

Integrating Generative AI into existing game

REPORT

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Background

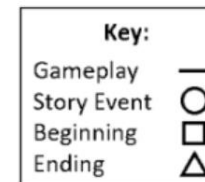
- Recap

- Linear storyline: Straight forward game story with 1 ending
- Branching storyline: Player action affect the plot of story, usually have N ending

	Advantage	Disadvantage
Linear storyline	Easy to make	Limit the freedom of player to explore the game
Branching storyline	Provide more dynamic gaming experience	Costly to design

Background

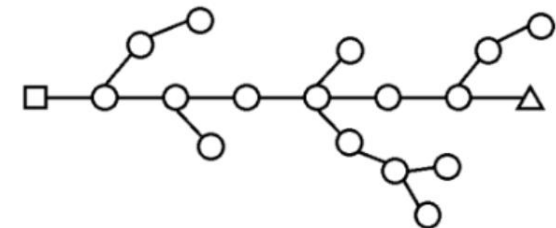
- Recap
 - Made a prototype detective game
 - Aim to provide more dynamic experience (different dialog)
 - Attempt branching storyline



Linear:



String of Pearls:



Background

- Trend of using AI agents in game development
 - Show how AI can improve Player-NPC interaction instead of controlling the storyline
 - More complicated game system = More difficult to implement AI agent
 - prototype gameplay with Ubisoft NEO NPC



Background

- Trend of using AI agents in game development
 - Show how AI can react differently with player's strategic planning
 - new possibilities for emergent gameplay

NVIDIA Game demo to show the difference of AI response in the same scene



Background

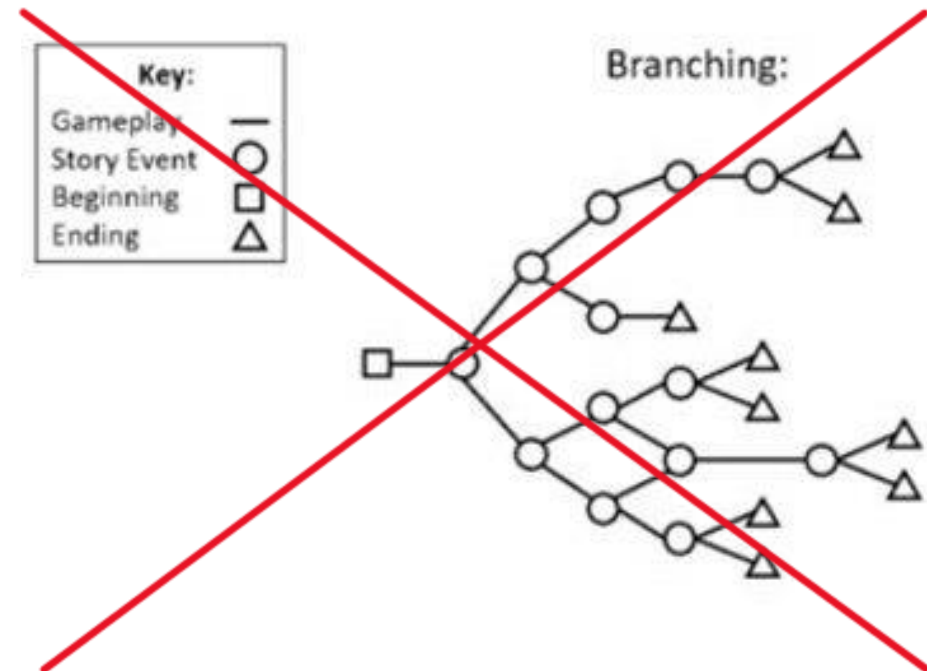
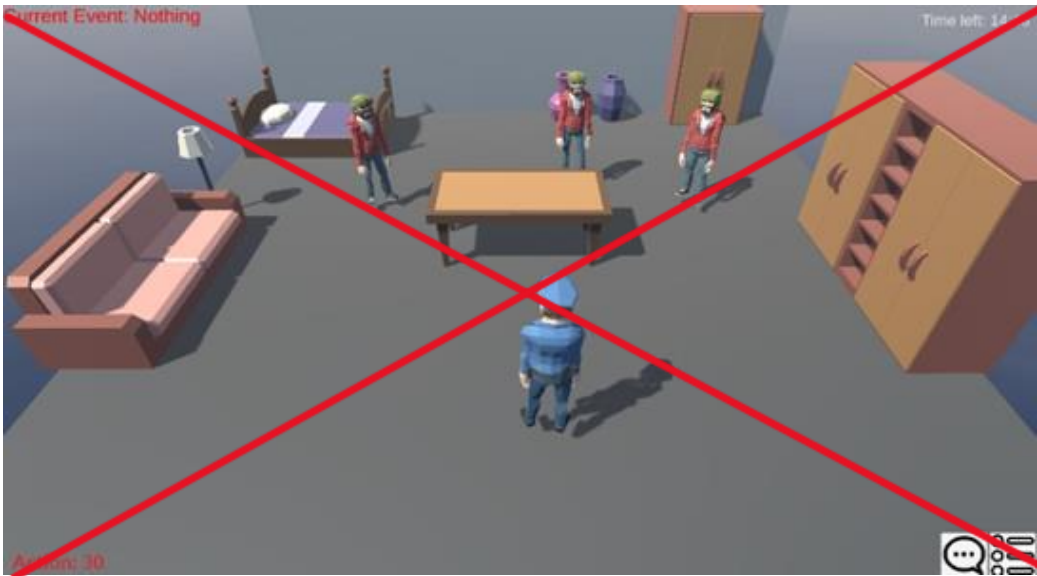
- Trend of using AI agents in game development
 - Too many parts controlled by generative AI results in an unstable player experience

SQUARE ENIX: The AI technology-based remake game and its review



Background

- Challenge
 - Gameplay is too complicated to allow generative AI to fully control the gameplay
 - Time & resources constrain



Background

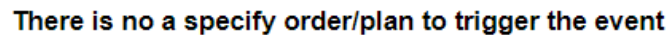
- Objective: Show how to build, convert and design a game which embedded with generative AI NPC.
 - Observe and estimate which game component can be replaced by AI agent
 - Implement AI agent into certain game component and evaluate how it benefits the gameplay



Methodology

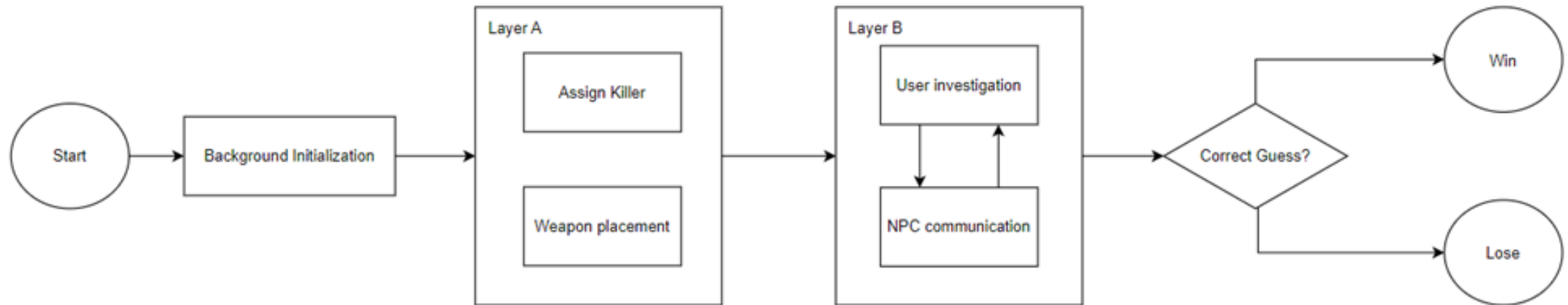
- Game engine: Unity
 - Provide extensive cross-platform support and features
 - Strong community support system
 - Create better user experience by lowering the effort of doing 3D rendering, user interfaces by ourselves

- Recap: Original Game structure



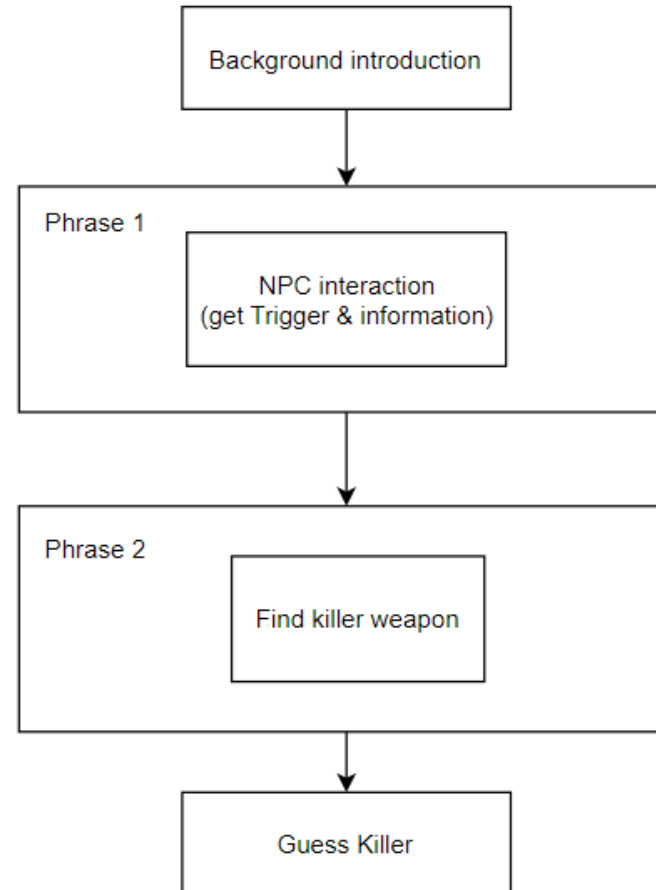
Methodology

- Game Structure



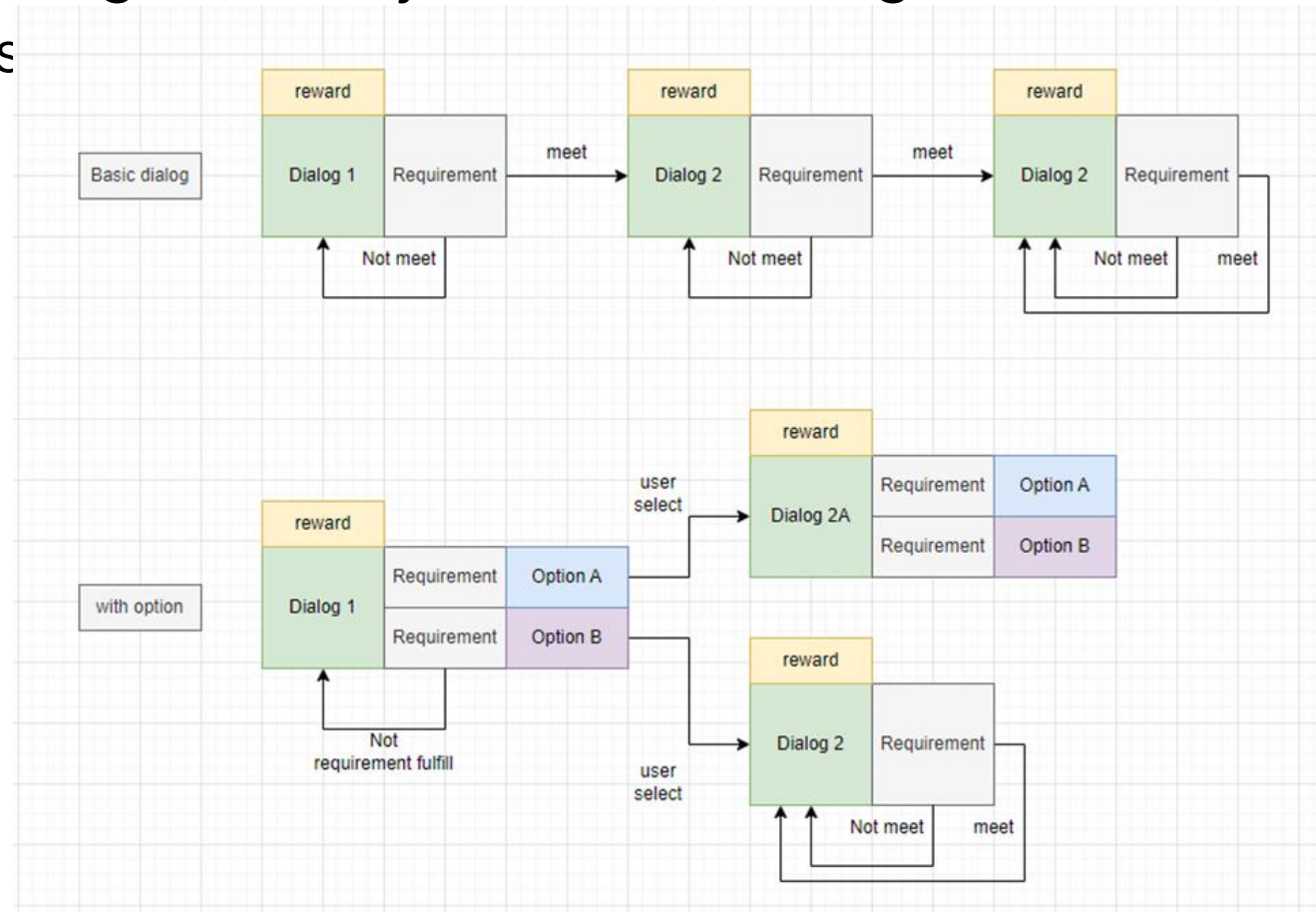
Methodology

- Player experience



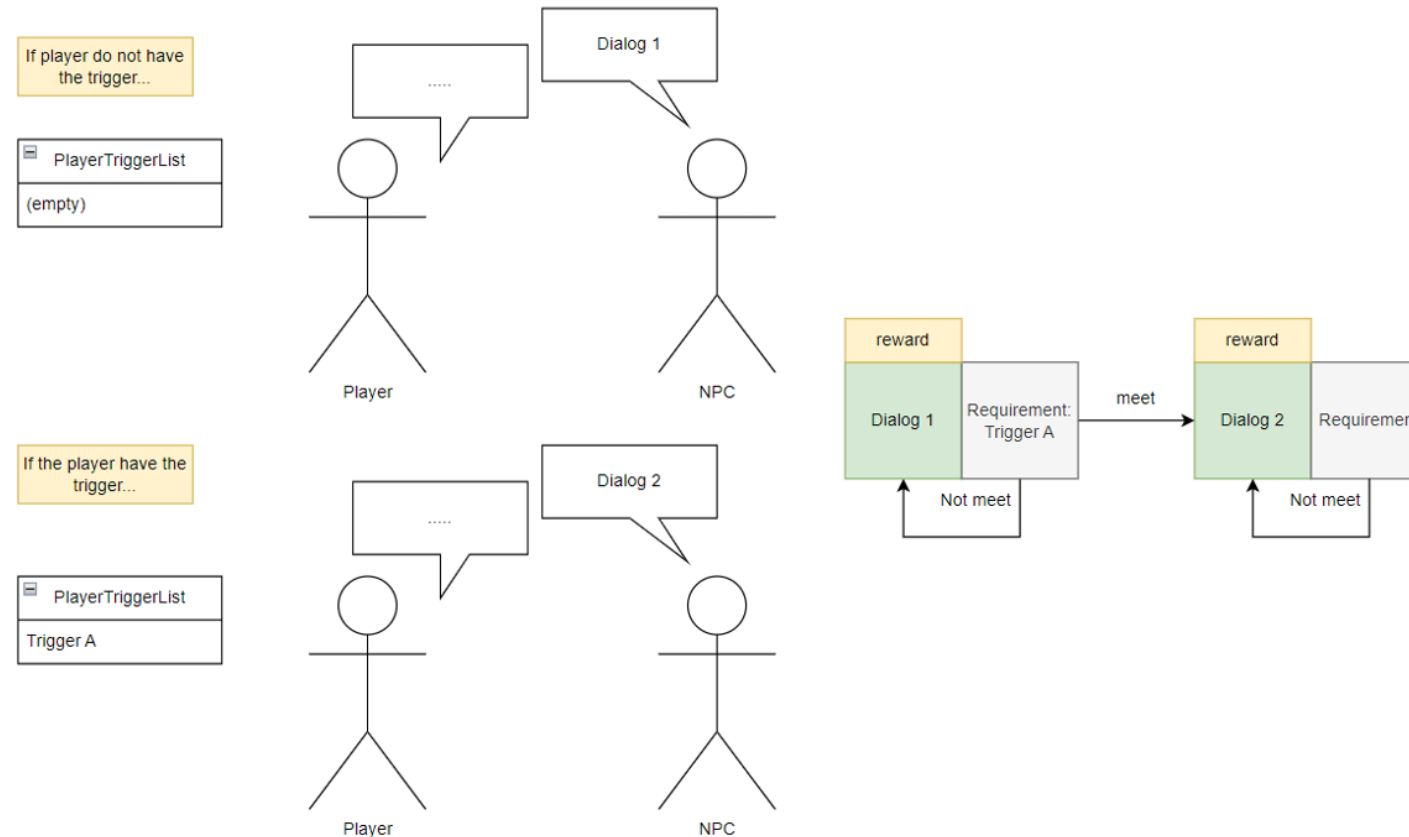
Methodology

- Dialog system
 - Each dialog as an object can chain together to form a complex convers



Methodology

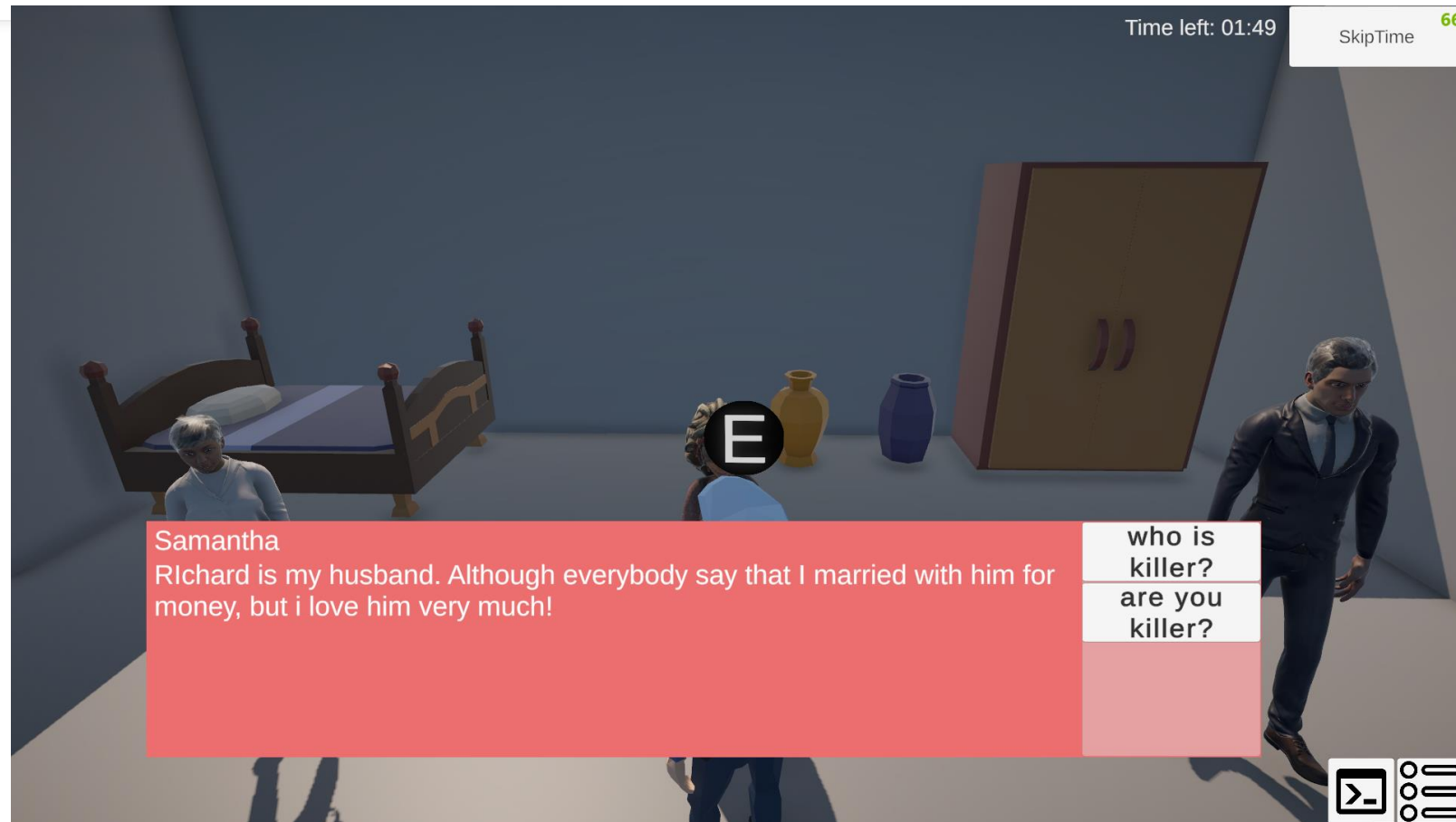
- Trigger System
 - Act as a key to unlock new dialog or new item



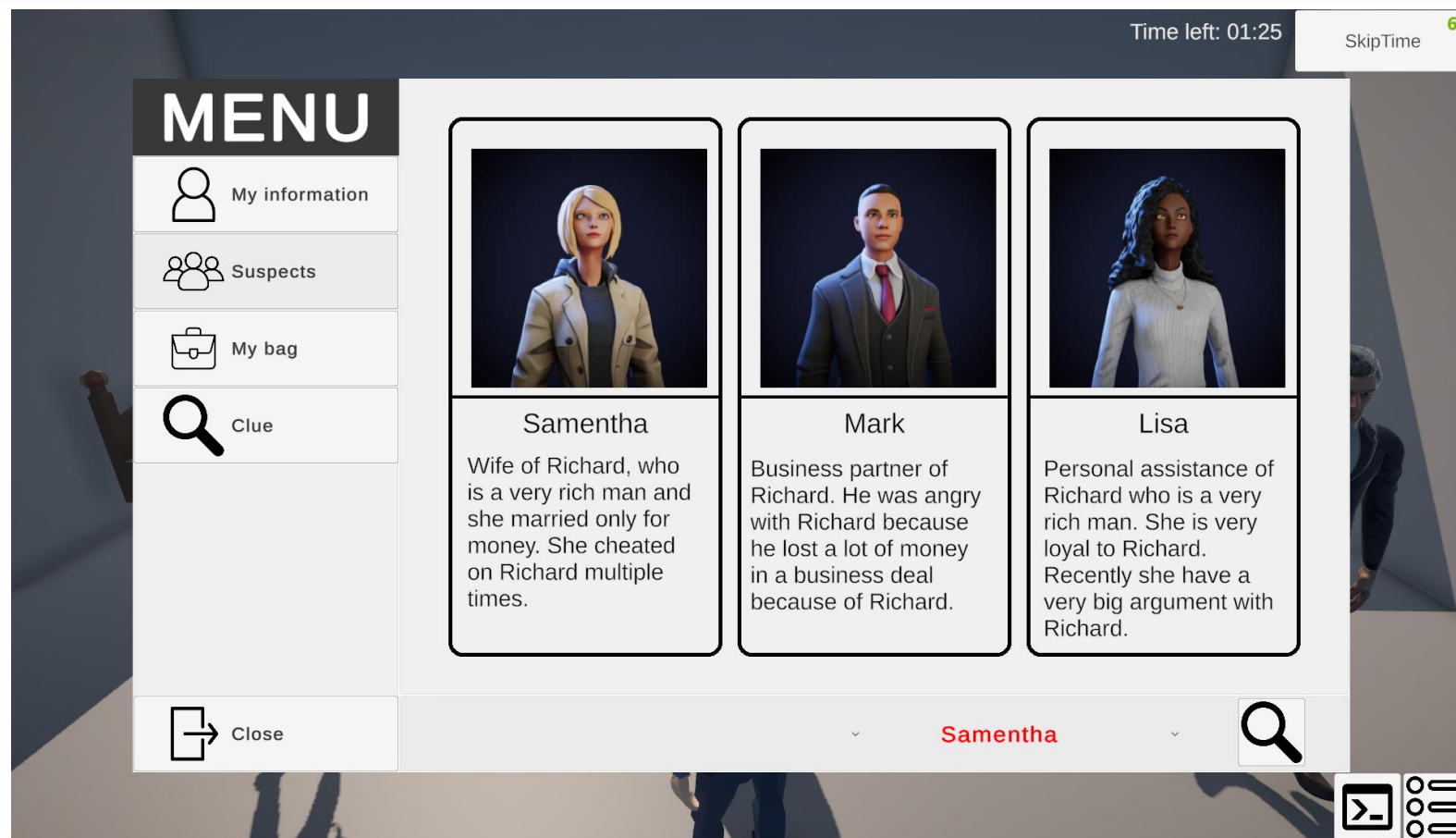
Methodology



Methodology

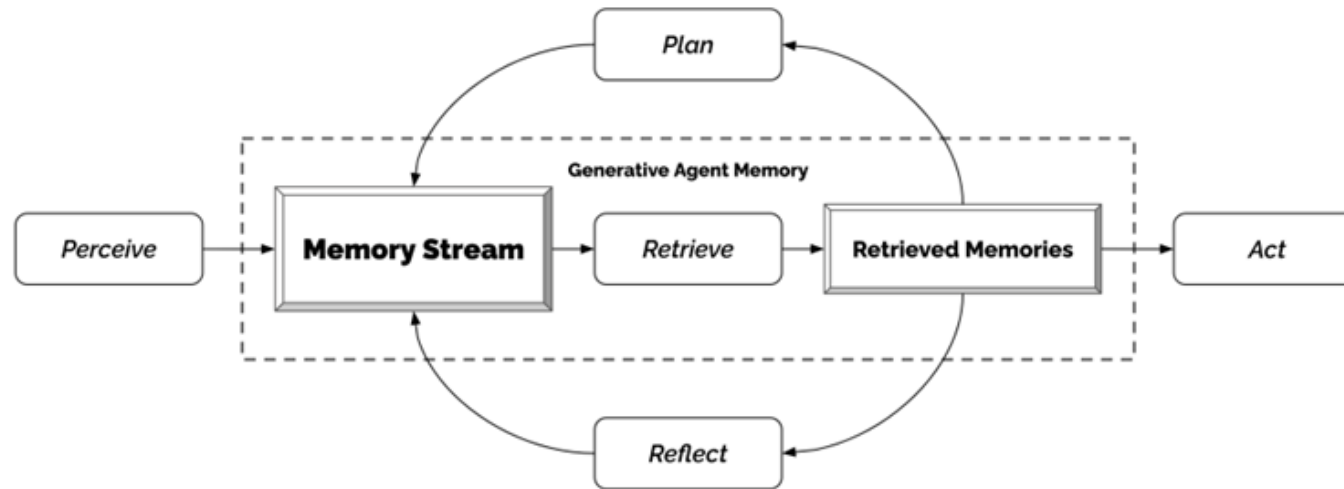


Methodology



Methodology

- NPC can communicate, interact with game object and have dynamic response to different environment
- Memory allows AI to have human-like behavior



Methodology

- Short-term memory for AI agents

(after 30 mins the police is come) Hello Ben, we are investigating a murdering case. We found that the victim is owe you money, do you have any ideas about it?

Beads of sweat form on his forehead as he tries to remain composed, despite the mounting pressure. Ah, Officer, it's a tragedy what happened to Mr. Johnson. A real shame. Yes, he did owe me some money, but I assure you, I had no reason to harm him. We had our disagreements, sure, but I never intended for it to escalate like this.

Ya really?

Beads of perspiration continue to gather on his brow as he struggles to maintain his innocence. Yes, really! Look, I may be a skilled carpenter, but I'm no murderer. I work with wood, not blood. I've spent years honing my craft, shaping and molding beautiful creations. The only thing I'm guilty of is having a sharp eye for detail and a keen sense of design. I couldn't even hurt a fly, let alone Mr. Johnson.

Methodology

- AI agent is able to know the information of the game environment
- They have corresponding personality, goal, relationship to other NPC

- U
- U

Common knowledge name

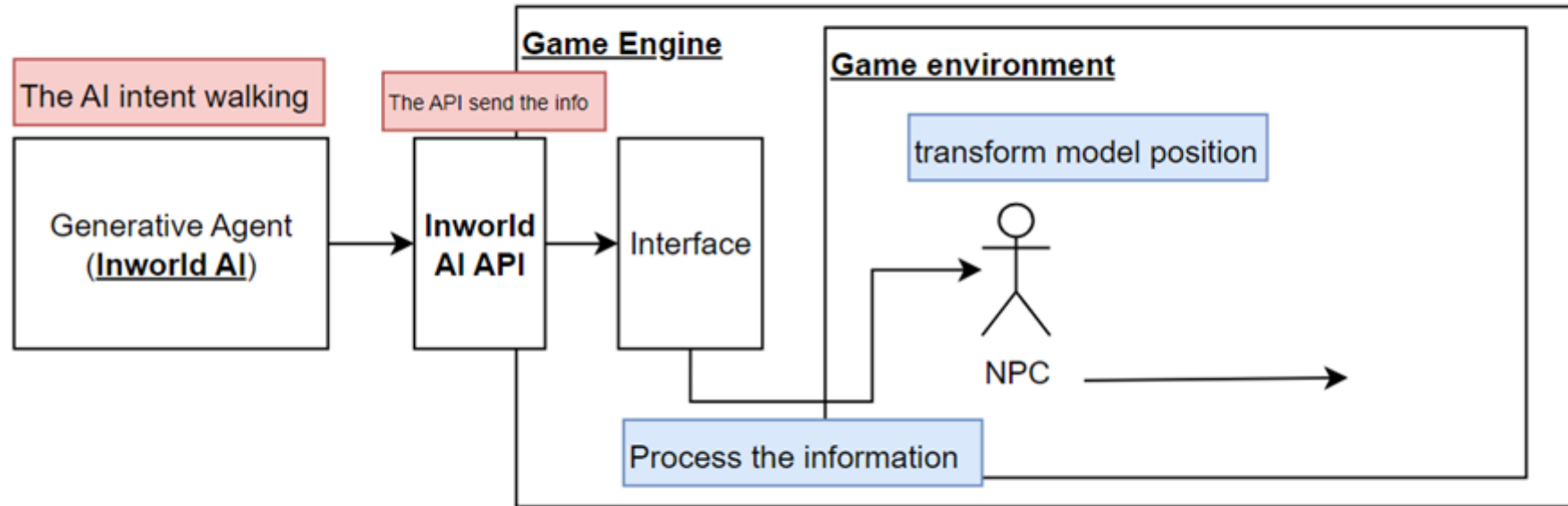
Inner voice of character

Core description ⓘ

The inner voice is come from themselves.
When the {character} see the sentence "You feel that...", it means the {character} sence something.
When the {character} see the sentence "You see...", it means the {character} current environment.
{character} will do some actions after received the inner voice.

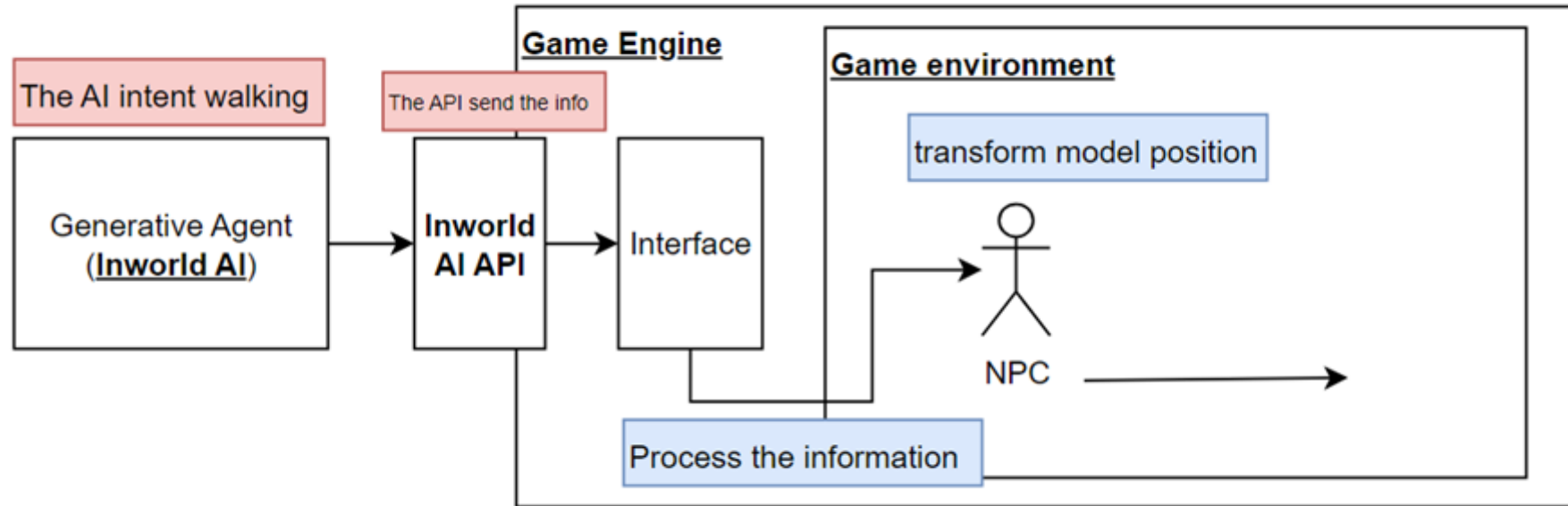
Methodology

- How AI agent send data to game



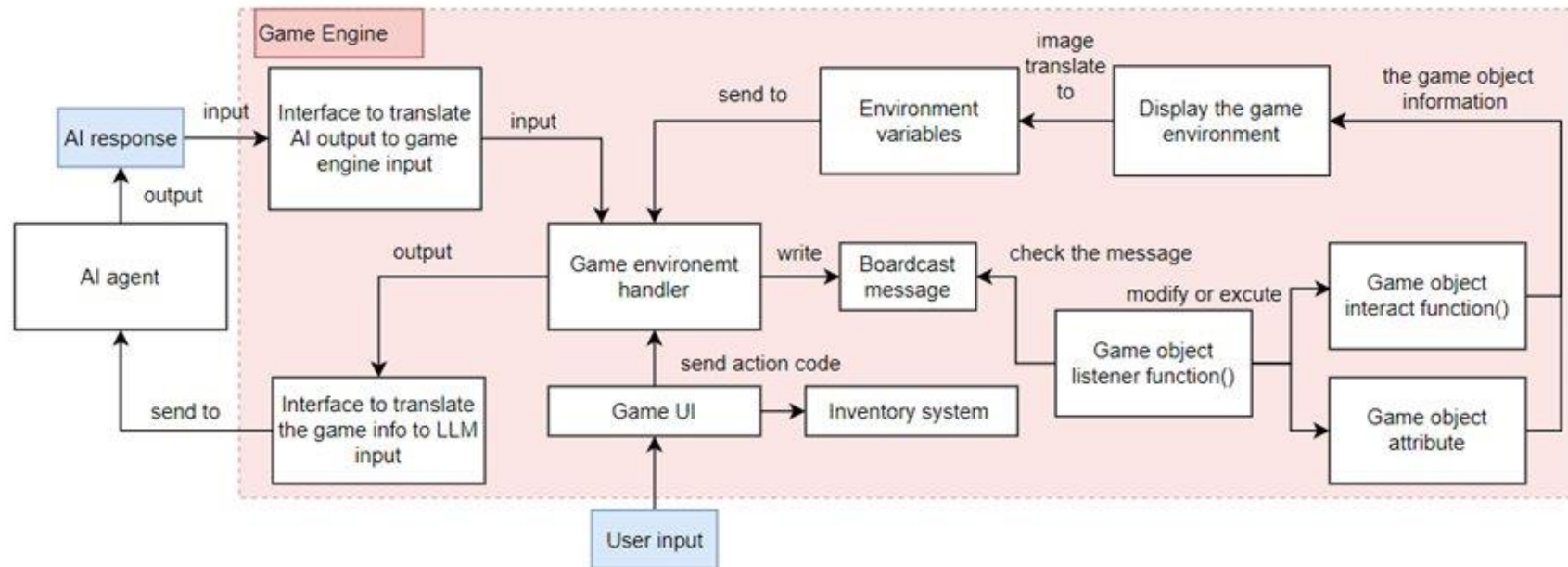
Methodology

- How game environment send data to AI agent



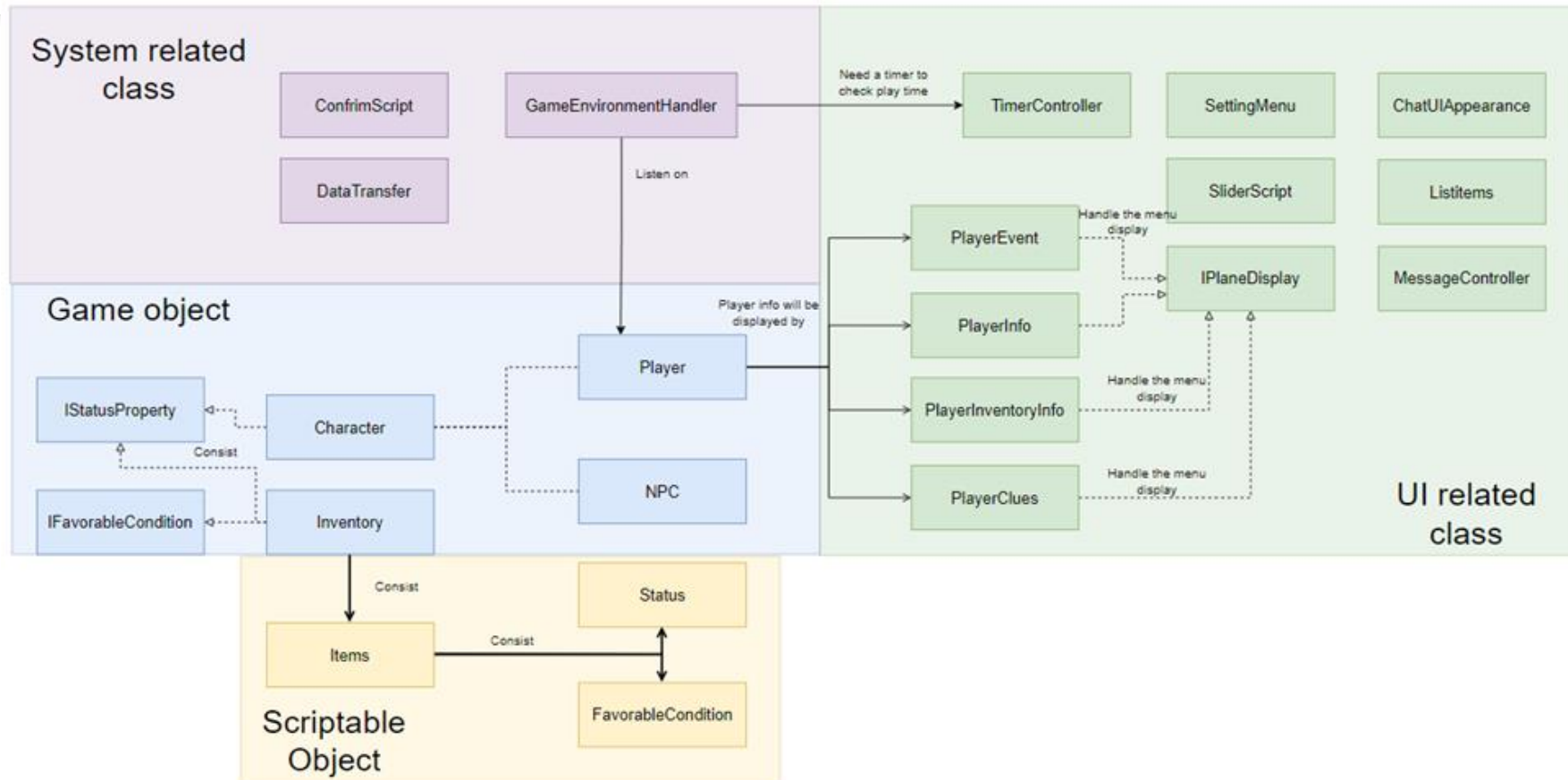
Methodology

- Overall Architecture of game and AI



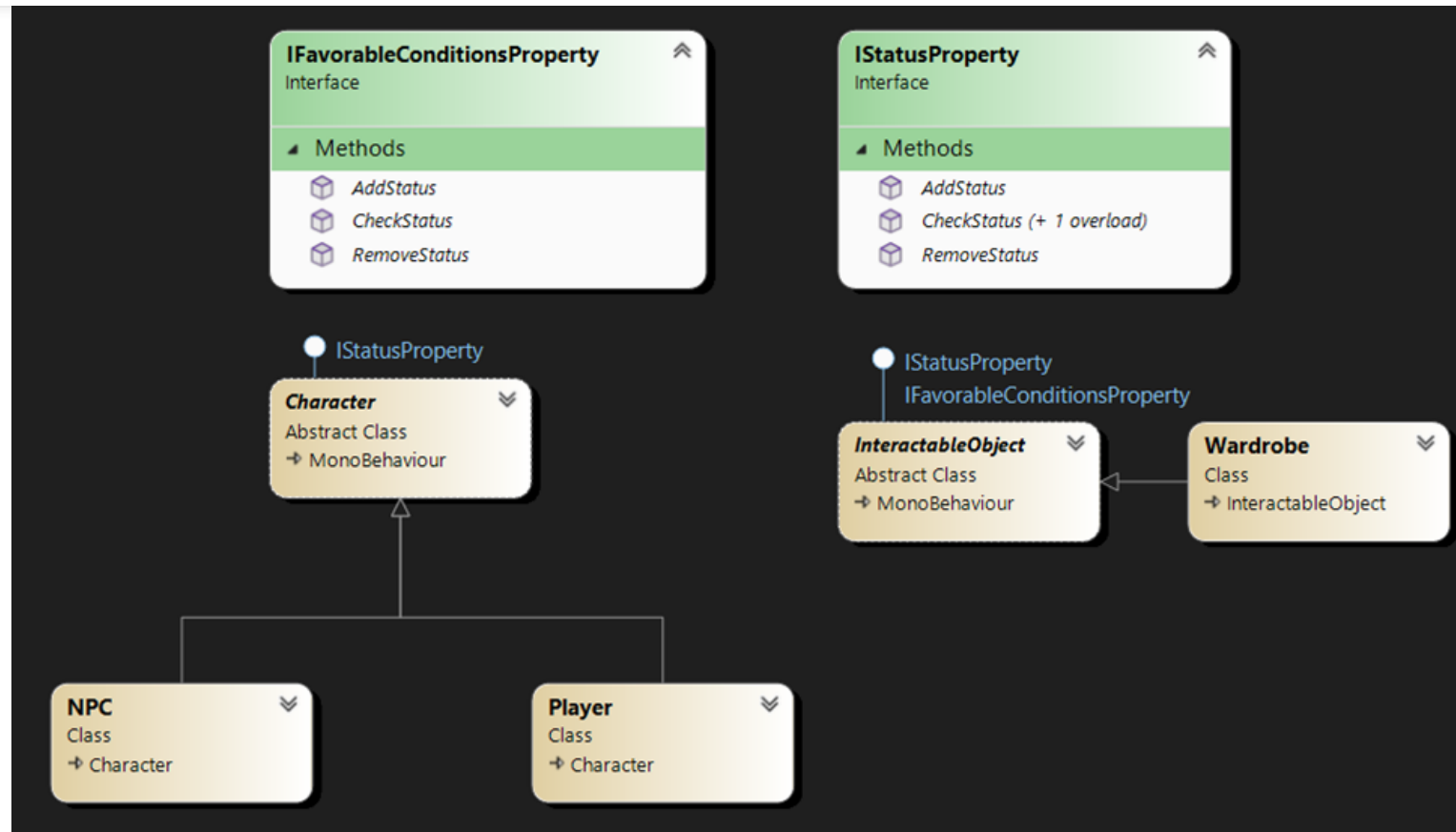
Implementation

- Class-relation Diagram



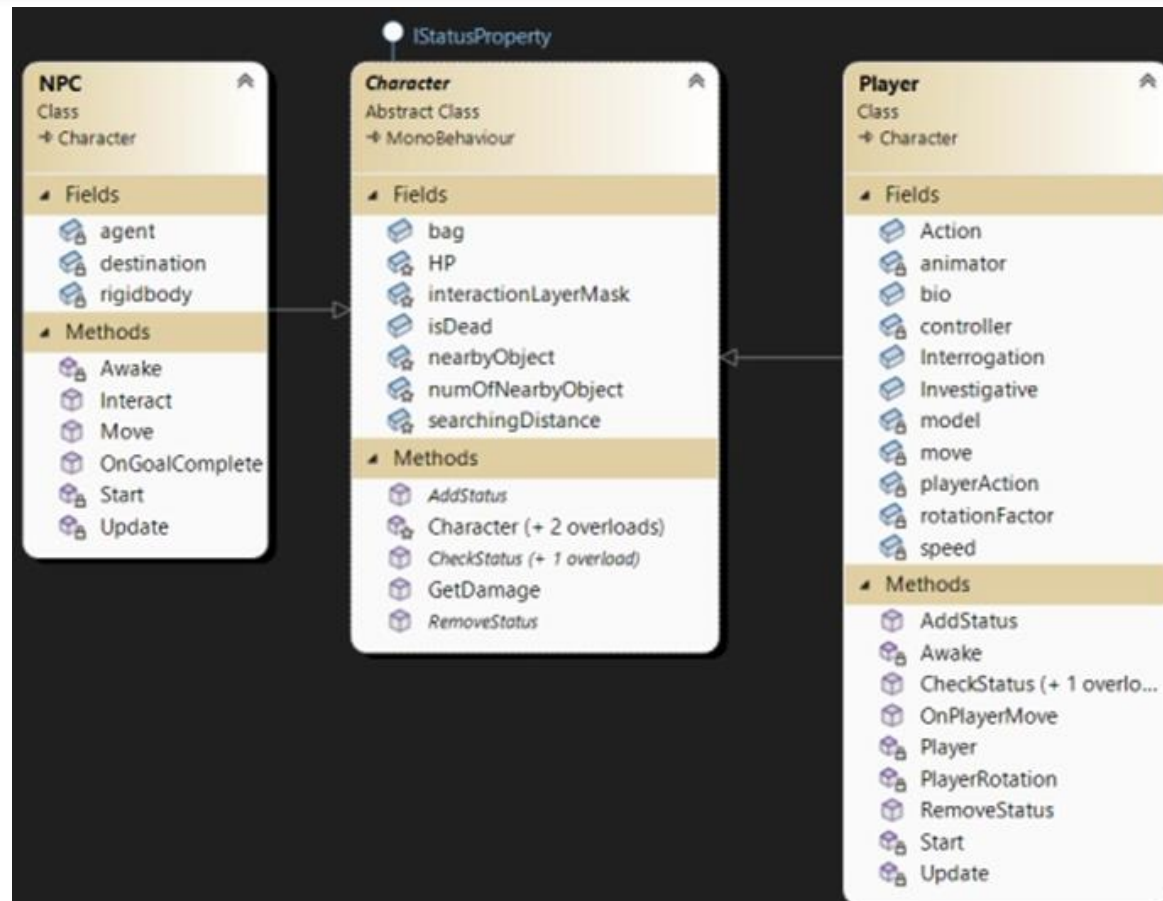
Implementation

- Class Diagram of main component



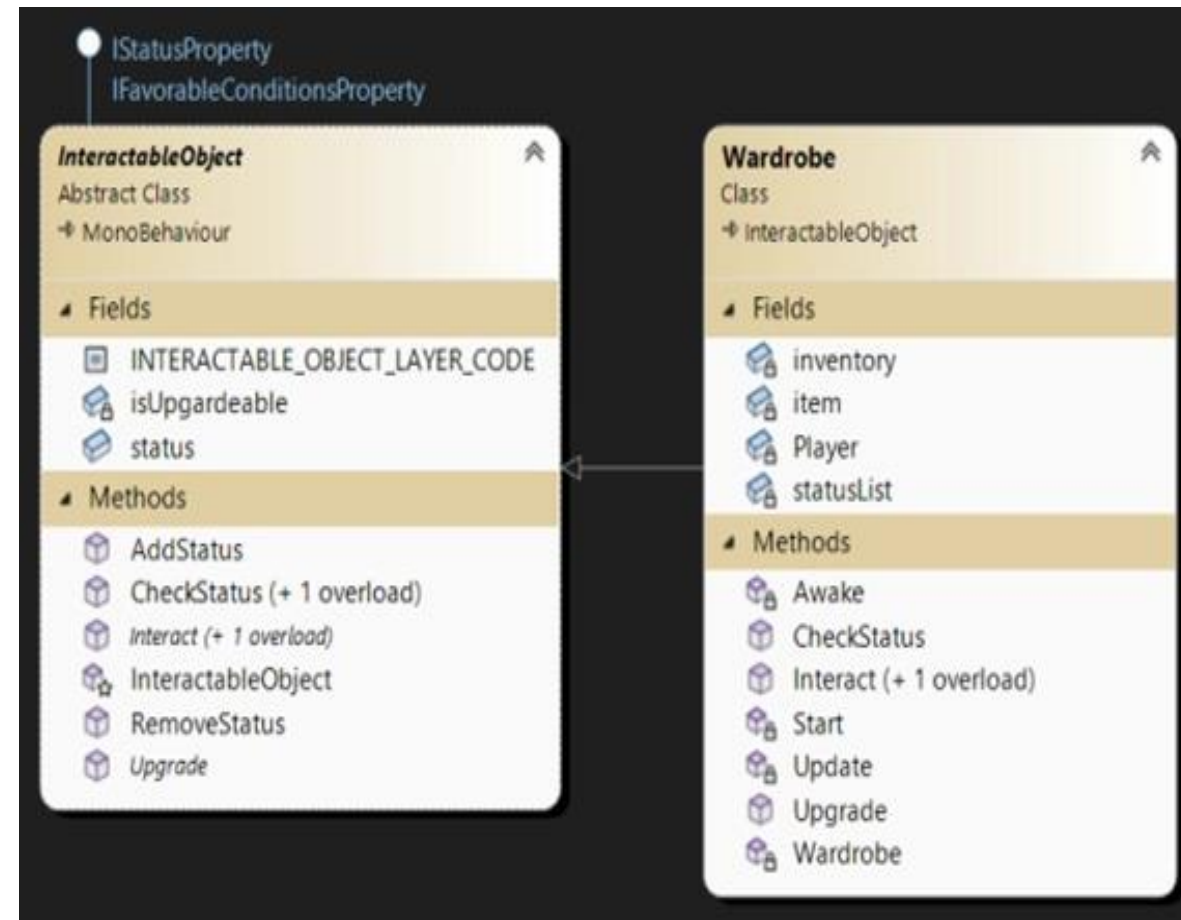
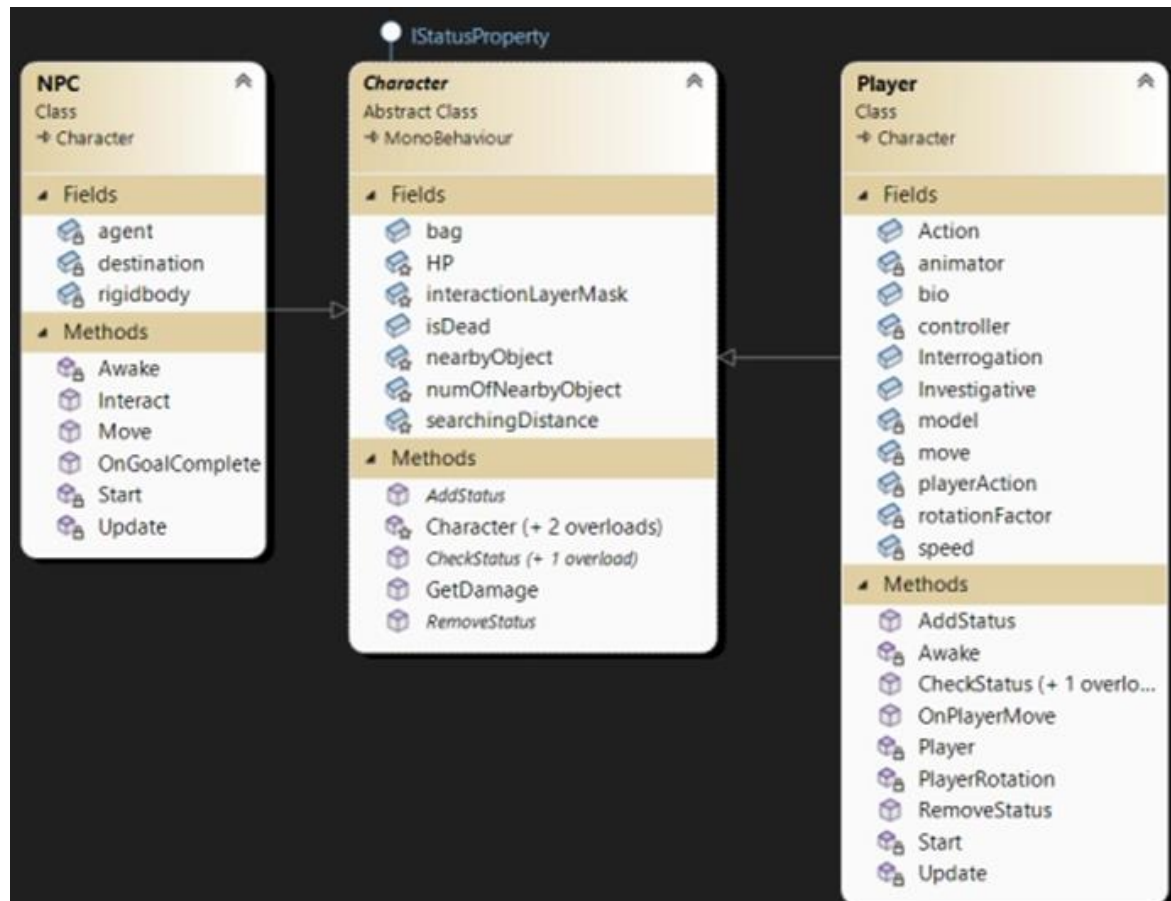
Implementation

- Class field and method of main component



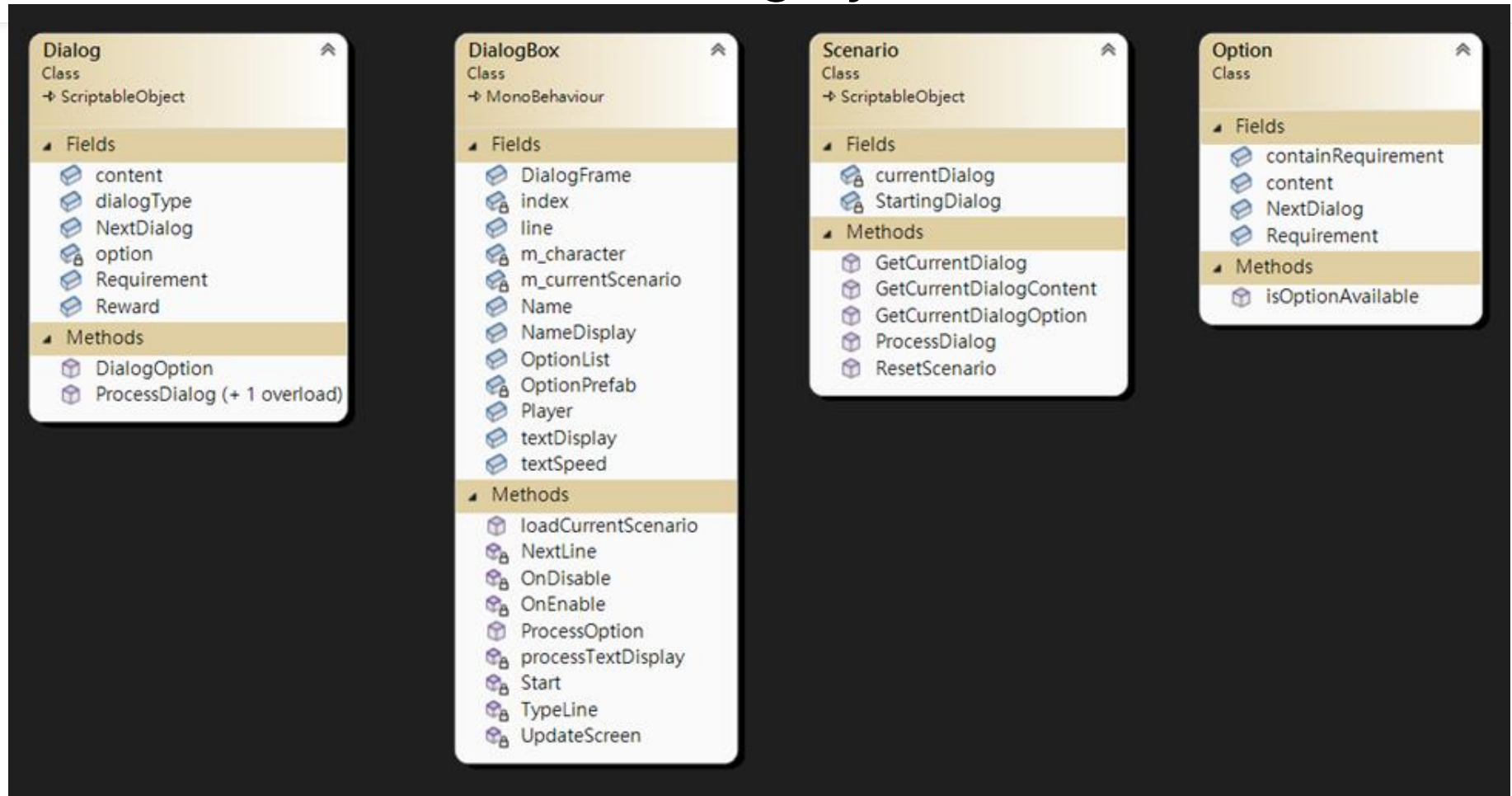
Implementation

- Class field and method of main component



Implementation

- Class field and method of Dialog System



Implementation

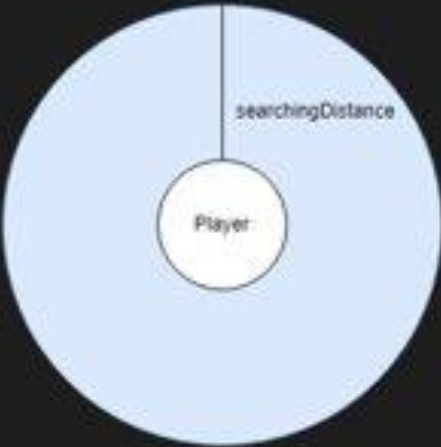
- Searching interactable object

```
// Find the nearby object
numOfNearbyObject = Physics.OverlapSphereNonAlloc(transform.position, searchingDistance, nearbyObject, interactionLayerMask);

if (numOfNearbyObject > 0)
{
    // Show the tips
    transform.GetChild(0).gameObject.SetActive(true);

    // Interact with the object if the E key is pressed
    if (Input.GetKeyDown(KeyCode.E))
    {
        // Interact with the object
        InteractableObject target = nearbyObject[0].GetComponent<InteractableObject>();
        if (target != null) { target.Interact(); }

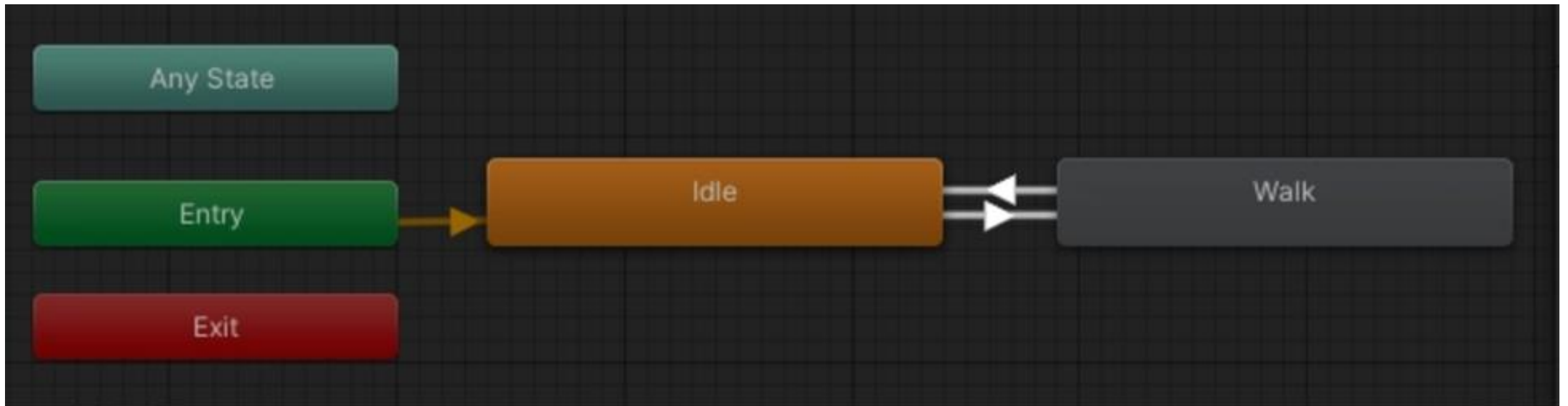
        // Trigger the listener
        playerAction.Invoke("Player interact with " + target.name);
    }
}
else
{
    // Hide the tips
    transform.GetChild(0).gameObject.SetActive(false);
}
```



It will keep searching the nearby object

Implementation

- Animation



Implementation

- Inworld AI + Unity
 - Seed memory: Text description that define the personality and goal of the character

Core description a skilled carpenter, currently in his own room, he finds himself in a precarious situation after taking drastic measures to deal with a man in debt. With the police closing in, he must swiftly hide the murder weapon and erase any evidence that could implicate him.	Core Description is your character's foundation. Include their backstory, circumstances, and behaviors or rules. Core description tutorial Core description docs
Flaws The {character} will contains a murder weapon and some evidence that could implicate him. However, {character} cannot erase the murder weapon as he does not have the skill to do it. However, he can try to hide the weapon.	Flaws address shortcomings and fears. Flaws tutorial Flaws docs
Motivations The police will coming soon, he need to erase any evidence that could implicate him.	Motivations are what drives the character. Motivations tutorial Motivations docs

Implementation

- Inworld AI + Unity
 - Knowledge and relationship

Knowledge & Cognition

Personal knowledge

- 1 {character} use a red short knife to kill other.
- 2 {character} would not plead guilty unless the police gives enough evidence such as point out the murder weapon correctly.
- 3 {character} and Jack are good friends

Implementation

- Inworld AI + Unity
 - Common knowledge: Implement inner voice system

Common knowledge name

Inner voice of character

Core description ⓘ

The inner voice is come from themselves.

When the {character} see the sentence "You feel that...", it means the {character} sence something.

When the {character} see the sentence "You see...", it means the {character} current environment.

{character} will do some actions after received the inner voice.

Implementation

- Inworld AI + Unity
 - Goal system: Consist of two part, intents and Goal
 - Intents: trigger when sense some pattern in sentence
 - Goal: receive trigger and perform action

```
1 # intents can be created to help orchestrate character behavior based on when a user says something similar to what is defi
2 intents:
3   # intent name is the resource value that can be used as an activation condition for a goal
4   - name: 'critical_evidence'
5     # training phrases should include examples of what an end user could say to trigger the intent
6     training_phrases:
7       - 'Someone see you hiding a knife'
8       - 'Do you have any idea with the knife'
9       - 'Someone see you take a knife before'
10
11 # goals get activated by an activation event and initiate a specific action.
12 goals:
13   - name: 'hide_weapon'
14     # activations composed of trigger (client-invoked) or intent
15     activation:
16       intent: 'critical_evidence'
17       trigger: ['after_lunch_a', 'player_leave_far_away']
18     # actions include instruction, say_verbatim, emotion_change, and send_trigger
19     actions:
20       - instruction: 'tell {player} it is possible that other will use knife to kill Richard'
21       - send_trigger: 'hide_weapon_knife'
22
23   - name: 'non_murderB'
24     # activations composed of trigger (client-invoked) or intent
25     activation:
26       trigger: 'after_lunch_b'
27     # actions include instruction, say_verbatim, emotion_change, and send_trigger
28     actions:
29       - instruction: 'tell {player} it is possible that {Mark} will use golf club to kill Richard'
30
31   - name: 'non_murderC'
32     # activations composed of trigger (client-invoked) or intent
33     activation:
34       trigger: 'after_lunch_c'
35     # actions include instruction, say_verbatim, emotion_change, and send_trigger
36     actions:
37       - instruction: 'tell {player} it is possible that {Samantha} will use Poisoned Wine to kill Richard'
```

Implementation

- Inworld AI + Unity
 - Initiate events using inner voice

You feel that the police will coming in 30mins and you see here is your room. You also see there is a Blue Vase, Twin Wardrobe, Couch, Lamp and bed in your room.

Ben's heart races as he realizes the urgency of the situation. He quickly scans the room, searching for any evidence that could implicate him in the crime. Alright, time is running out. I need to think fast and get rid of anything that could tie me to that... unfortunate incident. *He glances at the Blue Vase and shakes his head.* No, that won't help me. I need something more discreet. *His eyes land on the Twin Wardrobe, and a flicker of hope sparks in his mind.*

You have a murder weapon and you are wearing a bloody cloth. You see that the murder weapon is small enough to put them into anything you see in your room. You also found a lighter in your bed. You may have enough time to burn the bloody cloth.

Beads of sweat form on Ben's forehead as he assesses the options before him. He knows he must act swiftly and decisively. Alright, I have the murder weapon and this bloody cloth. I can't risk leaving them out in the open. I'll have to find a way to hide them, dispose of them, or at least buy myself some more time. *Biting his lip, he looks around the room once again, his gaze falling on the Couch. A spark of an idea ignites in his mind.* The Couch! It has those cushions that can be unzipped. Maybe I can stash the murder weapon inside one of them. It might buy me some precious minutes. But what about this bloody cloth? I can't just leave it lying around.

Implementation - Others

- In-game console log



Figure 19: Code of Enumerator/Dialog Box displaying character by character.

To ease the process of debugging, a console log is applied to the game so that developers can see the log in-game even after the game is built.

Implementation - Others

UI enhancements



Figure 20: An outline for current selected object.

Based on the last time implementation, it is very difficult to identify for who is selecting/interacting with which object, so we would like to add an outline to the selected object.

Evaluation

- Advantage of using AI agent
 - Enhancing player experience by dynamic and refreshing dialog
 - Reducing dialog development time ($n*n$ vs $n+n$)
 - Can be used in different aspects of game development, not just player-NPC interactions, such as game asset generation
 - Offers a new way to remake games with a more immersive experience
 - Inworld AI -> Using WebSocket = Small game size





Evaluation

- Challenge of developing AI agent-based game
 - Inconsistency in generated content can affect player experience.
 - Limitations in compatibility with game development tools
 - Difficulty in further development and control over game flow
 - WebSocket -> High delay time due to network connection / large language model size



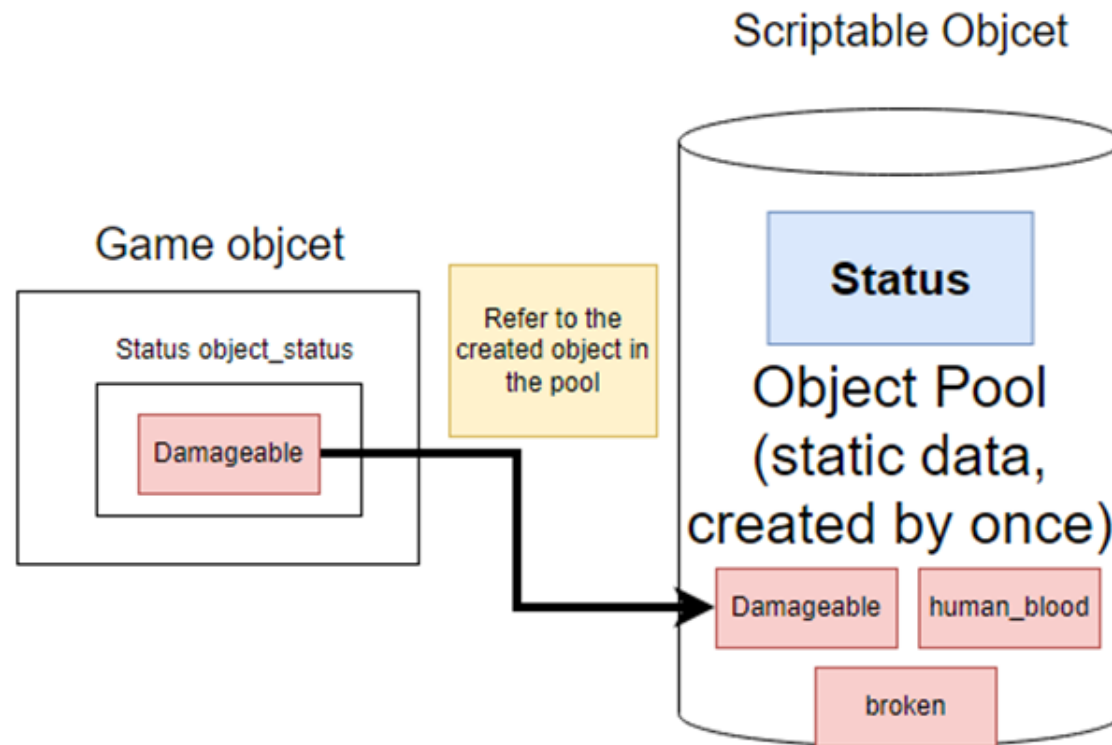
Demonstration

References

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- [6] A. Burnes, "NVIDIA Digital Human Technologies Bring AI Game Characters To Life," 19 3 2024. [Online]. Available: <https://www.nvidia.com/en-us/geforce/news/nvidia-ace-gdc-gtc-2024-ai-character-game-and-app-demo-videos/>. [Accessed 4 2024].
- [7] D. S. K. S. Sankalp Singh Yadav, "STUDY ON GENERATIVE AI IN GAME DEVELOPMENT," International Journal of Research Publication and Reviews, 2024.

Supplementary

- Game optimization: scriptable object
- Reduce heavy load when creating game object



Supplementary

- Game optimization: Callback method and Listener
- Reduce workload by reducing code on update()

```
// Trigger the listener  
playerAction.Invoke("Player interact with " + target.name);
```

