Computer-Aided Go on High-dan Level

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Abstract. Computers based on Monte-Carlo search have a playing style rather different from human Go. The strengths of both sides may complement each other to give a very strong team. In an experiment with team Manja Marz (EGF rating 2271) and bot "Crazy Stone" this indeed happened. In a sparring match over three games against Stefan Kaitschick (EGF rating 2385) "Crazy Manja" achieved two wins after some acclimatisation problems in round 1.

Key Words: computer-aided go, human-computer team;

1 Introduction

We want to demonstrate that human amateurs and computer programs can complement each other to give a team that is stronger than each of its parts. Unfortunately, currently there exists only one very strong go bot with an easy to use western interface for analysis purposes. It is "Crazy Stone" by Rémi Coulom.

A human player — in our case Manja Marz (EGF rating 2271) — got the free choice from the candidate move list of Crazy Stone's analysis. This gave her typically some 15 to 25 moves to select from. Obviously, a newbie has to collect experiences in such multiple choice situations. Manja Marz turned out to be a very quick learner. After one loss and a sleepless night she (+ Crazy Stone) achieved two wins against Stefan Kaitschick (EGF rating 2385).

This paper reports on the experiment and also gives some background information. In Sec. 2 we explain the analysis mode of Crazy Stone in some more detail. Sec. 3 gives a short historical review of the human+computer team "3-Hirn" in chess and its story of success. Some example positions from the experiment are shown and discussed in Sec. 4. The human+computer team approach is compared with Pair Go in Sec. 5. In Sec. 6 we make proposals for further refinement and improvement of Crazy Stone's analysis mode. The paper ends with a short conclusion in Sec. 7.

2 History of Crazy Stone, Analysis Features, and Setup of the Experiment

Rémi Coulom introduced Go programs based on Monte Carlo tree search. Immediately, his "Crazy Stone" won a gold medal in the Computer Olympiad 2006 on 9x9 board. After a long break as programmer he published a commercial version of Crazy Stone (for board sizes 9x9, 13x13, 19x19) in 2011. It was a strong bot, but without much of an analysis tool. In Fall 2011, Althöfer persuaded Coulom to let Crazy Stone analyse a key game of the German Championships (Dickhut vs. Teuber). Rémi put this analysis online [10], and it was observed by many "normal" go players. Even 6-dan Benjamin Teuber, one of the two players involved, looked through the analysis. He remarked that in some positions CS had proposed interesting moves which had not come to his own mind. Motivated by the feedback, Coulom implemented the analysis feature in the commercial 2012 version of Crazy Stone, which in turn led to increased sales numbers.

Features of the Analysis Mode

Crazy Stone has an analysis mode with helpful pieces of information. The program lists all moves for which playouts have been made. For each such candidate the number of playouts are shown as well as corresponding win quota. These numbers are updated each second. Another box on the screen shows a histogram: for each possible score the height of the bar indicates how many playouts had ended by this margin. Strange shapes in the histogram indicate that the bot has problems with (multiple) life and death problems.

Settings of the Experiment

The games were played on KGS, in the computer room. Stefan Kaitschick sat in Hamburg in front of his internet monitor. Manja Marz played in Jena. Ingo Althöfer helped her by operating the notebook (a moderately fast quadcore machine with Crazy Stone running). Manja observed both screens (CS-Analysis on the left one, KGS game window on the other) and made her choice from the candidate list.

3 Human+Computer Successes in Chess: The 3-Hirn

Between 1985 and 1997, Althöfer had performed many experiments with human-computer teams in chess, documented in [1, 8, 4]. In the basic "3-Hirn" setting, collaboration was organized as follows. Two different chess programs (the first two "Hirns"; "Hirn" is german and means "brain") computed for the current position and made one move proposal each. In case of identical proposals this move was executed. However, in case of different proposals the human boss ("Hirn" number 3) had the final choice amongst the two candidate moves. The human was not allowed to overturn the computers. In all 3-Hirn experiments, Althöfer himself was the human boss.

He had a chess rating (Elo number) of 1950. In the first year (1985) the chess computers in use were clearly weaker than the human: each one about 1500 points "strong". The 3-Hirn achieved an Elo performance of 1700. In the years after 1985 the chess computers and programs became stronger and stronger. What remained unchanged was the strength of the human boss (still 1950) and the success of 3-Hirn: always the 3-Hirn rating was about 200 rating points above those of the computers. This was the case even still in 1997, when the bots were around Elo 2550 (and Althöfer still at 1950). In an eight-game match the best German player (GM Arthur Yussupov, Elo 2640), was beaten by 5:3. This corresponds to a 3-Hirn rating of 2750. After the win against Yussupov no further 3-Hirn experiments took place, due to the lack of strong human opponents. Leading grandmasters were no longer willing to play against 3-Hirn, although interesting payment had been offered.

Interesting was one side observation: Two other chess amateurs (one with Elo 1800, the second with Elo 2300) independently tried the 3-Hirn approach in the years around the millenium jump. Both were not at all able to improve on the strength of the solo chess programs. In particular, +200 rating points were completely beyond their horizons. The likely reason is that a success of 3-Hirn depends heavily on the capability of the human in the team to control his/her EGO and influence. The games have to be set up harmonically; and computer-friendly positions have to be approached. The option to select between candidate moves of two machines does not mean that it is fine to switch arbitrarily between the proposals of the bots. In several 3-Hirn games (in chess), all but very few moves came from the same bot.

4 Some Example Positions from the three Games

SGF files of all three games are (soon) available at the website [5]. Stefan Kaitschick used his account `gogonuts` on KGS. The "Crazy Manja" team played via Ingo Althöfer's account `GoIngo`. Stefan won the first game persuasively, whereas Manja had some problems to find the right balance between playing her own style and "helping" Crazy Stone.

In the following we will describe moves with drastic changes in the games of "Crazy Manja". These moves could be considered in the future to improve future computer programs.

Manja about Game 1: Mainly following Crazy Stone naively

In the first game the human+computer team played white.

Move 24 (D11) When a player (as in Pair Go) analyzes the moves of the partner, he or she detects quickly this to be an unusual move. During the game I realized this move to be a complicated one, but only after the game I understood that it does not work, even if the opponent proceeds just "normally". It seems that the bot was not able to evaluate the sequence correctly (surely given by the fact of multiple choices and the Monte Carlo Approach). Instead of D11, normal would have been B6. After D11, see Fig. 1, White is clearly behind in the game and was not able to recover until the very end.

After move 95 (O8) White has several possible continuations. If I remember correctly, I always took the favorite of Crazy Stone, and this was neither plan A nor plan B, but a mixture of both. And this was bad: Move 96 (P10) and move 98 (P11) actually require another move on P12/Q13. Instead, move 100

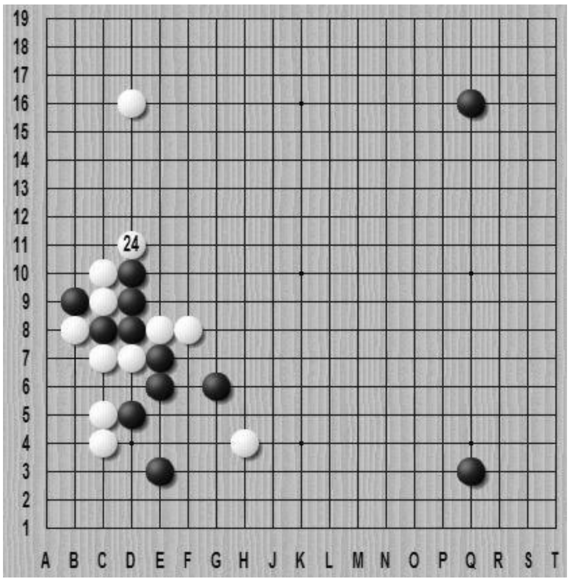

Figure 1: Game 1 – move 1–24. D11, a strange move by the human+computer team. "Crazy Manja" plays white.

(P6) was played, and this strange combination makes us falling back. Indeed, Stefan punished it appropriately. My lesson: It makes sense to play/select in a consistent way. (Comment of Ingo: I had to learn a similar lesson in 3-Hirn chess. The human has the task to form a consistent plan out of "isolated" bot moves.)

The upper left corner The situation was complicated with many options, and the bot failed. Again, I think the bot can not handly situations with multiple local choices appropriate. Here, I should have invested deeper thinking. It turned out to be simply wrong to think "the deep calculation is the computers part".

Manja about Game 2: Going for influence; trying to play one big line (which was not always influence-oriented)

Move 34 (P1) This was large for White in the corner. Black has influence, but rather crumbling. So the situation was not directly good for Black, but at the end everything turned out to be well for Black.

Move 37 (H17) It has been very interesting to observe Crazy Stone to suggest this move, see Fig. 2. Although being on top of the Crazy Stone's list, this is certainly a move which I would not select again. First, it is against influence; second, the invasion comes much too early. Other moves would have been more consistent with the overall strategy, such as K14 or M16.

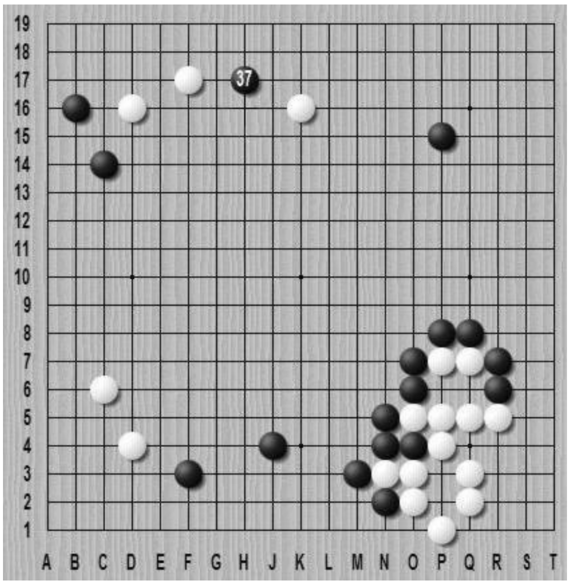

Figure 2: Game 2 – move 1–37 (H17). No longer preferred by Manja. Crazy Manja played black.

In the remaining moves, "we" always tried to fight against White influence, with success. There were only few other candidate moves in Crazy Stone's "portfolios". I remember that I would have preferred to play endgame at the sides, but finally I followed Crazy Stone with its seemingly "neutral" moves in the centre because they seemed to be so important for the bot.

Manja about Game 3: Something learned!

Move 10 (H6) This is normal, but absolutely not my style. I simply tried not to play strange moves.

Move 18 (P4) For Stefan it was surprising, that the bot had proposed P4. For me it was a natural cut. In contrast, Stefan argued this to be due to my "crazy crosscut style".

Move 44 (F5)/ Move 45 (E5) This is a very strange exchange, even a severe mistake. I selected it only because of one purpose: It "always" popped up as top candidate of the Crazy Stone list and I wanted to get rid of it, in order to have more memory for senseful moves left. In my opinion this move damages the left and has no visible benefit.

Move 50 (O9) to Move 54 (O11) I accepted the sequence proposed by Crazy Stone as a learning effect

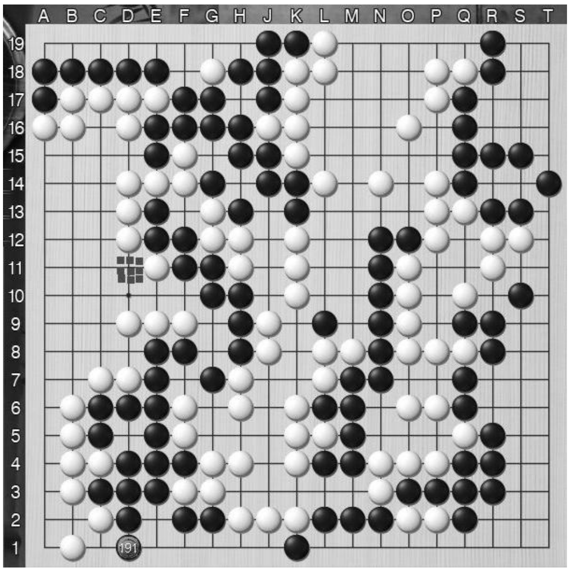

Figure 3: Game 3 – move 1–192 (D11). Crazy Manja played white.

from round 1.

The game ended by Stefan's resignation after move 192 (D11), see Fig. 3. For him this was a typical computer move indicating that the bot thought the game was over (in favour for the bot side). However, things were a bit different. D11 was only on rank 6 or 7 of the candidate list – but with expected 70% success rate for the bot. The moves on the better ranks did not have much better percent values. So, Ingo proposed that Manja should select this one because it is very safe. When Stefan was informed after resignation he thought to have been bluffed... In reality White was only very few points ahead in the end, and move 192 (D11) had even lost one of them.

Ingo Althöfer was originally meant only to operate Crazy Stone. But a few short discussions with Manja happened and helped in situations where she was unsure about the choice of the next move. Ingo was able to give some hints from his experience with go bots, in particular how best to avoid unsettled fights and Semeais.

5 Computer-aided Go vs. Pair Go

Manja Marz is a rather strong Pair Go player. In her eyes the computer-aided Go in the experiment was a bit like Pair Go: the partner has ideas, and one has to understand them and to decide: "ok, this way I go with you" or "no, that will lead to ruin". The difference is: in the experiment the partner (=the bot in a sort of autistic behaviour) changes his ideas very often (the top candidate moves typically do not follow one big plan). The only consistent thing were 1-2 useless or even harmful moves per game which were offered again and again.

Like in Pair Go, Manja tried to select a move which did not "destroy" the ideas behind the other top candidates in the current list. So, often she tried to select that move from the list that did not contradict the other list moves and plans. The human selector has to decide: whether or not to make an unnecessary or harmful exchange proposed by the bot. Making the exchange tries to avoid that this candidate move costs computing time over and over again.

In Pair Go, a player can simply avoid playing moves (s)he does not like, at least when it is his or her turn. This is the same in computer-aided Go. For example, look in game 1 at move H6. Manja: "I would neeevvver play something like that."

6 Proposals for Improvement of the Analysis Interface

In its current version the use of Crazy Stone's analysis mode requires a lot of mouse clicks, when the game is still in progress. When the move of the opponent has been entered, the following sequence of mouse actions is necessary.

```
1 click ``Analyze''
2 click ``Analyze current game''
3 click the selected move on the board
        twice
4 click ``Yes'', when asked
        ``do you want to continue...''
```

In contrast, Chess analysts are pampered by their bots: the engines immediately start thinking (without any mouse clicks or other user action) when a new move has been entered. The only action to be taken by the user is to enter his or her selected move. Hopefully, Crazy Stone and other commercial go bots will become similarly user-friendly in their analysis modes in the future. Helpful may also be an advice by computer chess dinosaur Johan de Koning [11, 12, 13]: "Mouse clicks are much more time-consuming than keyboard clicks. Avoid mouse clicks whenever possible."

When preparing this report, we got an idea how to improve the live display of the move candidate list. The list is updated every second. Observing the list would become more pleasant if those moves which got currently most playouts were highlighted by some fat font or by marks in an alarm colour. It might also make sense to display gliding averages for these "data changes". For switching eyes between the list with its move coordinates and the board it would be helpful to have coordinates not only on left side and bottom of the board, but on all four sides. Or even better: the candidate moves might directly be highlighted in the board by pulsing colour dots. Go programmers and interface designers may get some more stimulation from the website [3] or publication [6].

7 Conclusion

Playing Strength of Crazy Stone

One seemingly simple question was not answered in this report: how strong was CrazyStone in the settings of the experiment? Here we explain, why the answer is complicated.

In the experiment, CrazyStone (commercial version 2013) ran on a machine with about 12,000 playouts per second (in middle game positions). We asked Remi Coulom, the programmer, what this meant for the playing strength. His answer was: "It is really difficult to estimate strength as a function of node-count per second. First, because it also depends a lot on time control. And second, because I have little data. With the 64-core AMD server, CS does about 80-100 kilo-playouts per second and established a weak 6d rank on KGS at 15 seconds per move. The 6-core machine that won a game against F. J. Dickhut was doing maybe about 25k playouts per second. It would probably be a solid 5d on KGS. I also connected CrazyStone to KGS with account CrazySton4. It was playing with 2 million playouts per game, and reached 4d."

Having the 25k-statement in mind, perhaps CrazyStone was a weak 5-dan in ther experiment. But ... in the experiment the time setting was not something like x seconds per move plus for instance 5 Byoyomi phases. Instead, we played (on both sides) without time control. The only informal understanding was that a game in total should be completed within 2 hours. Such a "loose" setting typically helps the human somehow because for him it is stress to play the x seconds/move mode, in particular against a bot which almost always exploits the time by using x-2 or x-1 seconds for each move. So our conclusion: Perhaps, in the experiment CrazyStone was a weak 5-dan or it was a strong or "medium" 4-dan.

Speculation on Current and Future Playing Strength of Crazy Manja

Are 200 extra rating points possible? Or are they realistically achievable for a typical human+computer team with some training? A related question from practice would be: Currently bots need 4 handicap stones on 19x19 to be successful against pro players. Might "Crazy Manja" need only handicap 2?

Human+Computer Go Experiments by other People

A longterm project was executed by Darren Cook [9]. For almost a decade he used the account "sm9" to play (anonymously) 9x9-Go with computer help on the turnbased online server `LittleGolem.net`. sm9 had a breakthrough in performance after the Monte-Carlo revolution and became the leading player on LittleGolem for several Championships.

In the early years of the new millenium Stephan Kolassa (1-dan) was engaged in a 51-Hirn. He was shown the top 50 candidate moves of a (rather weak) non-Monte-Carlo bot and had to play one of them. Of course the team was clearly weaker than Stephan alone [7]. In his doctoral dissertation, Kolassa analysed shortlisting procedures mathematically [14].

Thomas Redecker put a lot of energy into a deep analysis of problem no. 120 of the Igo Hatsuyoron collection. He even wrote a whole book on his findings [15]. In some of the analysis lines, Redecker used help by a Monte-Carlo go bot in komi-slice technique. Here, a position is analysed by the bot for different (artificial) values of komi to get not only winning percentages but the "true" value when both sides try to get as many points as possible.

Time Tunnel: European Go Congress in Strausberg, 2000

Back in the year 2000, go computer programs were very weak, with ratings around 8th kyu. At the EGC 2000 in Strausberg an exhibition match was played: Japanese pro Saijo Masataki (8-pro) gave 2 handicap stones on 9x9-board [2]. His opponent was a large crowd from the congress. Two go programs were running on notebooks (Handtalk, the leading program in those days; and GoAhead, written by Peter Woitke, winner of the EGC computer tournament 2000). The move proposals by Handtalk and GoAhead were called out, and the crowd decided by majority voting which move to play. The pro won after a nontrivial battle. Having in mind today's strength of go bots on 9x9-board, such a setup with human majority voting would likely give weaker play than that of a solo bot.

Danger of Computer Cheating in Online Leagues

In several European coutries, Go team championships are played via KGS or other Internet servers. It is not easy to detect if a player or a team uses illegal computer help in such events. So far, computer cheating was not a big topic in the Go scene. The success of "Crazy Manja" may be a hint that certain actions should be considered to avoid computer cheating in the future. In the chess scene, big servers like the one run by ChessBase.com use fully-automatic software to detect computer-help cheaters.

More Speculation on Future Playing Strengths

In the final interview of the codecentric Go Challenge 2014 Remi Coulom made two remarkable statements [16]: (i) Top-level Go programs have stopped making progress for almost two years now. .. (ii) As soon as someone finds a good way to solve the semeai problem, then unbeatable programs may come very fast. These statements are meant with respect to "autonomous" go bots. Concerning human+computer teams, things may behave differently. The success of Crazy Manja was something unexpected until it happened, and further progress may come soon, independently of point (ii) above.

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