

Artificial Intelligence

Christopher Menart

Nikit Malkan

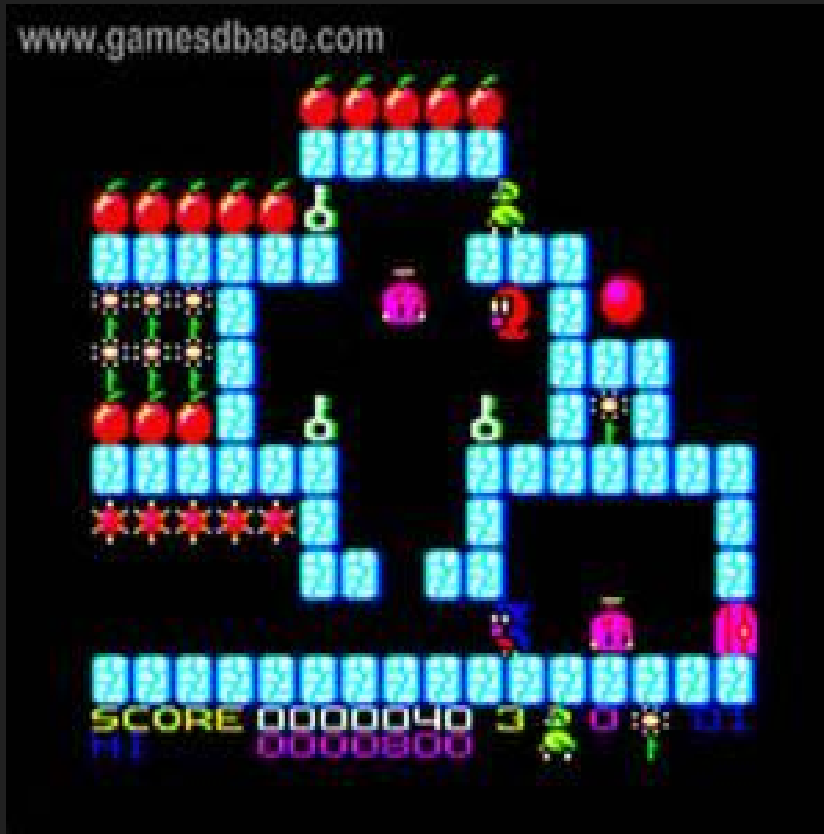
Chris Makepeace

Branden Ten Brink

The First Game AI



Qwak



Pac-Man



80's: Finite State Machines



Dune II

Did Garry Kasparov Have Fun?

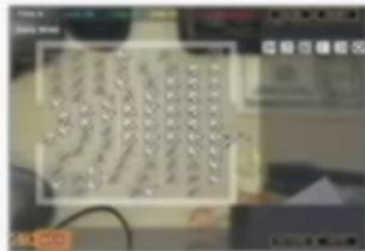


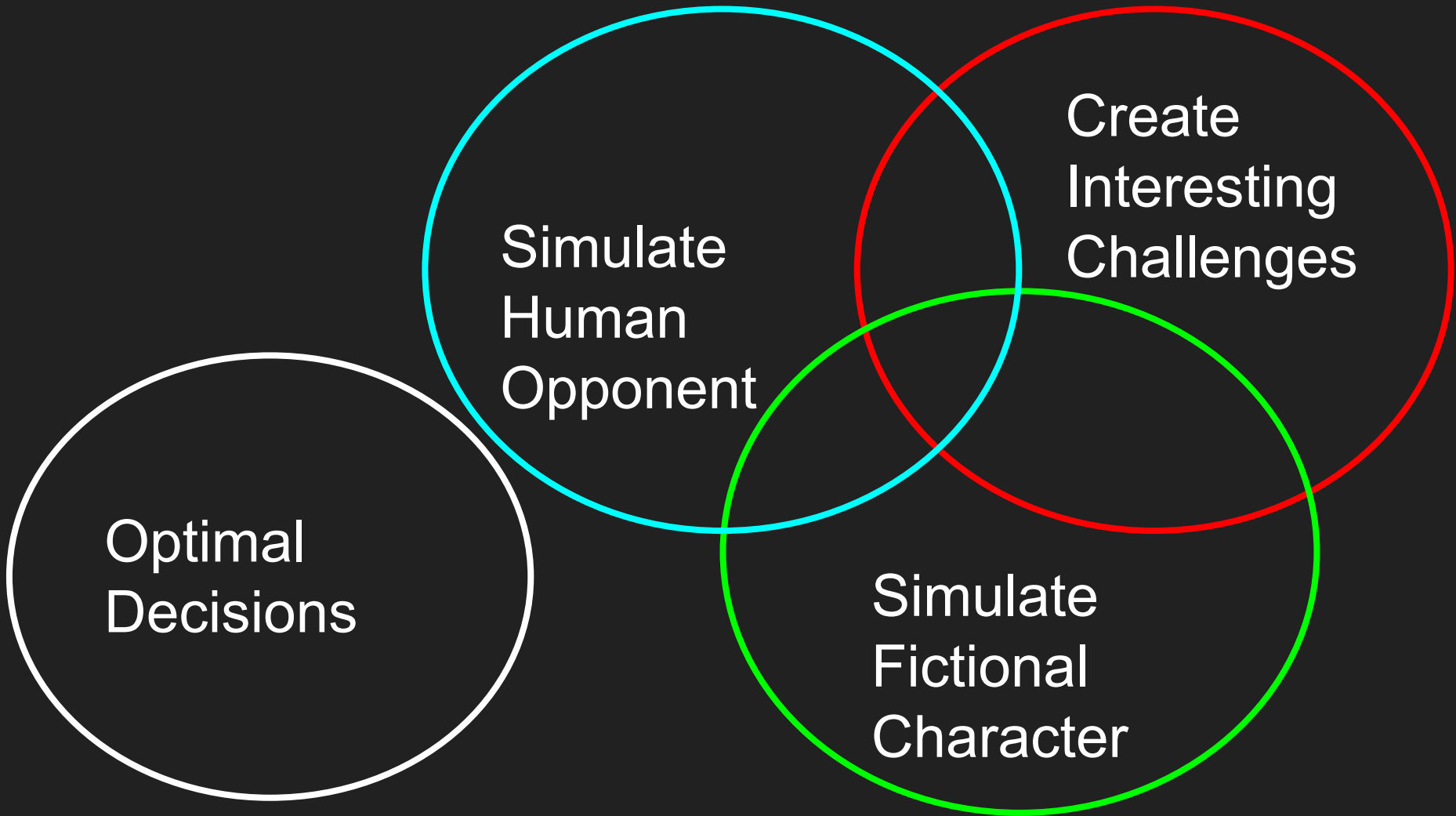


Strategy AI Spectrum

“Good”

“Fun”





Interesting Challenge



Simulating Fictional Characters

The screenshot displays a game interface with a central character portrait of Mahatma Gandhi. The interface includes a top status bar, a left-side text log, a right-side inventory panel, and a bottom dialogue box.

Top Status Bar: Gandhi - Indian Empire (Cautious)

Left Panel (Text Log):
Gandhi
Cast our name in India
+1: "Years of peace have strengthened our relations."
-1: "We are open to you even before we are ready to take the way of a Indian nation."

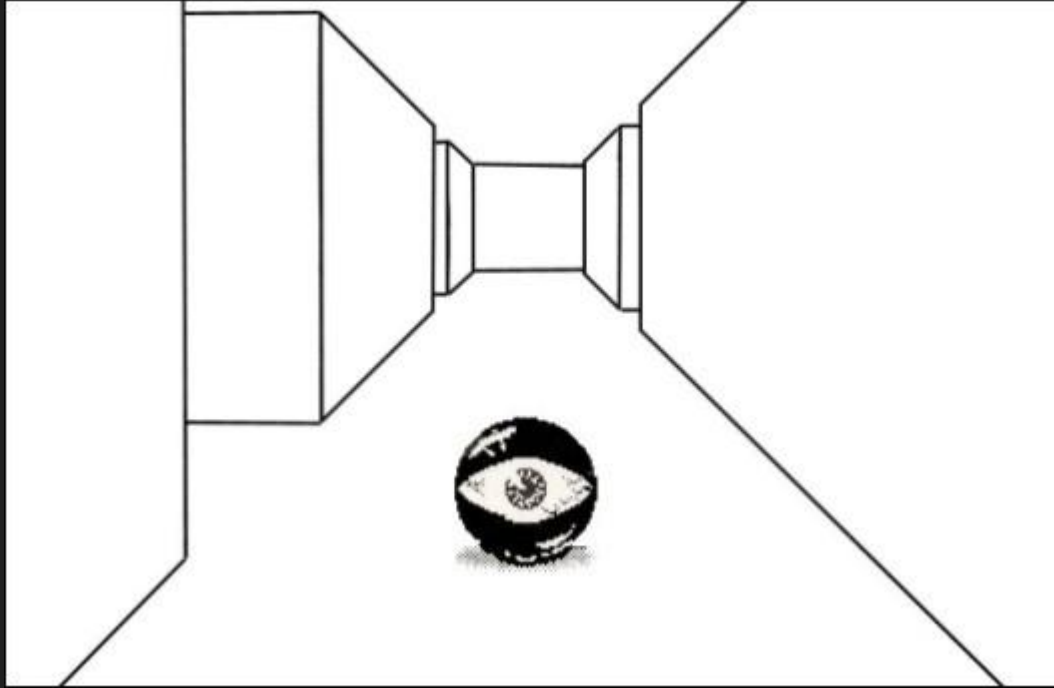
Right Panel (Inventory):
YOU HAVE
Tradeable Items

Bottom Dialogue Box:
Greetings, Sulla! What do you think of this deal?
Open Borders

Bottom Left Panel:
GANDHI OFFERS
Open Borders

Bottom Right Panel:
YOU OFFER
Open Borders

Simulating Human Opponents



Simulating Human Opponents



The Game



Optimal Decisions



AI and Cheating

Enhancing AI

You have the option to enhance various aspects of the AI to make the game more difficult and interesting. This only affects the main computer-controlled countries.

(For effects on your decision, check the information appearing when you move the mouse over the button.)

Let the AI to cheat as much as possible.

Difficult

Complicate the game a bit

Normal, no changes

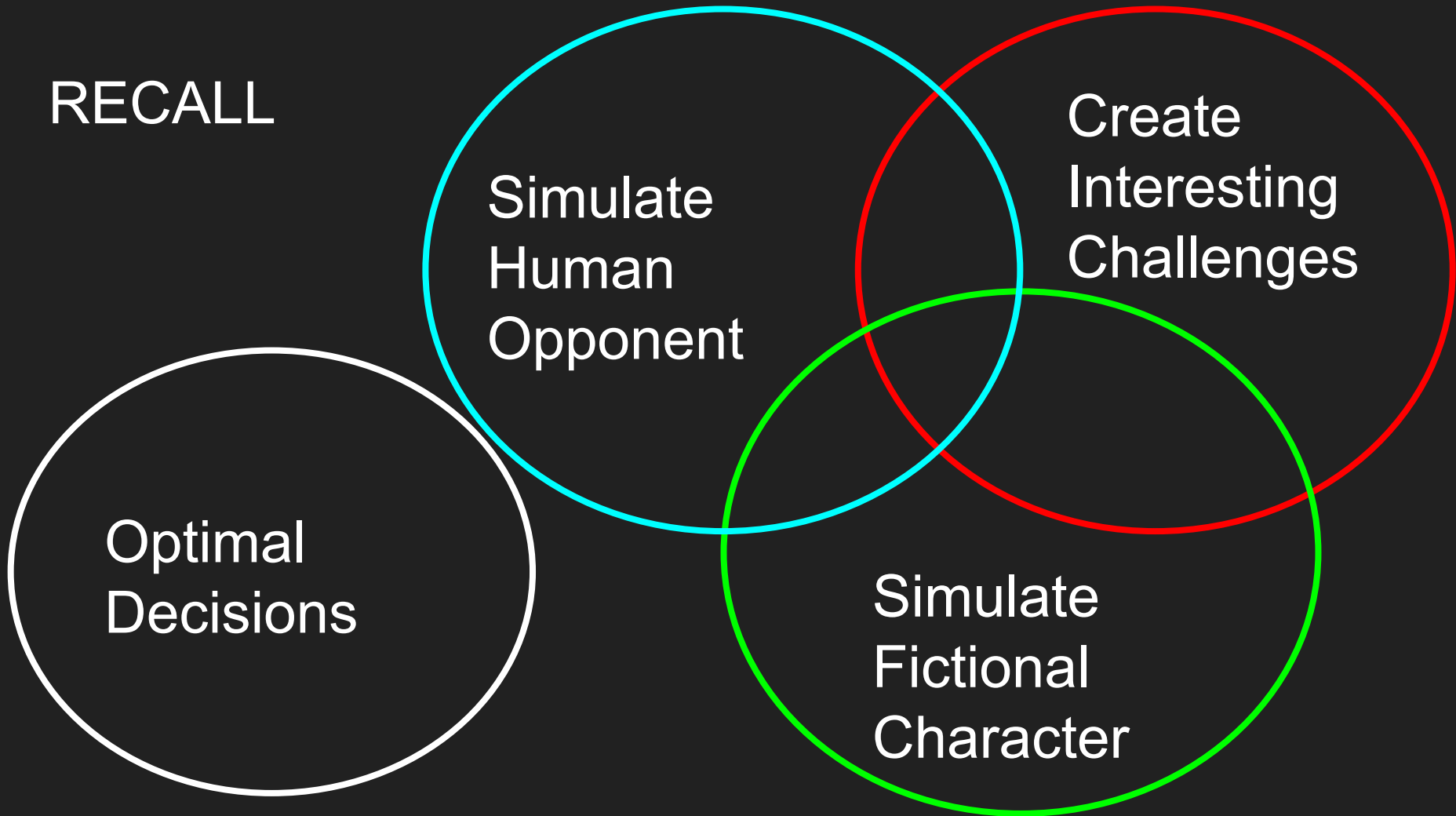
RECALL

Simulate
Human
Opponent

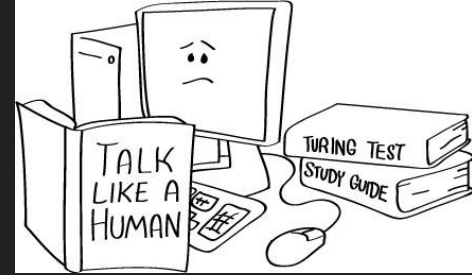
Create
Interesting
Challenges

Optimal
Decisions

Simulate
Fictional
Character

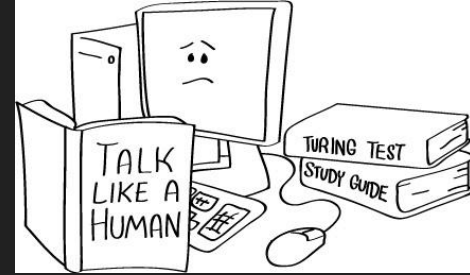


Simulate Fictional Characters ~ Act Humanly



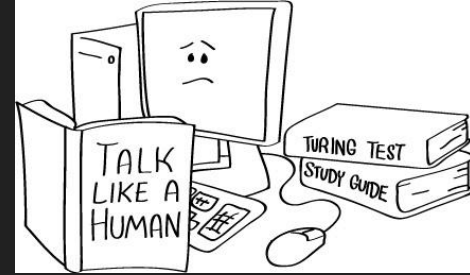
Simulate Fictional Characters ~ Act Humanly

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 - Often inefficient!
 - (It's more fun this way!)



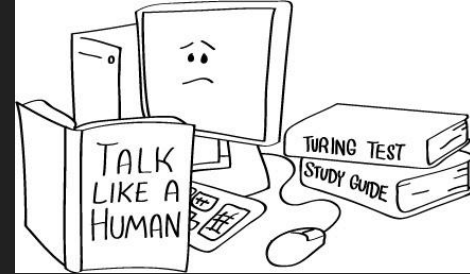
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 - Blue colour is best colour.
 - (This is a fact.)



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 - Have unique playstyles.
 - Often inefficient!
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 - Place arbitrary value on things.
 - Blue colour is best colour.
 - (This is a fact.)
 - Be notoriously fickle.
 - Our *perception* of how we perceive something changes at the drop of hat..
 - (This character beat me. \Rightarrow This character is broken. \Rightarrow I'm going to play this character.)



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- Form alliances.
 - And break them when convenient.
- Withhold information.
 - I don't have enough resources/units to fight.
- Lie and *cheat*.
 - What my cavalry are raiding your villagers during the skirmish?
 - I didn't notice...

Solving Interesting Challenges

- **Limited** amount of information.
 - Can see current status.
 - Can think about past events.

- Look for patterns.
 - Predict future outcomes.
 - Exploit what we can.

Bottom Line

We want to win!

Conflict

- We want to win.
 - Good AI wants to win.
 - Fun AI enables the *player* to win.
-
- Very difficult to find a balance.
 - Too easy ~ no challenge.
 - Too difficult ~ impossible challenge

Cheating ~ What's the Point?

- AI is very limited in what it can do.
 - Increase difficulty \Rightarrow Increase in available tactics.
-
- AI will need some help to keep up with player.
 - Cheating allows us to accomplish our three goals.

What is Cheating?

“...giving agents actions and access to information that would be unavailable to the player in the same situation.”

- Wikipedia: Artificial Intelligence (Video Games)

How to Cheat

Stat Modifiers

Stat Modifiers

- Modify stats
 - Higher difficulty = Better stats



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- Increase passive gold/income/exp rate
 - Resource gathering rate too
- Ignore population cap
 - Spawn free units
 - 0 pop units
- Faster build rates
 - Never 0 time for basic buildings



Ask the Game Engine (All Seeing AI)

- Ignore fog of war



Ask the Game Engine (All Seeing AI)

- Ignore fog of war
- Look up duration of status effects



Ask the Game Engine (All Seeing AI)

- Ignore fog of war
- Look up duration of status effects
- Know effects of all items on a stage



Different Rules or Mechanics

- Infinite ammo/no reloading
 - When you loot, limited ammo.



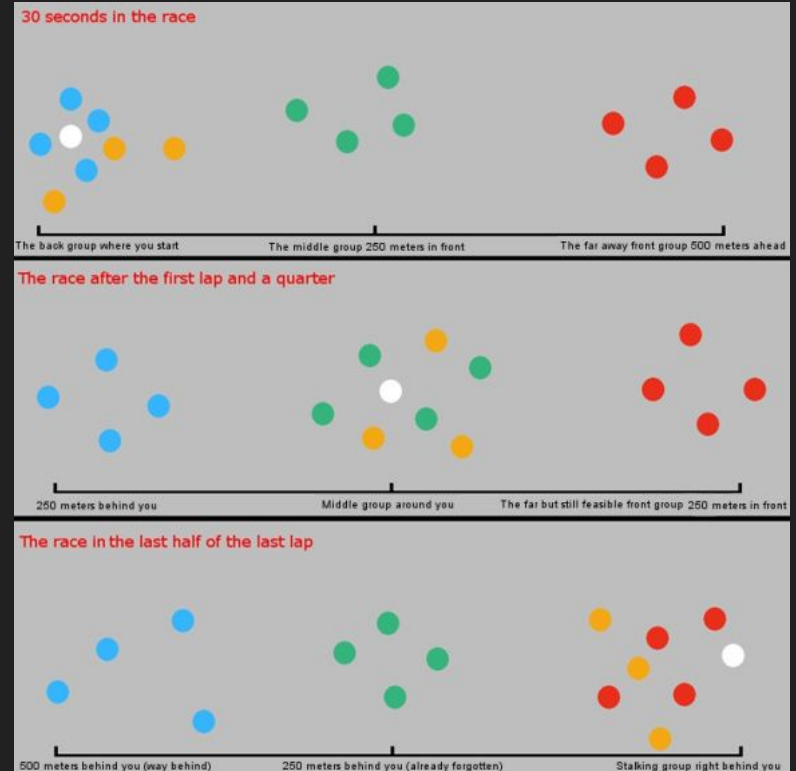
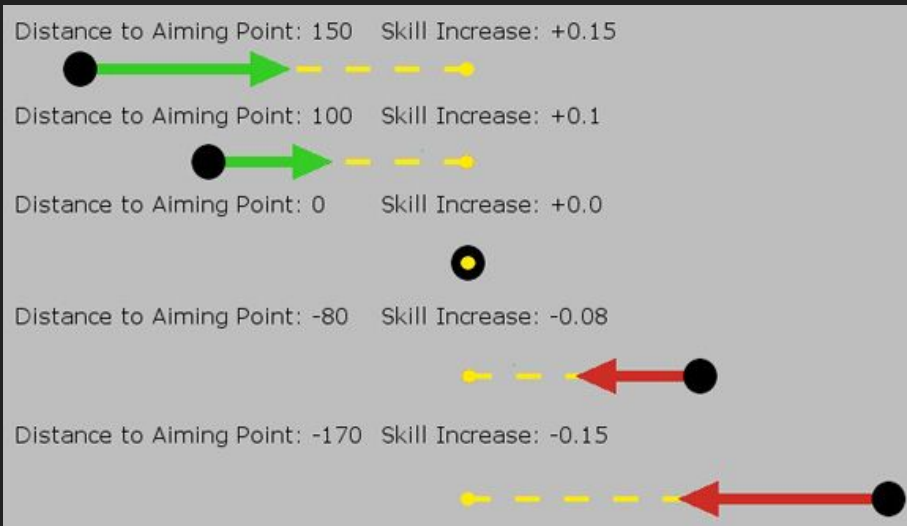
Different Rules or Mechanics

- Infinite ammo/no reloading
 - When you loot, limited ammo.
- Special AI specific moves
 - Fighting games.



Dynamic Game Difficulty Balance ~ Rubber Band AI

- Racing Games
- Sports Games



AI Learning

- Learn from the player's choices.
- Keep trying until the AI wins.



Rules of Cheating

“Cheat wherever you can. A.I.s are handicapped. They need to cheat from time to time if they're going to close the gap.”

- Jonny Ebbert, Relic, Lead Designer on Dawn of War 2

Cheat Fairly

- Humans are notoriously bad at detecting cheating.
 - If I did it it's because I'm skilled.
 - If the AI did it it's because it's cheating.
 - Even streaks of luck is “cheating”.

Golden Rule of Cheating

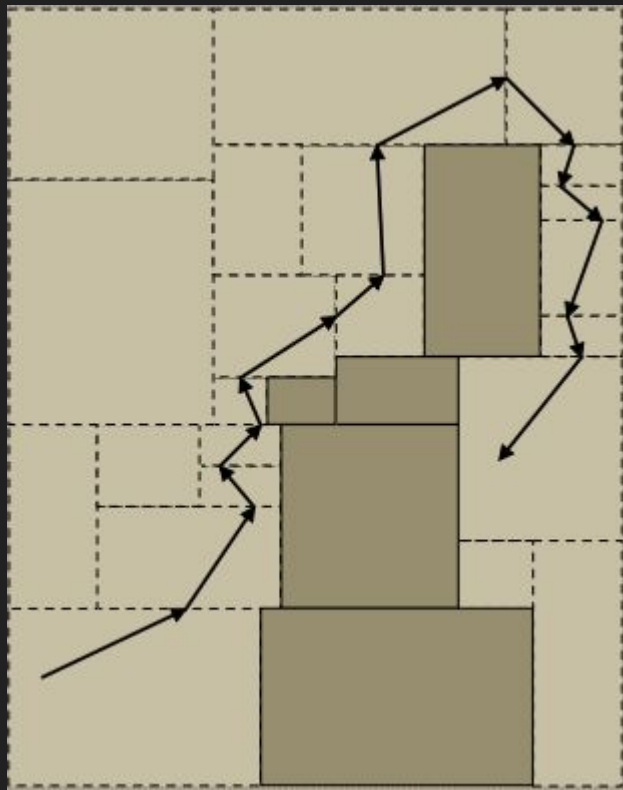
“Never get caught cheating. Nothing ruins the illusion of a good A.I. like seeing how they're cheating.” - Jonny Ebbert

Pathfinding

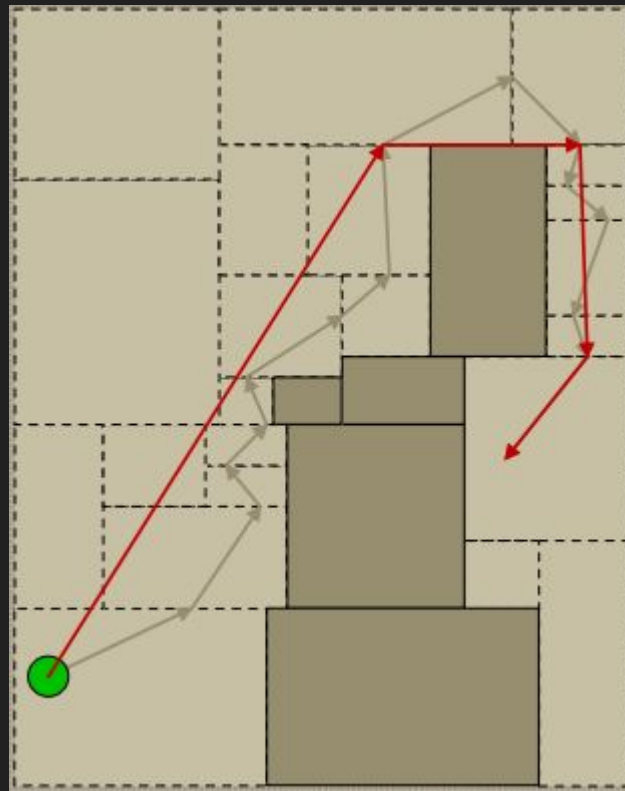
Good and Bad Pathfinding In Video Games

- Good
 - Fluid Human Like Movement
 - (Re)pathing cheap
 - Works well with other AI agents
- Bad
 - Pathing expensive
 - Repathing often
 - Robotic movement and all knowing AI

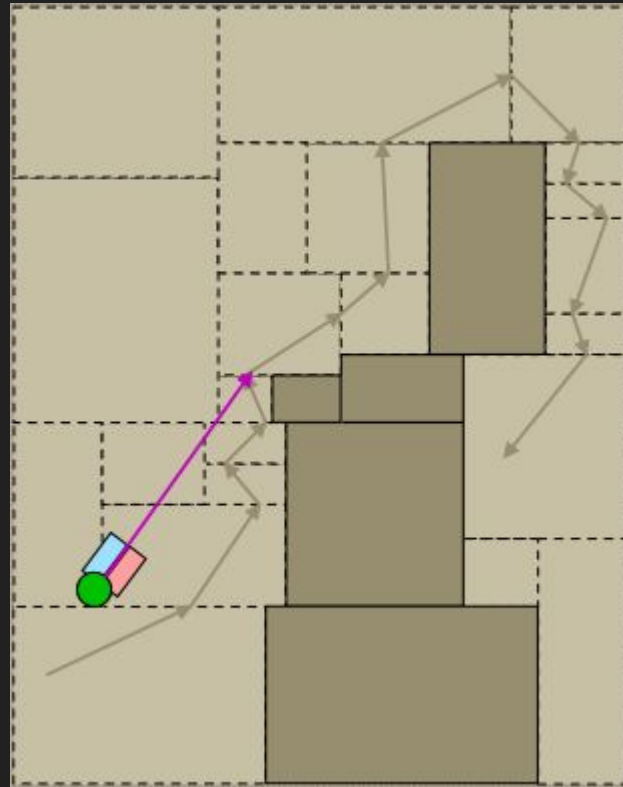
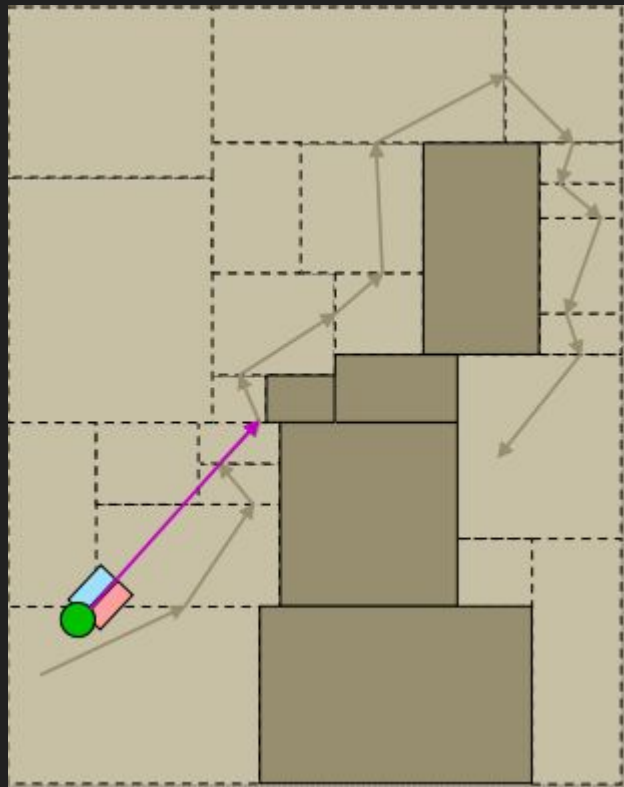
A* Through Navigation Mesh



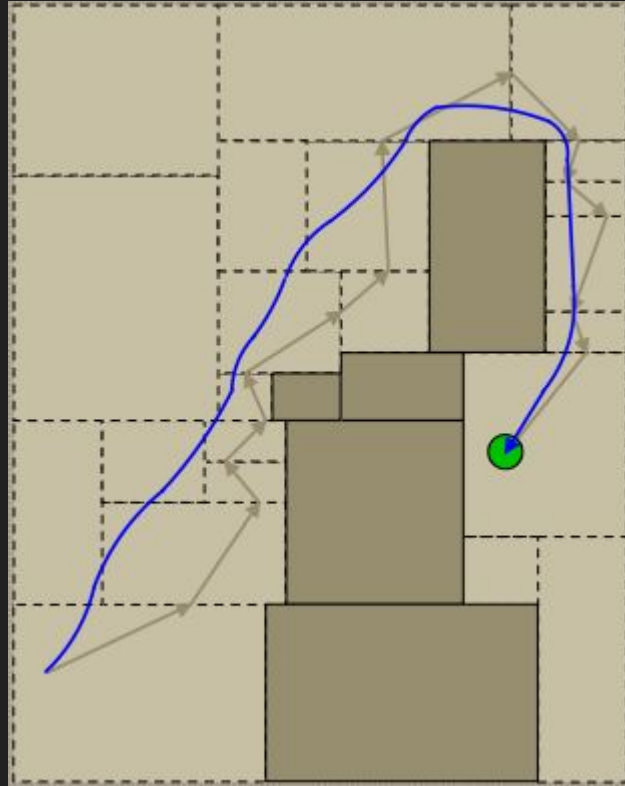
Path Optimization



Reactive Path Following



Reactive Path Following



Pathfinding Algorithms

- A*

Simple recalculations:

- D*
- DynamicSWSF
- Incremental A*
- D*-Lite

Any-angle movement:

- Field D*
- Theta*
- Incremental Phi*

Fast/Sub-optimal

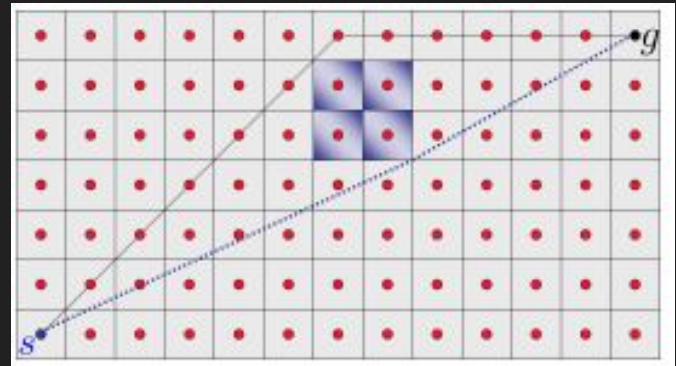
- Anytime D*
- HPA*
- HAA*

Field D*

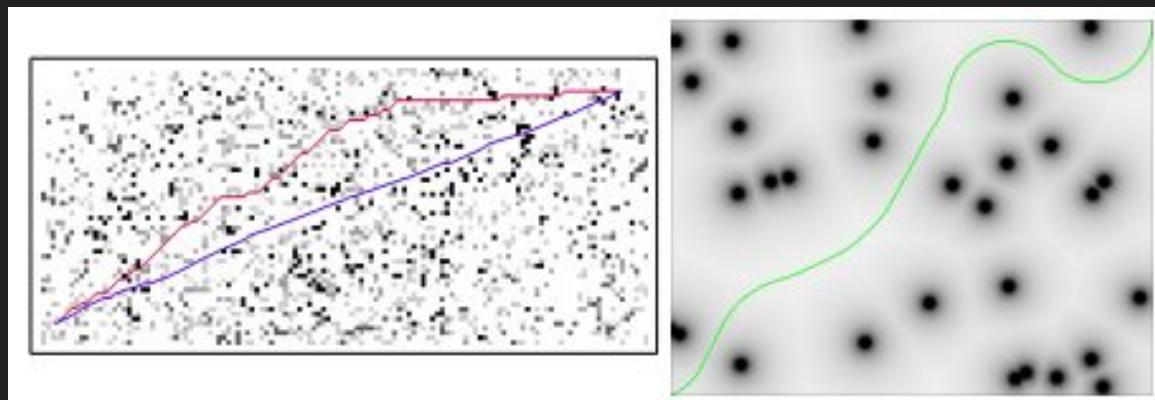
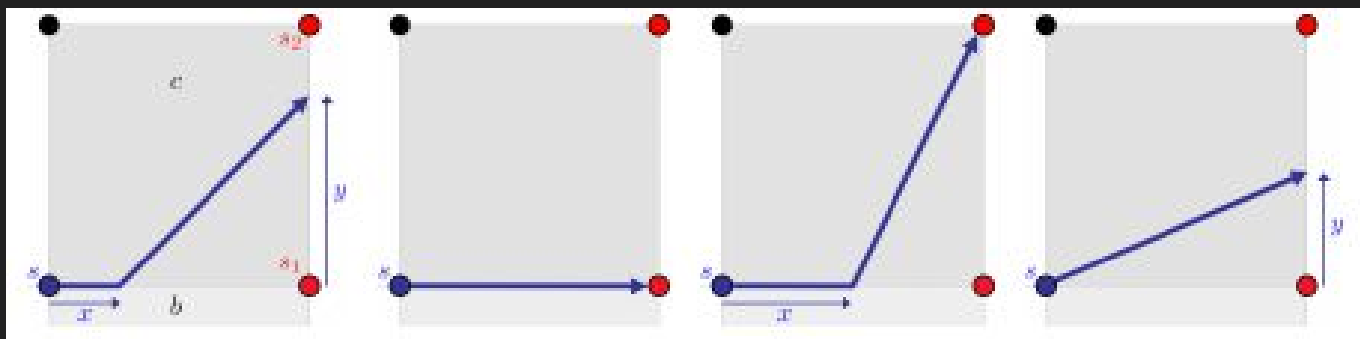
Uses path calculations similar to D*-Lite

Previous algorithm paths restricted to headings of $\pi/4$ or 45°

Uses Interpolation-based Path Planner and Replanner



Field D^*



Behavior Trees

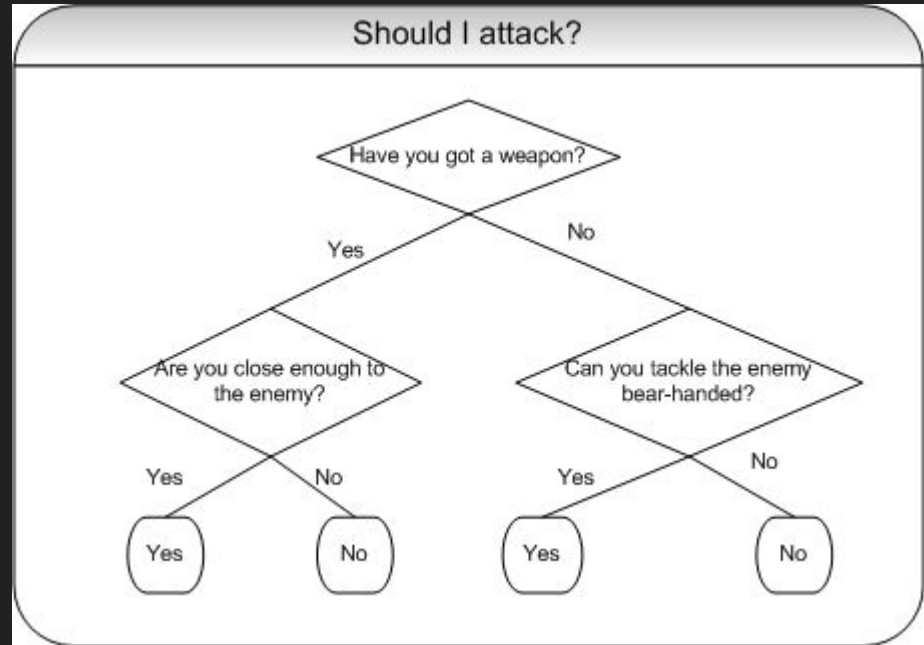
A Bit of History: Decision Trees

Pros

- Clean structure
- Easy implementation
- Decent level of behavior

Cons

- One-way, single behavior
- Complexity is hard to implement



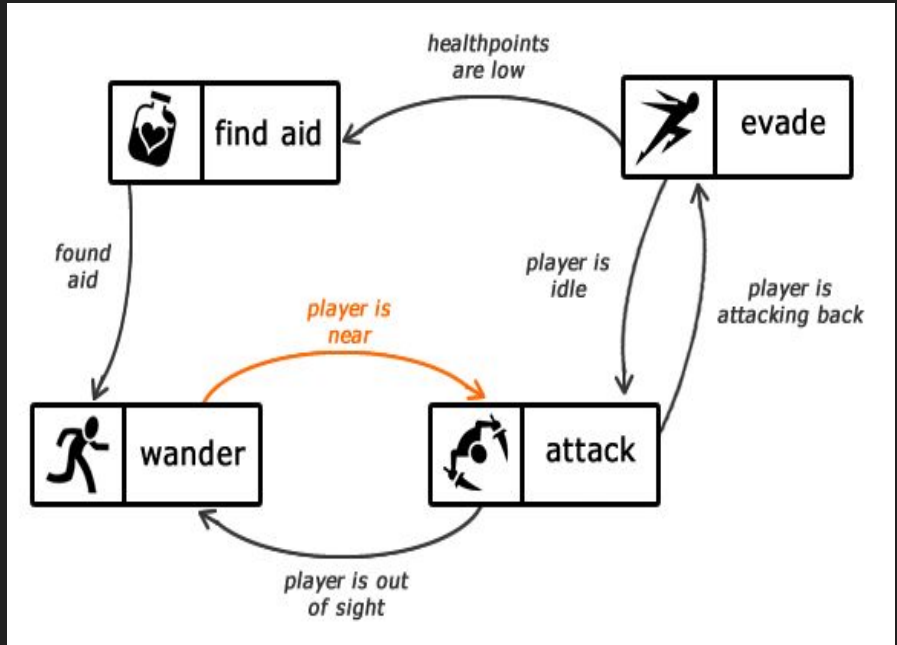
A bit of history: State Machines

Pros

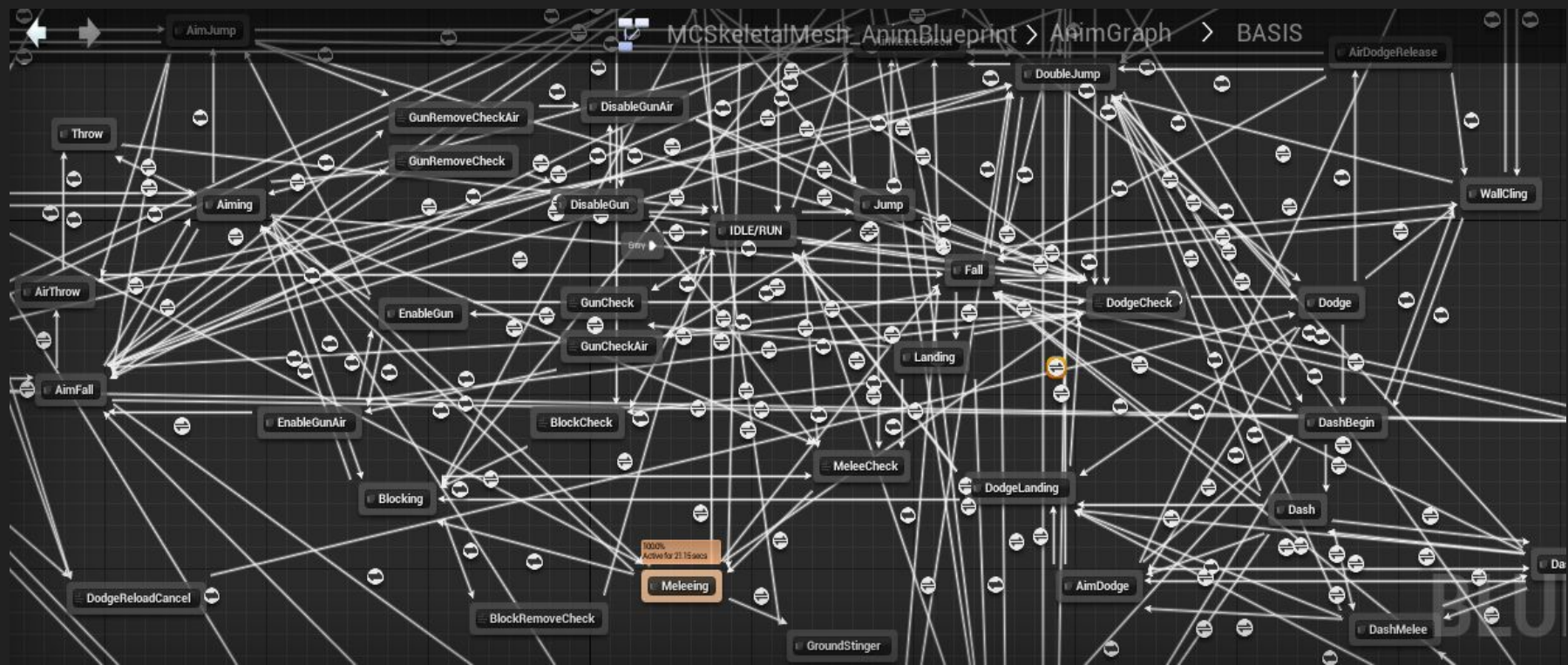
- Easy to implement
- Fast performance
- Can support complex behavior

Cons

- Transitions can be hard to manage
- Gets messy, very quickly!



When it goes wrong



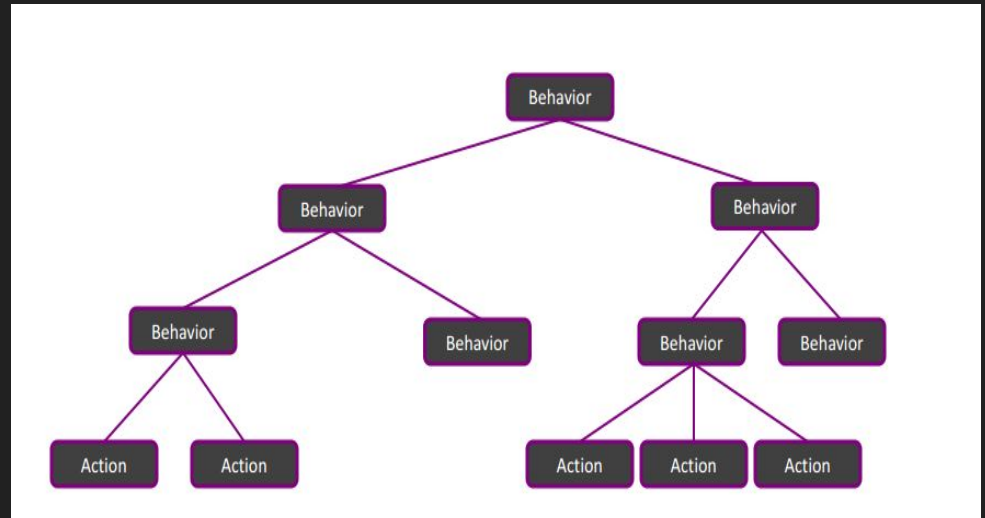
Enter, Behavior Trees

Pros

- Complex Behavior
- Clean Structure
- Non-linear traversal
- Industry Standard

Cons

- Complex implementation
- Custom Tree structure



Abstraction & Structure

Failure, Success, Halt

Tree Behavior

Selector, Sequence, etc

Node Type

Call Action/Behavior

Behavior

Abstract Classes

Base Class



What Types of Nodes Exist?

Selector

Sequence

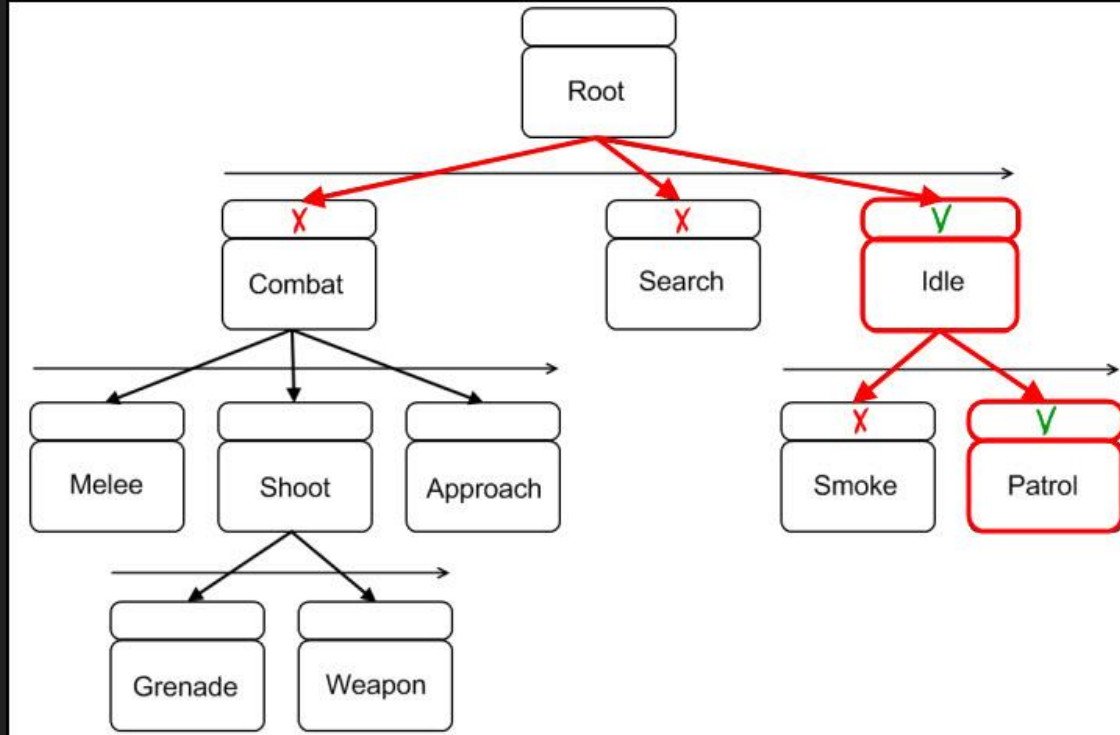
Inverter

Repeater

Leaf

Many More!

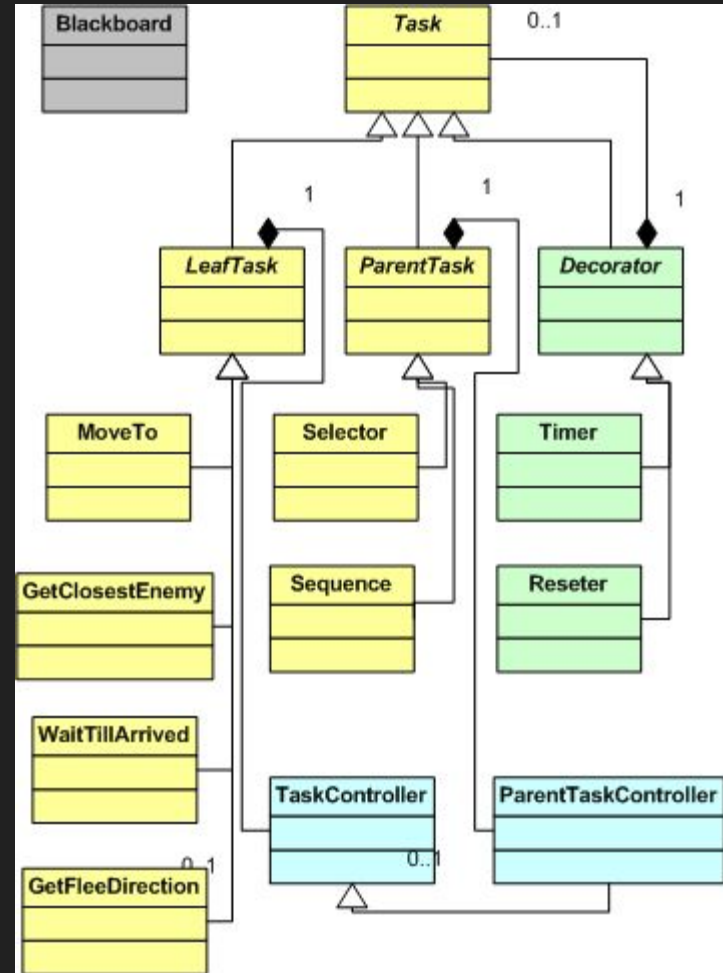
Bring It All Together



Control Room

Blackboard : Storage

- Type 1: Store References
 - Store reference to current node
 - Move to high priority behavior
 - Return to past node
- Type 2: Generate Sub-Trees
 - Create temporary Sub-Tree
 - Restart Behavior Tree



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