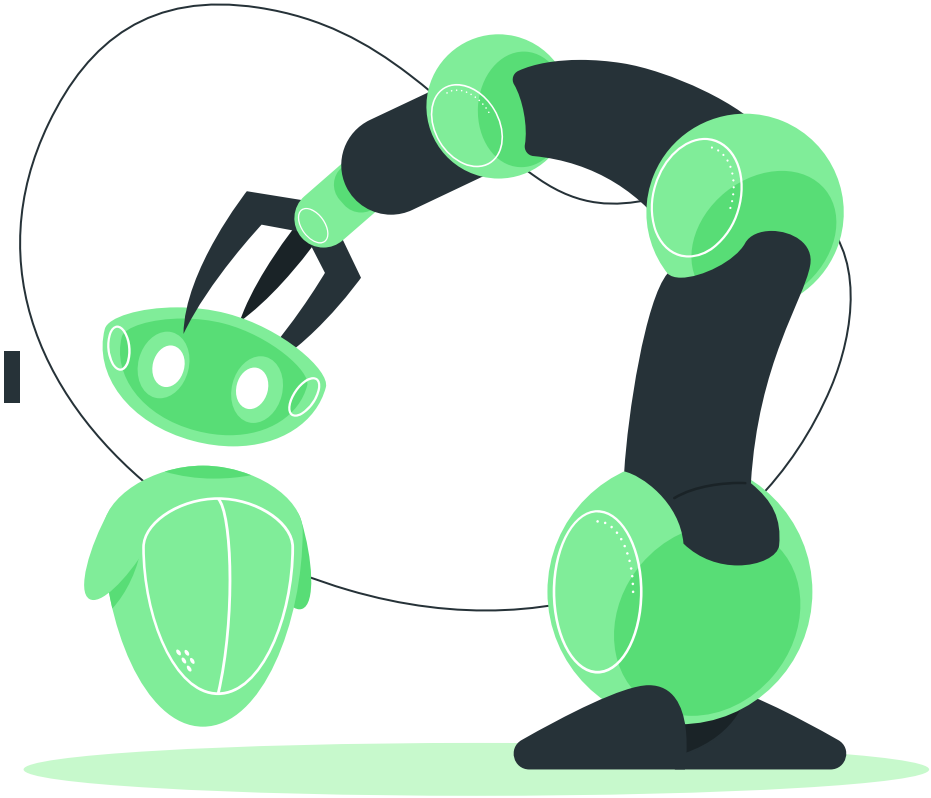
AlphaGo:

An Engineering Marvel



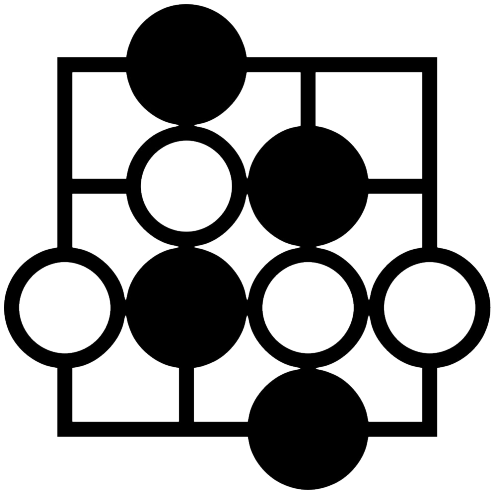
Presentation Flow

- Introduction on AlphaGo
- Challenges Faced
- Achievements of AlphaGo
- Significance of AlphaGo
- How technology can benefit our future lives


AlphaGo

Technology behind AlphaGo

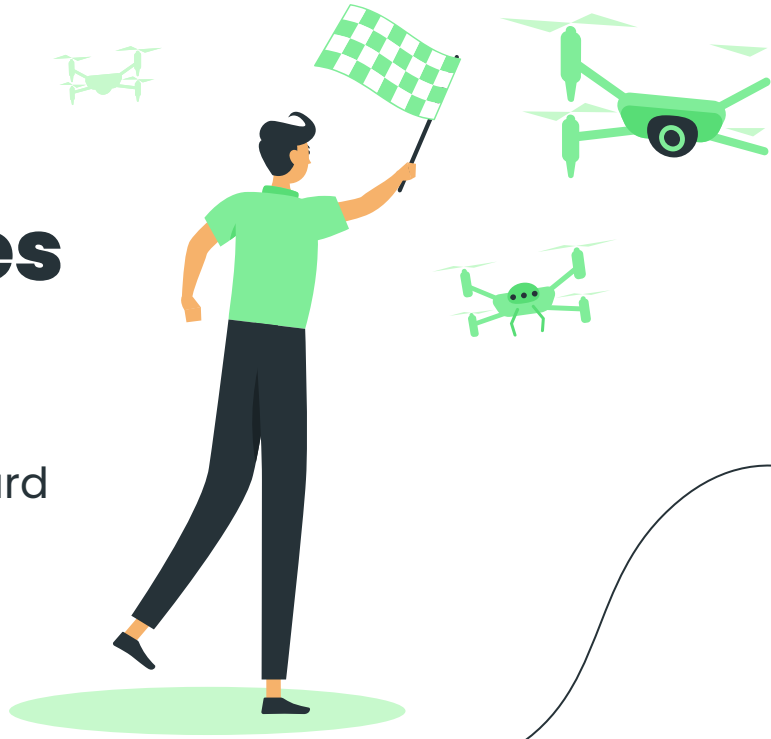
- Advanced Search Tree
- Deep Neural Network
  - Policy Network
  - Value Network
- Reinforcement learning




Companies
behind
AlphaGo

DeepMind Technologies and its aims

- British AI Subsidiary of Alphabet Inc
- Research teams will stop focusing on board games
- Shift of focus



2 AlphaGo's Challenges

Plethora of Moves

Guess:

How many possible moves in Go?

10^{360} possibilities!

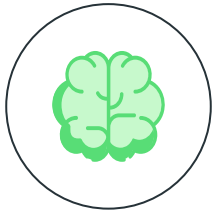
10^{82} atoms

More moves than atoms in the observable universe!

Plentiful Positions Problem: Conventional Algorithms

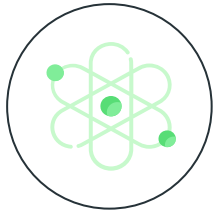
Typically Use Game Trees

Generate all possible moves and analyse to find the best one



Too Many Possibilities

Unrealistic to evaluate the boundless possibilities by brute force



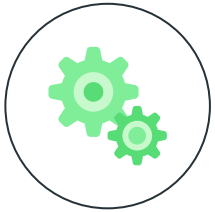
Cannot Predict Strength of Move

No pattern recognition, cannot examine and analyse all moves

Solution: General-Purpose Learning Algorithms

Deep Learning (Neural Networks)

Learning to predict the best moves using existing data



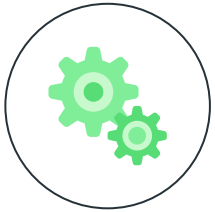
Reinforcement Learning

Learning to predict the best moves using trial and error

Deep Learning

Policy Network

Selects the best move to play next



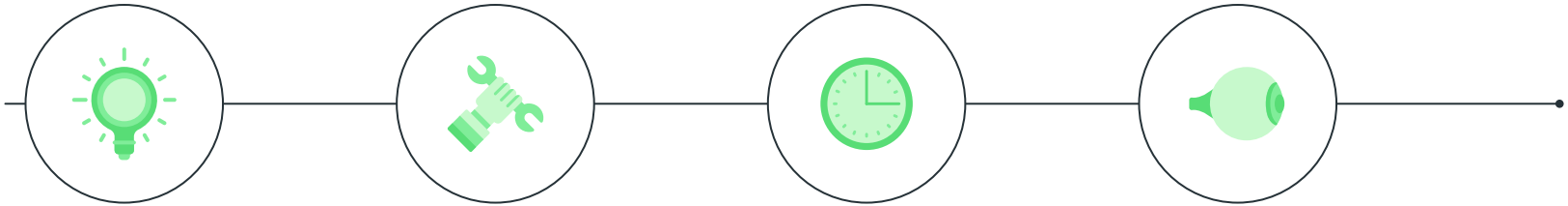
Value Network

Predicts the winner of the game from each move

Deep + Reinforcement Learning

Initial

Neural network knows nothing about Go



Start Training

Plays games against itself millions of times

Mid-Training

Tuned from mistakes and updated to predict moves and winners

Greatest of All TIme

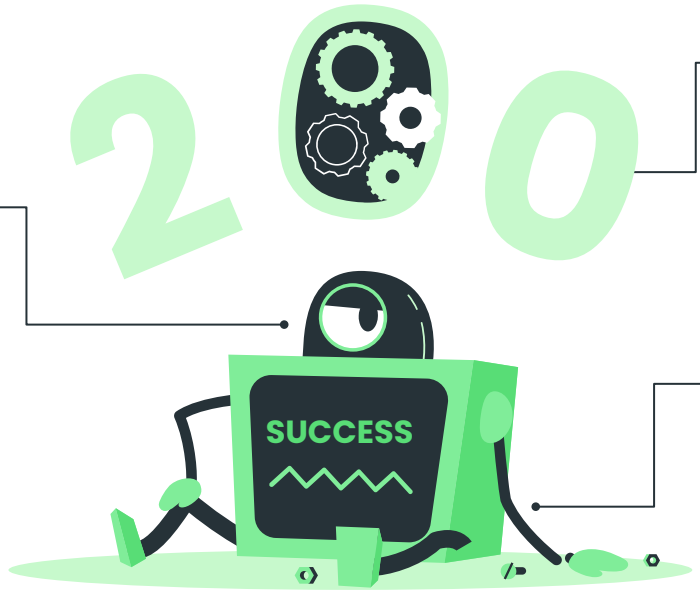
High accuracy in prediction and move selection

Deep + Reinforcement Learning

- No longer constrained by the boundaries of human knowledge
- More general yet more efficient

Achieving Optimisation

Search-and-Optimisation Innovation



Intuitive Pattern Recognition

Recognises patterns that lead to high scores

Combined with Neural Networks

Used to learn a function to capture good board position

Reinforces Behaviour

Improves play

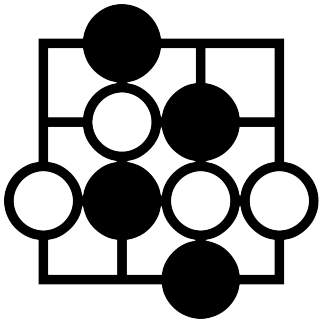

3
Achievements

AlphaGo’s Achievements

60-0
4-1 3-0
5-0

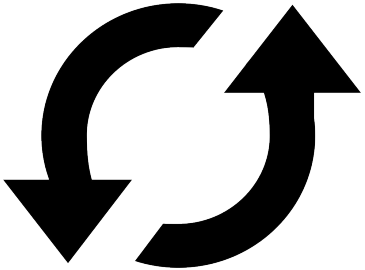
Winning Record

AlphaGo has defeated the best players humanity has to offer convincingly



Winning Moves

AlphaGo has invented winning moves that are unconventional



Regeneration

AlphaGo can be quickly regenerated from scratch in a matter of days

Winning Record

5-0 Win Over Fan Hui

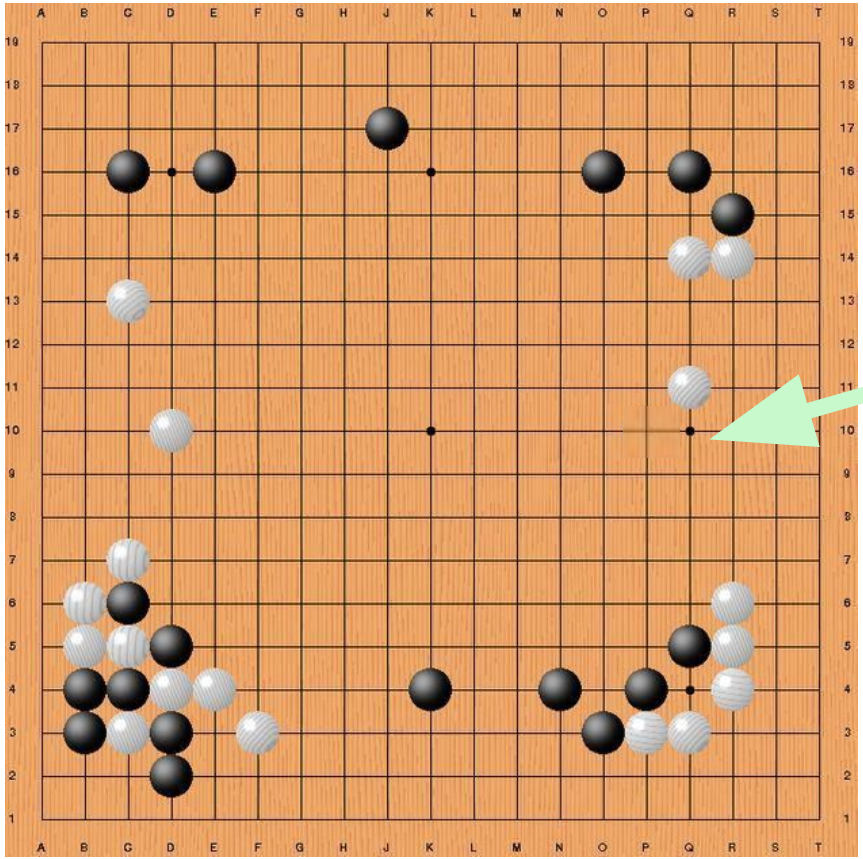
- October 2015
- Reigning Three-Time European Champion
- First time an AI has beaten a human professional without handicap in the game

4-1 Win Over Lee Sedol

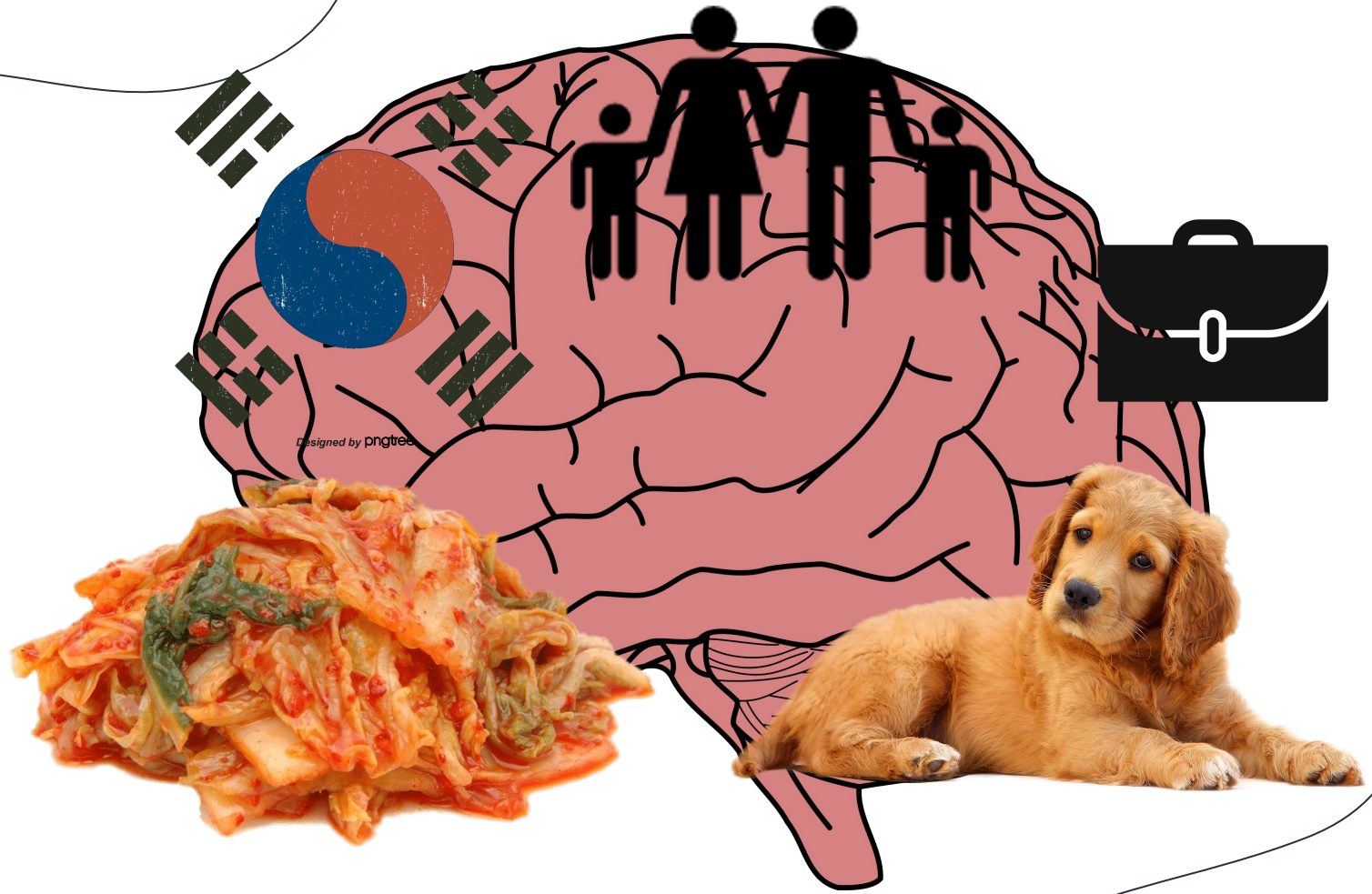
- March 2016
- 18-Time World Champion
- Widely considered as the best player in the past decade
- Earned AlphaGo a 9-Dan professional ranking

AlphaGo Vs Lee Sedol

VS

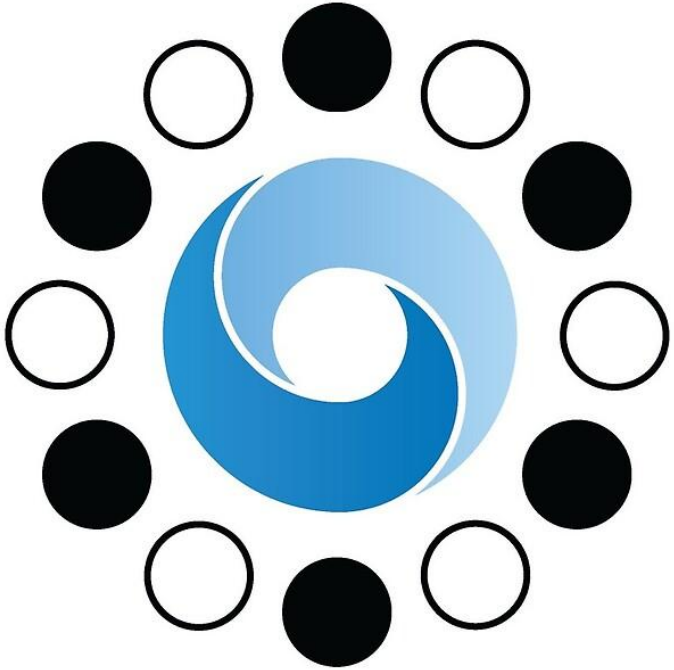


Move 37


Designed by pngtree

60-0 Over Top Professionals

- January 2017
- Improved Version of AlphaGo called AlphaGo Master was pitted against top professionals around the world



3-0 Win Over Ke Jie

- May 2017
- World’s number one player
- AlphaGo was retired after this match

Inventing Winning Moves

Move 37 VS Lee Sedol

- Second Match
- Move that top players thought was strange and some thought was a mistake
- Lee Sedol took 12 minutes to formulate a response

Conventional Moves

10^360

3000

Board Configurations

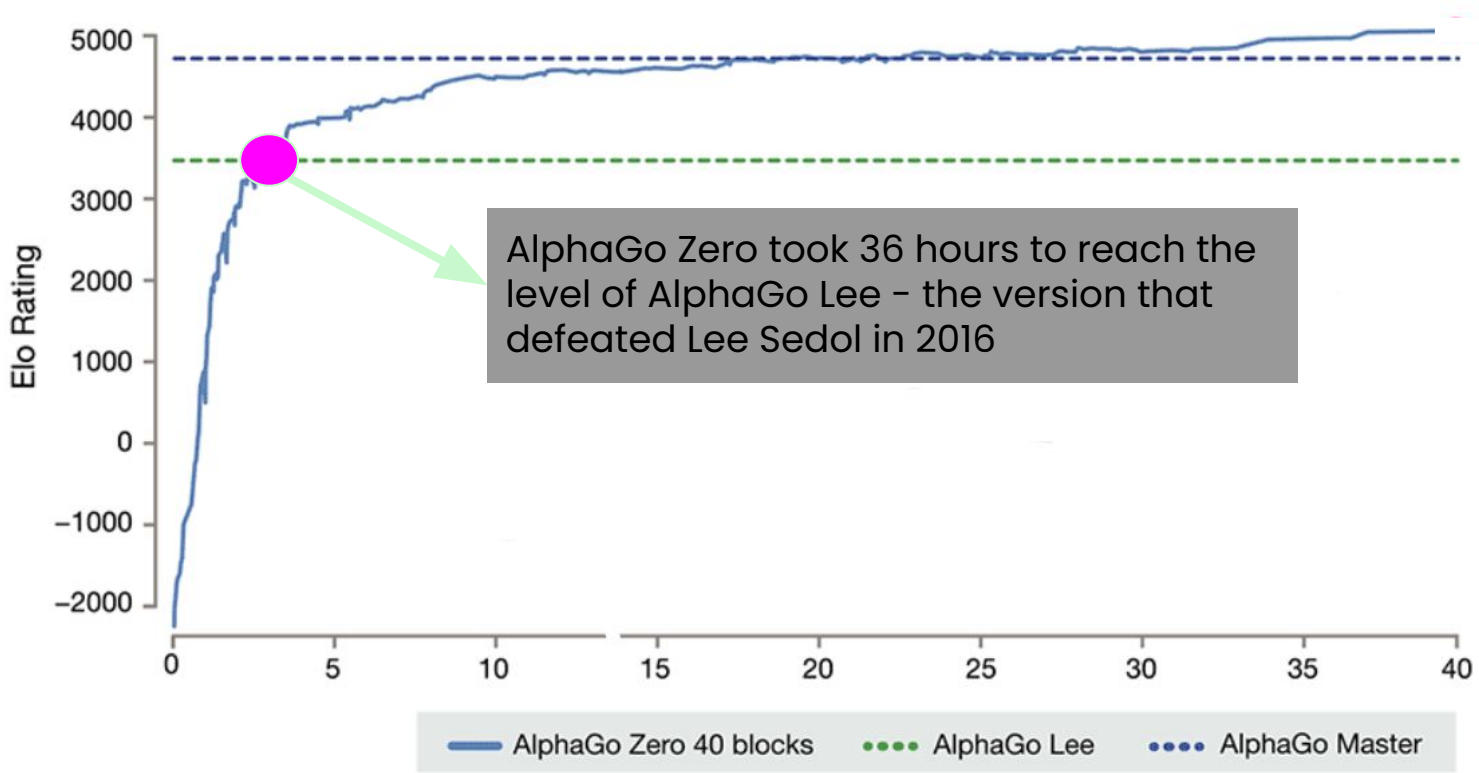
With such a large number of possibilities, it is difficult to determine whether a move is a good move

Years of History

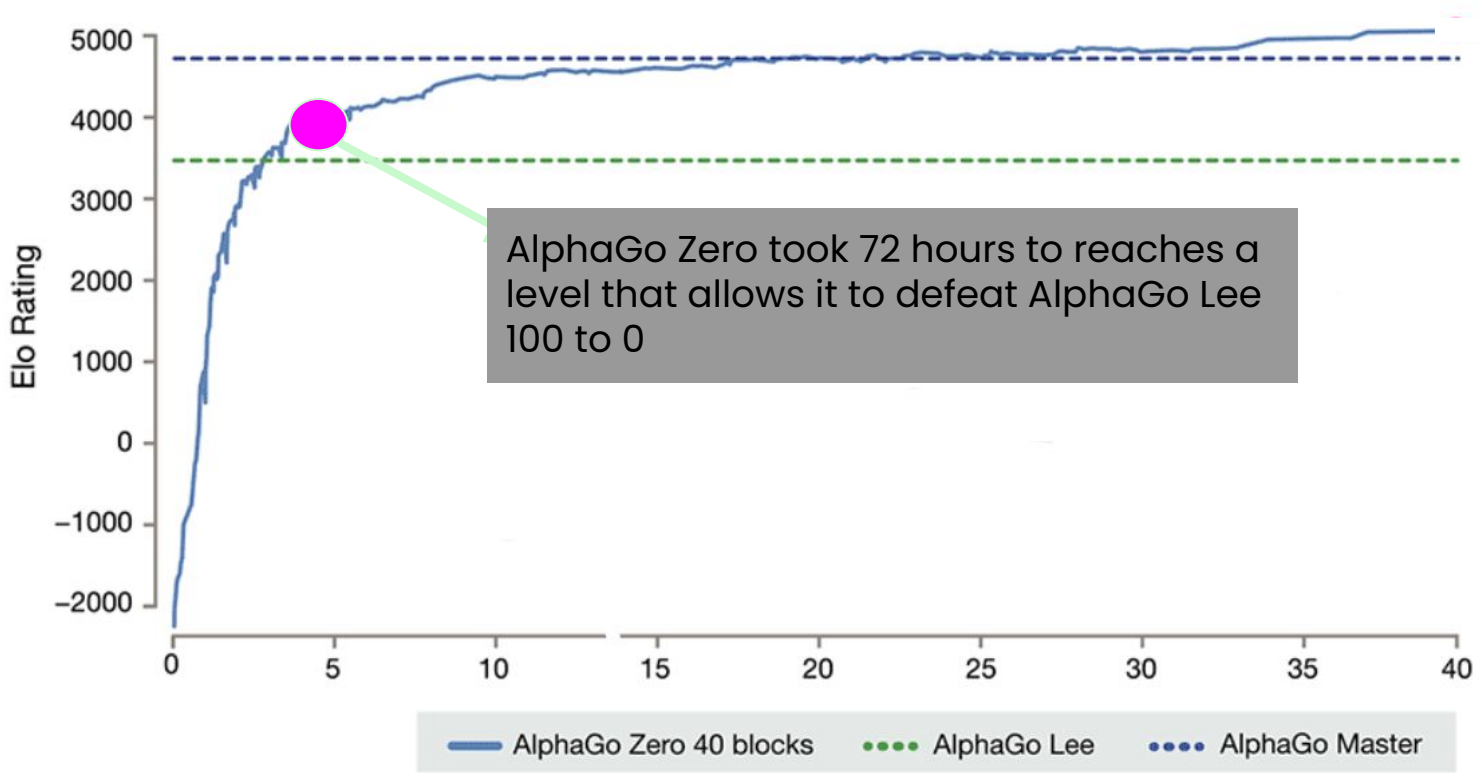
Conventional moves have been developed over the many years the game has been played

Building From Scratch

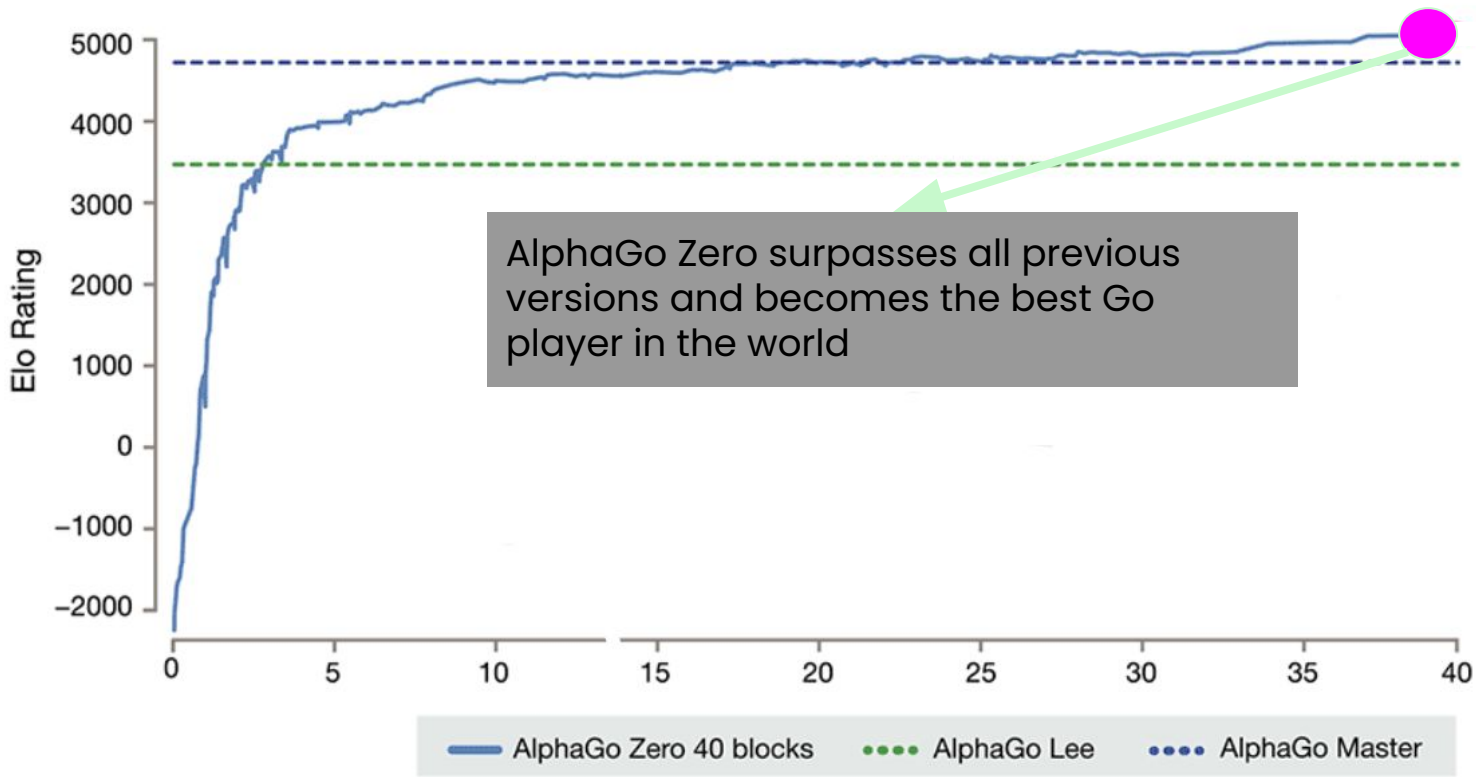
Three Days


5000
4000
3000
2000
1000
0
−1000
−2000
Elo Rating
0
5
10
15
20
25
30
35
40
AlphaGo Zero took 36 hours to reach the level of AlphaGo Lee - the version that defeated Lee Sedol in 2016
AlphaGo Zero 40 blocks
AlphaGo Lee
AlphaGo Master

Five Days


5000
4000
3000
2000
1000
0
−1000
−2000
Elo Rating
0
5
10
15
20
25
30
35
40
AlphaGo Zero took 72 hours to reaches a level that allows it to defeat AlphaGo Lee 100 to 0
AlphaGo Zero 40 blocks
AlphaGo Lee
AlphaGo Master

Forty Days


5000
4000
3000
2000
1000
0
−1000
−2000
Elo Rating
0
5
10
15
20
25
30
35
40
AlphaGo Zero surpasses all previous versions and becomes the best Go player in the world
AlphaGo Zero 40 blocks
AlphaGo Lee
AlphaGo Master


Significance of
AlphaGo

Significance of AlphaGo

- Enables humans to become more creative and benefit the society
  - AI develops their own distinctive style
- Able to identify/analyse and make an informed decision
- Create new products of engineering

Significance of AlphaGo

Tunnel Boring Machine(TBM)

International Space Station

Significance of AlphaGo

Saving energy at Google scale

Google's data centres contain thousands of servers that power services including Google Search, Gmail, and YouTube.

Understanding protein folding

Proteins are complex molecules that are essential to life. Each has its own unique 3D shape that determines how it works and what it does.

Identifying eye disease faster

We partnered with Moorfields Eye Hospital to develop faster ways of identifying, and better ways of understanding, common eye diseases from routine scans.

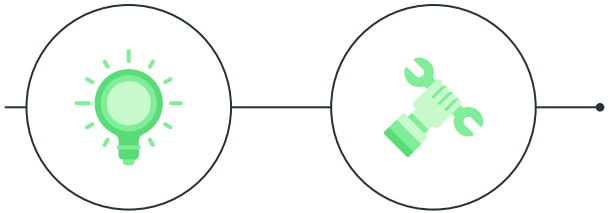
Protein Folding Problem

Finding a way to reliably determine a protein’s structure just from its sequence of amino acids.

History of Protein Folding

1972

Theory of Protein Folding started



1994

CASP (Critical Assessment of protein Structure Prediction) formed

History of Protein Folding

1972

Theory of Protein Folding started

1994

CASP (Critical Assessment of protein Structure Prediction) formed

2016

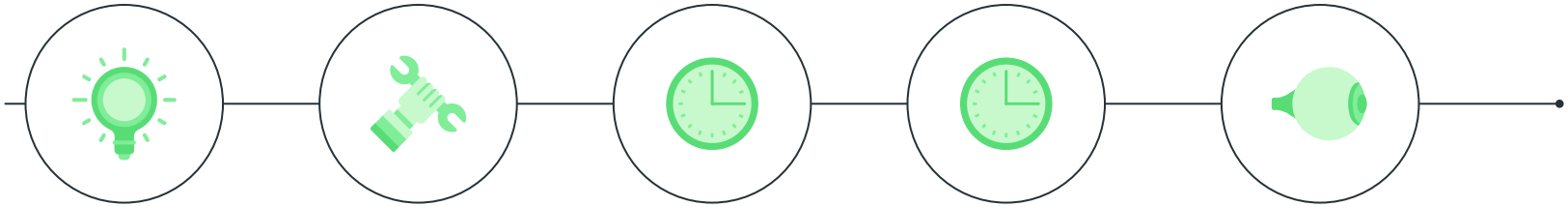
Project AlphaFold started

2018

AlphaFold ranked 1st in protein structure prediction

2020

AlphaFold 2 solved Protein Folding Problem



“It will change everything”

“This will change medicine. It will change research. It will change bioengineering.”

Andrei Lupas
Director of the Department of Protein Evolution

*"... AlphaGo showed us that moves humans may have thought are creative, were actually conventional ... this will bring a **new paradigm** to Go."*

Lee Sedol
18-Time World Champion

THANK YOU