Computational Intelligence Meets the Game of Go @ IEEE WCCI 2012

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Since 2008, National University of Tainan (NUTN) in Taiwan and other academic organizations have hosted or organized several human vs. computer Go-related events [1, 2, 3, 4, 5] in Taiwan and in IEEE CIS flag conferences, including FUZZ-IEEE 2009, IEEE WCCI 2010, IEEE SSCI 2011, and FUZZ-IEEE 2011. Chun-Hsun Chou (9P), Ping-Chiang Chou (5P), Joanne Missingham (6P), Shang-Rong Tsai (6D), Sheng-Shu Chang (6D), and Shi-Jim Yen (6D) were invited to attend the *Human vs. Computer Go Competition @ IEEE WCCI 2012* (http://oase.nutn.edu.tw/wcci2012/ and http://top.twman.org/wcci2012) held in Brisbane, Australia, in June 2012. Seven computer Go programs, including *MoGo*/*MoGoTW* (France, Netherlands, and Taiwan), *Many Faces of Go* (USA), *Zen* (Japan), *Erica* (Taiwan), *Fuego* (Canada), *Pachi* (Czech Republic and France), and *Coldmilk* (Taiwan), challenged the humans in the competition. In addition to observing how many advances have been made in artificial intelligence, the competition also observed physiological measurements for testing cognitive science on the game of Go. The topic is "*the Most Strategic Game"* because Go is the deepest known game for the classical "depth" criterion. The planned games in the competition include: (1) 7x7 small board games to see if computers can also outperform humans when the games conditions are slightly in favor of humans, (2) 9x9, 13x13, and 19x19 board games to see how far computers are from humans now, and (3) novel activities for physiological measurements to see if physiological signals are also impacted by various conditions. It is now known that Go is specific in the sense that brain areas involved in playing Go are not exactly the same as those involved in chess, in particular, more spatial reasoning, mental verbalization, and motor control. The design of games was to investigate the current level of strong programs on various board sizes, but also to monitor the human brain and to check the player strength assessment capabilities of Go programs. Australian Broadcasting Corporation (ABC, http://www.youtube.com/watch?v=KhGvzaMFNAI) also reported this event by the topic of "AI expo underway in Brisbane" on June 15, 2012. The games' results held in the IEEE WCCI 2012 are briefly listed as follows:

- **7x7:** We assume that the fair komi in 7x7 Go is 9, which is the usual belief on 7x7. In June 2011, *MoGoTW* won 20 games against 10 professional Go players with komi in favor of the computer, and each human played as Black and as White [6]. Komi was 9.5 when the computer was White, and 8.5 when the computer was Black. This was done in order to check the ability of the computer to reach optimal play in 7x7. In spite of a mistake in one game (followed by a mistake by the human), the computer had a perfect record of 20 wins out of 20 games [6]. For the competition held in IEEE WCCI 2012, we played both easy setting (Komi in favor of the computer, i.e. 9.5 when computer is White and 8.5 when computer is Black) and difficult setting (Komi in favor of the computer, i.e. 8.5 when computer is White and 9.5 when computer is Black). The game results show that *MoGoTW* won all games which were "easy" for it; and won 50% of "hard" games against three 6D players. *MoGoTW* also won 1 out of 6 games in the hard setting against professional players. However, Joanne Missingham (6P) said that the reason she lost the game is that she is not familiar with 7x7 game, and this lost game is her first 7x7 game. *MoGoTW* has outperformed humans in 7x7 Go, making no mistake whereas humans, including one 6P player, did mistakes.
- **9x9:** 9x9 is the favorite format of computers, which now win games routinely against professional players. Komi is often 7.5 in the past competitions. But komi is 7 this time so the game result may be a draw; computers must be able to deal with the draw situation. From the six 9x9 games' results, we know that (1) surprisingly, only amateurs lost games, (2) in fact, humans could perform so well in spite of playing blindfolded for two of these games, and (3) even strong bots like *Pachi* or *Many Faces of Go* can lose even games to professional players. Hence, humans are still strong in front of computers in 9x9 Go with komi 7.
- **13x13:** 13x13 is a nice platform for Go, as it is a less immediate fight than 9x9 Go and it is less time-consuming than the standard 19x19 Go. The eleven 13x13 games' results show that humans won all games, including the four kill-all Go games. In June 2011 [5], computers won four 13x13 games out of 8 against professional players with H2 and 3.5 komi (i.e. handicap roughly 1.5), the best performance so far. For 13x13 kill-all Go, in Tainan in 2011, *MoGoTW* could win as White with H8 against Ping-Chiang Chou (5P), which is seemingly the best performance so far.
- **19x19:** Humans are still stronger than computers, in particular for the big 19x19 board where strategic elements matter a lot. 19x19 Go is the main version of the game of Go. The thirteen 19x19 games' results show that the performance so far is a win with H4 when *Zen* was against a 9P player. The player (Chun-Hsun Chou) said that he miscounted the compensation and so he believed that the game was an easy win. When he understood his mistake, it was too late for trying to win. On the other hand, Joanne Missingham (6P) was in a very difficult situation in her H4 game against *Zen*; *s*he played a move for cheating *Zen* (a very suboptimal move, aimed at making the situation difficult) and *Zen* erroneously resigned, whereas the situation was admittedly a win for *Zen*. There are still 4 handicap stones, giving to the program an advantage in each corner, so professional Go players mentioned that switching to handicap 3 is a huge challenge. In particular, computers still have weaknesses for combining multiple local fights. Remarkably, *Many Faces of Go* won as Black with komi 3.5, i.e. roughly a handicap 0.5, against a 6D player (Sheng-Shu Chang).
- **Level assessment in Go:** Parts above were dedicated to the assessment of programs strength, and to physiological measurement. We here consider a different goal, for Go programs: to evaluate the level of the human opponents. Simple tools for level assessment in Go consist in playing several games, increasing the strength of the computer when the computer loses, and decreasing it when the computer wins. Then, the level of the human is estimated using a classical Bayes analysis using the

ELO model [7]. We performed such tests on players from kyu level to 6D, using *MoGoTW* playing on many computers in Taiwan in May 2012. We have then seen that in 5 games, we can estimate the strength of players somehow efficiently. This has direct applications for eLearning because evaluating Go players (by playing games) is similar to evaluating students (by proposing exercises). This time, in June 2012, each player also played only 5 games and we tried to compare three 6D players, a difficult task because they have a very similar strength. The games' results show that *MoGoTW* could nonetheless find out that Shang-Rong Tsai (6D) is a particularly strong 6D player. This shows that our artificial player is also able to analyze the strength of strong players. Importantly, along with this ability to evaluate the strength of humans, the computer can adaptively adjust its strength to the opponent, in order to increase entertainment, which is helpful for motivating children to learn.

- **Measurement in physiological signals**

Signal measurement is a good way to understand more about the difference in physiological signals between (1) normal people and Go players, (2) playing under hard and easy situation, (3) playing on small-size and big-size boards, and (4) playing usual Go and unnatural Go (kill-all Go) or blindfolded Go. In the competition, the measured physiological signals contained brain wave (electroencephalogram, EEG), skin temperature, skin conductance, heart rate, blood volume pulse, and respiratory wave during playing the game. With the collected physiological signals, it will be feasible to analyze game-level statistics to understand the variance of strategies employed by the human and computer in each game.

After a series of Human vs. Computer Go Competitions from 2008 to 2012, this event proves that artificial intelligence has improved a lot in computer Go, in particular *Zen*'s great progress. Additionally, Prof. Nikhil R. Pal (General Chair of FUZZ-IEEE 2013) and Dr. Gary Fogel (IEEE CIS VP for Conference) also expressed their interest to continue having this kind of competition in the FUZZ-IEEE 2013 and IEEE WCCI 2014, respectively, in the future. Overall, the event in IEEE WCCI 2012 was a great success and we would like to express our heartfelt thanks to everyone who offered any help, joined, and watched the games. We would also like to sincerely thank the IEEE CIS and the organizing committee of the IEEE WCCI 2012, especially Prof. Hussein Abbass, who rendered kind support and great help. The authors would like to thank the National Science Council (NSC) of Taiwan (99-2923-E-024-003-MY3 and 101-2919-I-024-001-A1), Brisbane Marketing, and HeroIT.com for their financial support. Additionally, this work was supported by the French National Research Agency through COSINUS program (EXPLO-RA ANR-08-COSI-004) and *MoGo*/*MoGoTW* are very grateful to Grid5000 for support in parallelization and access to clusters and grids.

Participatnts attending the opening ceremony, including Gary Fogel, Hisao Ishibuchi, Hussein Abbass, and Marios Polycarpou (foreground, left 1, left 5, left 7, and right 5, respectively).

Hussein Abbass (background, right 2) and Chang-Shing Lee (background, left 2) with Shi-Jim Yen (foreground, left 1) measuring the physiological signals.

References

[1] C. S. Lee, M. H. Wang, C Chaslot, J. B. Hoock, A. Rimmel, O. Teytaud, S. R. Tsai, S. C. Hsu, and T. P. Hong, "The computational intelligence of MoGo revealed in Taiwan's computer Go tournaments," *IEEE Transactions on Computational Intelligence and AI in Games*, vol. 1, no. 1, pp. 73-89, Mar. 2009.

[2] A. Rimmel, O. Teytaud, C. S. Lee, S. J. Yen, M. H. Wang, and S. R. Tsai, "Current frontiers in computer Go," *IEEE Transactions on Computational Intelligence and AI in Games*, vol. 2, no. 4, pp. 229-238. Dec. 2010.

[3] C. S. Lee, M. H. Wang, O. Teytaud, and Y. L. Wang, "The game of Go @ IEEE WCCI 2010," *IEEE Computational Intelligence Magazine*, vol. 5, no. 4, pp. 6-7, Nov. 2010.

[4] S. J. Yen, C. W. Chou, C. S. Lee, H. Doghmen, and O. Teytaud, "The IEEE SSCI 2011 Human vs. Computer Go Competition," *ICGA Journal*, vol. 34, no. 2, pp. 106-107, Jun. 2011.

[5] S. J. Yen, S. Y. Chiu, C. W. Chou, C. S. Lee, H. Doghmen, F. Teytaud, and O. Teytaud, "Human vs. Computer Go Competition in FUZZ-IEEE 2011," *ICGA Journal*, vol. 34, no. 4, pp. 243-247, Dec. 2011.

[6] C. W. Chou, P. C. Chou, H. Doghmen, C. S. Lee, T. C. Su, F. Teytaud, O. Teytaud, H. M. Wang, M. H. Wang, L. W. Wui, and S. J. Yen, "Towards a solution of 7×7 go with meta-MCTS," *Advances in Computer Games 13 Conference* (ACG13), Tilburg, The Netherlands, Nov. 20-22, 2011.

[7] A. Elo, The Rating of Chess Players, Past and Present, Arco. ISBN 0-668-04721-6, 1978.