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Gomoku Deep

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Outline

- Introduction
- Self-play reinforcement learning on Gomoku
- Experiment results
- Conclusion

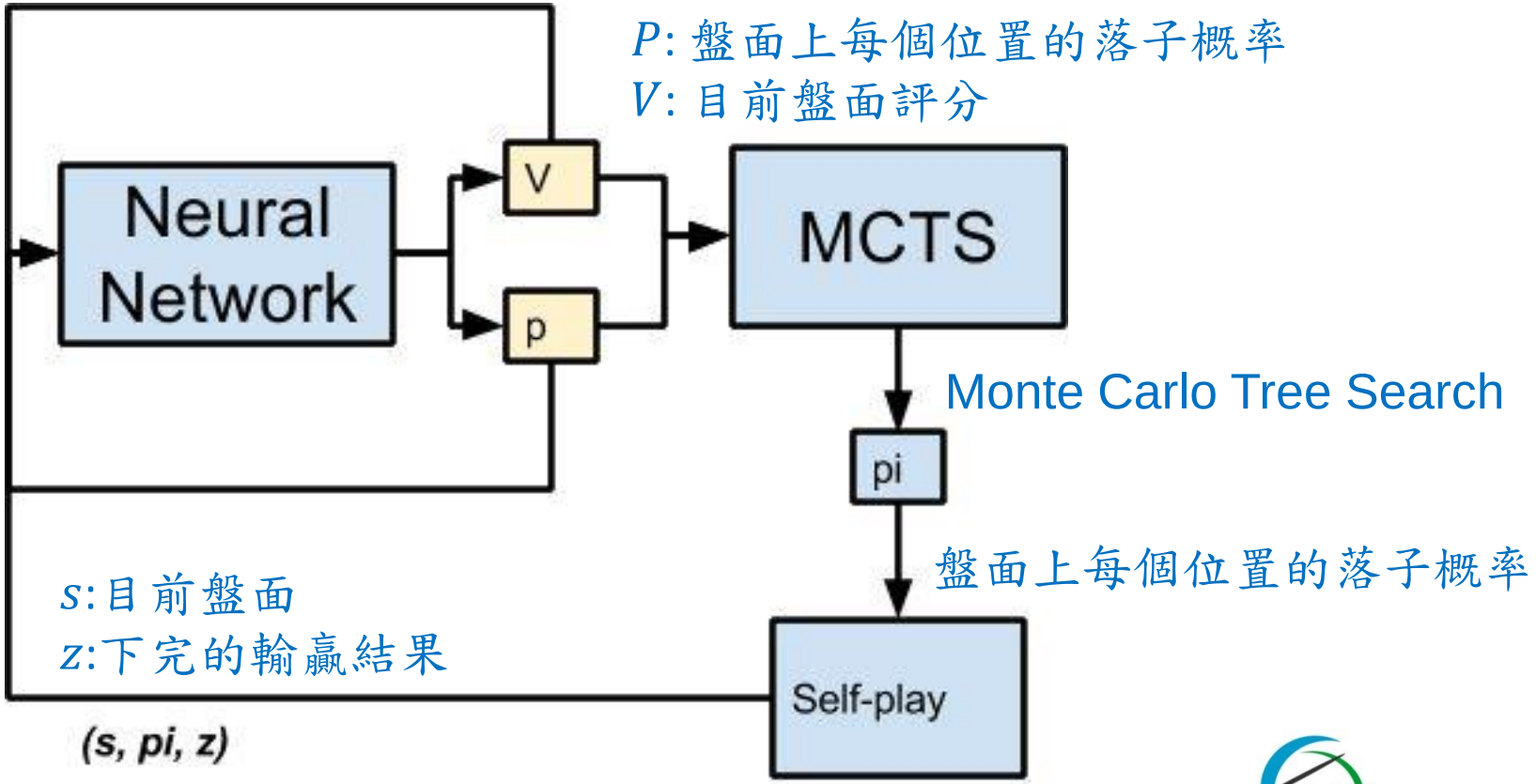
Introduction

- AlphaGo[1] 讓人工智慧再度受到重視
  - 結合強化學習(Reinforcement learning)與深度學習(Deep learning)的技術
- AlphaGo Zero[2] 有更好的表現
  - 僅使用深度強化學習(Deep reinforcement learning)
  - 以Self-play reinforcement learning稱之
- 目的：實作Self-play reinforcement learning在五子棋對奕上
  - 五子棋的規則相較於圍棋簡單
  - 訓練時間也相較少

[1] David Silver et al., ‘‘Mastering the game of Go with deep neural networks and tree search’’, *Nature*, 2016.
[2] David Silver et al., ‘‘ Mastering the Game of Go without Human Knowledge’’, *Nature* ,2017

Introduction

- AlphaGo Zero 結構圖[1]



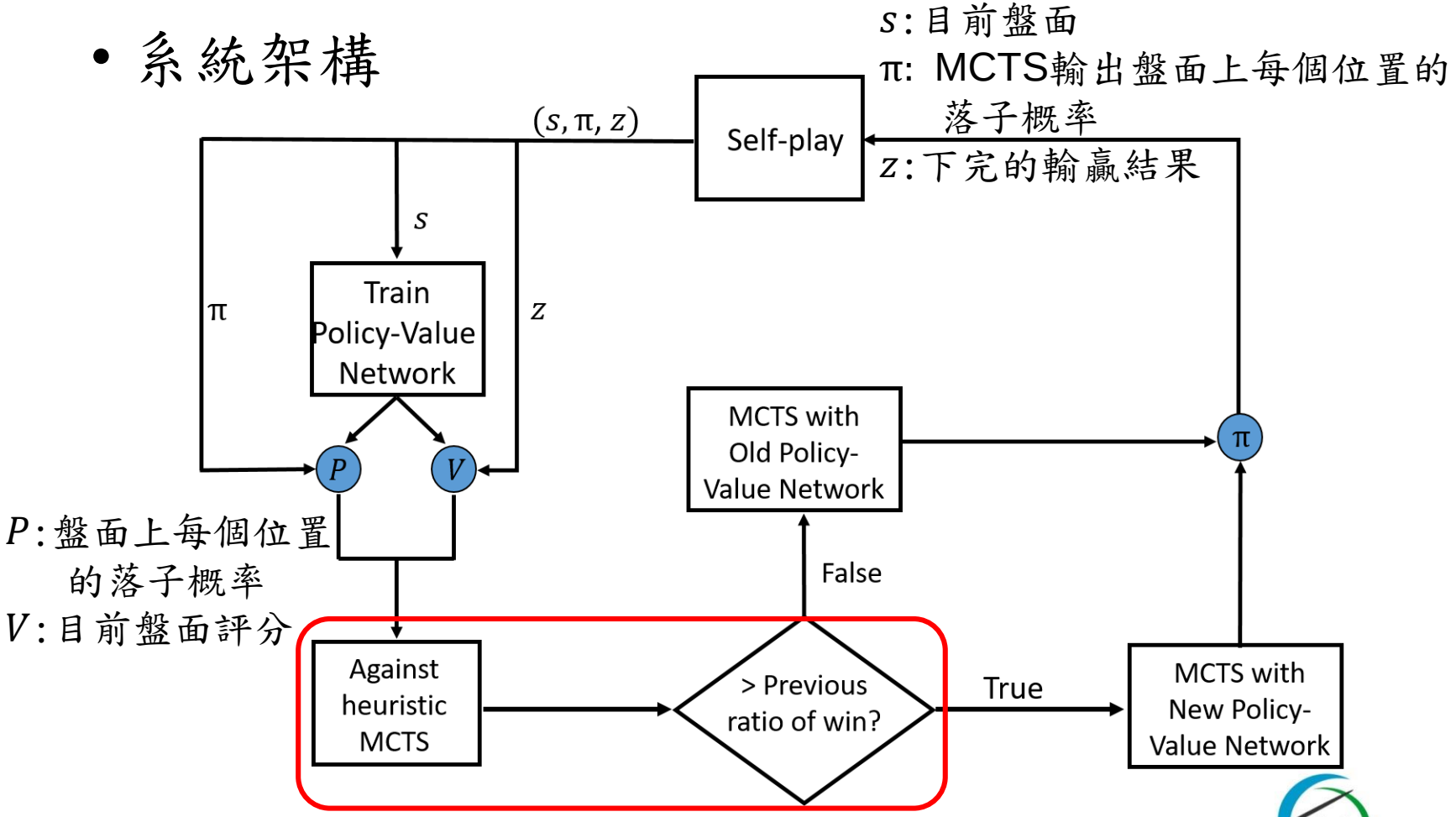
[1] https://zhuanlan.zhihu.com/p/30339643

Self-play reinforcement learning on Gomoku

- 模型的評估方式
  - AlphaGo Zero
    - 新的模型與舊的模型對戰，有如自己去和與自己實力相當的人對戰
    - 收斂速度很慢
  - Gomoku Deep
    - 新的模型與啟發式的MCTS對戰，有如自己去跟會下棋的人對戰
    - 收斂速度較快

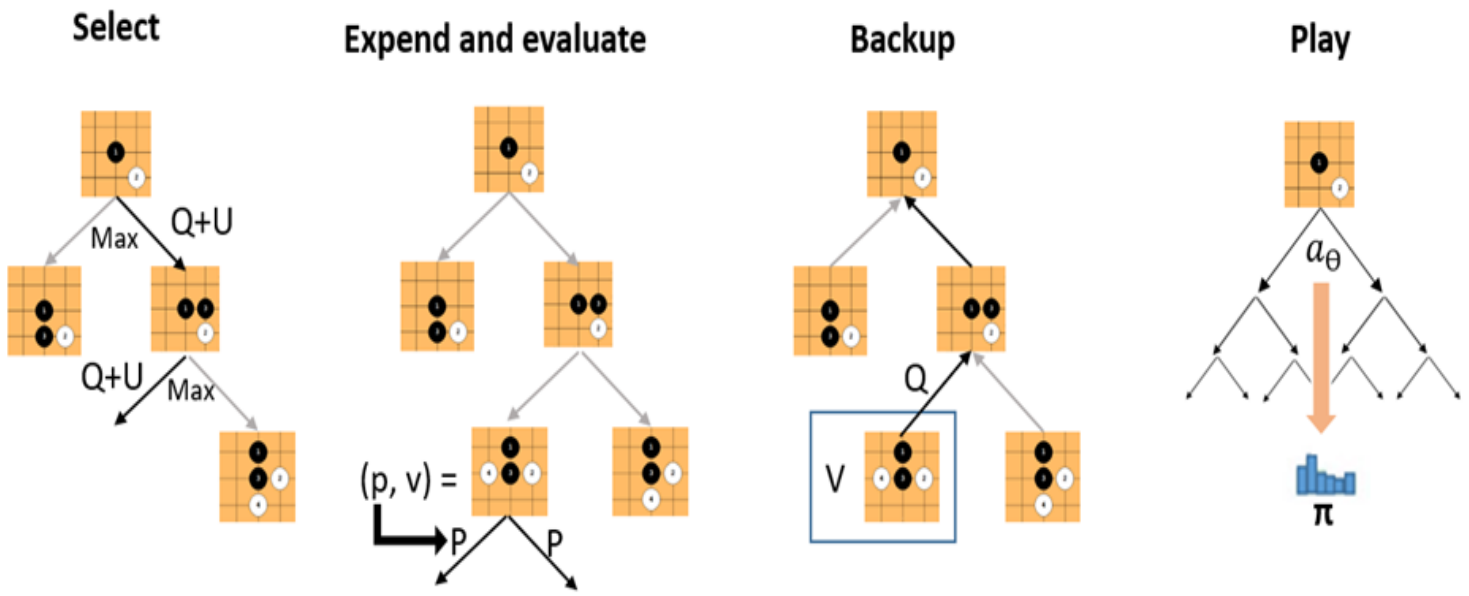
Self-play reinforcement learning on Gomoku

- 系統架構



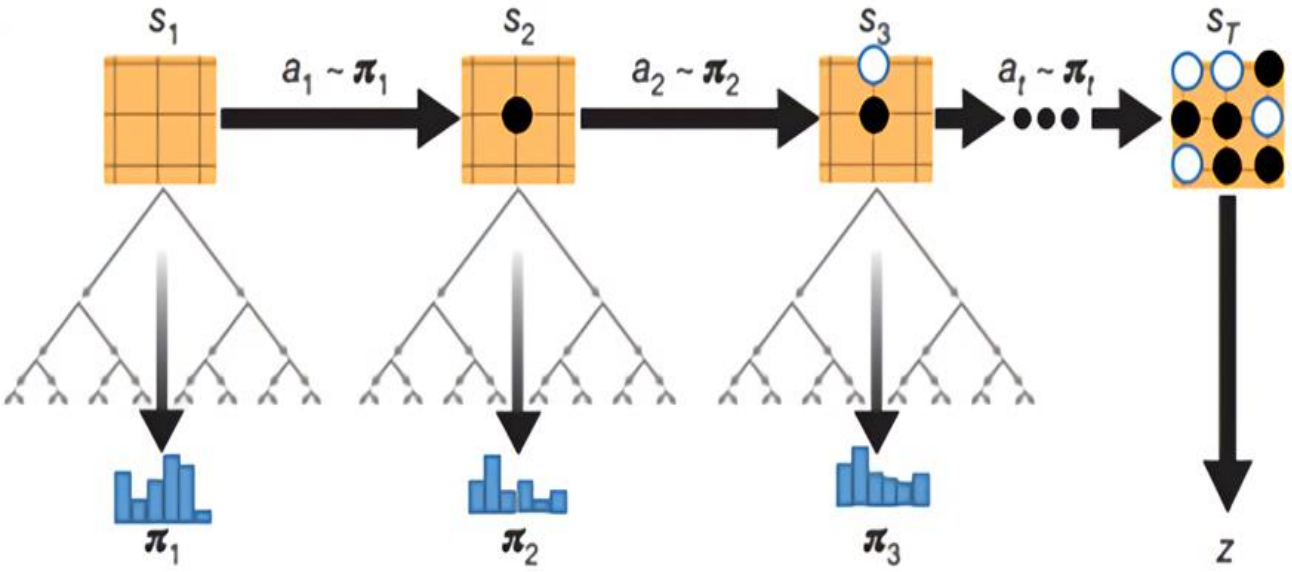
Self-play reinforcement learning on Gomoku

- Monte-Carlo tree search (MCTS)
  - 對抗式遊戲常用的啟發式搜尋演算法



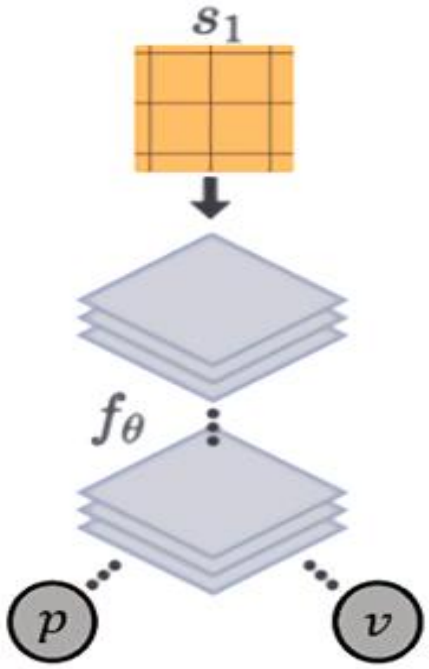
Self-play reinforcement learning on Gomoku

- Self-play for training
  - 自行產生 training data
  - 生成data的多樣性：加入exploration的方法
  - Data 保存和擴充：因對稱性，可旋轉和鏡像



Self-play reinforcement learning on Gomoku

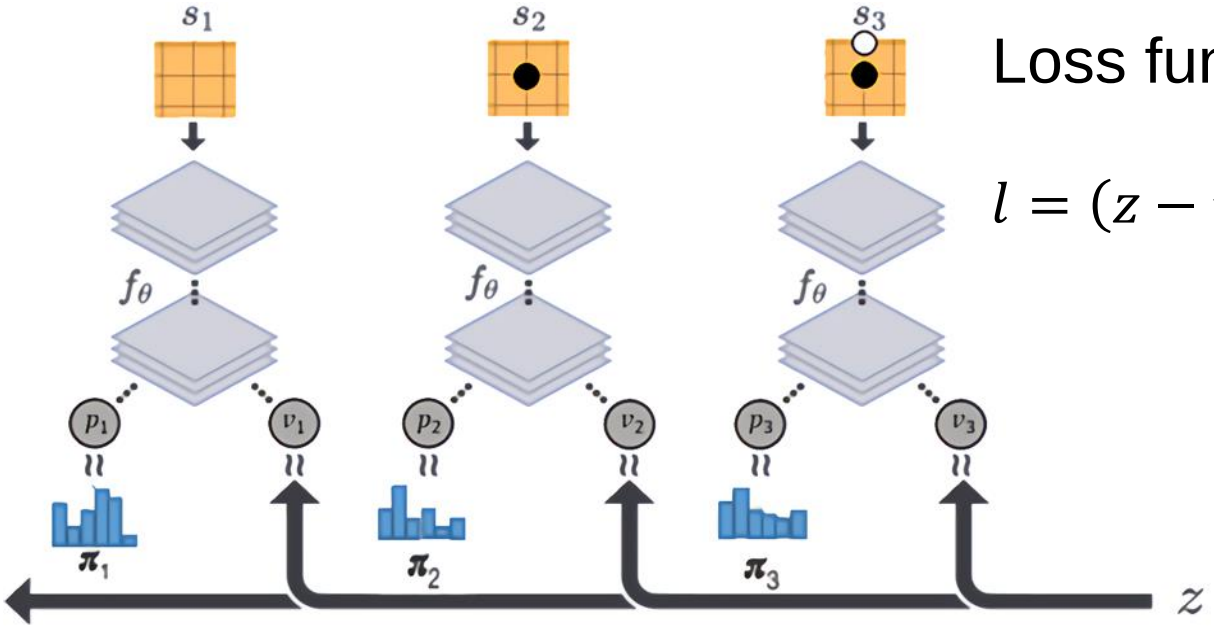
- 策略價值網路(policy-value network) f_θ
  - 輸入：盤面 s
  - 輸出：$(p, v) = f_\theta(s)$
    - 盤面每個位置的機率 p
    - 盤面的評分值 v
  - 卷積層：3
    - 32、64、128個 3x3 filter
  - 策略(Policy)
    - 4個1x1 filter 降維
    - 1個全連接層，透過softmax輸出
  - 價值(Value)
    - 2個1x1 filter 降維
    - 2個全連接層，透過tanh出書



示意圖

Self-play reinforcement learning on Gomoku

- 策略價值網路訓練
  - 機率 p 接近 MCTS的機率π
  - 評分 v 接近實際結果 z



Loss function [1]：

$$l = (z - v)^2 - \boldsymbol{\pi}^T log\boldsymbol{p} + c\|\theta\|^2$$

[1] David Silver et al., " Mastering the Game of Go without Human Knowledge ", *Nature* ,2017

Self-play reinforcement learning on Gomoku

- 策略價值網路的評估方式
  - 每50次的self-play，做一次評估
  - MCTS+新的策略價值網路 vs. MCTS + heuristic function
    - 每次評估對戰10局
    - 逐次增加 MCTS + heuristic function 的模擬次數，以提高其強度
- 總結訓練過程
  - self-play 提供 data 訓練策略價值網路
  - 評估後，好的留下；壞的捨棄
  - self-play 重新產生新 data，構成訓練的循環

Experiment and Results

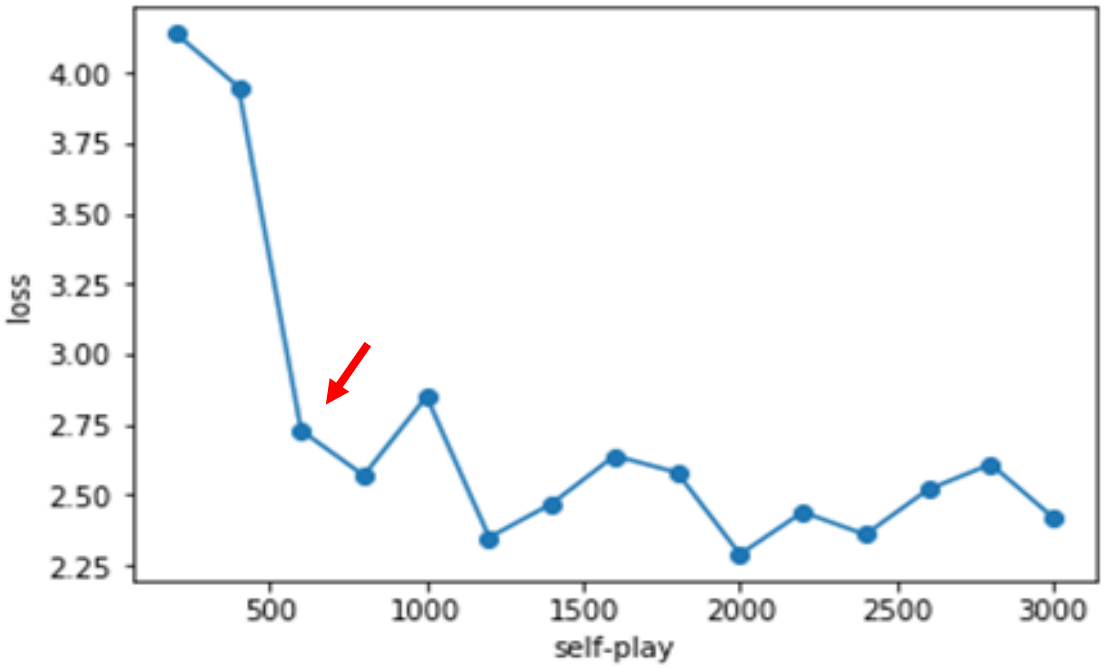
- 實驗設定

CPU	Intel I7 8700k
GPU	GTX 1080
RAM	DDR4 16GB
Chess board size	9x9

- 訓練時間
  - 3000 rounds in 3 days

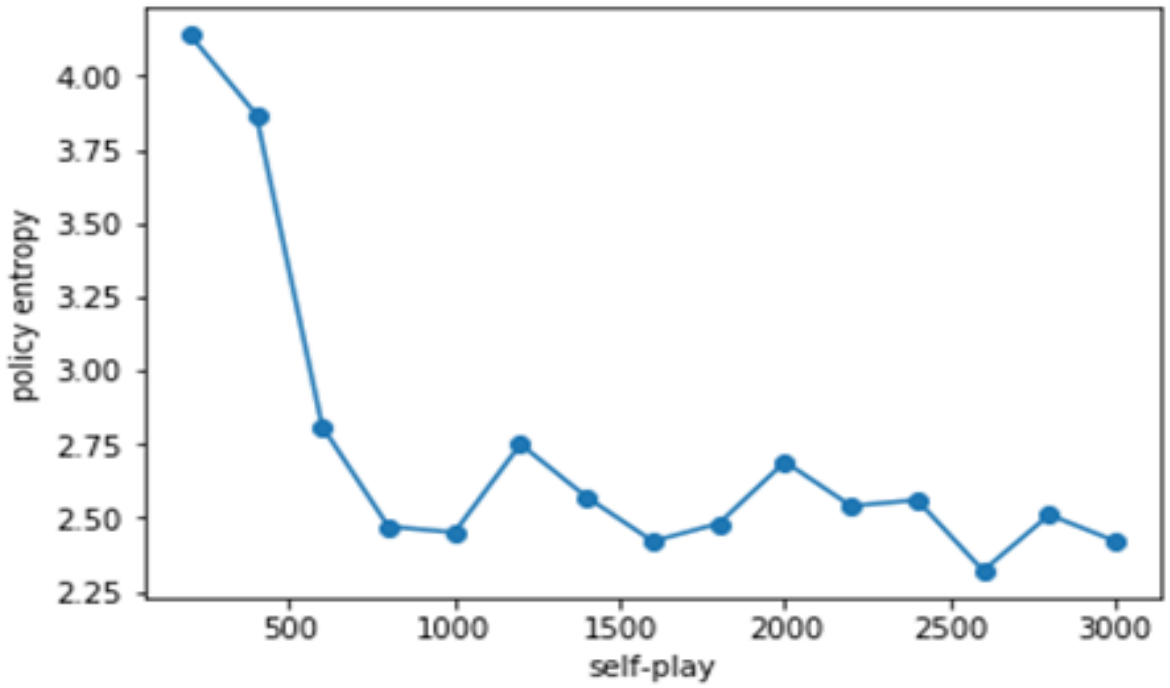
Experiment and Results

- Loss 函數變化
  - 收斂速度較快



Experiment and Results

- 輸出落子機率分布(策略)的entropy變化
  - 慢慢學會在不同的局面下哪些位置應該有更大的落子概率



Conclusion

- 實作Self-play reinforcement learning方法在五子棋對弈
  - Monte Carlo Tree Search
  - Policy-Value Neural Network
- 修改策略價值網路評估方式
  - 因為縮短了訓練時間，個人電腦也能實現Self-play reinforcement learning方法
- 實驗結果顯示本論文提出的修改方法不僅縮短了訓練時間，也確實強化對弈能力
- 對於棋面邊角的位置較缺乏對抗性，未來將會這部分於Training改進與修改

Thank you for listening