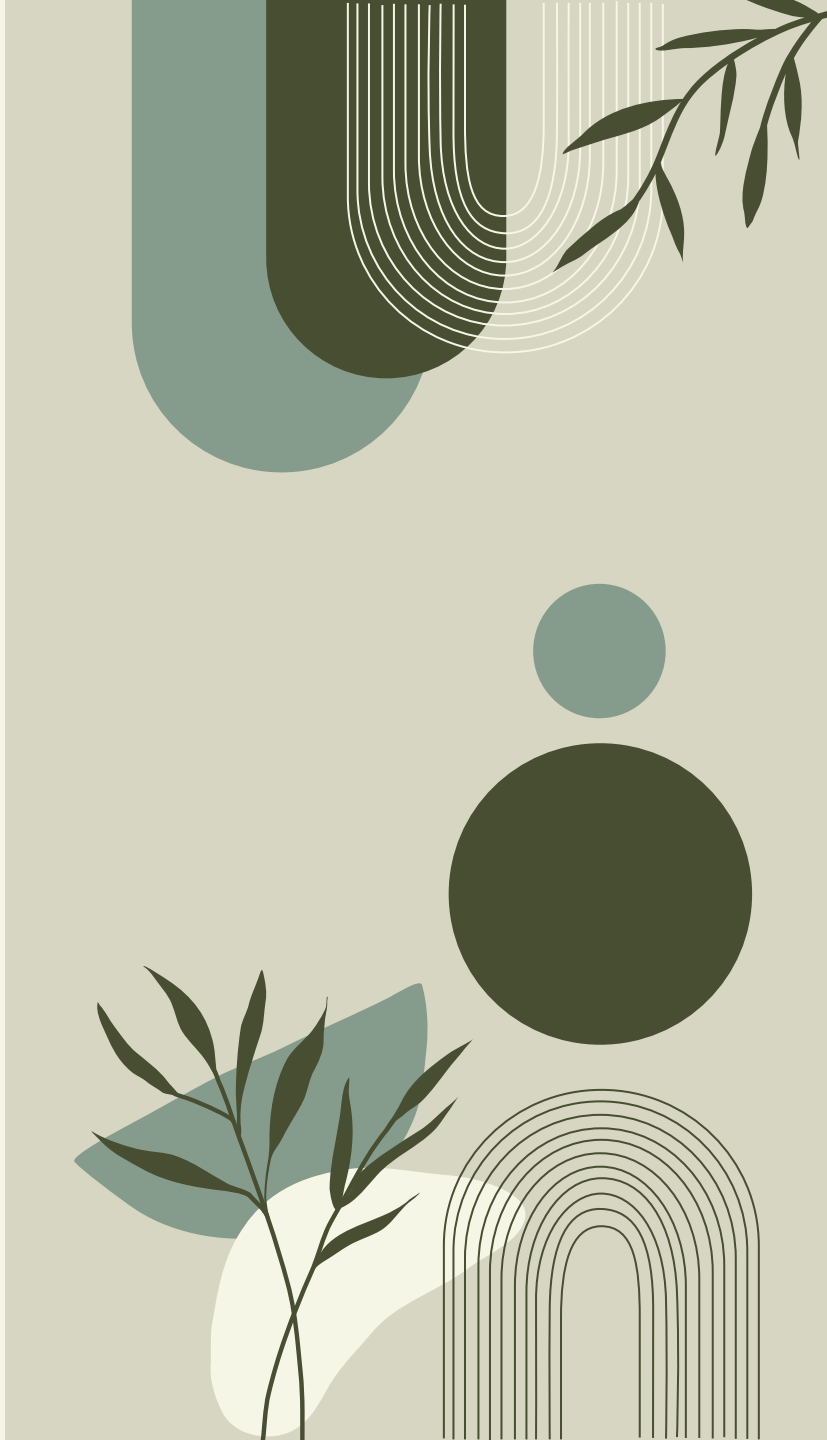
From AI ‘Go’ to Machine Learning

Yiwei Mao



What is ‘Go’ ?

- Recall the ancient memory on Feb 29th……
- Black and White play on 19*19 Go board, goal is to capture more territory than the opponent
- About 10^{170} number of possible games
- People have being trying to optimize the gameplay.

AlphaGo

- AlphaGo is a computer program that plays the board game Go.
- An success attempt to optimize Go gameplay with current human computer capacity
- Notable for being the first computer program to defeat a professional human Go player, as well as the first to defeat a world champion.

Timeline of AlphaGo

- 2014: AlphaGo research project was developed by Google DeepMind
- October 2015: AlphaGo plays against European champion Fan Hui and won by 5-0

the first time an AI had beaten a human professional player on a full-sized board without a handicap

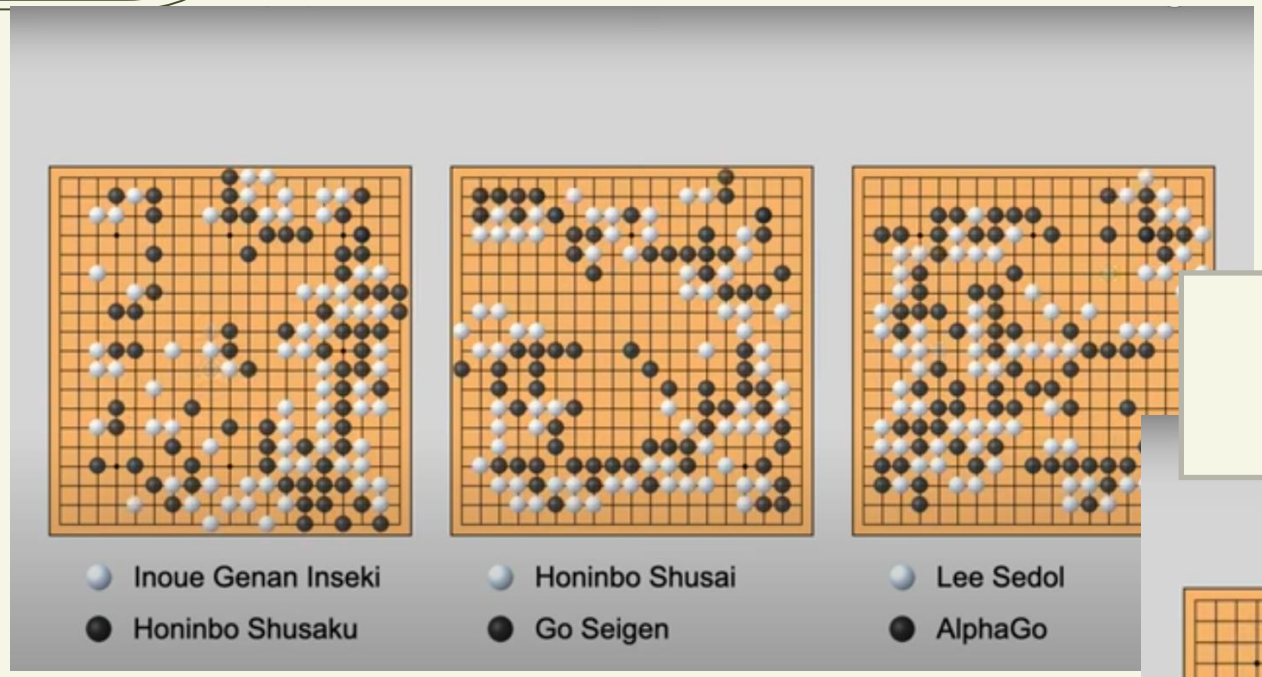
- March 2016: AlphaGo plays against the Word Champion Lee Sedol and won by 4-1
- May 2017: AlphaGo plays against current(in 2017)world No.1 ranking

How does AlphaGo Works?

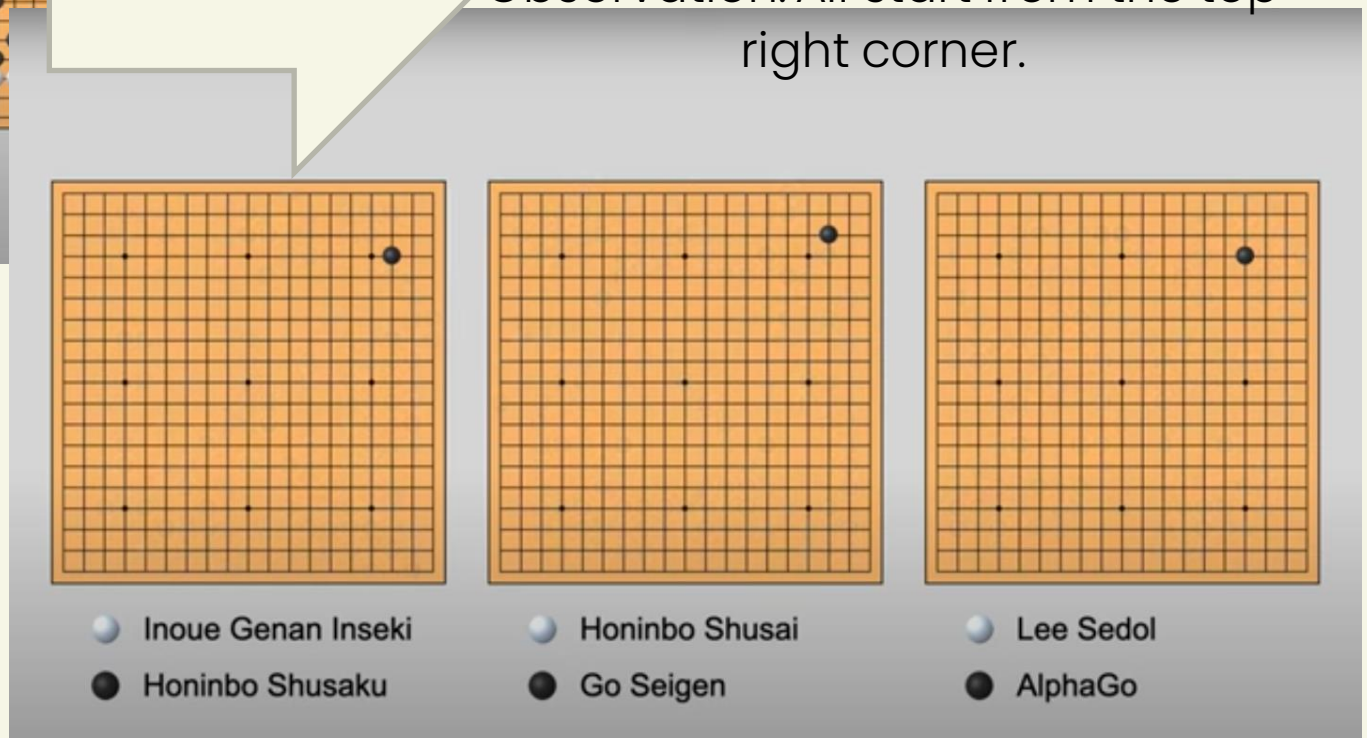
1. Learn from experts

2. Self-play and re-enforcement.

Learning from Expert

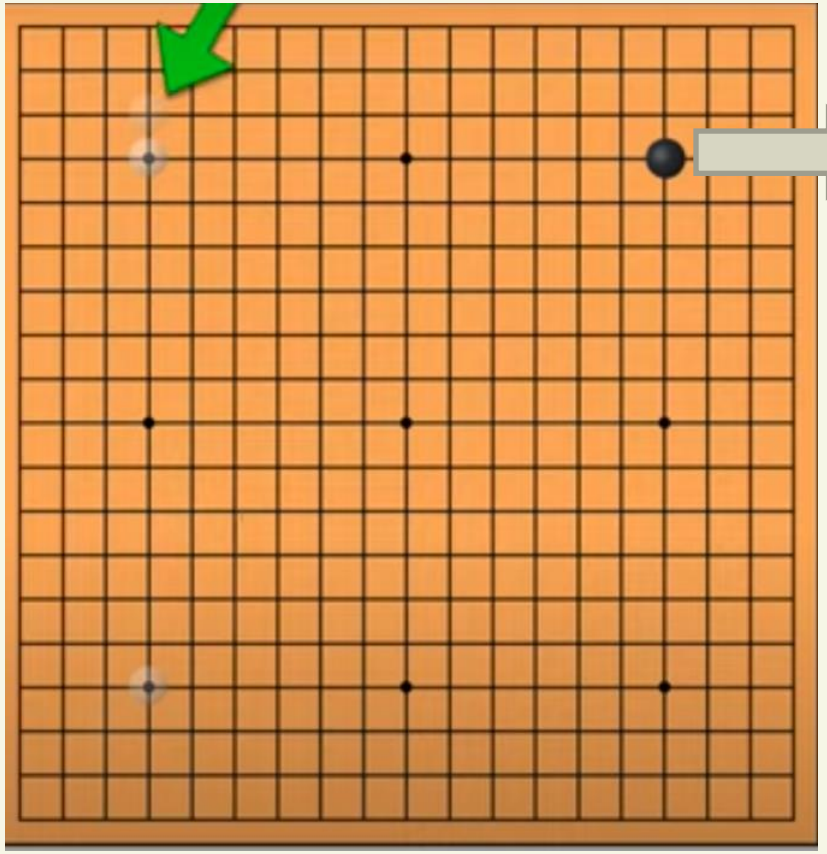


Observation: All start from the top right corner.



Learning from Expert

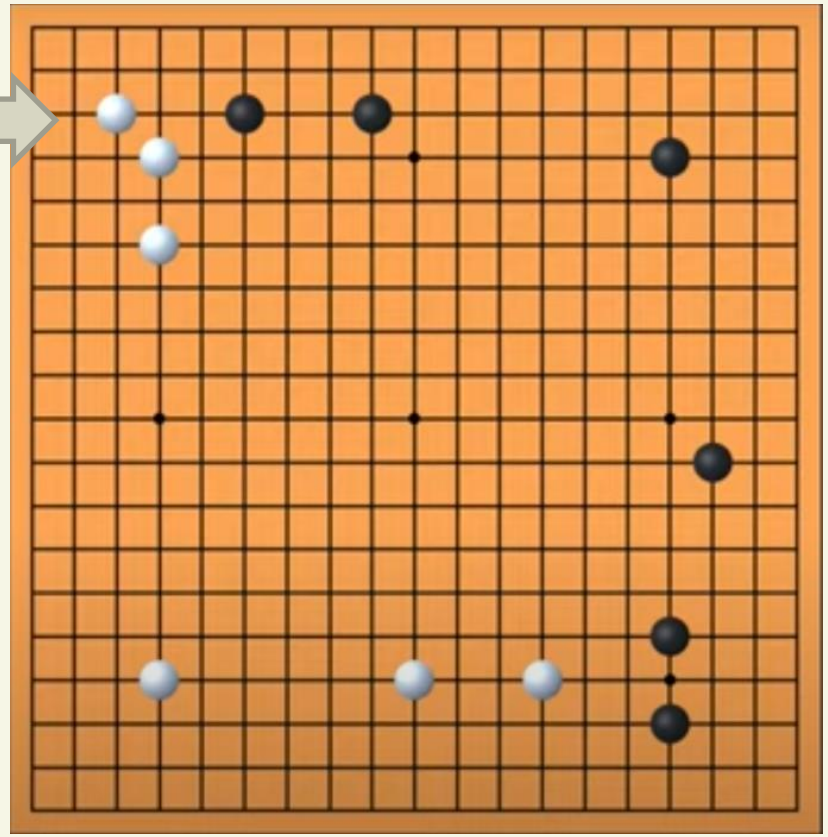
Choose the most popular move from sample



5541 games begin with this first move

What if we mimic what the majority of expert did in the same situation,
select the most popular next step and move on?

Choose the most popular move from sample

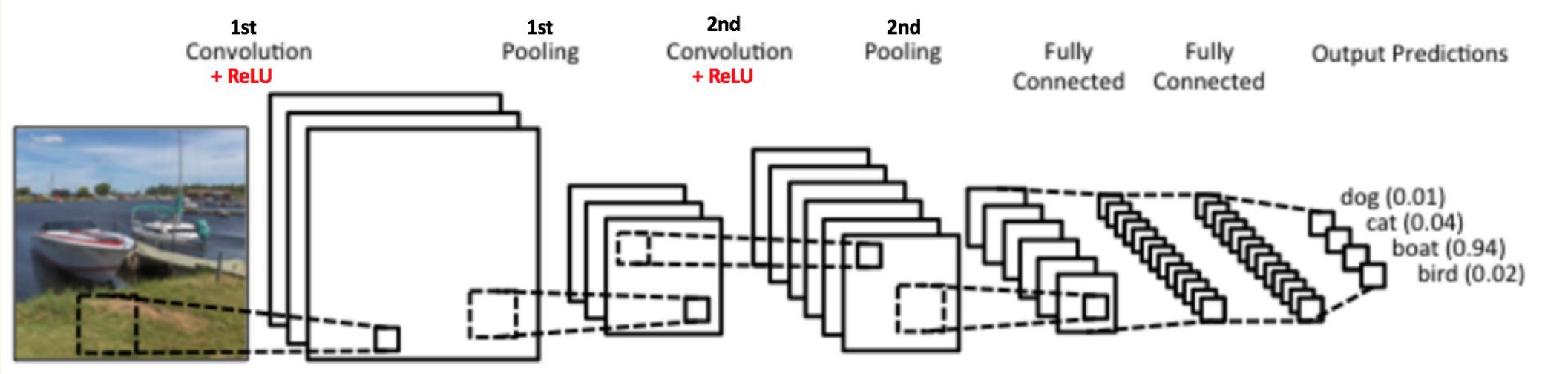


Only have **1** games from here on

Even with a 10000 scale sample, after about 13 steps, it will be down to a single matching game: The uniqueness of Go game requires more deliberate method for learning from samples.

Convolutional Neural Network (CNN)

machine learning model often use to analyzing visual data.

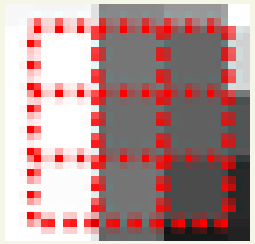


Input a image, let it go through the network, can obtain a output with classification

The network are trained through huge amount of samples

Convolutional Layer / Filter

Linear transformation and projection
Single Convolutional layer can be used in image processing

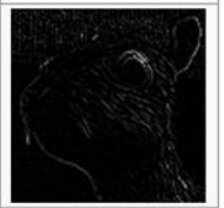


$$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$$

Represent a image as a matrix and go through transformation and projection

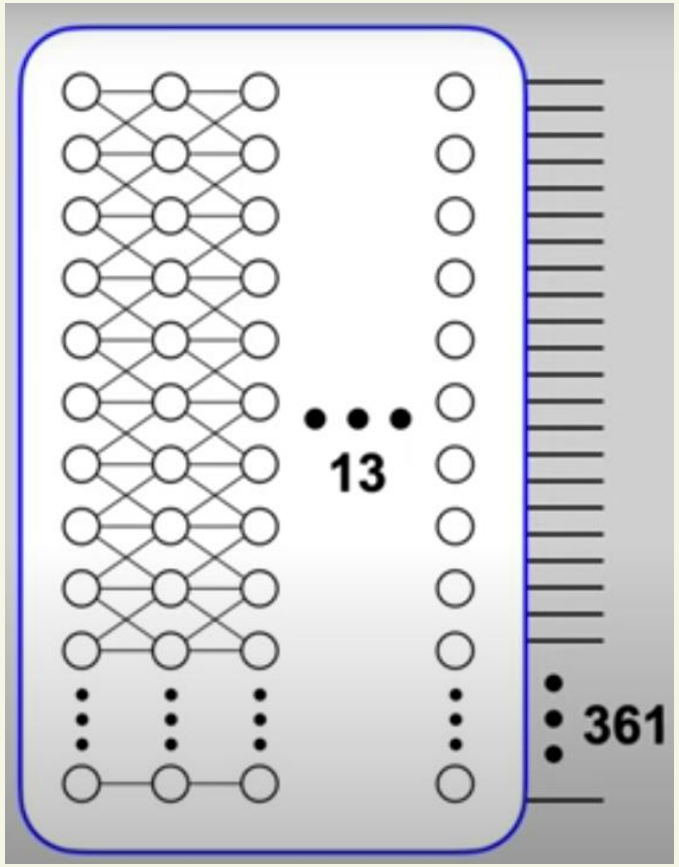
Convolutional Neural Network Filter

Filters

Operation	Filter	Convolved Image
Identity	$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{bmatrix}$	
Edge detection	$\begin{bmatrix} 1 & 0 & -1 \\ 0 & 0 & 0 \\ -1 & 0 & 1 \end{bmatrix}$	
	$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}$	
	$\begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$	
Sharpen	$\begin{bmatrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{bmatrix}$	
Box blur (normalized)	$\frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$	
Gaussian blur (approximation)	$\frac{1}{16}\begin{bmatrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{bmatrix}$	

Sample Learning in AlphaGo

- Sample: For each state *s*, a human makes a move *a*. This is a natural training sample ⟨*s*,*a*⟩, which results in 30 million training samples from about 20000 professional games.
- Input: *s* is input as a 19x19 two-dimensional image
- We use the sample to train a Convolutional Neural Network (CNN).
- The objective is to predict the next human moves '*a*' by using a large amount of data, gradually improving the computer's ability to mimic the next human move.



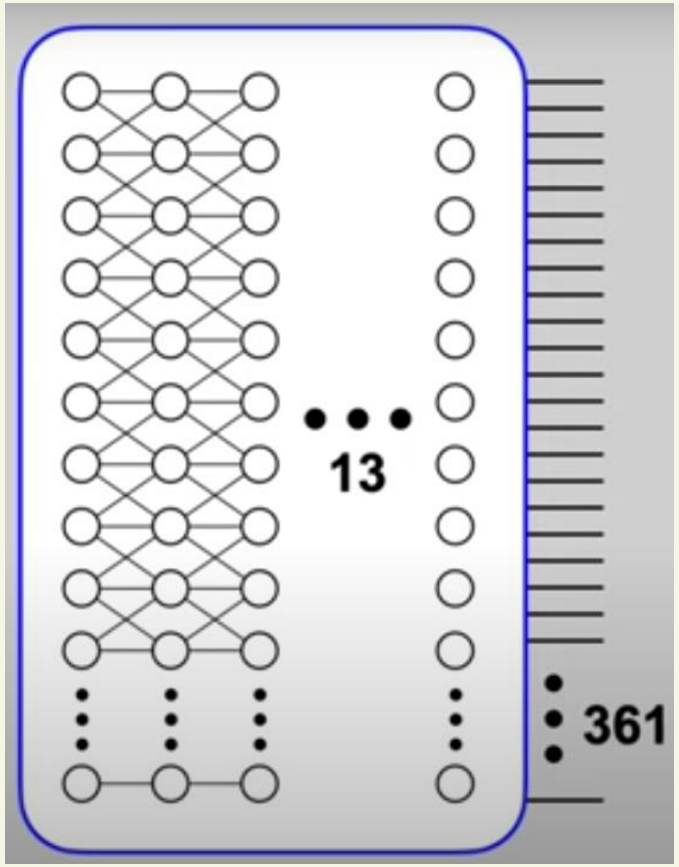
Convolutional Neural Network

Convolutional Neural Network (CNN)

Input state: two-dimensional image

Trained Network

Output the prediction:
Move(points) closest to human
with relative probability

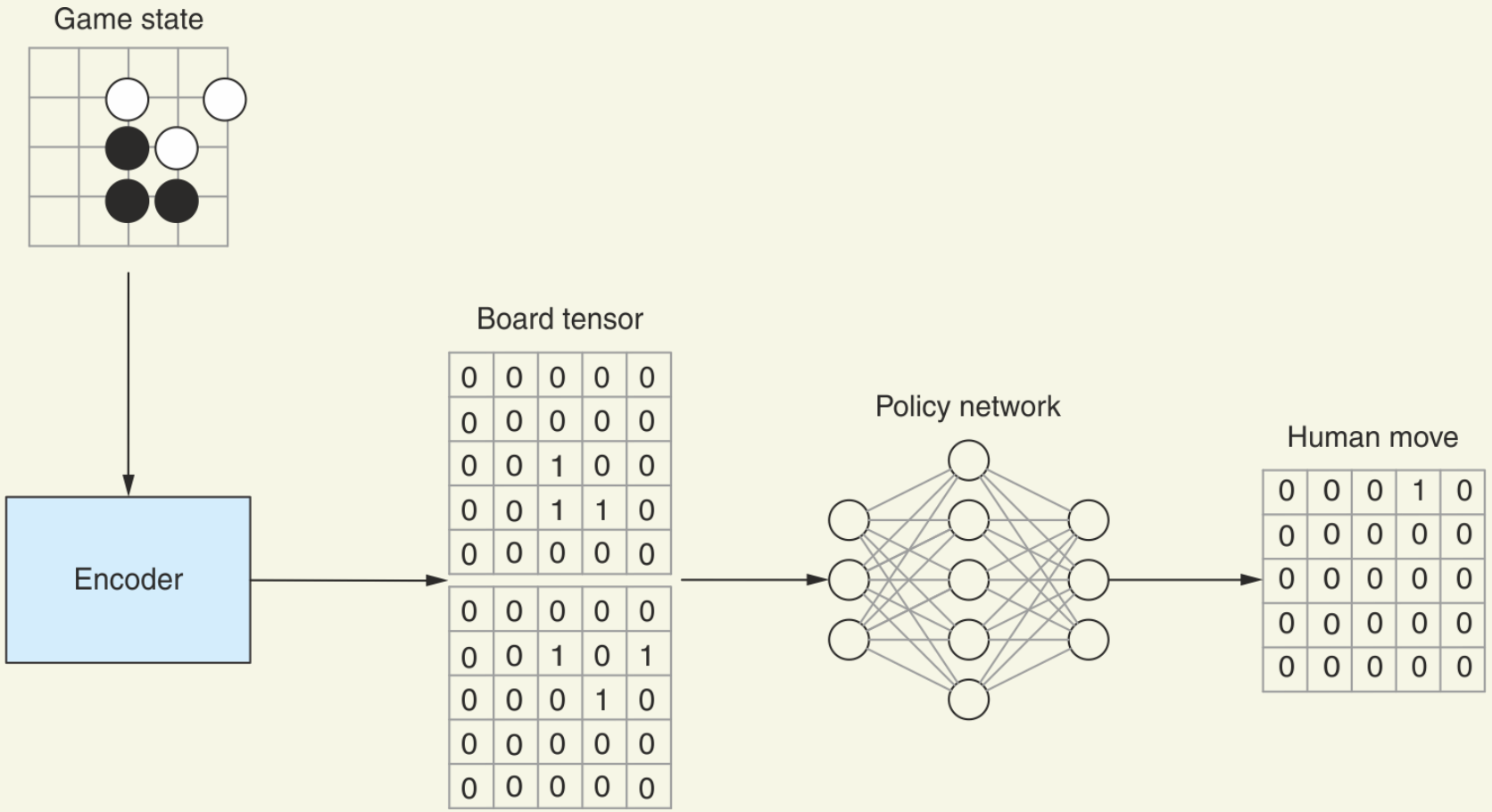


Convolutional Neural Network

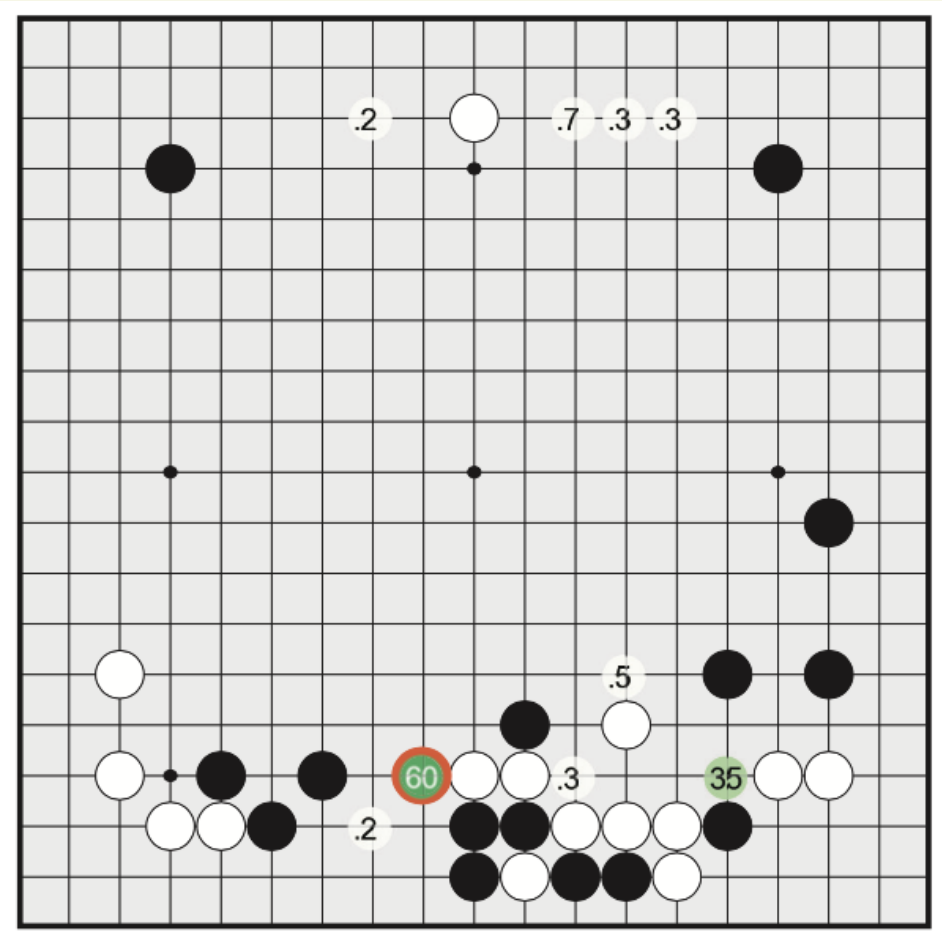
# of layers are set by developers regarding computer capacity and accuracy

Convolutional Neural Network Filter

Simplified example



Result



From FanHui vs AlphaGo

In state *s*, which move *a* is closest to the human style?

Result

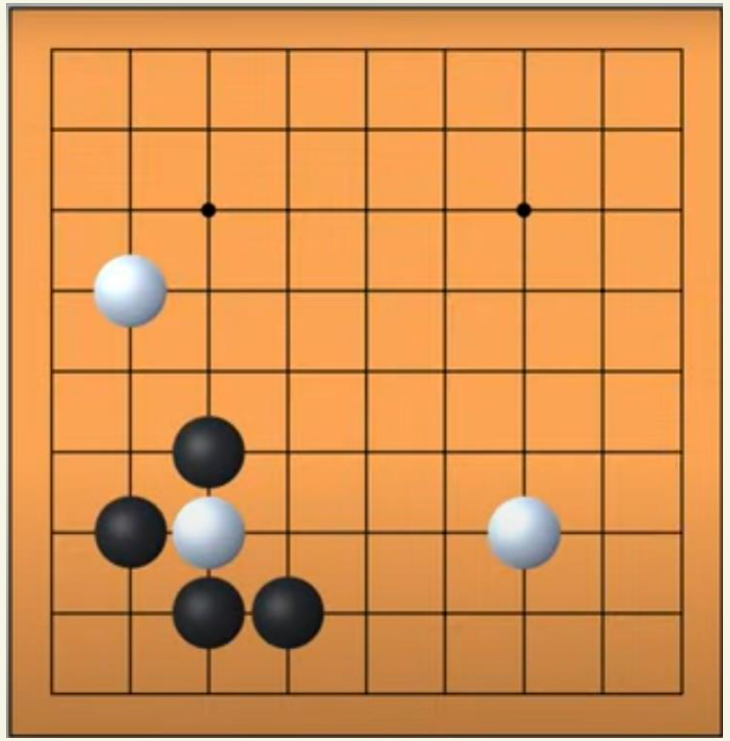
After incorporating this sampling learning, AlphaGo is able to play basic games, but can only reach a high level in amateur Go player.

More Approach to Think Like Expert

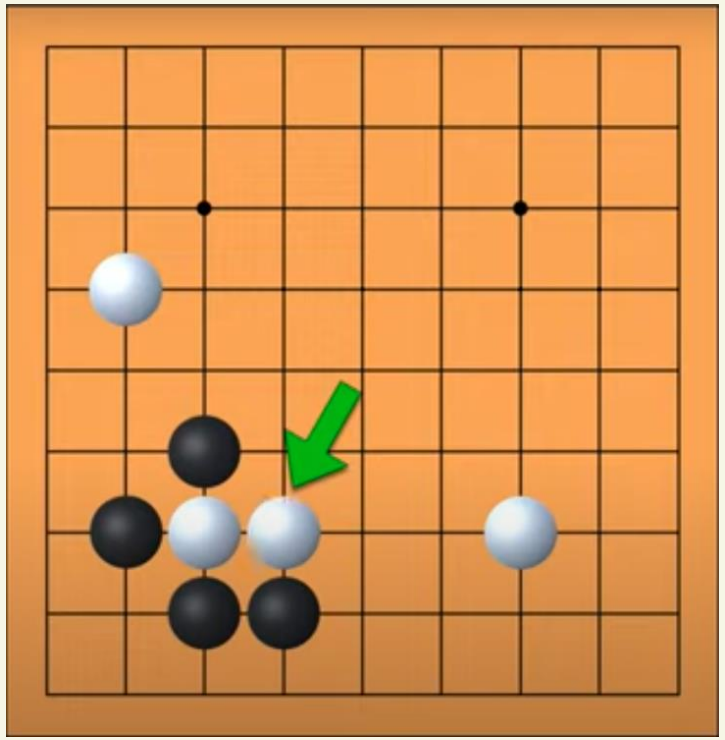
- Currently, only the next move is considered
- While professional players plans ahead in more than ten moves

Bad patter

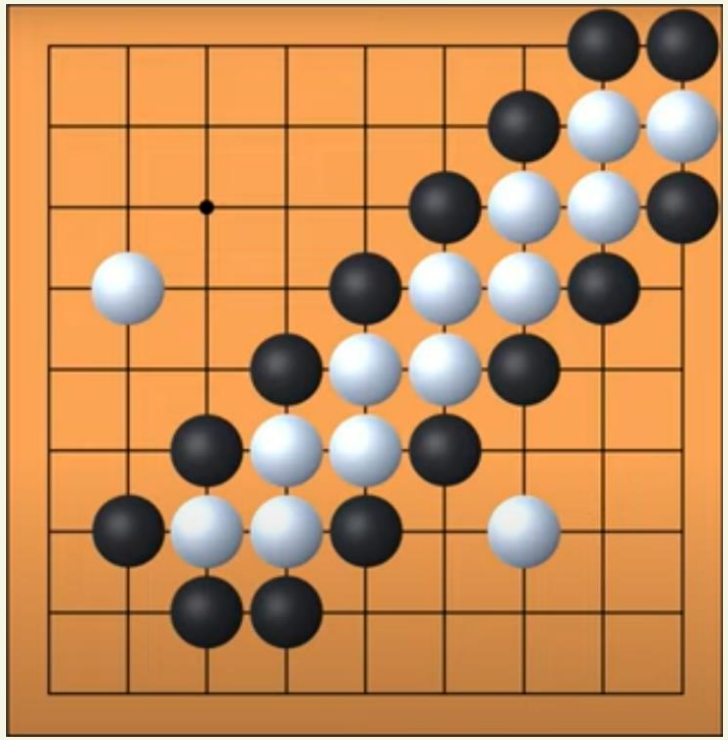
But how can computer recognize it



White's turn



Consider only one step

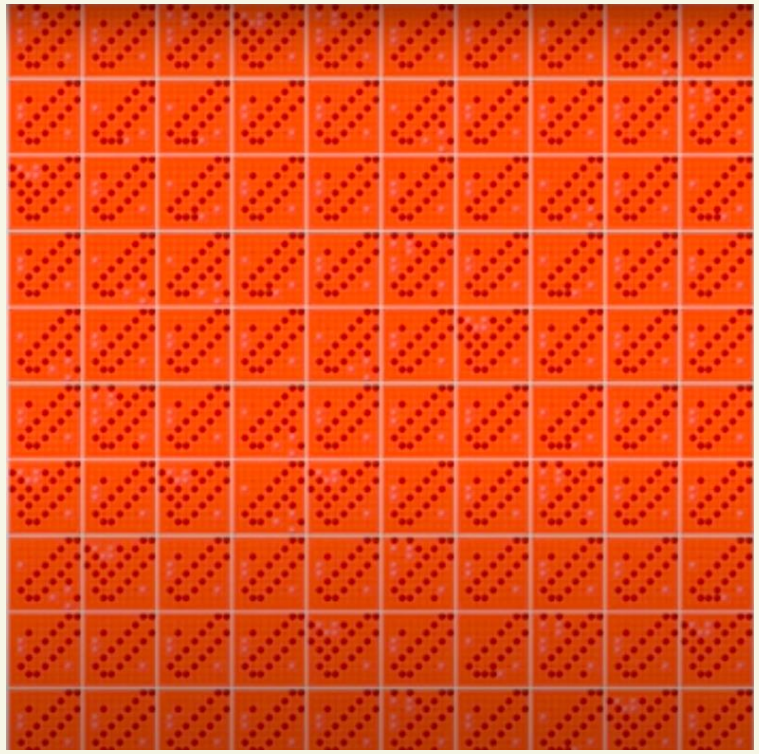


Lose all territory

Value Function

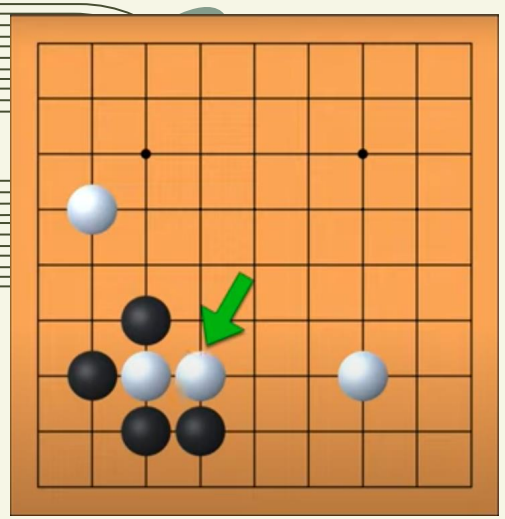
- With existing ladder pattern, use current algorithms to simulate 100 games

0% White Wins



100% Black Wins

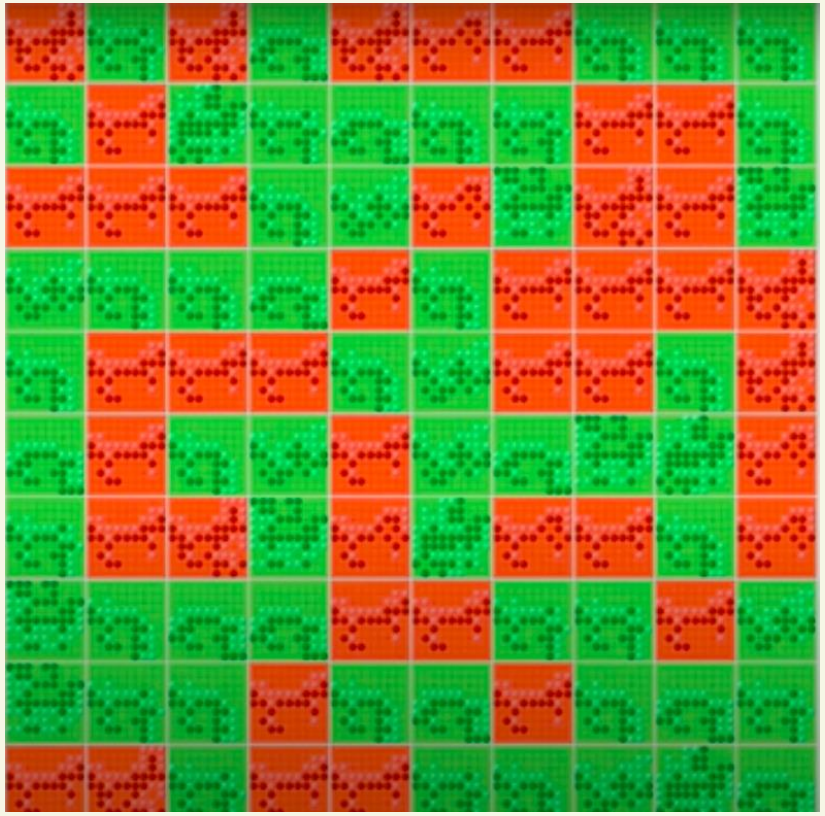
value of this state is 0/100 = 0



Value Function

- simulate 100 games before the step was made

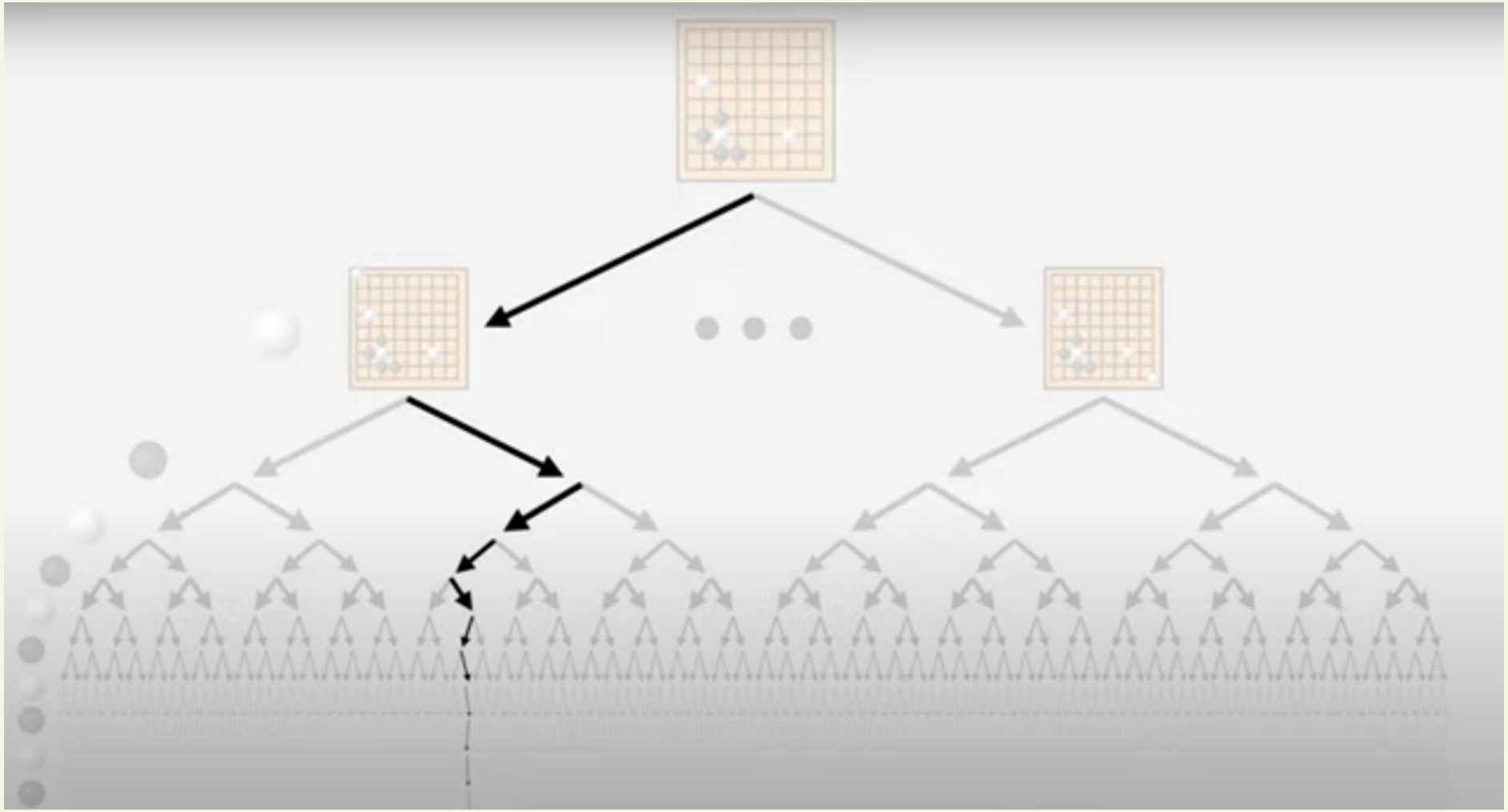
57% White Wins



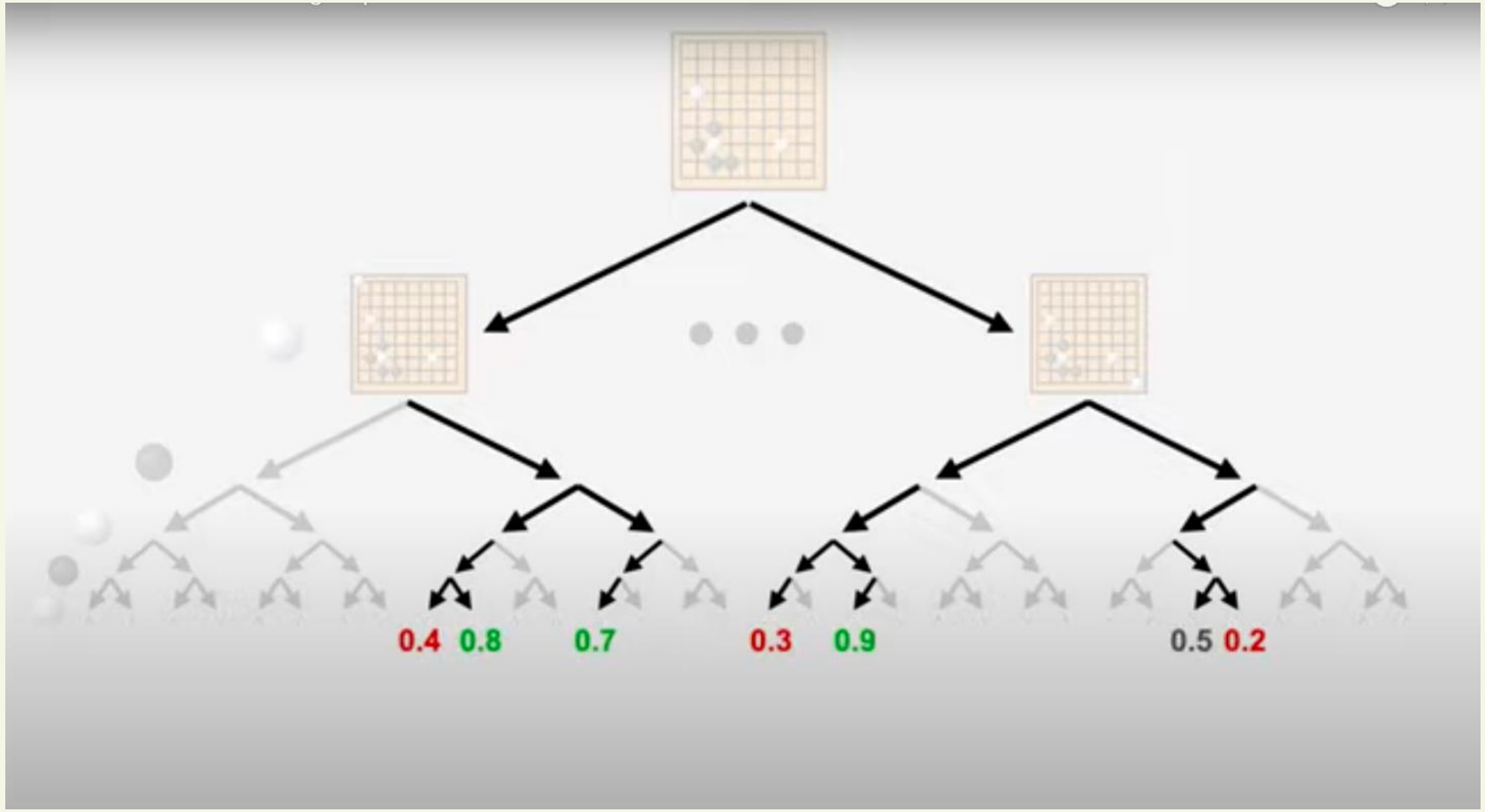
43% Black Wins

value of this state is 57/100 = 0.57

Search Tree: Planning Ahead



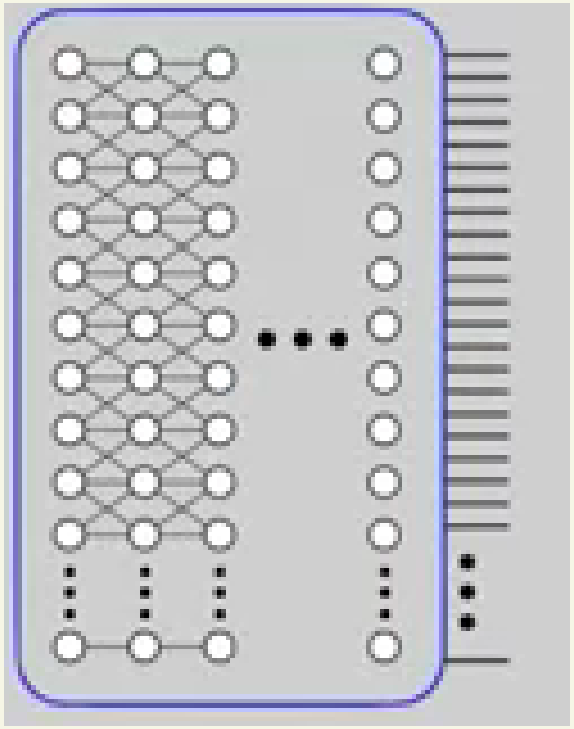
Search Tree



- Expert Policy: choose steps with highest probability
- Value function to limit the depth of the search, don't have to search the entire game.
- Complete large number of searches and reflect to the root on which path to

Reinforcement Learning

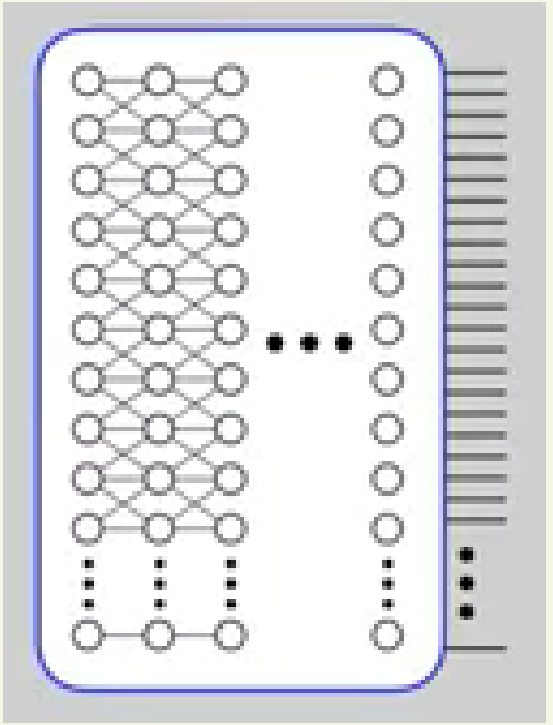
Black



- Use a settled policy

VS

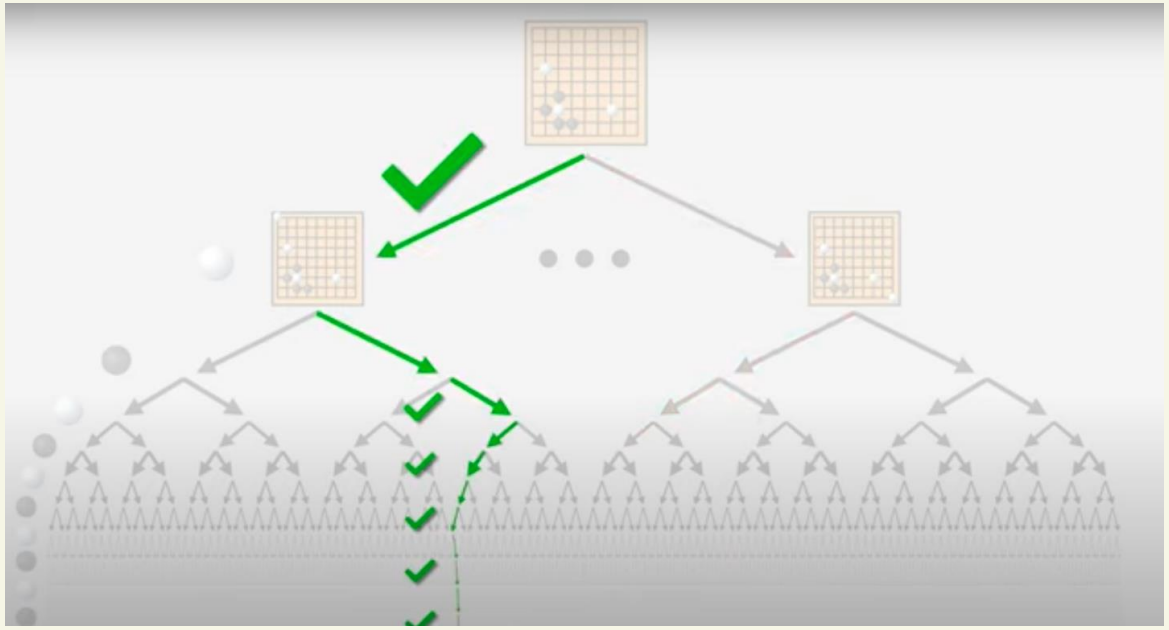
White



- Use the policy we trained

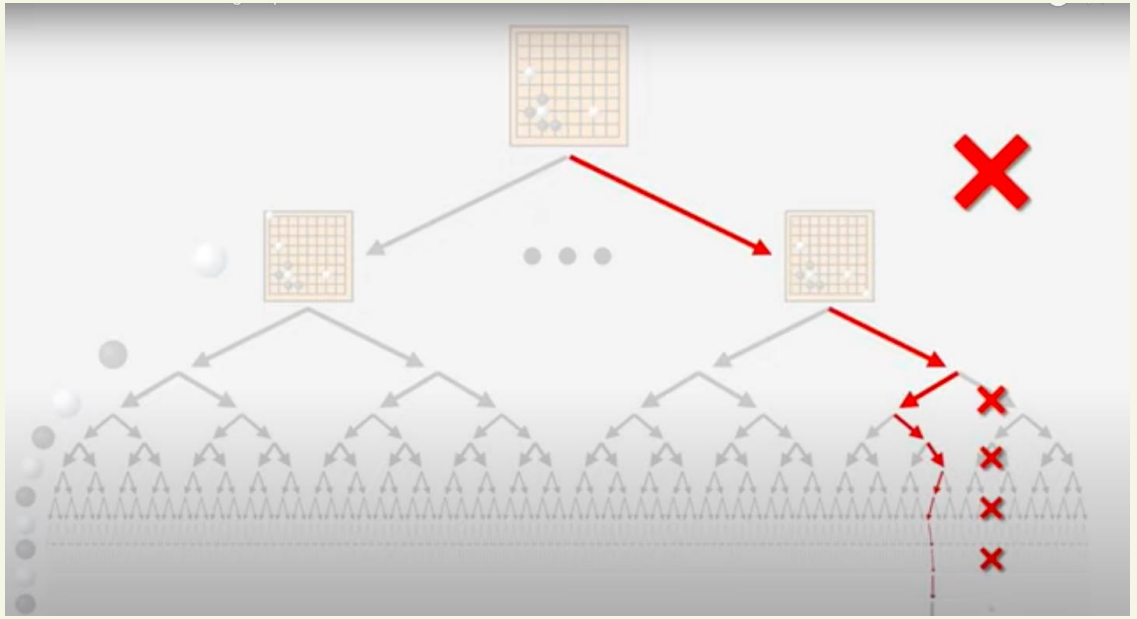
Reinforcement Learning

White Wins



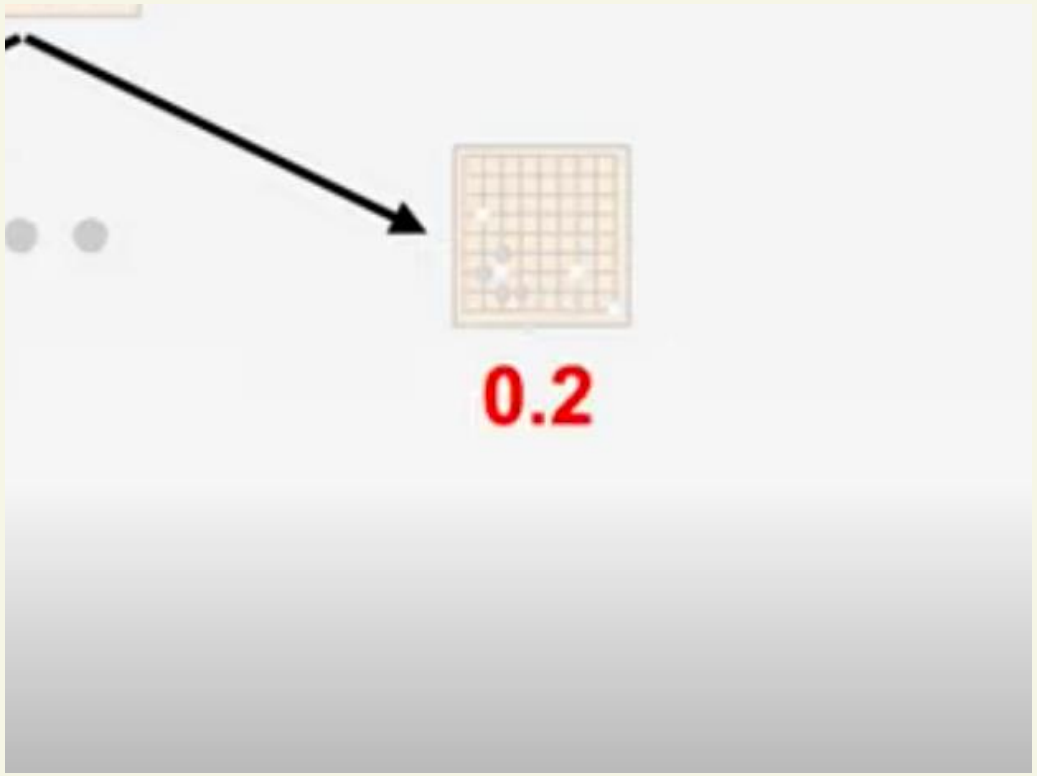
- Moves are reinforced

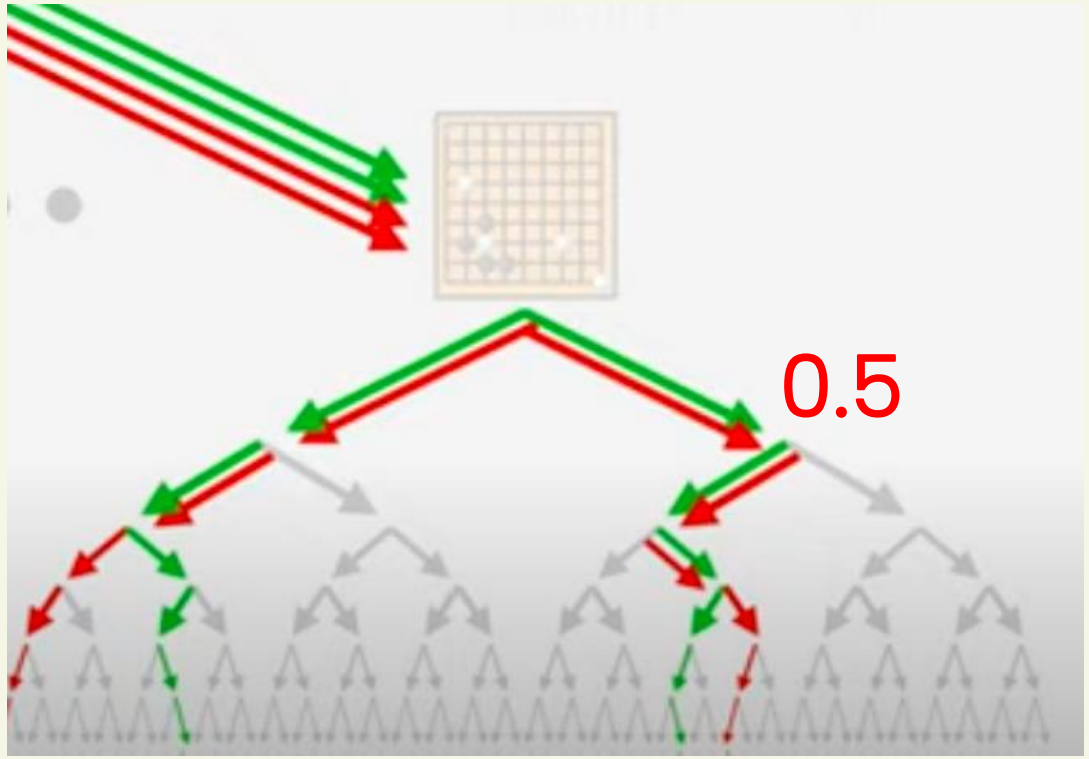
White Loses



- Moves are penalized

Use the self play games to update values and value function

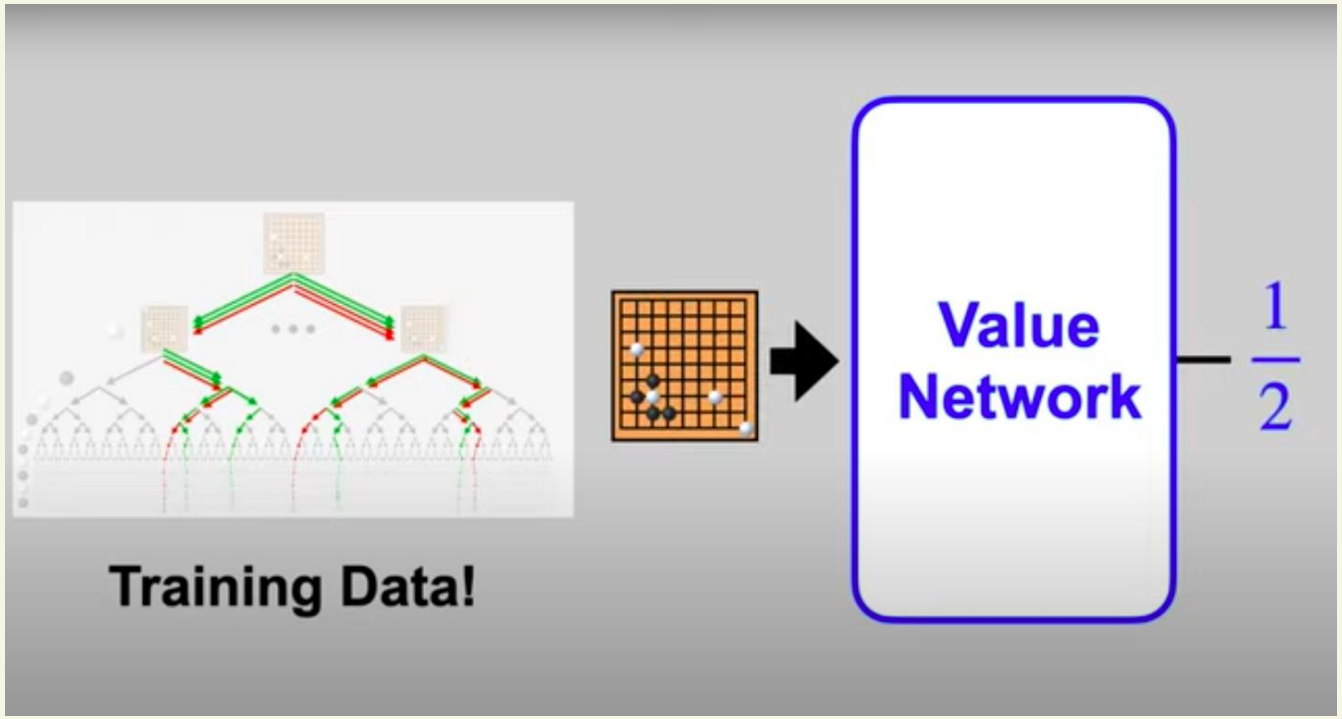




What about unseen states?

Generalize Unseen States

- Try to do as much simulations as possible(30 million vs 10^{170})
- Use self play games as training data, train the value network to get value for unseen states



Modifications

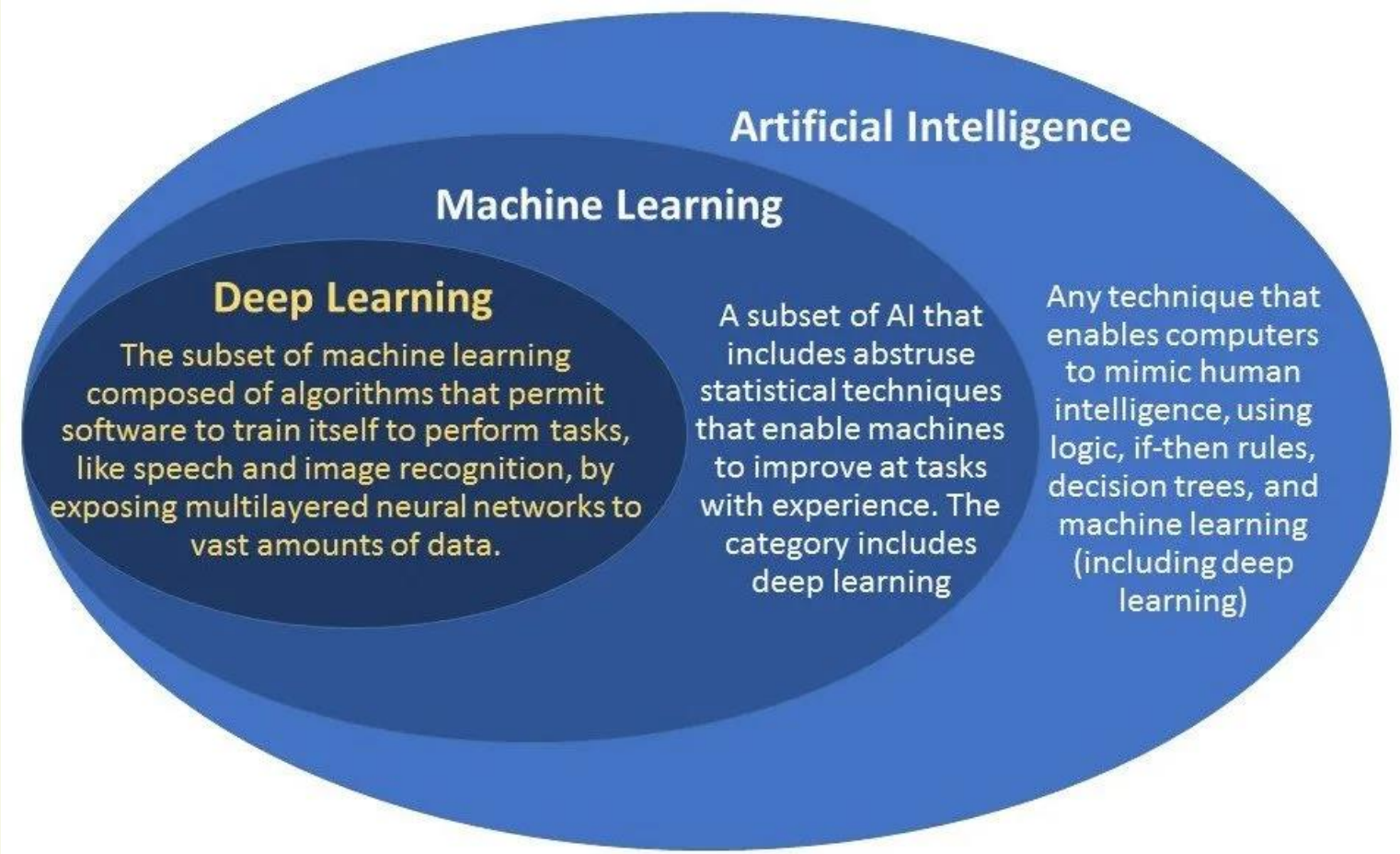
AlphaGo plays against the Word Champion Lee Sedol and won by 4-1

Lee Sedol make a completely unexpected move at move 78, which described it as a “divine move”.
This step was unexpected by AlphaGo, and Lee Sedol successfully turn the situation around.

Importance of AlphaGo

- Go had previously been regarded as a hard problem in machine learning that was expected to be out of reach for the technology of the time
- The success of AlphaGo show the immense potential of artificial intelligence and deep learning in solving complex real-world problems, and is major milestone in artificial intelligence research.

AI-Machine Learning-Deep Learning

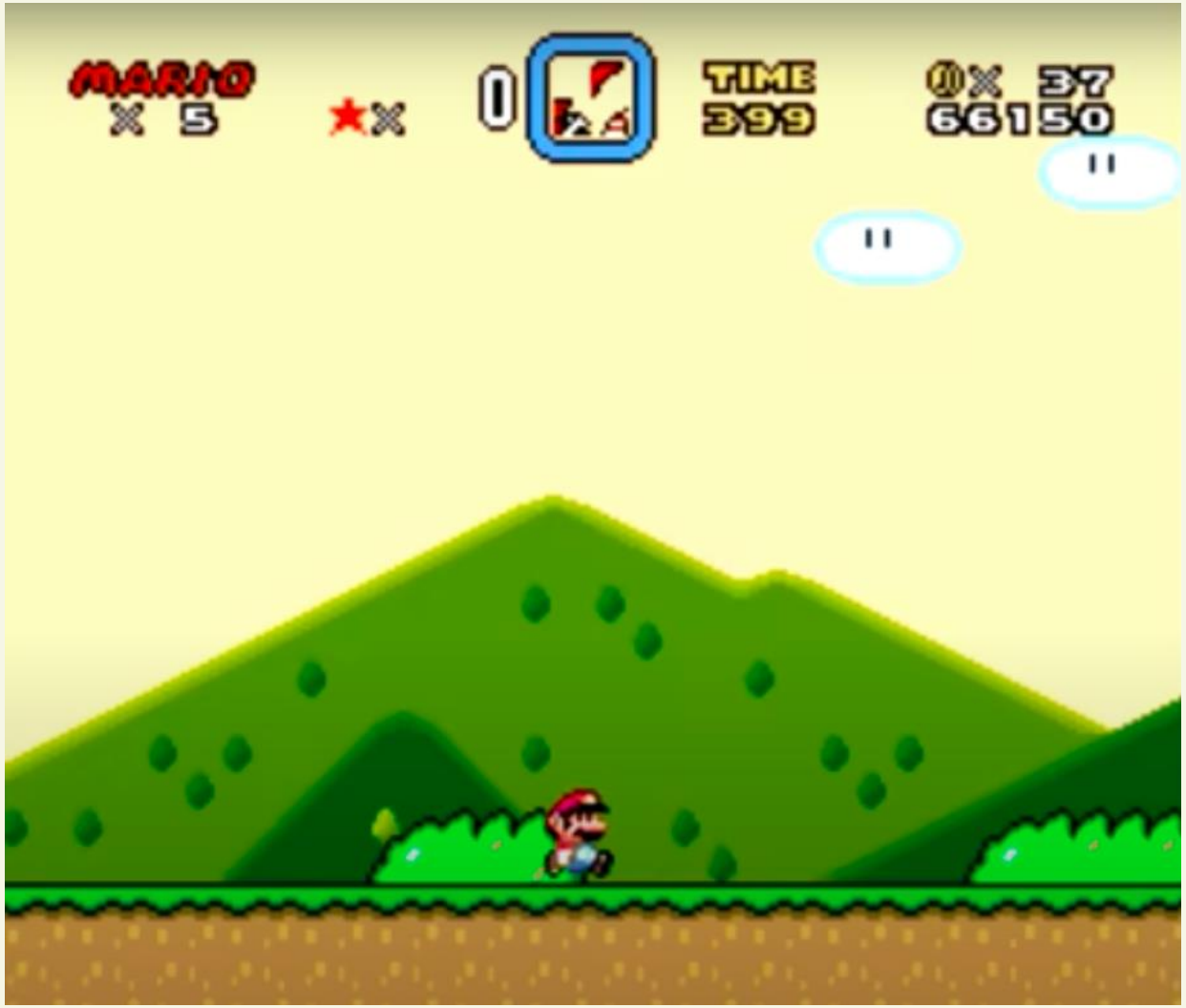


How is it related to our daily life?

- Recommendation systems
- Social media connections
- Image recognition
- Natural language processing (NLP)
- Virtual personal assistants
- Stock market predictions
- Credit card fraud detection
- Traffic predictions
- ...

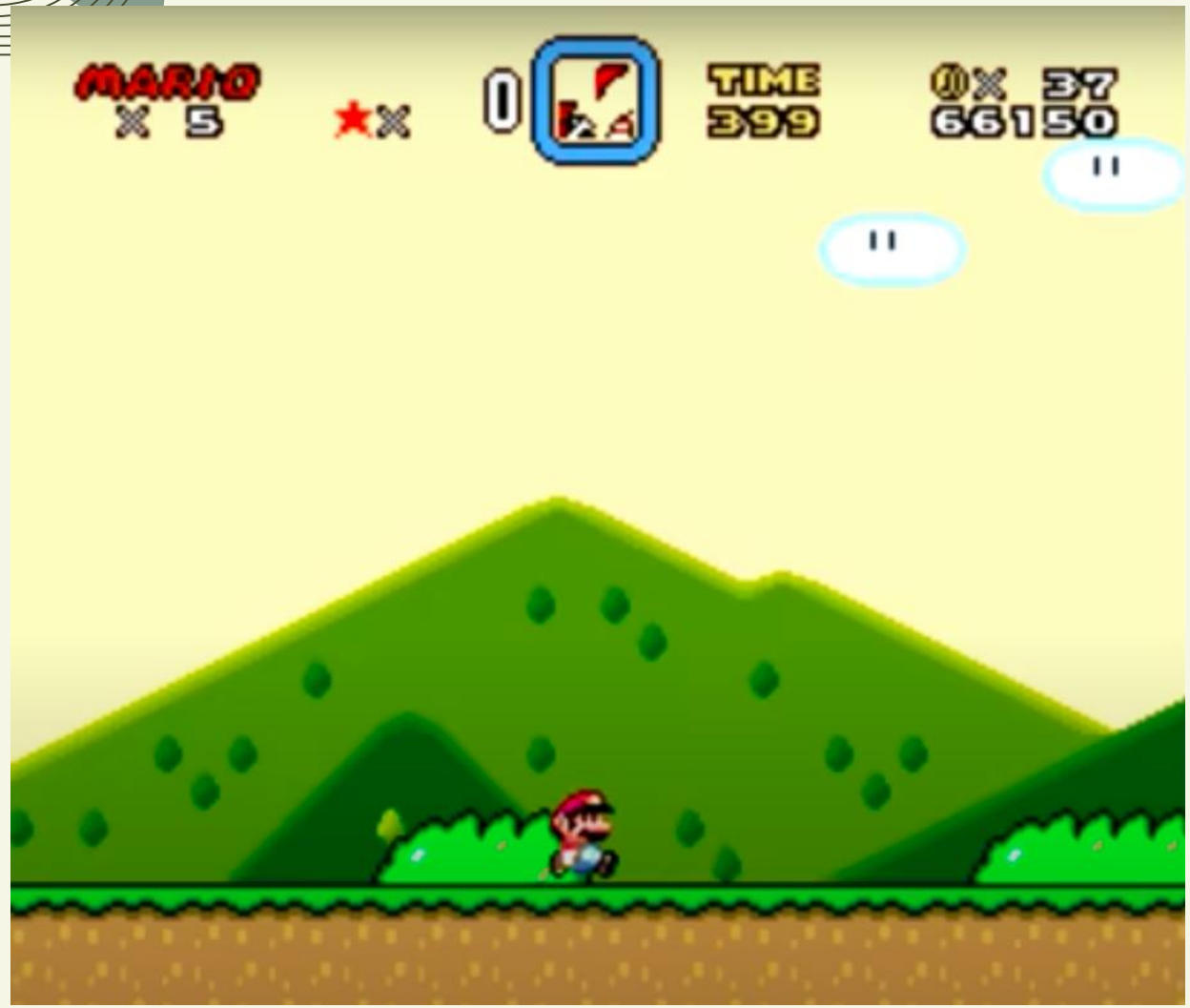
What can we apply machine learning to do?

Play Computer Games!



MarI/O – Machine Learning for Video Games

Observations



MarI/O – Machine Learning for Video Games

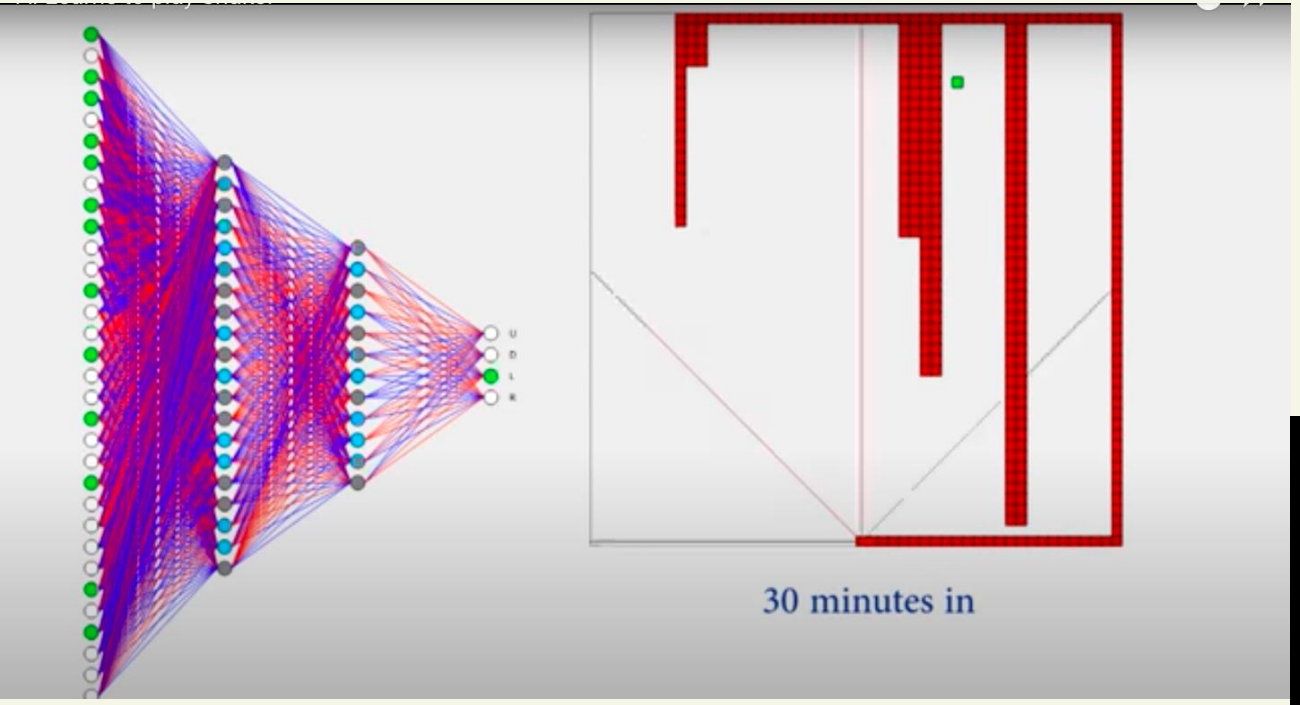
No human interference with the network

The fittest generation figured out spin jumping, a technique that can kill potential enemy it touches

This is a generally useful rule that players developed by playing themselves

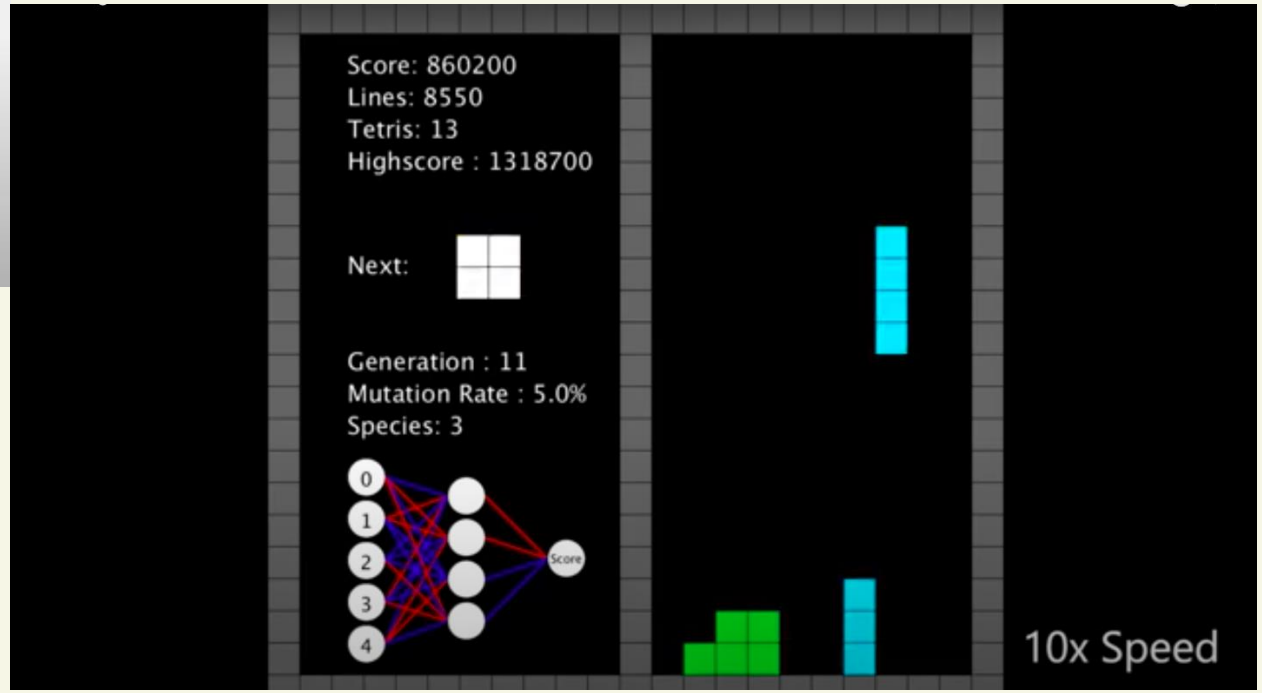
AI ‘learns’ what human develops without giving guidance

More Computer Games



AI playing Snake!

AI playing Tetris



More Computer Games

AI playing Mario Cart

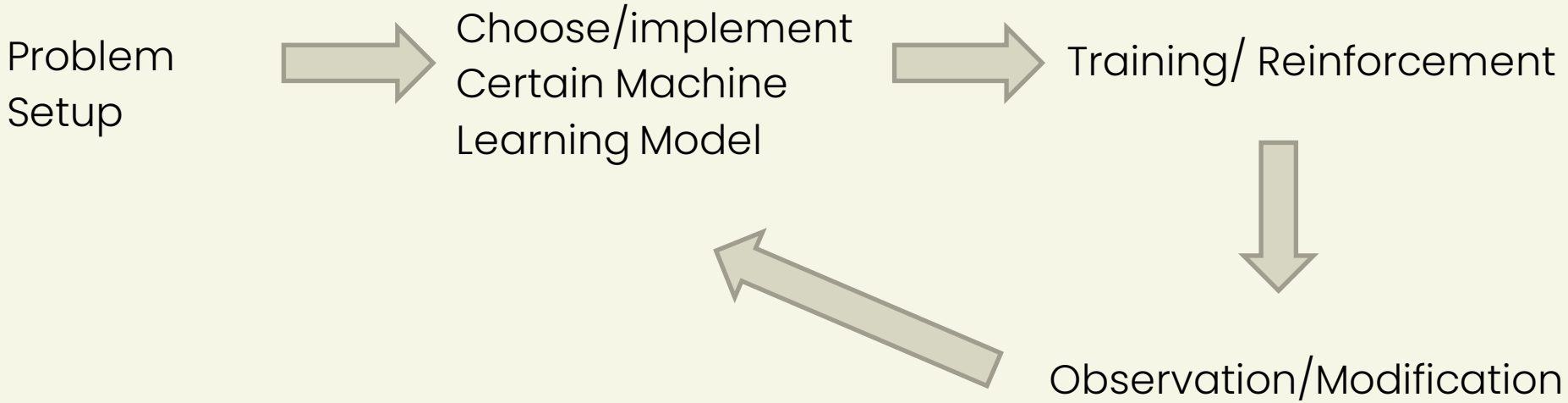
AI playing Flappy Bird

```
  ID   age  size  fitness  adj fit  stag
 ====  ===  ====  =======  =======  ====
    1   17    21      8.9    0.550    15
    2   17    25      9.3    0.409    14
    3    7    24      8.3    0.406     5
    4    4    30      8.7    0.383     2
Total extinctions: 0
Generation time: 3.345 sec (4.080 average)

****** Running generation 18 ******

Population's average fitness: 5.98400 stdev: 2.60303
Best fitness: 9.70000 - size: (3, 4) - species 3 - i
Average adjusted fitness: 0.563
Mean genetic distance 1.736, standard deviation 0.64
Population of 100 members in 4 species:
  ID   age  size  fitness  adj fit  stag
 ====  ===  ====  =======  =======  ====
    1   18    17      9.0    0.661    16
    2   18    32      8.8    0.464    15
    3    8    25      9.7    0.581     6
    4    5    26      9.2    0.544     3
Total extinctions: 0
Generation time: 3.519 sec (4.087 average)
```

Patterns Observed



Thoughts & Further Explorations

01 | Necessity of Human’s role

AI doesn’t ‘think’ like human, programmers set up to ‘make’ them think like human

02 | Combination of technique

For complicated real life problem, it often requires combination of multiple techniques
Different Approach can be make depending on what we have

03 | Potential to improve

Potential modifications often exists

04 |

We don’t need to know everything to try those method out.
Instead of make things perfect, try to make life more convenient or more interesting with things we

Thank you!

Questions?

Reference

"Timeline of AlphaGo." Timelines Wiki, 9 June 2023, https://timelines.issarice.com/wiki/Timeline_of_AlphaGo.

Graphics in 5 Minutes. "Reinforcement Learning: AlphaGo." YouTube, 14 Aug. 2023, www.youtube.com/watch?v=4PyWLgrt7YY.

Silver, David, et al.(2016). "Mastering the Game of Go with Deep Neural Networks and Tree Search." Nature, vol. 529. ResearchGate, https://www.researchgate.net/publication/292074166_Mastering_the_game_of_Go_with_deep_neural_networks_and_tree_search

Karn, U. "An Intuitive Explanation of Convolutional Neural Networks." KDnuggets, n.d. https://www.kdnuggets.com/2016/11/intuitive-explanation-convolutional-neural-networks.html.

Powell, V. "Image Kernals". n.d. https://setosa.io/ev/image-kernels/

Costa, D. "What Is Machine Learning & Deep Learning?" Medium, 26 Aug, 2019, https://medium.com/@clairedigitalogy/what-is-machine-learning-deep-learning-7788604004da

Related Links

Introduction about the Opening in Go:

https://senseis.xmp.net/?PlayingTheFirstMoveInTheUpperRightCorner%2FDiscussio
n

Introduction to CNN:

https://www.youtube.com/watch?v=x_VrgWTKkiM

Alternating way for AI playing Marl/O(With sample):

https://www.youtube.com/watch?v=CI3FRsSAa_U

AI playing Snake!:https://www.youtube.com/watch?v=vhiO4WsHA6c

AI playing Tetris: https://www.youtube.com/watch?v=1yXBNKubb2o

AI playing Mario Cart:https://www.youtube.com/watch?v=Ipi40cb_RsI

AI playing Flappy Bird :https://www.youtube.com/watch?v=vhiO4WsHA6c