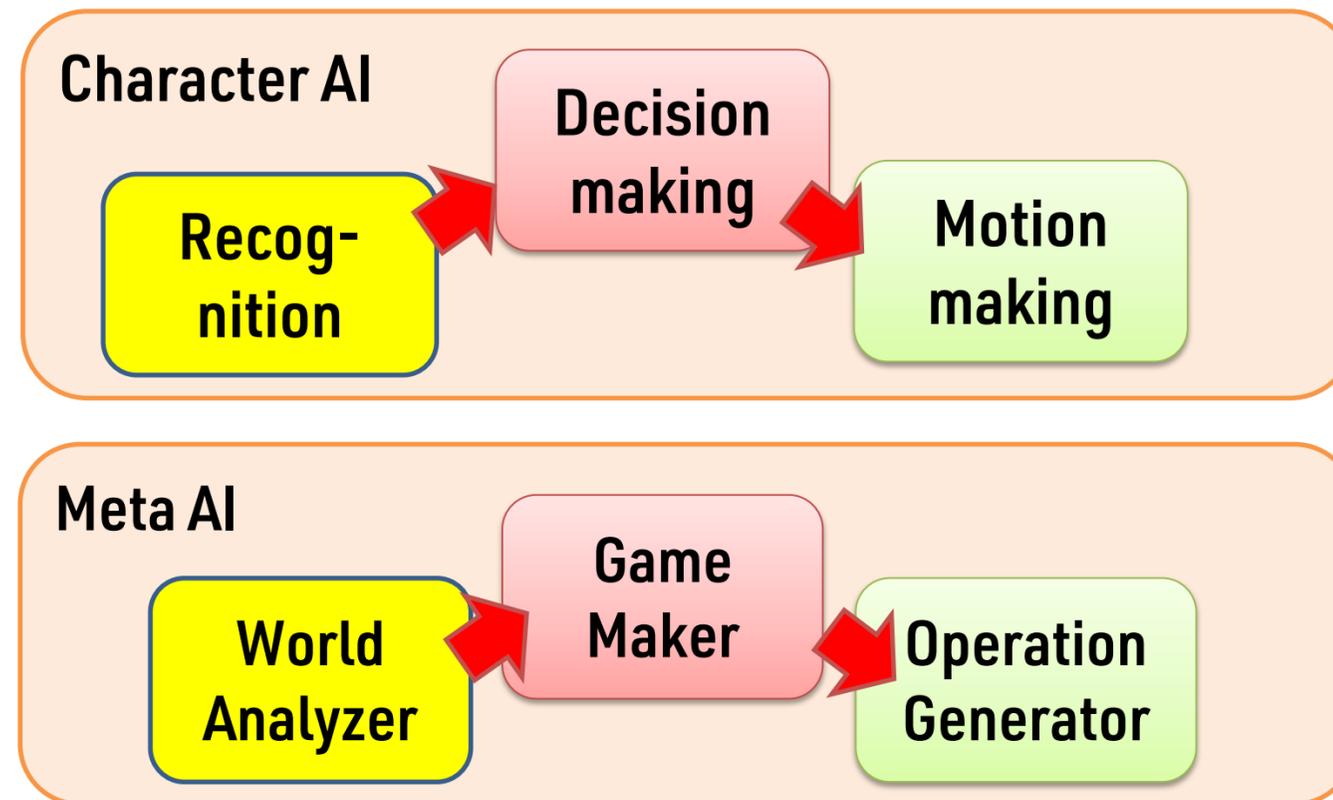
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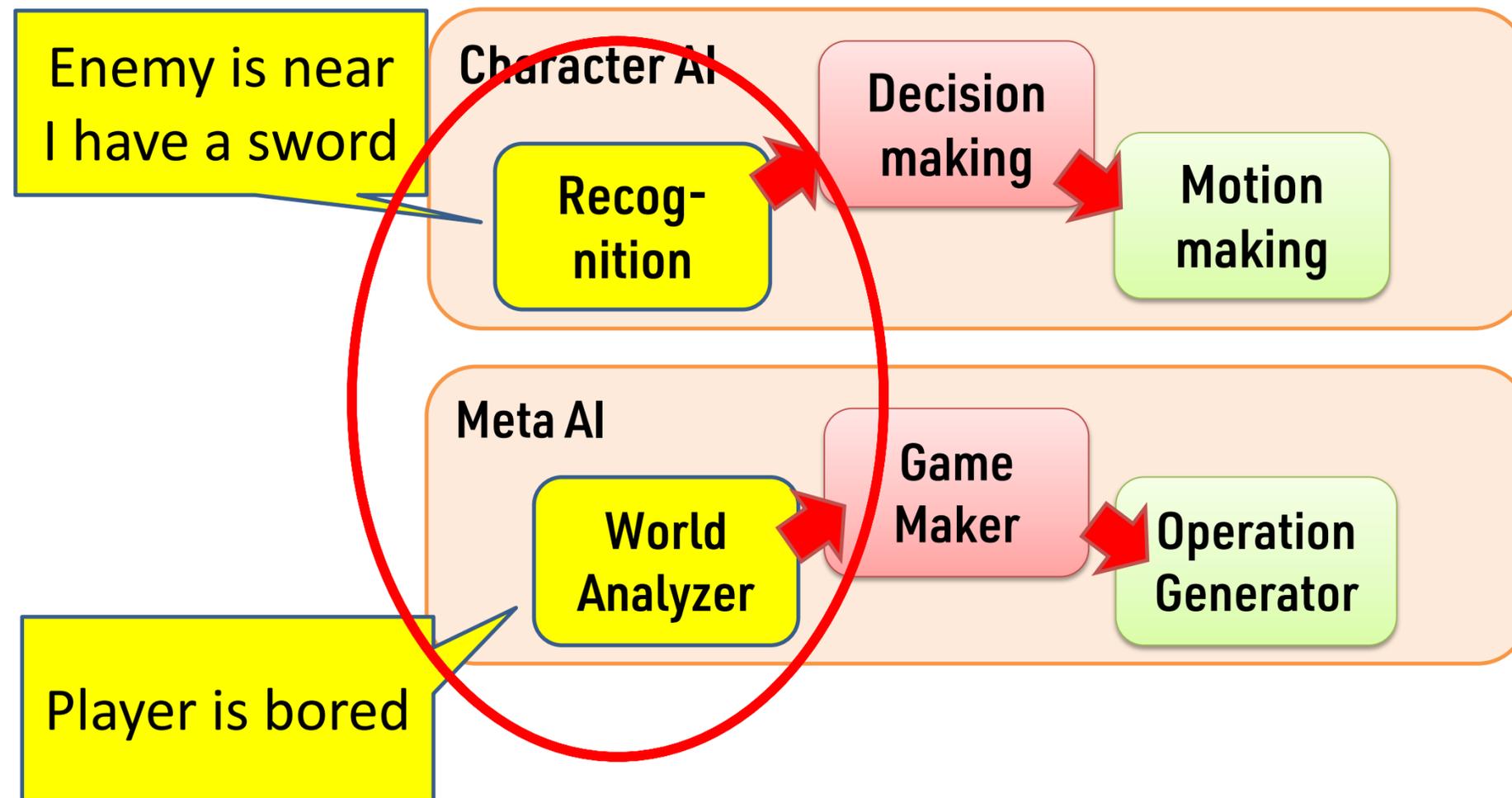
Comparison With Character AI

We can see that Meta AI is similar to character AI.



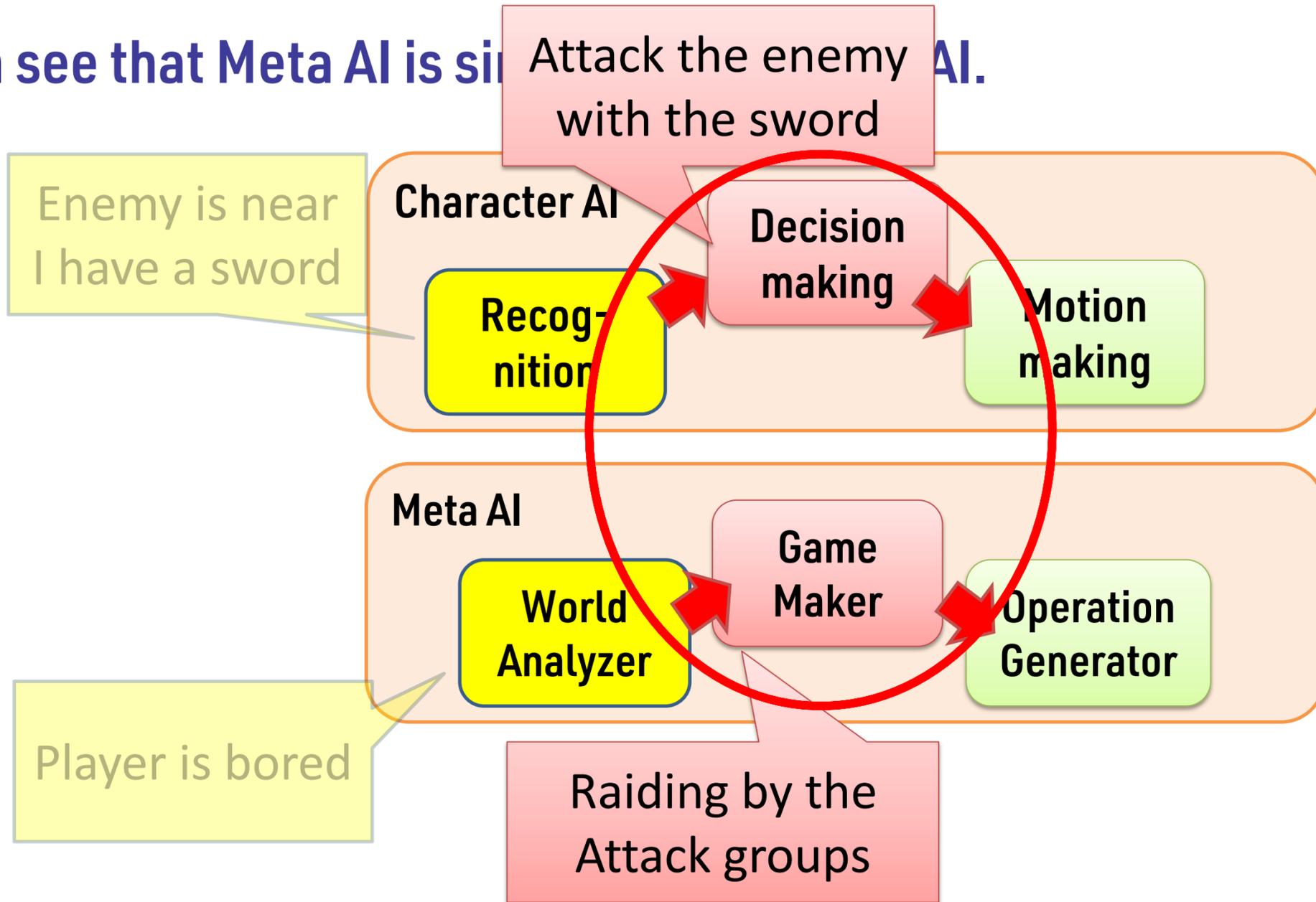
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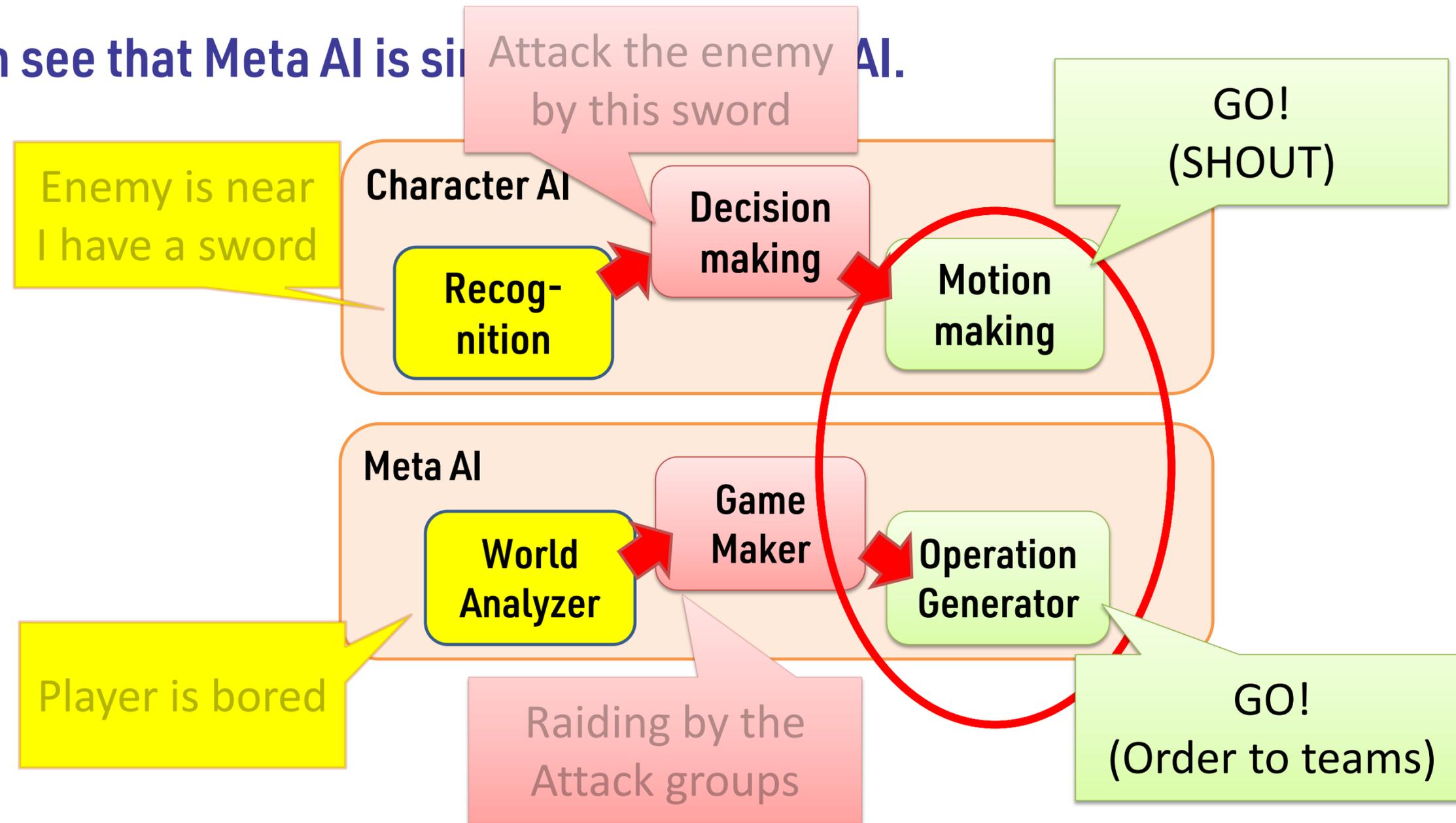
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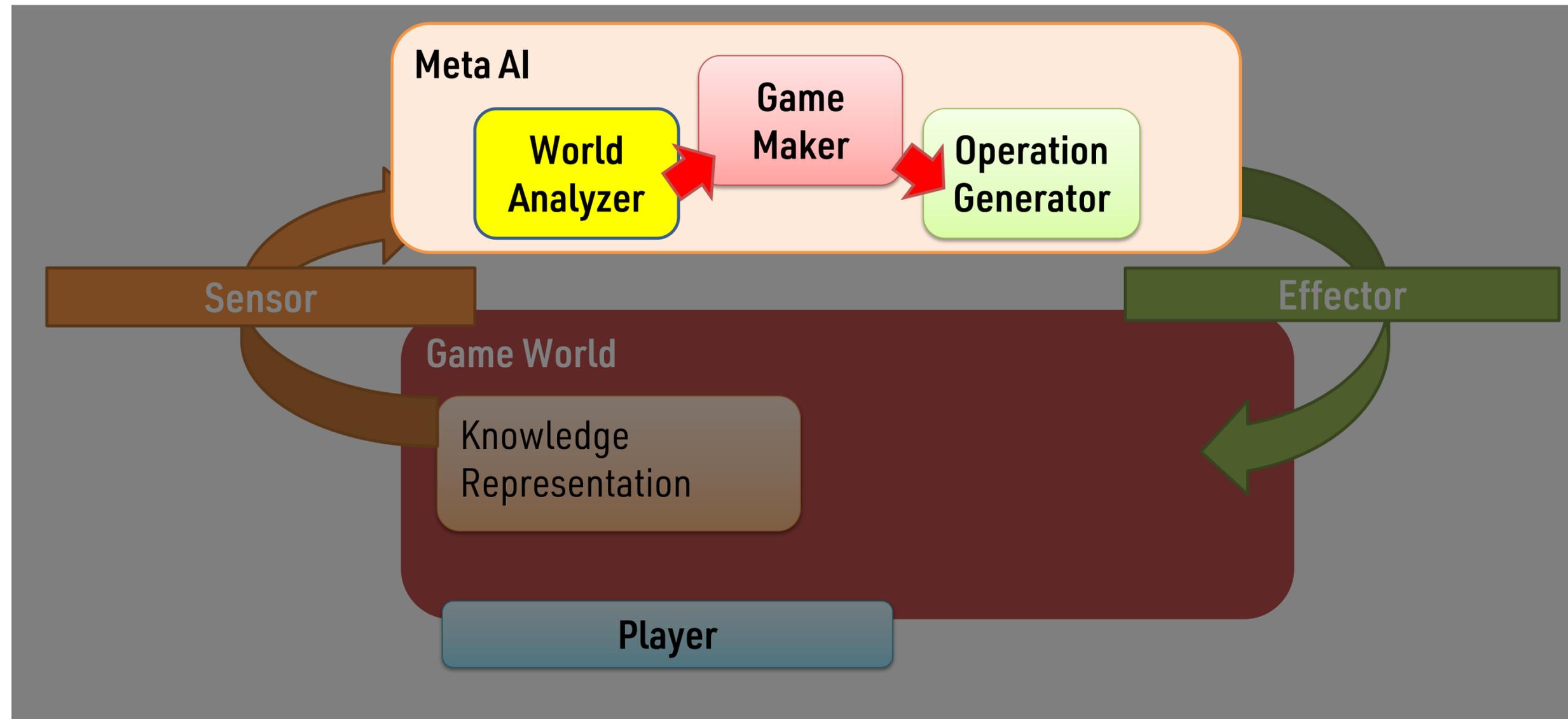
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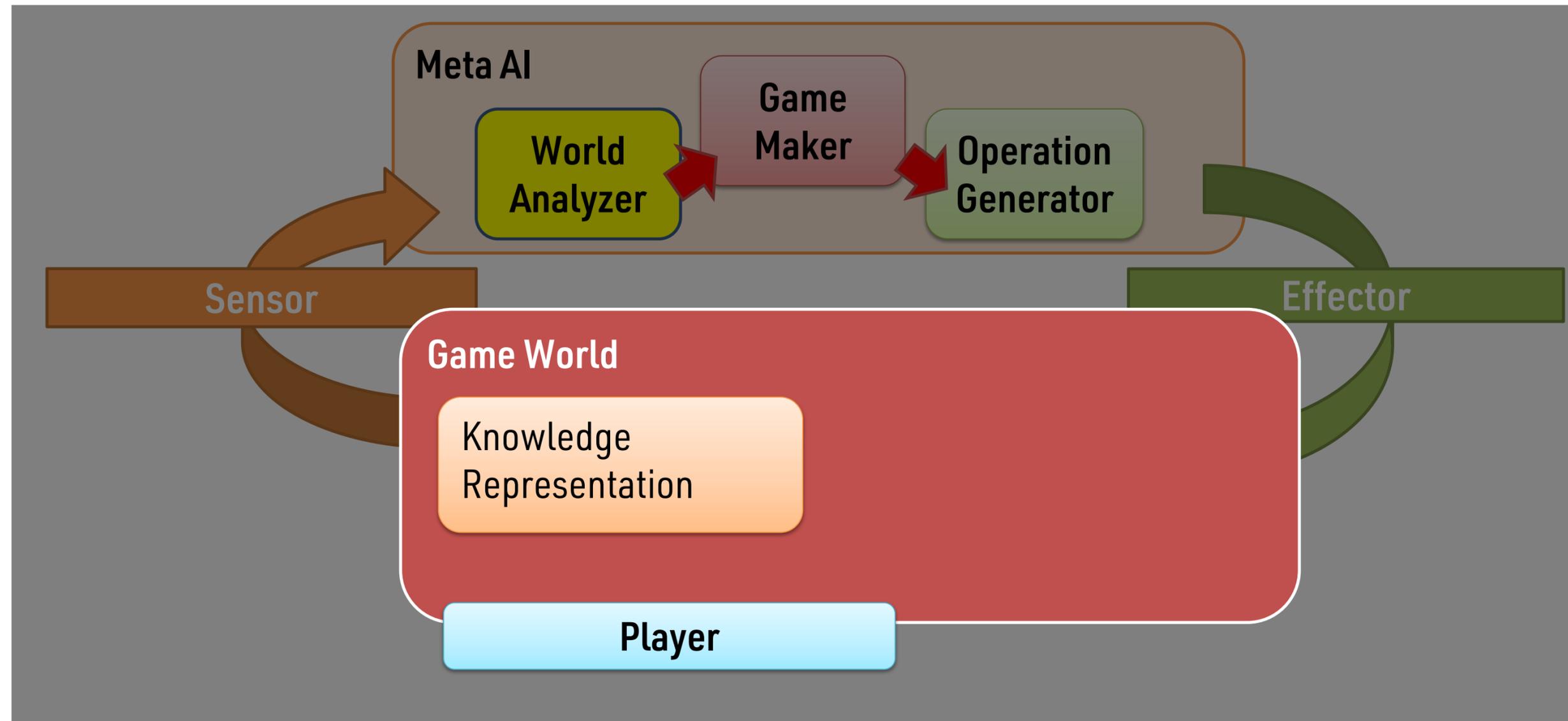
Main Part Of Meta AI

The explanation of the Meta AI main part is finished. Let's move to the game world part.



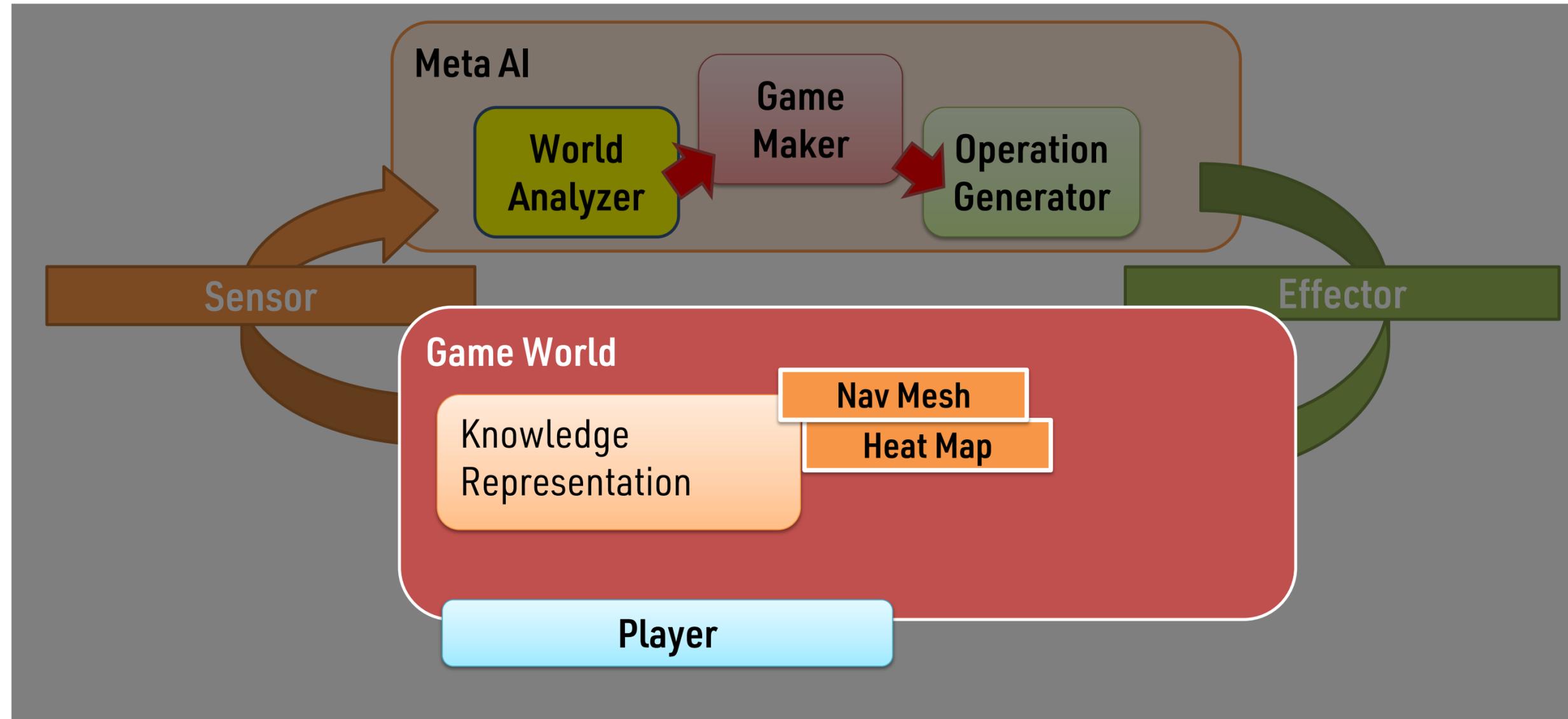
Game World For Meta AI

What information is usable by the Meta AI in the game world?



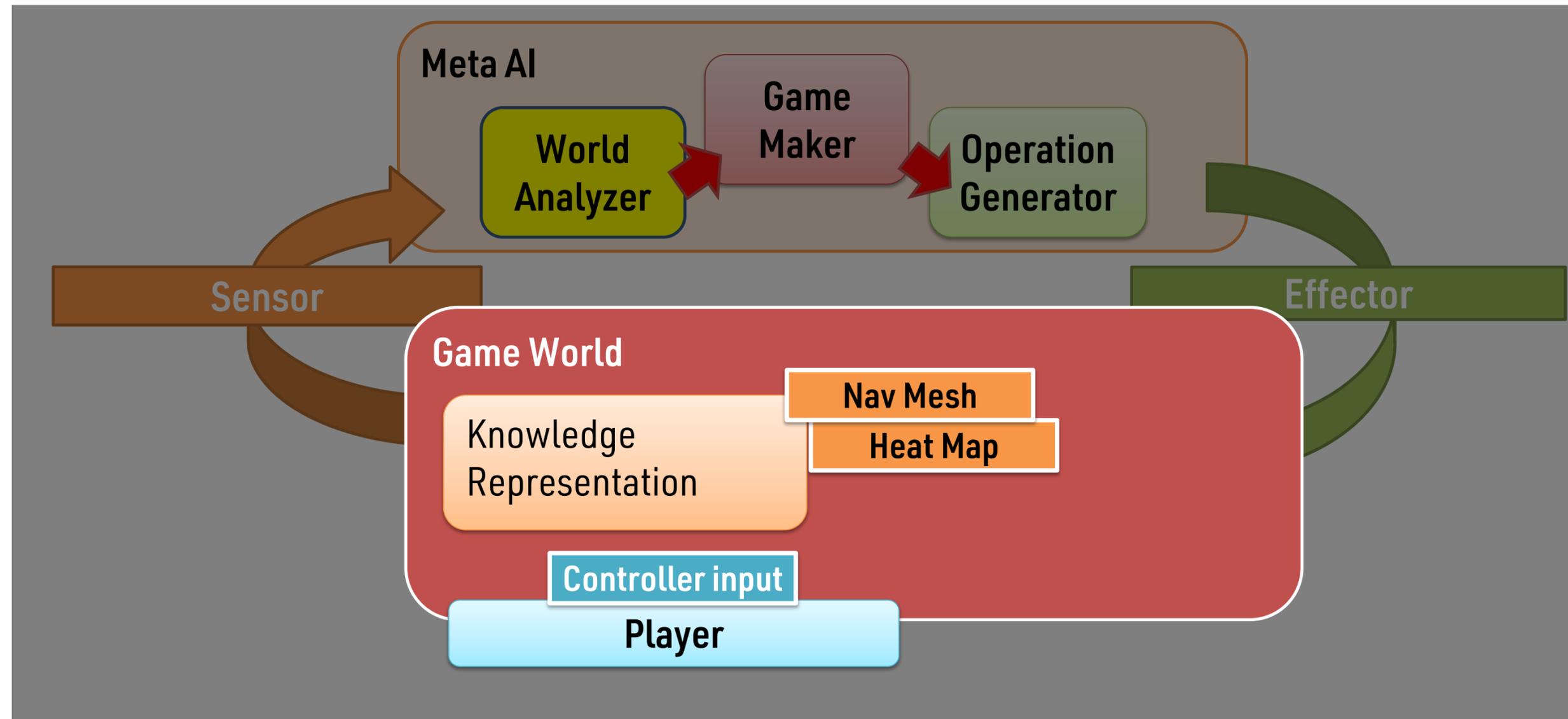
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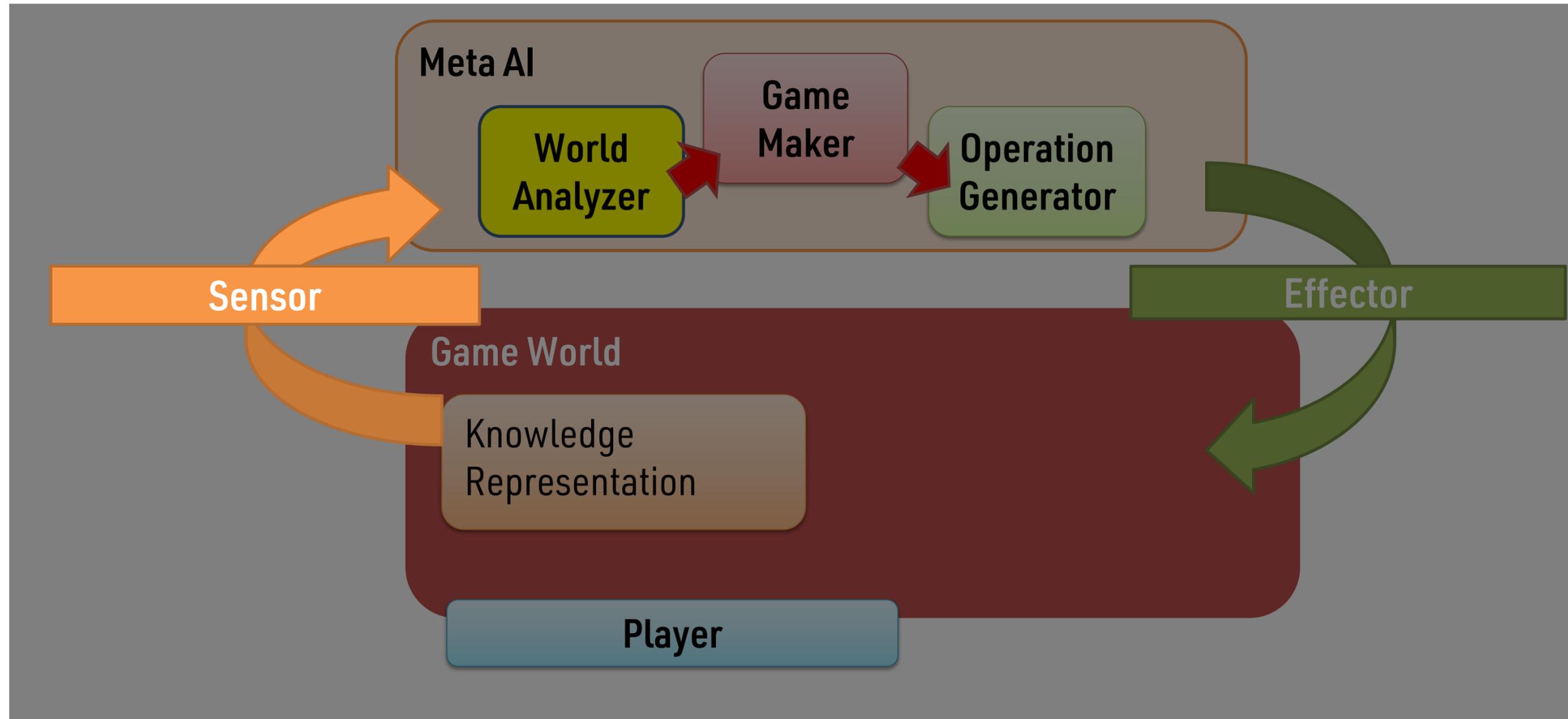
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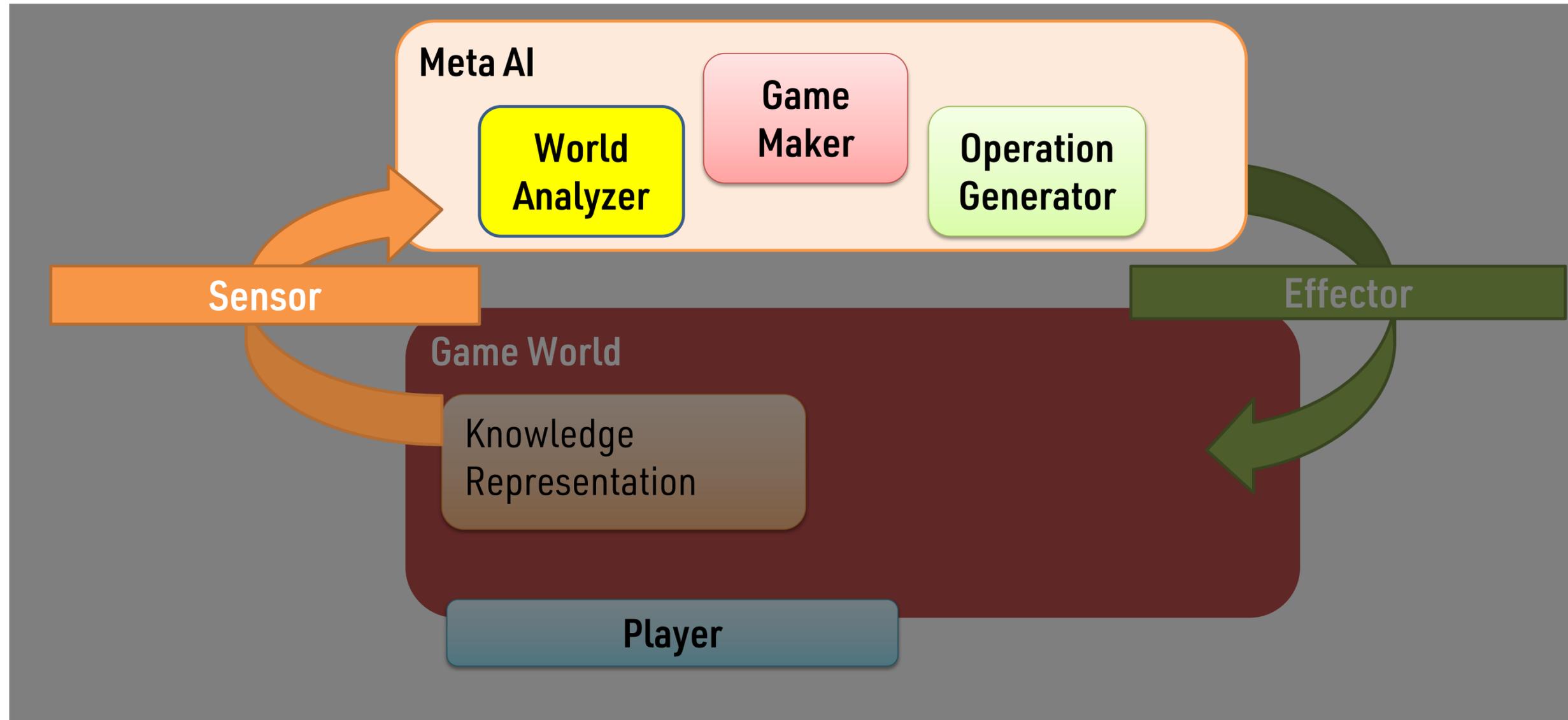
Sensor of Meta AI

Sensors gather information and send it to the world analyzer.



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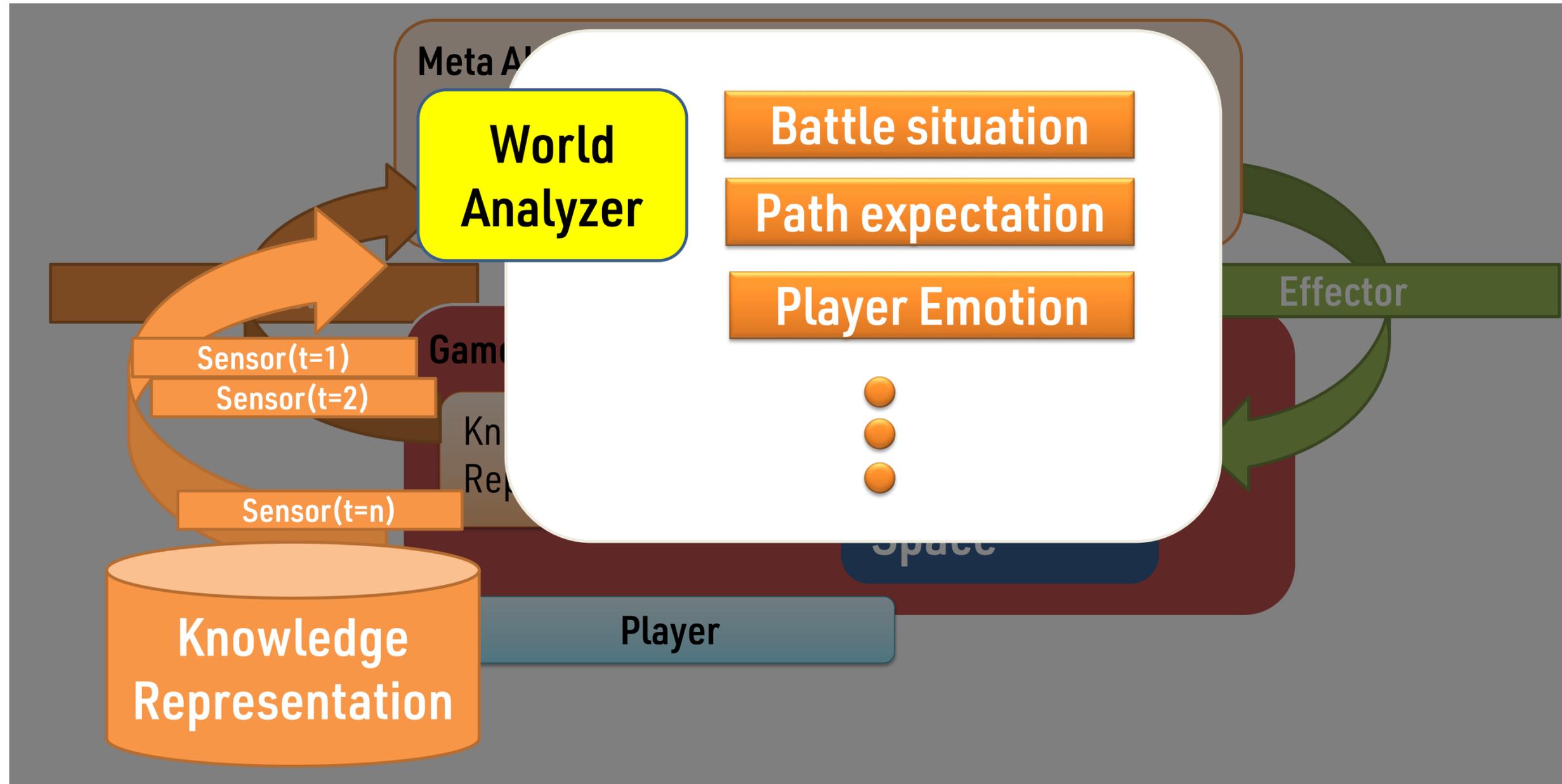
World Analyzer

What does world analyzer do?



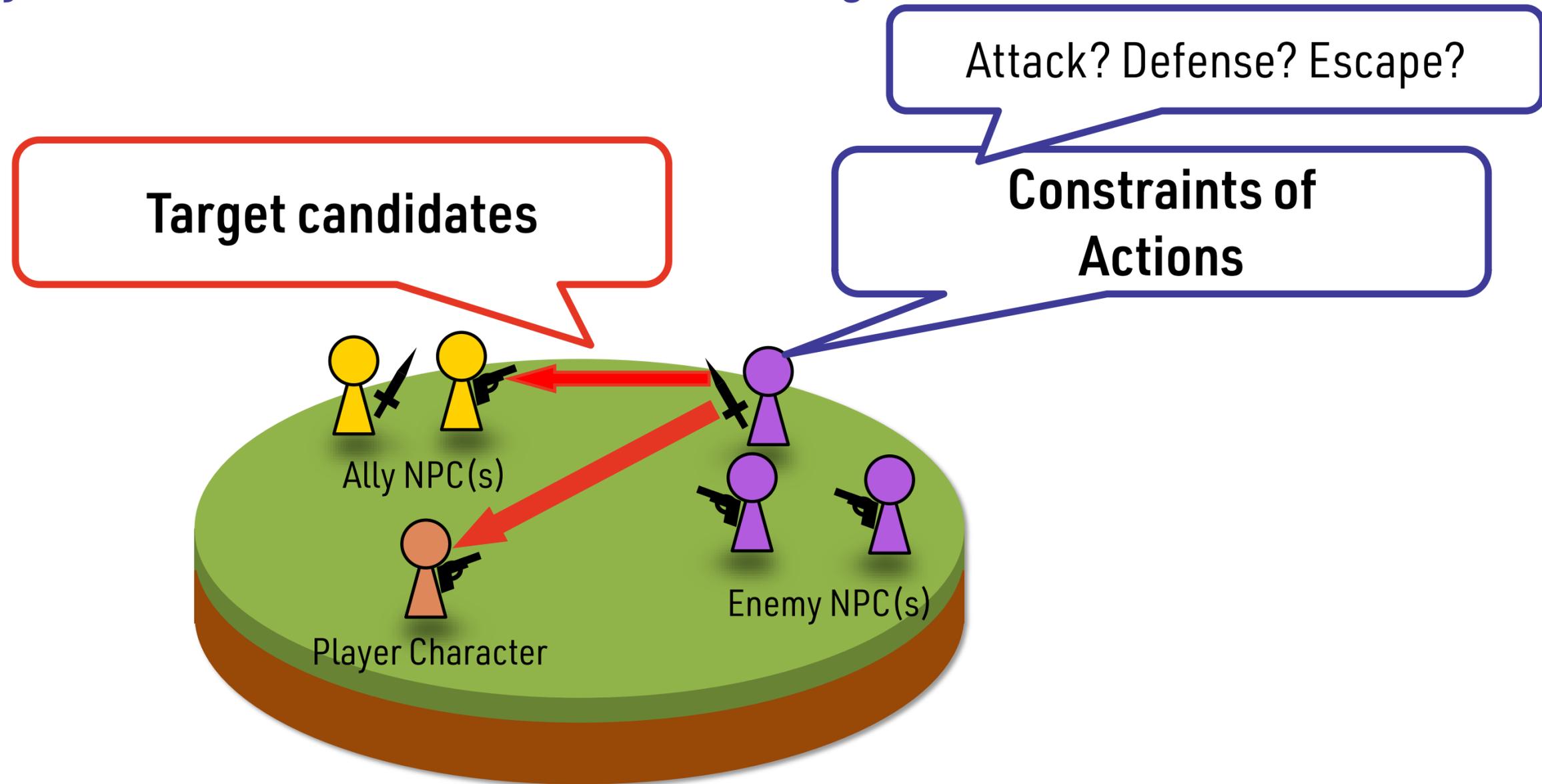
World Analyzer

The world analyzer makes usable information for the game maker.

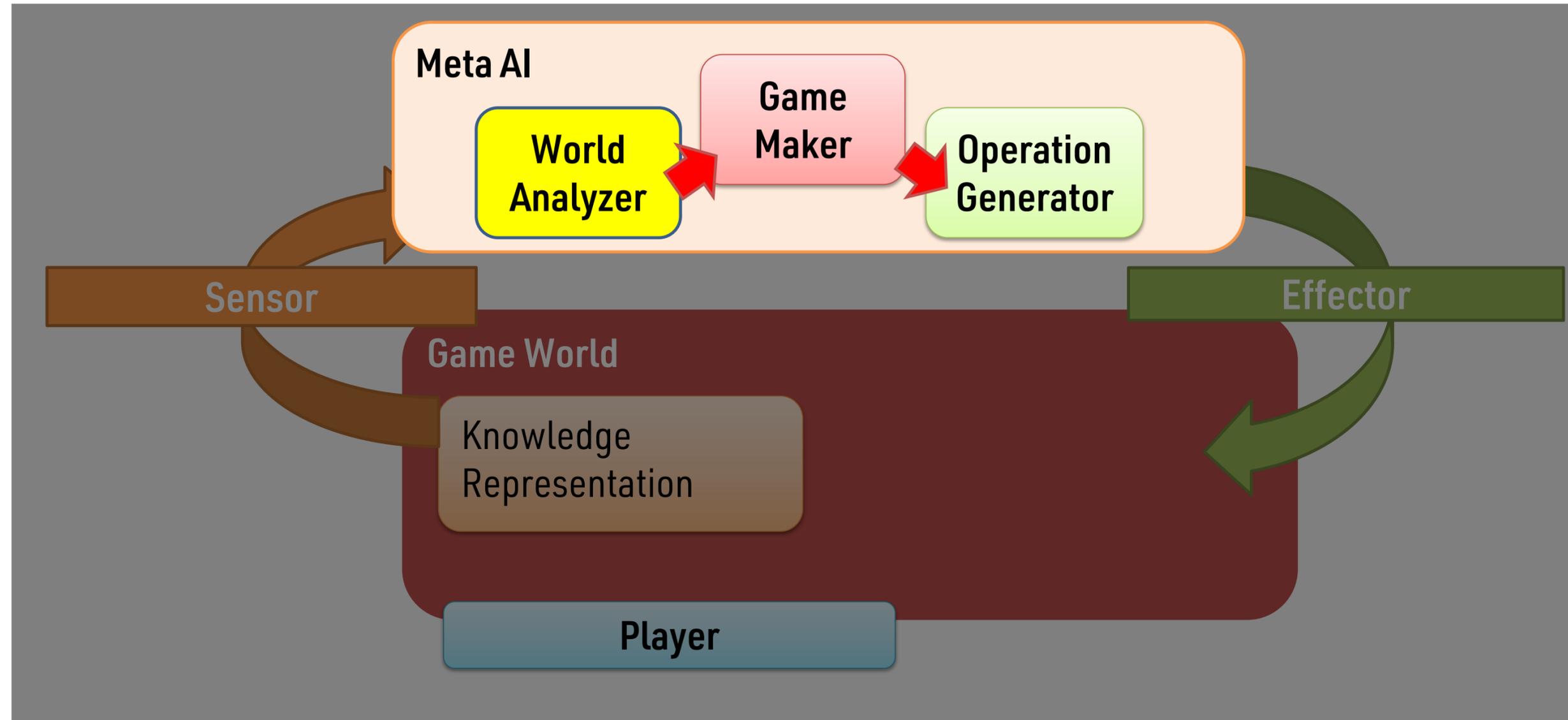


World Analyzer

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General Design Of Meta AI



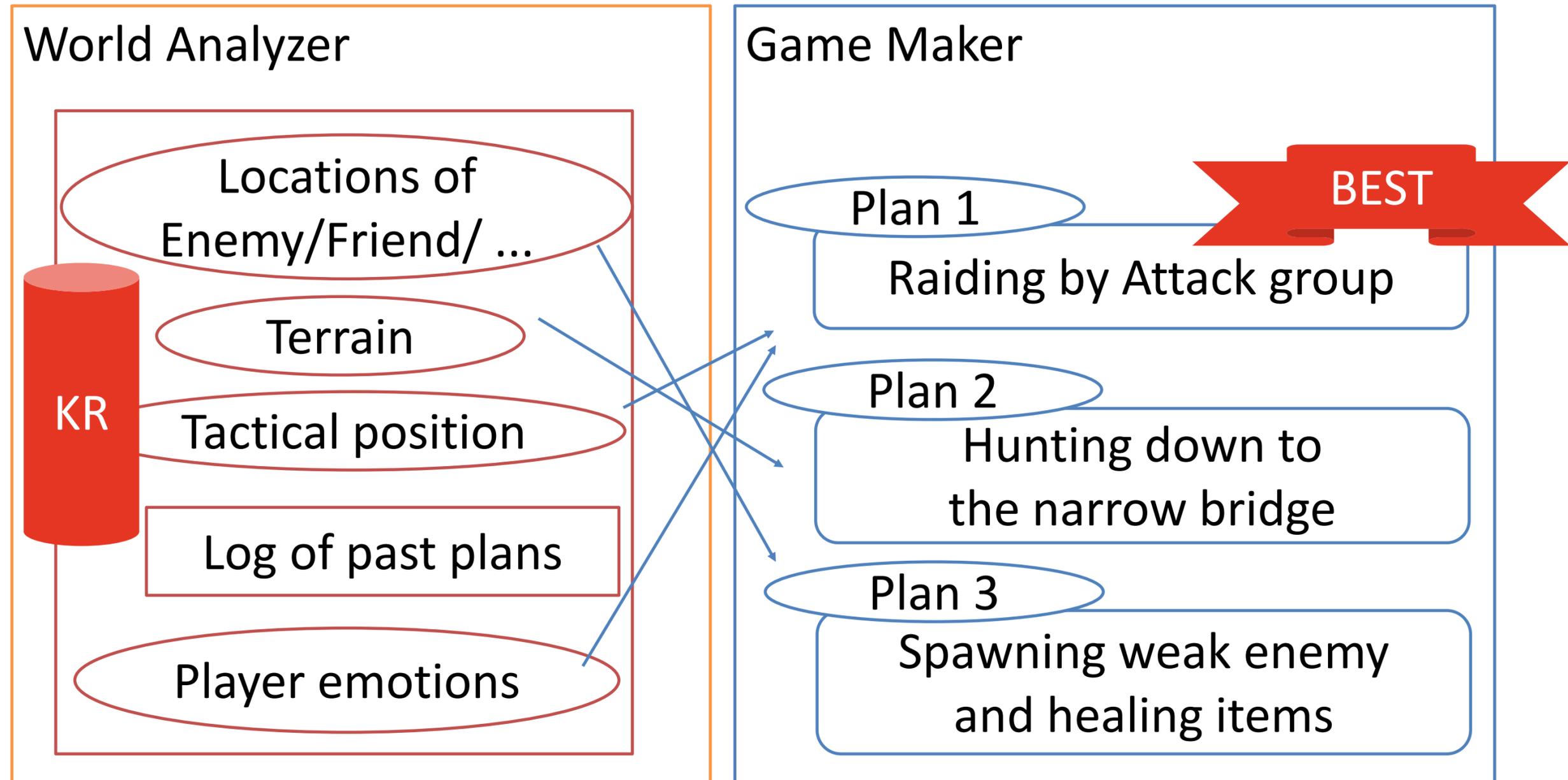
General Design Of Meta AI

What does the game maker do?



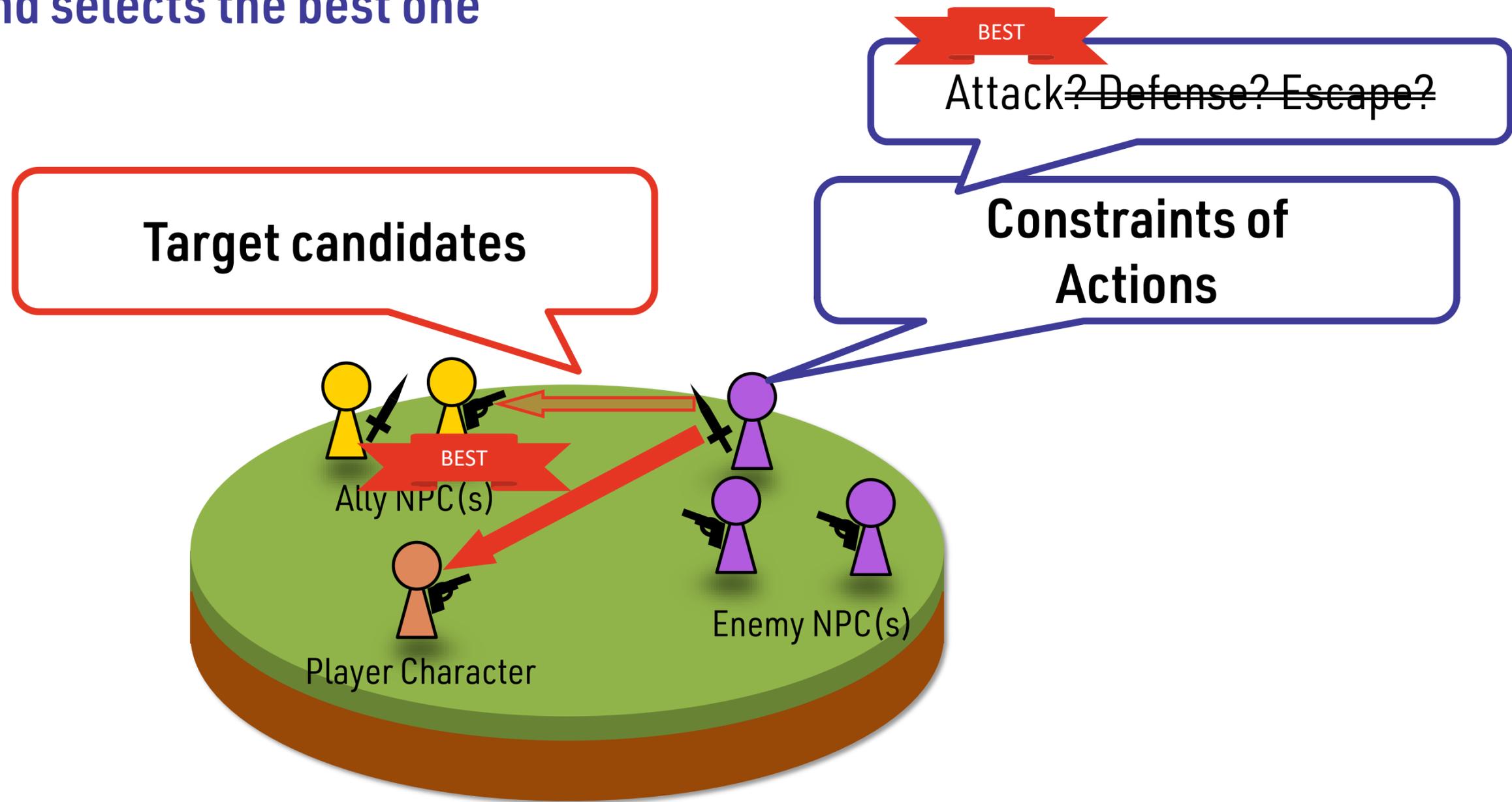
Game Maker

Makes plans and selects the best one

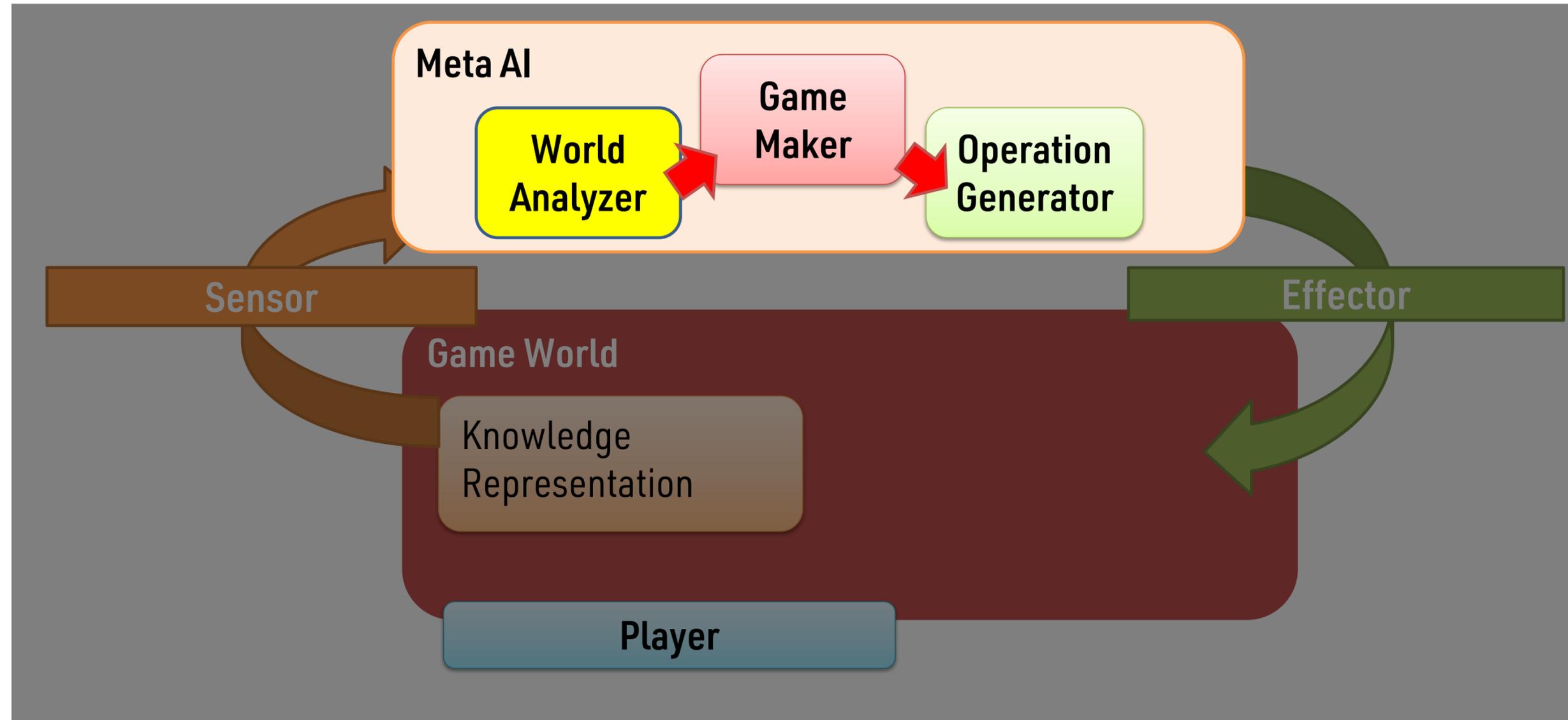


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General Design Of Meta AI



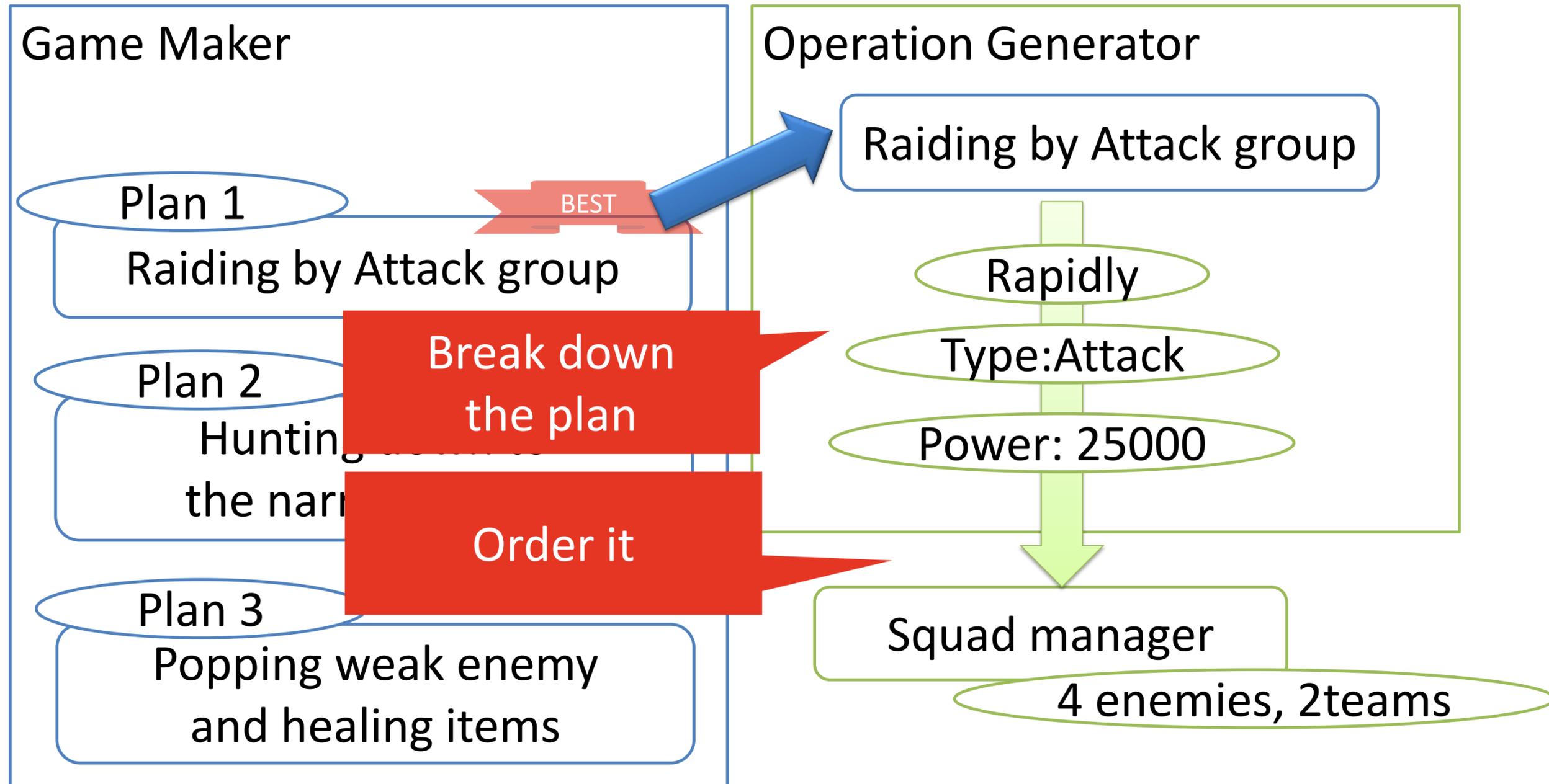
Operation Generator

What does the operation generator do?



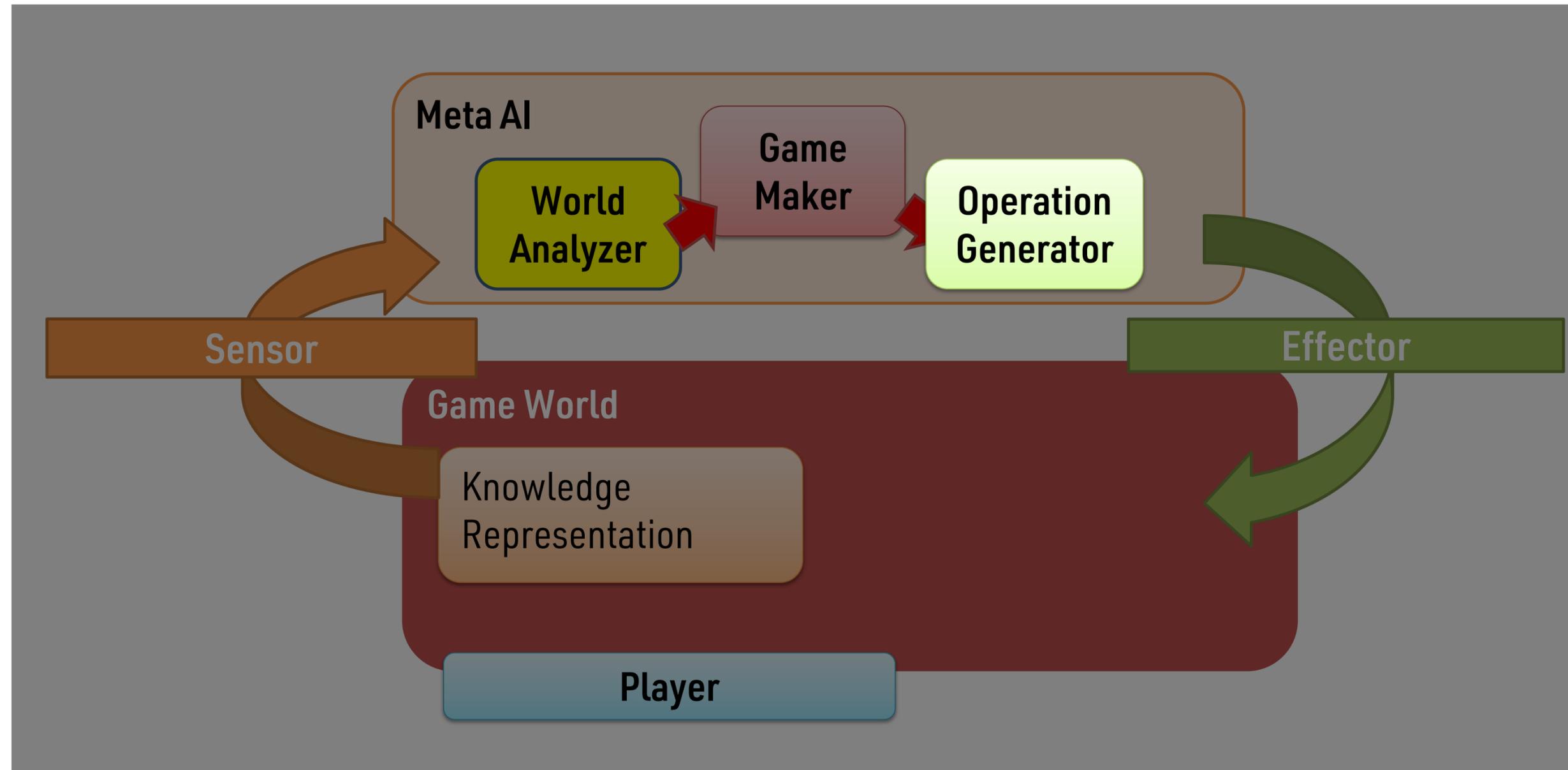
Operation Generator

The operation generator breaks down the plans into operations



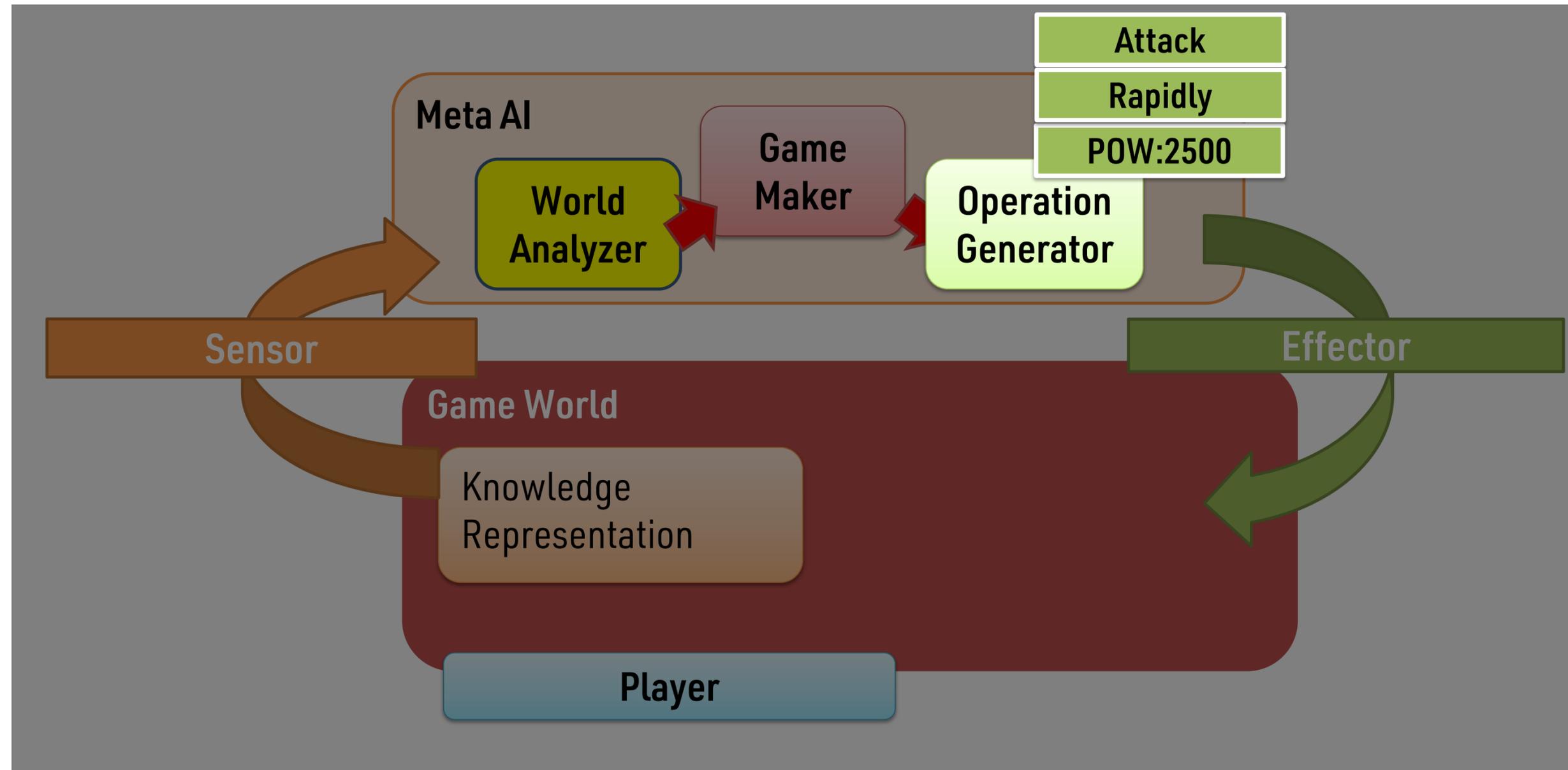
General Design Of Meta AI

The operation generator sends parameters through effectors.



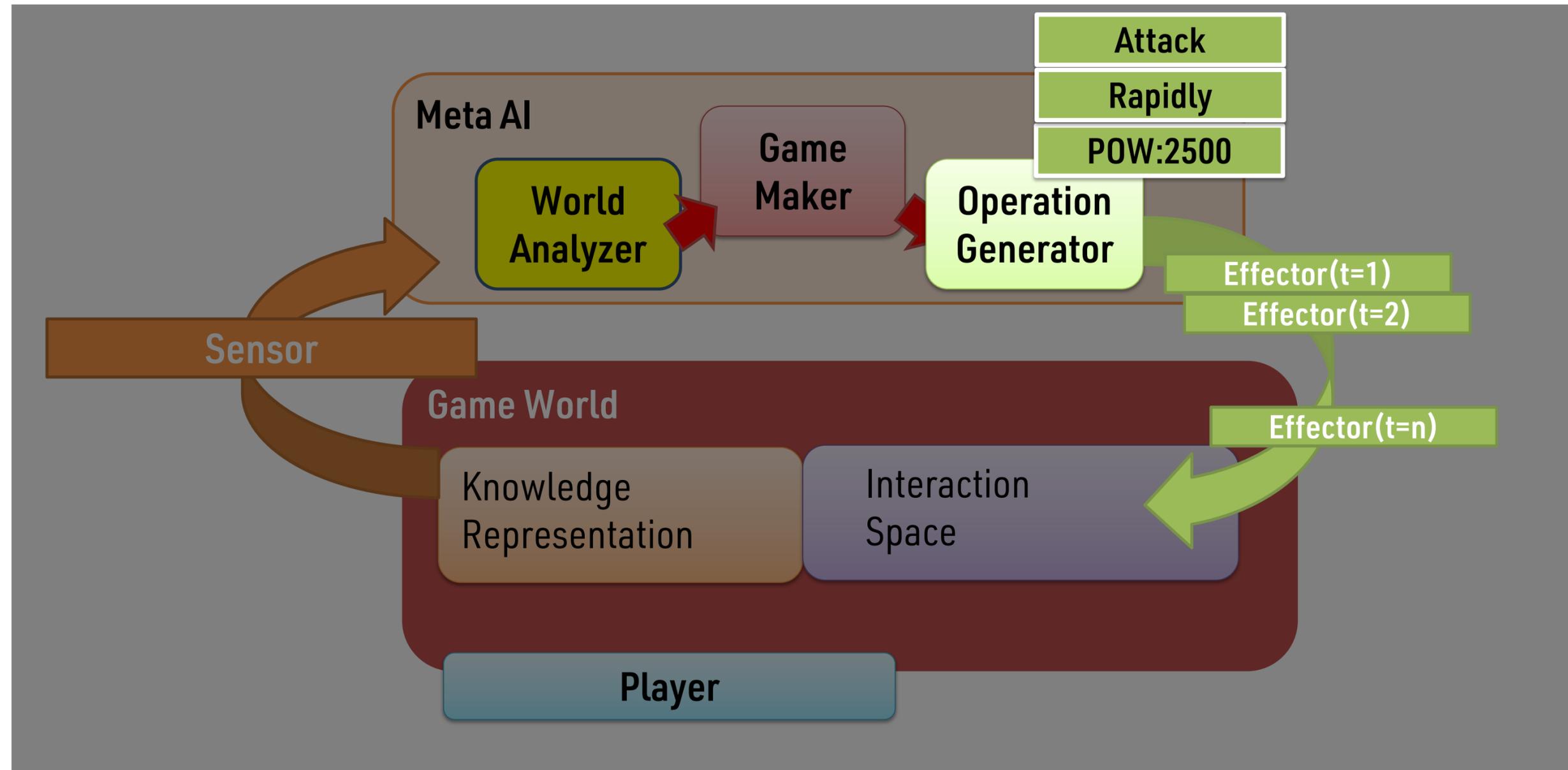
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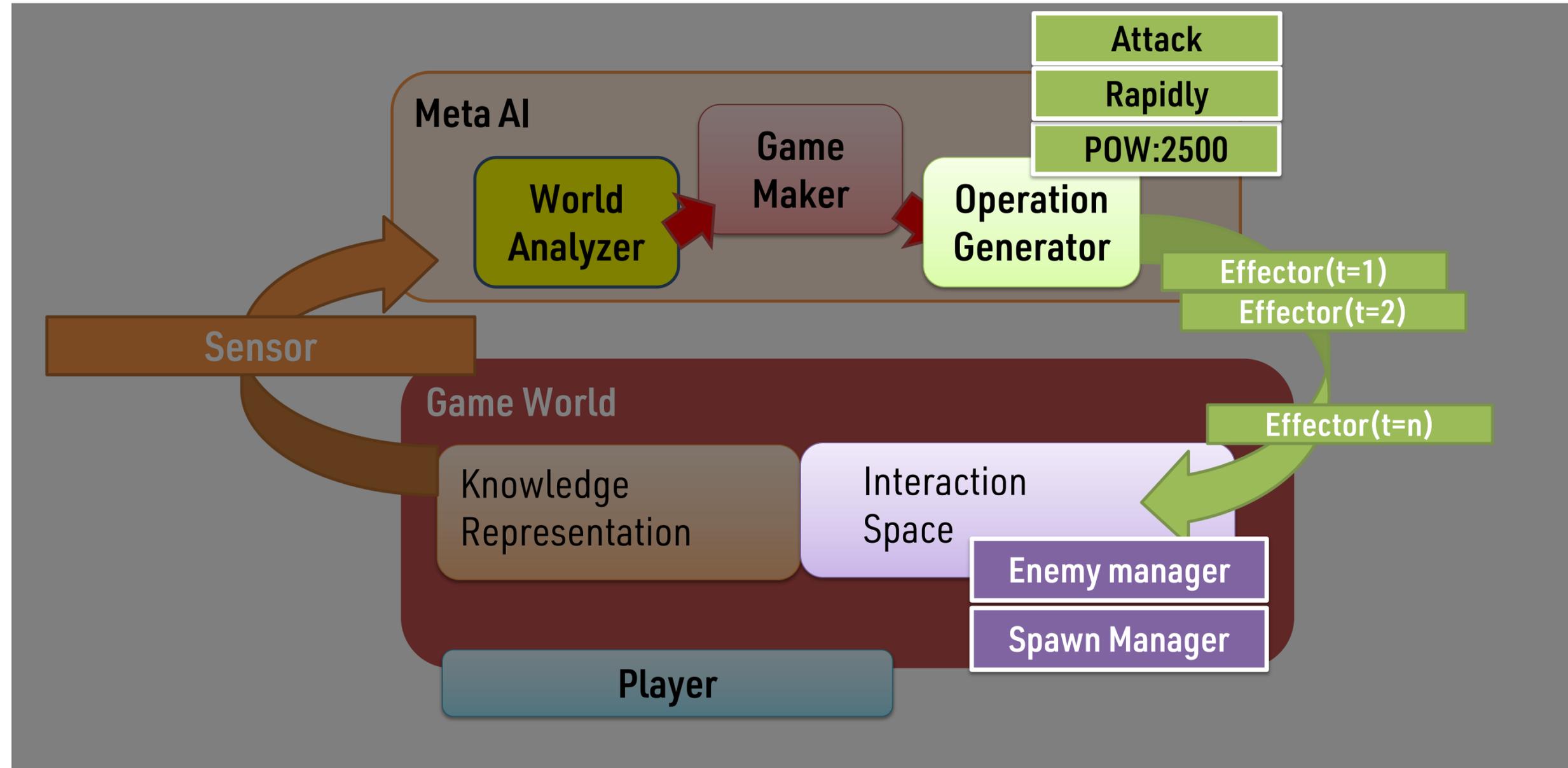
General Design Of Meta AI

Effectors send them to the interaction space.



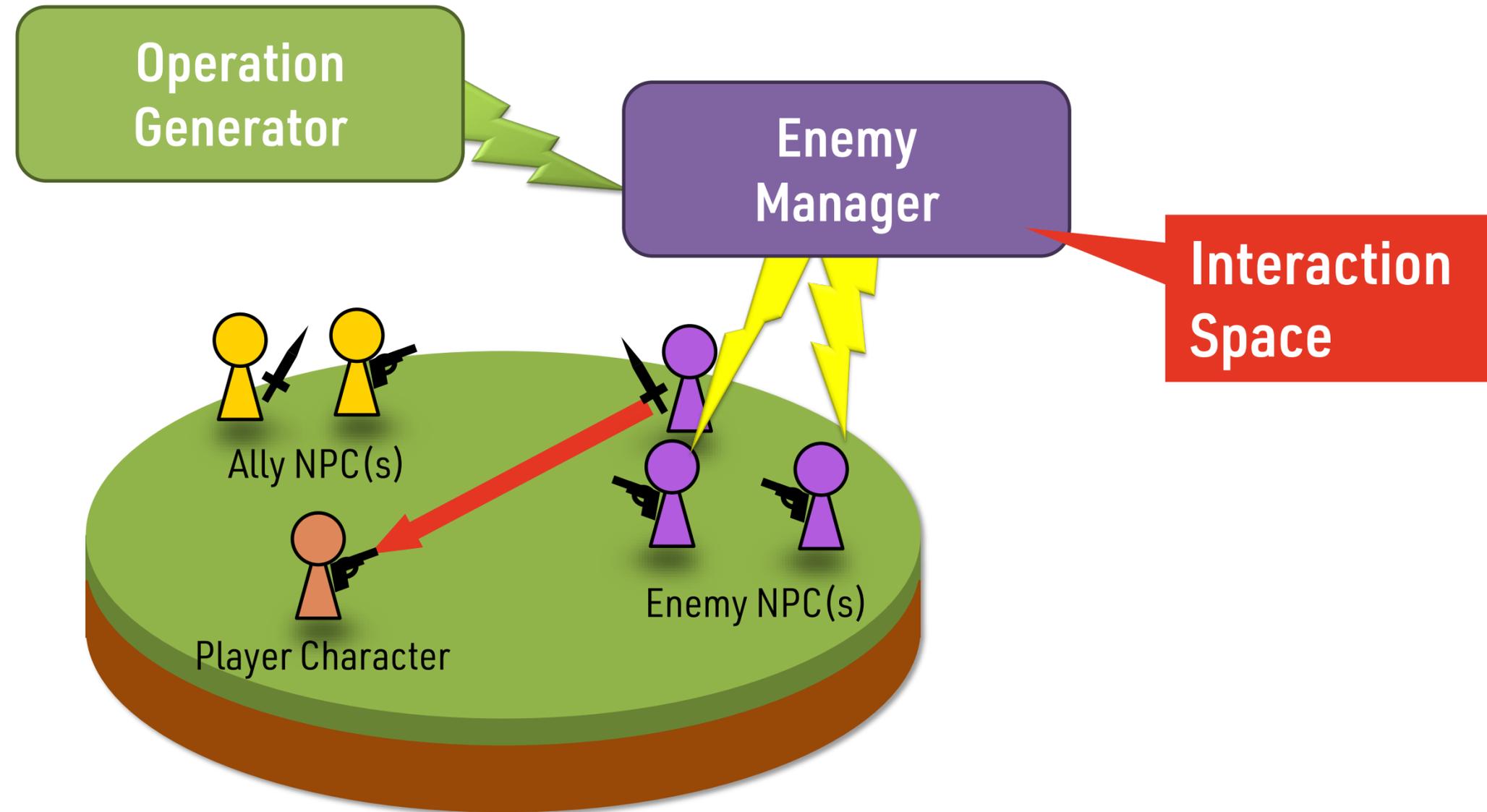
General Design Of Meta AI

The interaction space controls the game with the operations.



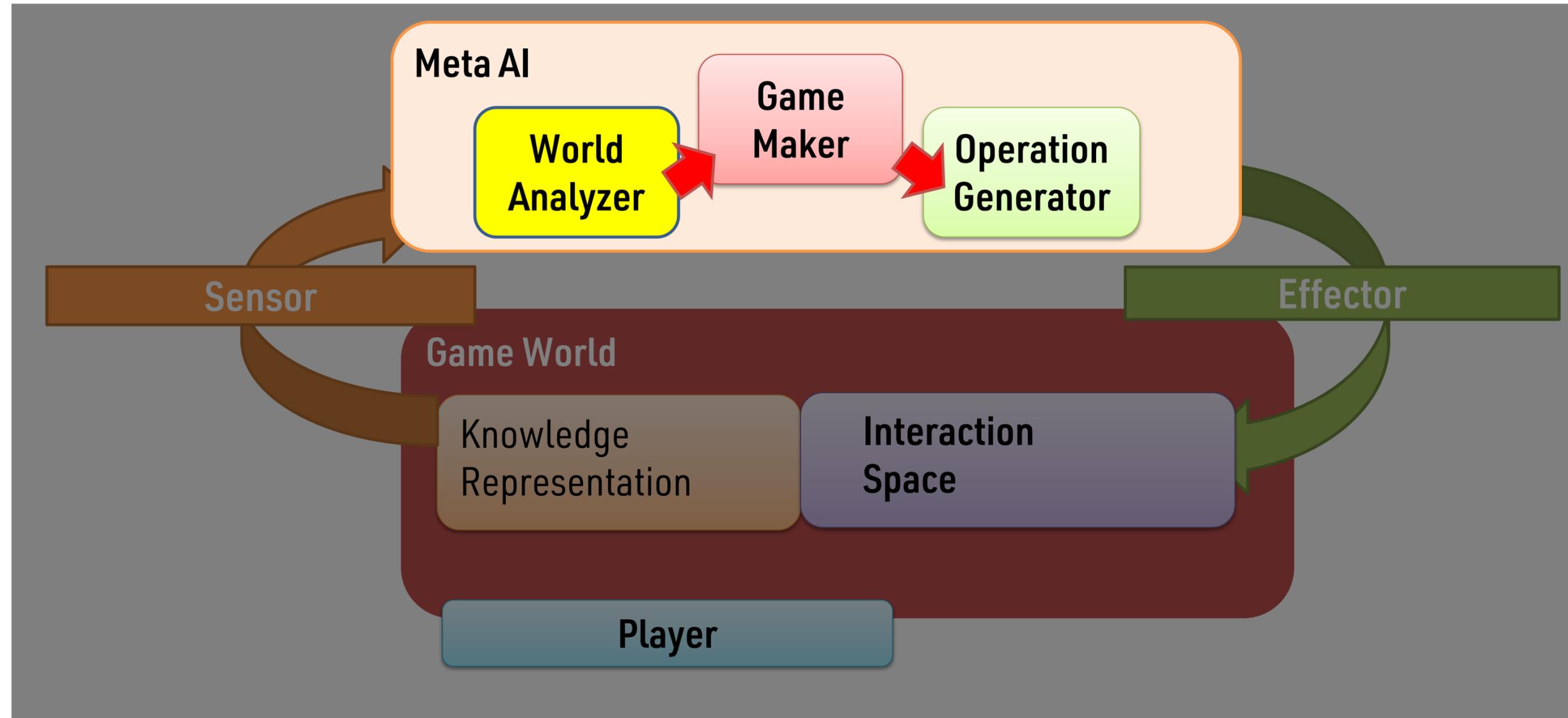
Operation Generator

The operation generator sends operations to the enemy manager.



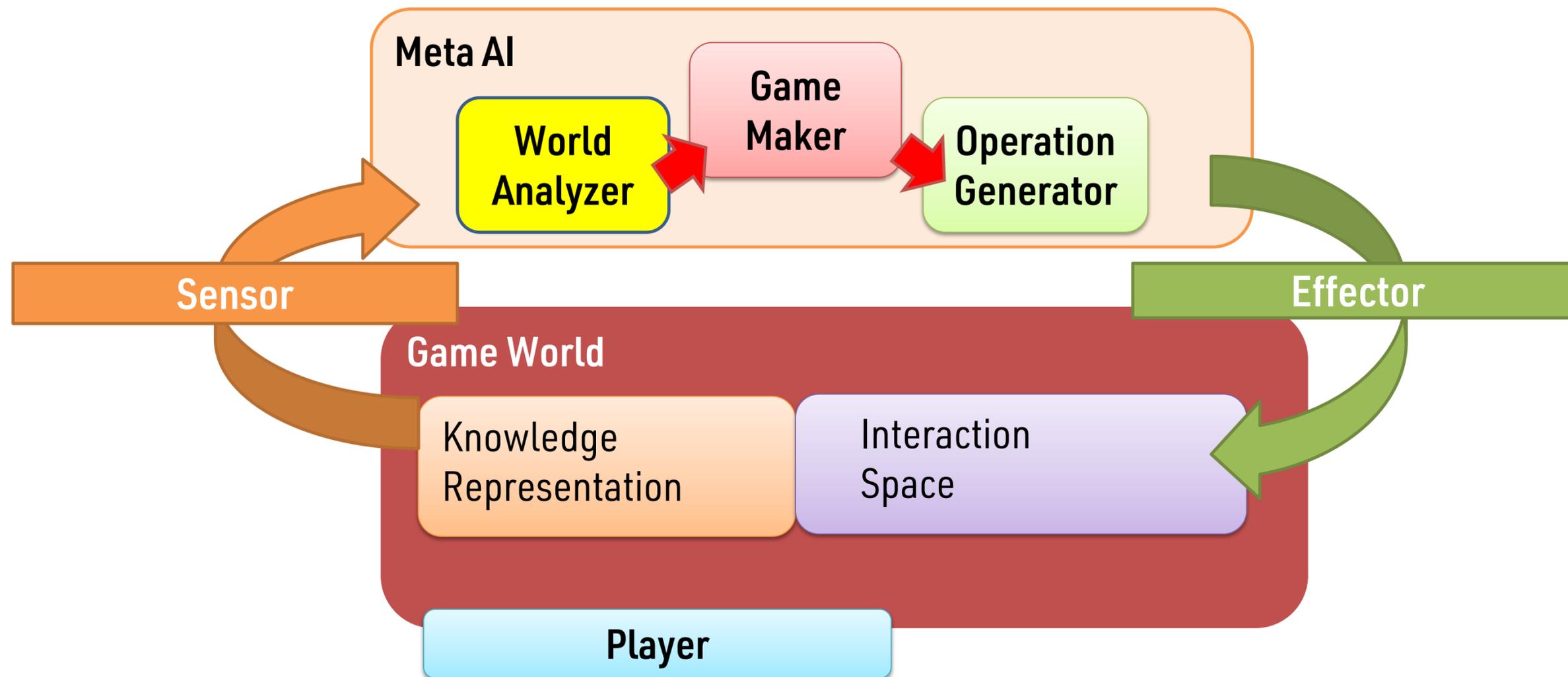
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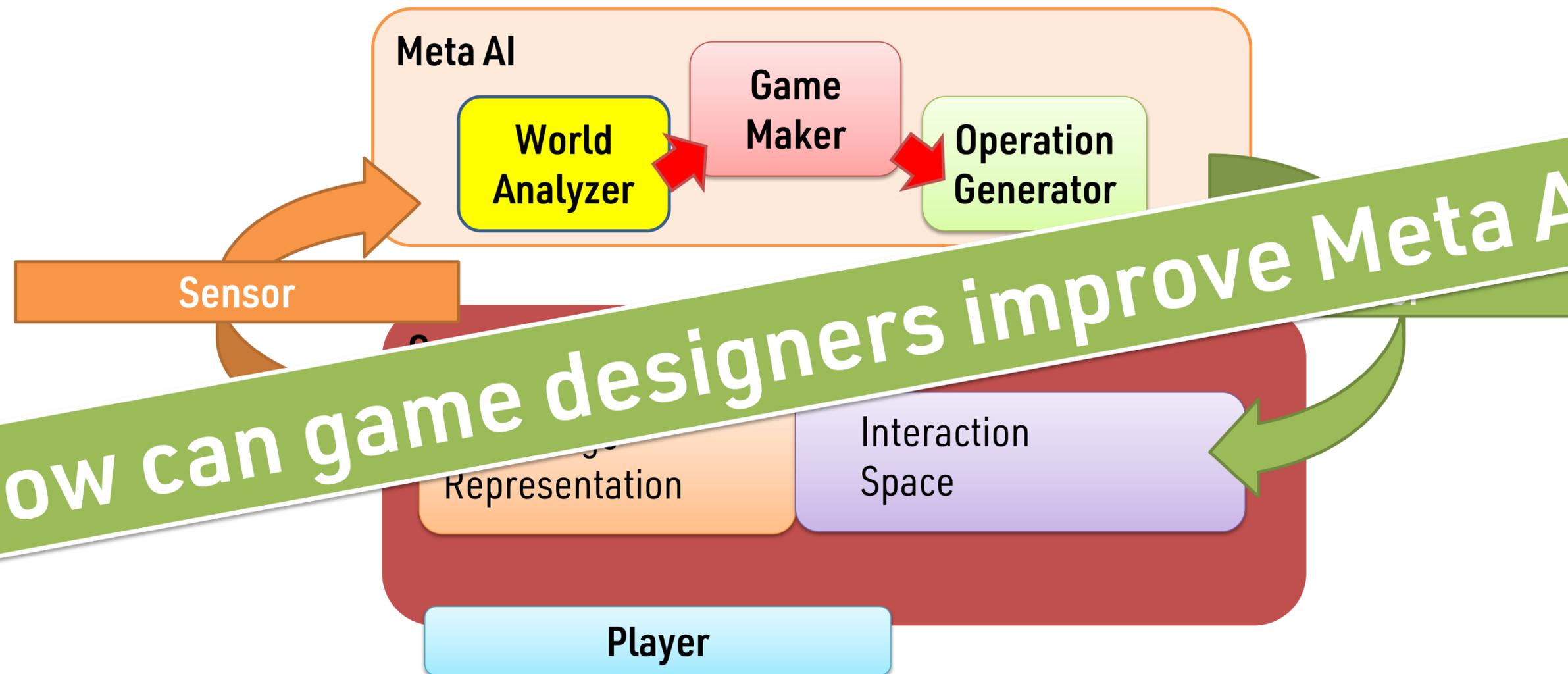


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 - What is Meta AI
- **Meta AI General Design**
 - How to make Meta AI
 - **How can game designers improve Meta AI?**

Game Designer for Meta AI

Elements controlled by Meta AI are deeply related to game design.



Too Flexible, Too Complex

How to identify which element is the best to be controlled by Meta AI?

Meta AI: Too Flexible

Games: Too Complex

Too Flexible, Too Complex

How to identify which element is the best to be controlled by Meta AI?

Meta AI: Too Flexible

Games: Too Complex

Break down into smaller elements

Too Flexible, Too Complex

How to identify which element is the best to be controlled by Meta AI?

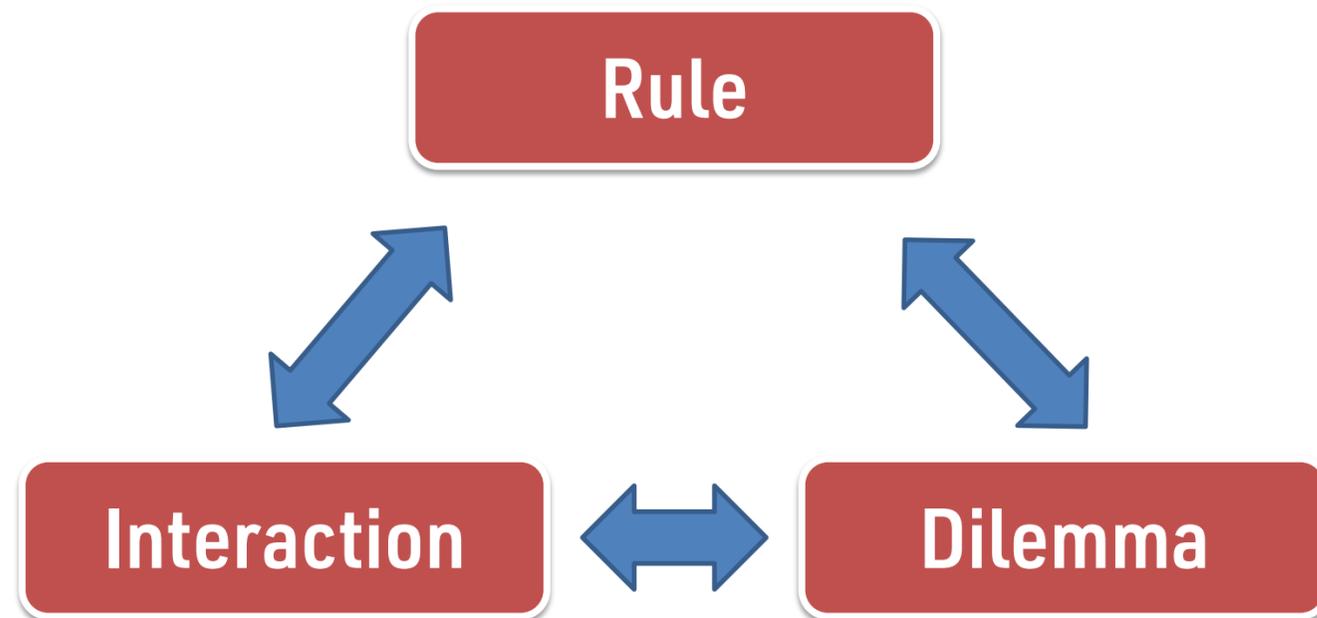
Meta AI: Too Flexible

Games: Too Complex

**Break down into smaller elements
with fellow game designers**

Too Flexible, Too Complex

Break down your game into 3 elements "Ru-I-Di"



Fun game should have

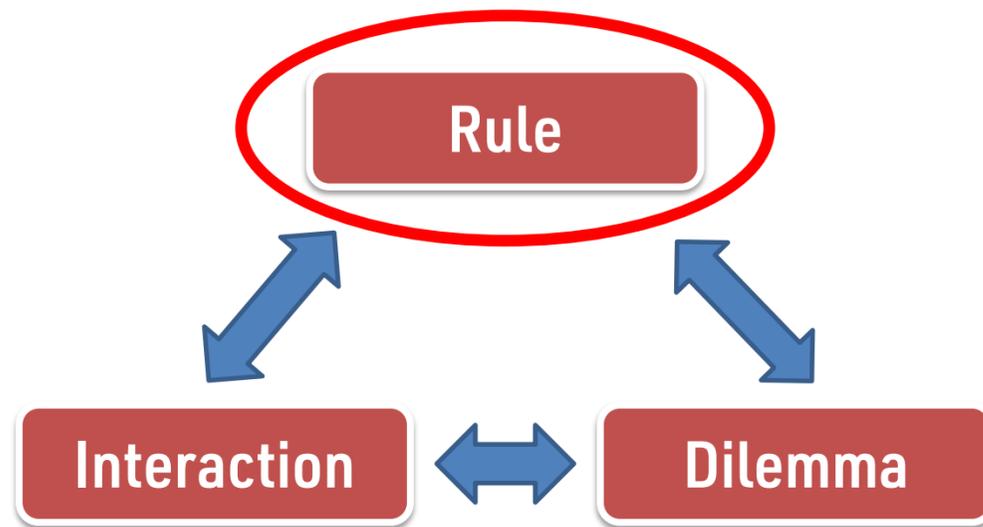
"Ru-I-Di -ism"

[Yonemitsu, 2006]

(Similar to *Luigi?*)

Ru-I-Di -ism

Rule defines and controls Interaction and Dilemma of your game

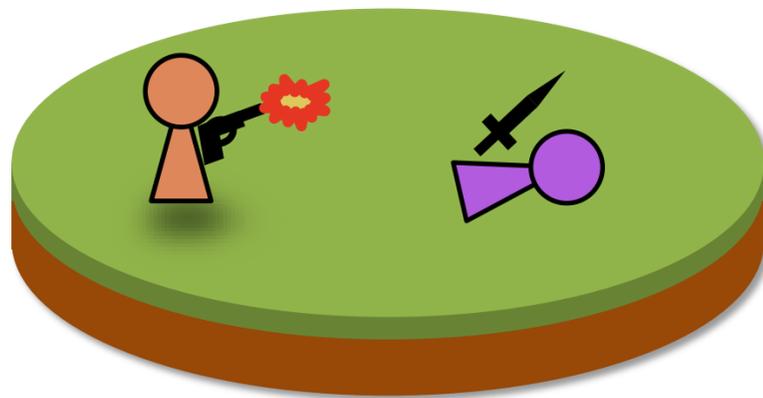


The rule defines what should be Interaction and Dilemma, controls the difficulty and frequency of Interaction and Dilemma.

e.g.)

Key input -> What will happen

Condition of Win / Spawning
Physics



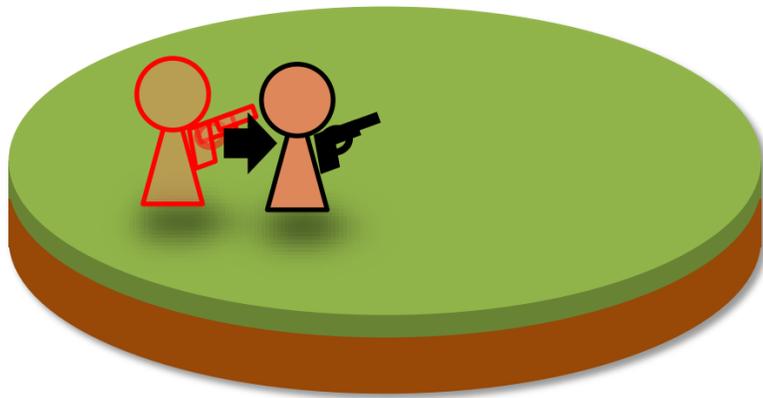
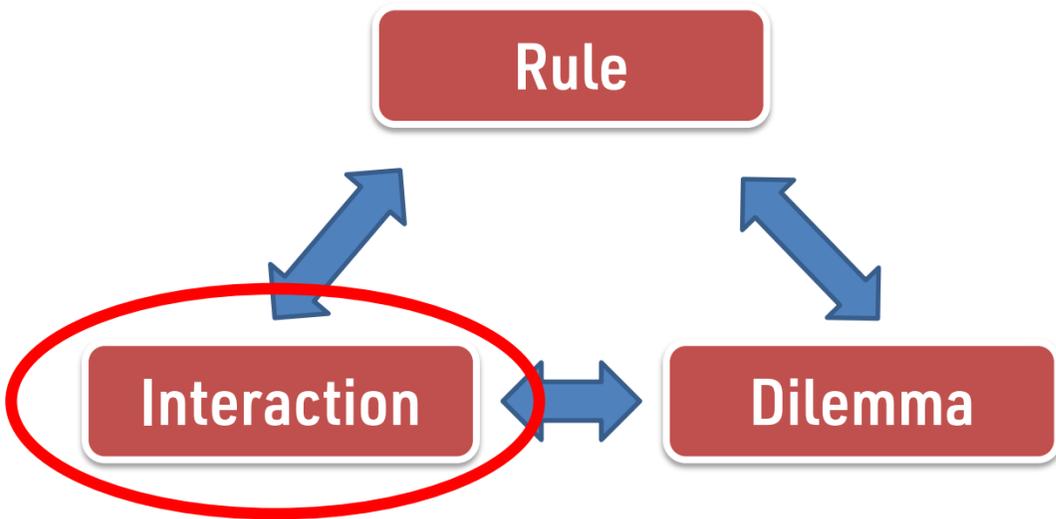
Ru-I-Di -ism

Interaction makes the game loop.

Interaction = the reaction loop

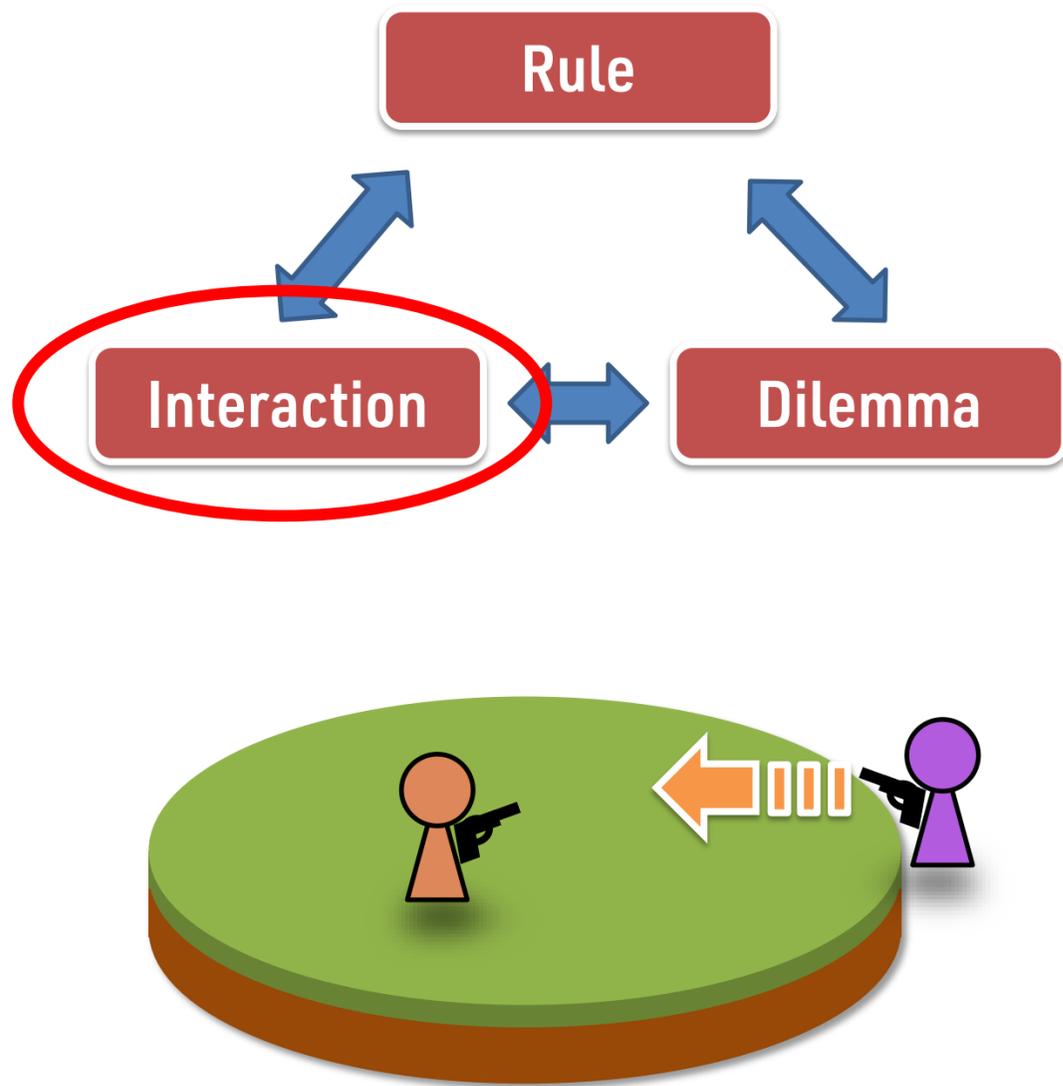
(1)

Player's
Action

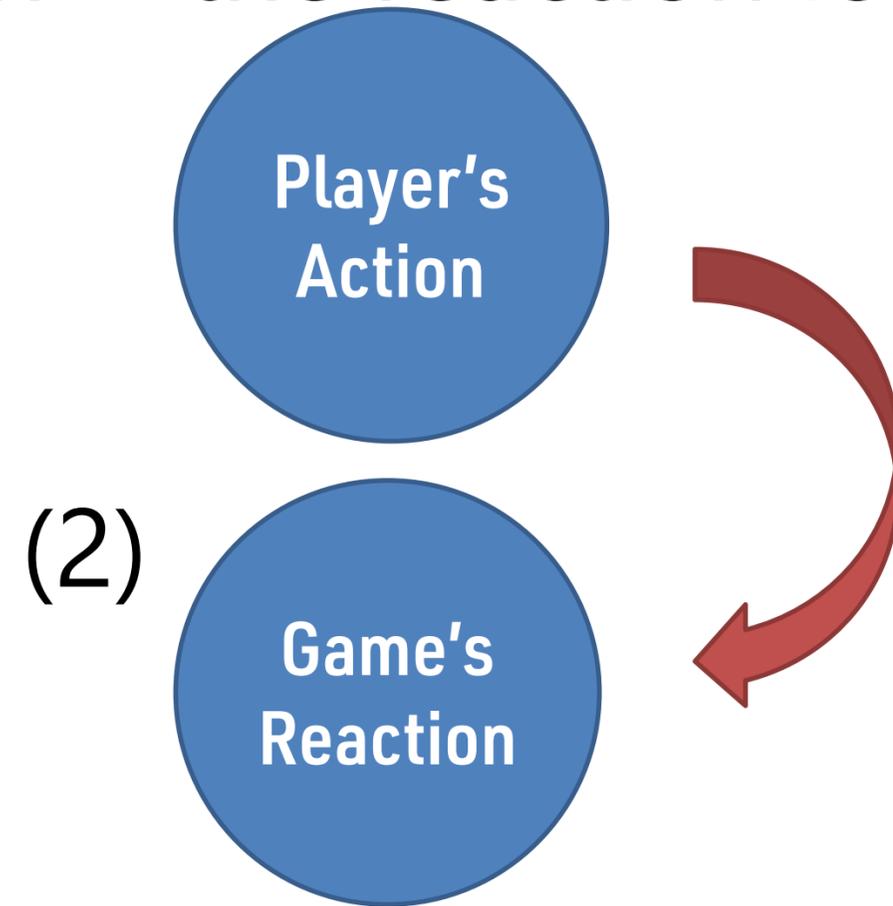


Ru-I-Di -ism

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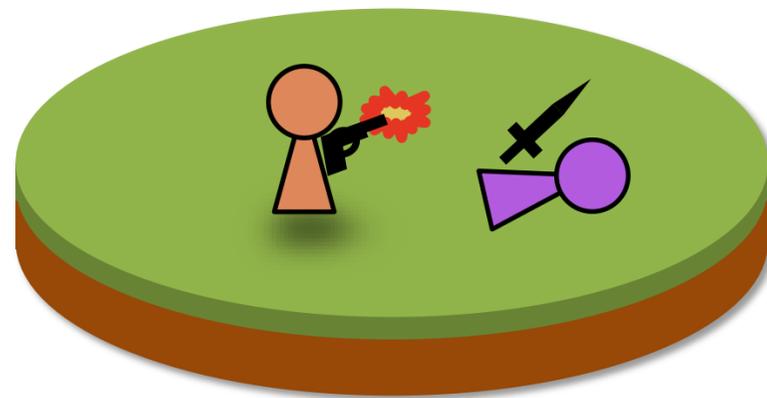
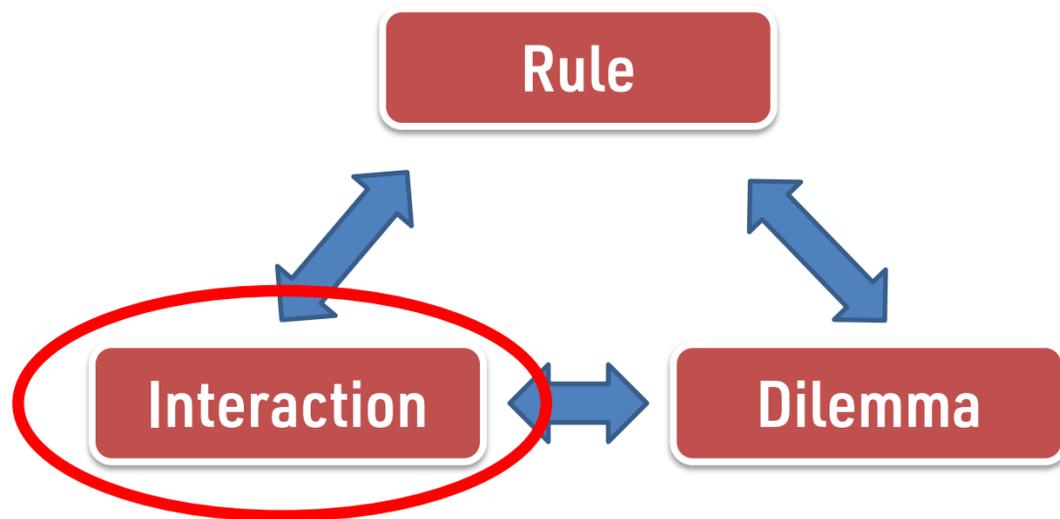


Interaction = the reaction loop

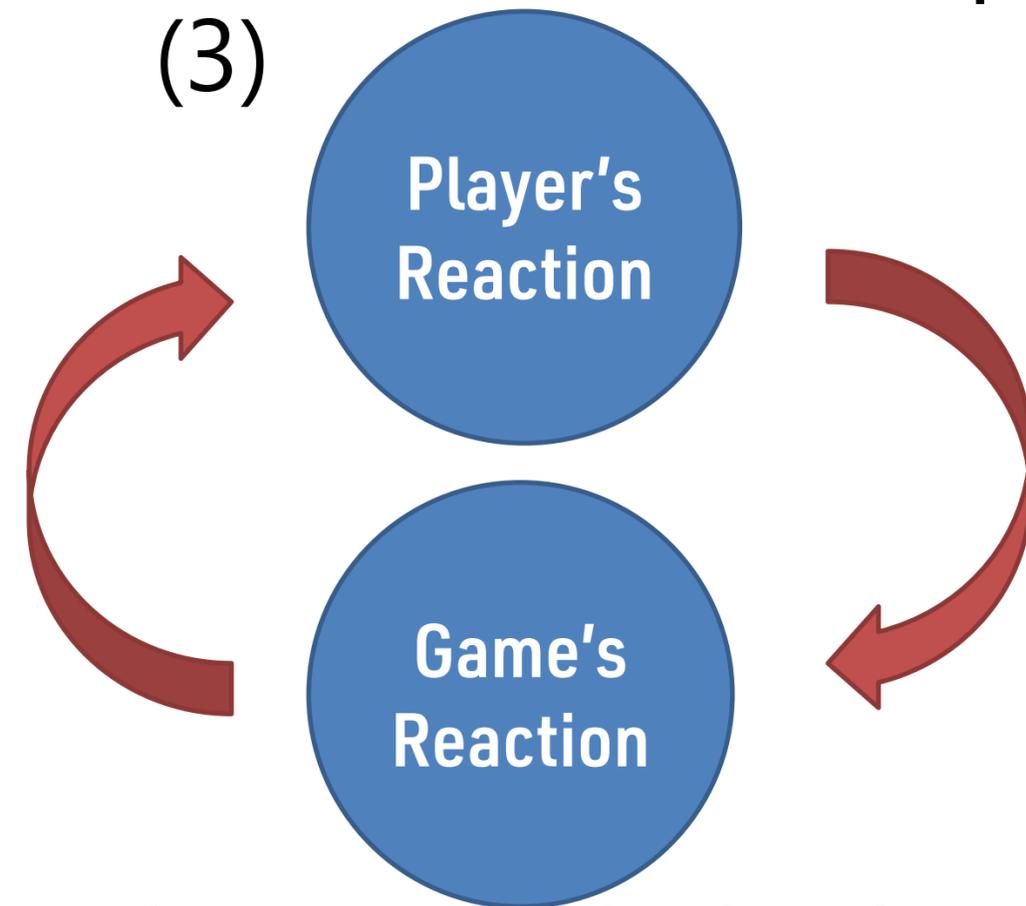


Ru-I-Di -ism

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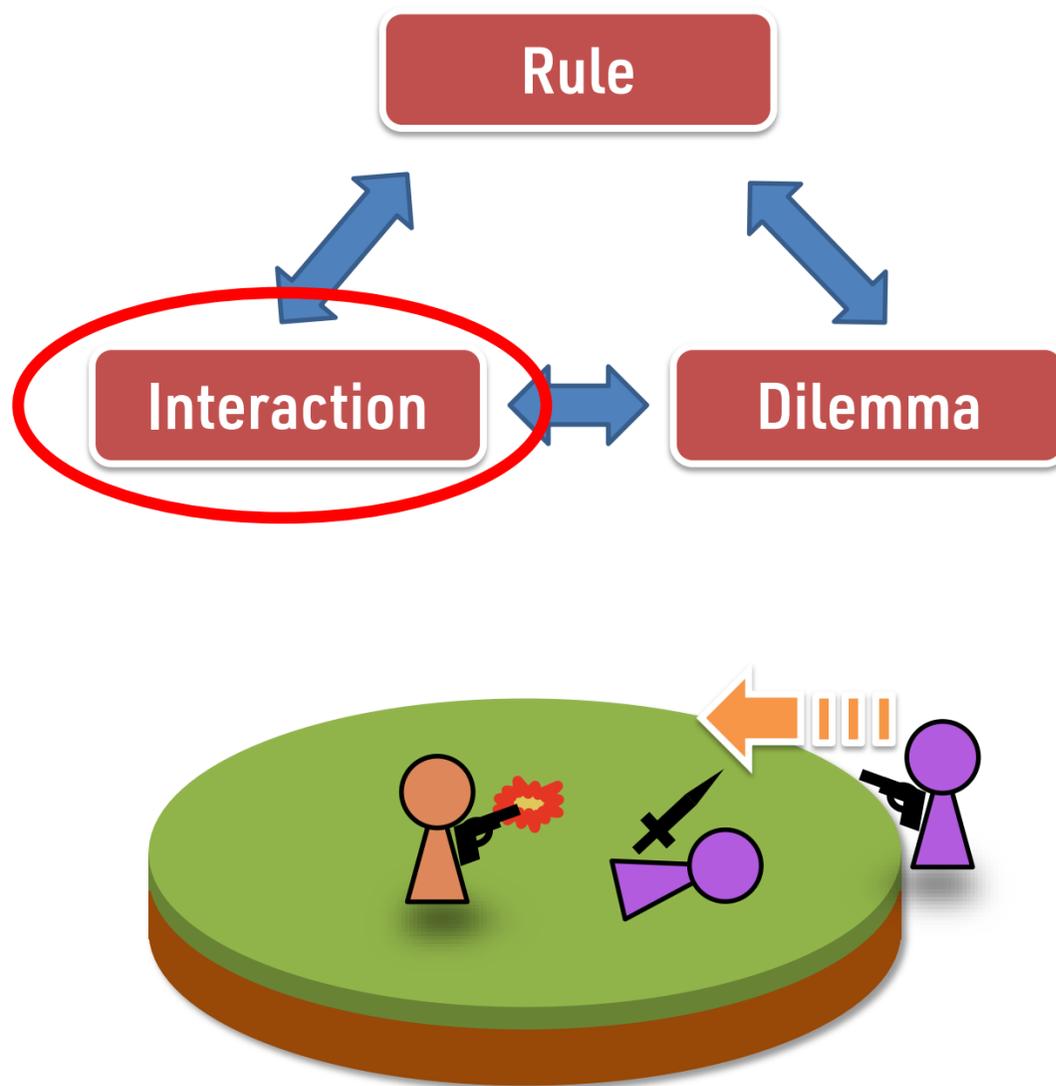
Interaction = the reaction loop
(3)



Progress of game with this loop
→ Fun of the game

Ru-I-Di -ism

Rule for Interaction and Dilemma



Interaction is the loop of action and reaction.

- Player's action and reaction
- Game system's action and reaction
- ...

For example ...

Ru-I-Di -ism

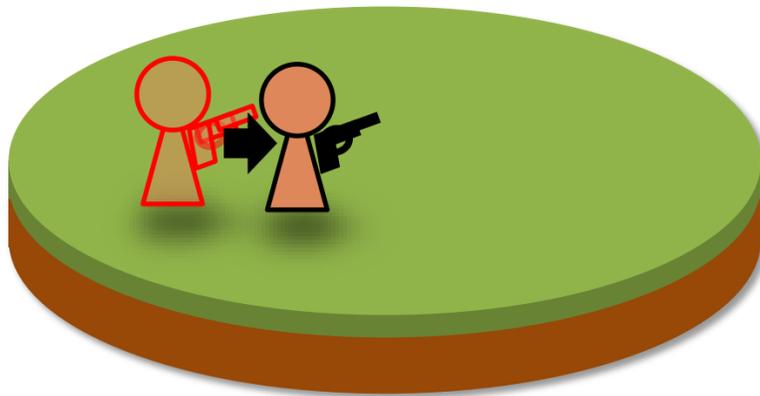
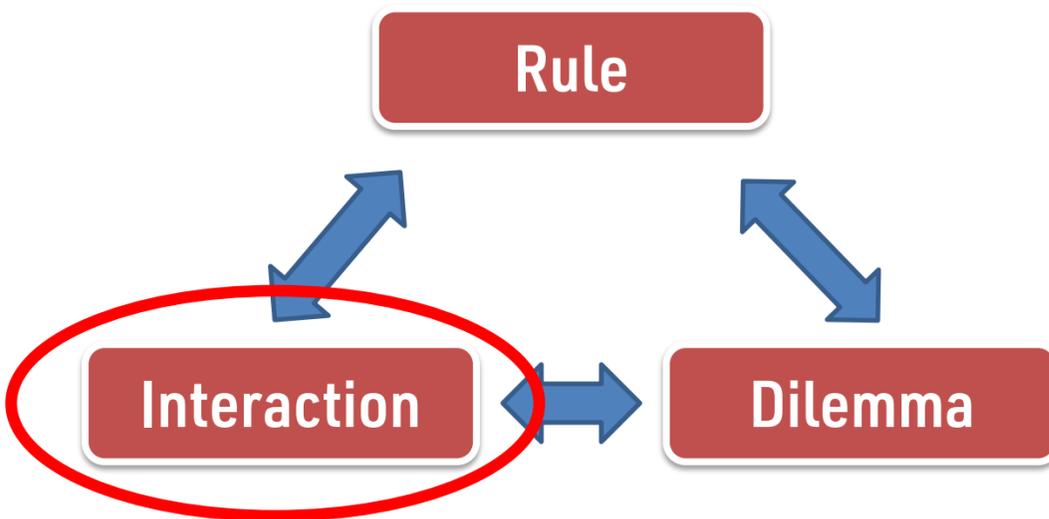
Interaction makes the game loop.

Interaction = the reaction loop

(1)

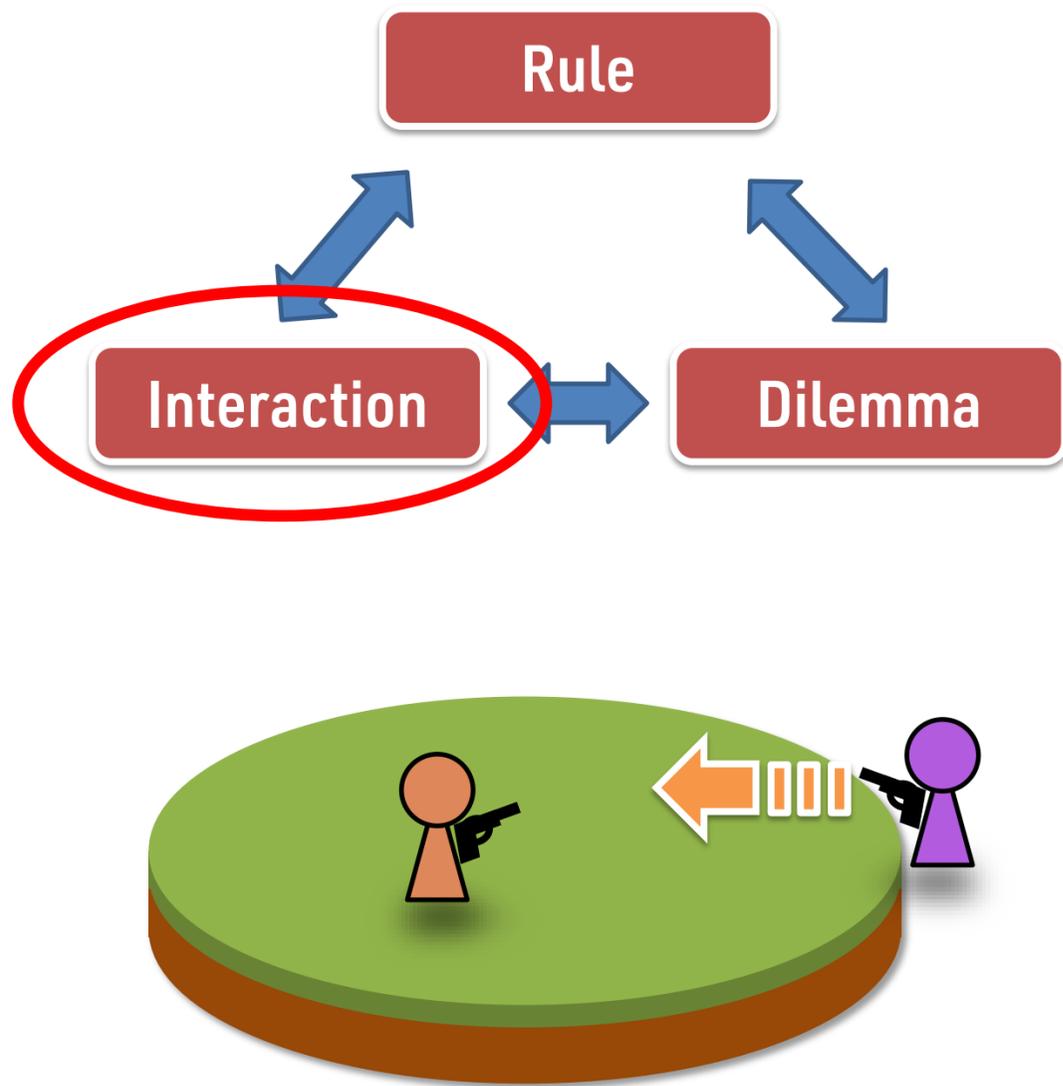
Player's
Action

Moving

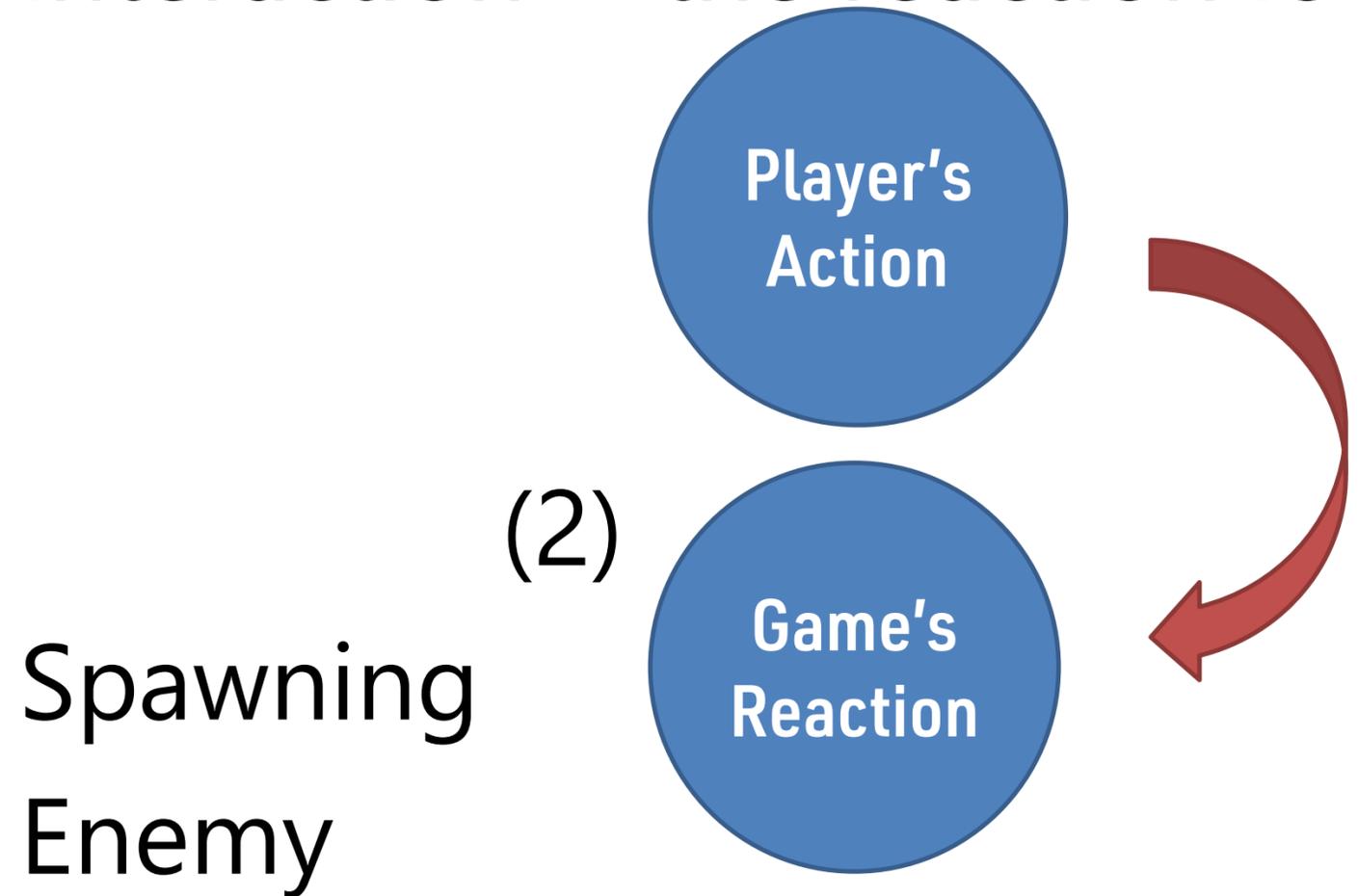


Ru-I-Di -ism

Interaction makes the game loop.

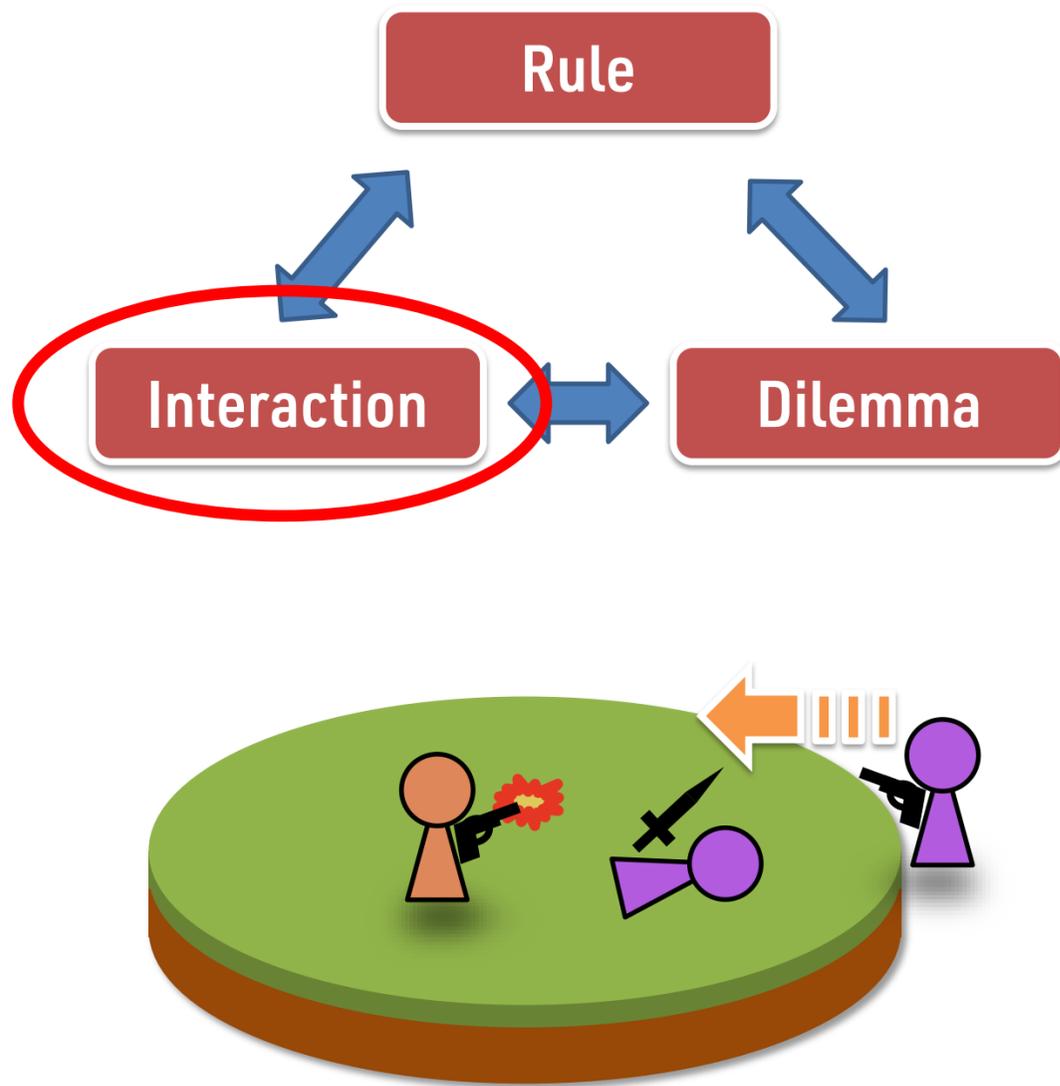


Interaction = the reaction loop

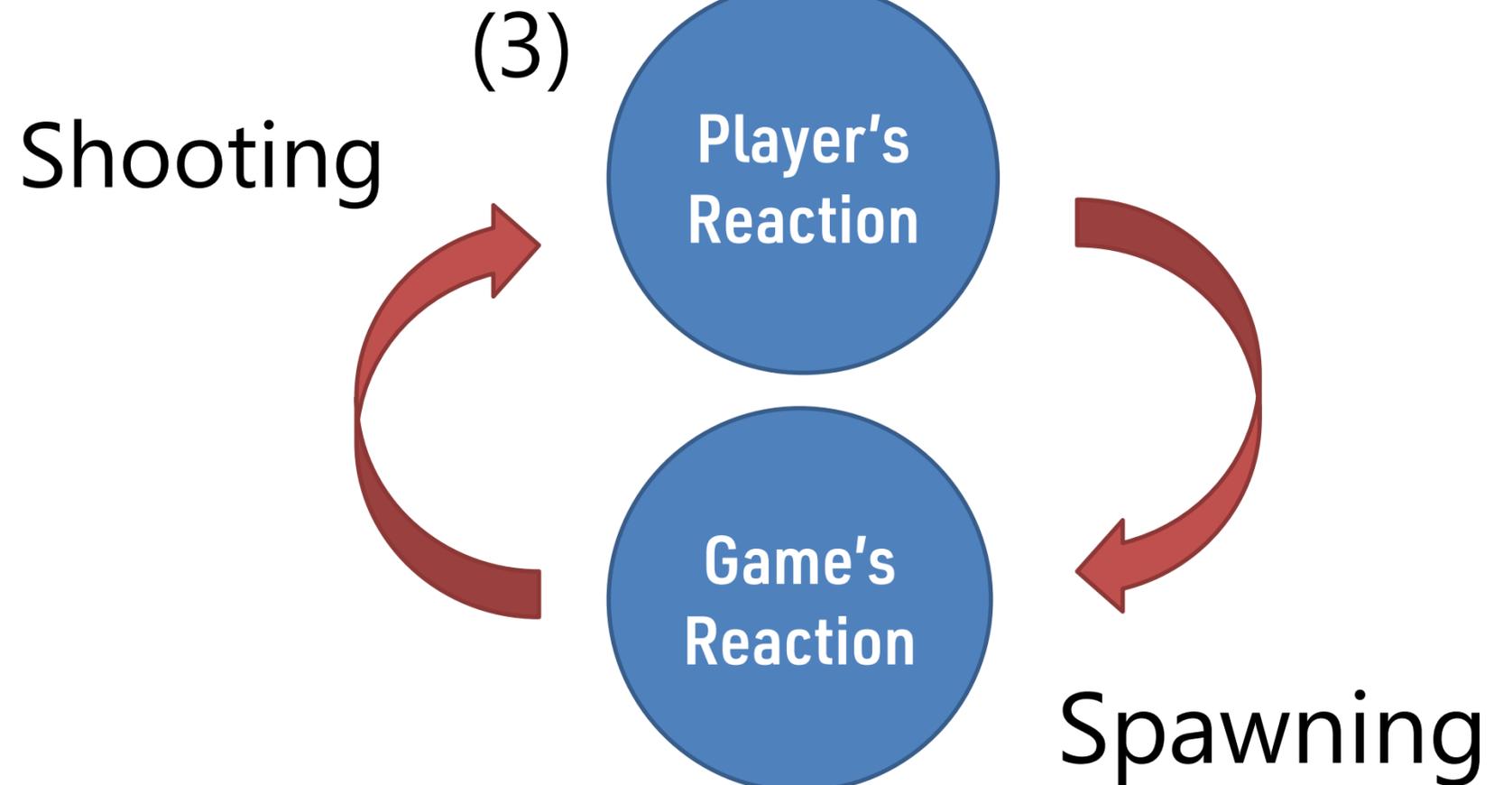


Ru-I-Di -ism

Interaction makes the game loop.

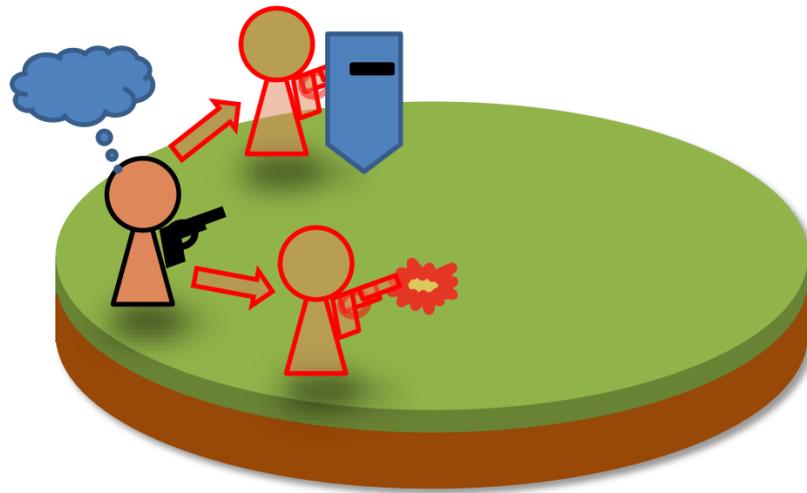
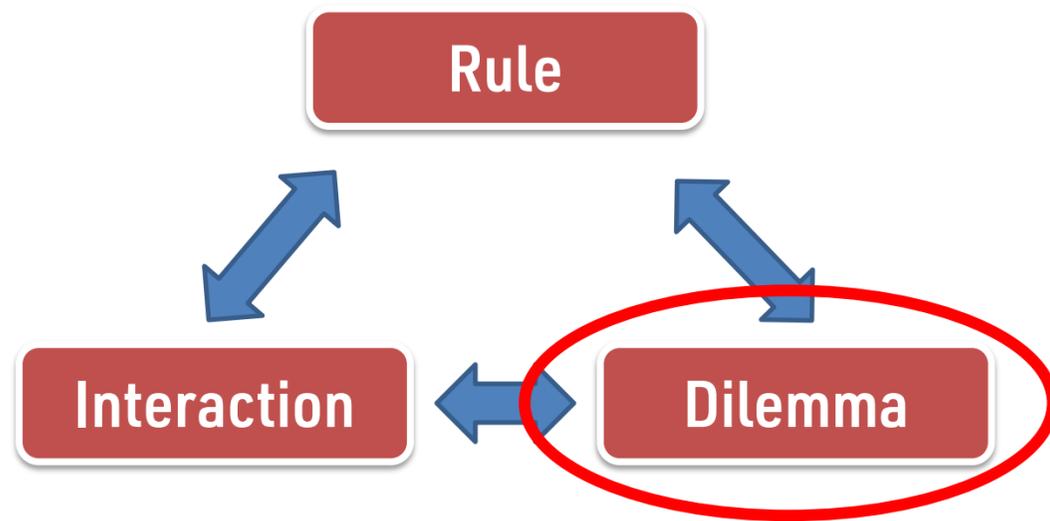


Interaction = the reaction loop



Ru-I-Di -ism

Dilemma to make interaction continuously



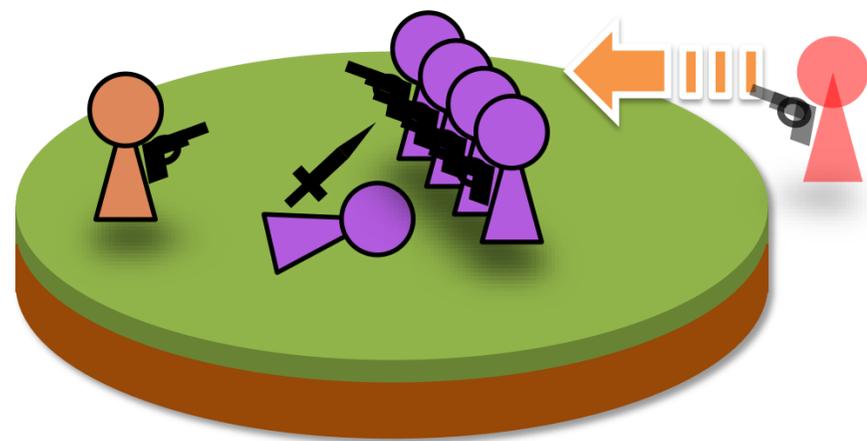
Causes the player to make interactions continuously

Players are forced to select by dilemma

Makes the player believe to be able to control the success or failure

Ru-I-Di -ism (e.g. Dilemma)

Meta AI sets two treasures to different places



There is energy shared between the bomb attack and normal shots

Many enemies = seems a good time to bomb

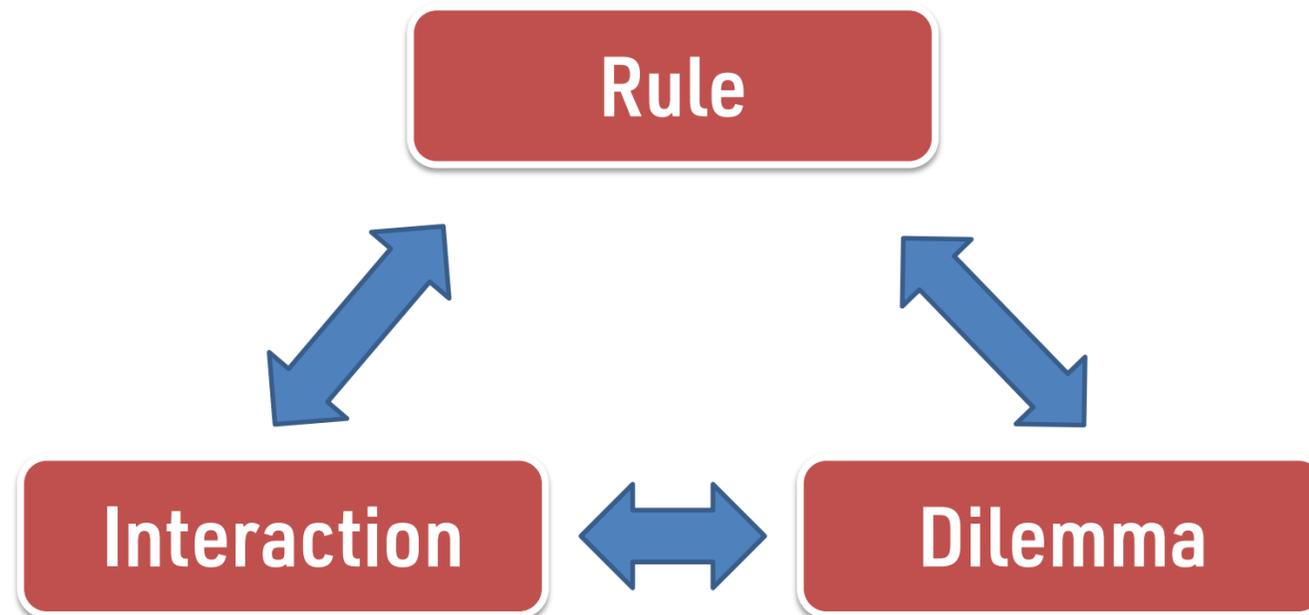
There is a rare enemy that can only be defeated with the bomb

-> Do you use the bomb now?
Or keep it for the rare enemy?

-> **Meta AI controls spawning** of rare enemy

Games Are Too Complex To Adjust

Break down the game into three ingredients



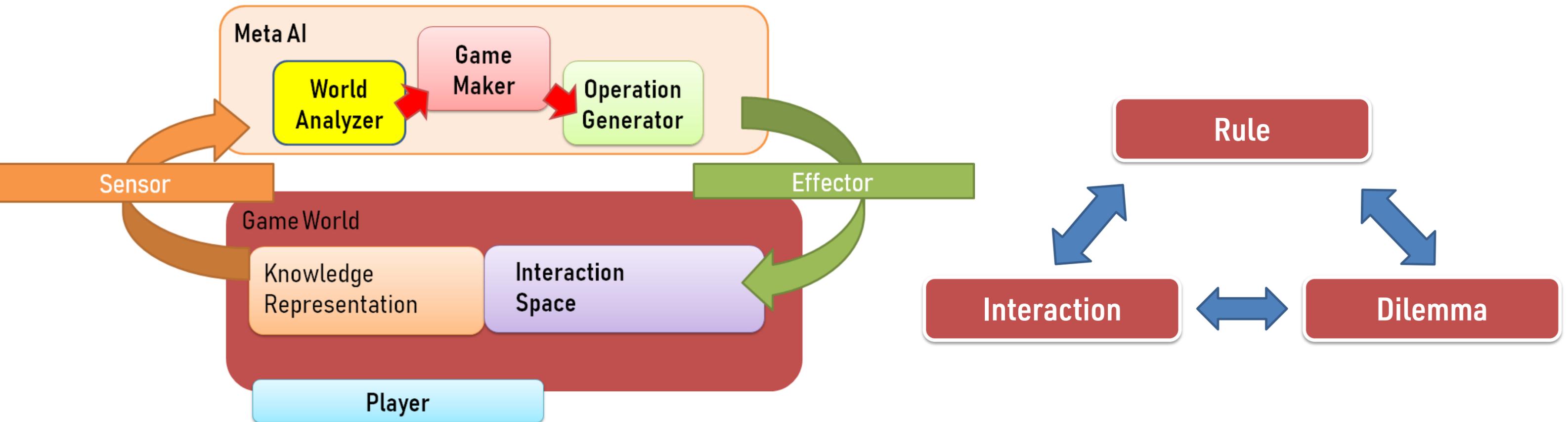
Fun game should have

"Ru-I-Di -ism"

Ru-I-Di -ism helps game designers figure out which elements are the best for Meta AI

Make Your Own Meta AI

What can we do to make the BEST games?

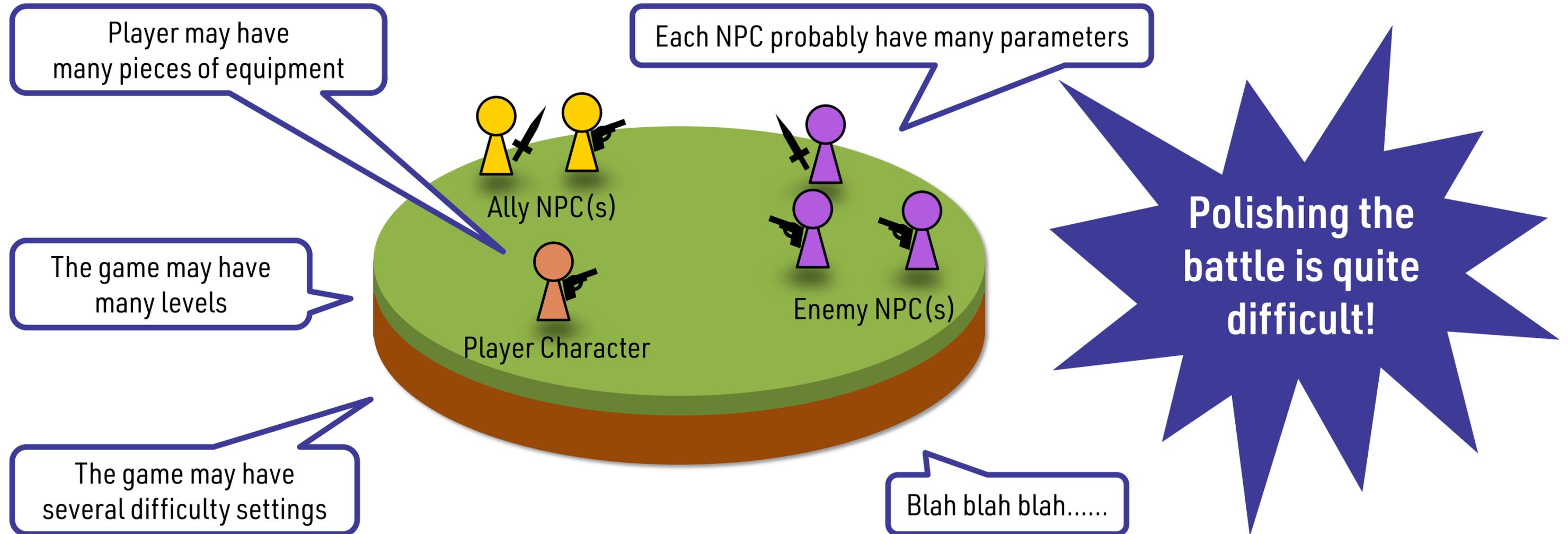


**Use Ru-I-Di -ism with fellow Game Designers
to make your own Meta AI**

Summary

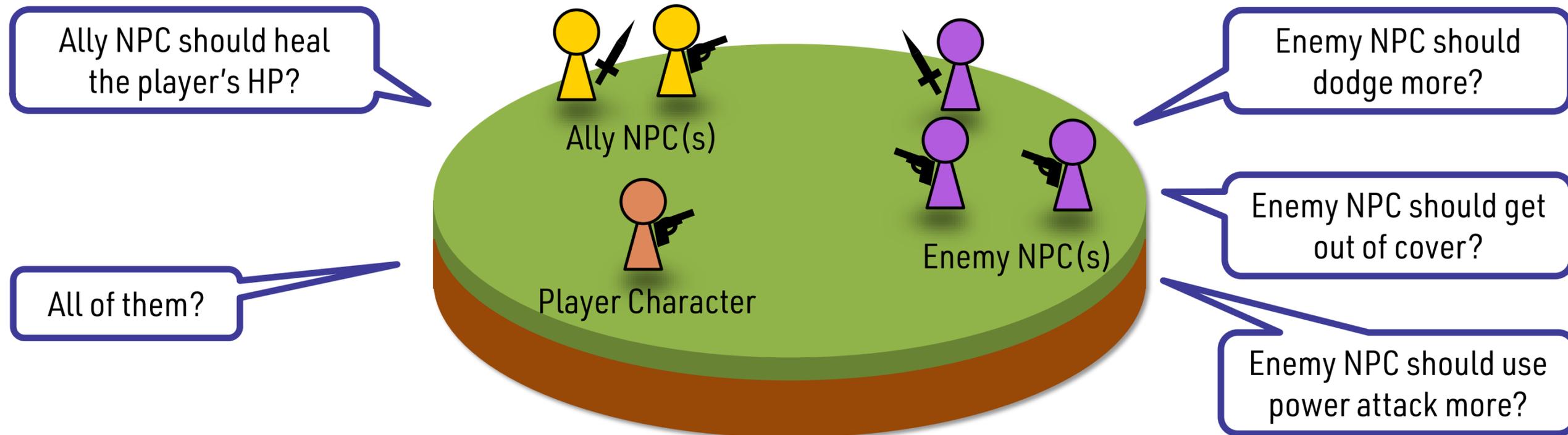
- **Meta AI overview**
 - Why Meta AI
 - What is Meta AI
- **Meta AI General Design**
 - How to make Meta AI
 - What can Game Designer do for Meta AI
- **Meta AI Practical Model**
 - Emotion-based Meta AI
 - Visualization for Meta AI

In usual combat scenes...

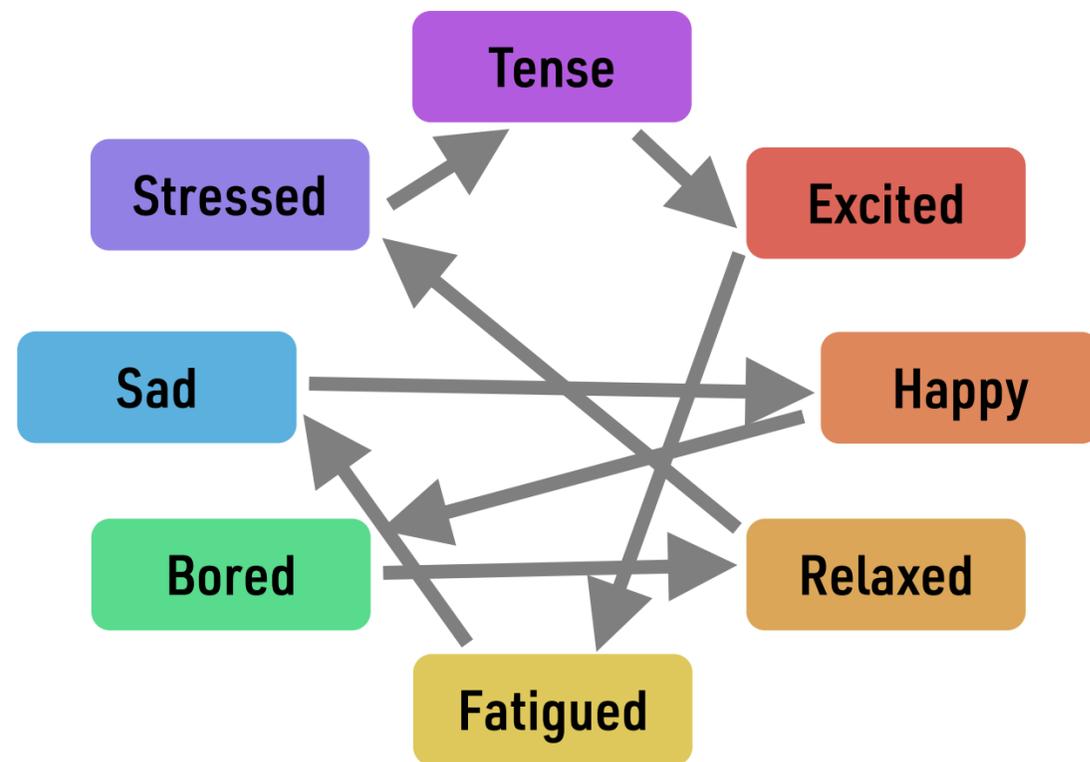


Effectors of Meta AI

How should the Meta AI control the elements to make the game more fun?



Our goal

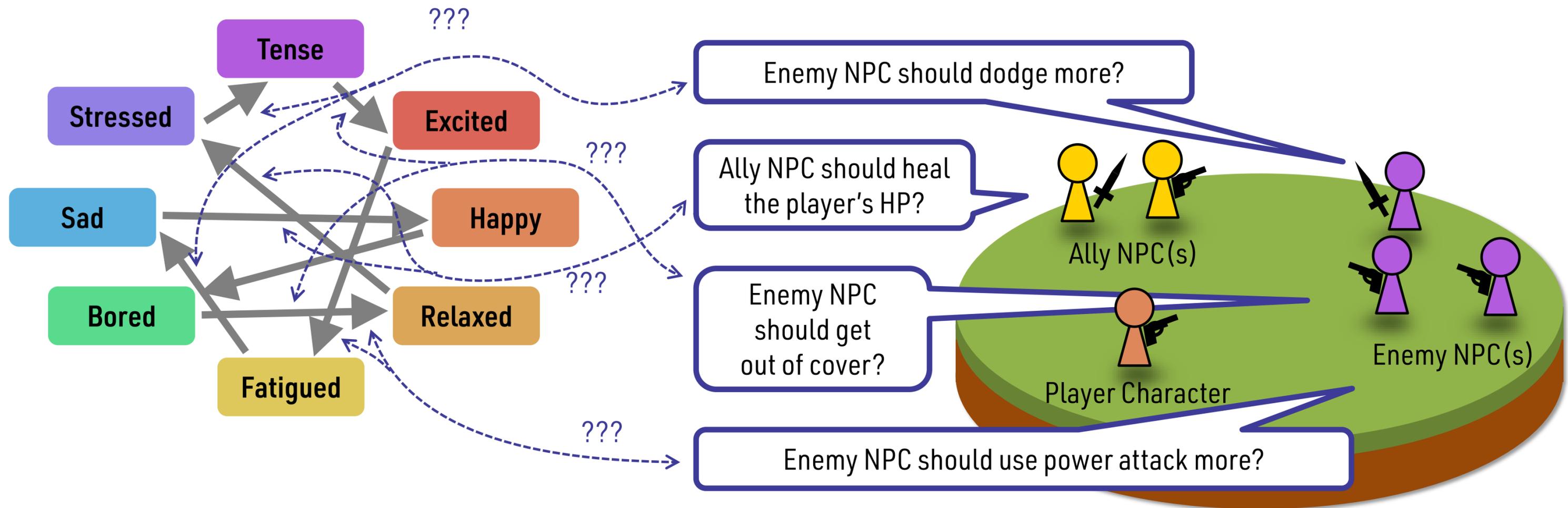


We want to know
the player's emotion

And try to move it
toward a specific direction

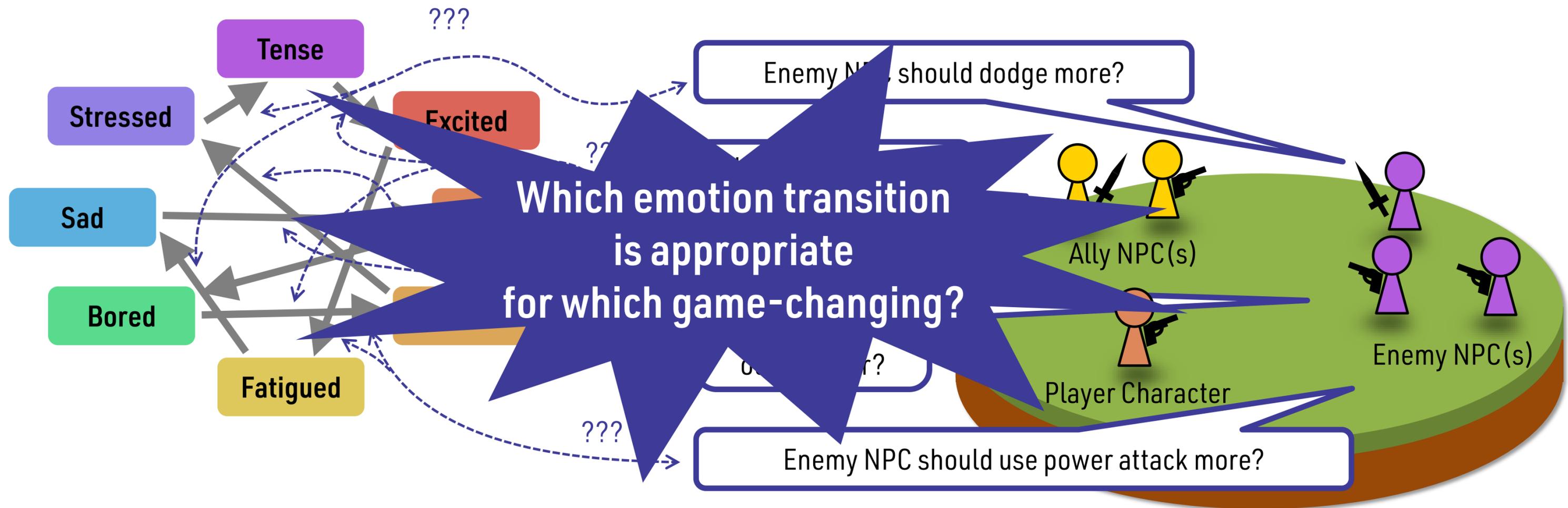
Our goal

How should the Meta AI control the elements to make the game more fun?



Our goal

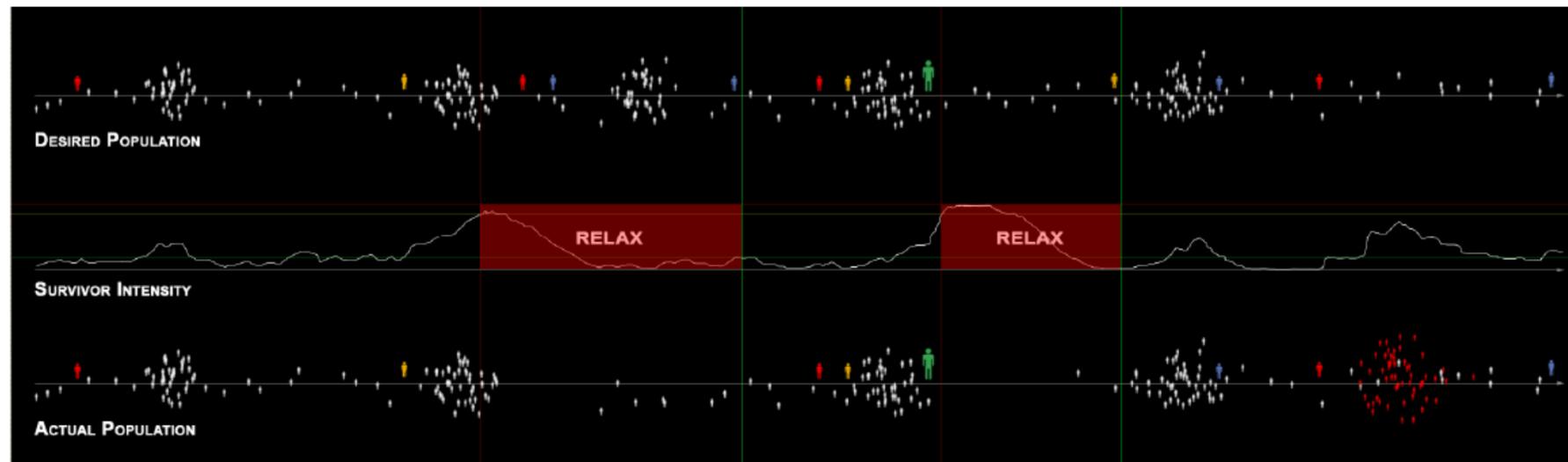
How should the Meta AI control the elements to make the game more fun?



Related works: intensity-based Meta AI

E.g., Left 4 Dead and Warframe

- Controlling the game by introducing periodic variation on the player's emotional intensity. (i.e. relaxed/stressed emotion)
- In general, Meta AI controls the intensity by spawning enemy NPC and adjusting spawning position.



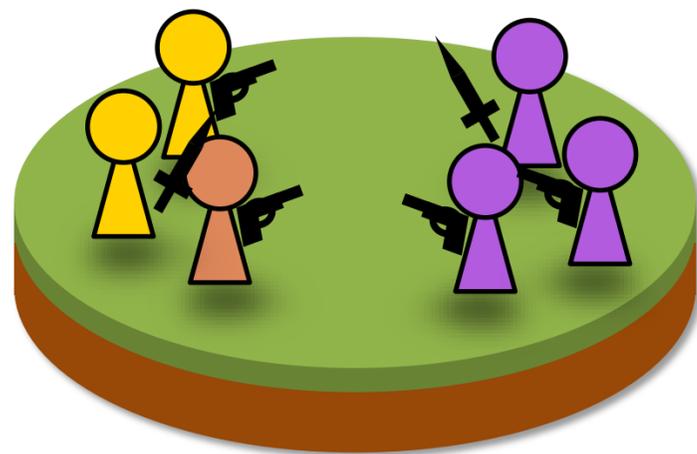
Meta AI (AI Director) on Left 4 Dead [Booth 2009]

[Booth 2009] Booth, M.: Replayable Cooperative Game Design: Left 4 Dead, GDC 2009 (2009)

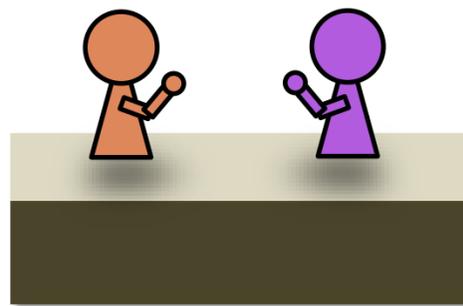
Problems of intensity-based Meta AI

1. In many cases, impossible to control the number of NPCs

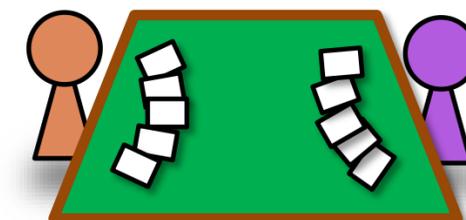
- Games with fixed number of characters or objects are common even now.
- Even when non-fixed, game design or level may prevent the Meta AI from spawning NPC at specific times or desired positions.



Shooter game



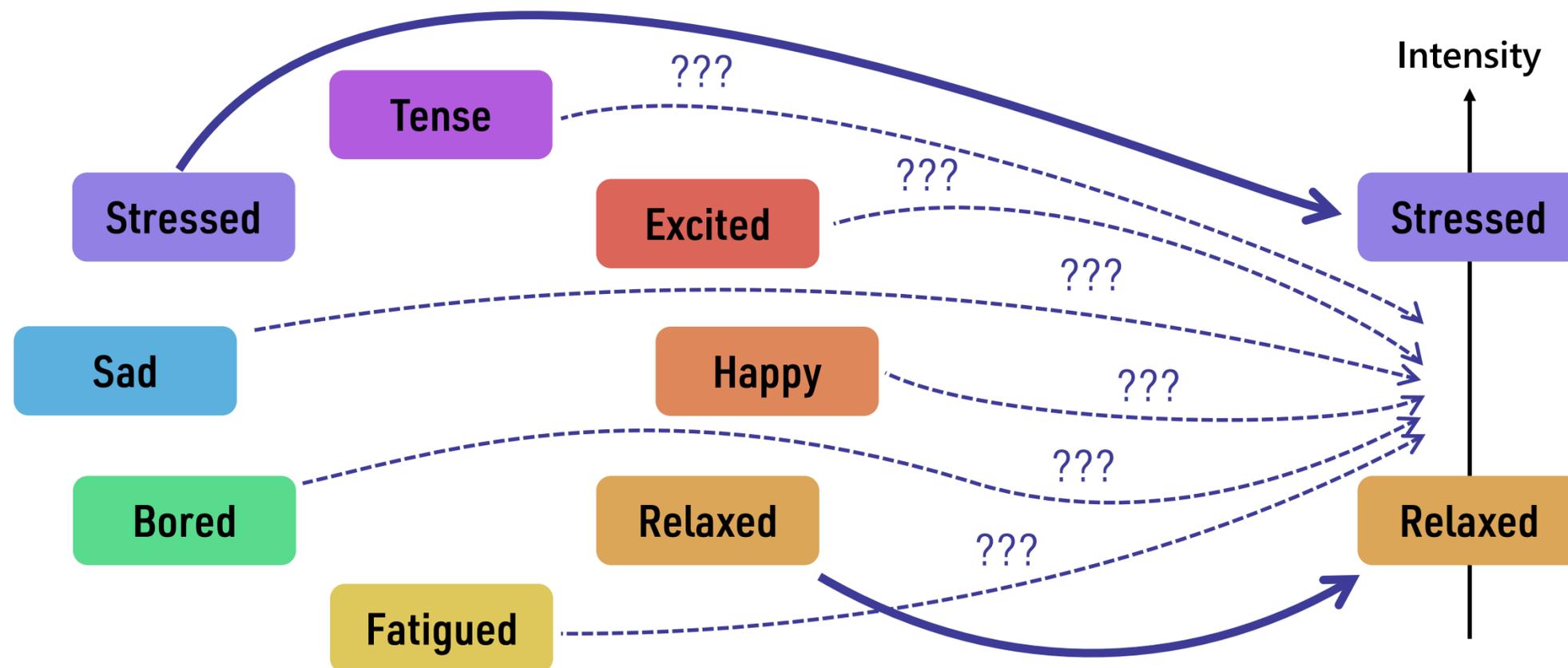
Fighting game



Card game

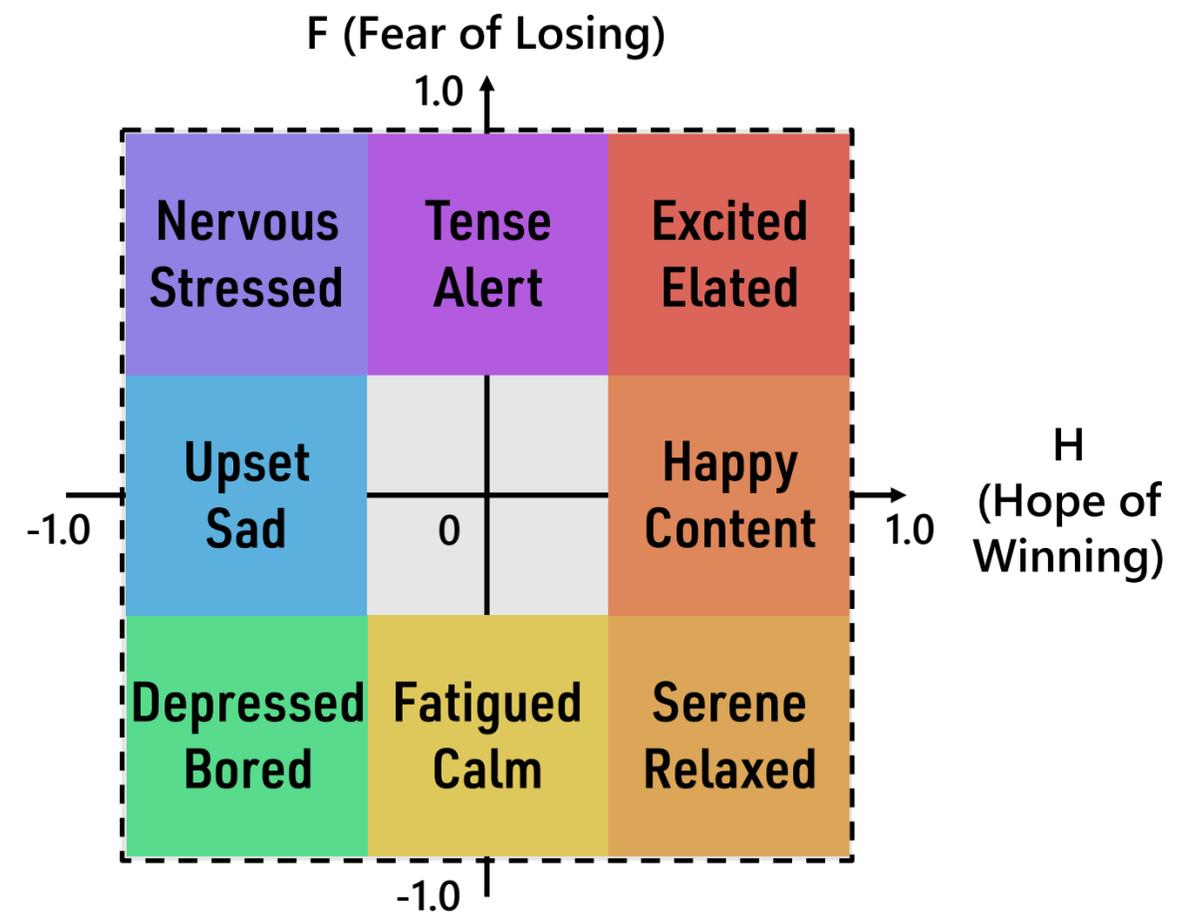
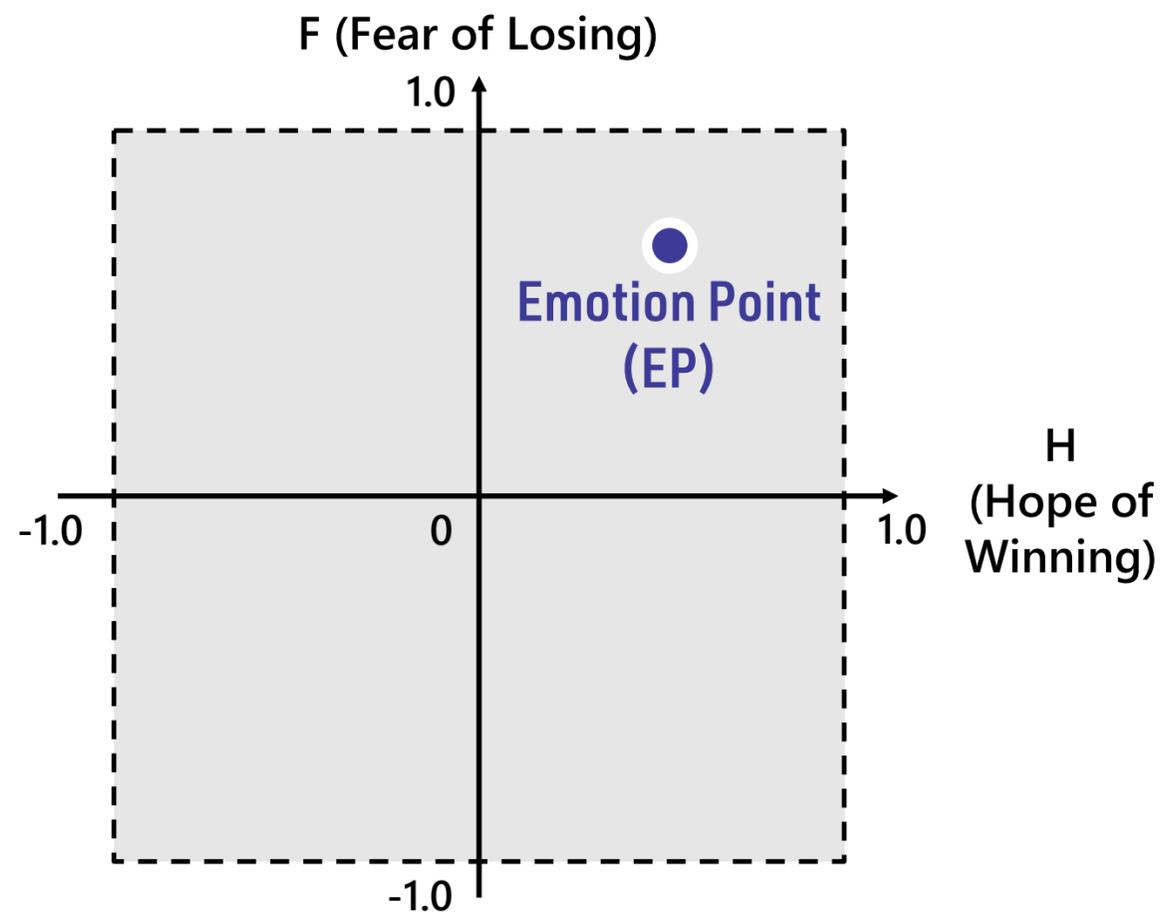
Problems of intensity-based Meta AI

2. Difficult to deal with the player's various types of emotions



Key idea: 2D Emotion Map

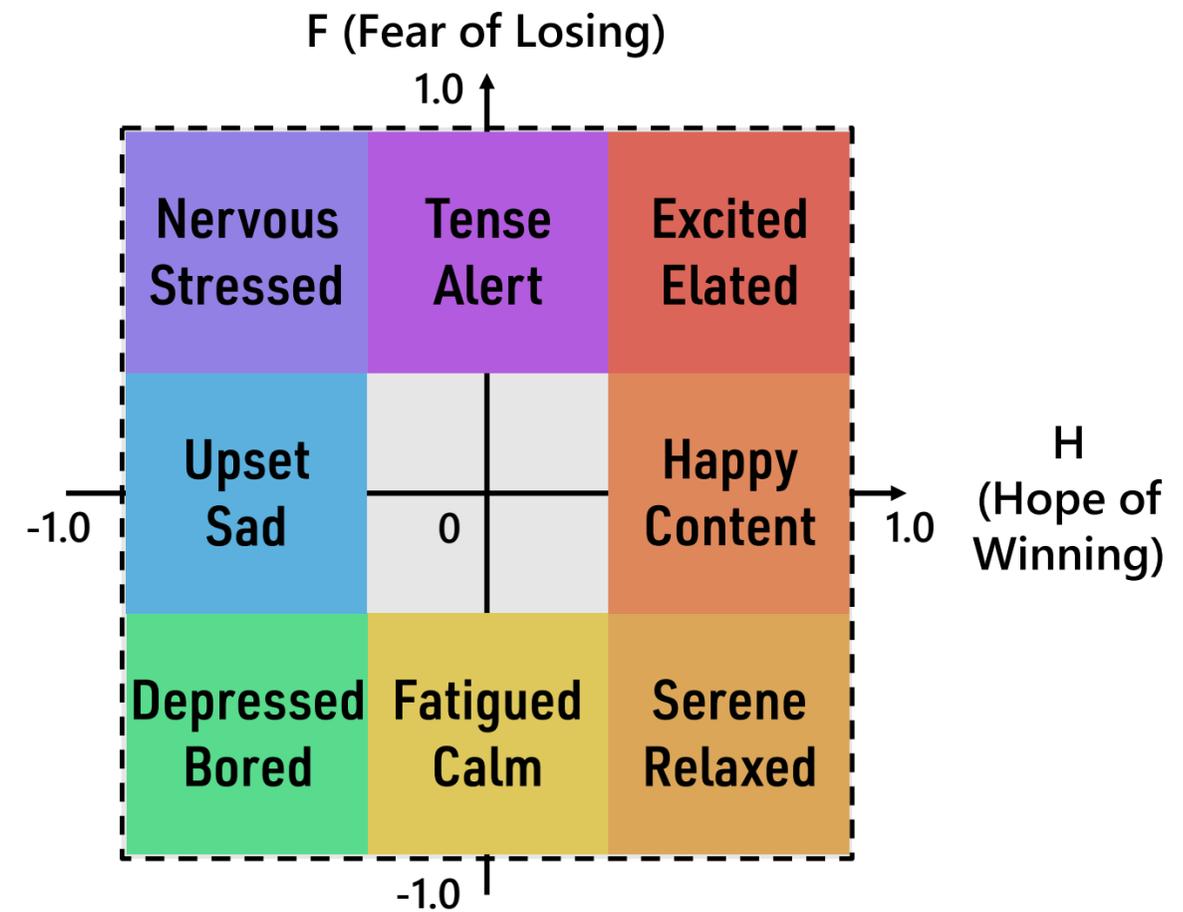
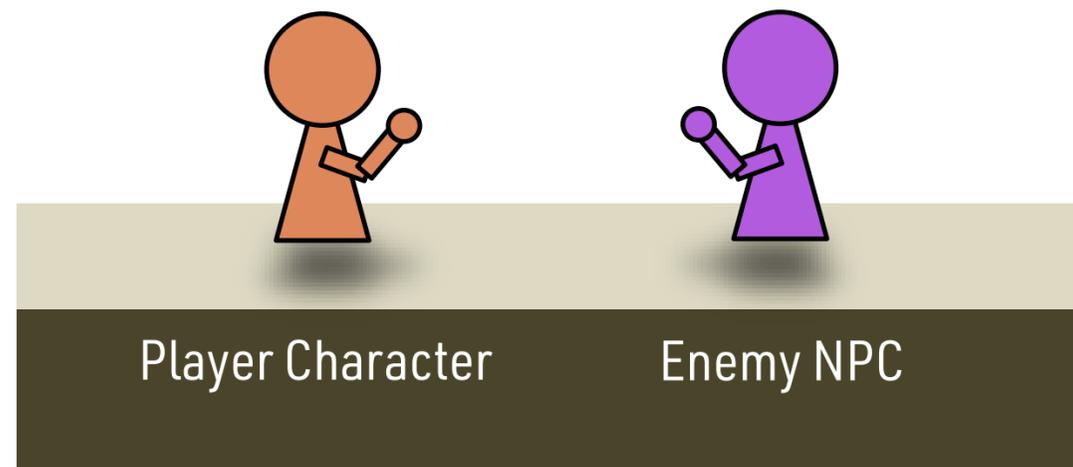
- Represent the player's emotion with a combination of "Hope of Winning" and "Fear of Losing."
- Inspired by the psychological emotion model. [Watson and Tellegen 1985]



[Watson and Tellegen 1985] Watson, D. and Tellegen, A.: Toward a consensual structure of mood, Psychological Bulletin, Vol.98, pp.219-235 (1985)

Why 2D Emotion Map?

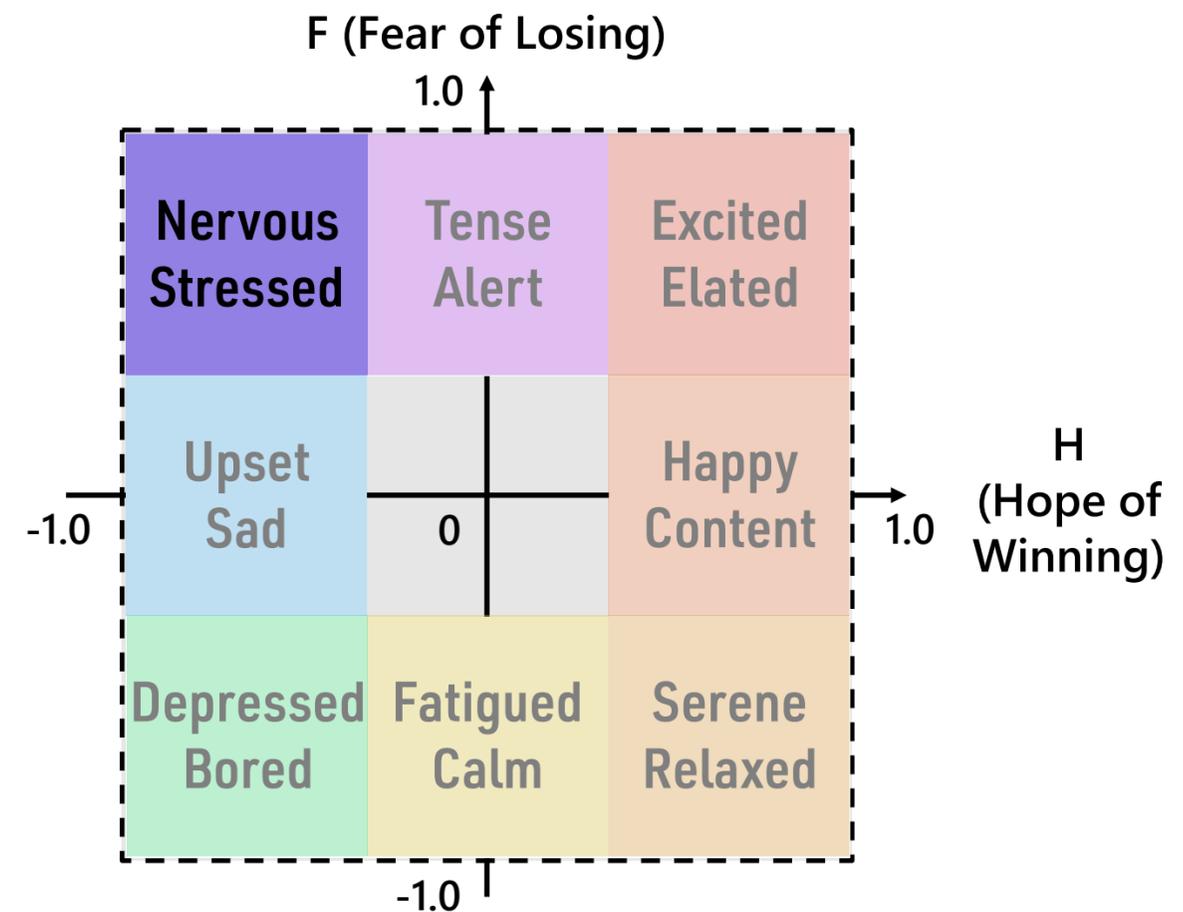
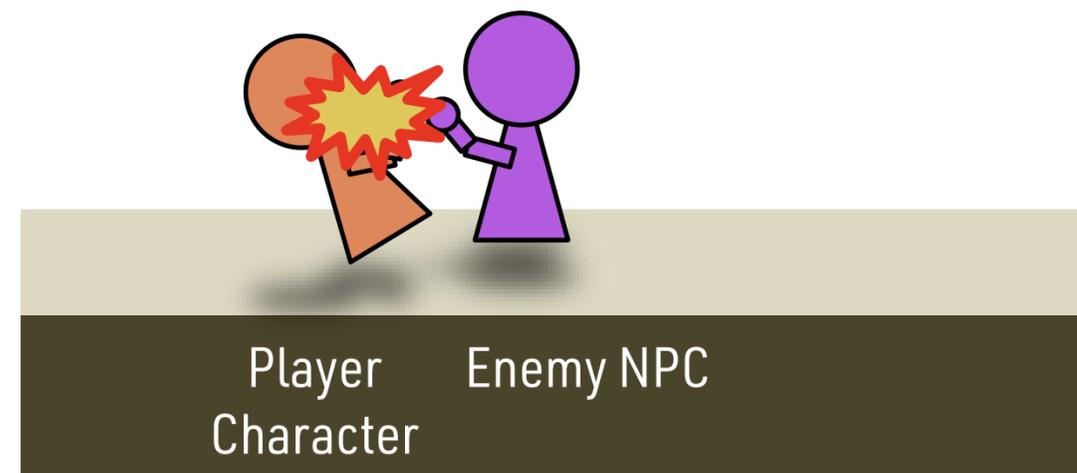
Various emotions/situations can be expressed by combination of Hope/Fear values



Why 2D Emotion Map?

Various emotions/situations can be expressed by combination of Hope/Fear values

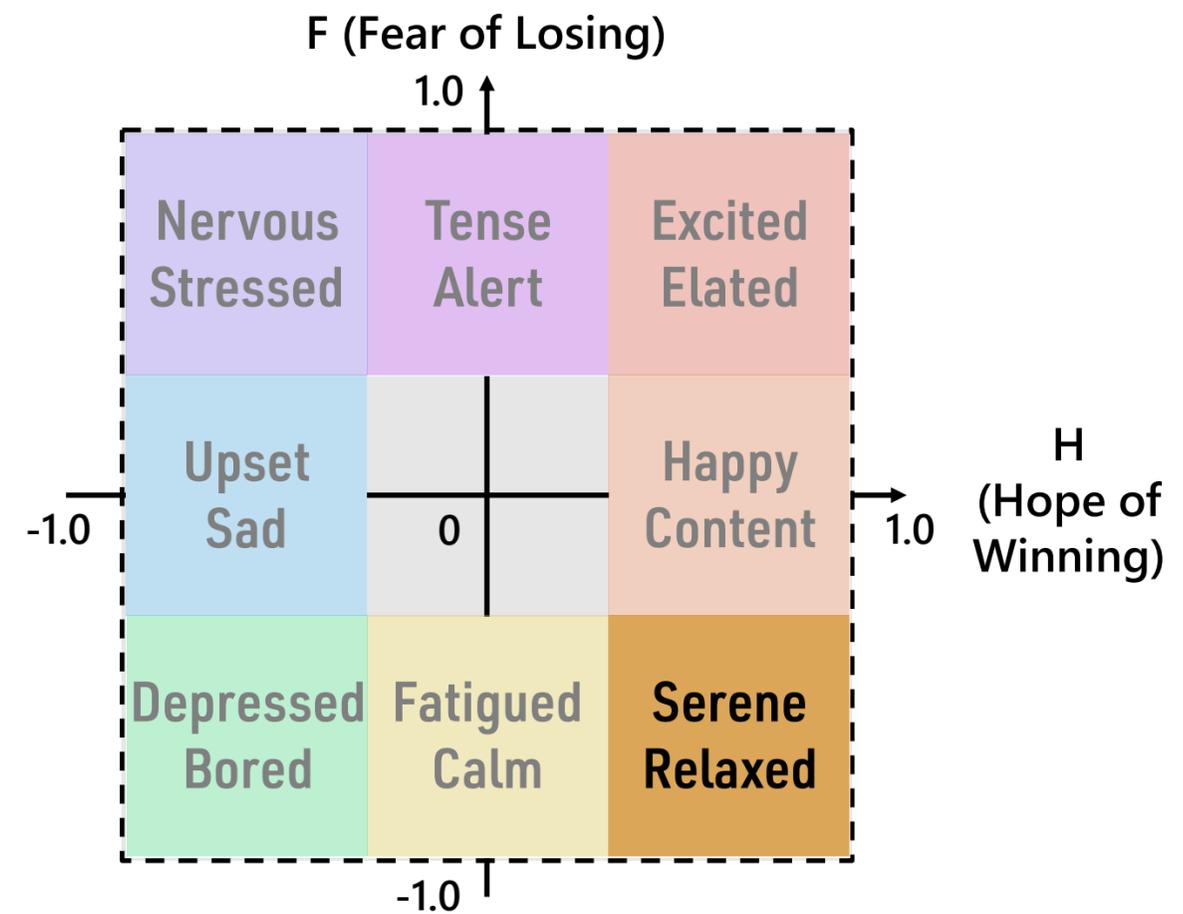
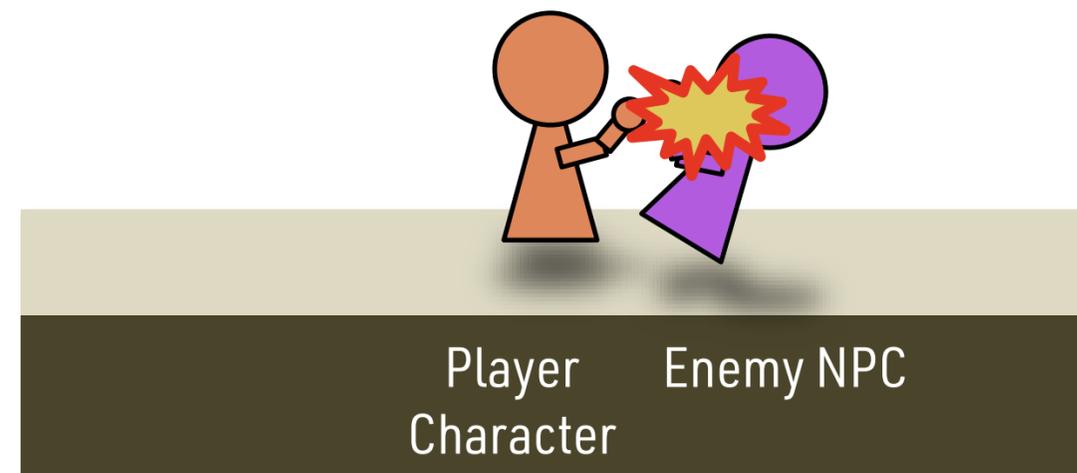
[Case 1/4]



Why 2D Emotion Map?

Various emotions/situations can be expressed by combination of Hope/Fear values

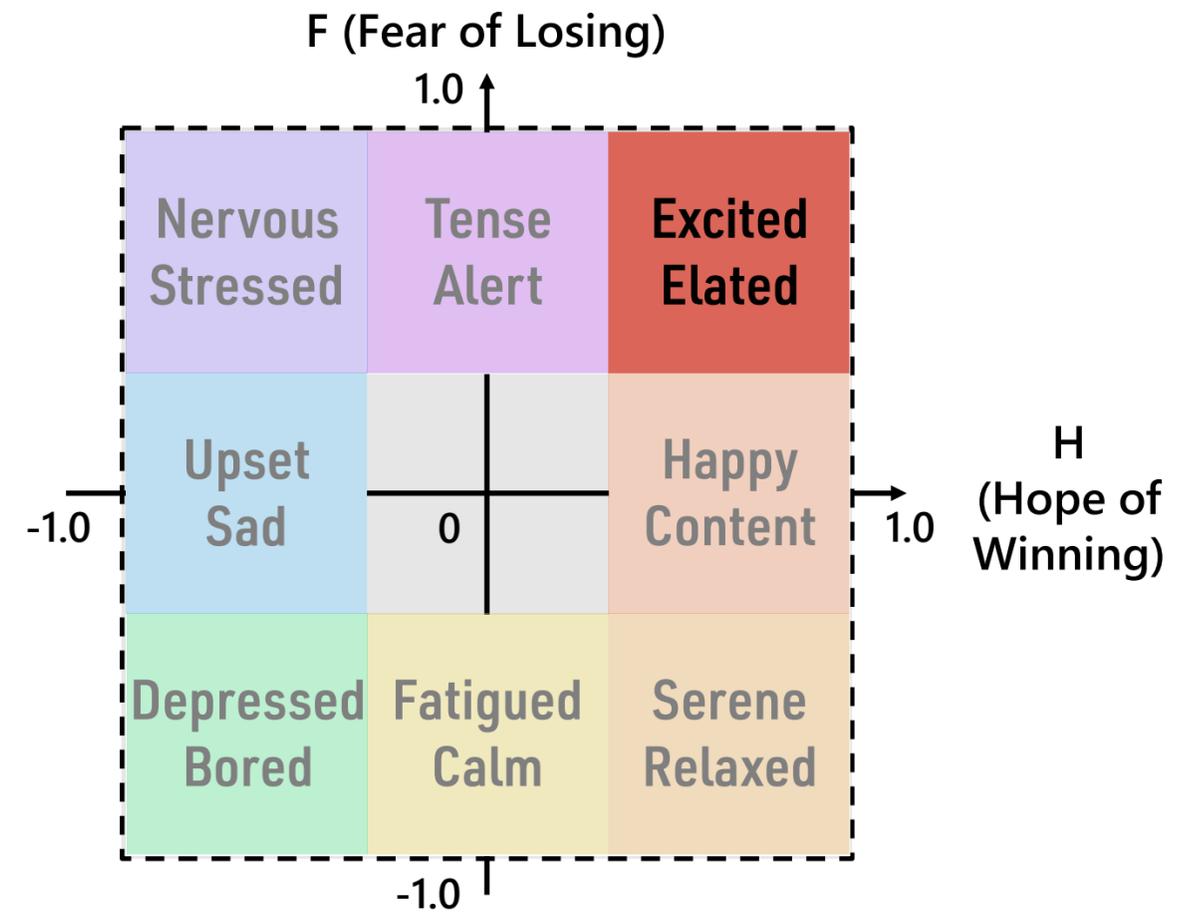
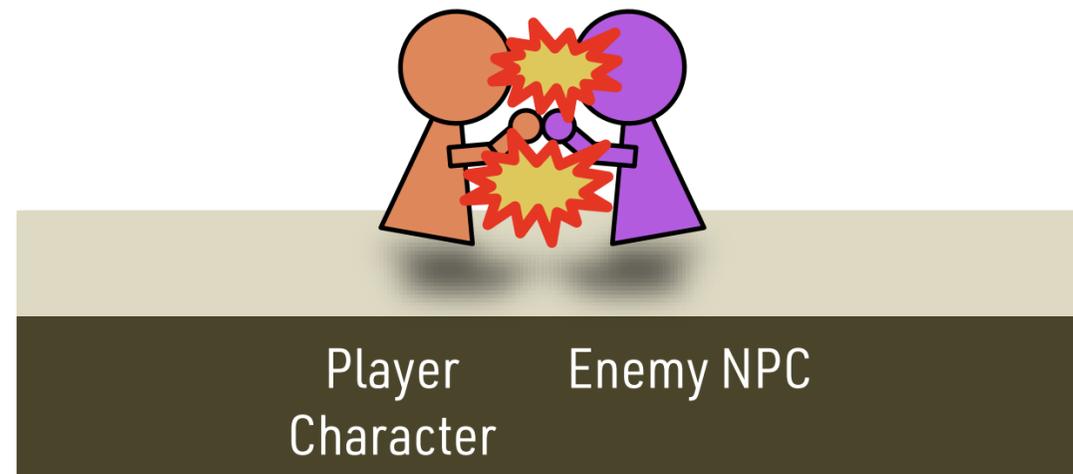
[Case 2/4]



Why 2D Emotion Map?

Various emotions/situations can be expressed by combination of Hope/Fear values

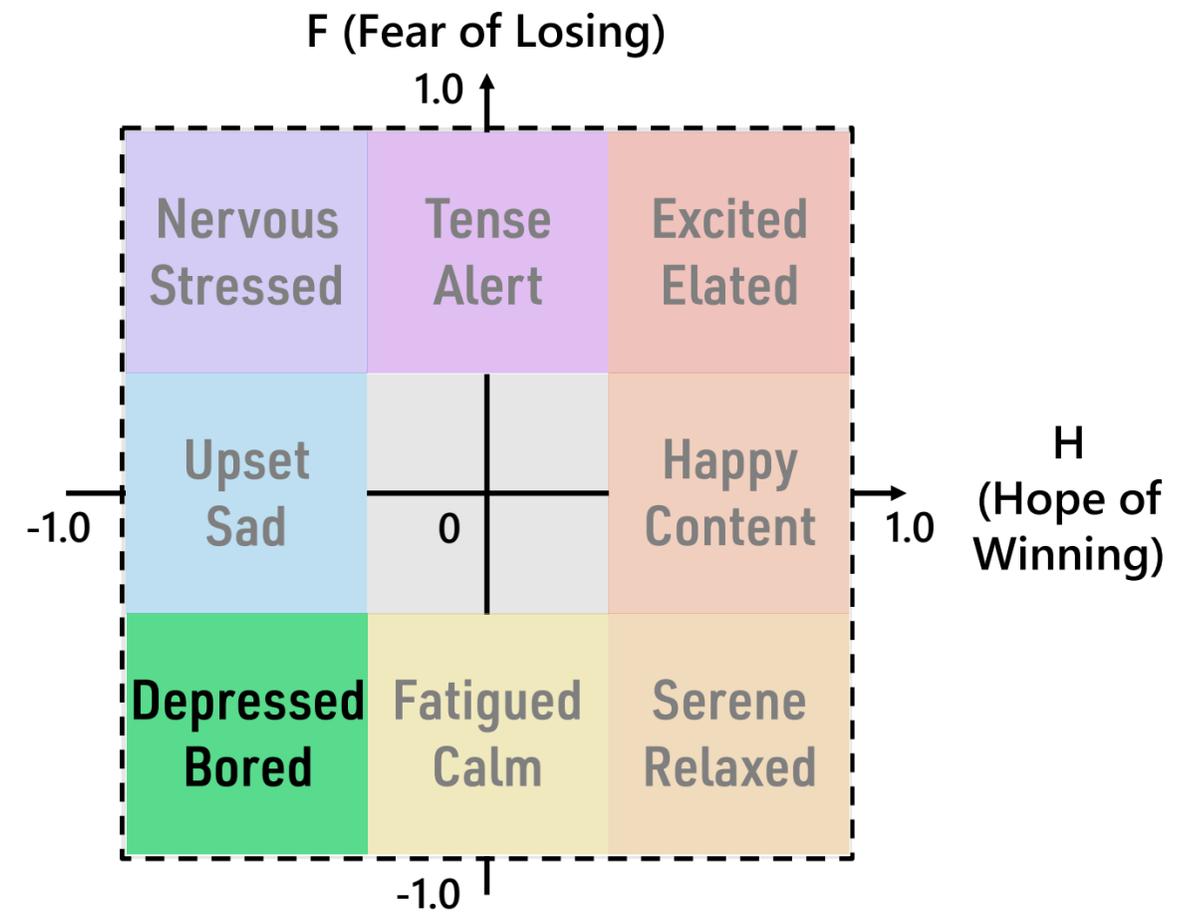
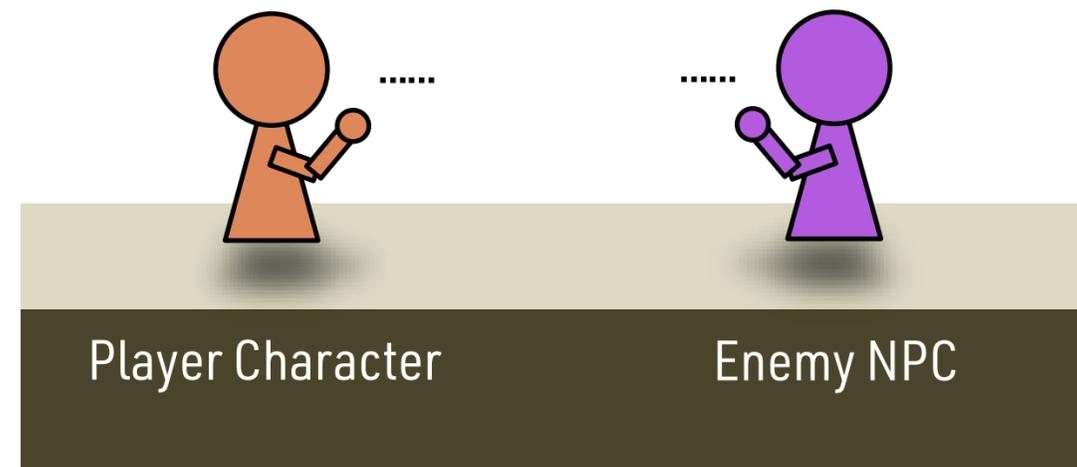
[Case 3/4]



Why 2D Emotion Map?

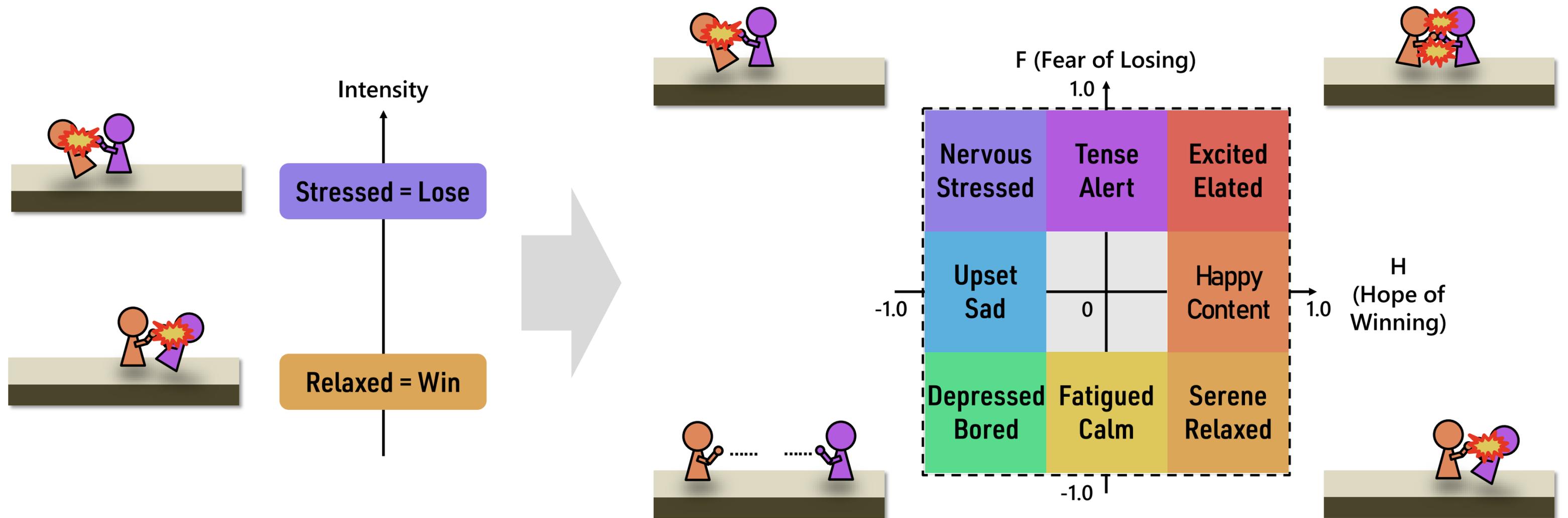
Various emotions/situations can be expressed by combination of Hope/Fear values

[Case 4/4]



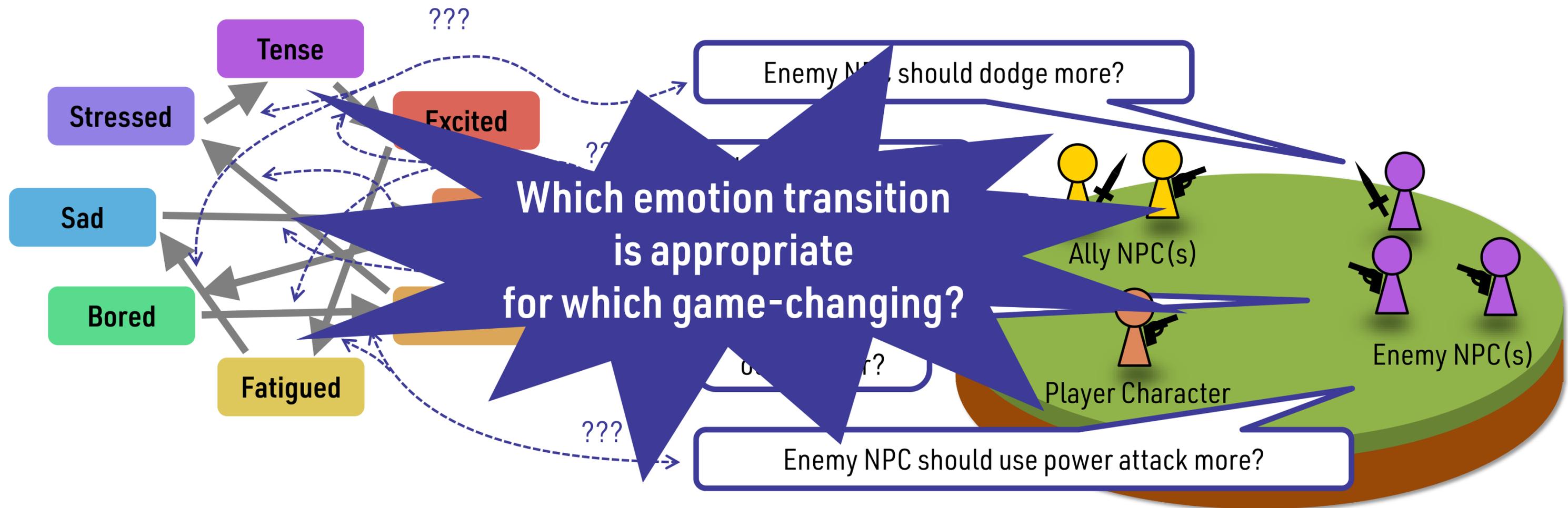
Why 2D Emotion Map?

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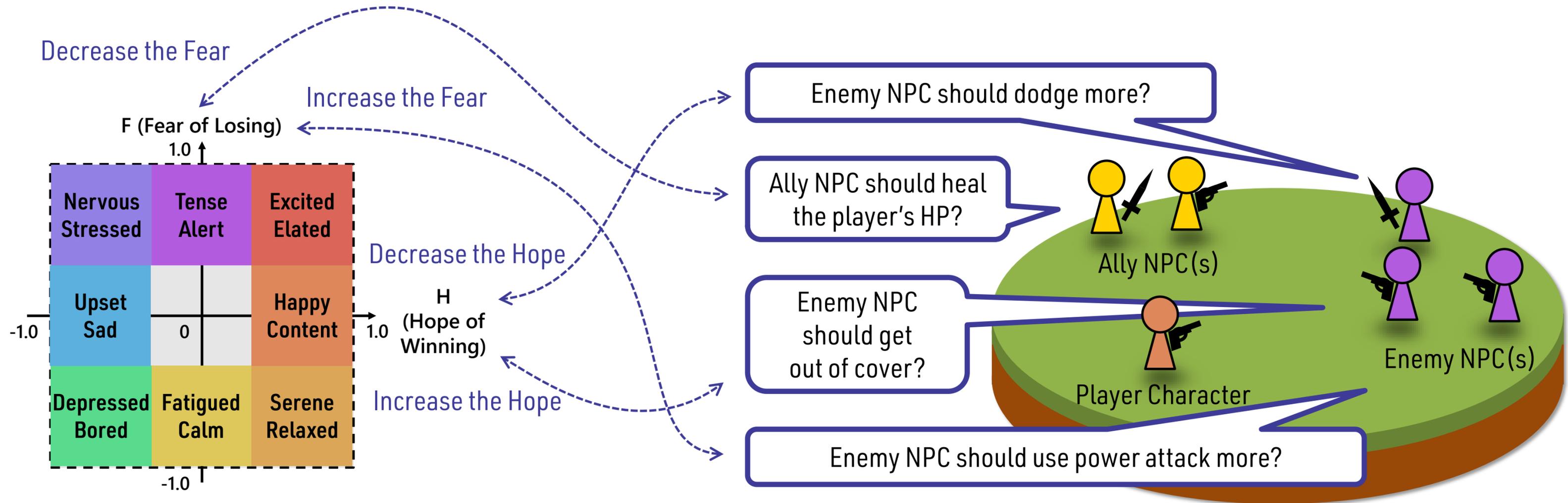
Our goal

How should the Meta AI control the elements to make the game more fun?

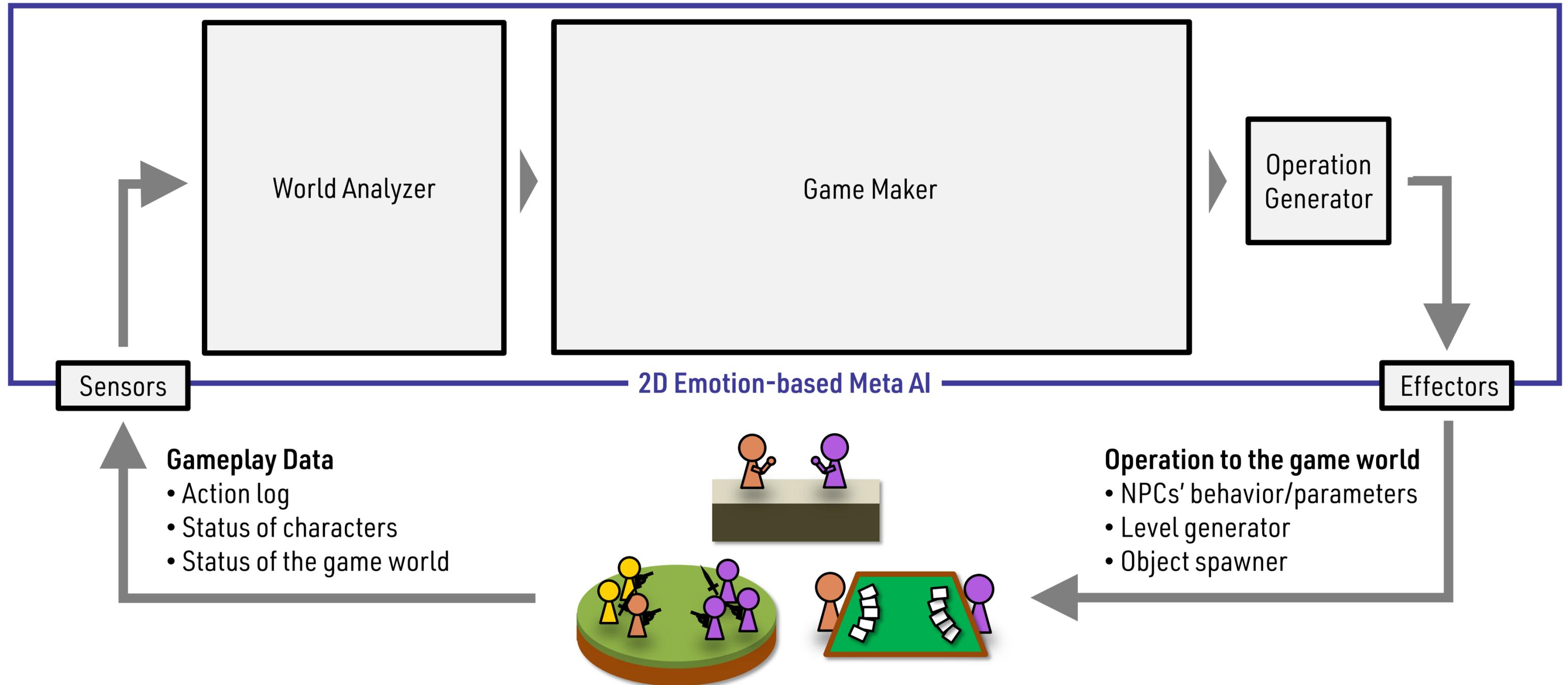


Why 2D Emotion Map?

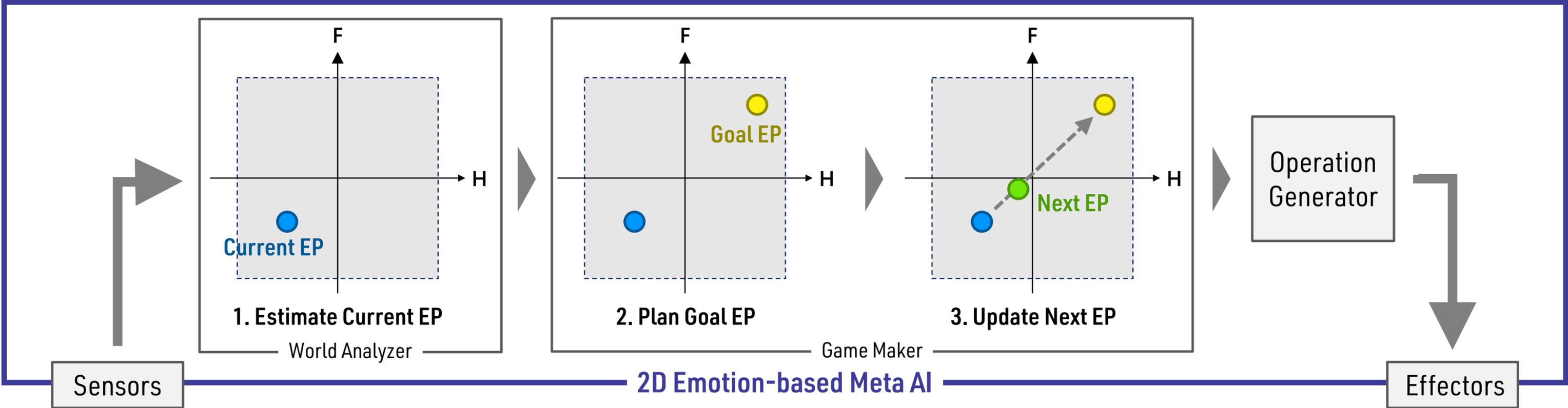
It can map the Meta AI's operations to the player's emotions clearly



Method overview

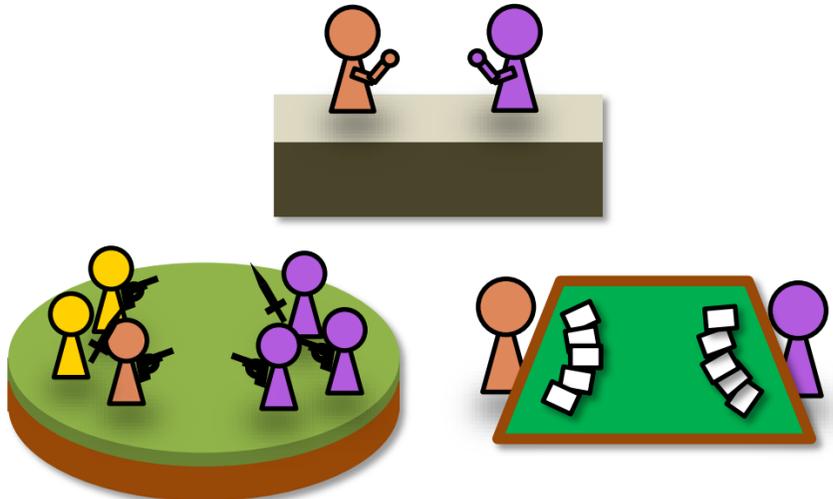


Method overview



Gameplay Data

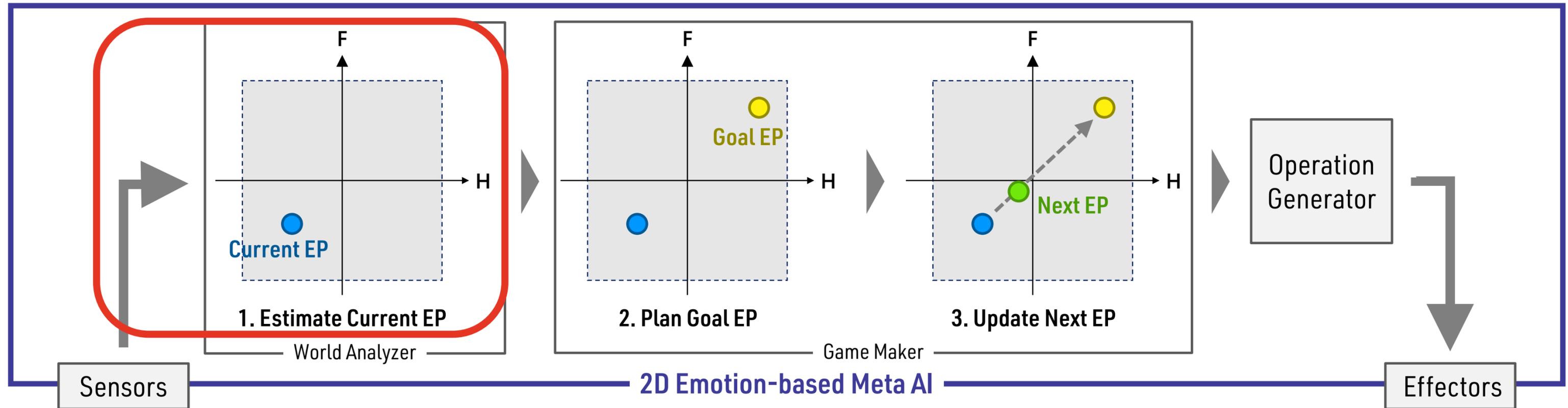
- Action log
- Status of characters
- Status of the game world



Operation to the game world

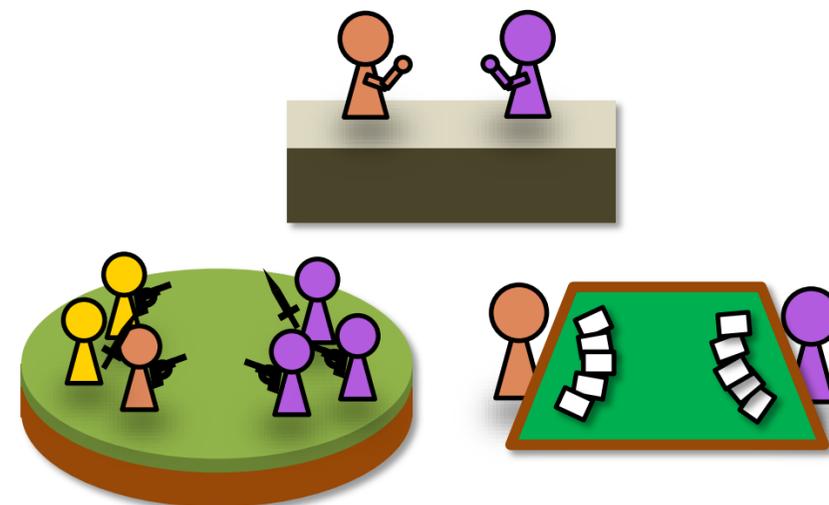
- NPCs' behavior/parameters
- Level generator
- Object spawner

Method overview



Gameplay Data

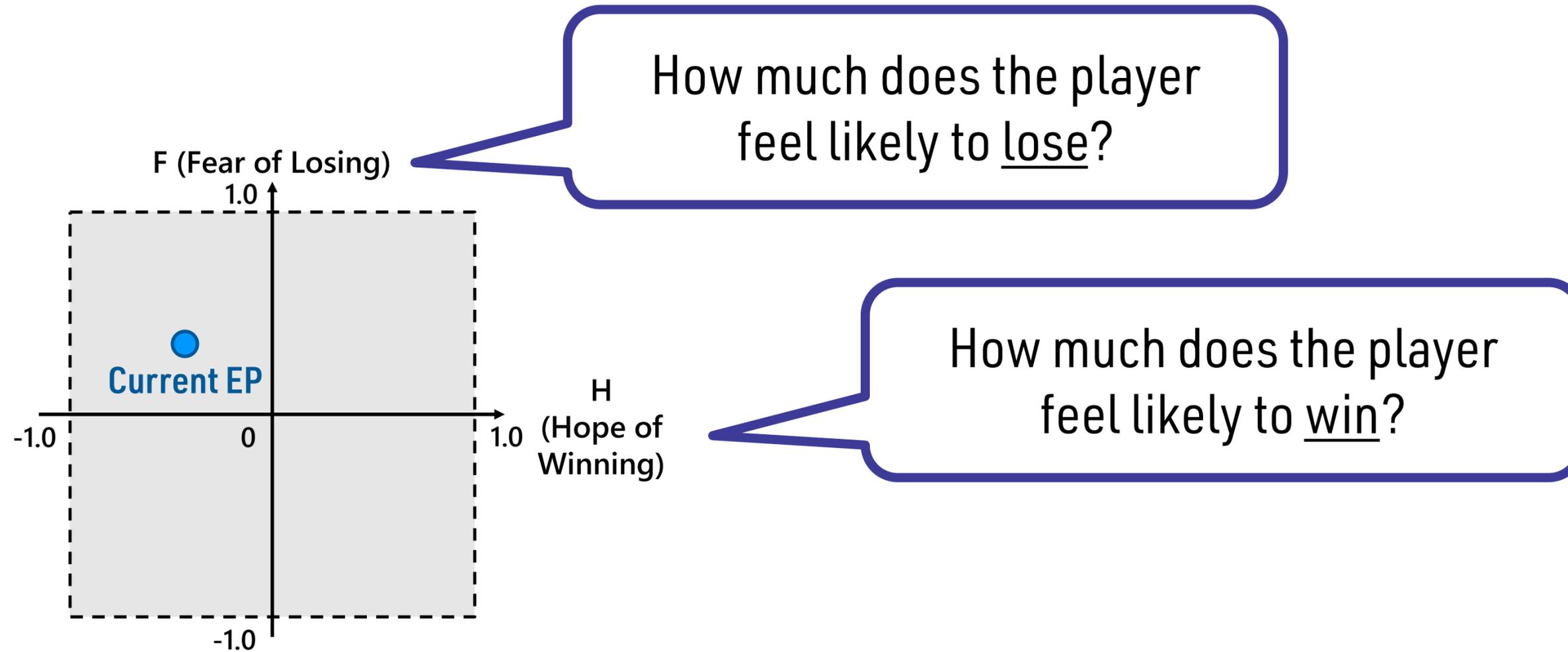
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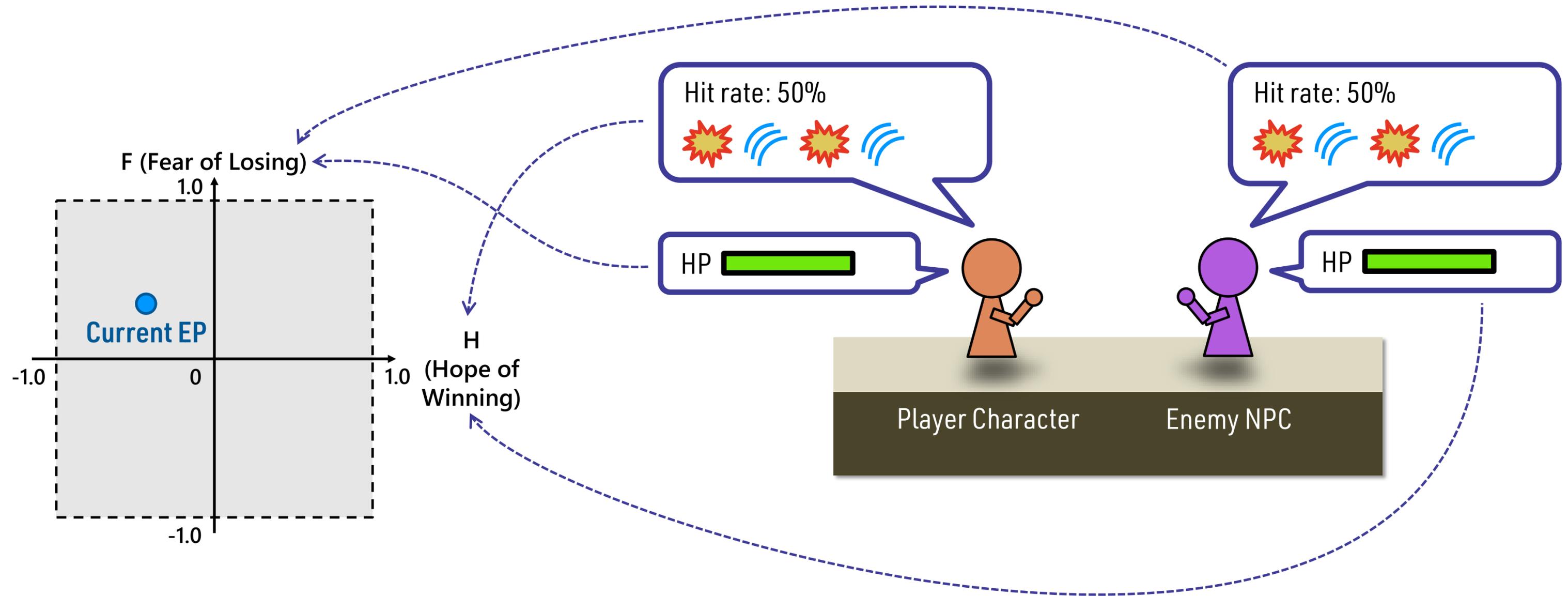
Operation to the game world

- NPCs' behavior/parameters
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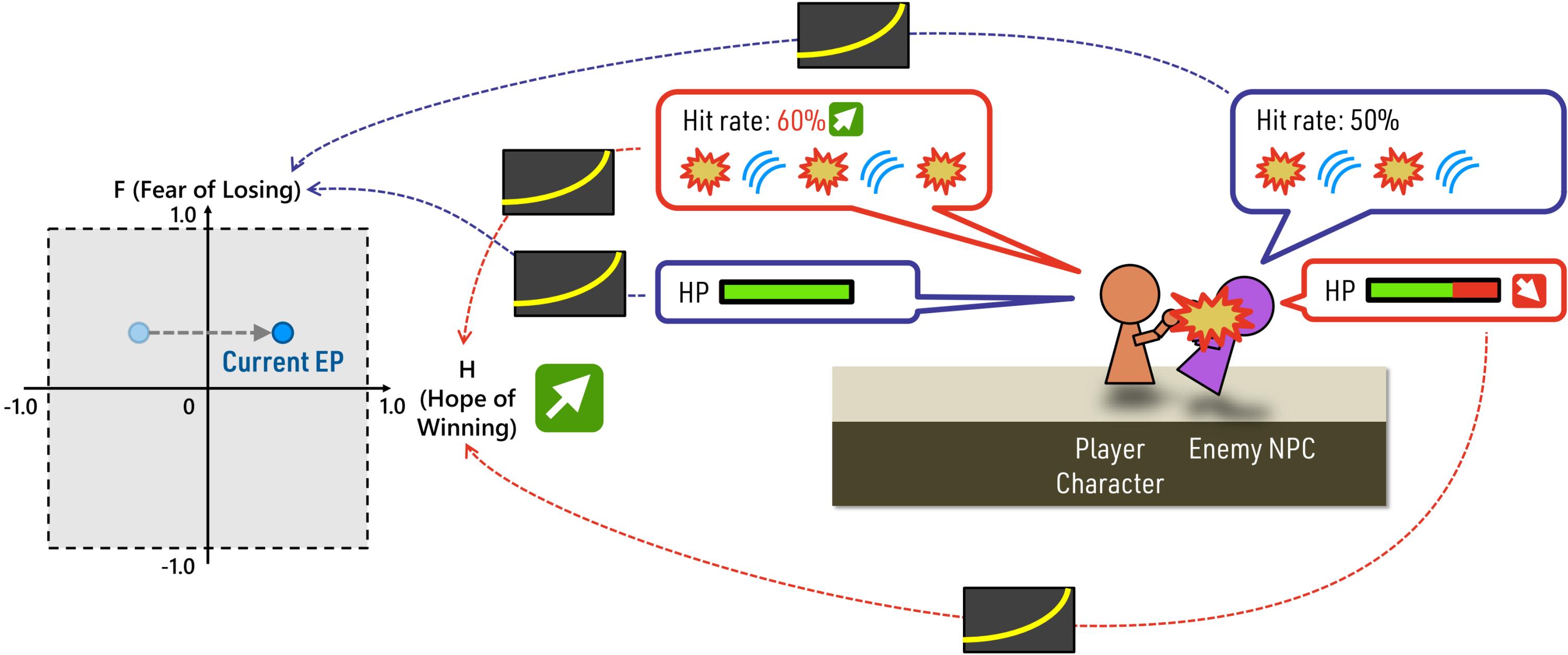
What is Current EP?



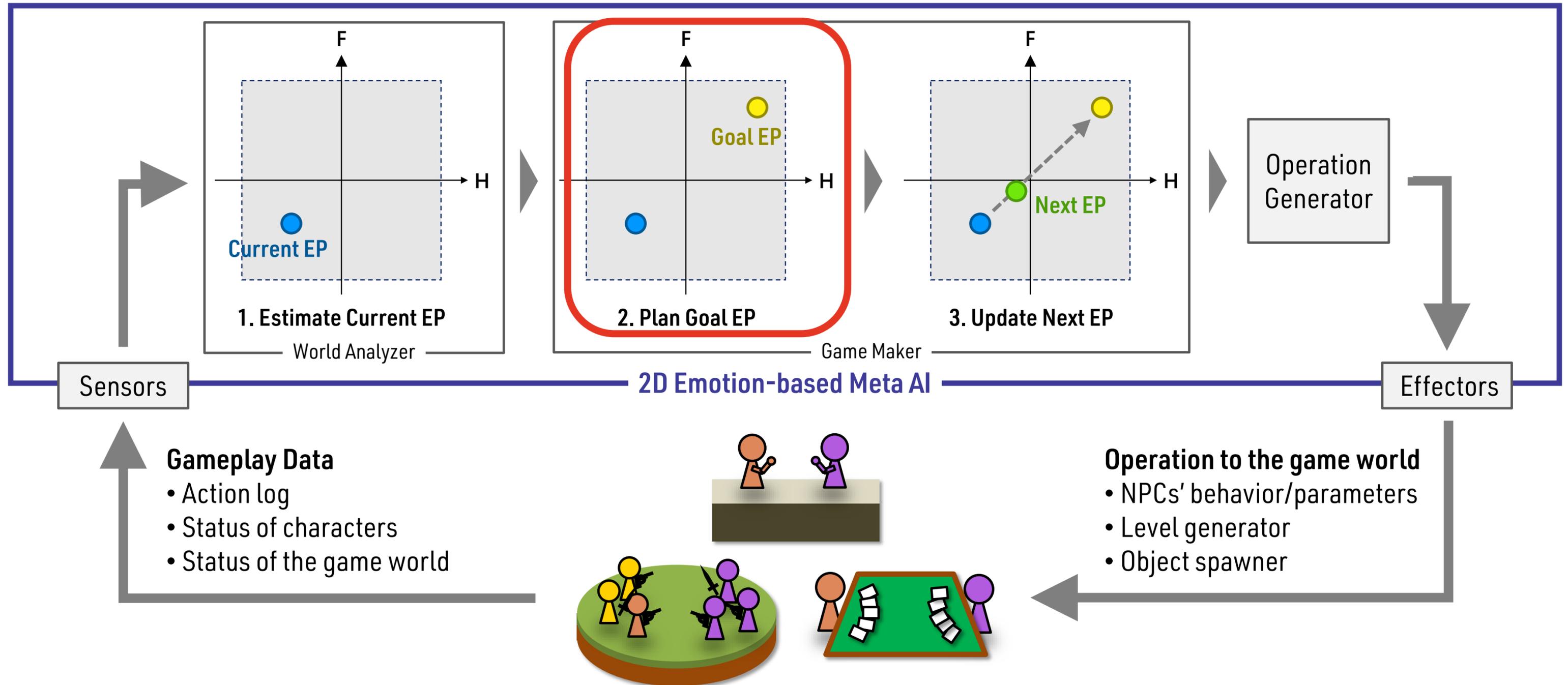
Estimate Current EP in a fighting game



Estimate Current EP in a fighting game



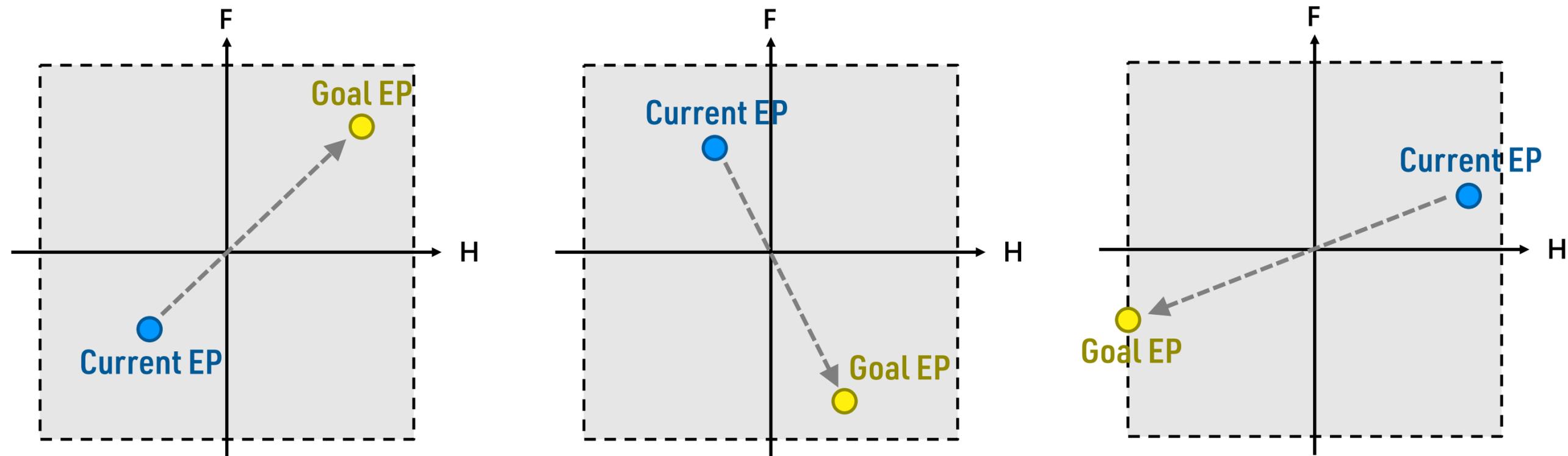
Method overview



Plan Goal EP

Highly depends on the game design

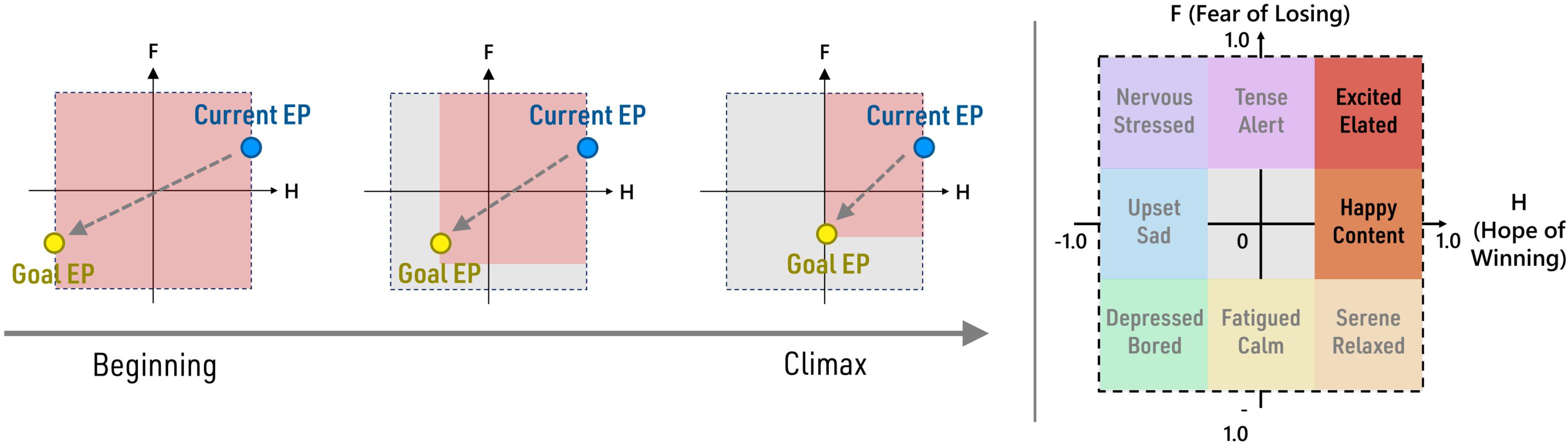
- In one game project, every 5 seconds the Goal EP is put on the opposite side of the Current EP.
- In other words, Meta AI always tries to shake the player's emotion.



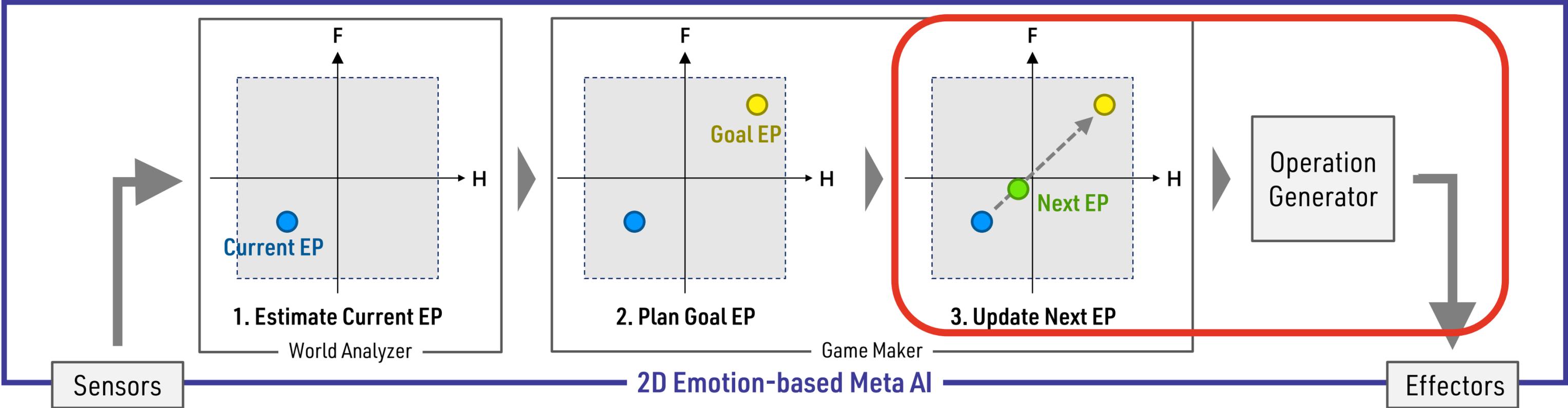
Plan Goal EP

Bias the Goal EP

- In one game project, we restricted movable area of the Goal EP by the battle progression.
- This bias the player's emotion to be more excited or happy at the end of battle.

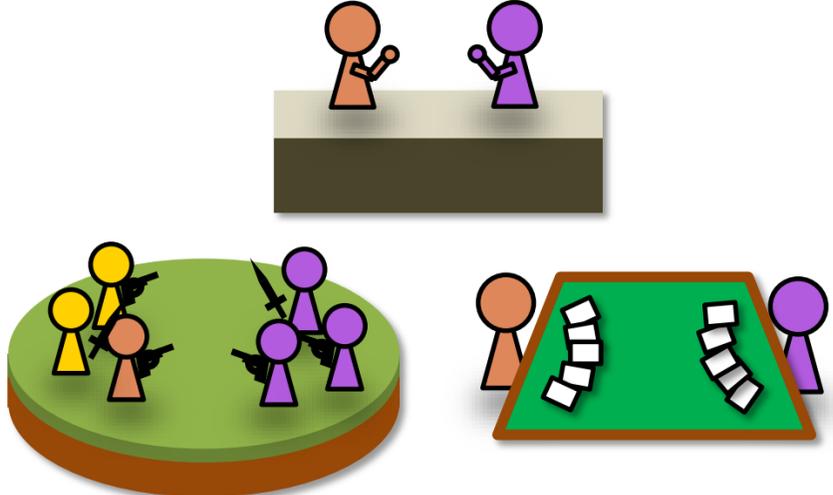


Method overview



Gameplay Data

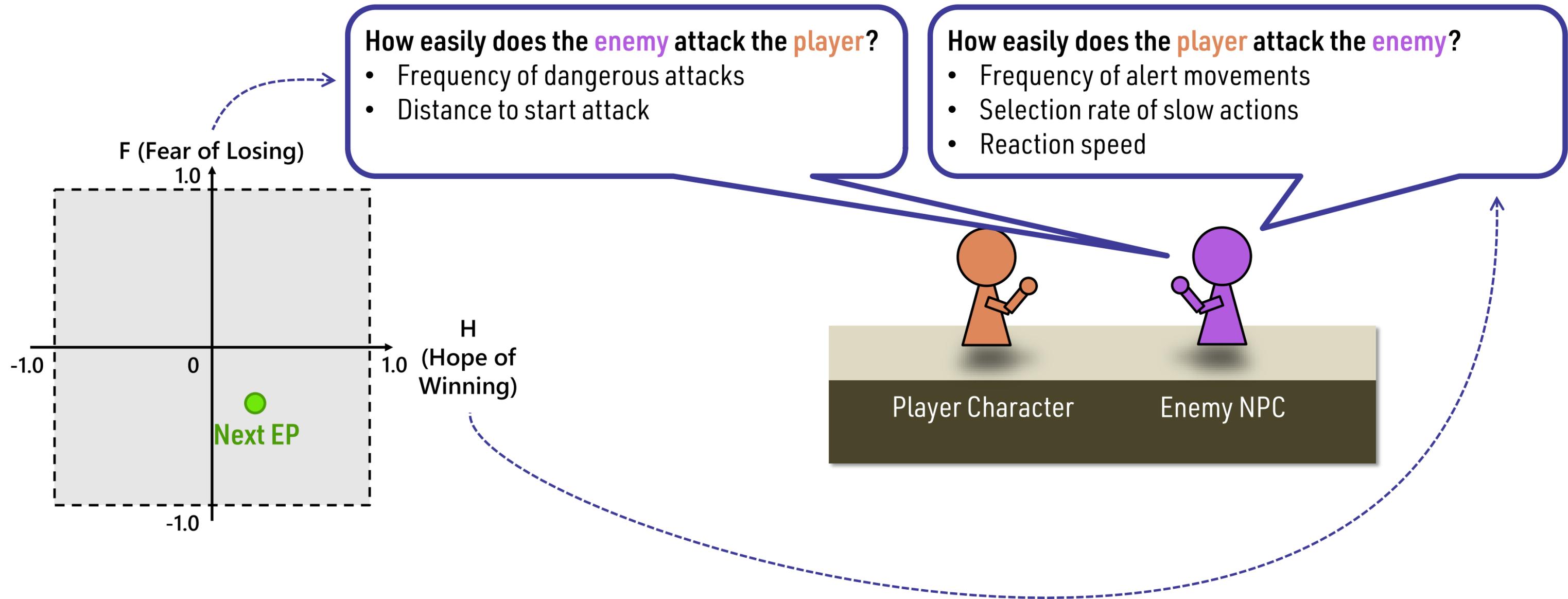
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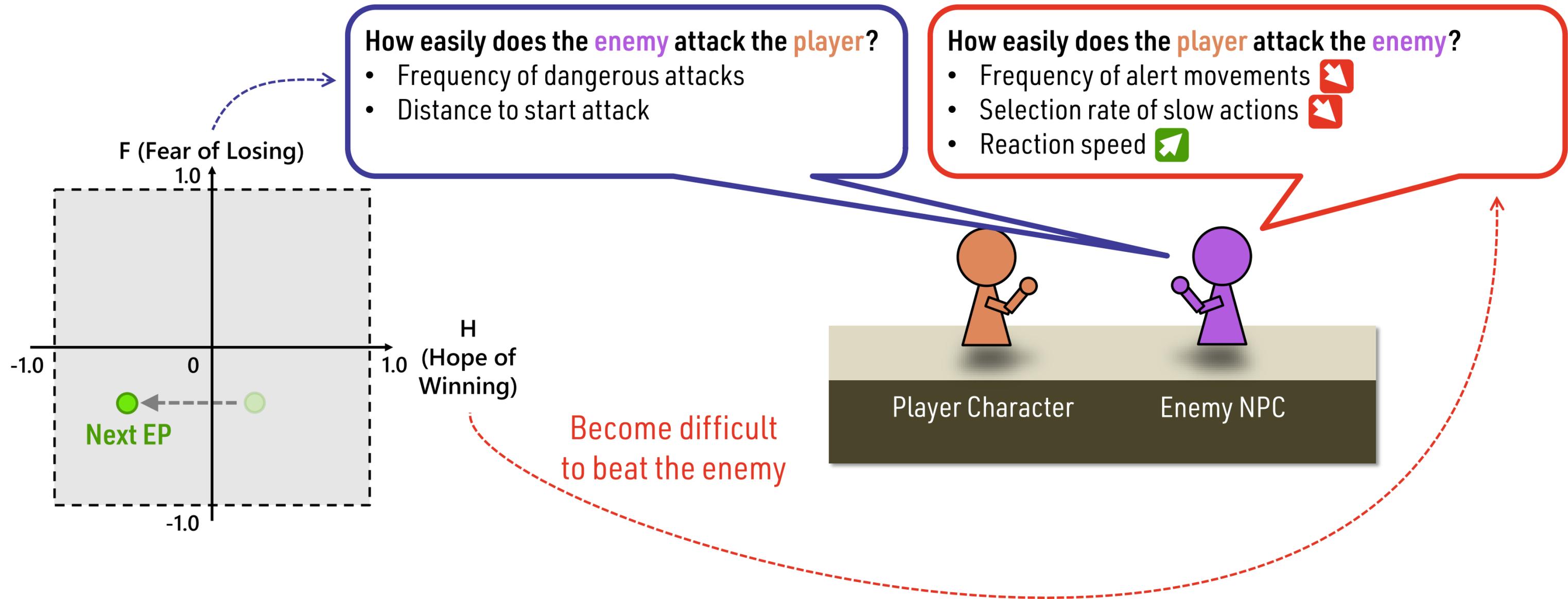
Operation to the game world

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- Level generator
- Object spawner

Control a fighting game using Next EP



Control a fighting game using Next EP

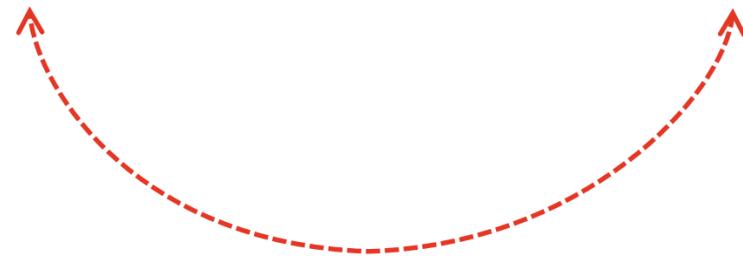


Meta AI – Game World Interaction

Your game's genre	Element examples of the game world			
	Affect to Current EP		Controlled by Next EP	
	Hope	Fear	Hope	Fear
Fighting game	<ul style="list-style-type: none"> • Hit rate of the player's attack • HP of the enemy 	<ul style="list-style-type: none"> • Hit rate of the enemy's attack • HP of the player 	<ul style="list-style-type: none"> • Frequency of alert movements • Selection rate of actions with large gap • Reaction speed 	<ul style="list-style-type: none"> • Frequency of dangerous attacks • Distance to start attack

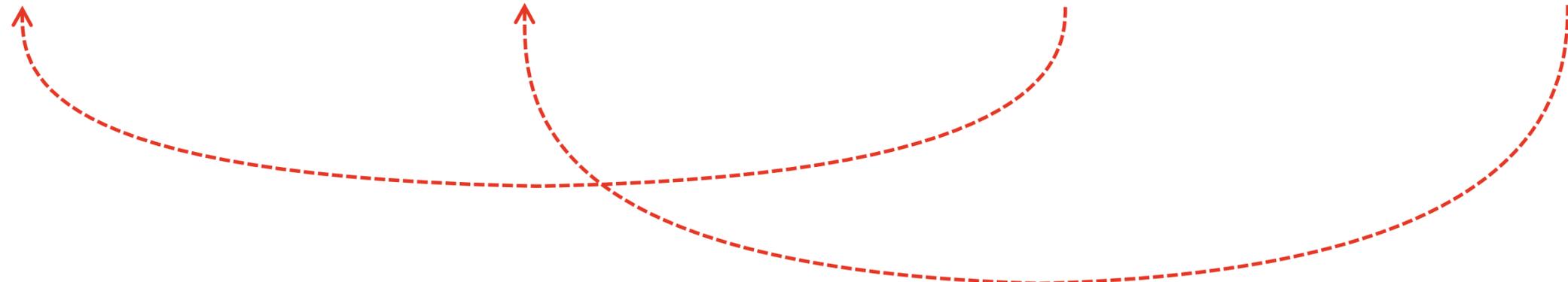
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Meta AI – Game World Interaction

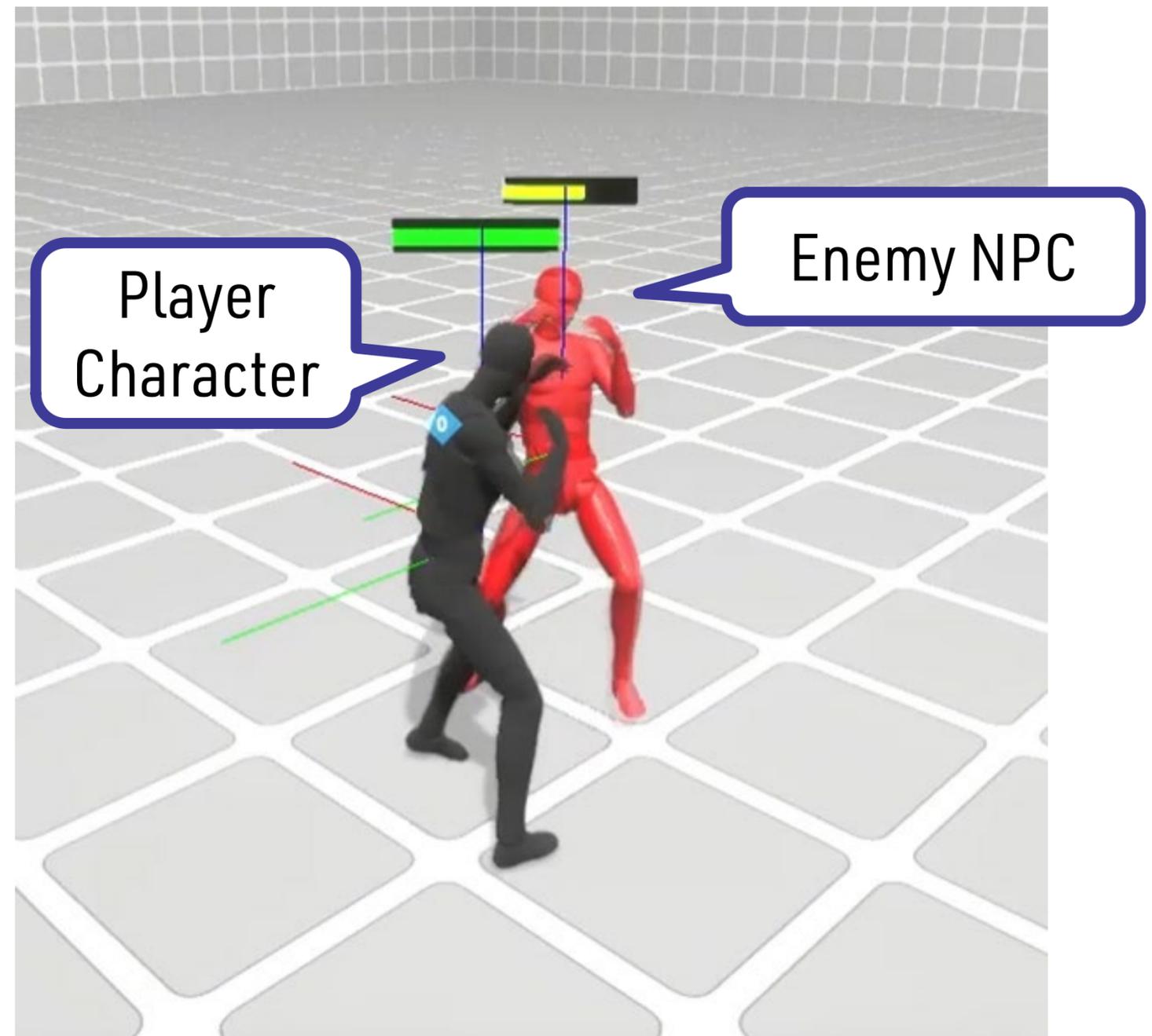
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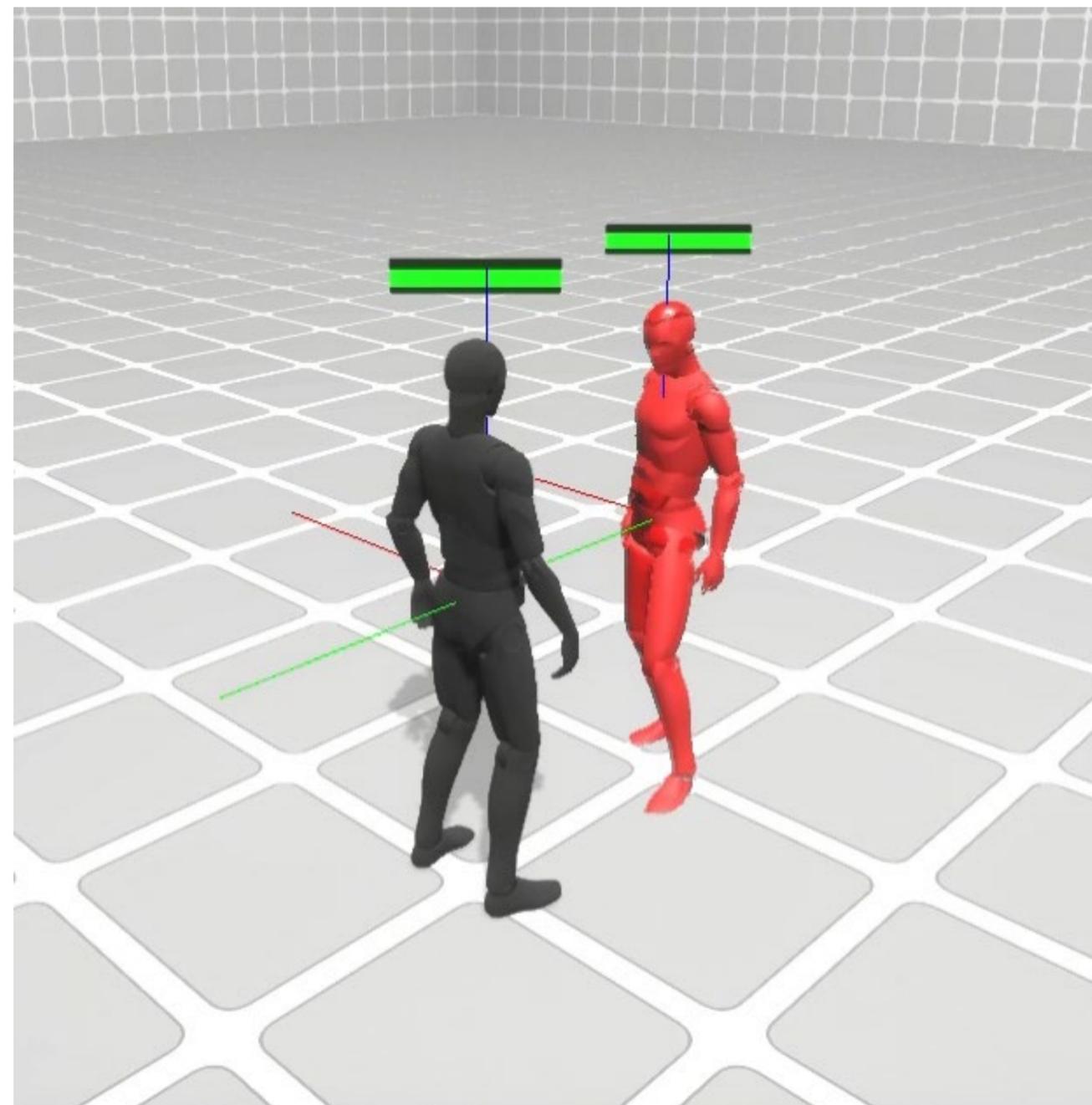
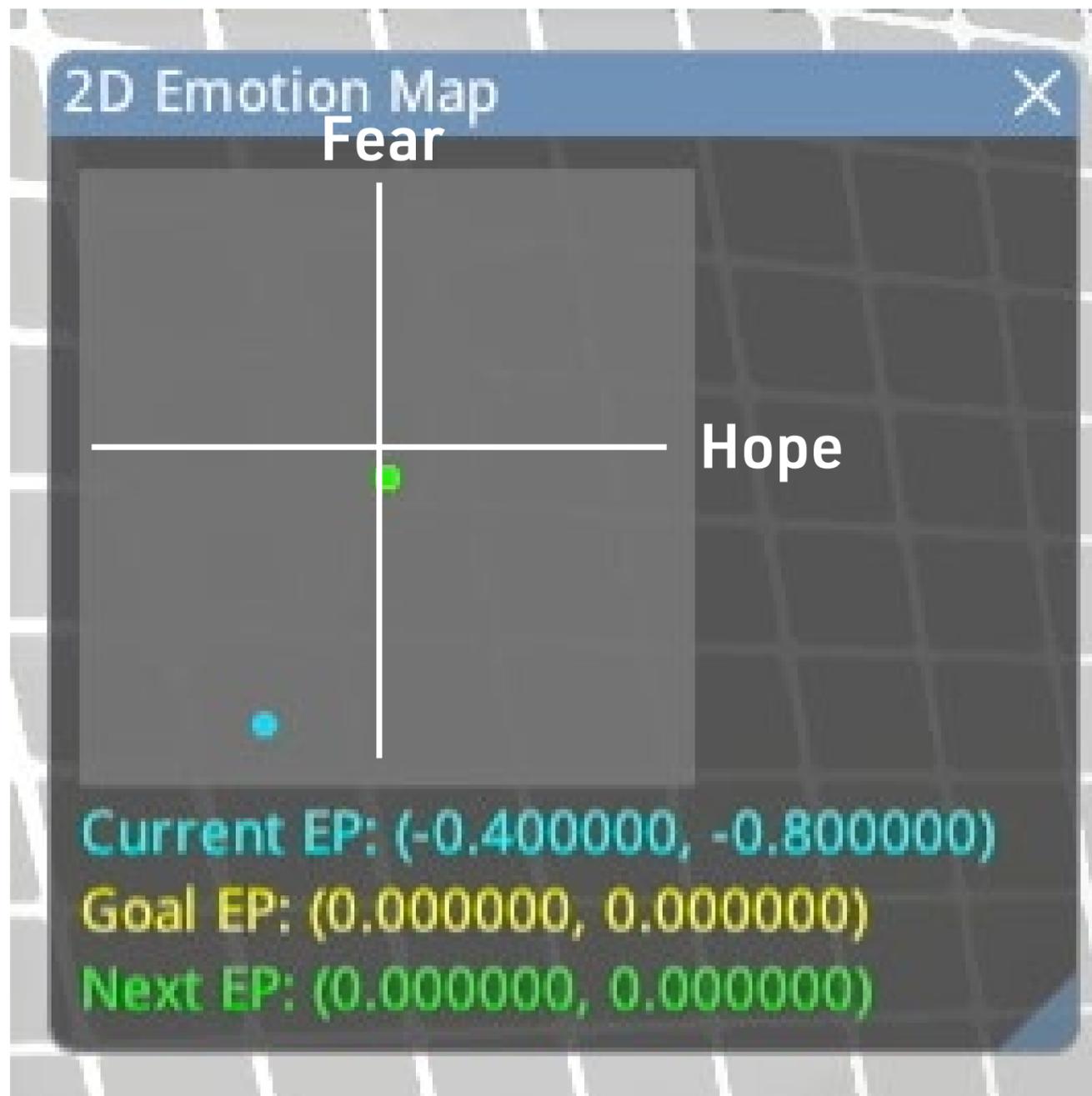
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Shooter game	<ul style="list-style-type: none"> • Same as fighting game • How many actions the player have to attack the enemy (e.g., attack type, possessed item, moving route) 	<ul style="list-style-type: none"> • Same as fighting game • How many actions the enemy have to attack the player (e.g., attack type, possessed item, moving route) 	<ul style="list-style-type: none"> • Same as fighting game • Spawning frequency of recovery item, weapon or ammo 	<ul style="list-style-type: none"> • Same as fighting game • Spawning frequency of trap or mob enemy
Card game	<ul style="list-style-type: none"> • Evaluated score of the player • Player's decision is quick and precise 	<ul style="list-style-type: none"> • Evaluated score of the enemy • Player's decision is slow and uncertain 	<ul style="list-style-type: none"> • Drawing probability of cards that provide chance to player 	<ul style="list-style-type: none"> • Drawing probability of cards that provide chance to enemy • Search depth of enemy

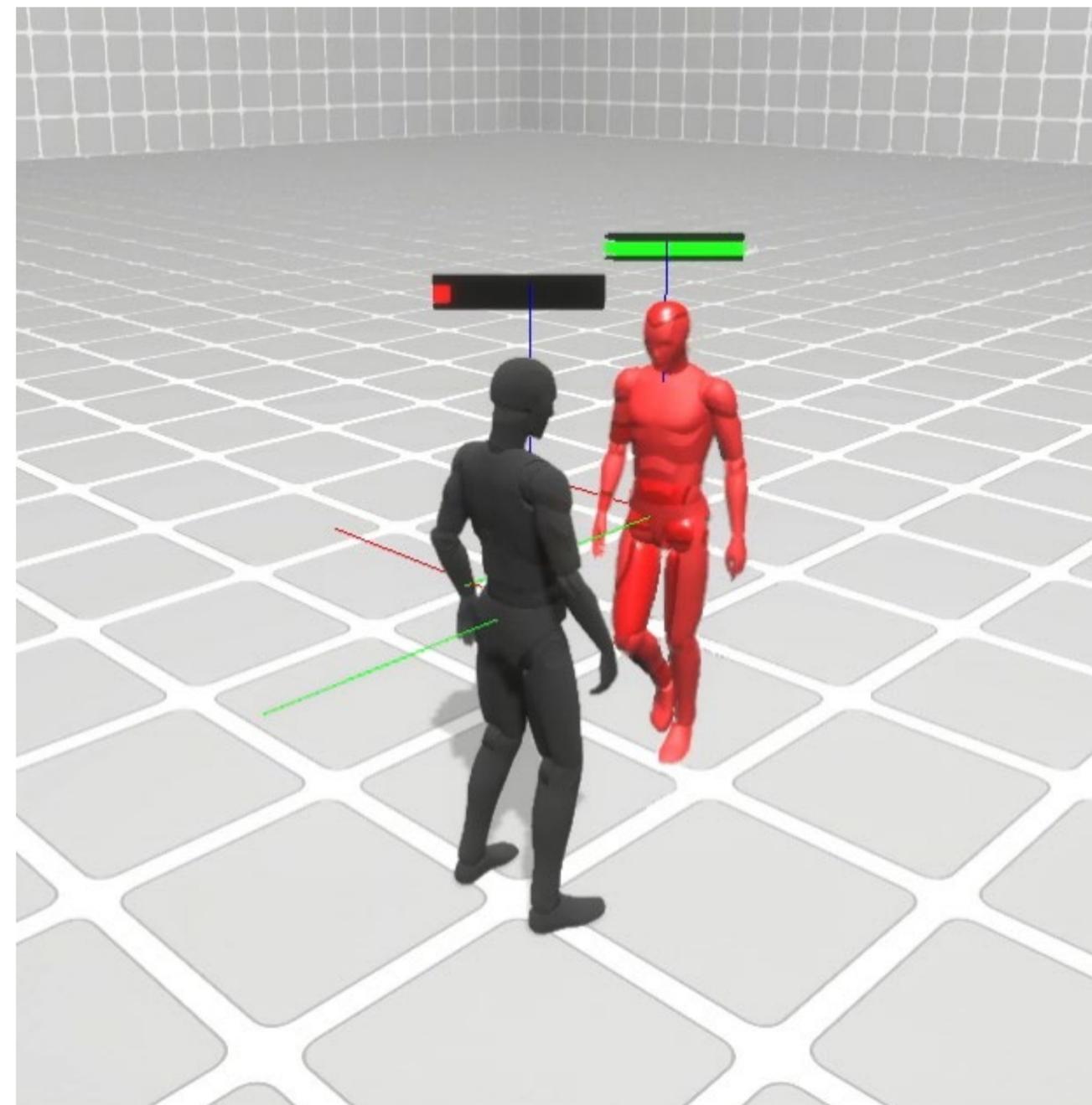
Simple 1 on 1 combat example



Case 1: Next Fear is high – Enemy uses rapid attack



Case 2: Next Fear is low – Enemy uses slow attack





Gameplay analysis

Default settings



SESSIONS LIST

TIMELINE

日本語

Gameplay analysis tool

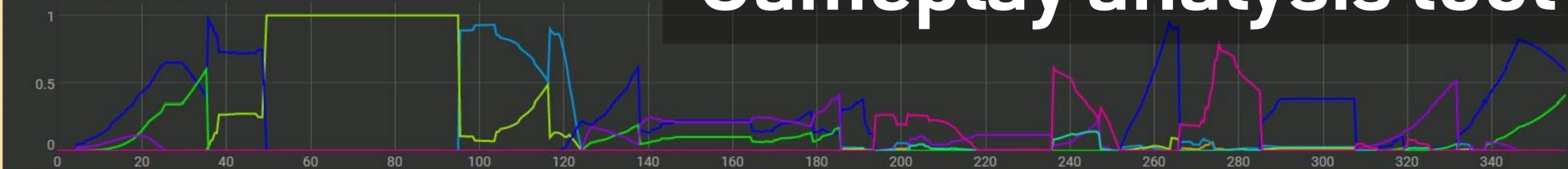
Events selection

Visualization

Strokes length



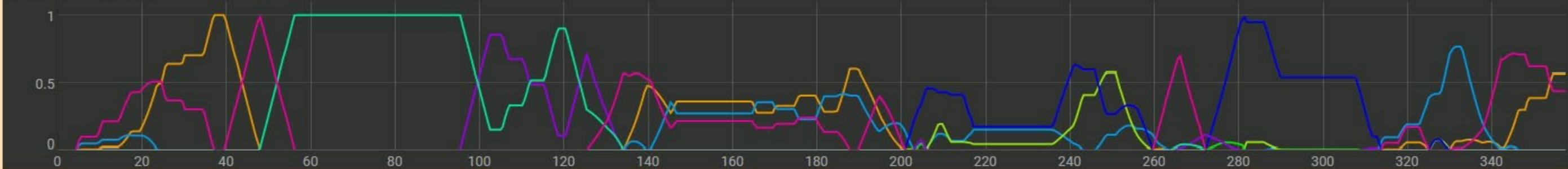
Emotions (Current)



Emotions (Goal)



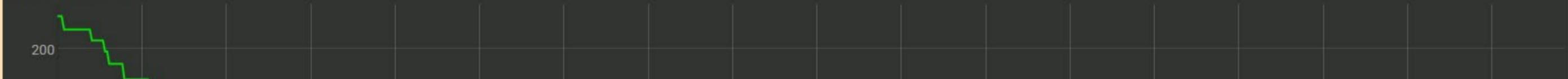
Emotions (Next)



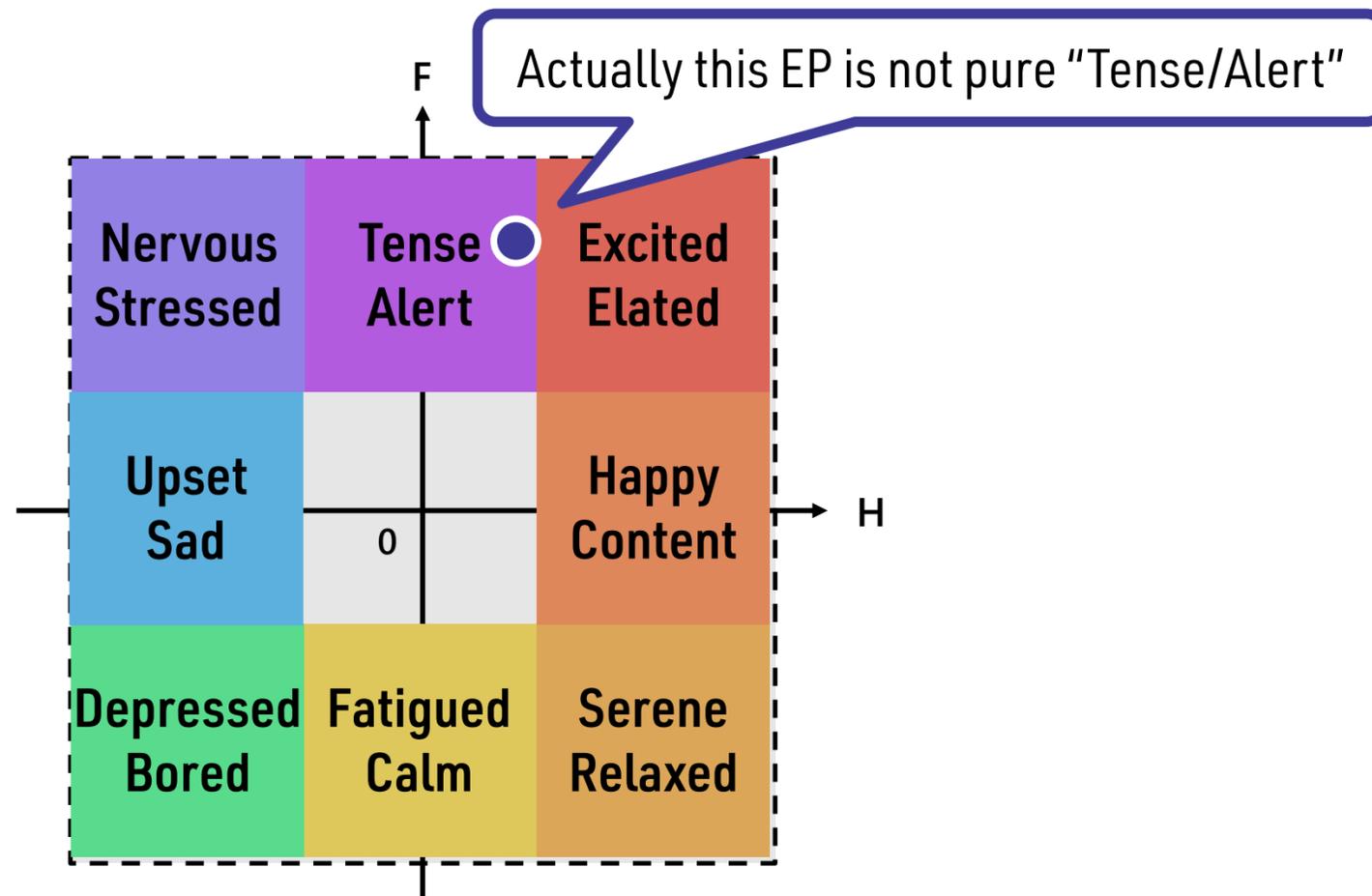
Player Character



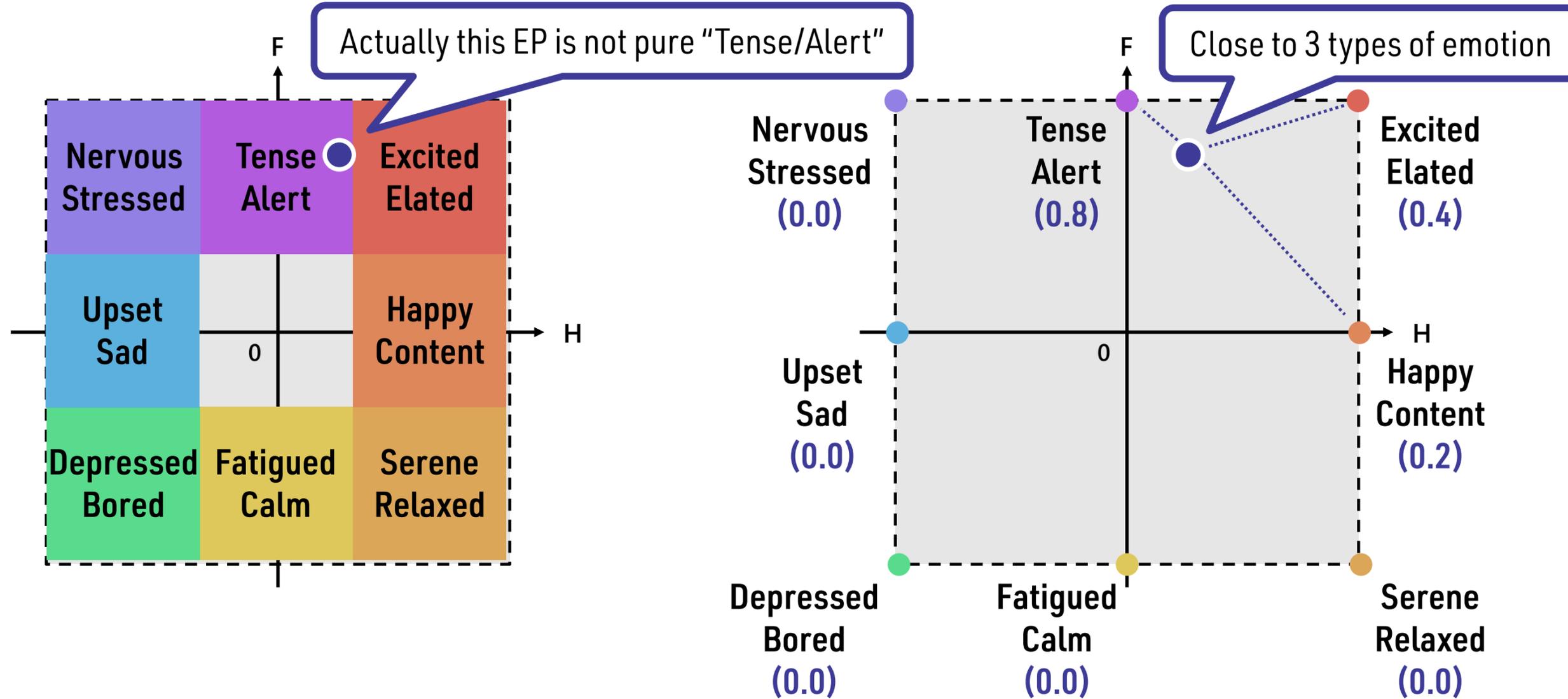
Friend NPC 1



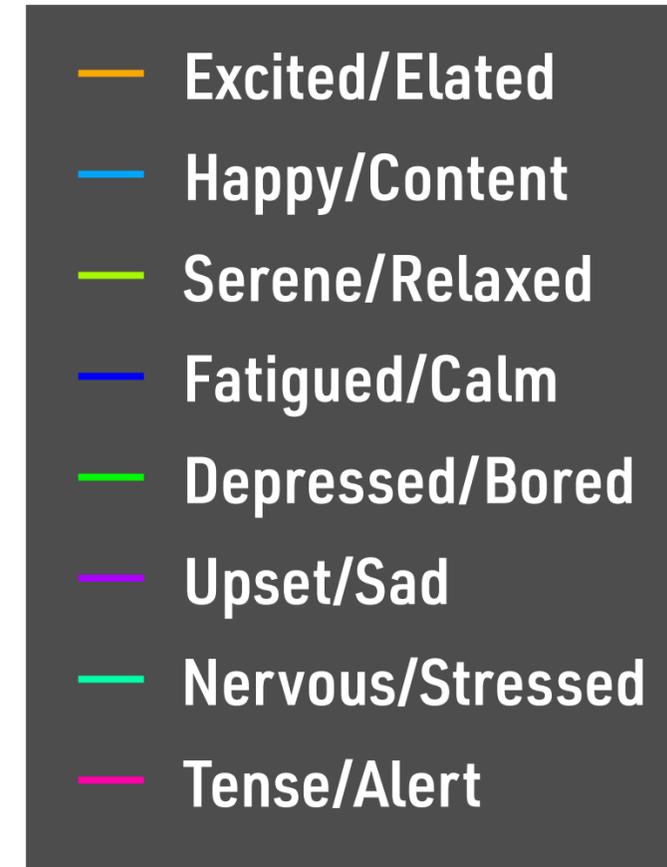
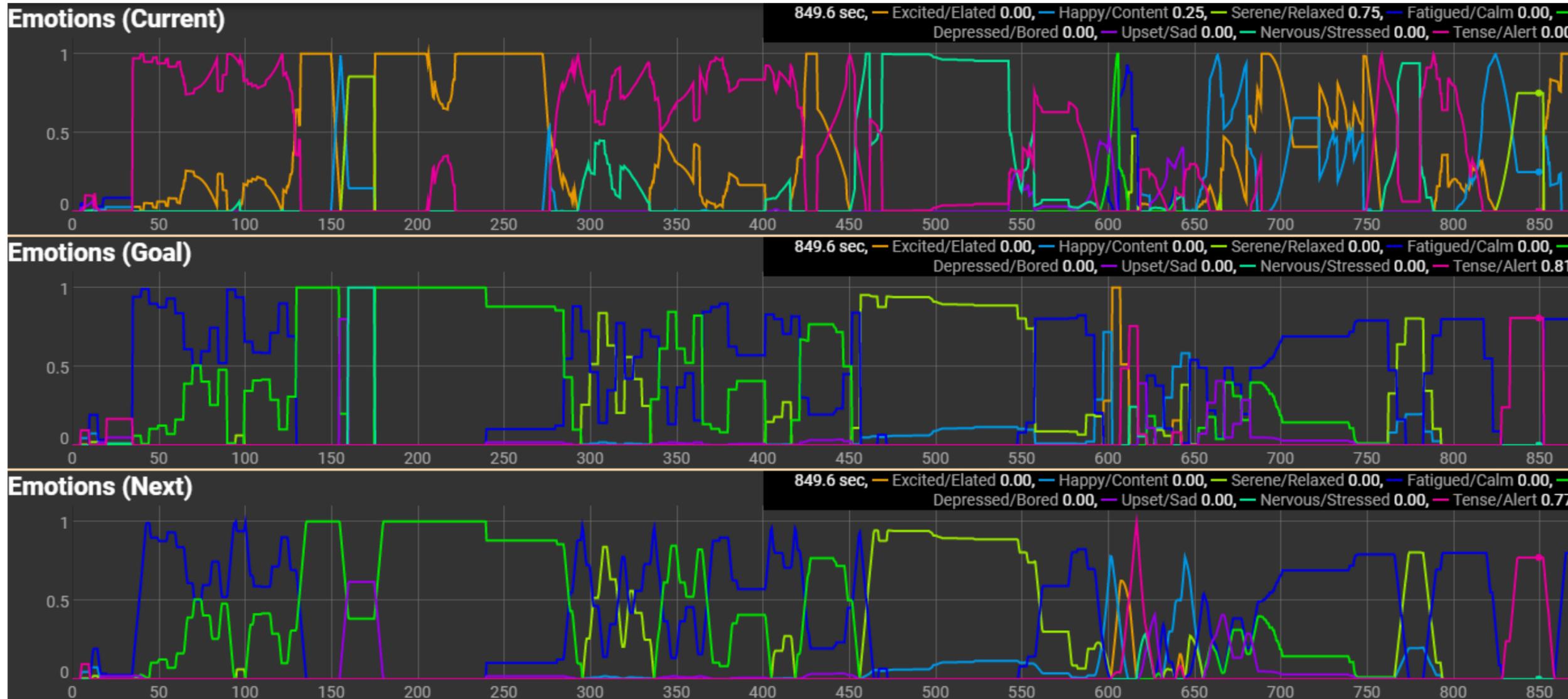
Emotion strength (similarity)



Emotion strength (similarity)

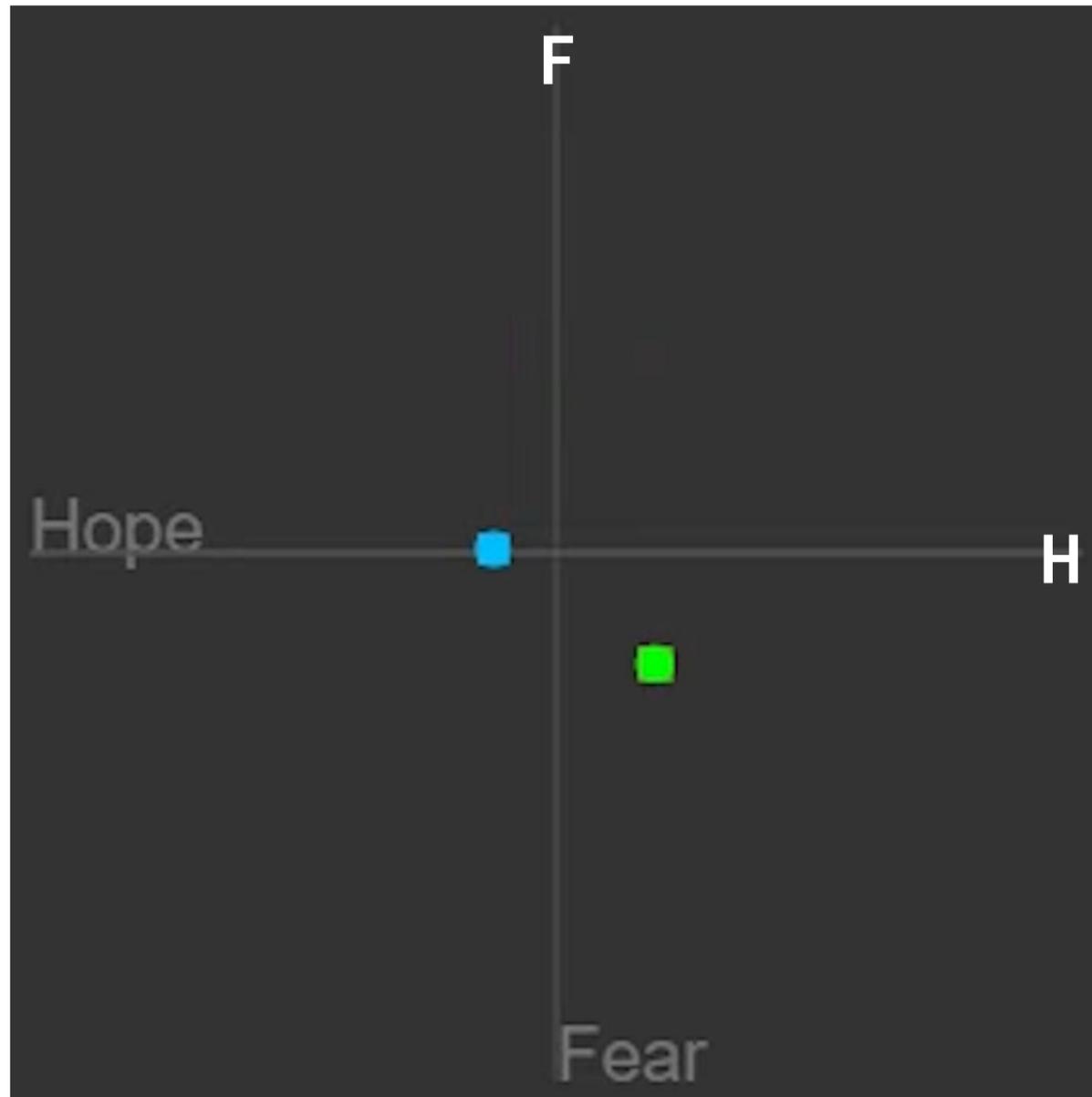


Charts of emotion strength



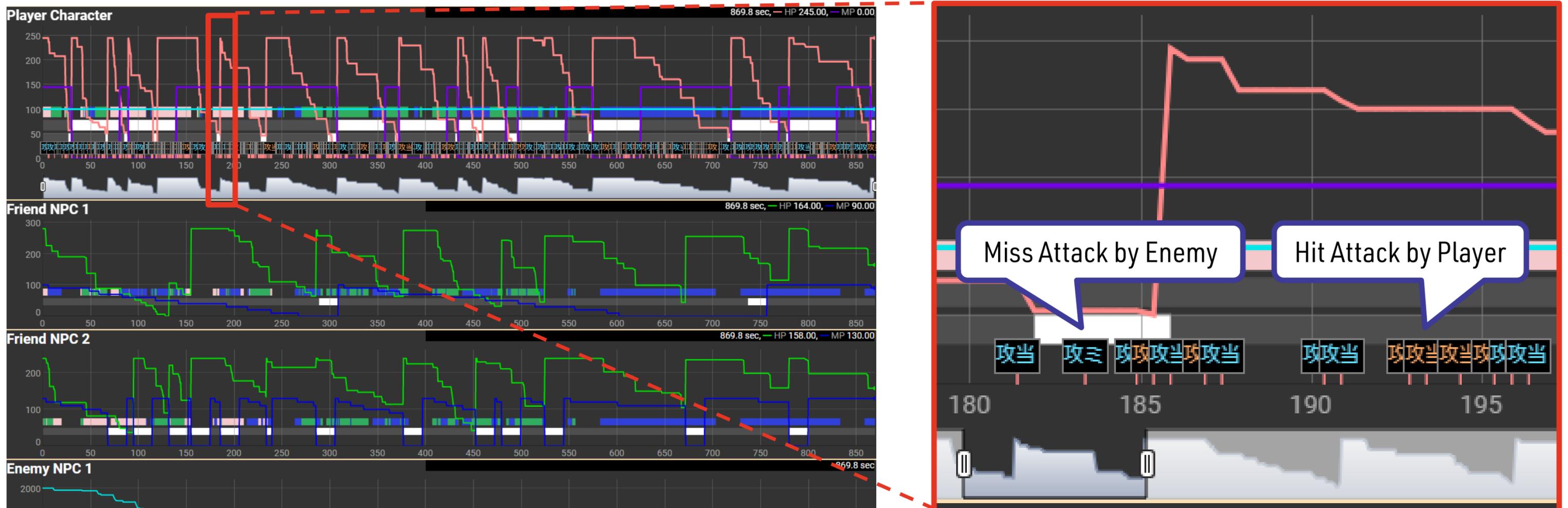
Time

Trajectories of EP on 2D Emotion Map



Charts of character status / battle events

We can see the line charts of character status such as HP or MP and discrete game events such as "Hit Attack by Player" through the icons on the bottom of timeline.



Feedbacks from a real game

Testers (10 people)

- Beginners and experts felt the battles overall a bit difficult but fun.
- Almost all of them finally clear the battles in 1~3 tries.

The battle concept was achieved! :)

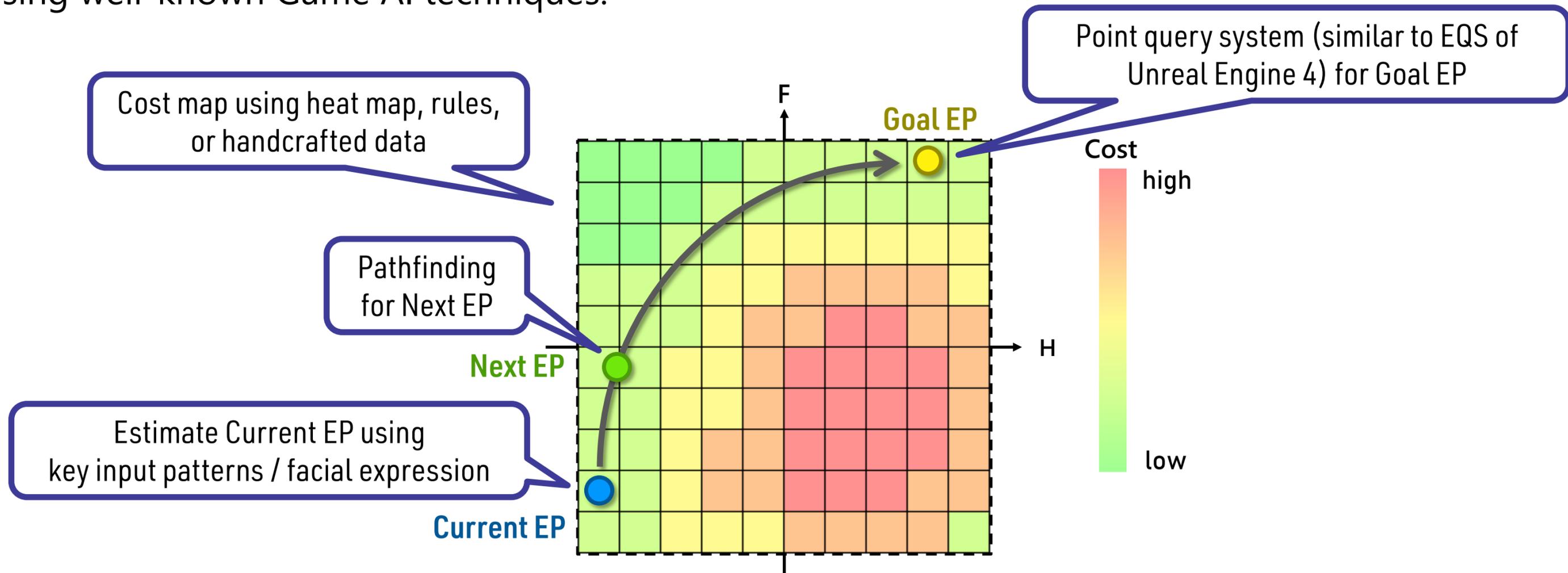
Game designer

- After the parameter tuning of Meta AI, EP and his emotion (voice recorded) became mostly consistent.
- Gameplay analysis tool:
 - Good to find reasons behind strong variations of the player's emotion.
 - Still difficult to understand accumulative effect of game events on the player's emotion.

The tool made his work 100 times better! :)

Two-dimensional future works

Within the 2D Emotion Map, we will be able to deal with the player's and NPC's emotion more effectively using well-known Game AI techniques.

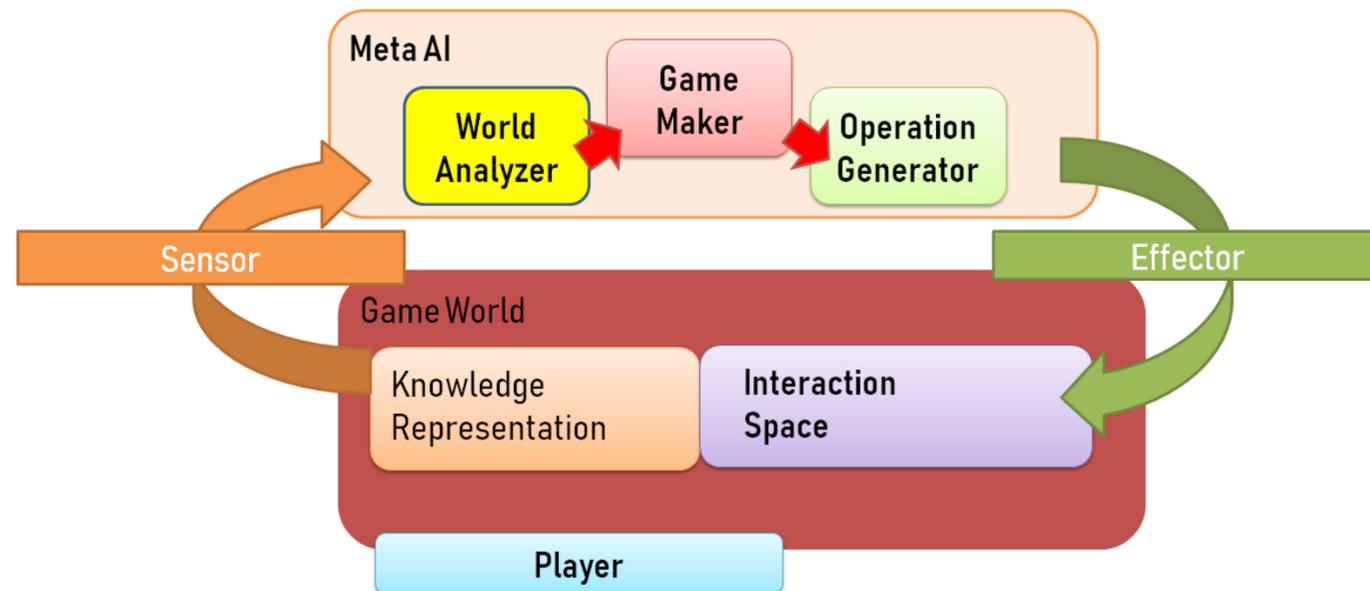


Takeaways

- **Meta AI General Design** helps changing your game dynamically
- **Use Ru-I-Di-ism with fellow game designers** to make your own Meta AI
- **Measure and influence** the player's emotion
- **2D Emotion-based Meta AI** is beneficial for various games
- **Visualize** emotions with gameplay data to polish the Meta AI

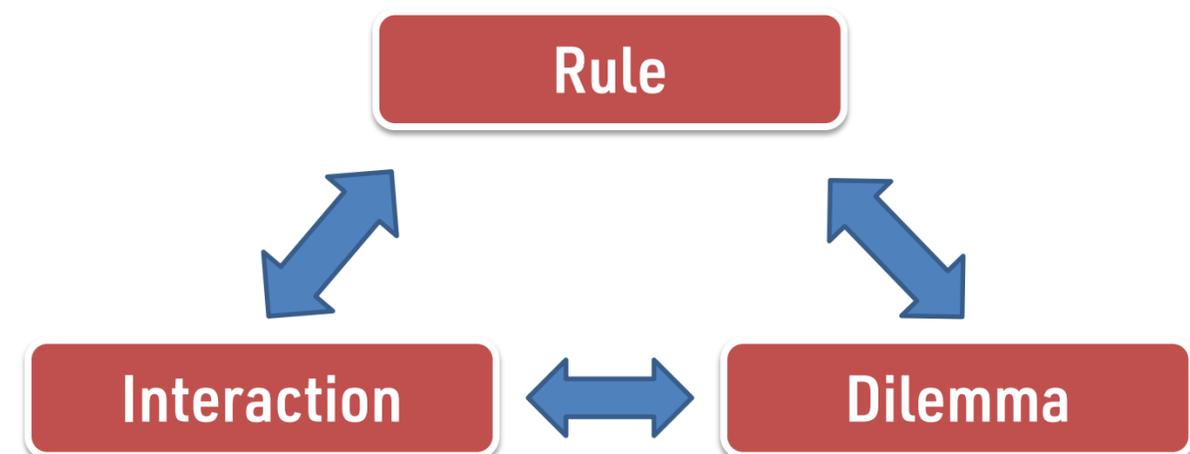
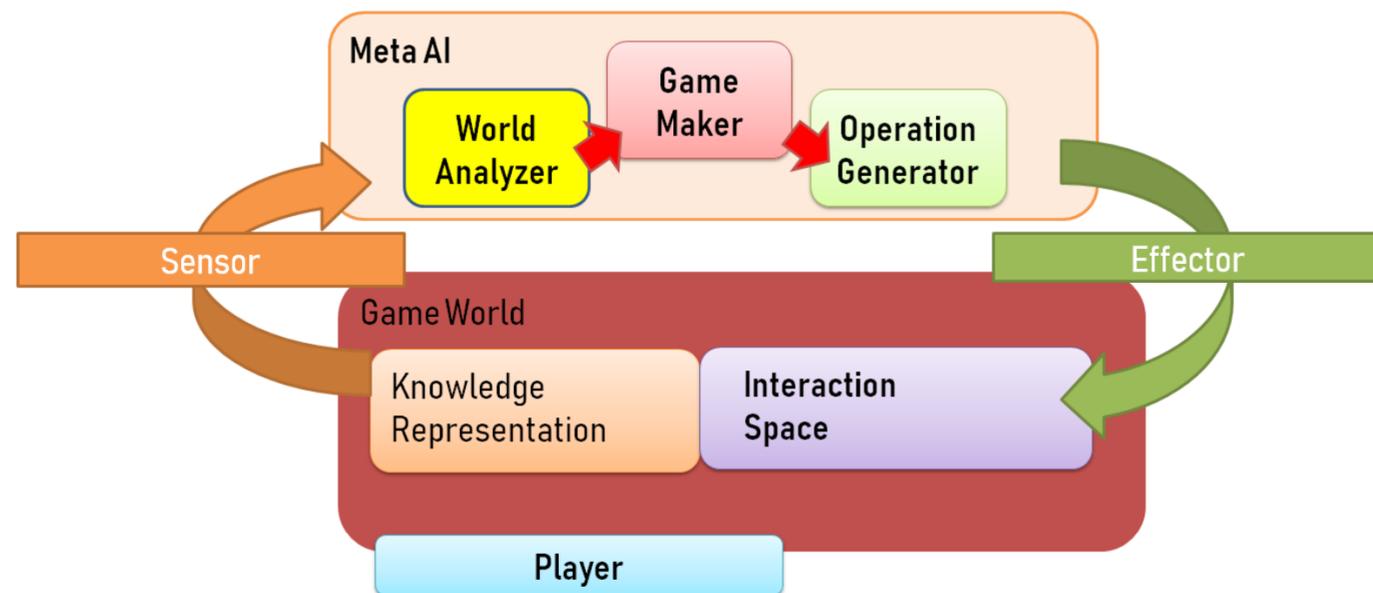
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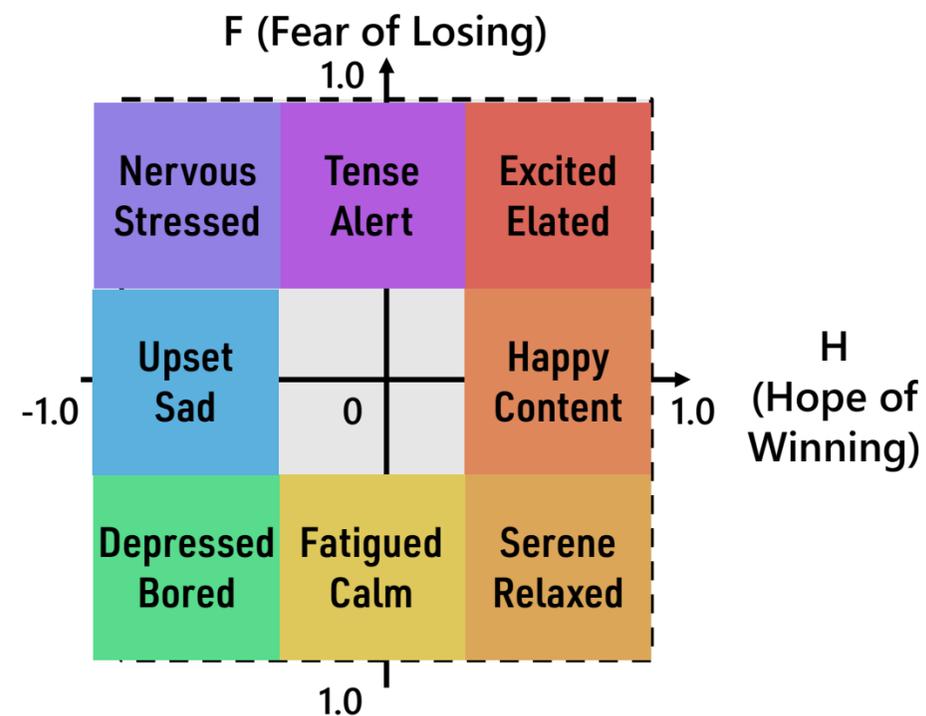
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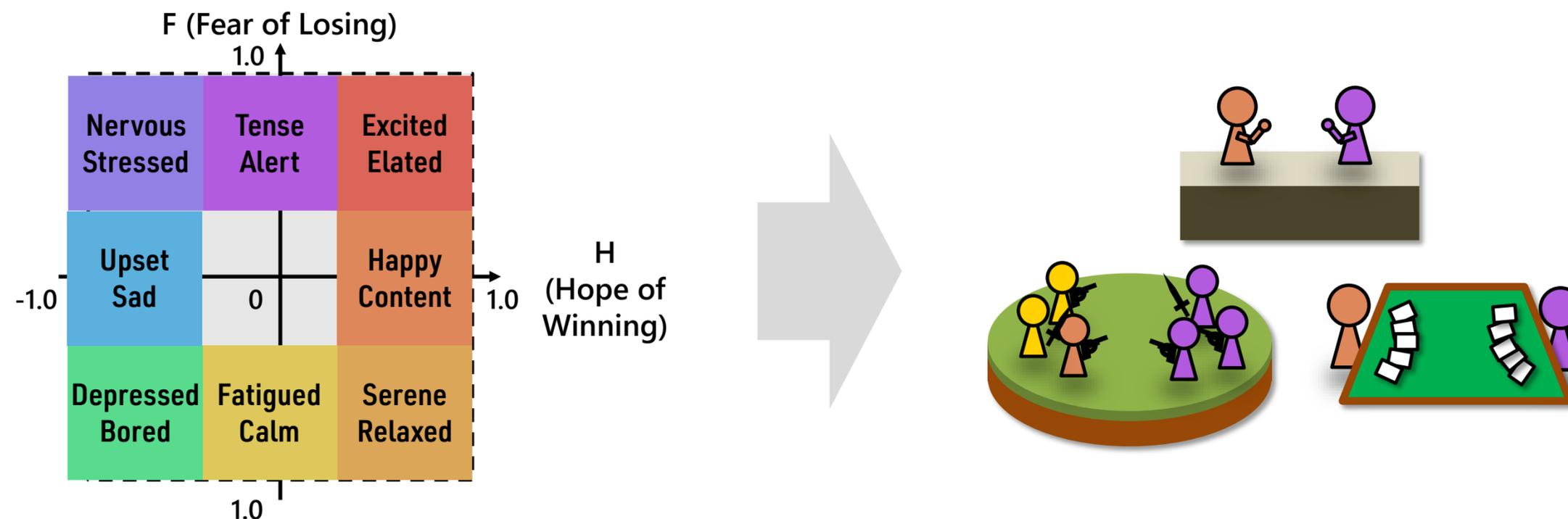
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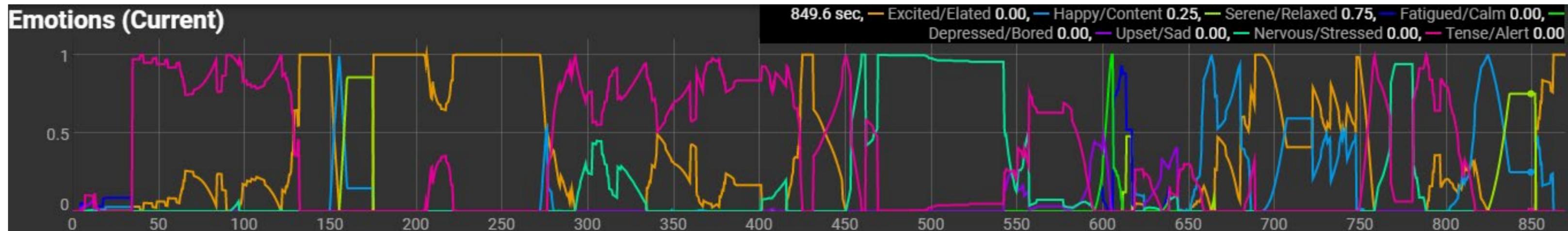
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Thank you for listening!

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