UCT-Enhanced Deep Convolutional Neural Networks For Move Recommendation in Go

Sarun Paisarnsrisomsuk

Pitchaya Wiratchotisatian
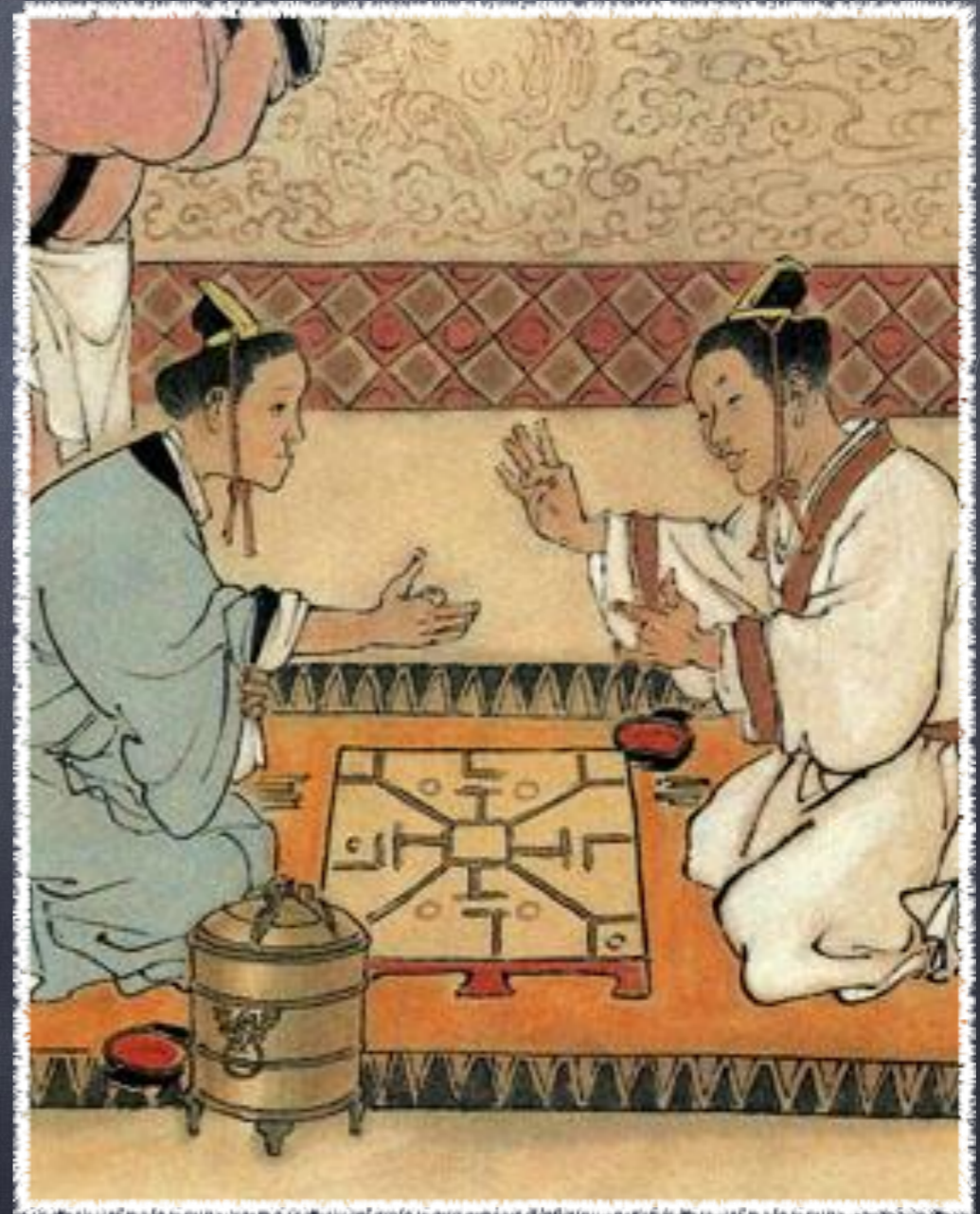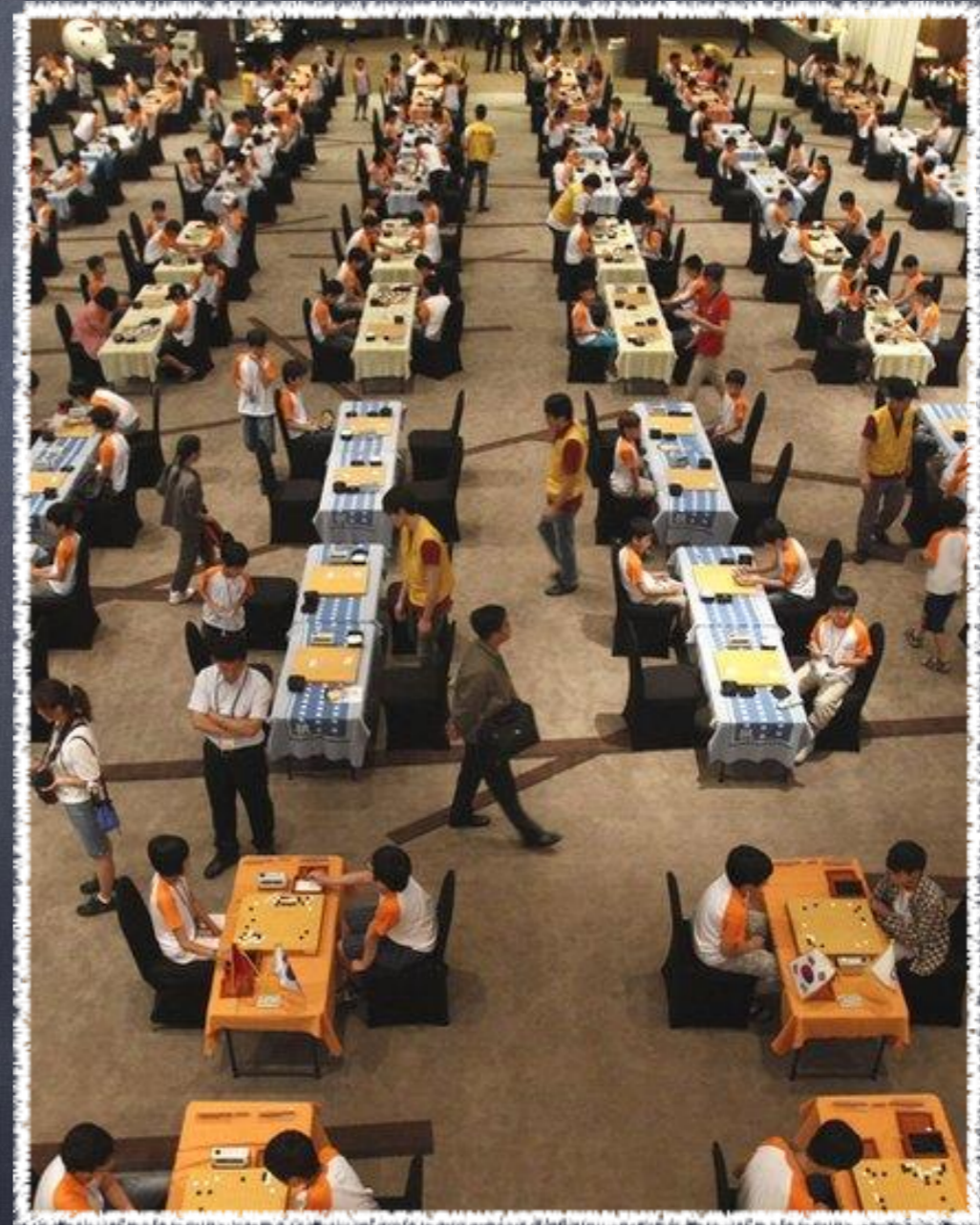
Outline

Go: An Ultimate Challenge for AI

- An ancient board game

- Two-player

- Zero-sum

- Deterministic

- Perfect-information

Simple Rules, but Complex Strategies

- Place stones in turn on a 19x19 board

- Basic goal: secure more territories than the opponent

- Enormous combinatorial complexity
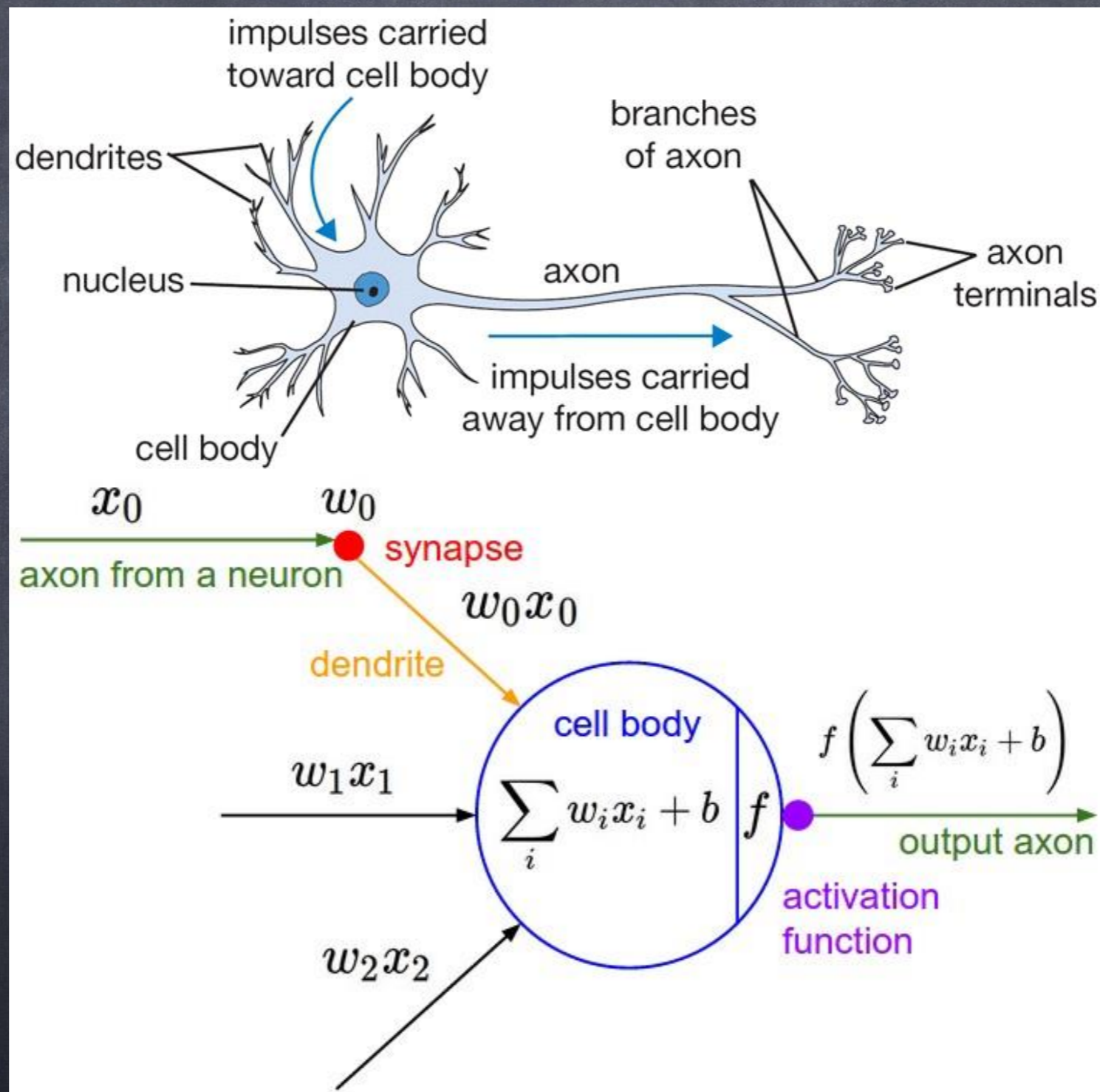
- Long-term influence of a move

Goal

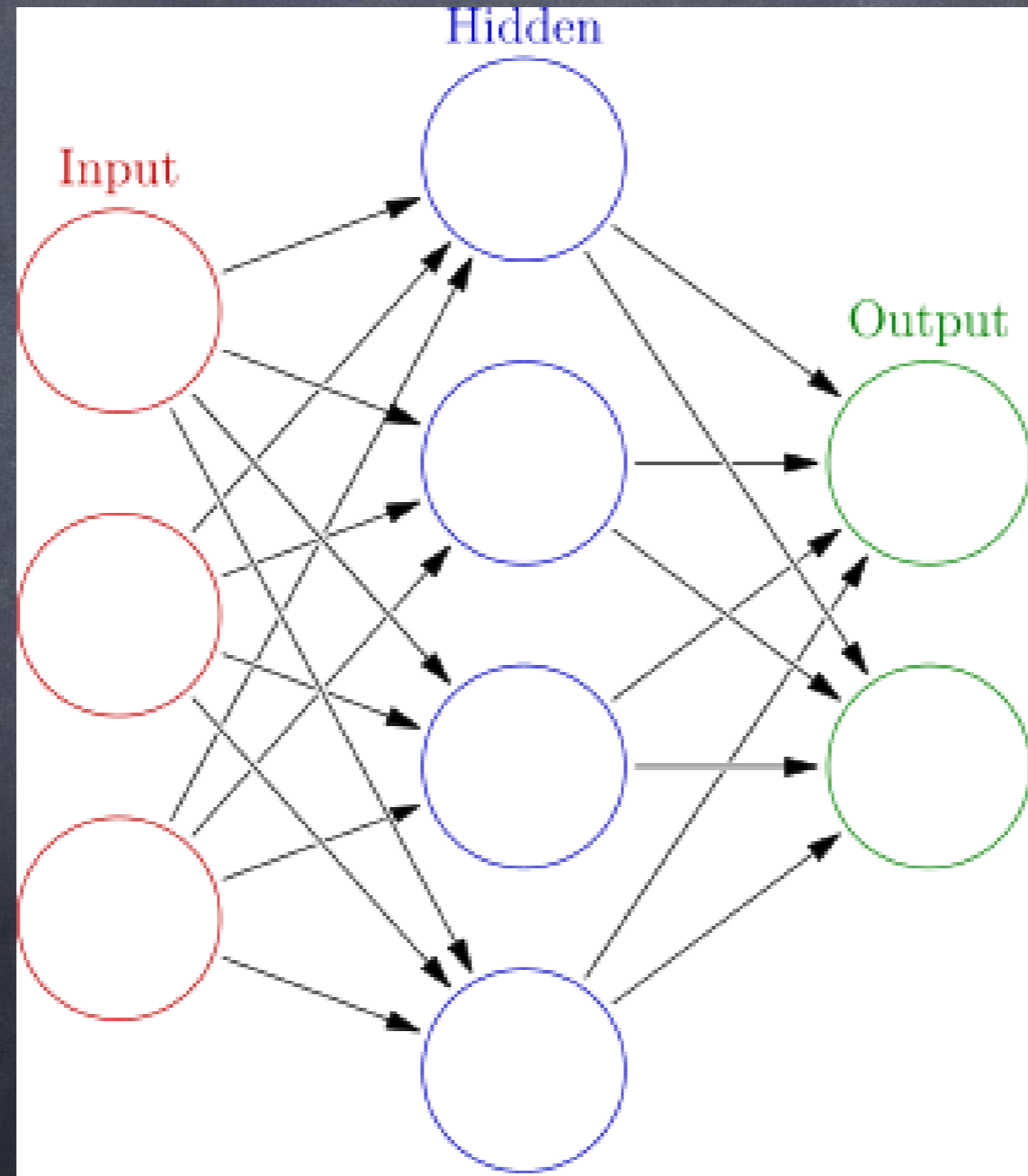To enhance move recommendation in Go using DCNN and UCT
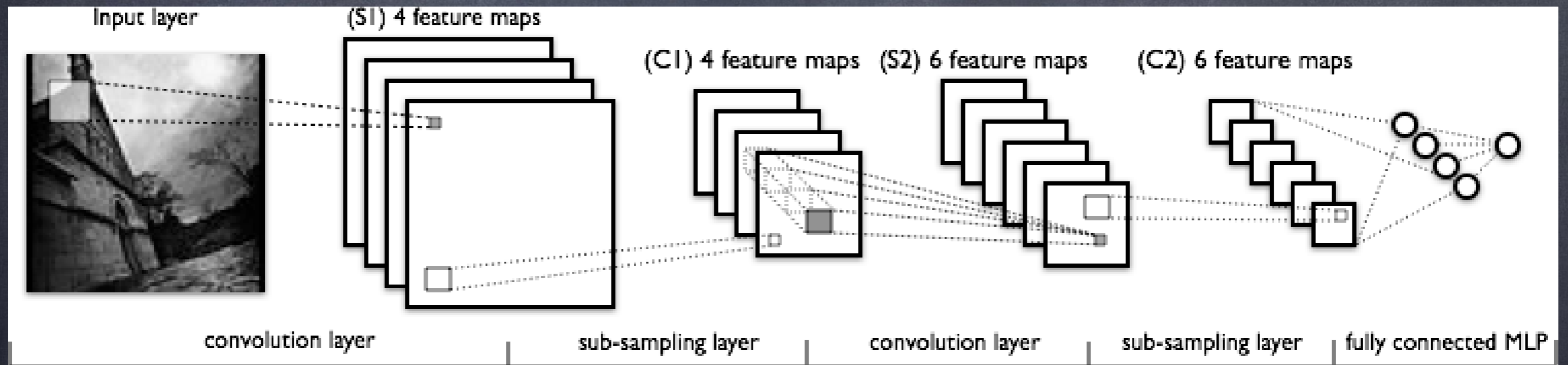
Deep Convolutional Neural Networks (deep CNN)
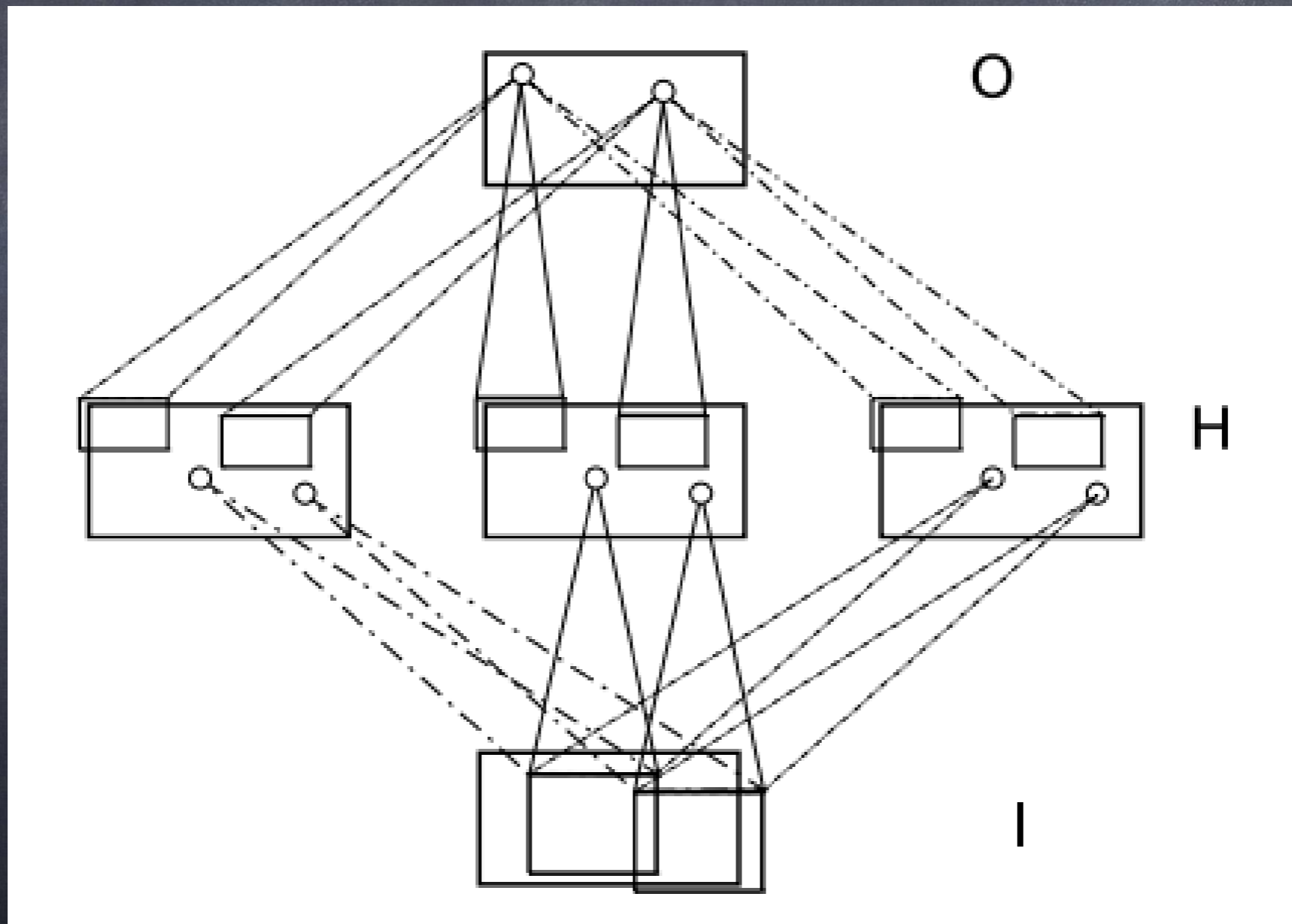
Neural Network

Neural Network
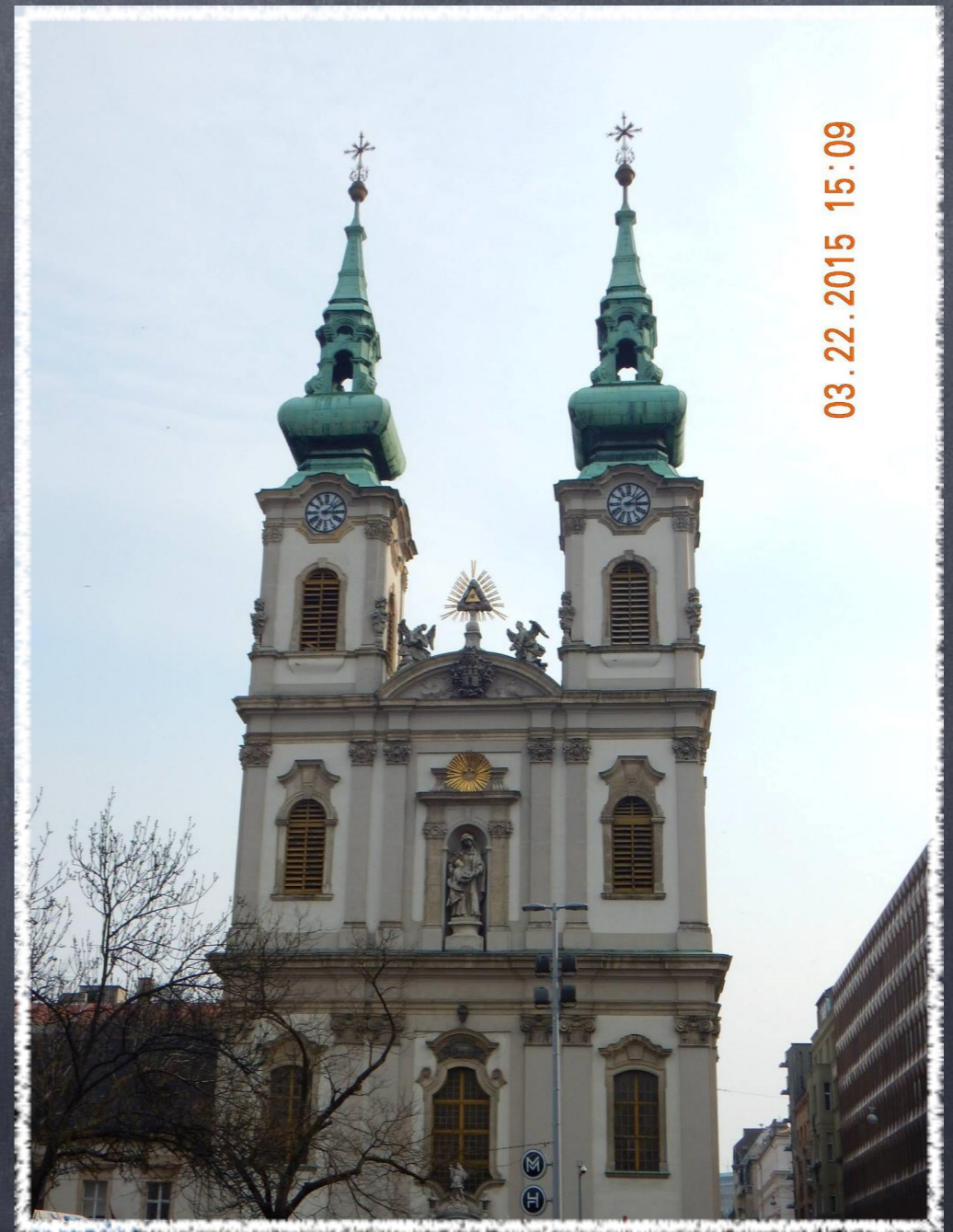
Deep Convolutional Neural Networks
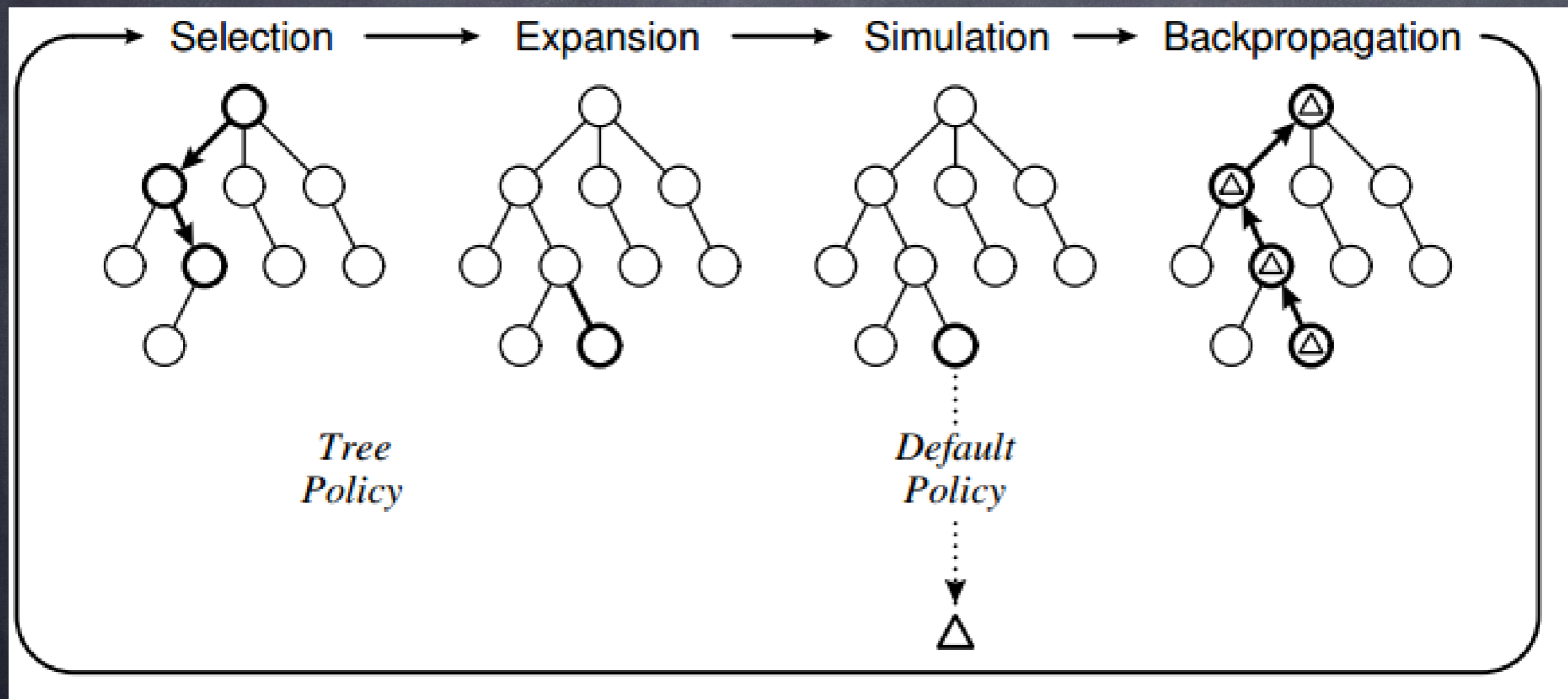
Deep Convolutional Neural Networks

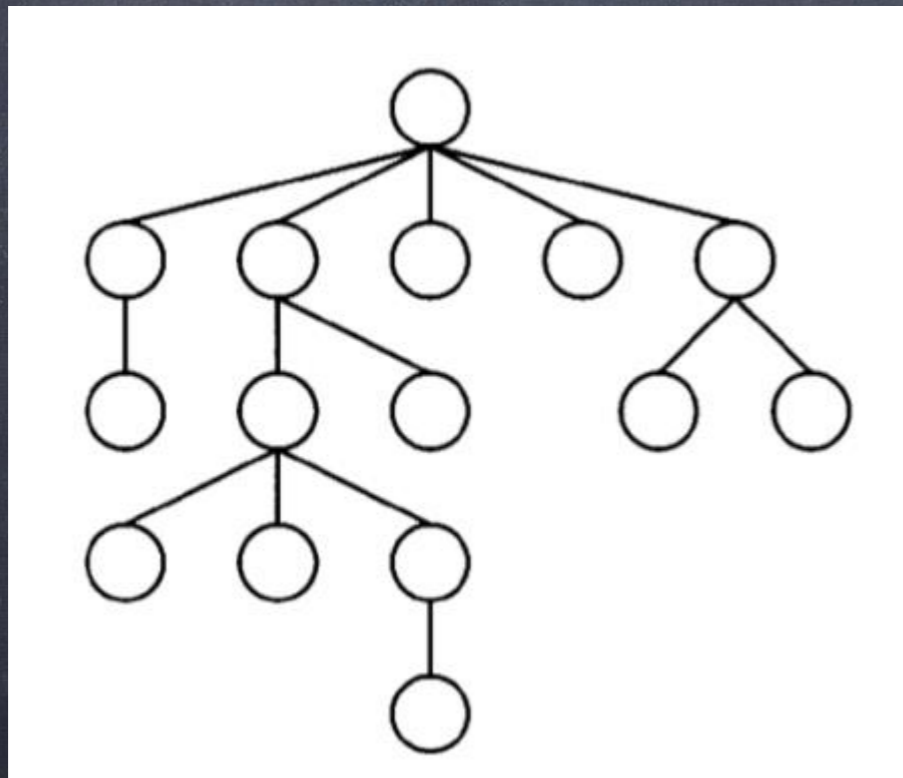# Upper Confident Bounds applied to tree (UCT)

Applied bandit-based method to guide Monte-Carlo planning

Monte Carlo Tree Search

Upper Confident Bounds applied to tree (UCT)

Selection Policy:

$$UCT = \overline{X}_j + 2C_p\sqrt{\frac{2\ln n}{n_j}}$$

Exploitation

**Exploration**

Choose node which has maximum value of UCT

Methodology

Go Data

- 170,000 complete games from the KGS Server (Kiseido Go database)

- Extracted features from each individual move

| Feature	Planes	Description
Black / white / empty	3	Stone colour
Liberties	4	Number of liberties (empty adjacent points)
Liberties after move	6	Number of liberties after this move is played
Legality	1	Whether point is legal for current player
Turns since	5	How many turns since a move was played
Capture size	7	How many opponent stones would be captured
Ladder move	1	Whether a move at this point is a successful ladder capture
KGS rank	9	Rank of current player
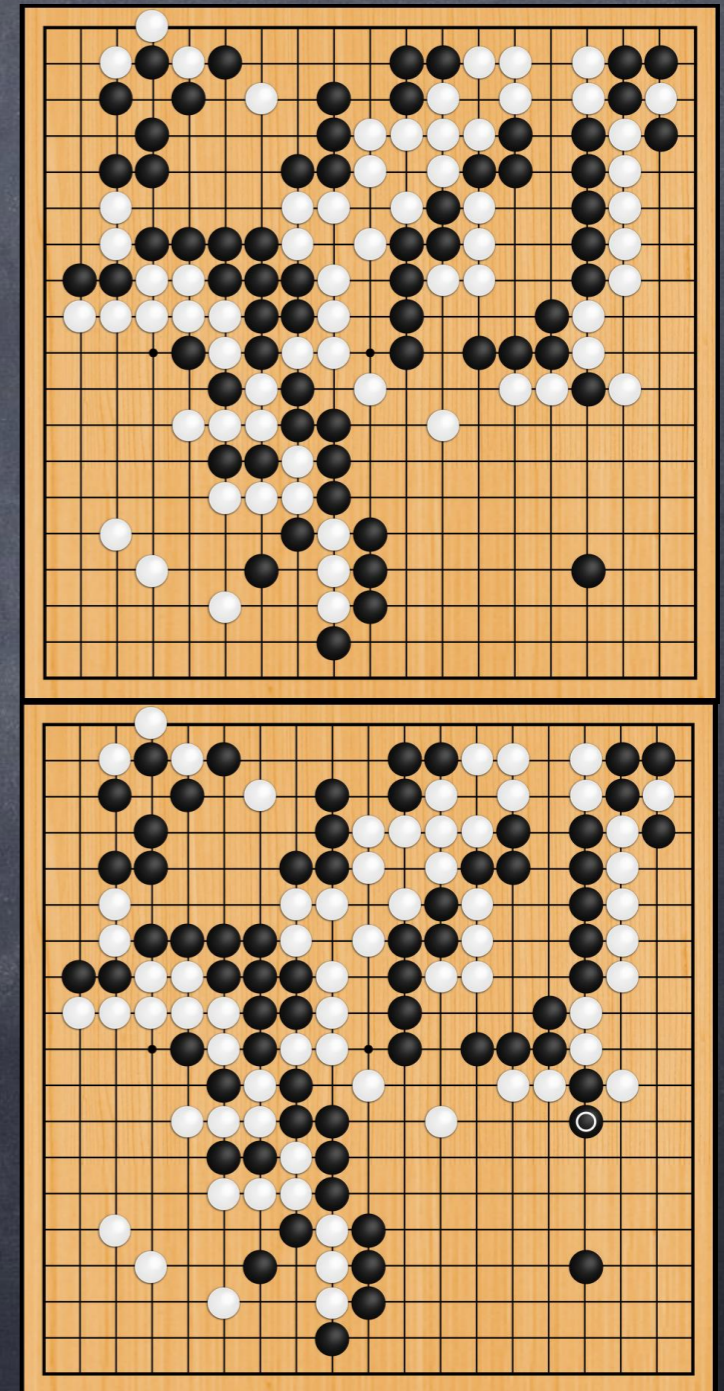
New Feature

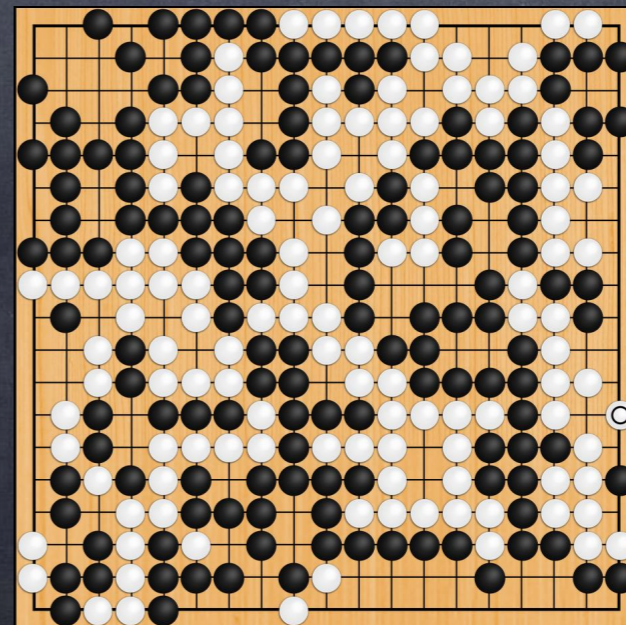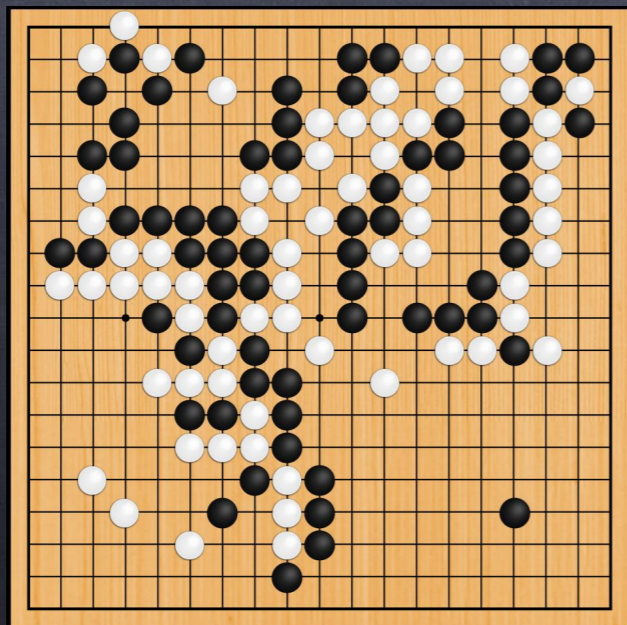- Board pattern at the end of game, or "final board pattern"
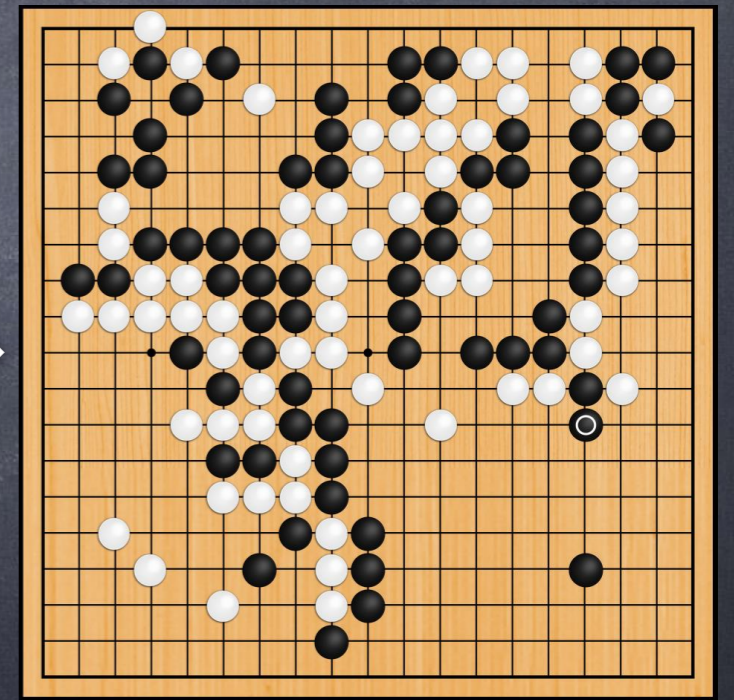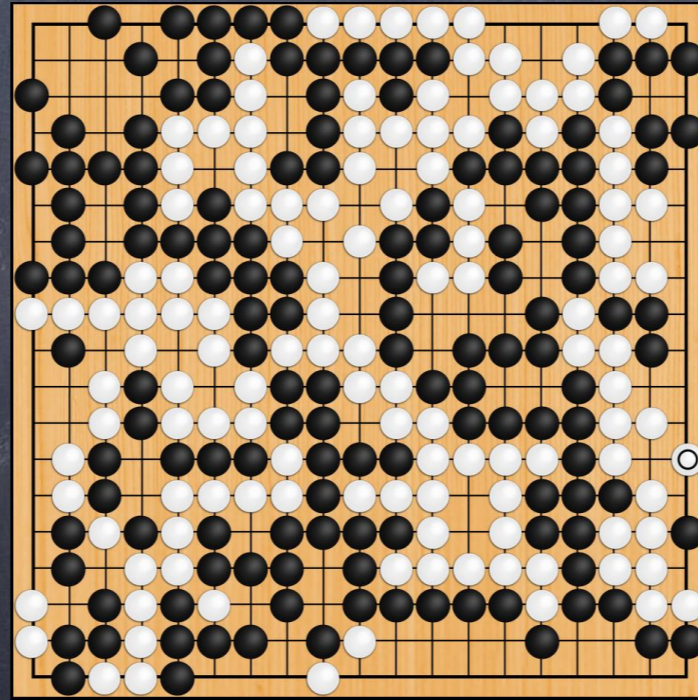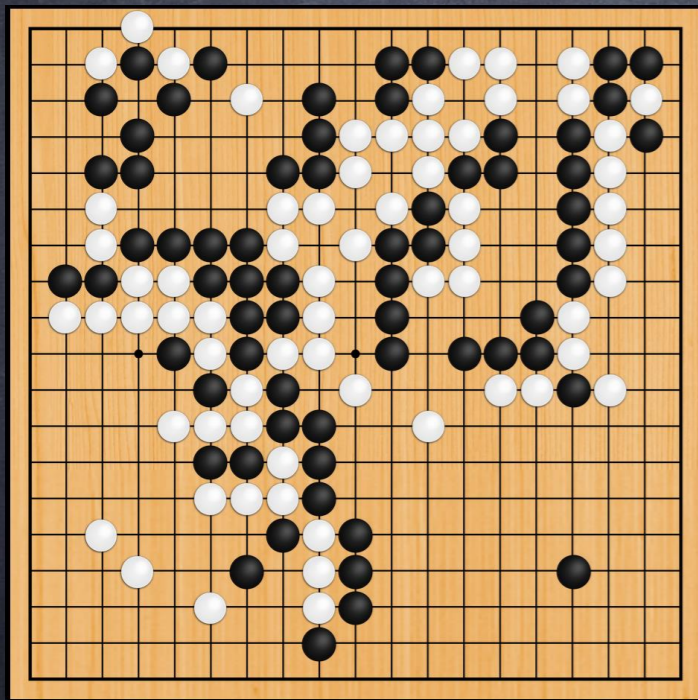
Deep Convolutional Neural Network

We implemented a small deep CNN
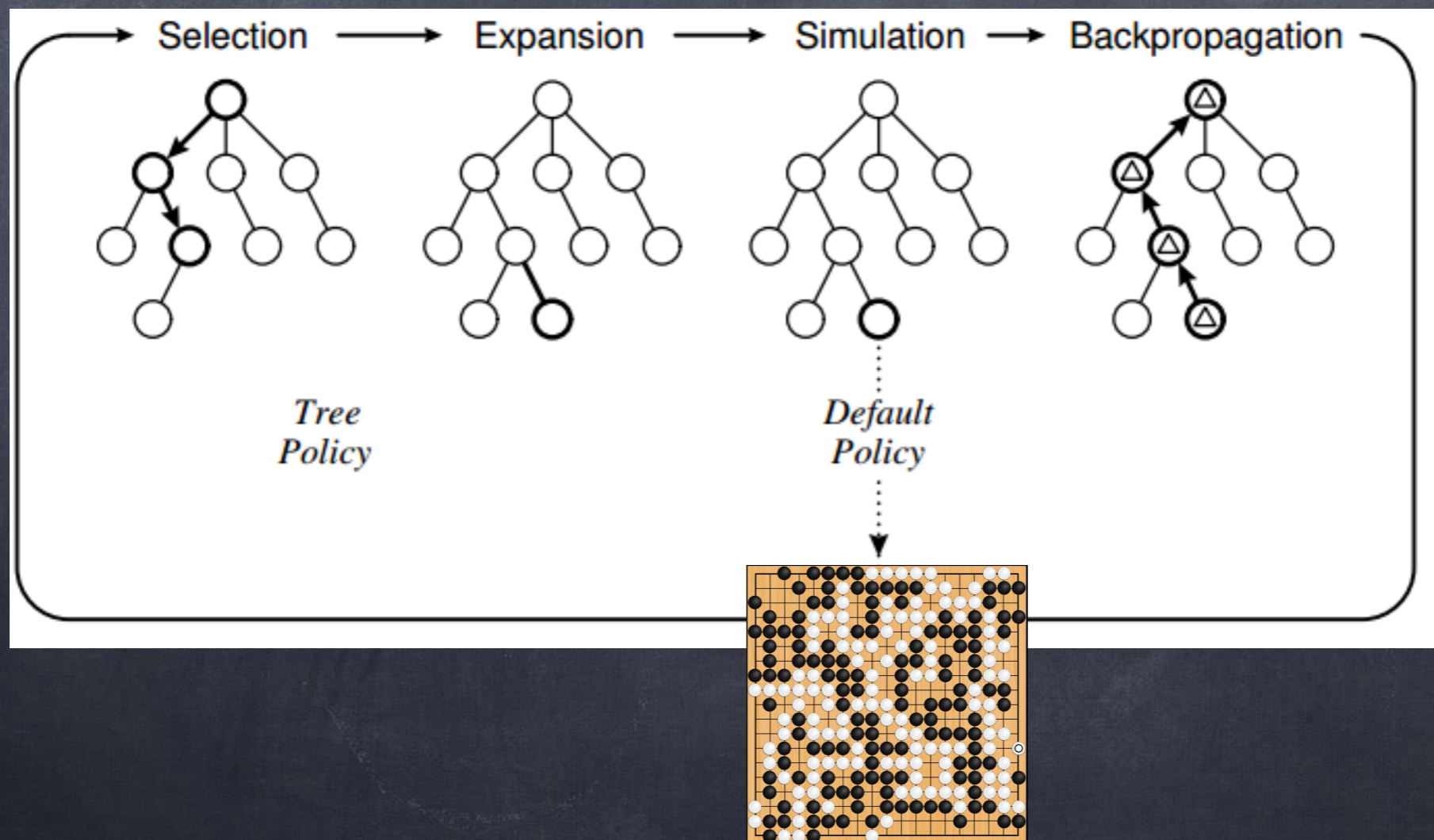
- 1 hidden layer; no pooling

- 10 kernels
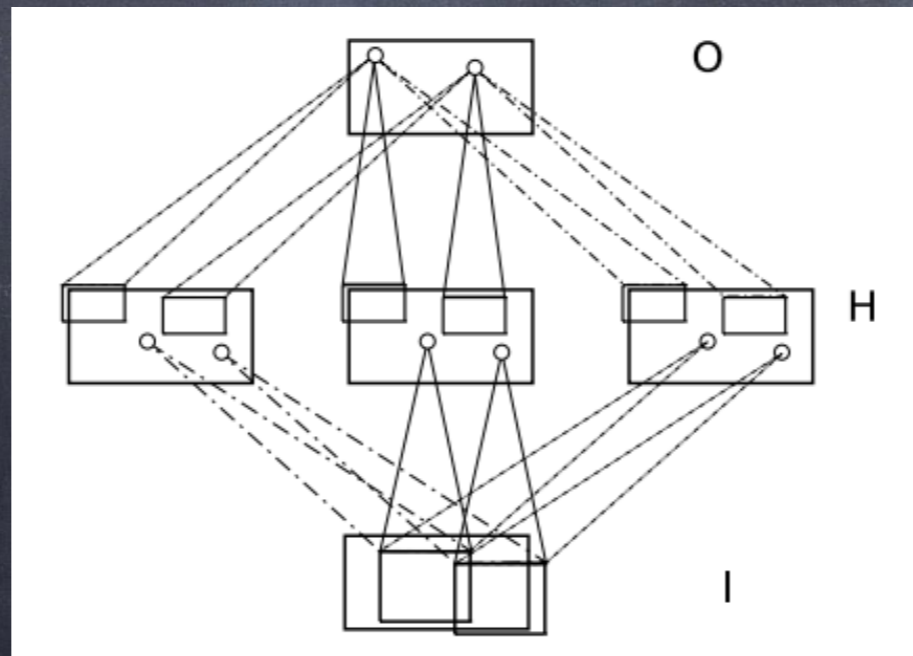
Result from Adding Final Board Pattern to input

- Without final board pattern, accuracy 6%

- With final board pattern, accuracy 18%

- The actual final board pattern is not possible to be obtained
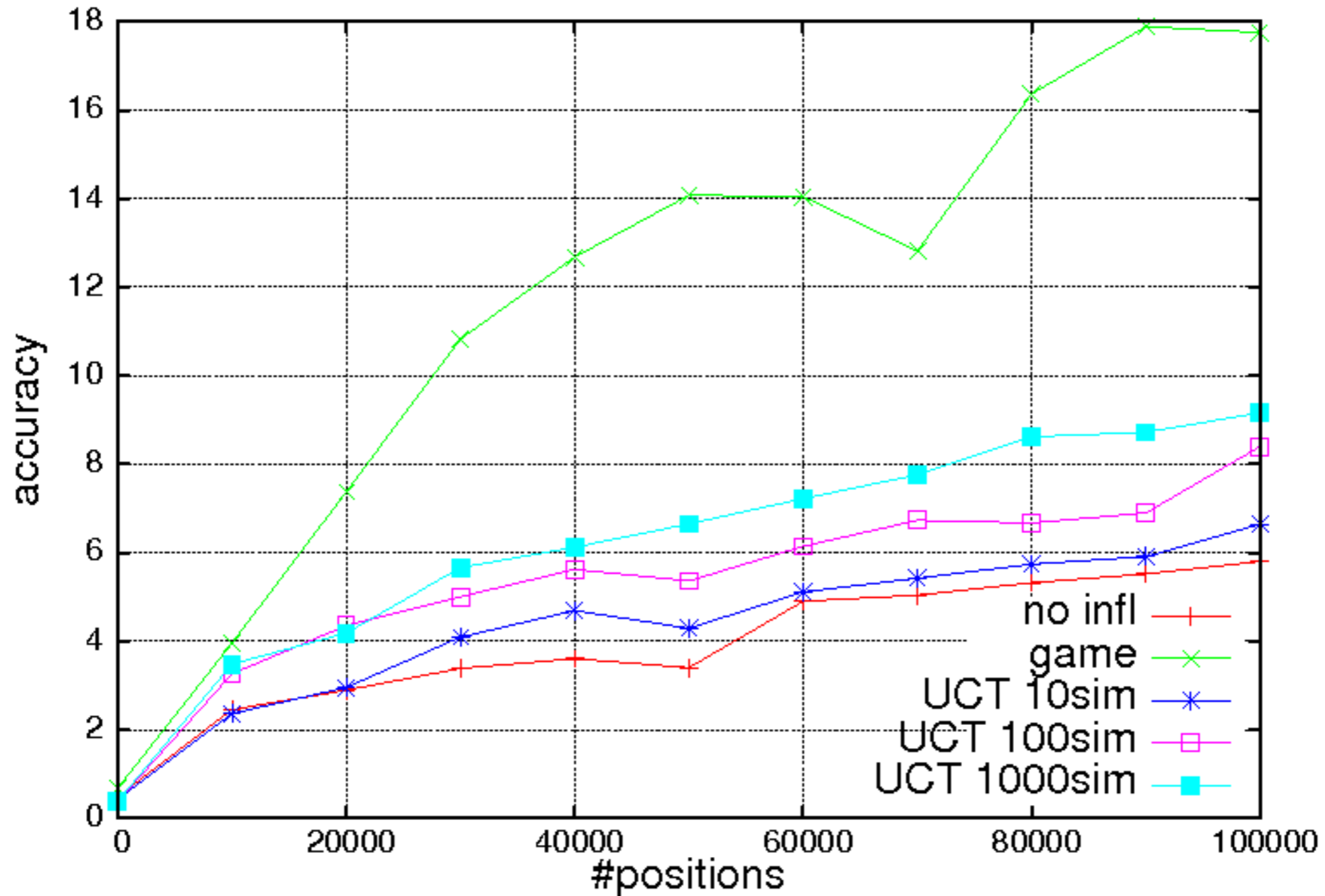
UCT-Simulated Final Board Pattern

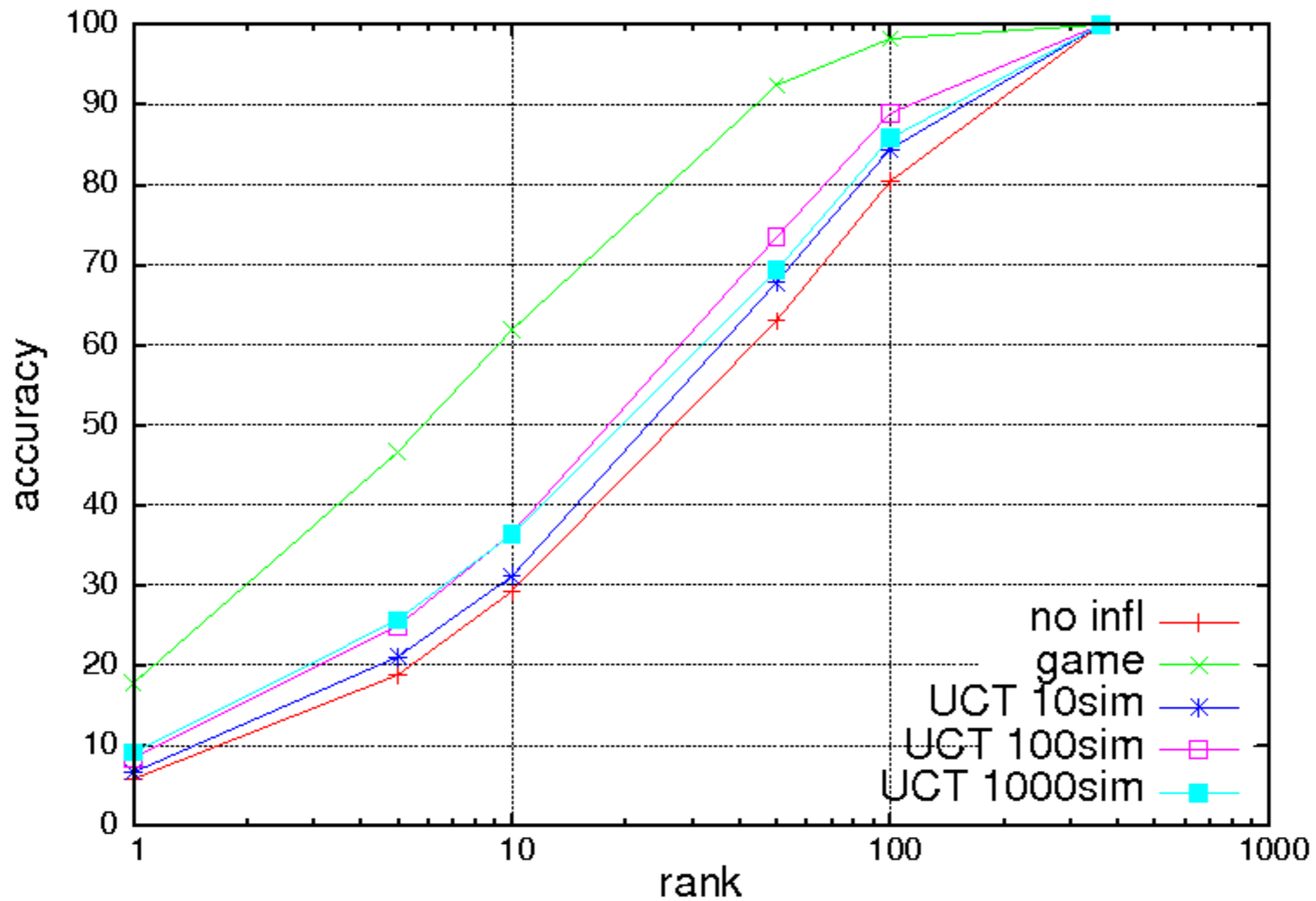Collect final board pattern in each simulation during UCT

Experiments and Results

Result

Result

Conclusion and Future Work

Conclusion

- Adding final board pattern to inputs of the deep CNN improves the accuracy of the network.

- In practice, we can collect statistics in each simulation of UCT to approximate final board pattern.

Future Work

- Deep network's size

- More Training Data

- Additional Features

- Combining deep network with UCT

Acknowledgements

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Questions?

Köszönöm szépen!