

# Practical AI modules for Non-Player Characters in Video Games

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# Overview

- Cognitive robotics
- Applying cognitive robotics to video games:
  - ▶ the AI researcher perspective;
  - ▶ the game developer perspective.
- The need for practical AI modules for video games
- The temporal projection module
- Future work / discussion



# Cognitive robotics

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**Cognitive abilities** such as being able to:

- learn from past experience,
- think ahead and plan before acting,
- communicate and coordinate with other agents, ...

These are based on **reasoning** or “taking into account”:

- the current state of the world and sensory data,
- the goals that need to be achieved,
- the actions that can be performed in the world,
- the mental states of other agents, ...



# Cognitive robotics and video games

Modern video games are ideal for applying cognitive robotics research:

- detailed software worlds with advanced 3D game engines,
- the world consists of objects that follow realistic physics,
- many autonomous Non-Player-Characters (NPCs) interact with the objects in the world, the player, and with each other,
- rich sensor data for each NPC.

Some of the NPCs in a video game could be implemented as cognitive robots! Let's see how that would go..



# Cognitive NPC: the AI researcher perspective

Pick a cognitive robotics system, implement the NPC..

..and connect it to the game world (3D game engine).

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Pick a cognitive robotics system, implement the NPC..

## 1 Specify the world that the NPC is situated:

- ▶ the *changing properties* of the world and their current value;  
`door1=locked, availWeapons=[w1,w2]`
- ▶ the *actions* that can take place in the world;  
`kick(x), fireWeaponAt(x), move(d,s)`
- ▶ the *effects* of the actions in the world;  
`kick(door) → open(door) provided ...`

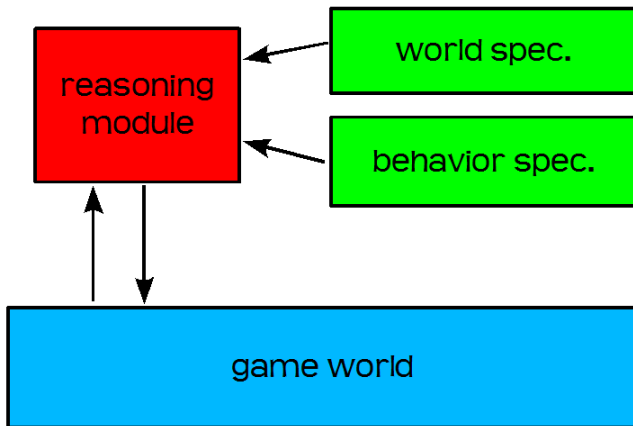
## 2 Specify the intended behavior of the robot using features such as *goals, intentions, preferences, utility functions*, as well as predefined *reactive rules, plans*, etc;

The *reasoning core* of the system mixes ingredients **1** and **2** appropriately to produce intelligent behavior.

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# Cognitive NPC: the game developer perspective

## Practical difficulties:

- It requires a lot of memory and computing time.
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Moreover, it would be awkward to implement cognitive NPCs like this because:

- Typically the AI system assumes **full control** over the agent:  
All aspects of the NPC's behavior need to be encoded in the AI system using the language for specifying parts 1 and 2.  
For instance, how about path-finding?
- In order to use the AI system for only some reasoning task you need to know the inner workings of the system..

Let's see some more details on the implementation of an NPC in a 3D game engine..



# Cognitive NPC: the game developer perspective

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The body of this function usually implements a finite-state-automaton (FSA) as a big if-then-else block.

The conditionals depend on:

- ▶ the state of the NPC, i.e. variables of the form  
`state=ATTACKING, energy=80;`
- ▶ sensory data, i.e. C++ functions of the form  
`bool enemyInSight();`
- ▶ other implemented helping functions such as  
`bool pathfind(from,to,options).`



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Game developer:

```
int NPC::think() {  
    if (state==IDLE &&  
        energy>70 &&  
        enemyInSight())  
        state=ATTACKING;  
    else if ...  
        ...  
}
```



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AI researcher:

```
int NPC::think() {
    get sensory data;
    push data to the AI
    system;
    wait for the system to
    compute the next move;
    perform the next move;
}
```

**Two extremes:** either all in C++ or all in the AI system..



# Practical AI modules for NPCs

- **Two extremes:** either all in C++ or all in the AI system.
- **Middle ground:**  
Identify practical **AI modules** that can **replace C++ code** that the game developer needs to implement for the behavior of the NPC.
- Historically that's the most common way that AI techniques have been used in commercial video games.
- Most widely used AI technique:
  - **A\* heuristic search**, used for path-finding:
    - ▶ solves a particular sub-problem with clear input and output;
    - ▶ can be embedded easily to any control structure for NPCs.
- That's the kind of AI modules we should be aiming for!



# Practical AI modules for NPCs: Temporal Projection

A **temporal projection module**: keeps track of the current state of the world and predicts how it changes when actions take place.

You can think of it as a special database or data structure that:

**A** stores:

- ▶ the *changing properties* of the world and their current value;
- ▶ the *actions* that can take place in the world;
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**B** features a language for expressing queries and getting answers about

- ▶ the *current state* of the world;
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**Bigger question:** Would this module be useful?



# Video games and AI: Discussion

One last point about the use of AI techniques in video games.

- A\* dates back to 1968.
- The only reasoning module ever used in a commercial game (F.E.A.R., 2005, Monolith Productions, Vivendi) is a simplified version of a STRIPS planner that dates back to 1971.
- AI techniques need **feedback** from the video game industry so that they evolve as needed for the video games.
- What kind of modules should AI provide? What are the things that are difficult to deal with right now?

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