阿爾伯塔大學 Owen Randall 先生演講：
Efficiently Solving Games with Expected Work Search

文／邱恆毅 資訊科學與工程研究所碩士生

講者 Mr. Owen Randall 來自於阿爾伯塔大學 (University of Alberta)，他在阿爾伯塔大學攻讀了碩士學位並且後來逕行修讀博士學位。目前是 Martin Müller 教授研究團隊當中的一員，研究領域包含強化學習 (reinforcement learning) 及遊戲樹 (game-tree) 相關的研究等。Martin Müller 教授也是 AlphaGo 團隊的領導者 David Silver 的博士指導教授。

本次的演講，講者 Mr. Owen Randall 為我們介紹了他作為第一作者的論文：“Expected Work Search: Combining Win Rate and Proof Size Estimation”。提出這個方法的動機在於他們的研究團隊發現若是單單只靠勝率 (win rate) 或是證明數 (proof size) 來評估一個盤面可能是不夠的，這會導致一些問題。

以圍棋為例，若單單只靠勝率來評估盤面，當我們有一個非常好的盤面，各個位置的勝率都接近 100%，agent 便有可能會下在盤面上的任何位置上，但能夠使用最少步數取得勝利的下法可能只有少數幾個（甚至只有一個），下在其他位置上雖然最終仍然能獲得勝利，但會需要花費更多的步數，也就耗費更多的運算資源。因此，在這個層面上，他們希望可以在勝率差不多的條件下，盡可能找出可以最快獲勝的步數（也就是 proof size 最小的）。

另一方面，若僅僅依靠 proof size 來評估盤面，當我們有一個可以吃掉對手棋子的盤面時，因為我們吃掉了對手的棋子，導致我們可以下的位置變多了，因此 branching factor 也就隨之上升，但這樣便導致 proof number search(PNS) 會傾向於不對這個位子做 expansion，也就導致了我們的勝率降低。因此，從這個角度來看，他們希望可以在 proof size 跟勝率之間取得良好的平衡，既可以不要花太多時間證明，又可以有不錯的勝率。

這篇論文提出的方法 — Expected Work Search(EWS)，其中最主要的貢獻在於這個方法提供了一個可以很好地在勝率與 proof size 中取得平衡的方法，它同時考慮了勝率與 proof size 的資訊去對 game tree 上各個 node 的 children 做排序，藉由這個排序，我們就可以選擇 proof size 相對小且勝率又不錯的 child 做 expansion，以此來達到速度快、勝率高的目的，他們的方法相較於傳統的 go-solver 加速了 6 倍以上的速度，這證明了此方法的可行性。此研究已撰寫成論文，並獲得 IJCAI 頂尖會議接受。

最後，在演講結束後，聽眾與講者一同共進午餐，我們非常感激可以有這樣難得的機會可以和來自世界一流大學的講者進行學術上的交流，這是一個令人難忘的經驗。

Speech by Owen Randall from University of Alberta
Efficiently Solving Games with Expected Work Search

Our speaker, Owen Randall, is from the University of Alberta. He completed his Master's degree there and is now pursuing his Ph.D. He is currently part of Professor Martin Müller's research team, focusing on reinforcement learning and game-tree studies. Professor Martin Müller was the Ph.D. advisor to David Silver, the leader of the AlphaGo team.

During the lecture, Mr. Randall introduced a paper titled "Expected Work Search: Combining Win Rate and Proof Size Estimation," where he serves as the lead author. The method was developed in response to his research team's discovery that evaluating a game state based solely on win rate or proof size would be insufficient and lead to various problems.

Taking the game of Go as an example, if we rely solely on win rate to evaluate the game state, we may encounter situations where the win rates for various moves are close to 100%. This might give the impression that any move on the board could be equally good. However, the reality is that only a few specific moves will lead to victory in the shortest number of steps. While other moves could still lead to winning the game, they would require more steps and computational resources. Therefore, the aim in such situations is to identify moves that lead to victory in the shortest number of steps (i.e., with the smallest proof size) under similar win rate conditions.

When evaluating the game state based on proof size, discovering a scenario where we can capture the opponent's pieces to increase the number of possible moves leads to a higher branching factor. However, the increase in options can discourage further expansion of such a position through proof number search (PNS), ultimately reducing our chances of winning. Therefore, it's important to strike a balance between proof size and win rate, so that we don't spend excessive time on proofs while still maintaining a good chance of winning.

In this paper, a new approach called Expected Work Search (EWS) is introduced. EWS strikes a balance between win rate and proof size by leveraging metrics from both aspects to prioritize the nodes in the game tree. This prioritization process allows the method to focus on nodes with smaller proof sizes and promising win rates for expansion, ultimately aiming for both speed and high win rates. Compared to traditional Go solvers, this method achieves an impressive sixfold speed increase, showcasing its practicality. For more details, the research paper has been accepted at the esteemed IJCAI conference.

After the lecture, Mr. Randall and the audience enjoyed lunch together. We are truly grateful for the unique opportunity to participate in academic discussions with esteemed speakers from leading universities around the world. This experience has left a lasting impression on all of us.