

# Conception of an AI for the game Stratego

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# Outline

## 1 Stratego

# Outline

① Stratego

② State-of-the-art

# Outline

① Stratego

② State-of-the-art

③ Techniques

# Outline

① Stratego

② State-of-the-art

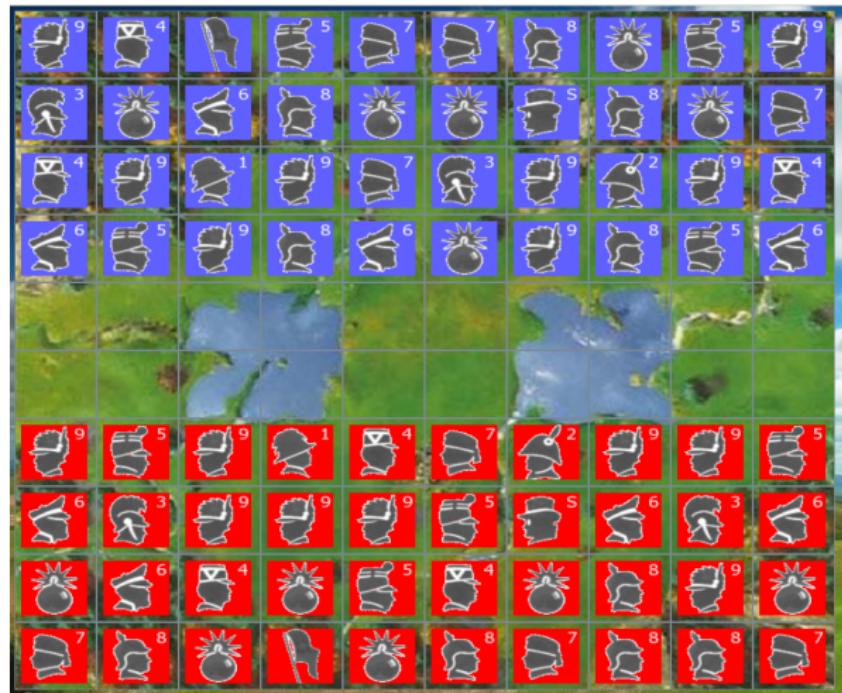
③ Techniques

④ Results

# The game

- Board of size  $10 \times 10$
- 40 pieces per player divided in 12 ranks
- 2 players taking turns
- Imperfect information
- Vast state space

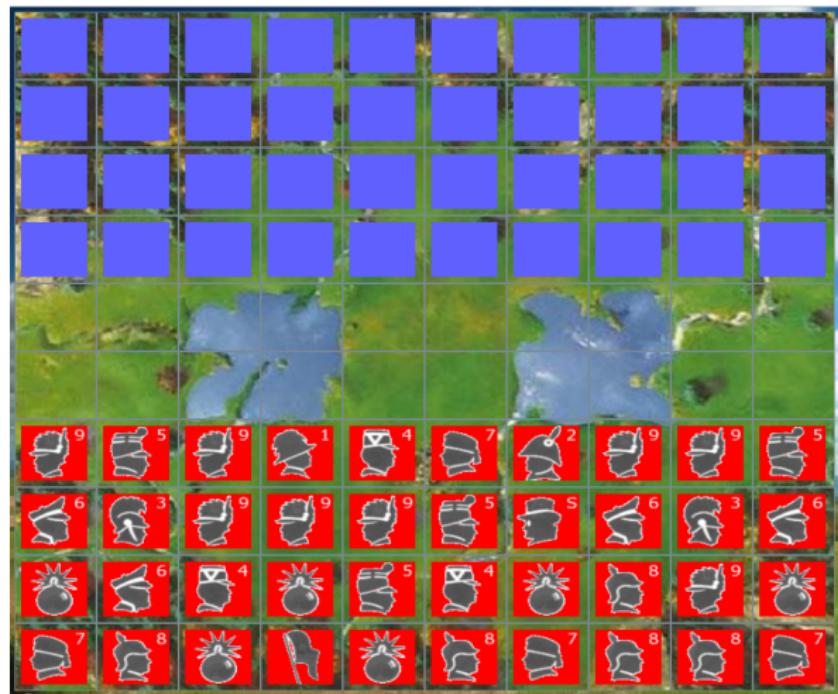
# Board and pieces



Full Board

Piece	Symbol
Flag	Flag
Bomb	Bomb
Spy	S
Scout	9
Miner	8
Sergeant	7
Lieutenant	6
Captain	5
Major	4
Colonel	3
General	2
Marshal	1

# Board and pieces



Real Board

Piece	Symbol
Flag	Flag
Bomb	Bomb
Spy	S
Scout	9
Miner	8
Sergeant	7
Lieutenant	6
Captain	5
Major	4
Colonel	3
General	2
Marshal	1

# Game flow : Setup phase



Full setup board

# Game flow : Setup phase



Real starting board

# Game flow : Attack phase



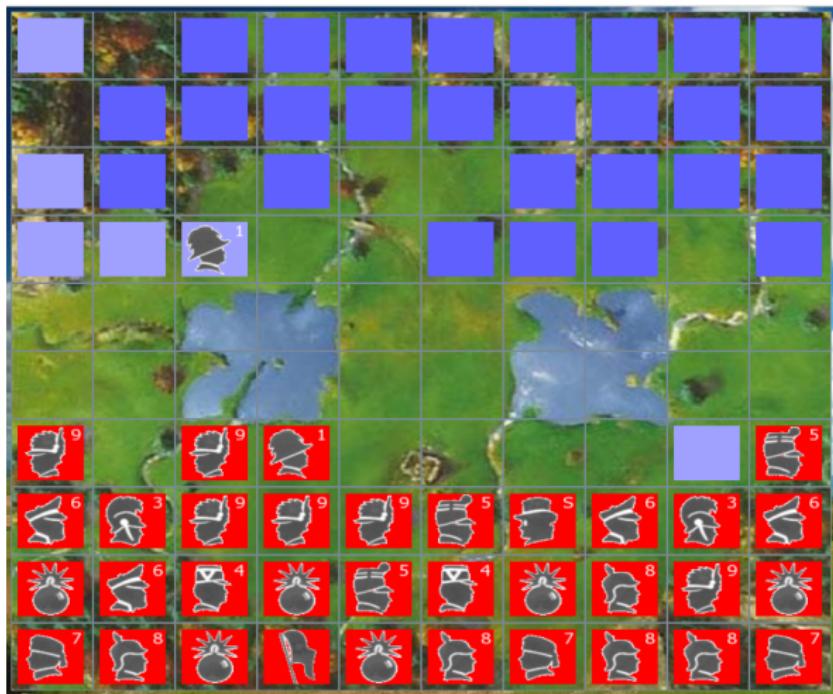
Before the attack

# Game flow : Attack phase



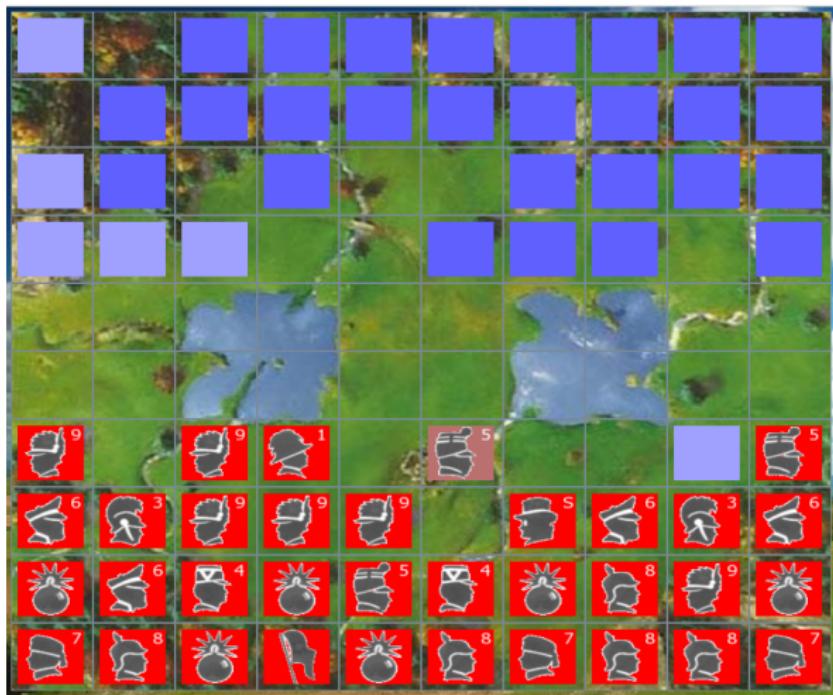
Revealing the opponent's piece

# Game flow : Attack phase



Outcome of the attack : Capture or tie

# Game flow : Attack phase



The pieces return to a hidden state

# Game flow : Objectives

- Capture opponent's flag
- The opponent has no more moves possible
- Limit of move set

# Thesis subject

What are trying to do here ?

# Thesis subject

What are trying to do here ?

→ Autonomous AI agent



# Difficulties

- Vast state space
- Imperfect information
- Lacks of links between a move and its impact
- Prediction of opponent's move
- Game length

# Outline

1 Stratego

2 State-of-the-art

3 Techniques

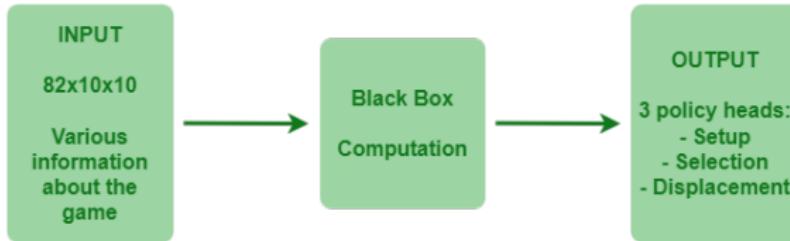
4 Results

# Big families of methods

- Big model : DeepNash
- Evaluation of moves : Asmodeus / Hunter
- Exploration of a Tree of State : Demon Of Ignorance

# Big model : DeepNash

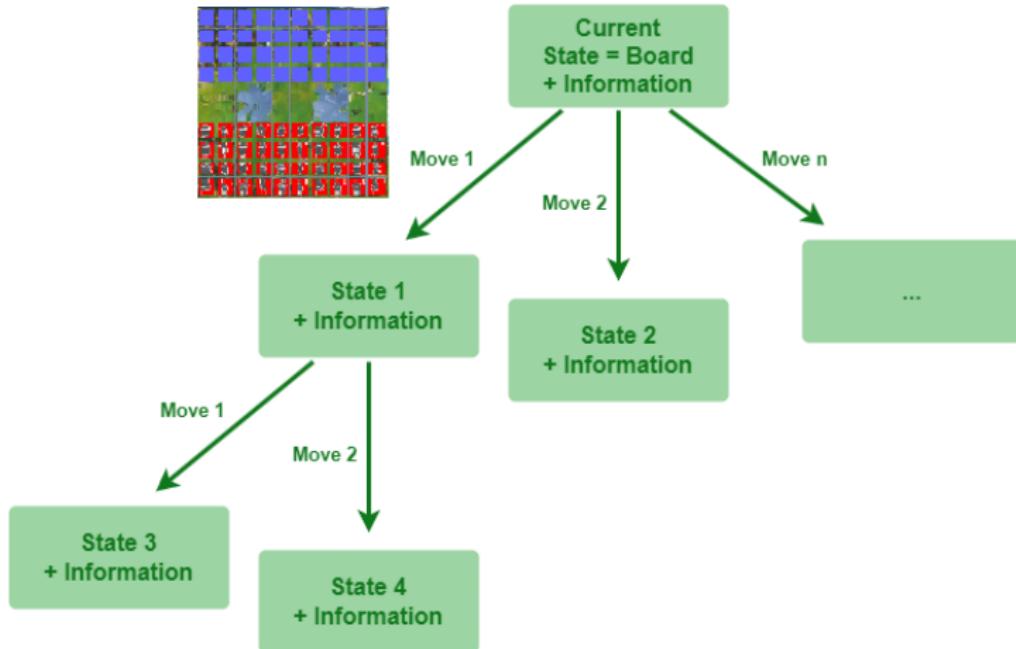
- Autonomous AI that decides plays via a black box
- Self-learned a Nash Equilibrium
- Achieved 3rd all time on Gravon and beat all other AI more than 90% of the time.



# Evaluation of moves : Asmodeus / Hunter

- Evaluate moves one by one
- Each pieces and reachable opponent pieces + their fight's outcome
- Lots of tuning to correct behavior
- Limitation : No modeling of future

# Tree Of State



# Exploration of a Tree of State : Demon Of Ignorance

- Evaluate nodes one by one by level
- Alpha-Beta with lots of optimization techniques
- Customizable difficulty : Time of thinking

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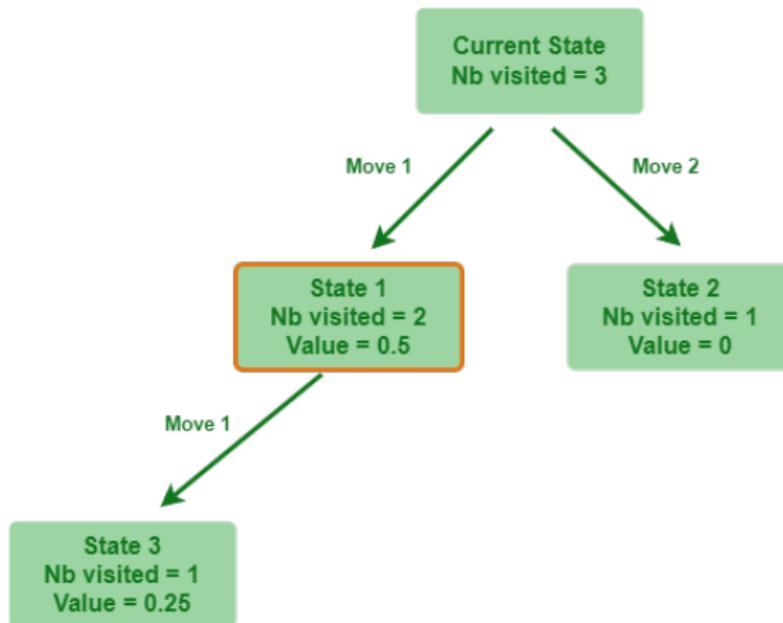
3 Techniques

4 Results

# Monte Carlo Tree Search (MCTS)

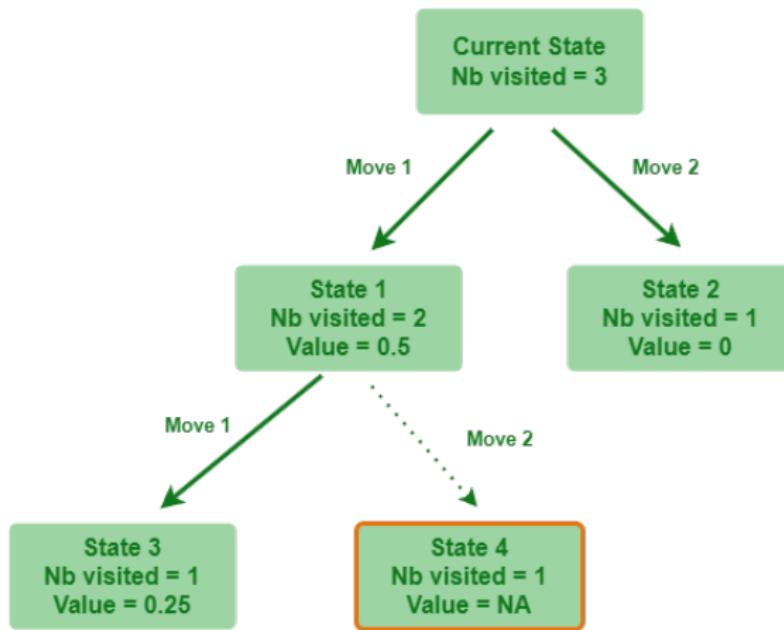
- Vanilla better exploration of the Tree Of State
- Use simulation of the game
- 4 phases repeated a certain number of time :
  - Selection : Choose the next leaf node to expand
  - Expansion : Expand one child of this node
  - Simulation : From this node, run simulation of future moves to evaluate a node
  - Backpropagation : Backpropagates results to the parents

# MCTS 4 phases



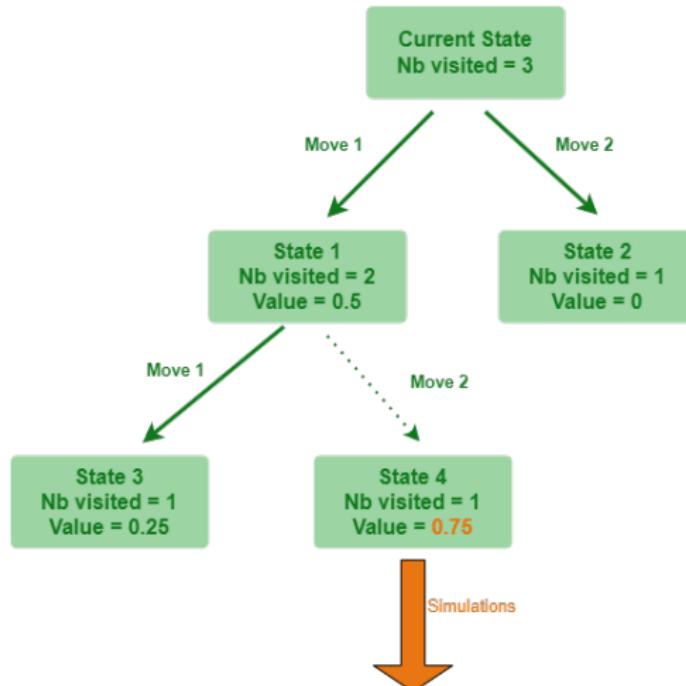
## 1. Selection of a leaf node

# MCTS 4 phases



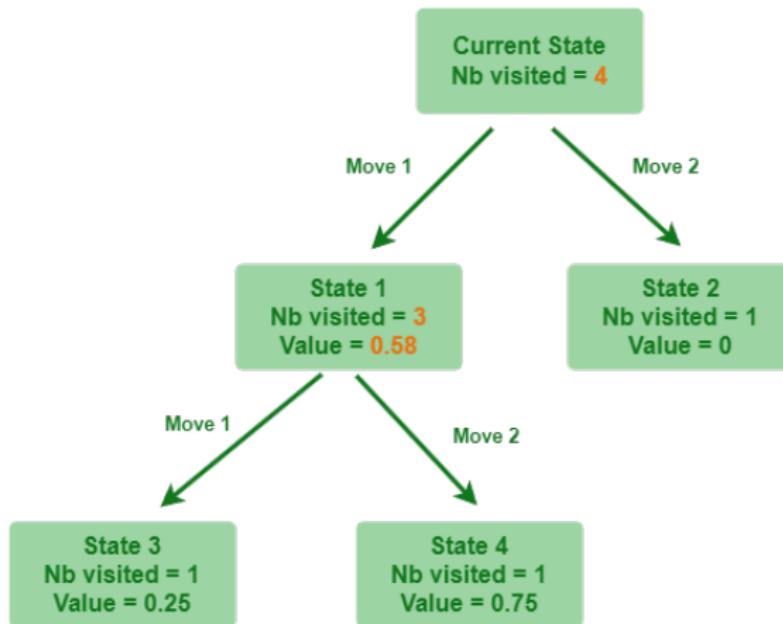
2. Expansion of one child

# MCTS 4 phases



### 3. Simulation to evaluate

# MCTS 4 phases



## 4. Backpropagation to the parents

# Summary of the techniques

## Monte-Carlo Tree Search

Starts with the current state generated and loops over A-D multiple times

**A) Selection**  
of the next node to expand

**B) Expansion**  
of the selected node

**C) Simulation:**  
Run *rollouts* simulations from this node to evaluate it.

**D)**  
**Backpropagation**  
of the result to its parents

## Evaluator

**Evaluate**

**Prior**

## Opponent modeling

### **Information:**

- Statistics
- Scout
- Moved Before
- Non-discovered pieces
- Partial state

**State generation**

# Tuning of MCTS

## Monte-Carlo Tree Search

Starts with the current state generated and loops over A-D multiple times

**A) Selection**  
of the next node to expand

**B) Expansion**  
of the selected node

**C) Simulation:**  
Run *rollouts* simulations from this node to evaluate it.

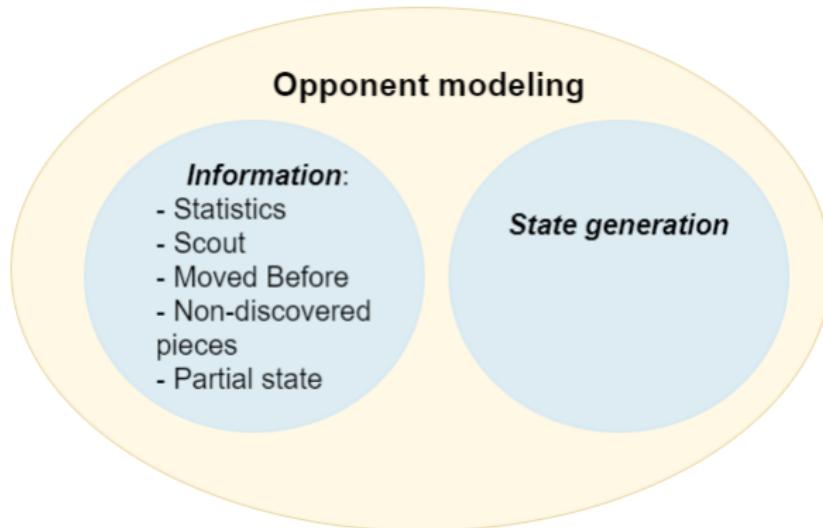
**D)**  
**Backpropagation**  
of the result to its parents

## Evaluator

Evaluate

Prior

# Opponent modeling



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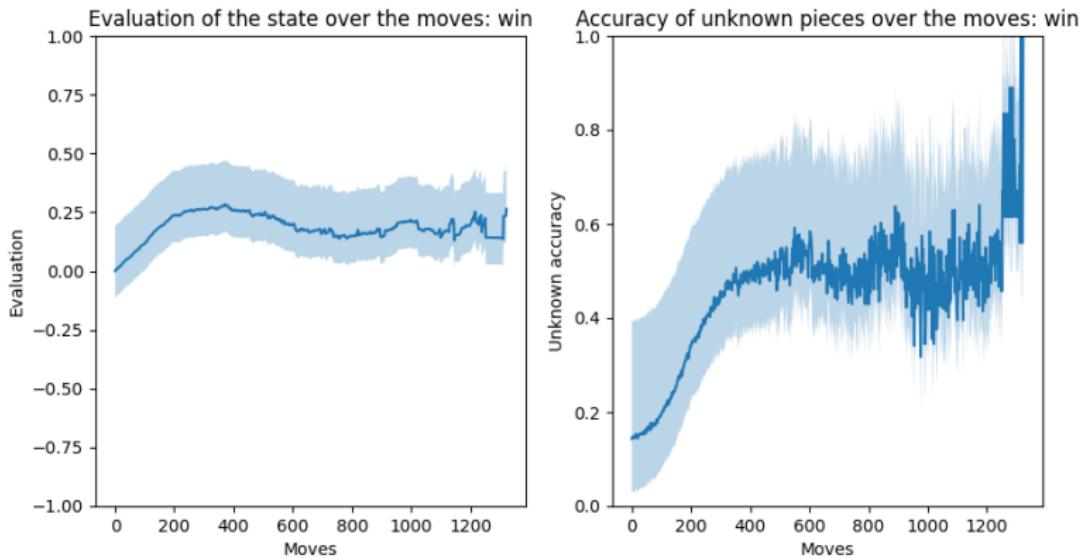
4 Results

# Winrate summary

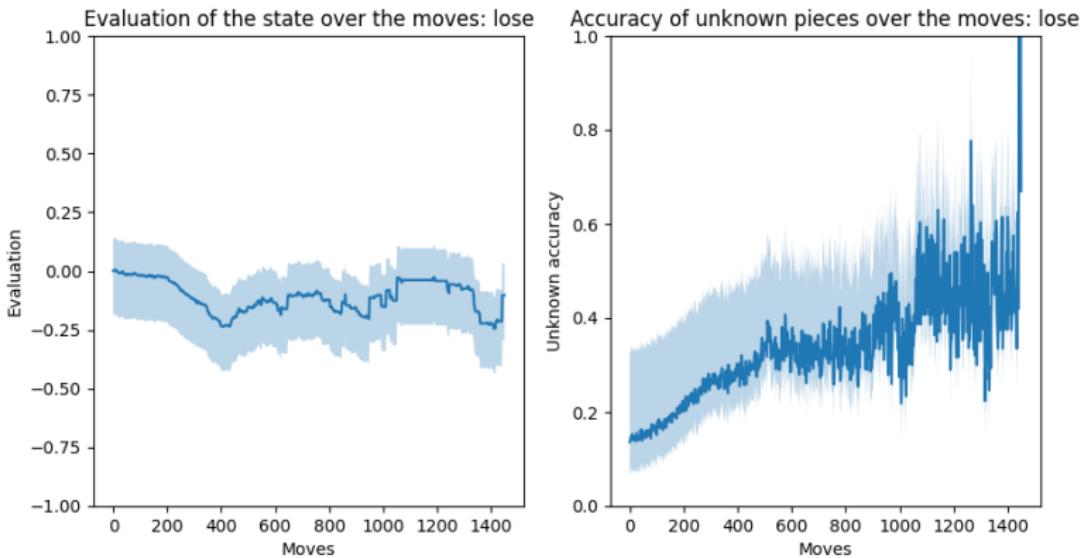
...	Custom	Asmodeus	Hunter	MCTS	Doi
Custom		66	55	82	20
Asmodeus	27		42	38	NA
Hunter	38	37		64	0
MCTS	15	56	27		NA
Doi	80	NA	60	NA	

Table – Global results of bots in percentage

# Graphs : Wins



# Graphs : Loses



# Conclusion

- We have seen the Stratego and its difficulties
- Some state-of-the-art techniques to play it
- And finally my way to conceive an AI
  - MCTS
  - Heuristics
  - Opponent modeling

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Thank you for your attention !

