Jesper Edström dat12jed Emil Widell dat12ewi

Agency modeling in Hearthstone

What is hearthstone?

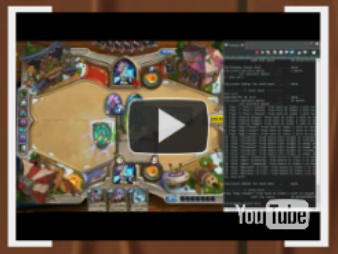
What we've done

Thank you!

AI discussion

Questions!

Demo video



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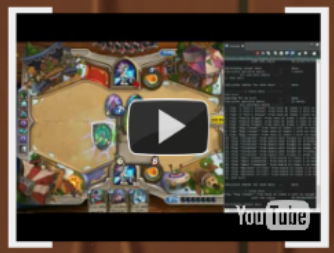

What is hearthstone?

TI


0/3
Weapon
2
8
29
2
Opponent
History
2
2
2
2
Enemy Minions
END TURN
Your Minion
3
2
Your Deck
Hero Power
Player
2
26
Mana
Your Hand
1/3
4
5
3
2
4
Fireball
River Crocol
Oasis Snapjaw

What is hearthstone?

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Actuator
How do we perform moves inside the game?
We made a robot-class that can perform "moves" in the game-client.
Perception
How do we know what happens in the game?
Hearthstone has no API to fetch data from.
But we found out that we could turn on logging in the client!
The log outputs a lot of data so we needed to establish what data we needed to build our state.
Intelligence
How do we play the game well?
Our approach is to make informed evaluation of BoardStates with an advanced Heuristic function.
Example
Agent
Summary
Time for decision?
Yes
No
Calculate all states
Evaluate all states
Perform chosen move
Standard Agent Design

Actuator

How do we perform moves inside the game?

We made a robot-class that can perform "moves" in the game-client.

There are 19 possible moves, some examples of moves are:

```
playMinionFromHandToIndex
(int indexInHand, int indexOnBoard)

attackAction
(int friendlyIndex, int enemyIndex)

endTurn()
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It also interpolates the cursor between points instead of teleporting it.

It makes the mouse-movement look more human-like.

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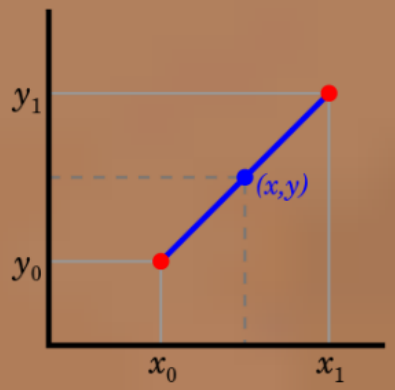

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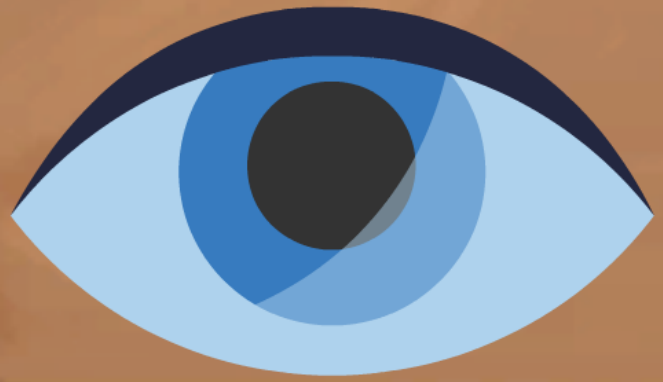

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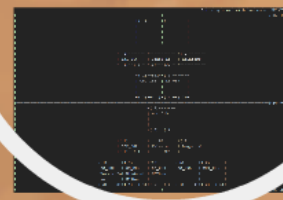

Example

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Therefor the heroHealth weight returns a greater value, making the parameter more impactful.

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```
(Filename: C:/buildslave/unity/build/artifacts/generated/common/runtime/UnityEngineDebugBindings.gen.cpp Line: 65)

[Power] GameState.DebugPrintPower() - TAG_CHANGE Entity=AlphaStone tag=MULLIGAN_STATE value=DEALING

(Filename: C:/buildslave/unity/build/artifacts/generated/common/runtime/UnityEngineDebugBindings.gen.cpp Line: 65)

[Power] GameState.DebugPrintPower() - BLOCK_START BlockType=TRIGGER Entity=AlphaStone EffectCardId= EffectIndex=6 Target=0

(Filename: C:/buildslave/unity/bu                s/generated/common/runtime/UnityEngineDebugBindings.gen.cpp Line

[Power] GameState.DebugPrintPower                -     SHOW_ENTITY - Updating Entity=[id=                    layer=1] CardID=CS2_024

(Filename: C:/buildslave/unity/bu                d/artifacts/generated/common/runtime/Unit

[Power] GameState.DebugPrintPower                -         tag=COST value=2

(Filename: C:/buildslave/unity/bu                d/artifacts/generated/common/runtime/Unity

[Power] GameState.DebugPrintPower                -         tag=ZONE value=HAND

(Filename: C:/buildslave/unity/bu                d/artifacts/generated/common/runtime/Unity

[Power] GameState.DebugPrintPower                -         tag=FACTION value=NEUTRAL

(Filename: C:/buildslave/unity/bu                d/artifacts/generated/common/runtime/Unity

[Power] GameState.DebugPrintPower                -         tag=CARDTYPE value=SPELL

(Filename: C:/buildslave/unity/bu                d/artifacts/generated/common/runtime/Unity

[Power] GameState.DebugPrintPower                -         tag=RARITY value=COMMON

(Filename: C:/buildslave/unity/bu                d/artifacts/generated/common/runtime/Unity

[Power] GameState.DebugPrintPower                -         tag=FREEZE value=1

(Filename: C:/buildslave/unity/bu                s/generated/common/runtime/UnityEngineDebugBindings.gen.cpp Line

[Power] GameState.DebugPrintPower() -     TAG_CHANGE Entity=[id=32 cardId= type=INVALID zone=DECK zonePos=0 player=1] tag=ZONE_POSITION value=3

(Filename: C:/buildslave/unity/build/artifacts/generated/common/runtime/UnityEngineDebugBindings.gen.cpp Line: 65)

[Power] GameState.DebugPrintPower() -     HIDE_ENTITY - Entity=[name=Azure Drake i      zone=HAND zonePos=3 cardId=EX1_284 player=1] tag=ZONE value=DECK
```

Event

```
s/generated/common/runtime/UnityEngineDebugBindings.gen.cpp Line

-     SHOW_ENTITY - Updating Entity=[id=2                                    os=0

d/artifacts/generated/common/runtime/Unit

-         tag=COST value=2

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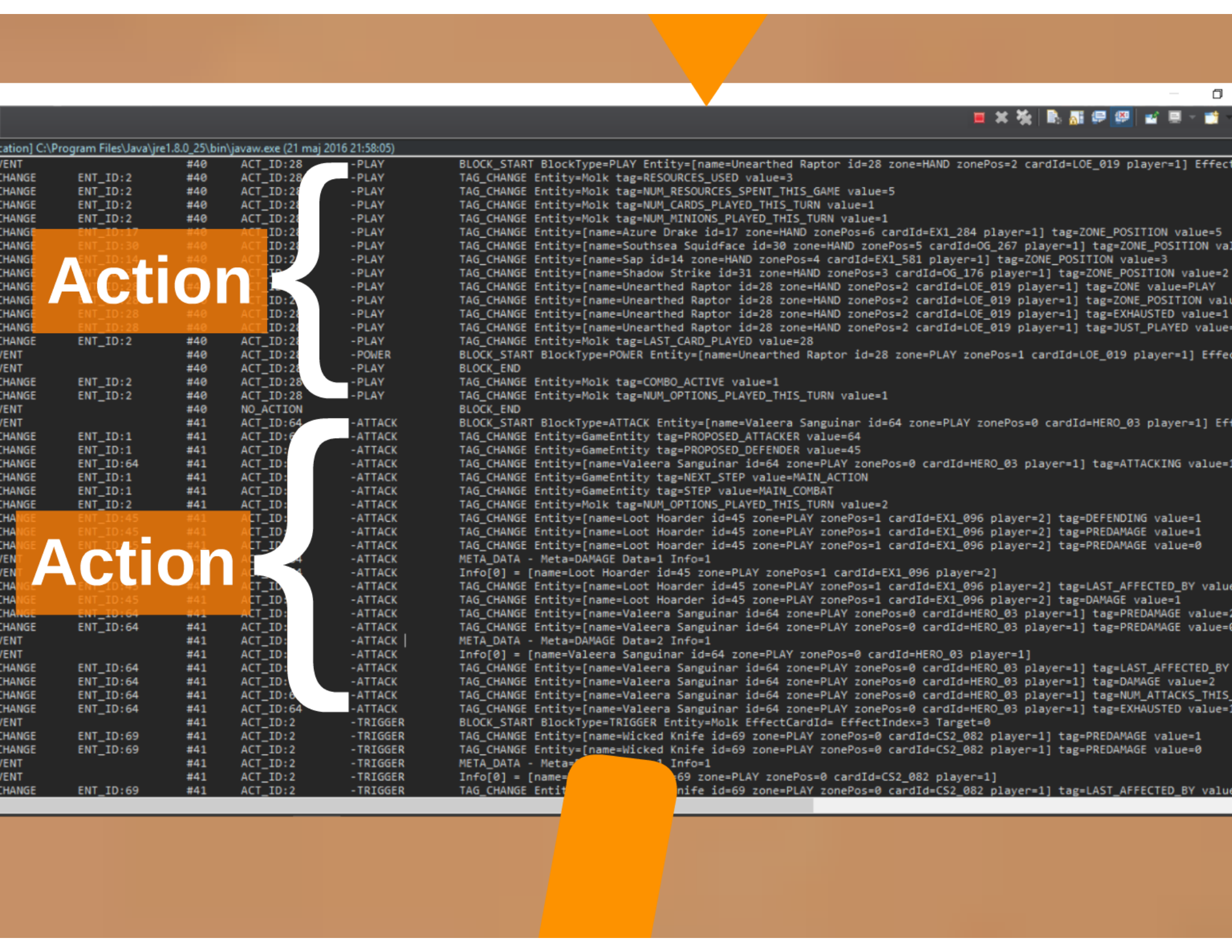

Action
Action

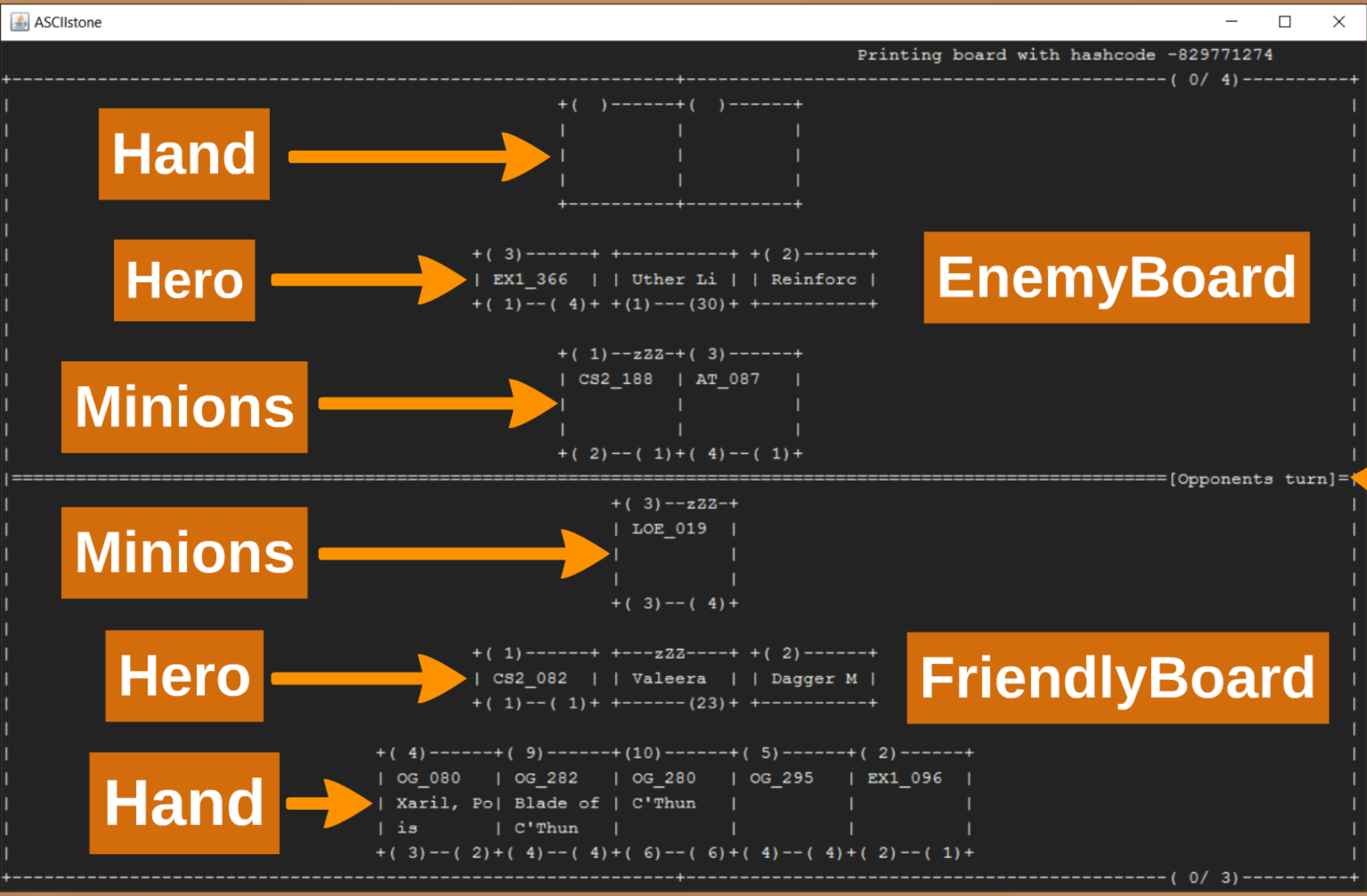
We learned that all things
in the game are treated as **entities**.

An **entity** is built up by unique tags that are set to values. We chose to represent an **entity** with a:

```
HashMap<String, String> tags
```

A **boardstate** is built up by 70 **entities** from the start but as the game progresses more are added. We chose to represent a **boardstate** with a:

```
HashMap<String, Entity> entities
```


ASCIIstone
Printing board with hashcode -829771274
(0/ 4)
Hand
Hero
Minions
EnemyBoard
[Opponents turn]
Minions
Hero
FriendlyBoard
Hand
(0/ 3)

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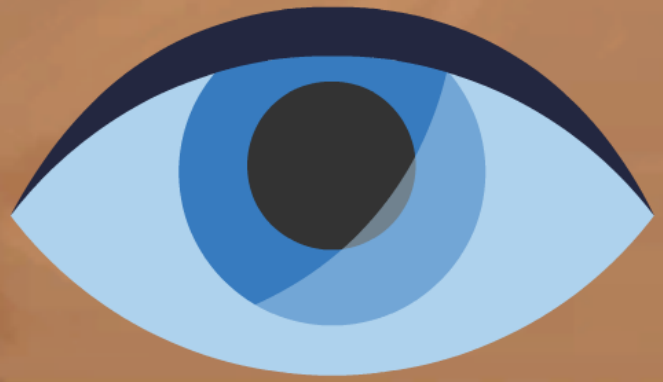

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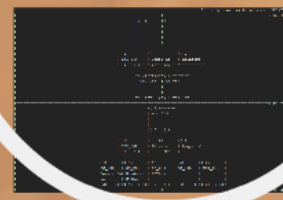

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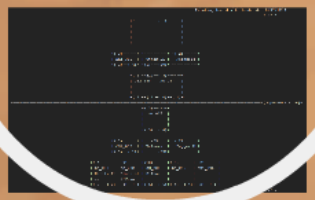

When we are to make a decision we first simulate all states (within this turn) and put into an array.

Then we evaluate all the states and pick the move that has the best outcome.

The evaluation function extracts many different parameters from the state and multiplies them with a dynamic weight.

The weights change value depending on which turn it is, how much health our hero has got left etc.

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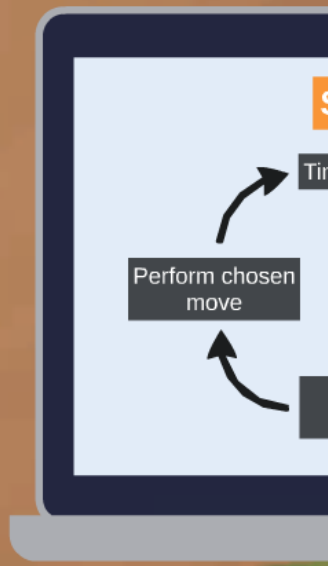

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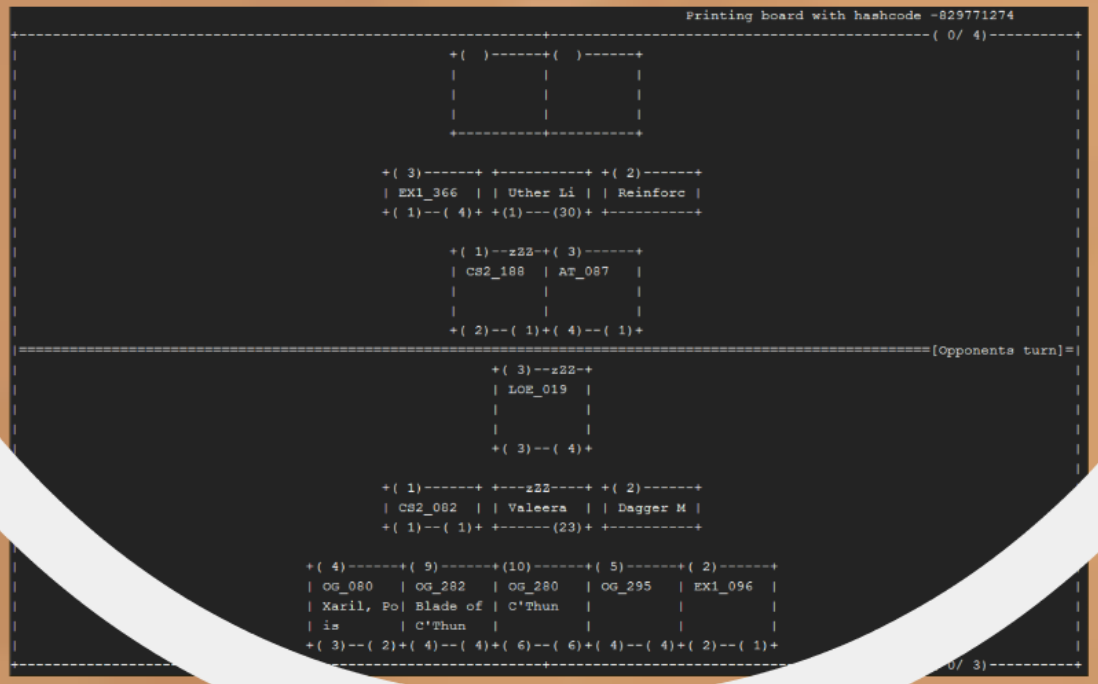

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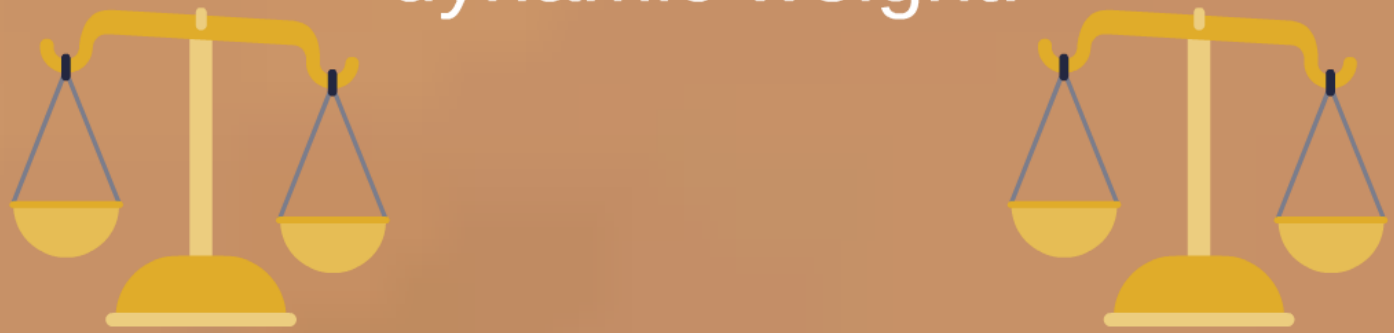

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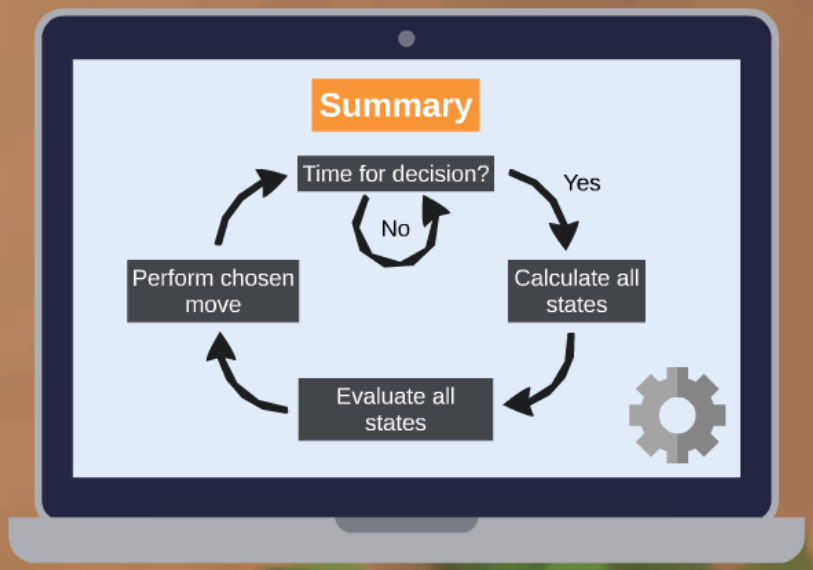
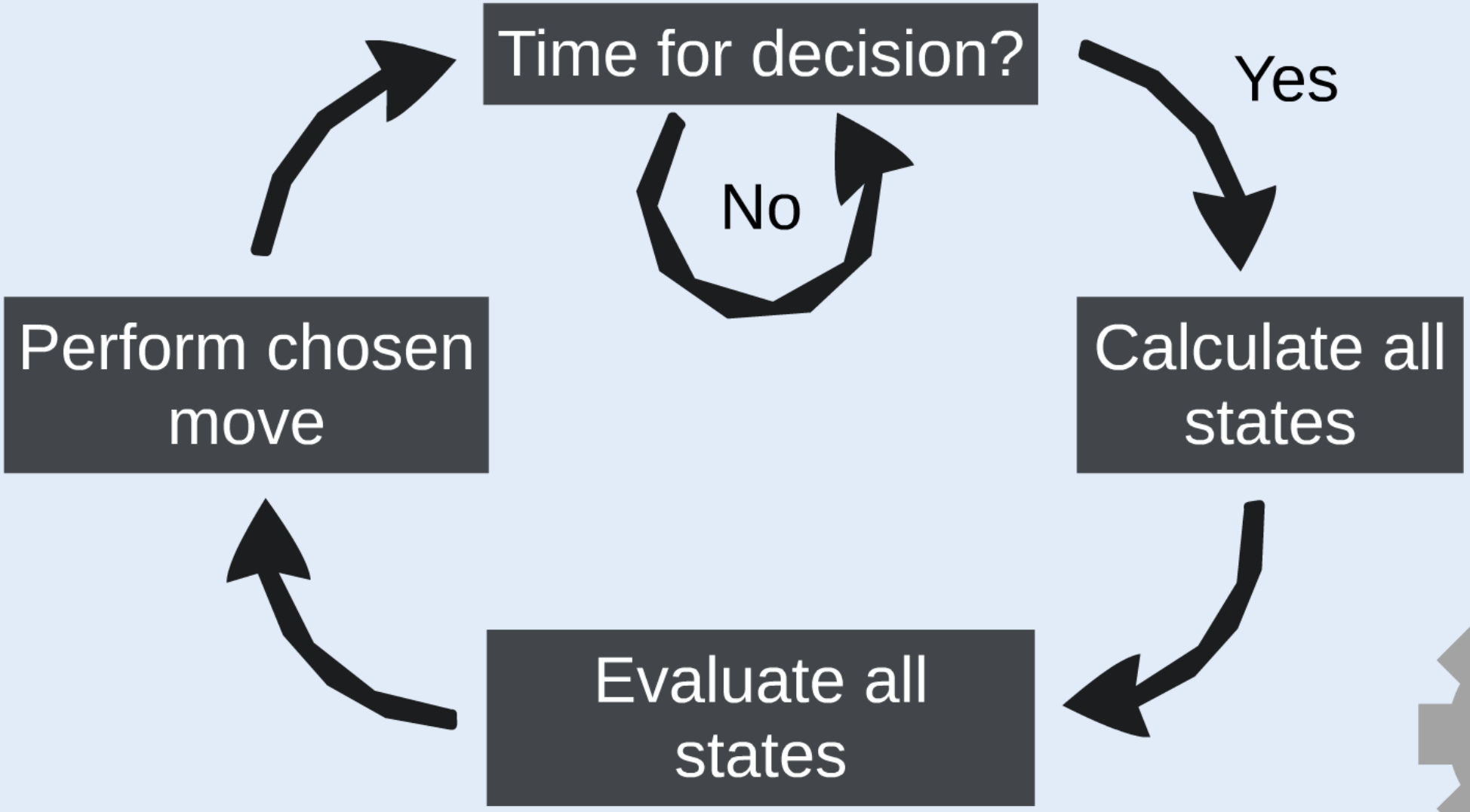


Summary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Yes
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Calculate all states
Evaluate all states
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What we've done

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AI discussion

Why not use a planning algorithm

There are over 2000 cards in the game, how could we reason about what the opponent might do?

...Even if we could reason effectively, we would not have time to implement all the cards

Why not a machine learning algorithm

A game commonly take between 5-15 minutes

It would take too long for us to play enough games

Our approach

There are a lot of knowledge about good tactics and what to strive for in Hearthstone

A heuristic function was a way to implement some of that knowledge into the AI

A future approach

If we were to continue our work

We would try to use machine learning to tune the weights and improve the heuristic function

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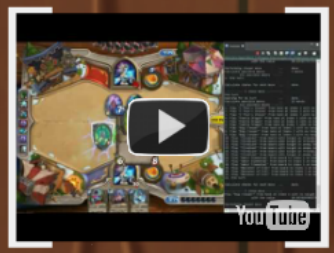

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