Mastering the game of Go with deep neural networks and tree search

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Overview

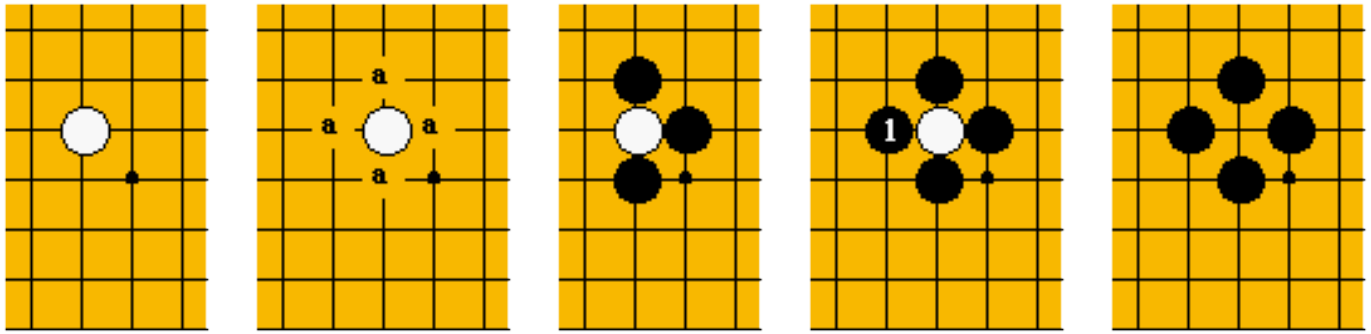
- Introduction to the game of Go
- The development of Artificial Intelligence in Go
- Introduction of AlphaGo
- Deep Neural Networks
- Monte Carlo Tree Search
- How AI makes a move in a Go game

What is Go?

- A board game for two people
- Grid is 19 rows and 19 columns
- Playing pieces: stone (White and black
- Evaluating board position and moves

Win condition:

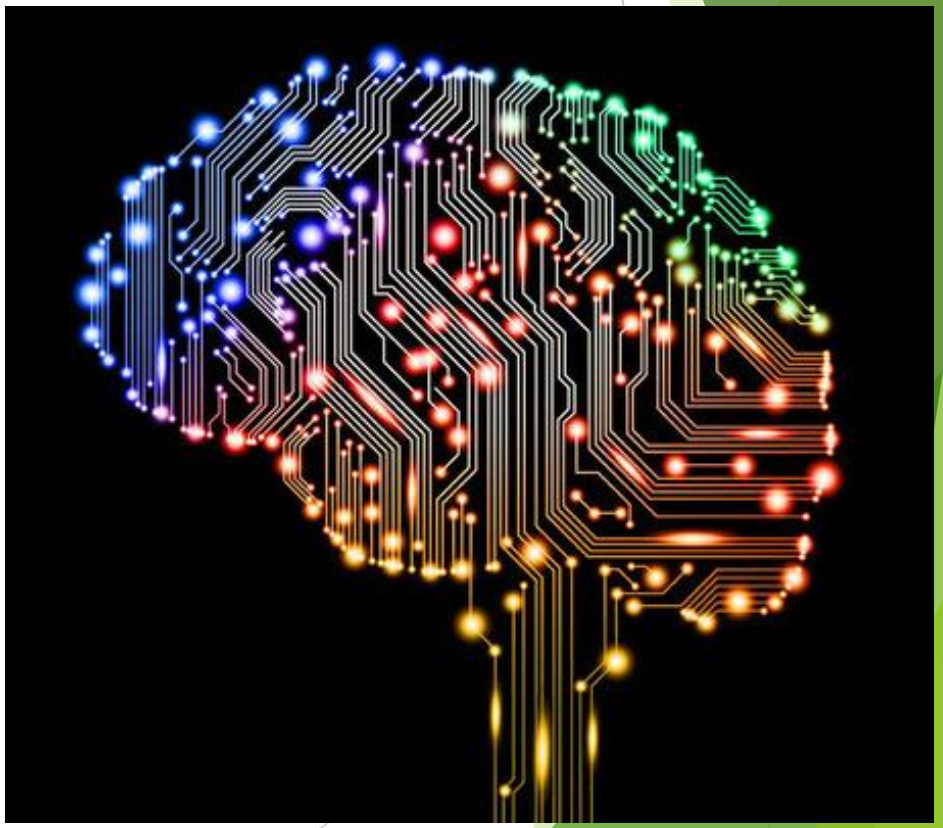
- The **purpose** of the game is to try to use your stones to surround a larger part of the board than your opponent.
- The area you control is called 'territory' and whoever has more territory at the end of the game wins.



Dia. 3 | Dia. 4 liberties | Dia. 5 atari | Dia. 6 capture | Dia. 7 result

Why is Go difficult for AI to master?

- Has been viewed as the most challenging of classic games for artificial intelligence.
- Enormous search space and the difficulty of evaluating board positions and moves.
- Program needs to explore as many combination of moves as possible.
- Hundreds of different places a stone can be placed.
- Hundreds of way another player can respond.
- Example: first two moves can have 130,000 possibilities.



AlphaGo

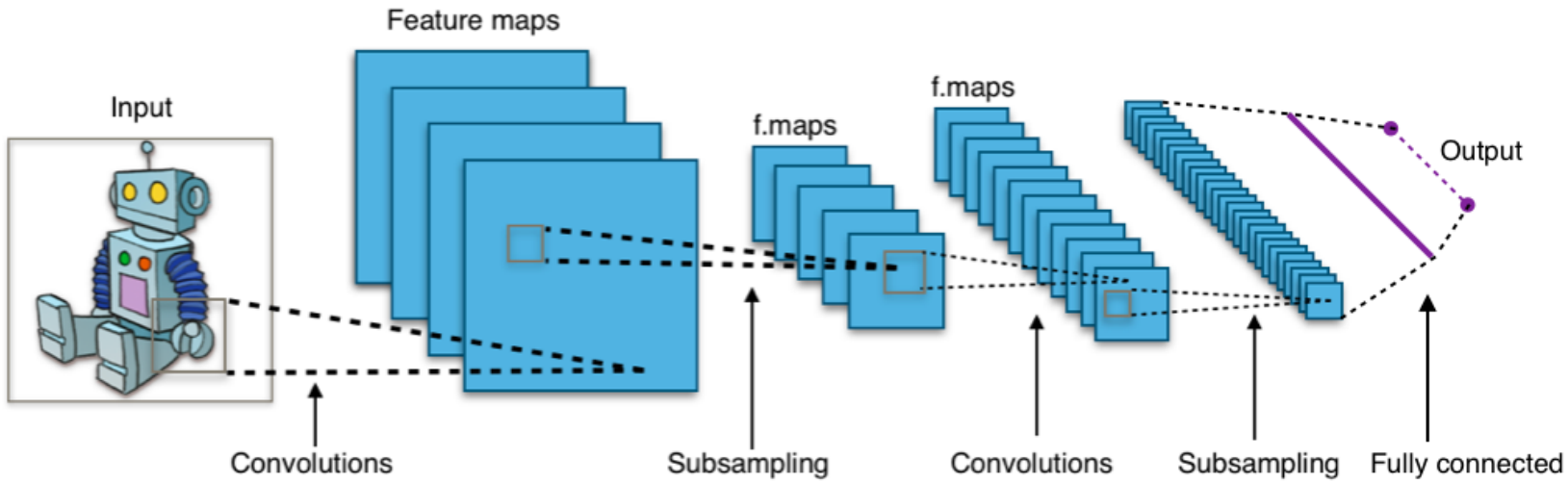
- **AlphaGo** is a computer program that plays the board game Go
- Developed by Alphabet Inc.'s Google DeepMind in London
- The first time a computer Go program has beaten a 9-dan professional without handicaps.

What are the tools being used in the AlphaGo?

- Policy networks: select valid possible moves.
- Value network: evaluate biggest value from board positions.
- Learning from Human and from self-played games
- Monte Carlo Tree Search (MCTS)

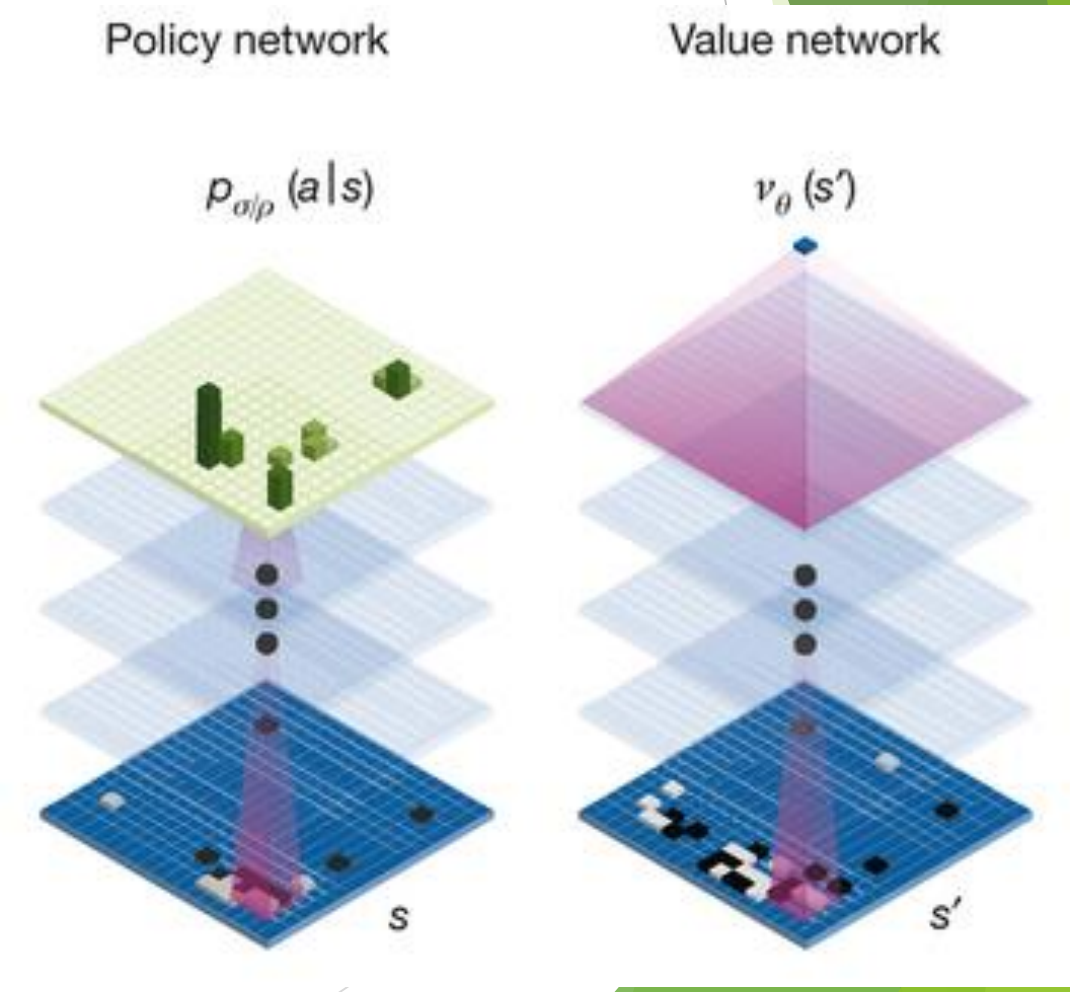
Convolutional network

- Sub-type of neural network that are especially well adapted for the processing of image data.
- Take input as an image
- At each layer in the network, a series of filters is applied on the image.
- highly computationally efficient on image data
- applied to all kinds of tasks that take images as input



Two types of Convolutional Networks: Policy Network and Value Network

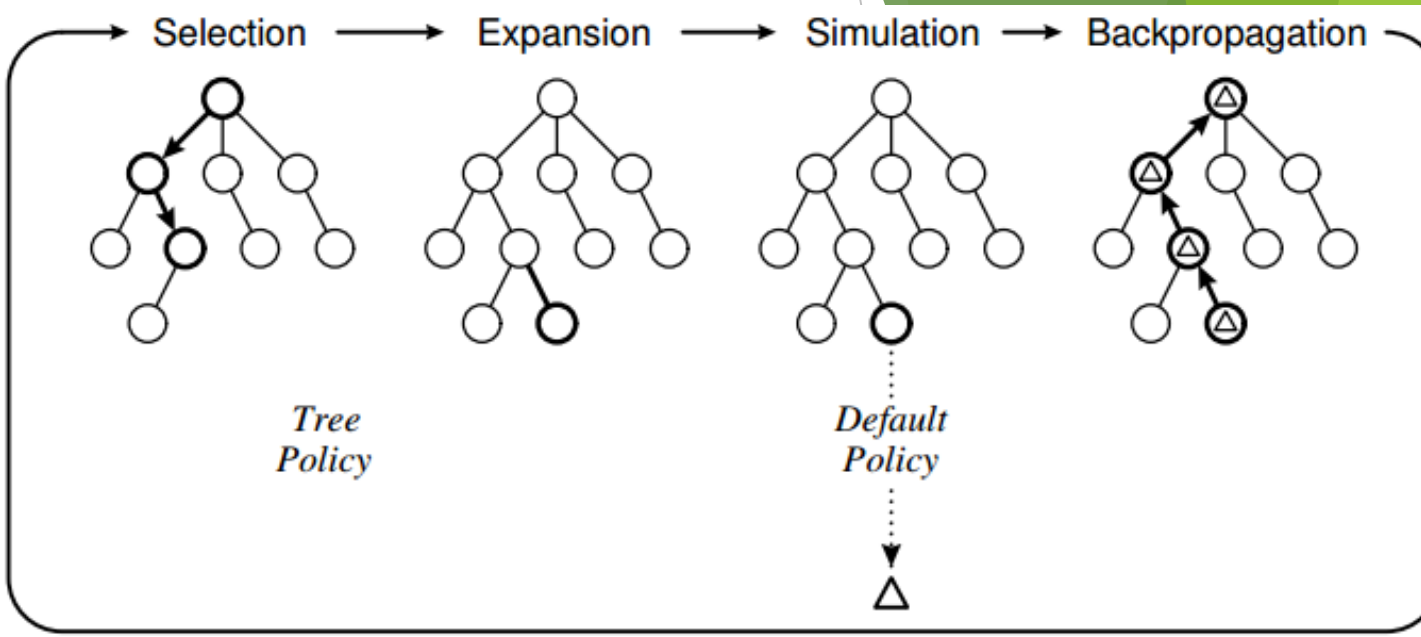
- two different kinds in AlphaGo: *policy networks* and one *value network*.
- Both types of networks take as input the current game state, represented as an image.
- The value network provides an estimate of the *value* of the current state of the game.
- The policy networks provide guidance regarding which action to choose, given the current state of the game.



Monte Carlo Tree Search

Monte Carlo Tree Search

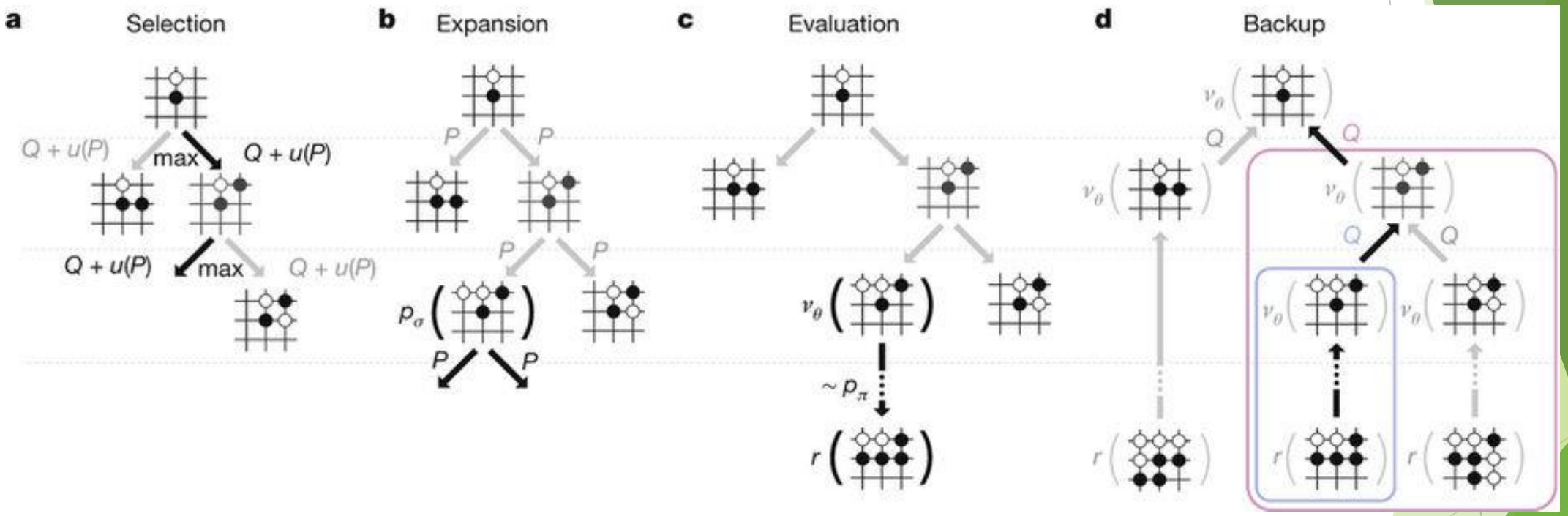
A method for making optimal decisions in artificial intelligence (AI) problems, typically move planning in combinatorial games.



- 1. Selection

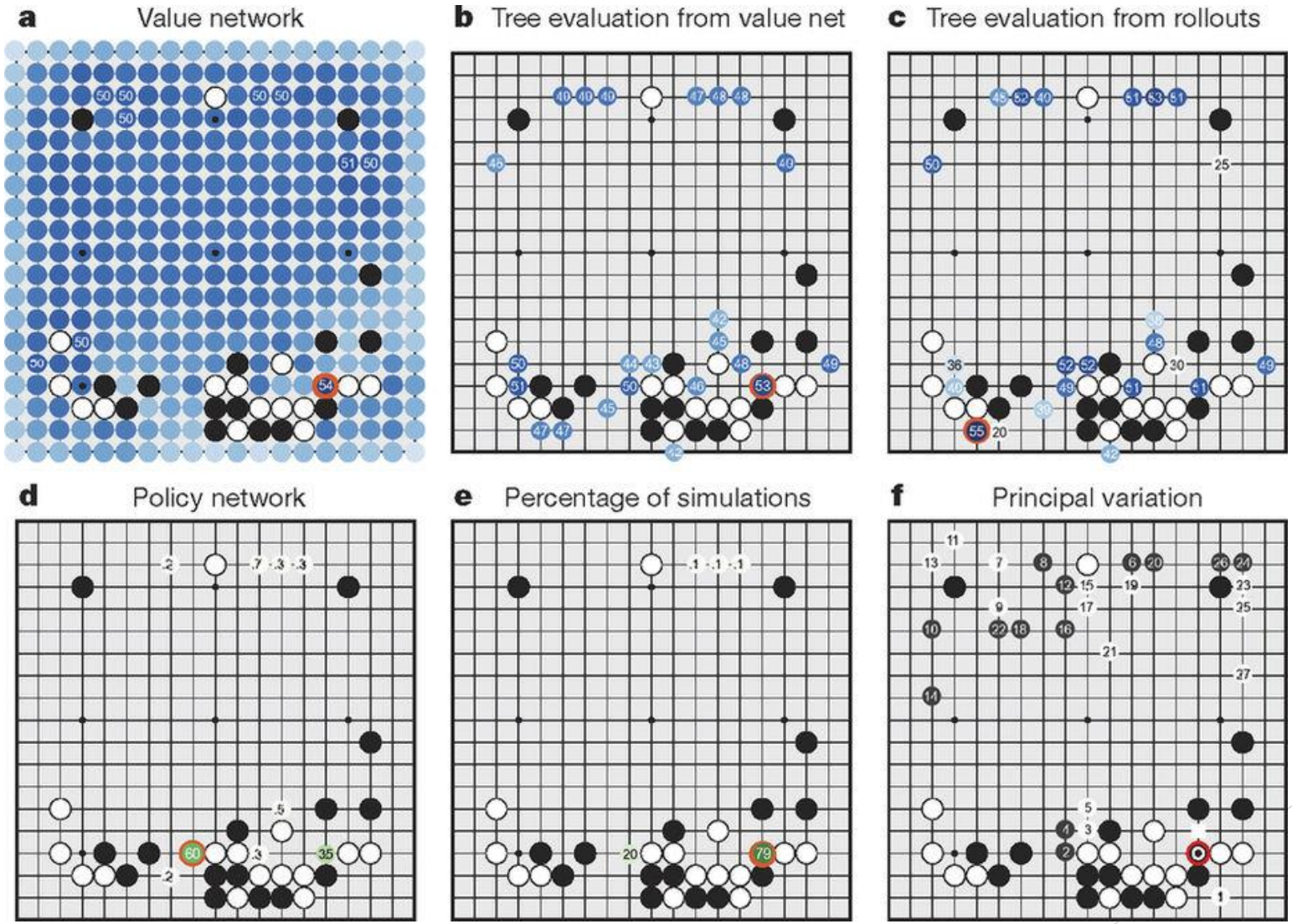
  Starting at root node, recursively select optimal child nodes.
- 2. Expansion
  If root is a not a terminal node (i.e. it does not end the game) then create one or more child nodes.
- 3. Simulation
  Run a simulated playout until a result is achieved.
- 4. Backpropagation
  Update the current move sequence with the simulation result.

Monte Carlo Tree Search in AlphaGo



Q: max action value
U(p): bonus value that depends on a stored probability of p on that edge.

How AlphaGo Makes a move in a Go Game?



Fun Fact:

- AlphaGo has been kicked out of the Go player ranking after reaching No.1 earlier this year.
- https://www.goratings.org/en/

Rank	Name	♂ ♀	Flag	Elo
1	Google DeepMind AlphaGo			3611
2	Ke Jie	♂		3608
3	Park Junghwan	♂		3588
4	Lee Sedol	♂		3556
5	Iyama Yuta	♂		3535
6	Mi Yuting	♂		3529

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- Burger, PhD Christopher. “Google DeepMind's AlphaGo: How It Works.” *On Personalization and Data*, On Personalization and Data, 6 Feb. 2017, www.tastehit.com/blog/google-deepmind-alphago-how-it-works/.

Thank You!