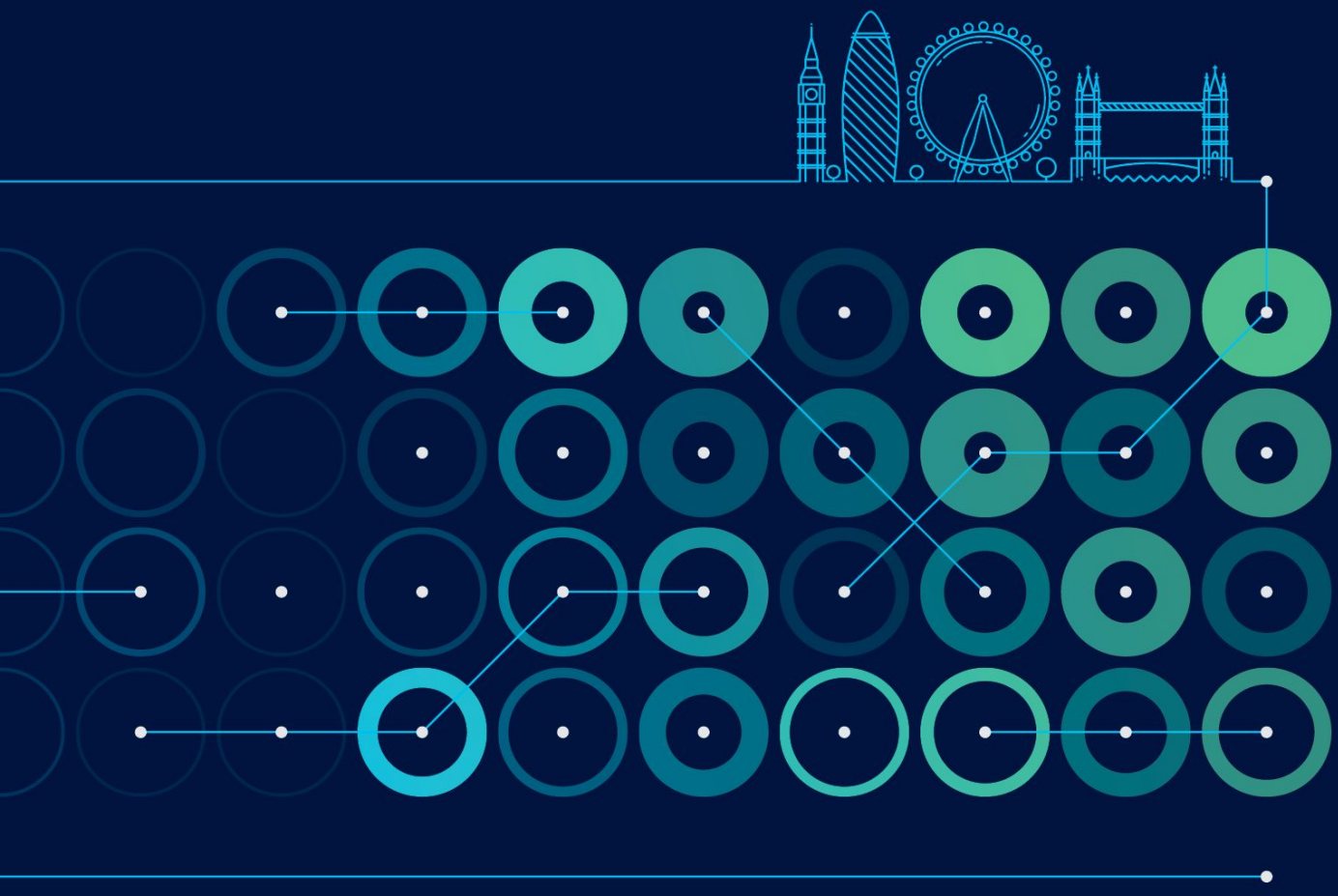
Google DeepMind

AlphaGo vs AlphaGo



Game 3: “Freedom”

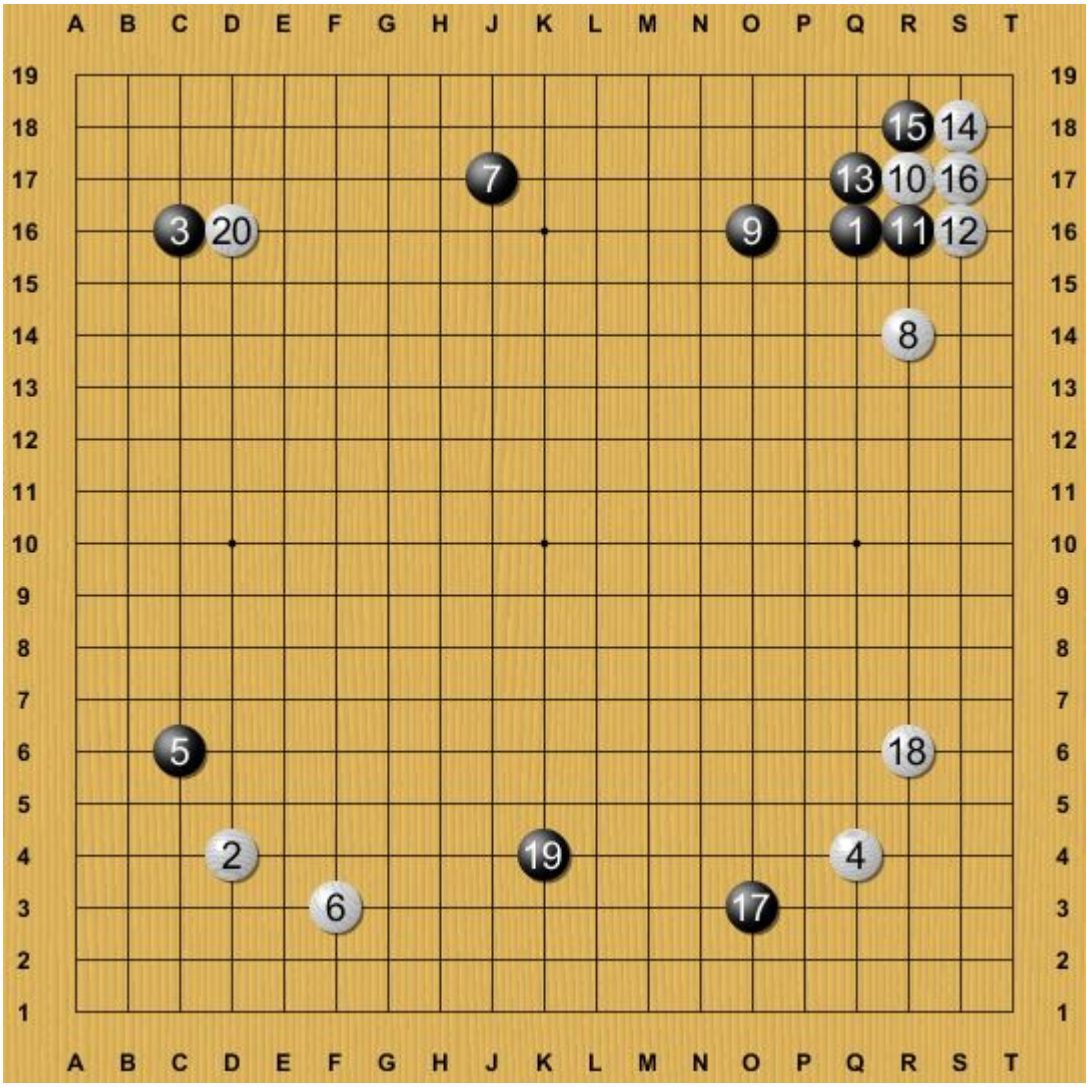
Commentary by Fan Hui

Go expert analysis by Gu Li and Zhou Ruiyang

Translated by Lucas Baker, Teddy Collins, and Thore Graepel

Game 3: Freedom

Moves 1-20



If you know anything about Go, White 20 will catch your eye the second you see this kifu. No, that is no misprint - AlphaGo really played there. We will turn our attention to this move soon, but first let's explain from the beginning.

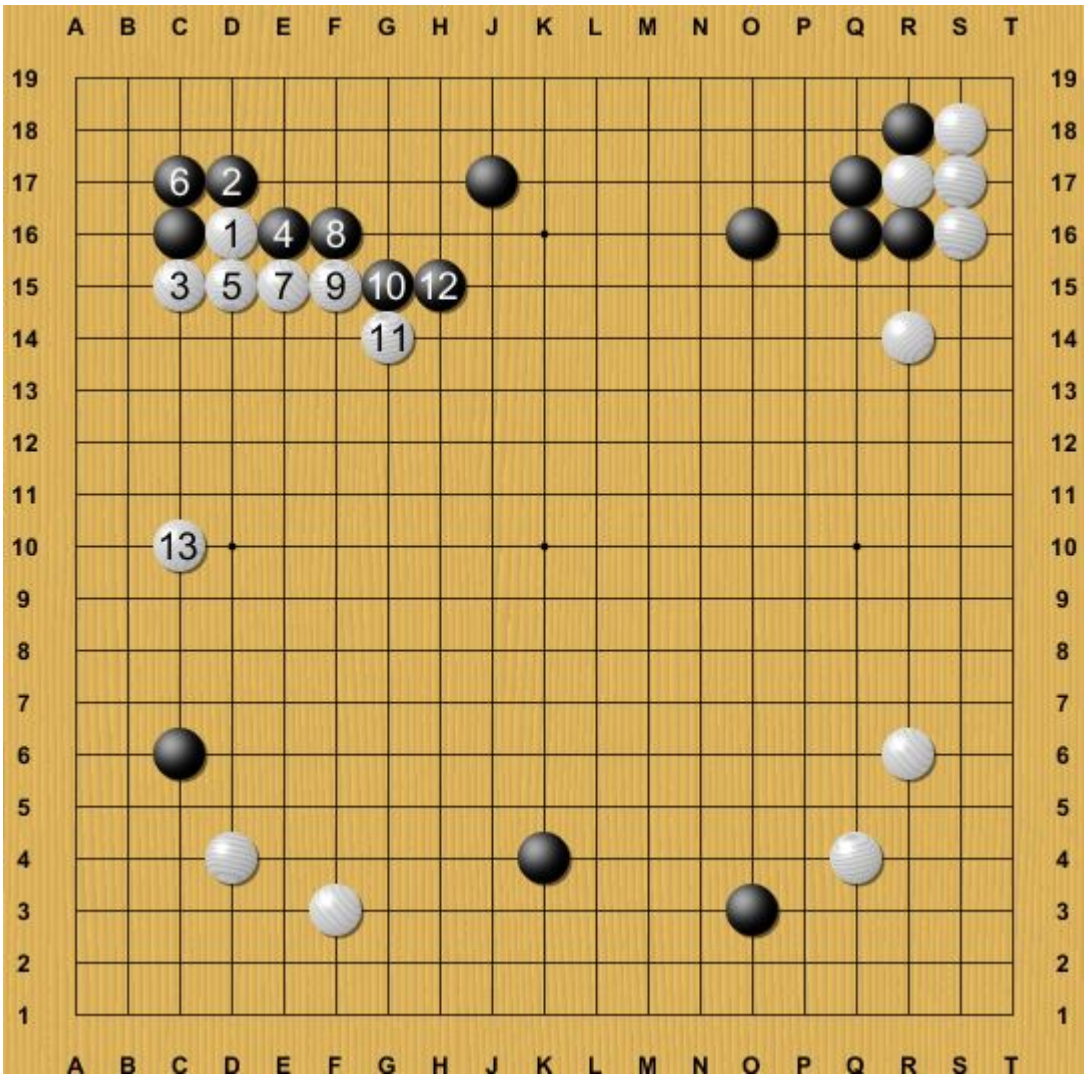
Here, AlphaGo once again demonstrates its preference for the Chinese opening. In this game, Black approaches the corner at 5 before setting up the Chinese opening with 7. What is this exchange about? When I asked Gu Li and Zhou Ruiyang, they said that while it is unusual, it does not lose anything.

Black's block at 13 would strike professional players as soft, but it turns out to be an acceptable move. See the commentary on game 1 for a deeper investigation. The approach and extension with 17 and 19, a common strategy in AlphaGo's games, are likewise analyzed there.

Now we come to White 20. Whereas the first two games allowed only five seconds per move, this game was played at a more classical pace of one to two minutes per move. The difference between these time controls is night and day, and the slower pace dramatically improves AlphaGo's calculations. This helps explain why White dares to spurn conventional wisdom with a move like 20!

Of course, this move is not something AlphaGo dreamed up on the spot, but rather a strategy fashioned over time through many self-play games. But what is the reasoning behind it?

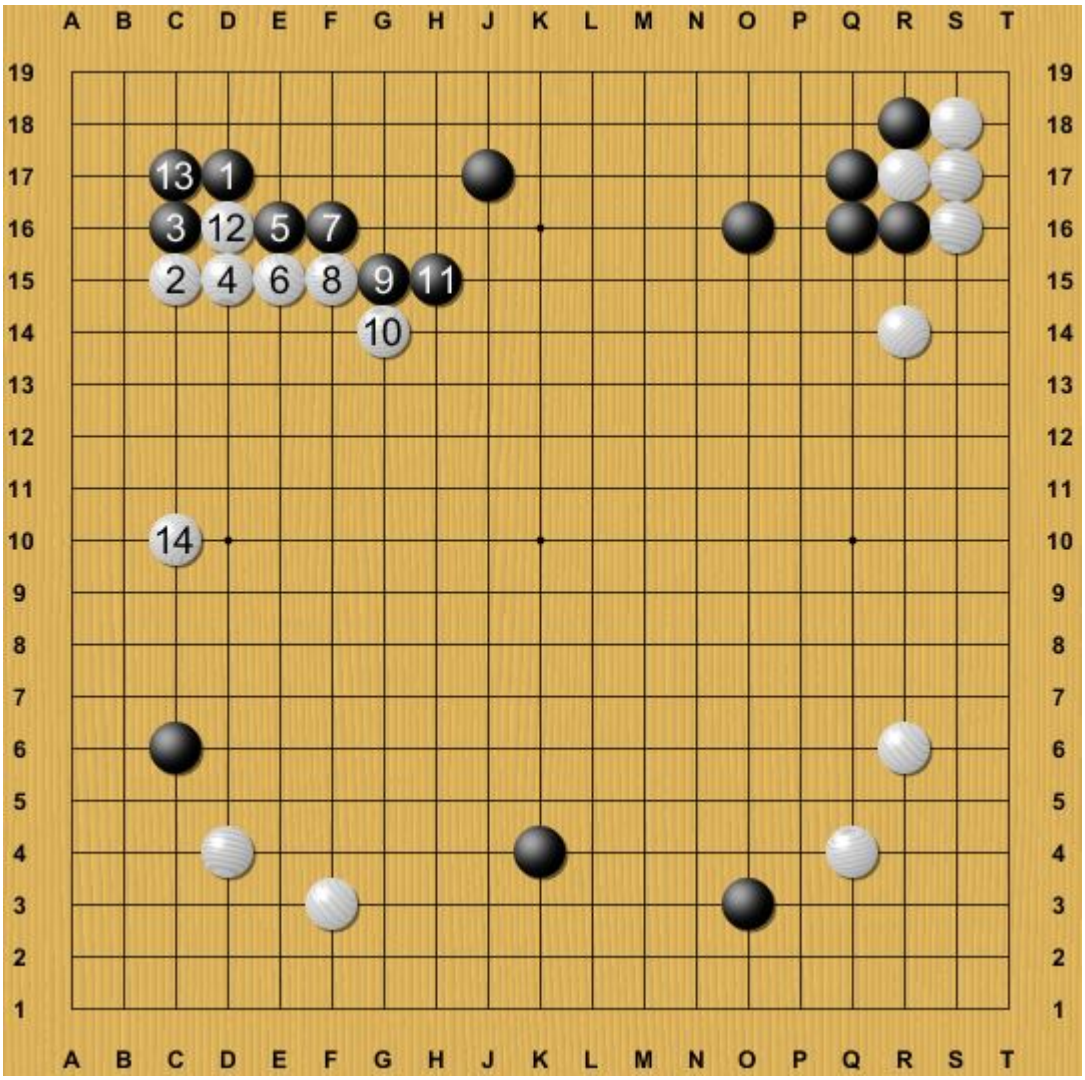
Diagram 1



Normally Black's first instinct would be to defend the corner, letting White hane at 3 and build influence towards the left. Through 12, Black protects the top, and White extends on the left side. Although Black has built significant territory, the stone on the third line is inefficiently placed, while White's extension on the left doubles as an ideal pincer. Black cannot be satisfied.

Diagram 2 offers an alternative way of looking at the position.

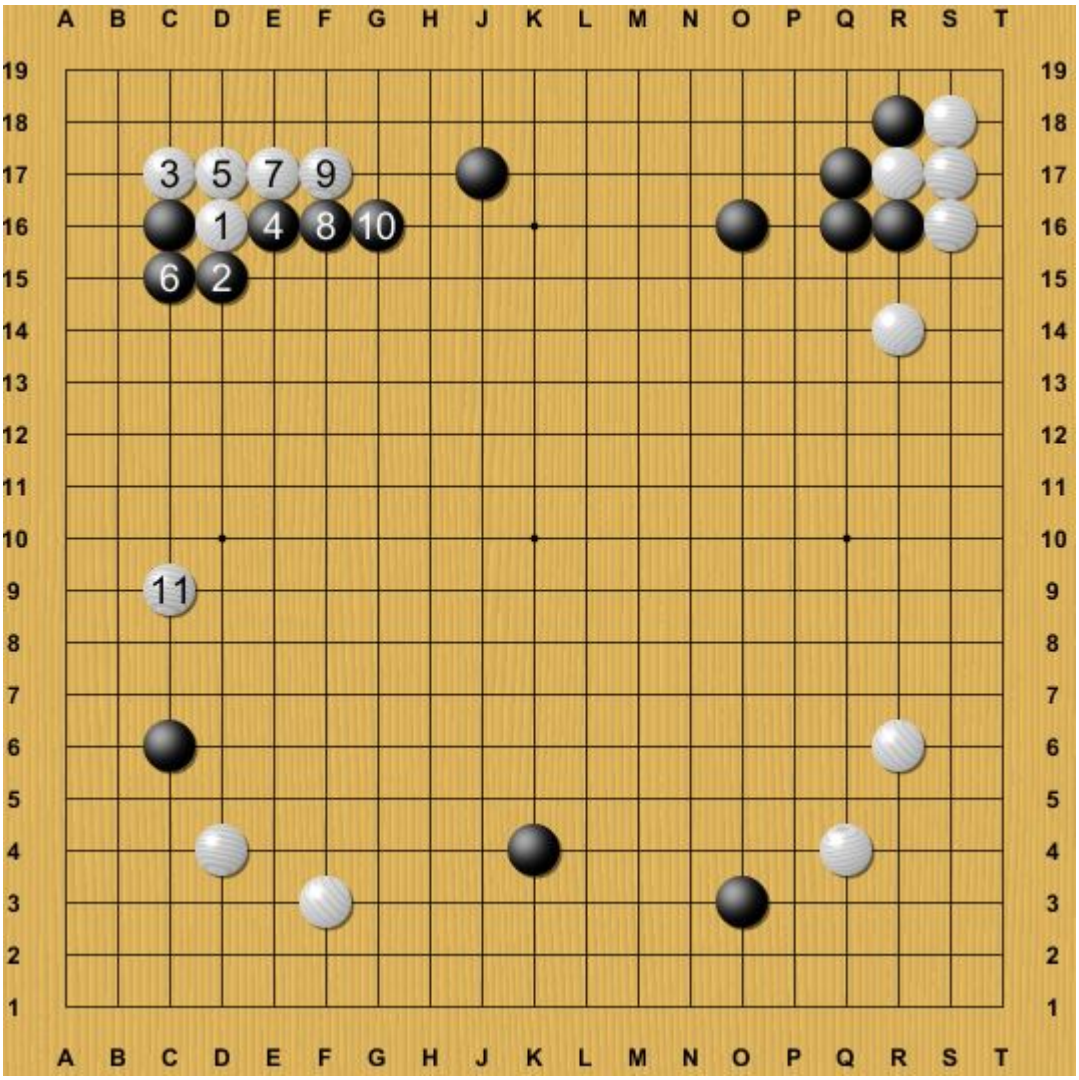
Diagram 2



To better assess the strengths and weakness of a given move, professional players often use tewari analysis. This method, in which one permutes the order of moves, aims to clarify the position by creating exchanges that directly contrast good moves with bad ones.

In diagram 2, the result is the same as in diagram 1, but here Black's initial stone is at the other 3-4 point. White’s corner approach at 2 is fairly common, but Black 3 and 5 are clearly a mistake in direction. Next, White presses with 6 through 10, an even exchange according to Go theory. Although the push at 12 takes away one of White's liberties, this hardly compensates for Black's losses with 3 and 5. Thus, White is clearly superior.

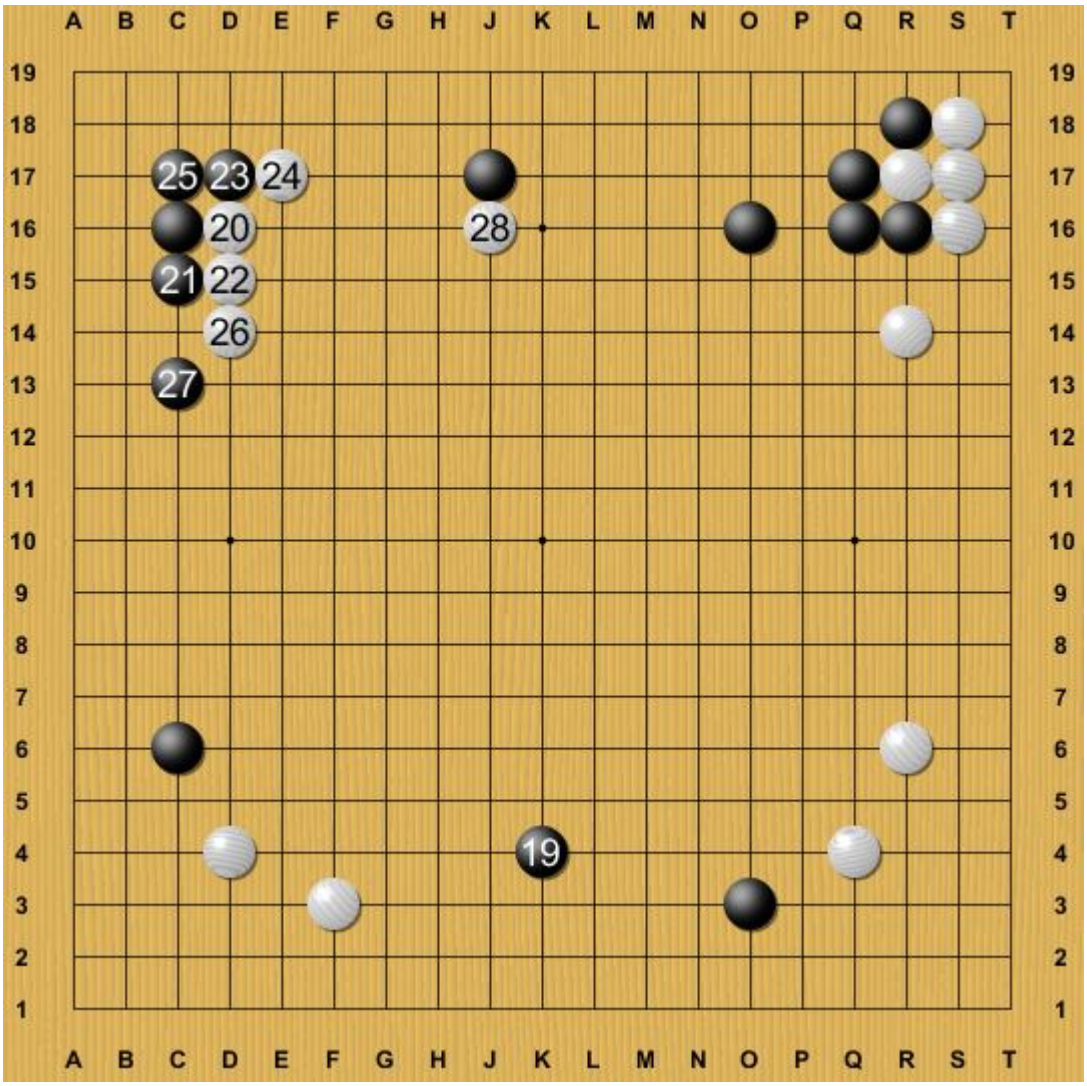
Diagram 3



What if Black chooses a different direction? If Black hanes on the outside instead, White will live in the corner. Although Black can get outside influence, because the left is so open, White can come back to pincer at 11. Black's wall will be very difficult to use effectively, and it is hard to see what Black is doing here! White prevails.

While looking through these sequences with Gu Li and Zhou Ruiyang, we discovered many complex variations. Although we have not reached a definite conclusion about this move, we would not be surprised to see it appear in many games to come. AlphaGo has opened our minds and inspired us to reassess conventional Go wisdom regarding what is right and wrong. Sometimes we instinctively reject moves because they clash with our experience or training, or even because we fear the ridicule of others. Yet these concerns obstruct our progress. AlphaGo does not have this layer of human prejudice, and that is what makes it so free, bold and unrestrained! As Go players, shouldn't we also seek to embody such a spirit?

Moves 19-28

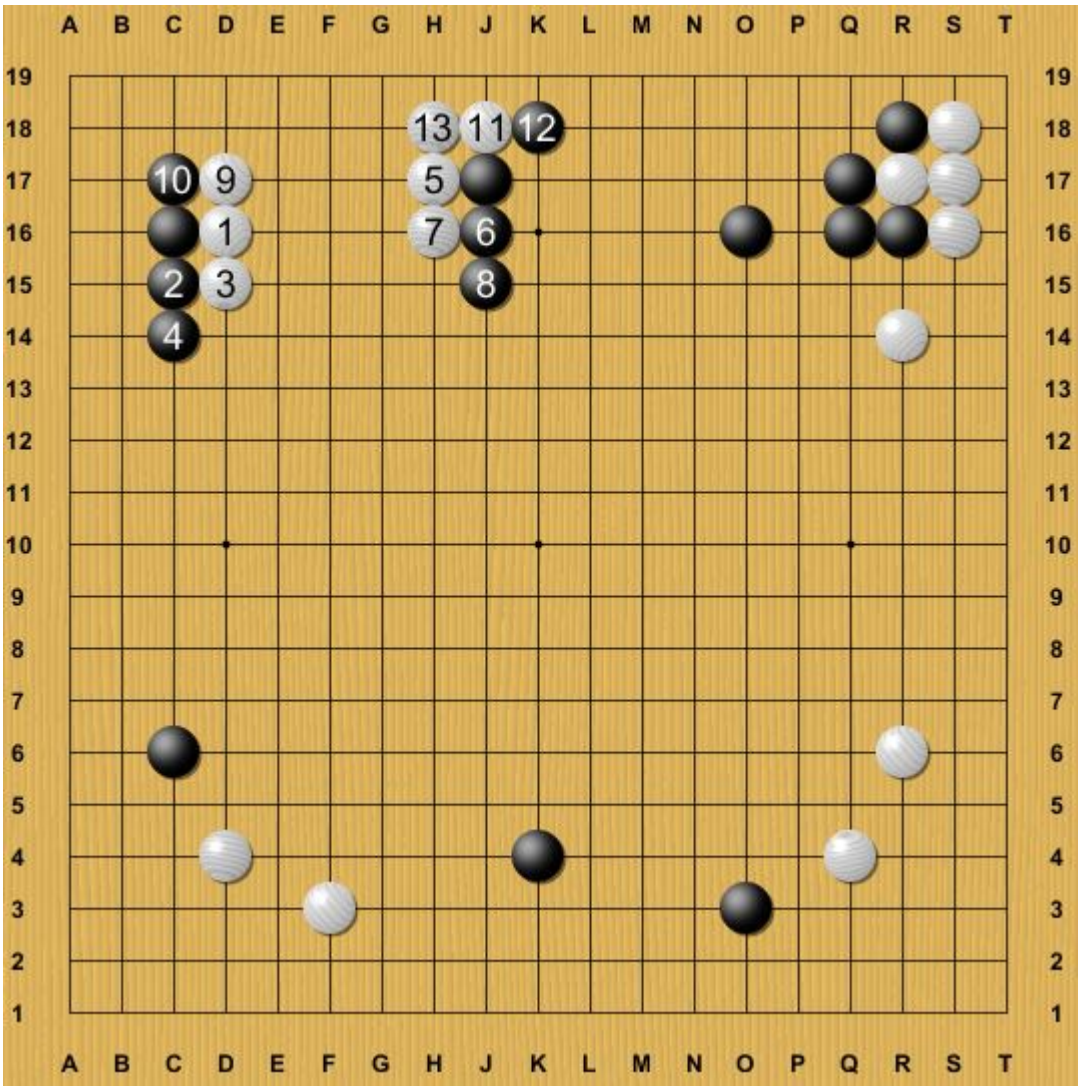


In the game, Black extends at 21. White presses tightly at 22, and when Black plays the inside hane at 23, it feels as if the corner might transpose to the avalanche joseki. So, does Black have any alternatives to 23? See diagrams 4 through 6.

To see why Black would not be satisfied with the small avalanche, see diagram 7. Instead, Black simply connects at 25. Black is planning to coordinate with the stones at the top to attack White, but 28 is a severe response! Gu Li and Zhou Ruiyang praised this move highly. At first it looks like an overplay, but actually, Black has no good counter.

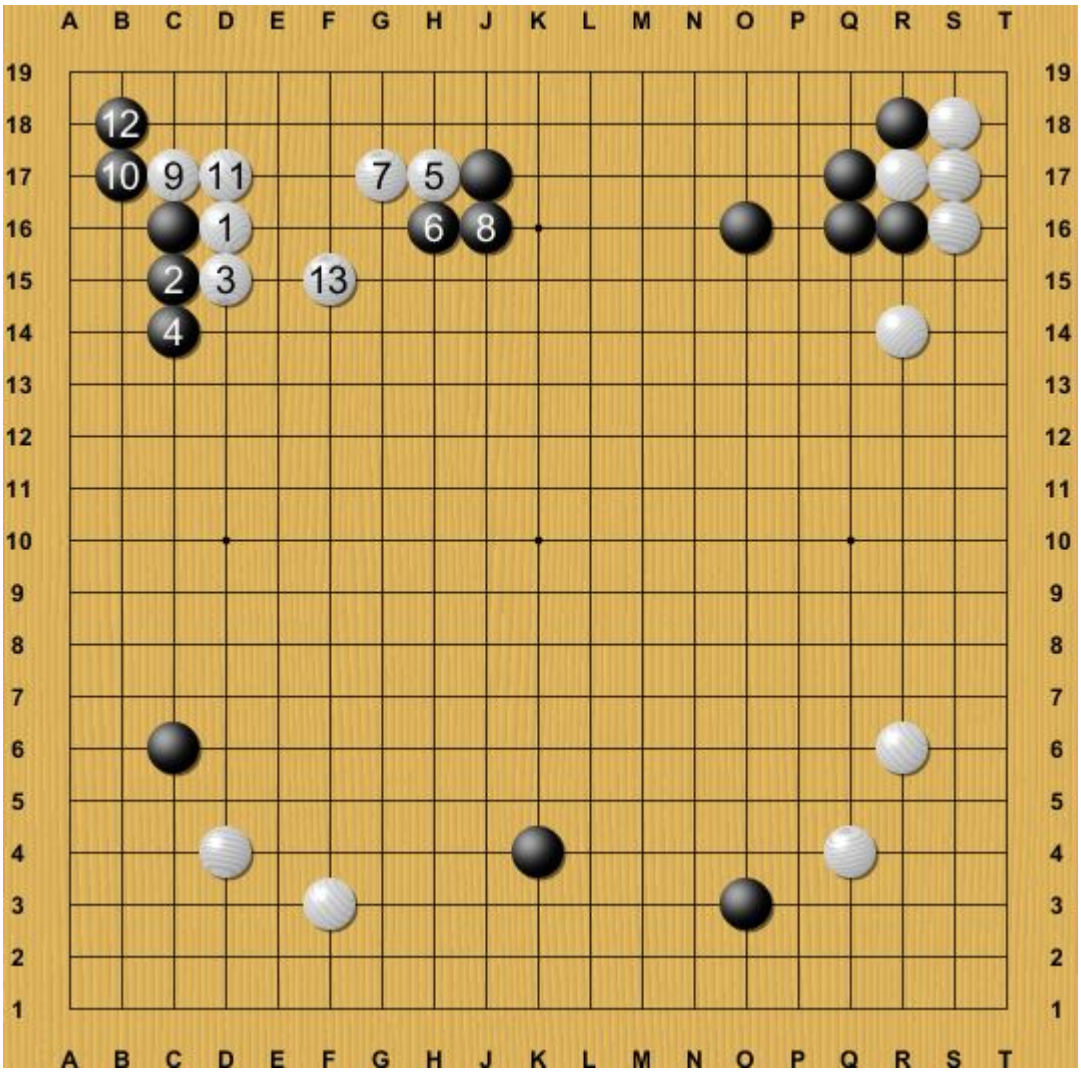
Thanks to its powerful calculations, AlphaGo can play these sorts of strong moves without reservation. This is perhaps its greatest strength.

Diagram 4



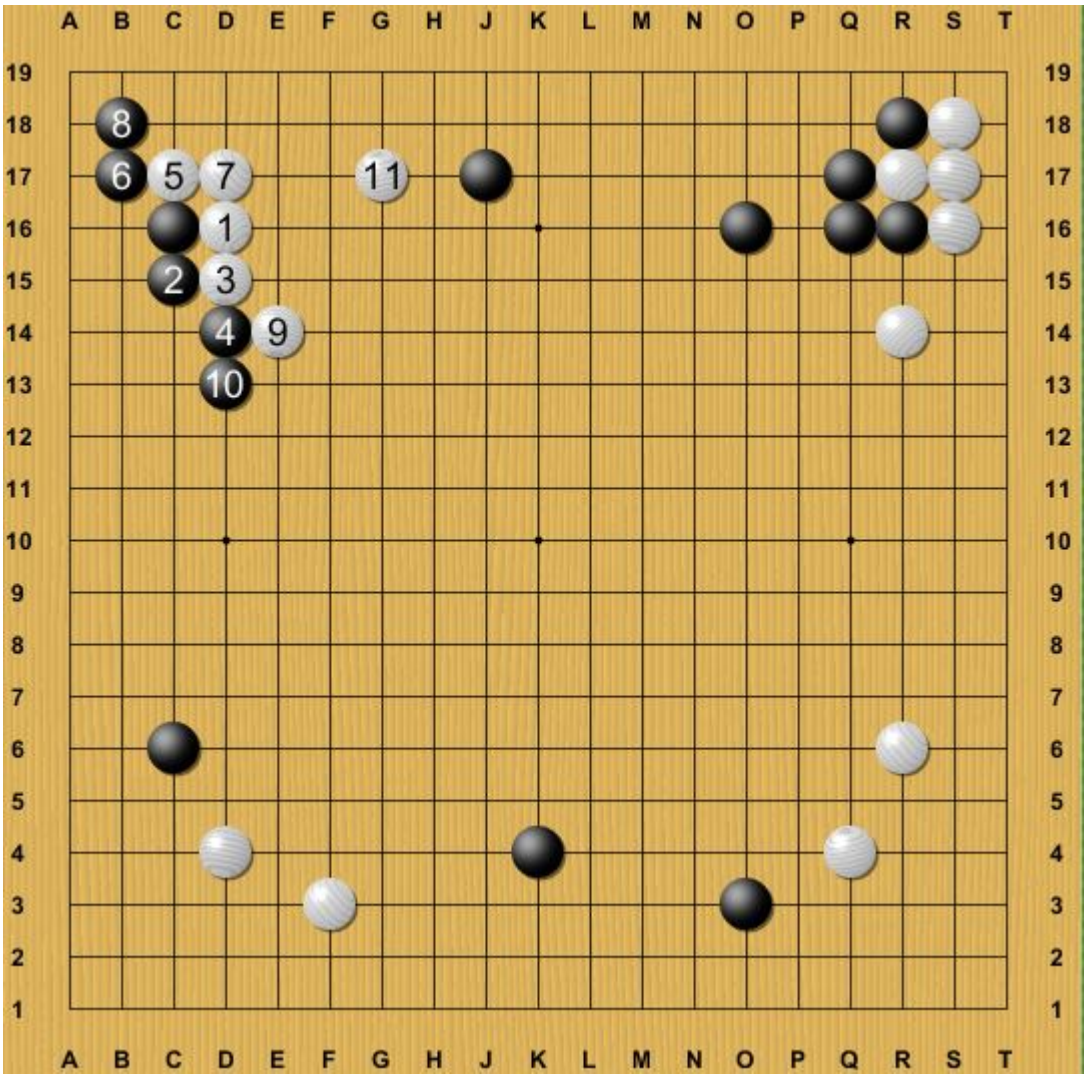
If Black extends once more on the left, White can attach at 5, building strength while leaving the possibility of claiming the corner. If Black denies White the corner with 10, the hane and connection at 11 and 13 easily establish a base in the middle of Black's area. Black cannot be satisfied.

Diagram 5



If Black impatiently hanes over at 6, White, after pulling back, can establish a comfortable base in the corner with 9 through 13. This is insufficient for Black.

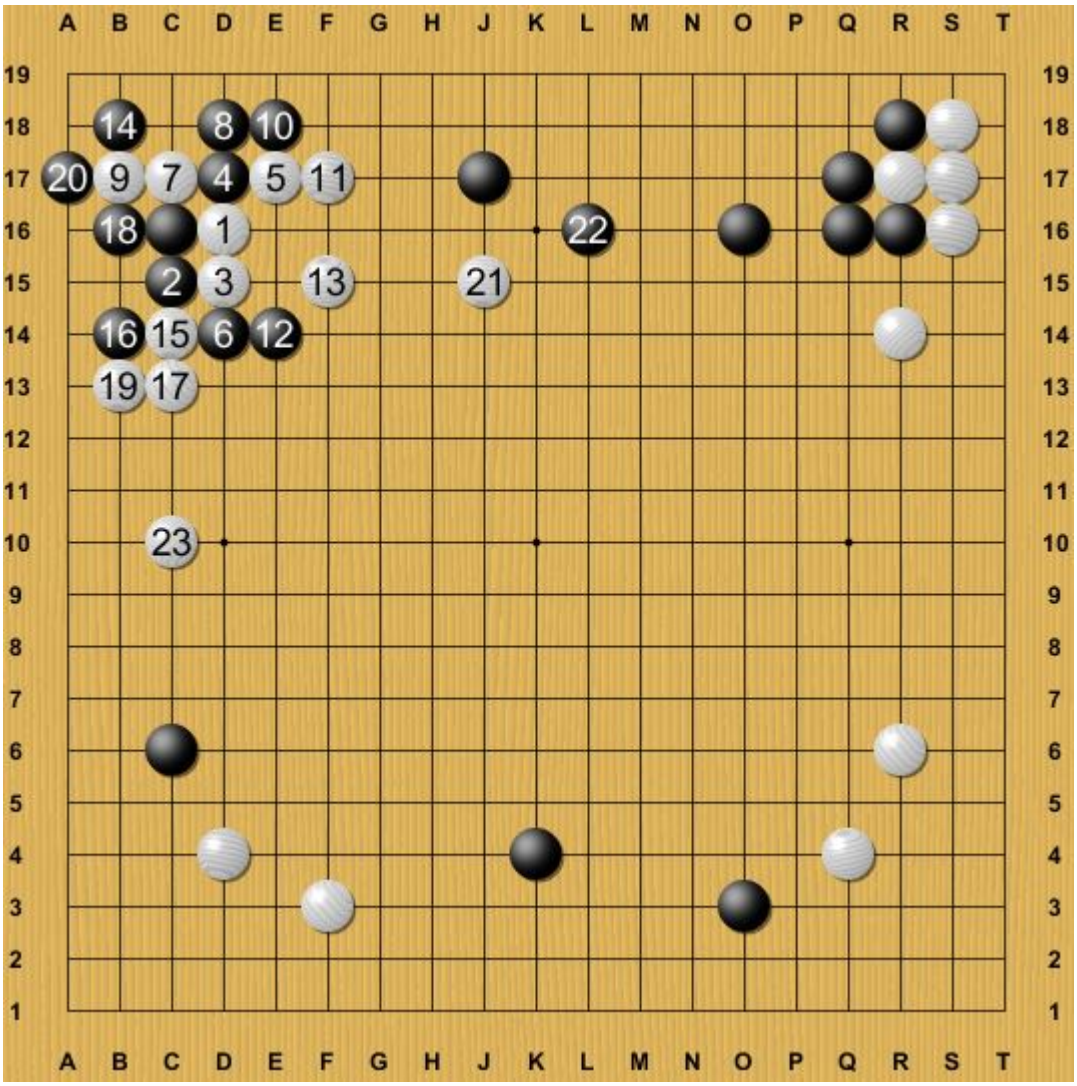
Diagram 6



If Black hanes at the head of two stones with 4, White can hane and connect in the corner. Through 11, White gets a decent position at the top. Again, Black is dissatisfied.

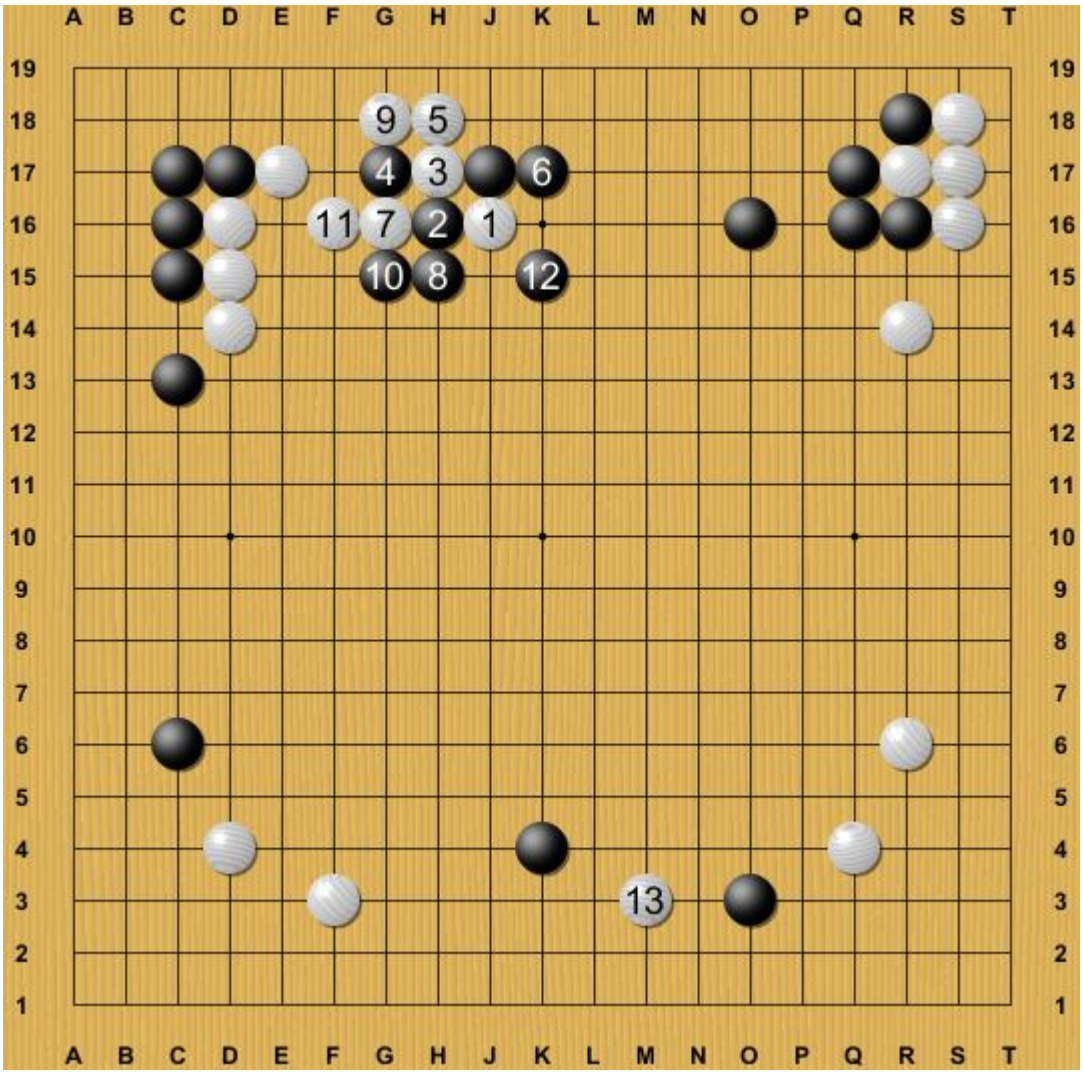
When White hanes at 5, Black cannot cut, or else the position will transpose to the small avalanche in diagram 7.

Diagram 7



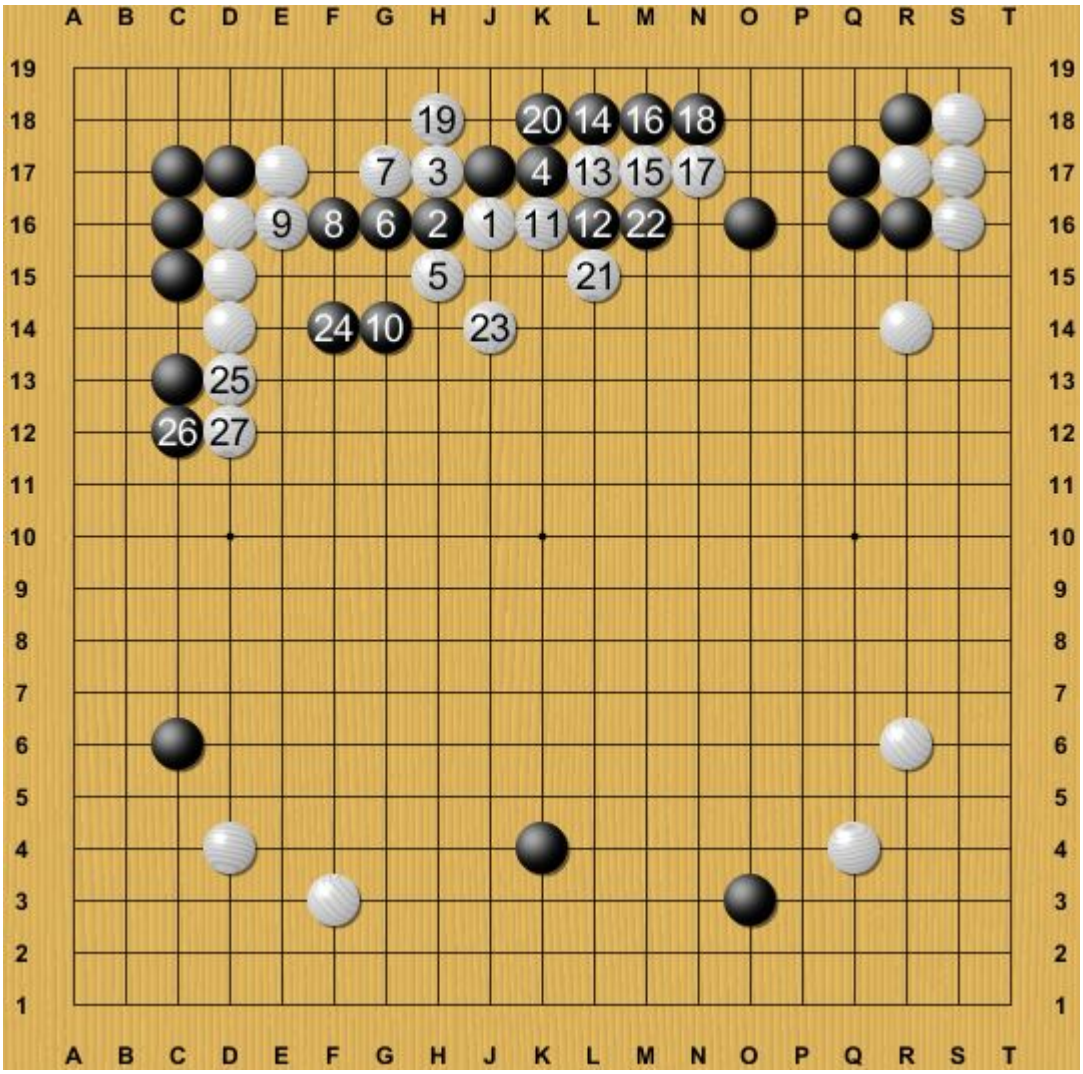
Suppose Black chooses the small avalanche. Since White has the ladder, the extension at 11 works. Although Black captures the stones in the corner, White can cut at 15, reinforce the top in sente at 21, and finally extend on the left at 23. White is racing around the board, while Black has no clear profit. This result favors White.

Diagram 8



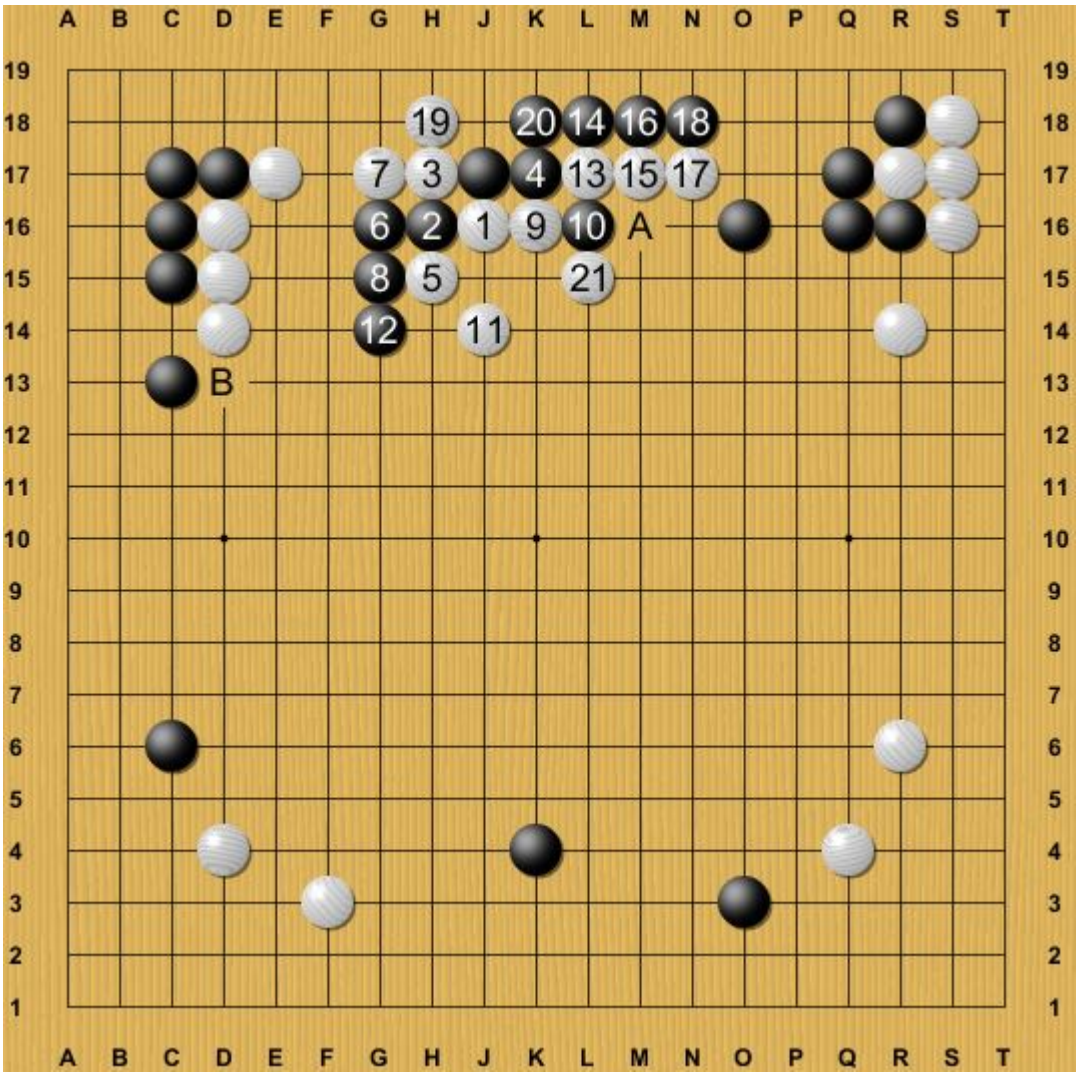
After White attaches at 1, if Black hanes inside, White must crosscut. If Black takes the simple approach with 4 and 6, White only has to sacrifice one stone in return for unconditional life on the top. Furthermore, Black must capture in gote, leaving White free to invade at 13. This is a success for White.

Diagram 9



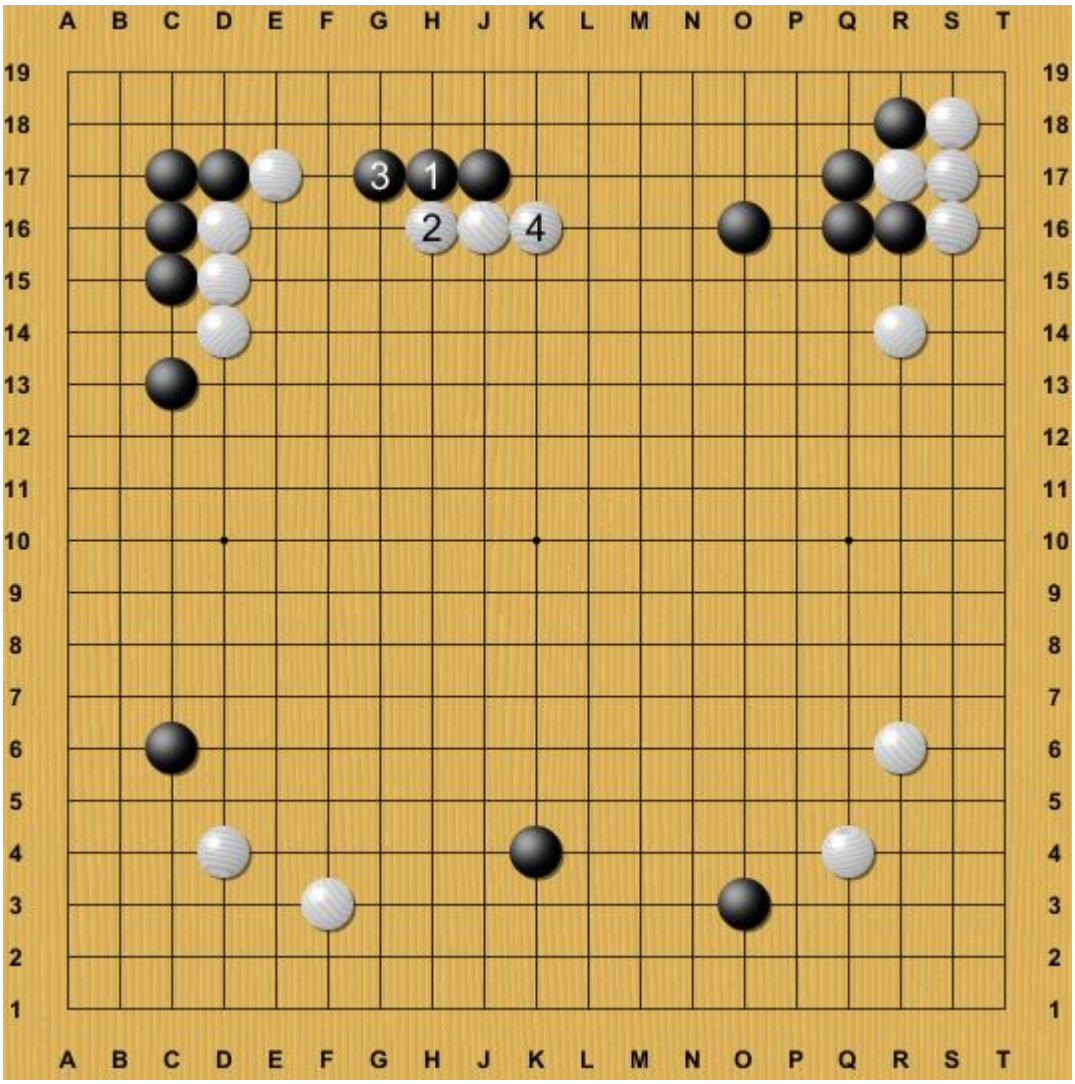
Black's strongest move is the extension at 4, but White can fight tenaciously with 5, 7, and 9. After pressing at 11 and cutting at 13, White achieves a comfortable position. Through 27, Black faces a painful fight: the top side has been flattened, and the group in the middle is heavy. Black cannot bear the burden of the komi this way.

Diagram 10



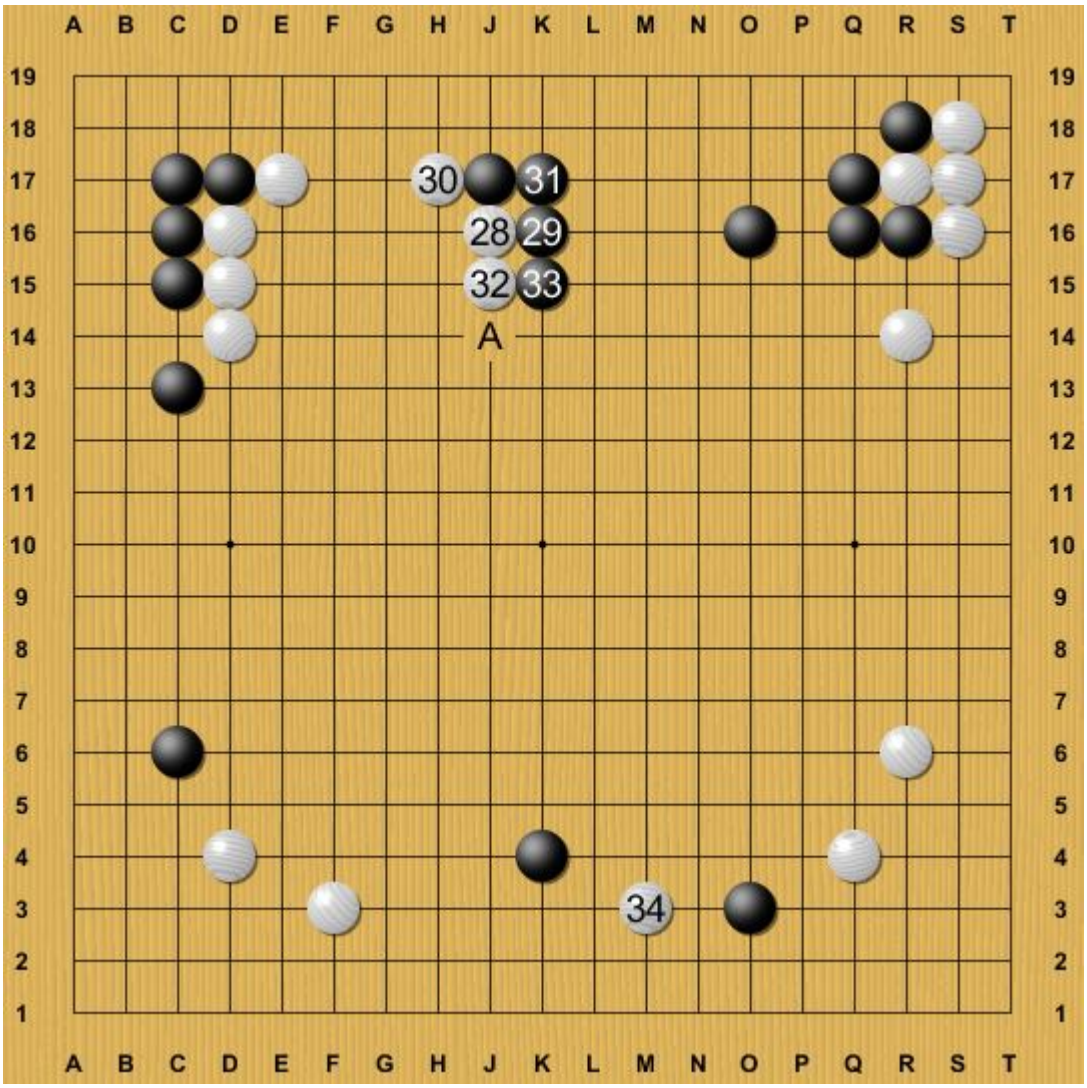
If Black simply turns at 8, White will still play as in diagram 9. Through 21, White makes miai of A and B, so Black has no way to capture. This is also a success for White.

Diagram 11



Black's solid extension at 1 invites White to press at 2, and Black has clearly been taken advantage of. When White extends at 4, Black's position at the top feels cramped.

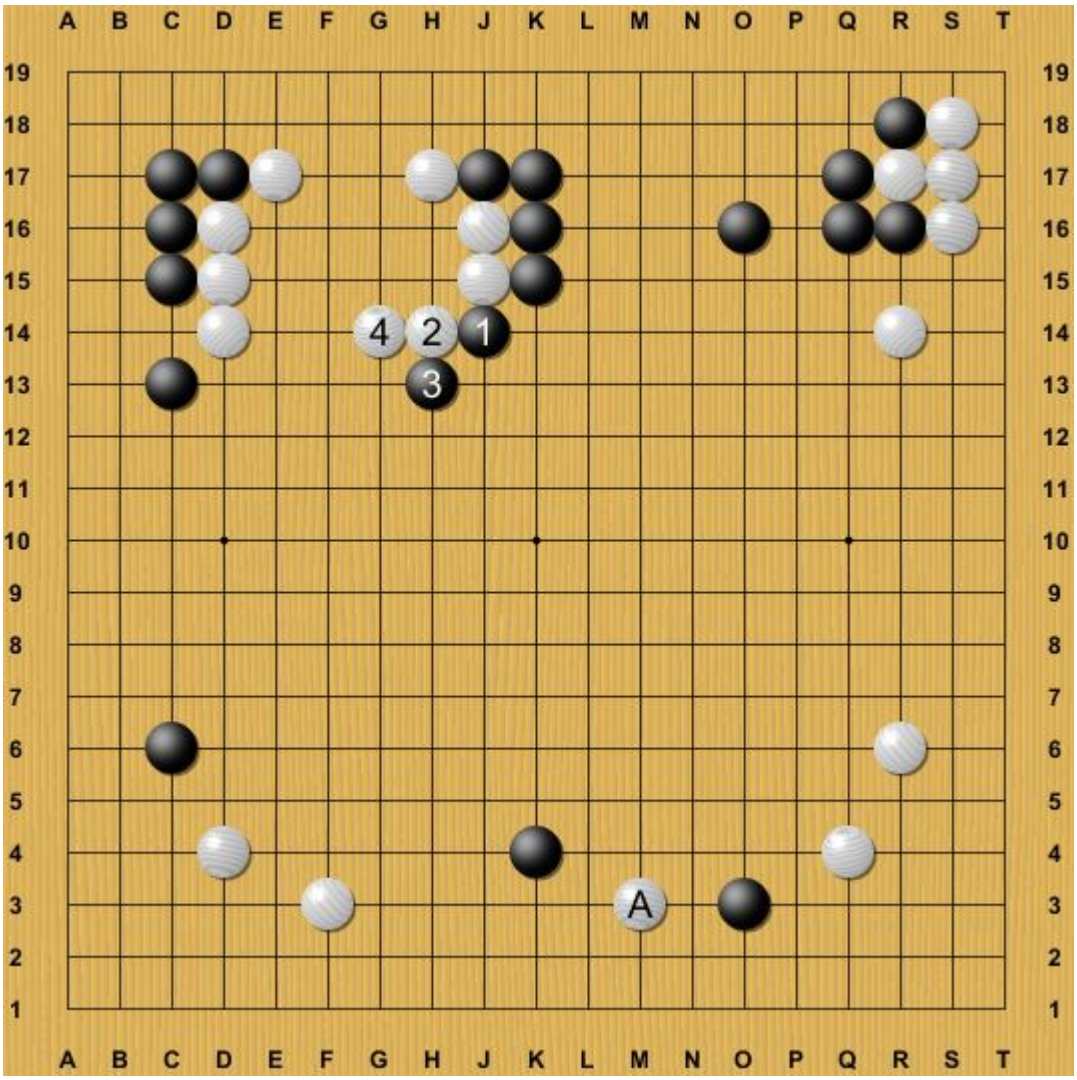
Moves 28-34



Here, Black and White have reached an agreement of sorts. Black hanes on the outside, and White hanes and extends at 32 for a very comfortable position. However, just as we were thinking White would be satisfied with the extension at A, White pleasantly surprised us by invading directly at 34! Could it be that AlphaGo does not understand the importance of a hane at the head of two stones? Truly, AlphaGo never ceases to amaze. One would never find a tenuki like this in a game between professionals.

What will happen if Black plays the hane now? See diagram 12.

Diagram 12

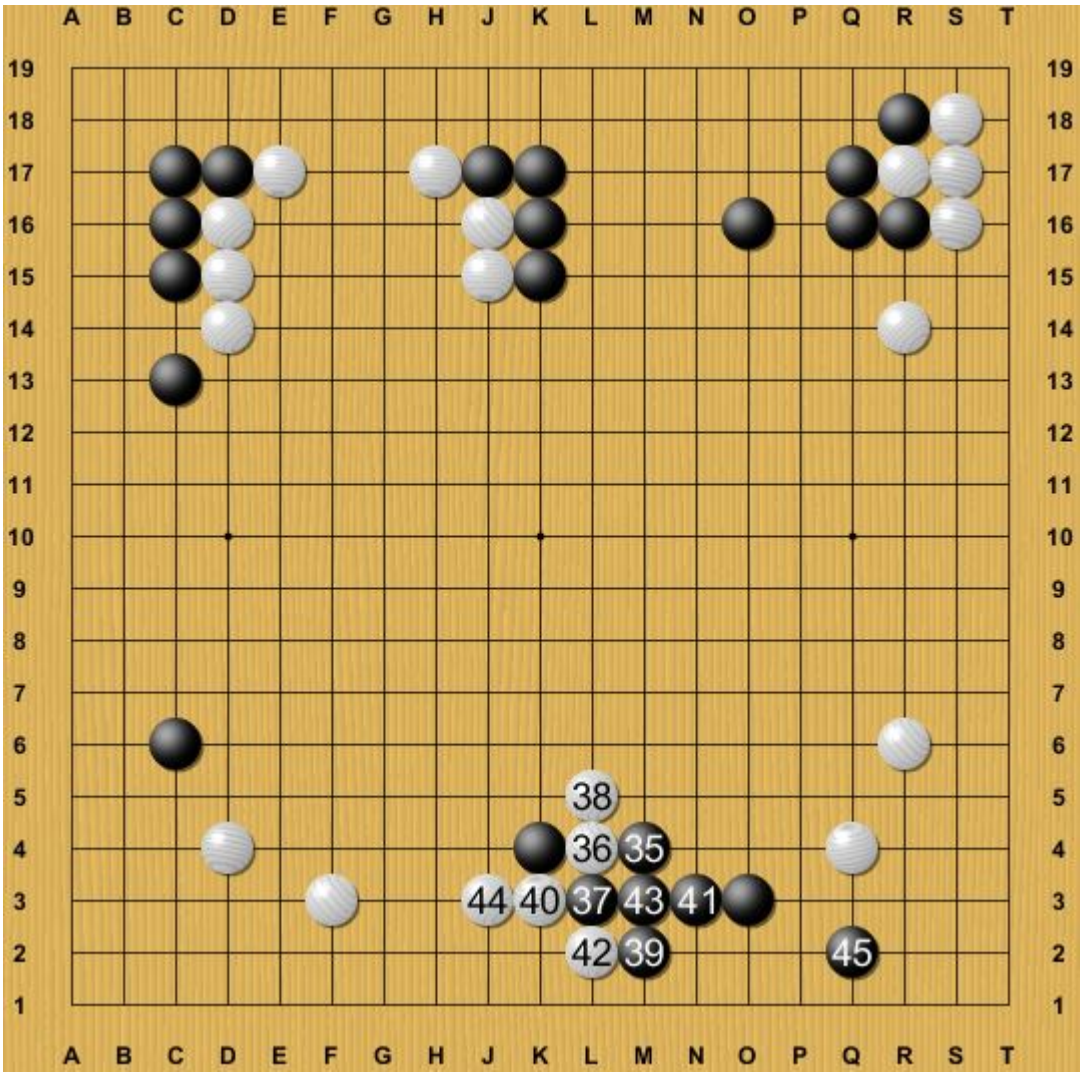


When Black hanes at the head of two stones, White must hane in return, and Black's double hane looks very comfortable. But if we look closer, are Black’s profits actually that significant? White is alive with territory, and the aji of the cutting points diminishes Black's advantage in the middle. Furthermore, White has already invaded at the bottom. Has Black truly profited?

Despite this, Zhou Ruiyang emphasised strongly, "If it were me, I would have extended."

Wrong or right, AlphaGo has once again opened our minds to a new perspective. Perhaps we really can play this way.

Moves 35-45

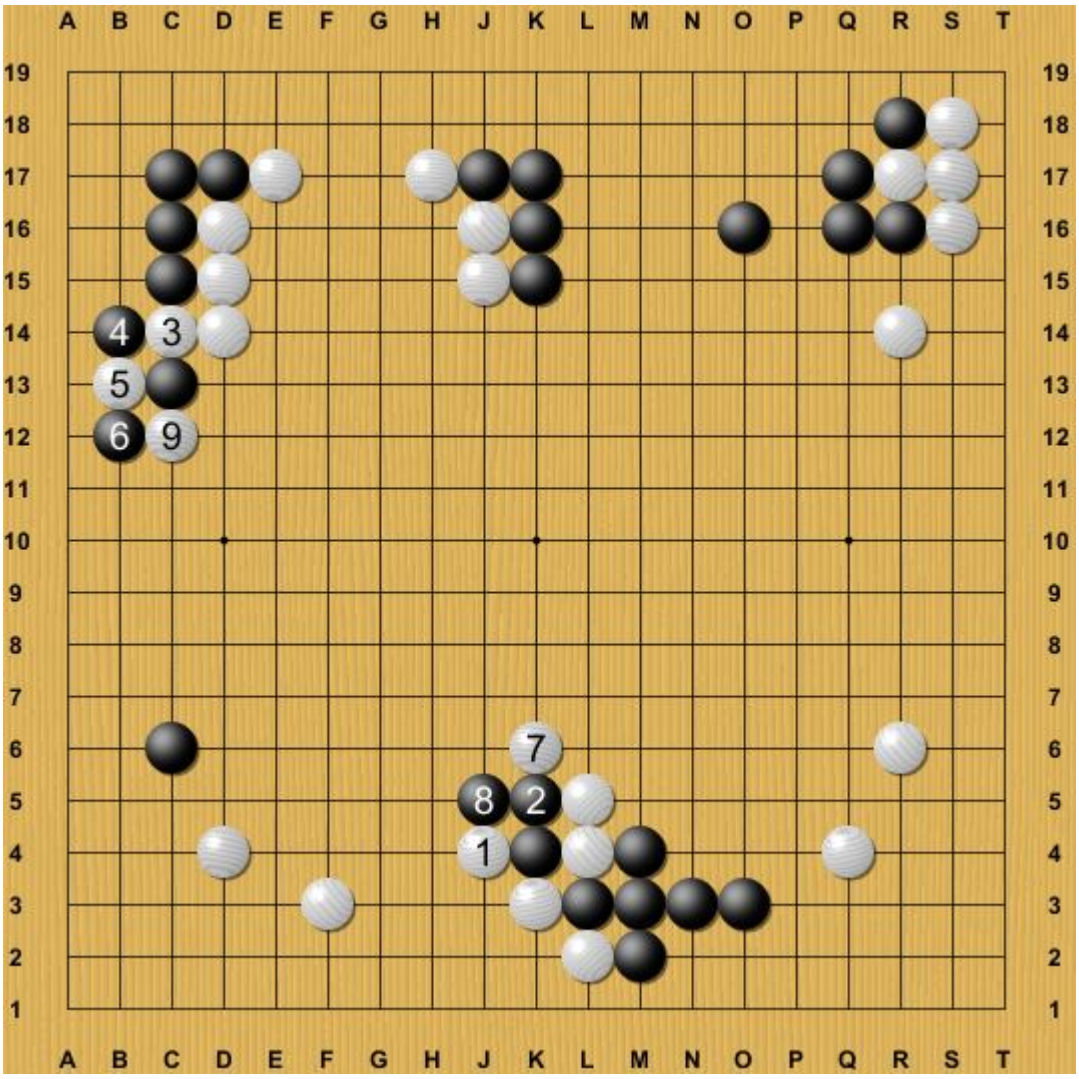


Once again, both sides have reached a common understanding. Disregarding the normal imperative to hane at the head of two stones, Black attaches on top at 35, and White wedges at 36. Generally, White cannot wedge when the ladder is unfavorable, so I requested that Zhou Ruiyang and Gu Li explore this move a bit further. See diagrams 13 and 14.

In any case, White settles on the extension at 44, and AlphaGo seems satisfied with White's position.

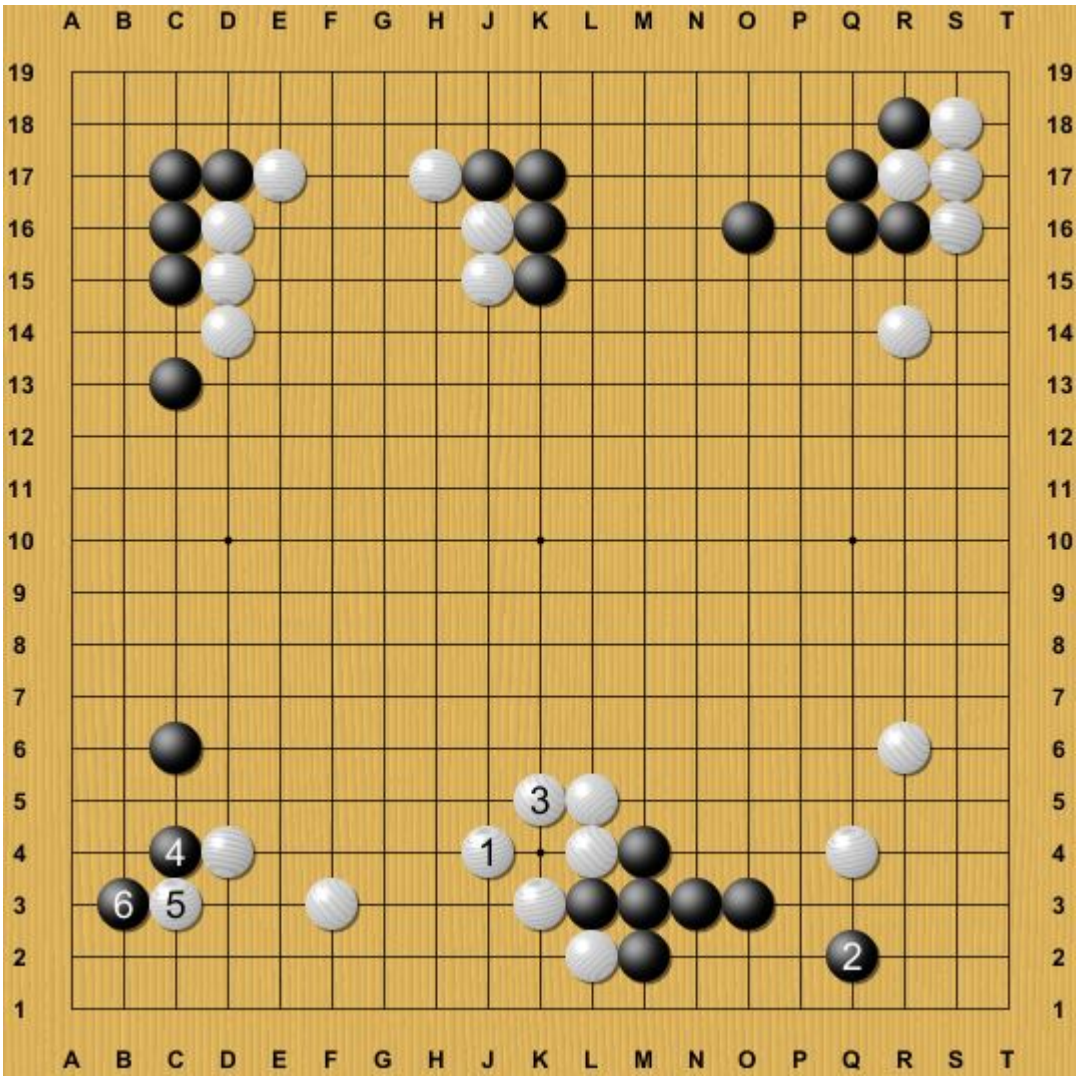
Black must play the knight's move at 45 to secure the group. Now should White finally extend at the top?

Diagram 13



Zhou Ruiyang showed what might happen if White starts the ladder at 1. Although the ladder does not work yet, White can activate it with the push and cut. When White ataris at 9, Black must either relinquish the three stones at the bottom or allow White to capture in the upper left.

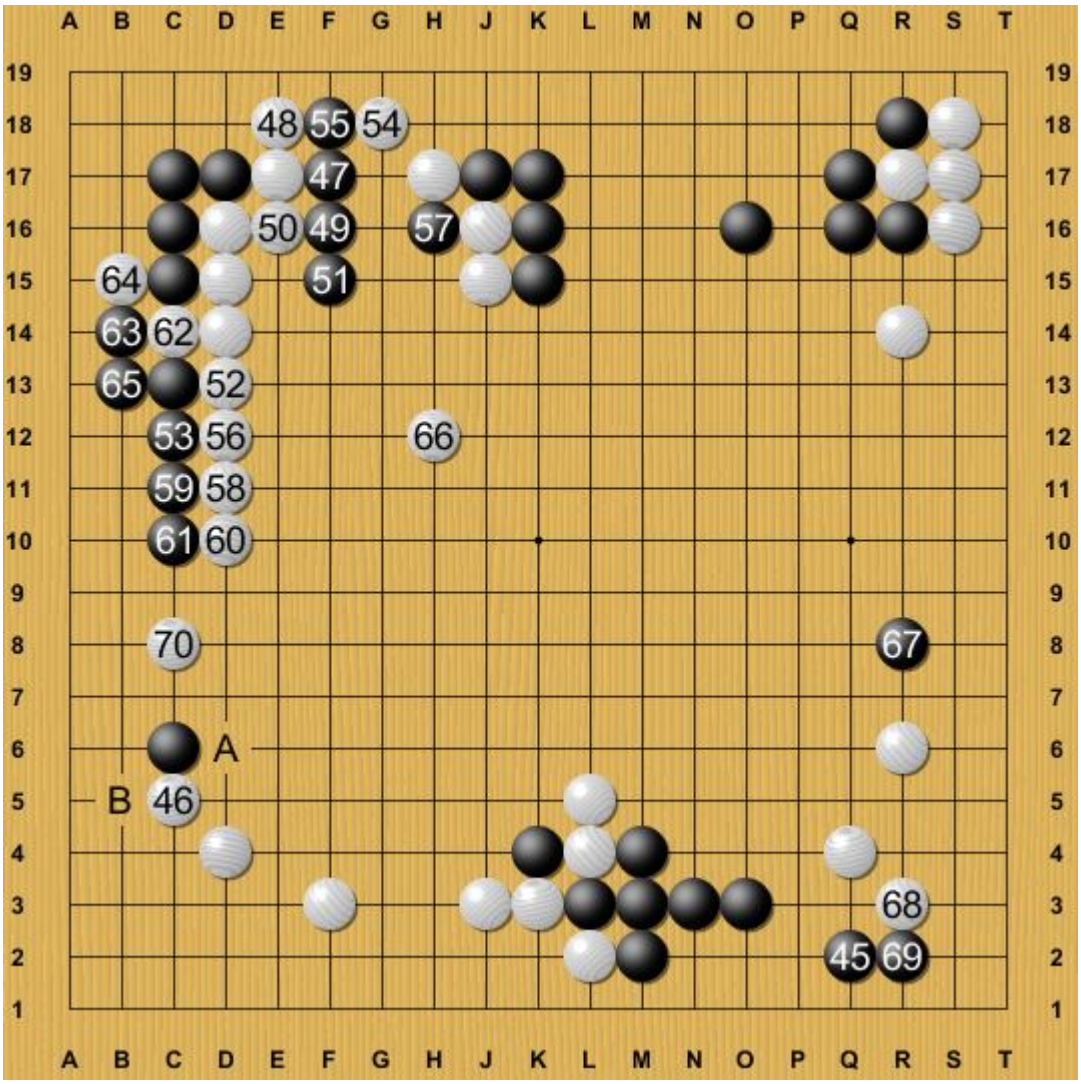
Diagram 14



"Let's look at this another way," said Gu Li, laying out the sequence in diagram 14. Although White captures one stone in a ladder, Black gets sente to play 4 and 6, and seems to be doing fine.

This is one of the great marvels of Go: it seems that no matter the move, there is some way to make it work!

Moves 45-70



Getting back to the game, White kicks at 46. This is a common attacking technique, but AlphaGo's response is unusual. The typical move would be to extend at A, but AlphaGo prefers to tenuki, either right away or after exchanging the hane at B and the atari in sente. It seems AlphaGo has no fear of allowing the tiger's mouth at A.

Black now clamps at 47, prompting the descent at 48. In the end, it seems neither player was ever concerned with the hane at the head of two stones.

Black extends at 53, probably anticipating diagram 15, but after the kosumi at 54 and the press at 56, White has clearly improved on that result. Though Black can cut at 57 to connect, the hane on the second line would have been much cleaner, whereas this way leaves more aji.

Black must crawl twice on the right with 59 and 61. White's push and cut is well timed - Black must connect at 65 to avoid diagram 16.

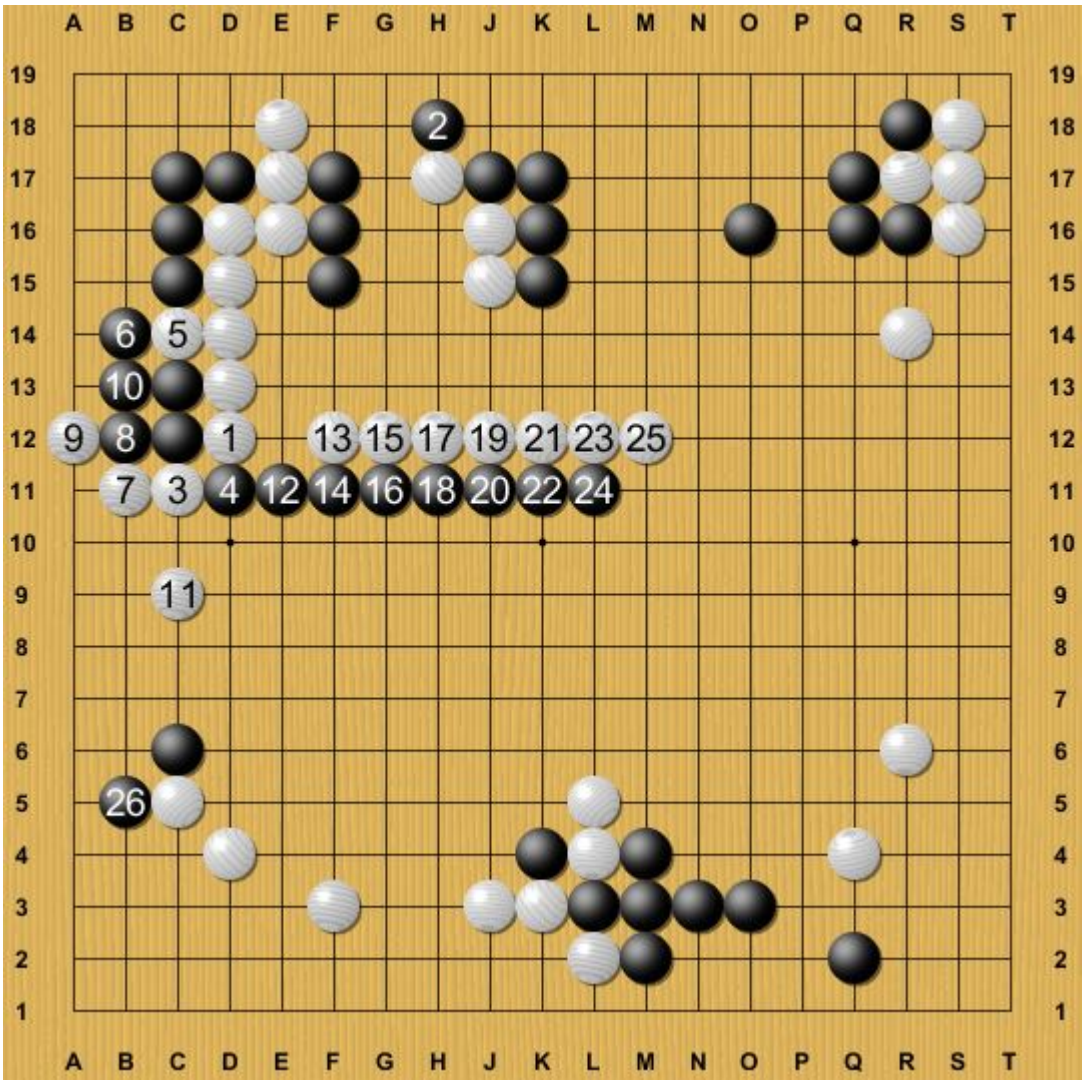
White then leaps out into the centre with the magnificent move of 66! This one move embodies all of AlphaGo’s formidable genius. It strengthens White's group on the left,

reduces Black's top side, and aims at the aji around 57. One can even hear the faint echoes of a White moyo forming in the centre. If there were an ear-reddening move for AlphaGo, this would be it!

Black 67 is the only reply. Not only does Go theory say to play in the widest area, but this move begins to threaten White's safety in the corner.

After shoring up the corner by exchanging 68 for 69, White continues operations in the centre with the big move at 70.

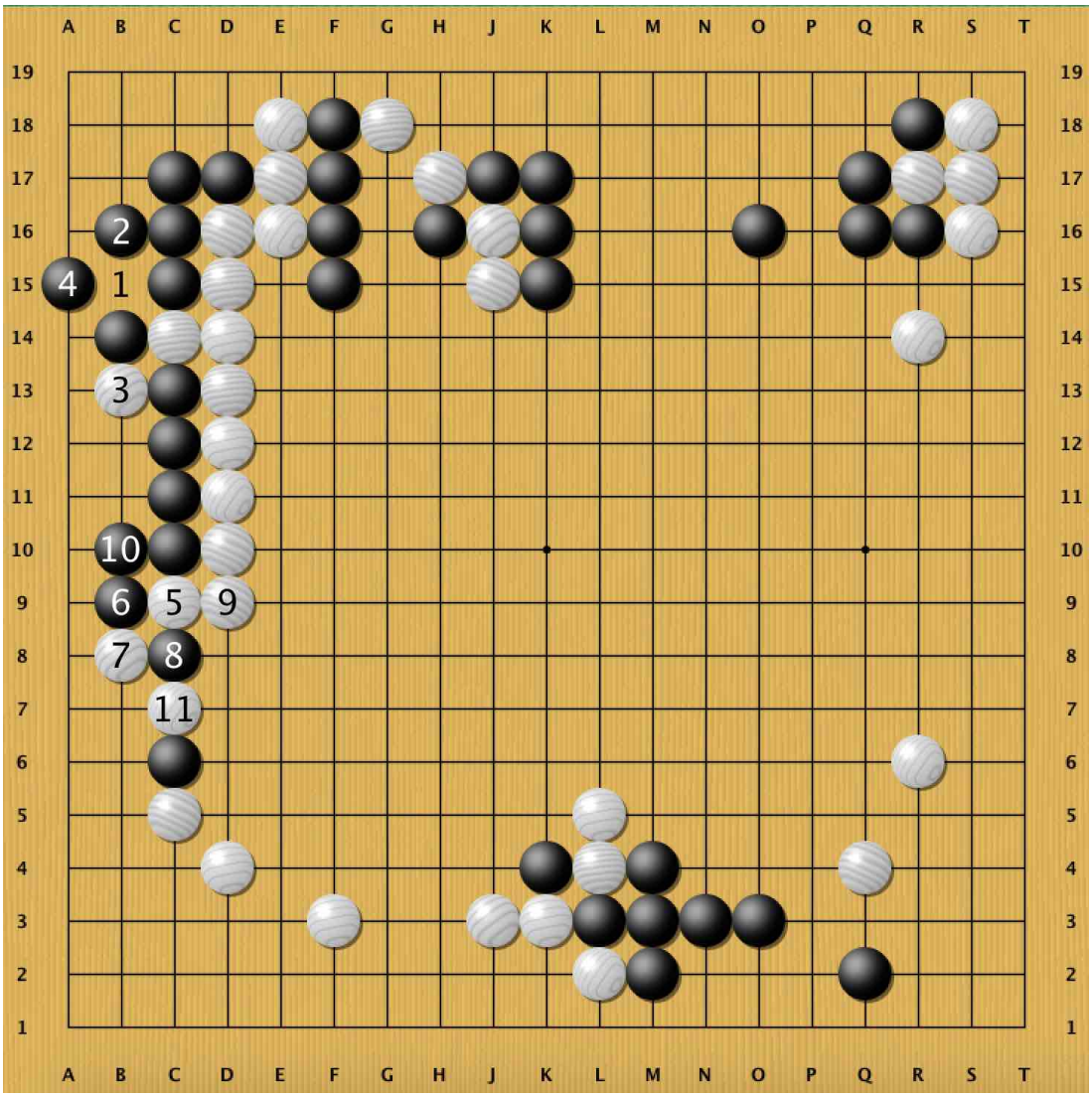
Diagram 15



Black thinks that White will press at 1, allowing Black to connect at 2. White hanes, Black cuts, and after enduring White's forcing moves on the left, Black pushes all the way through 24. Black can now turn back to fight on the left side.

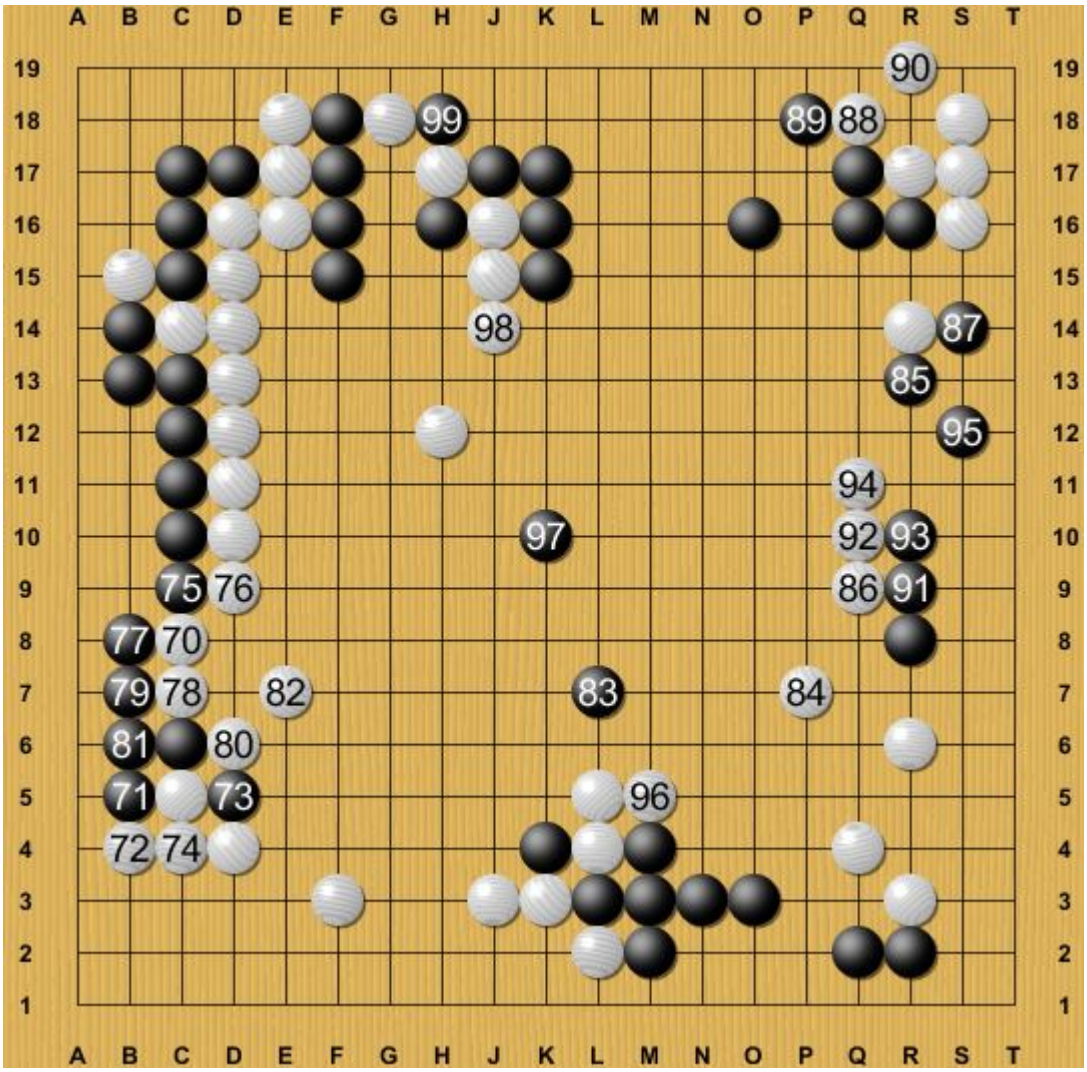
Gu Li and Zhou Ruiyang were not sure about this variation - it would make for a very complicated game.

Diagram 16



If Black captures the cutting stone directly, White can take advantage of Black's shortage of liberties with the double hane. Black must connect at 10, but after the atari at 11, Black is completely sealed in. White is better.

Moves 70-97



Against White 70, Black takes an extremely direct approach. Black first plays the forcing moves at 71 and 73, then connects up the left side, and finally plays a reducing move at 83, aiming to make White's centre overconcentrated. Although the aim is clear, most players could not tolerate the crudeness of the sequence on the left side.

Up to here, this game conveys the feeling that White is playing with masterful lightness, while Black is being dragged around the board. Gu Li and Zhou Ruiyang felt this to such an extent that they declared the game "totally one-sided," almost as if White were playing by itself. Yet in AlphaGo's own calm-minded assessment, White has a win rate of just 51.5%, a lead by only the slimmest of margins. When I informed the two masters, they sighed deeply. In professional matches, they told me, one often encounters situations in which one feels sure of a tremendous advantage - but after a few soft moves, the outlook has reversed completely.

To analyse the position in detail, Black's territory is not small, and though White has great potential in the centre, it is still unknown how this will be converted to real profit. On top of that, White is not completely safe in the corner, which increases the pressure on the centre. Sometimes the difference between feeling good about a game and feeling great is just a single detail. In such cases, players may lean too much on feelings to guide their judgment.

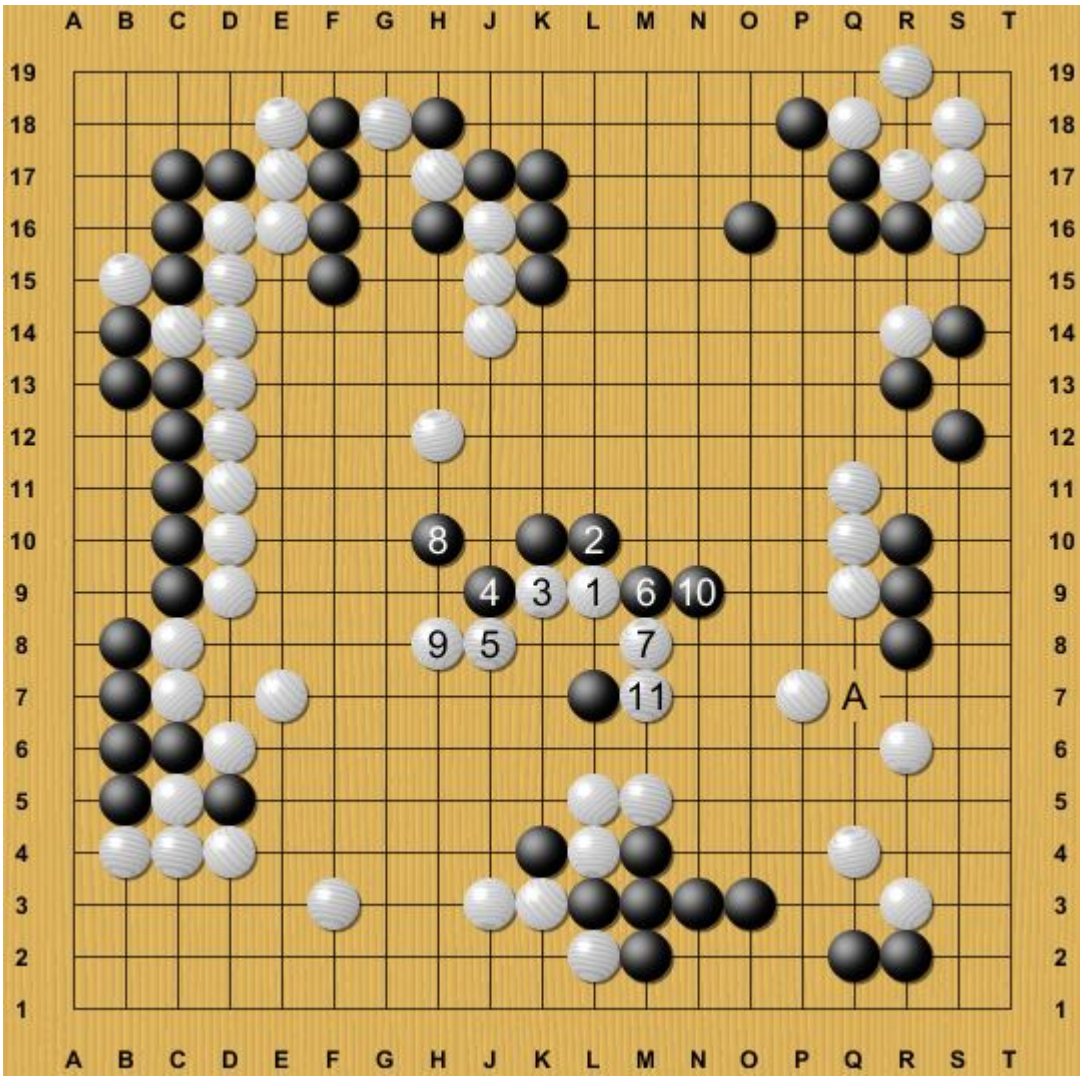
This reminds me of a comment Lee Sedol made after the AlphaGo match. He declared, "I will no longer rely on feeling - I will focus on precise calculation." This could be what he learned from his games with AlphaGo, and the secret behind his subsequent 9-game win streak.

White starts a fight with the knight’s move at 84, and Black 85 is a very interesting reply. AlphaGo often attaches when the local shape looks like this, and it seems that it has already developed the follow-up into a new joseki.

In the following moves, White continues to build up the centre, and Black continues with the strategy of "profit, then erase." Through 95, Black has secured considerable territory across the board.

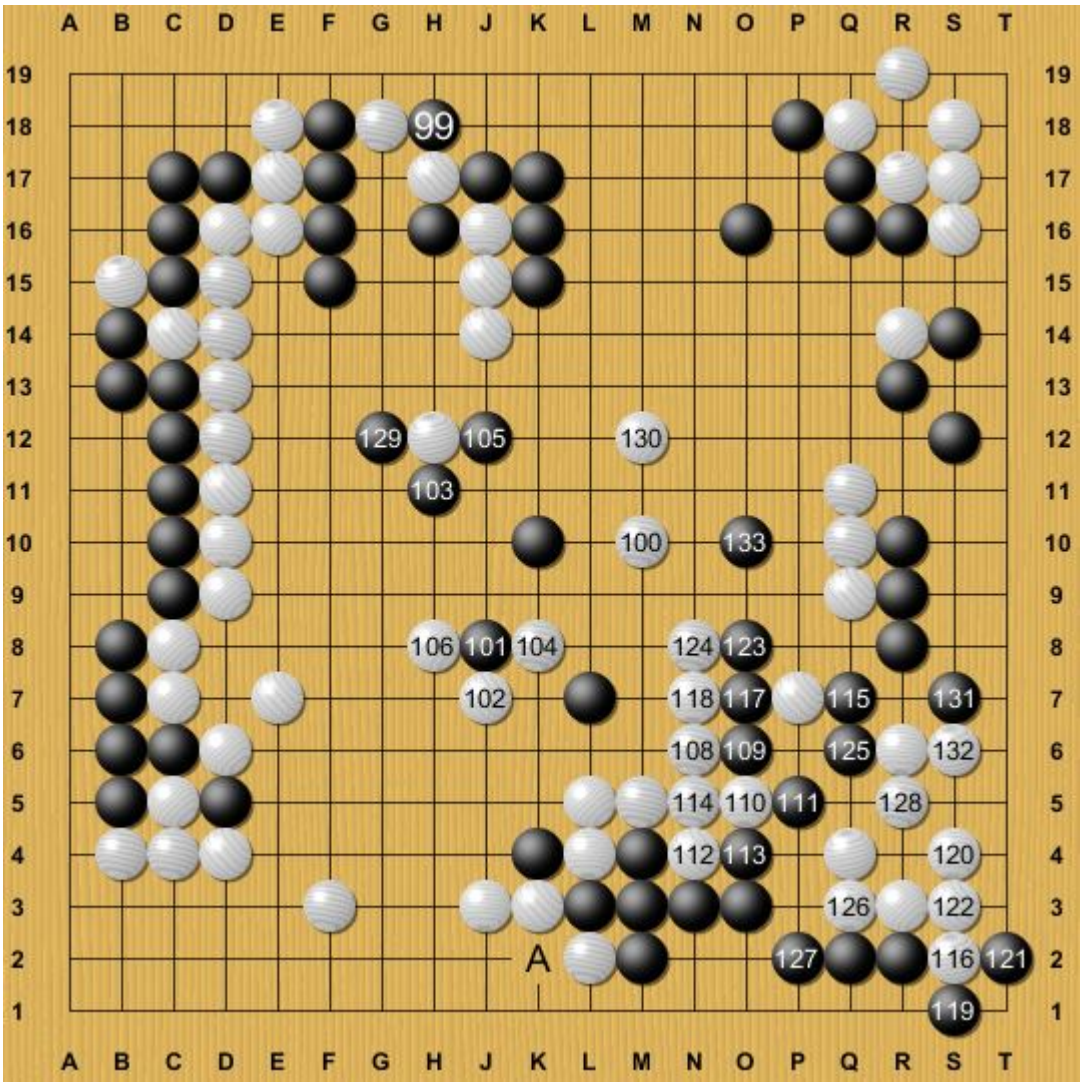
White's turn at 96 is necessary, and Black 97 throws some support to the lonely centre stone. The exchange of 98 for 99 helps prepare White's coming attack. Here, the two sides diverge slightly in their thinking about the position, as shown in diagram 17.

Diagram 17



Black thinks White will cut at 1, after which Black plans to sacrifice the lower of the two stones. Through 11, although White has secured considerable territory, Black is prepared to hammer at White's weak points. With Black 12 preparing to cut, White is at a loss to defend.

Moves 99-132



107 = 114

White 100 starts the attack slowly, hitting the vital point of Black's shape. The knight's move at 101 feels like the right response, after which White attaches at 102 and Black attaches at 103. When I asked Gu Li about these moves, he and Zhou agreed that 'these feel like good moves that will be hard to counter, but the calculations are fundamentally unclear.' I believe AlphaGo calculated these moves deeply, but sadly we cannot see its internal variations. Through 106, a trade has developed, and the outlook has reversed: Black's win rate now stands at 56%. In other words, Black believes that the fight in the middle has been a success. However, this judgment is predicated on Black's ability to further harass White in the centre. We will investigate this assumption soon.

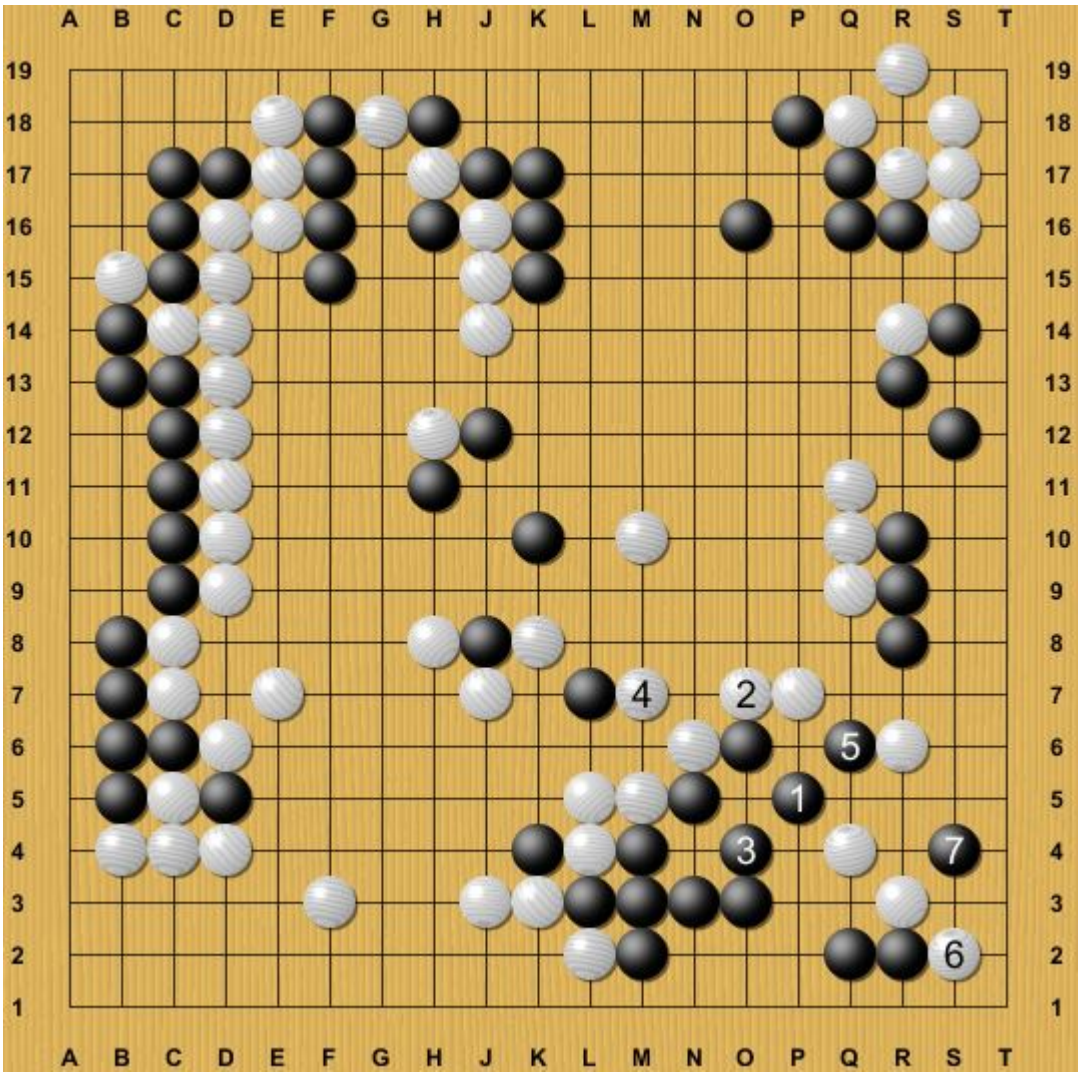
Next, Black seals in the White stones on the right. Note that White cannot use 112 to atari at 117 - see diagram 18.

Black has successfully cut off the corner, but this has no impact on White's life and death status. Zhou Ruiyang thought Black played poorly here.

White 126 is a very strange move, and incurs a definite loss of territory. Before this move, connecting at A may have influenced the status of Black's group, but once White provokes 127, the connection becomes completely gote. AlphaGo may like to play the clearest variations, but this move must be called a mistake.

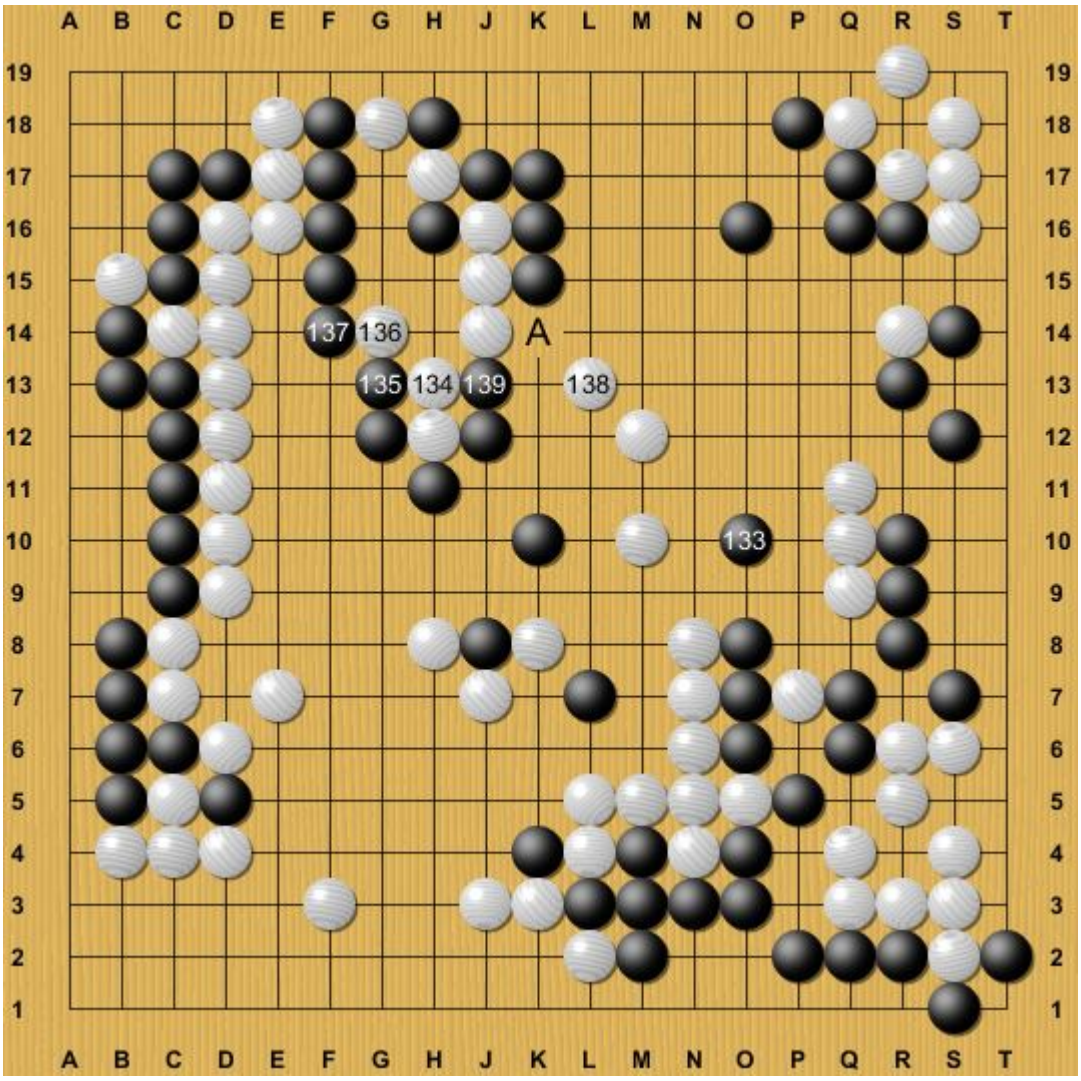
Through Black 133, Black's win rate stands at 53%.

Diagram 18



Although White can reinforce the centre with 2 and 4, the corner group will have a serious life and death problem. When White hanes at 6, Black can kill with the placement at 7.

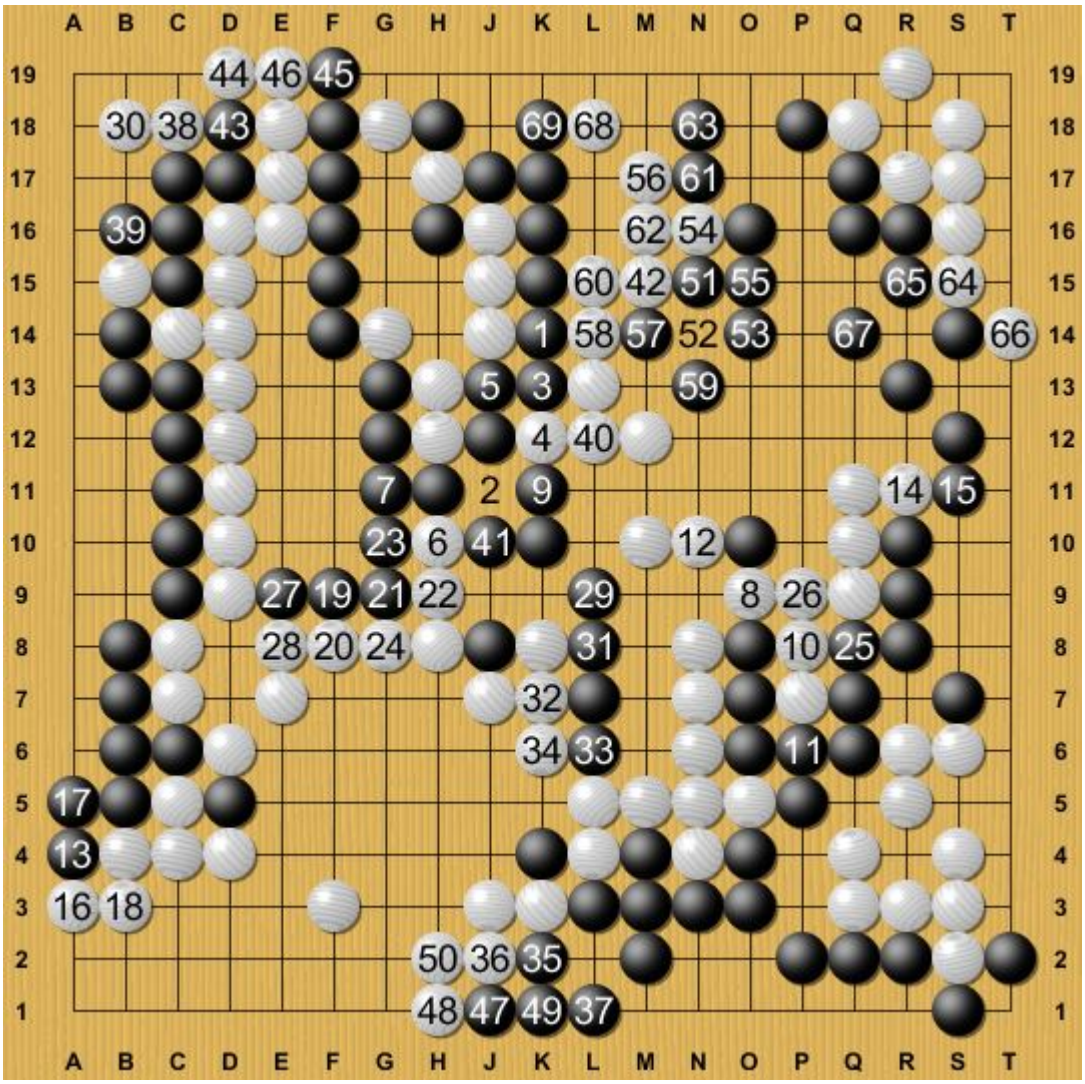
Moves 133-139



The game has entered a stage of extreme suspense. When Black jumps to 133, Black believes that White will be overwhelmed trying to balance the middle and the right side. More precisely, Black thinks both sides are in danger of dying, and this is the reason behind the splitting move at 133. White also believes that the situation is difficult, but when White hanes at 136, the win rate begins to shift, as though both sides failed to foresee this move. After White plays kosumi at 138, Black has nothing better than the atari at 139!

The two pressing questions are: why didn't Black push and cut at A? And why does White appear to give away points with the hane at 136? Before answering these questions, let's take a look at AlphaGo's predictions. See diagram 19.

Diagram 19

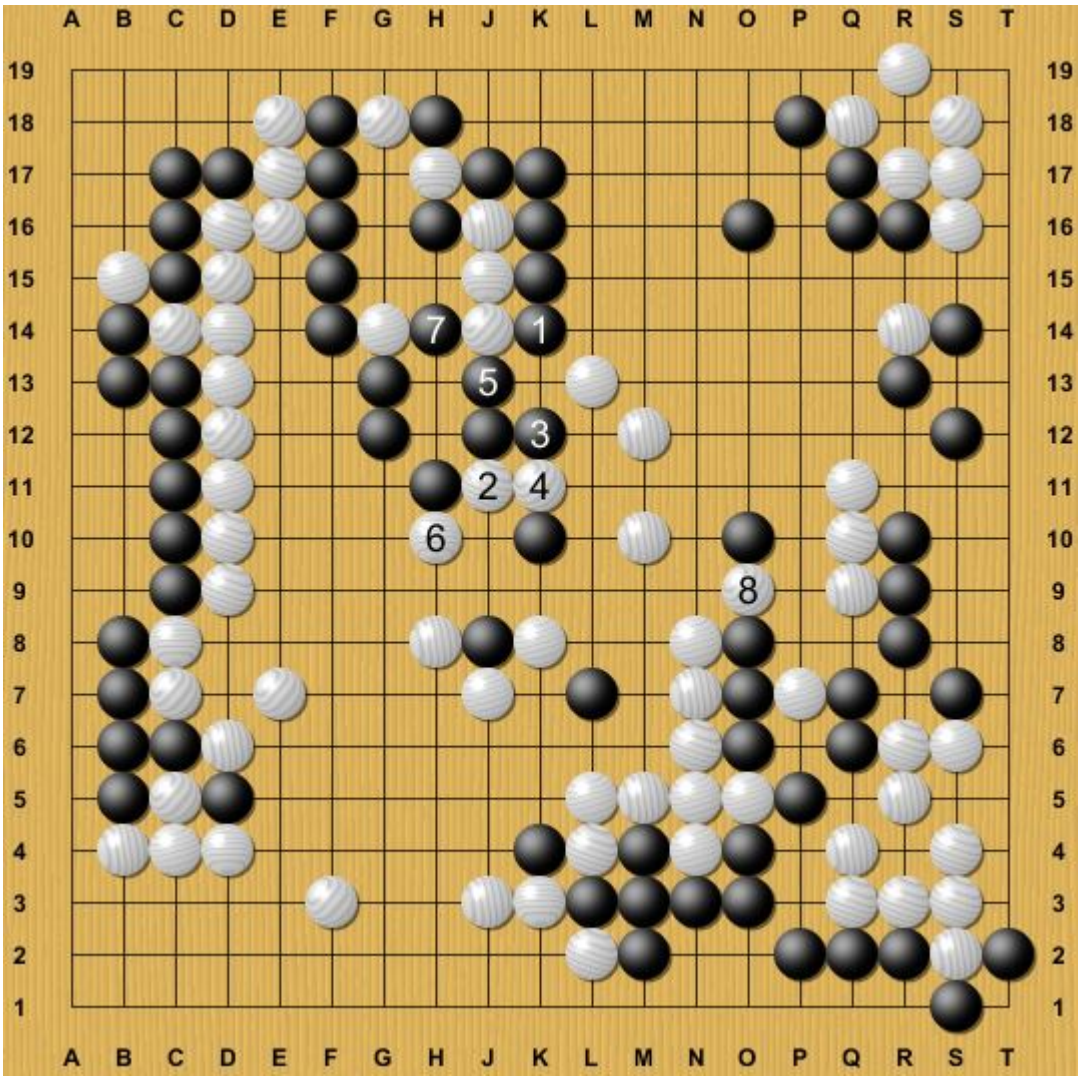


AlphaGo believes that if Black pushes and cuts with 1, White will cut at 2, forcing Black to complete the capture at 3. Through 69, AlphaGo expects a narrow victory for White. According to Gu Li and Zhou Ruiyang's analysis, every move looks very reasonable. Although the endgame is the easiest stage to calculate, the fact that AlphaGo can envision a nearly optimal 69-move sequence is truly incredible!

This variation helped us understand why Black did not push through at 1.

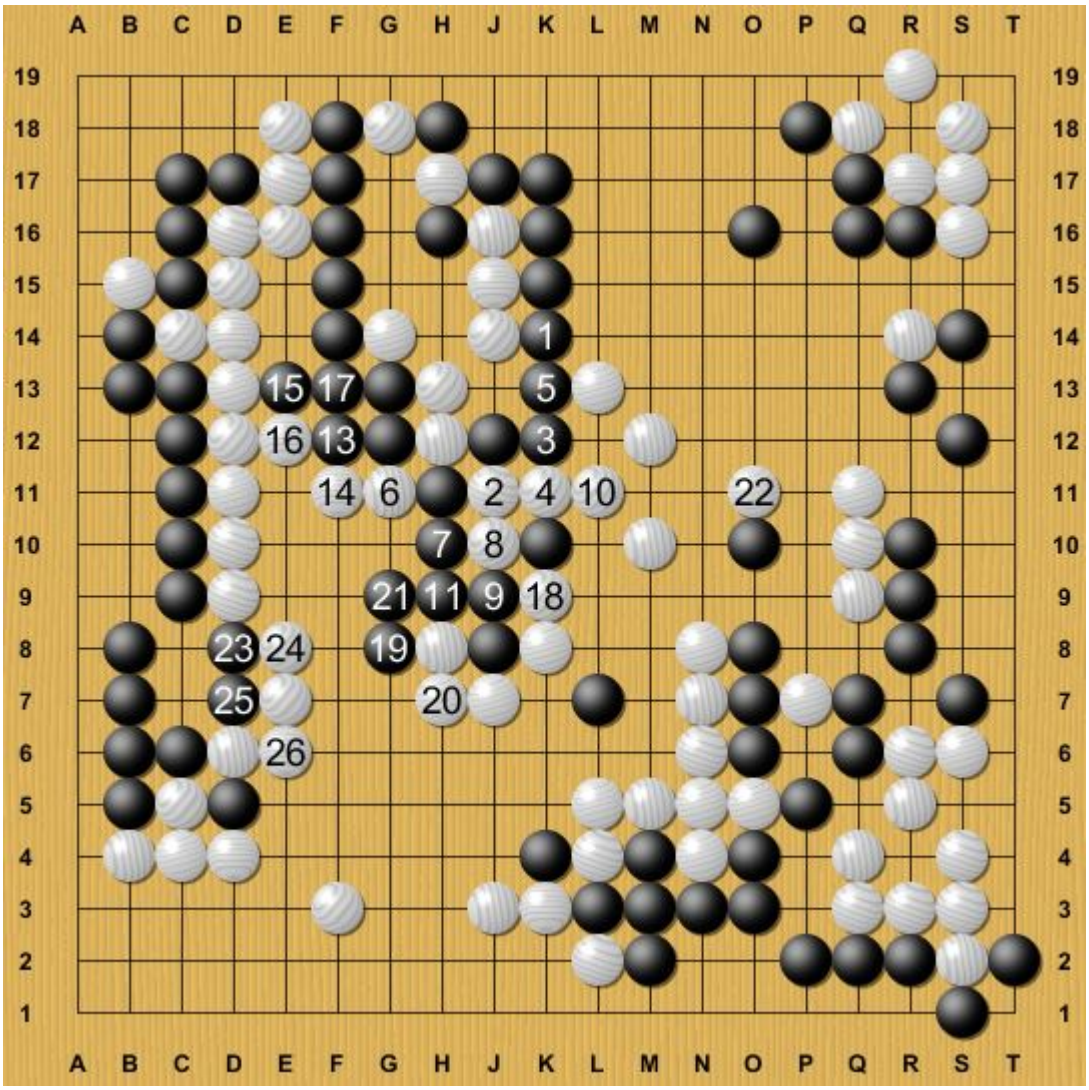
In the diagram above, why doesn't Black extend at 4? See diagram 20.

Diagram 20



Going back to the start, wouldn't it be better for Black to extend at 3? White's most tenacious reply is the push through at 4. If Black pulls back at 5, then White ataris with 6 and defends the right side with the wedge at 8. This is no good for Black.

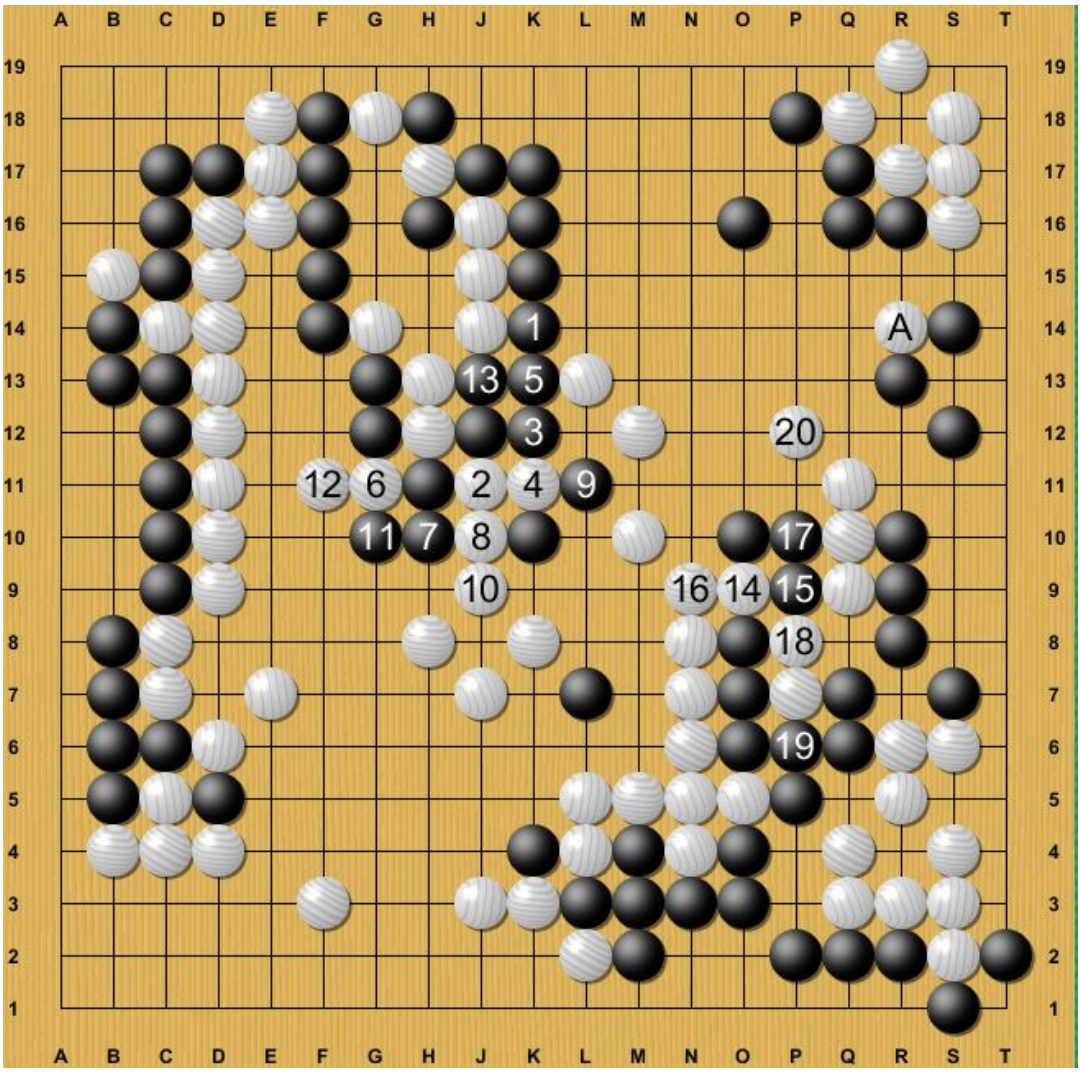
Diagram 21



12 = 17

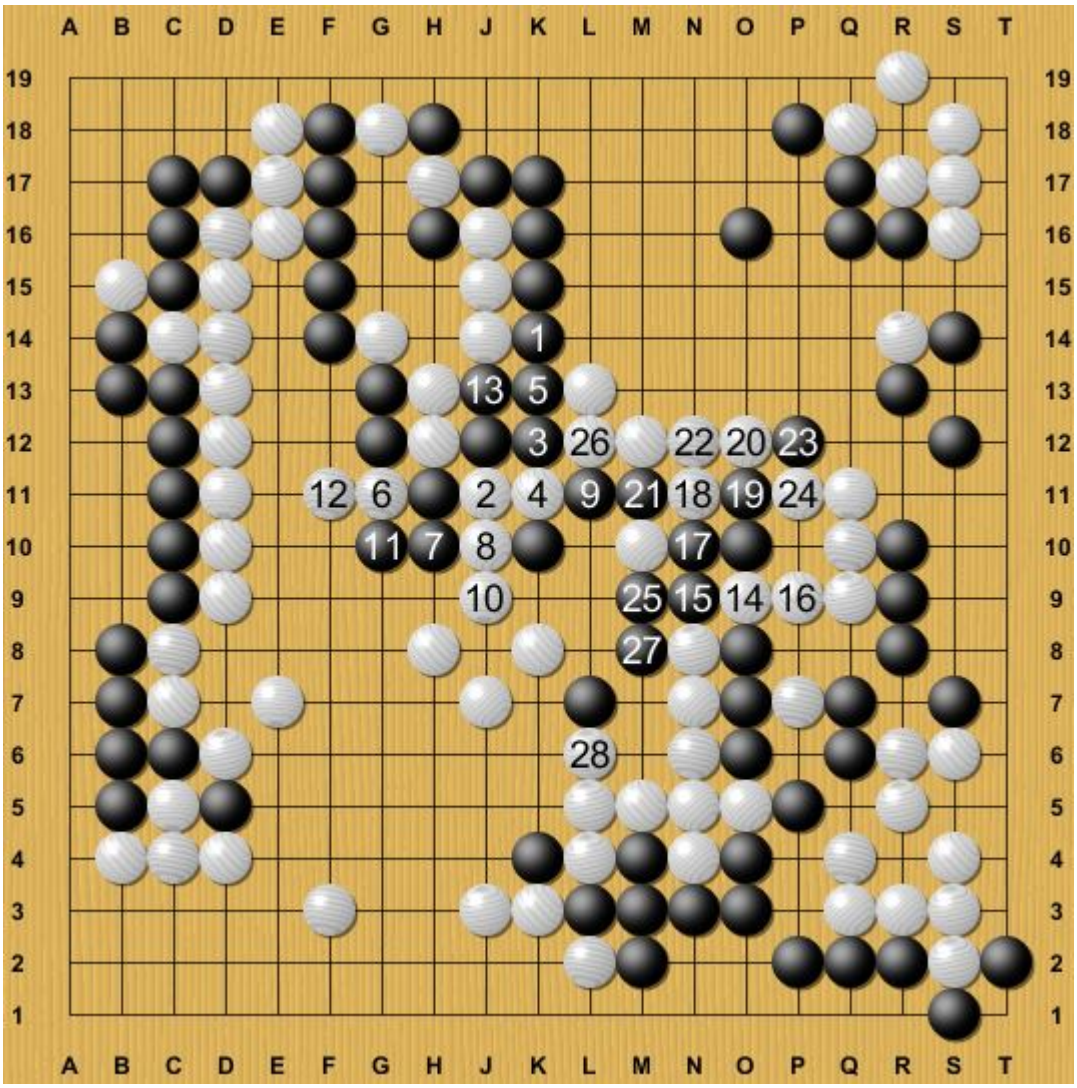
Black can stubbornly resist with the connection at 5, but then White can secure profit in sente with 6 through 20. When Black connects at 21, White calmly links up the three stones on the right with 22. Although Black can capture two stones on the left, the territorial loss in the centre is disastrous. White is better.

Diagram 22



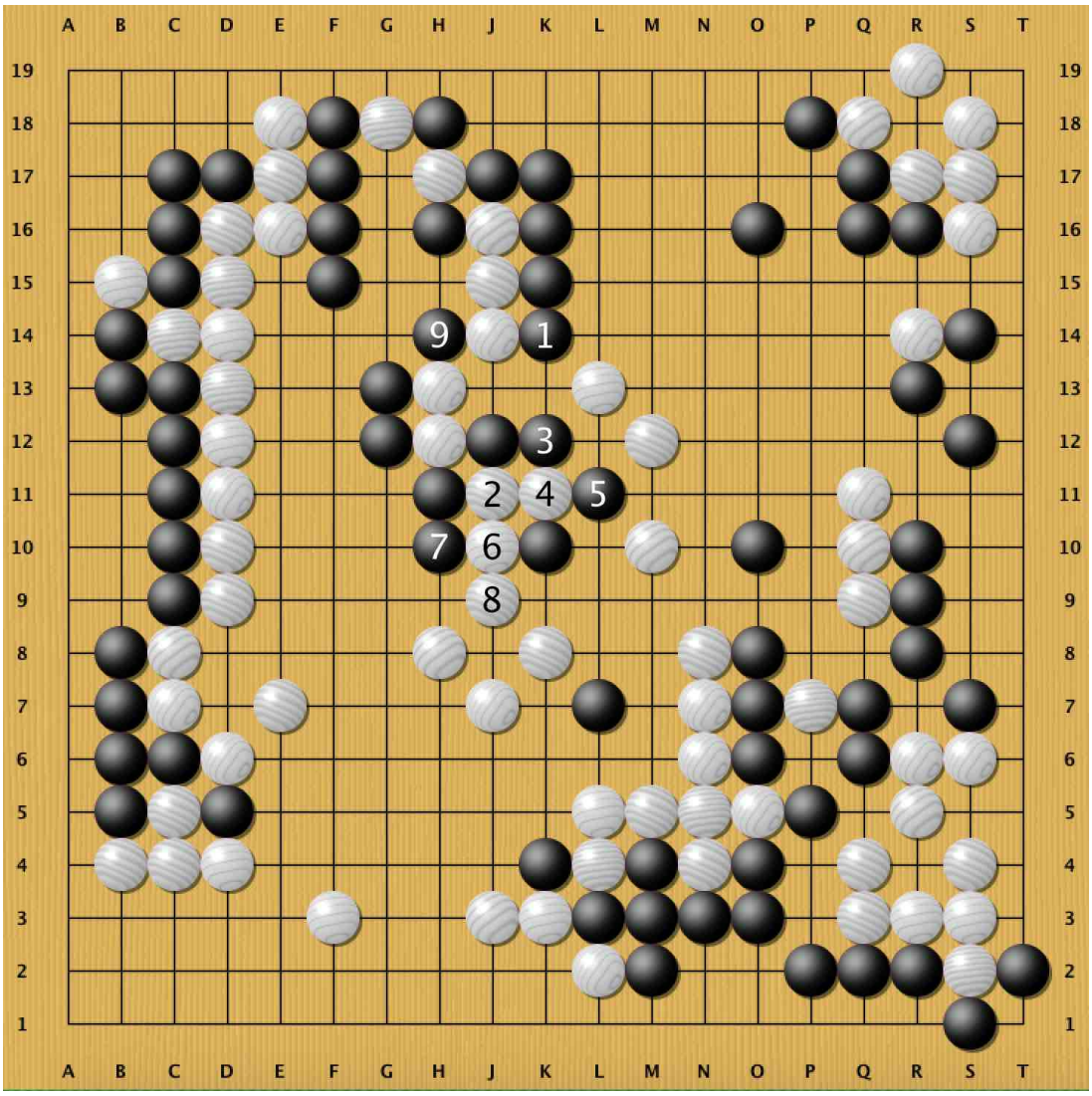
What if Black ataris from the right when White pushes through at 8? With the sequence through 13, White profits considerably on the left. After the perfectly timed wedge at 14 and the following exchanges, White smoothly links up the left and right with the kosumi at 20! White's stone at A plays a pivotal role in safeguarding the connection. If you are curious why, feel free to lay out the position and try to cut as Black.

Diagram 23



In diagram 22, if Black plays the atari at 15 from the other side, White can resist and counterattack. Through 28, Black is dead.

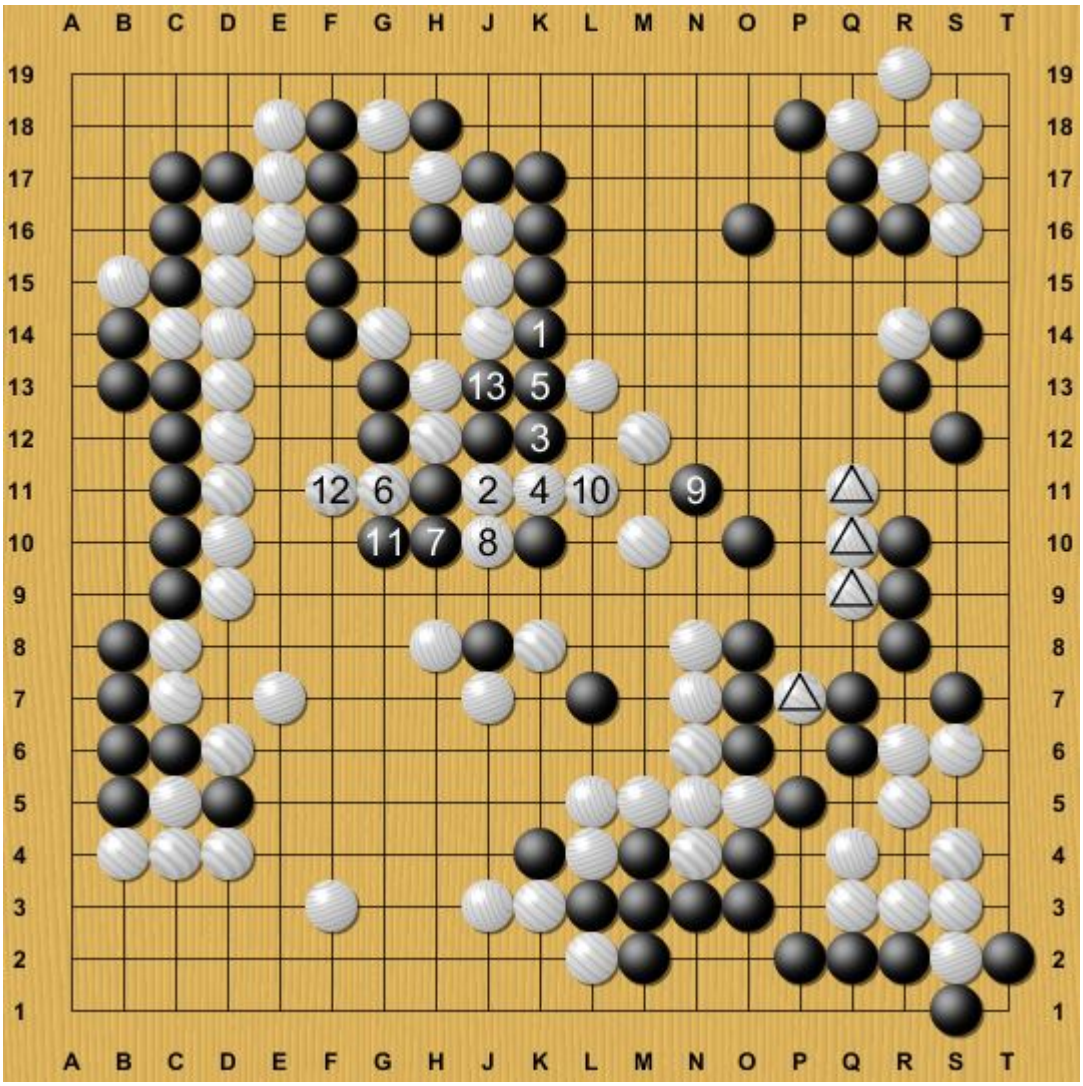
Diagram 24



Now that we know why Black did not push and cut, we can address the second question: why the tiger's mouth at 136? If White omits this exchange, then when White attempts to follow diagram 22, Black can atari directly at 9. This way, Black clearly has more points than in the previous variations.

Just as we thought we had finally understood White's move after several hours of research, another thought occurred to us. See diagram 25.

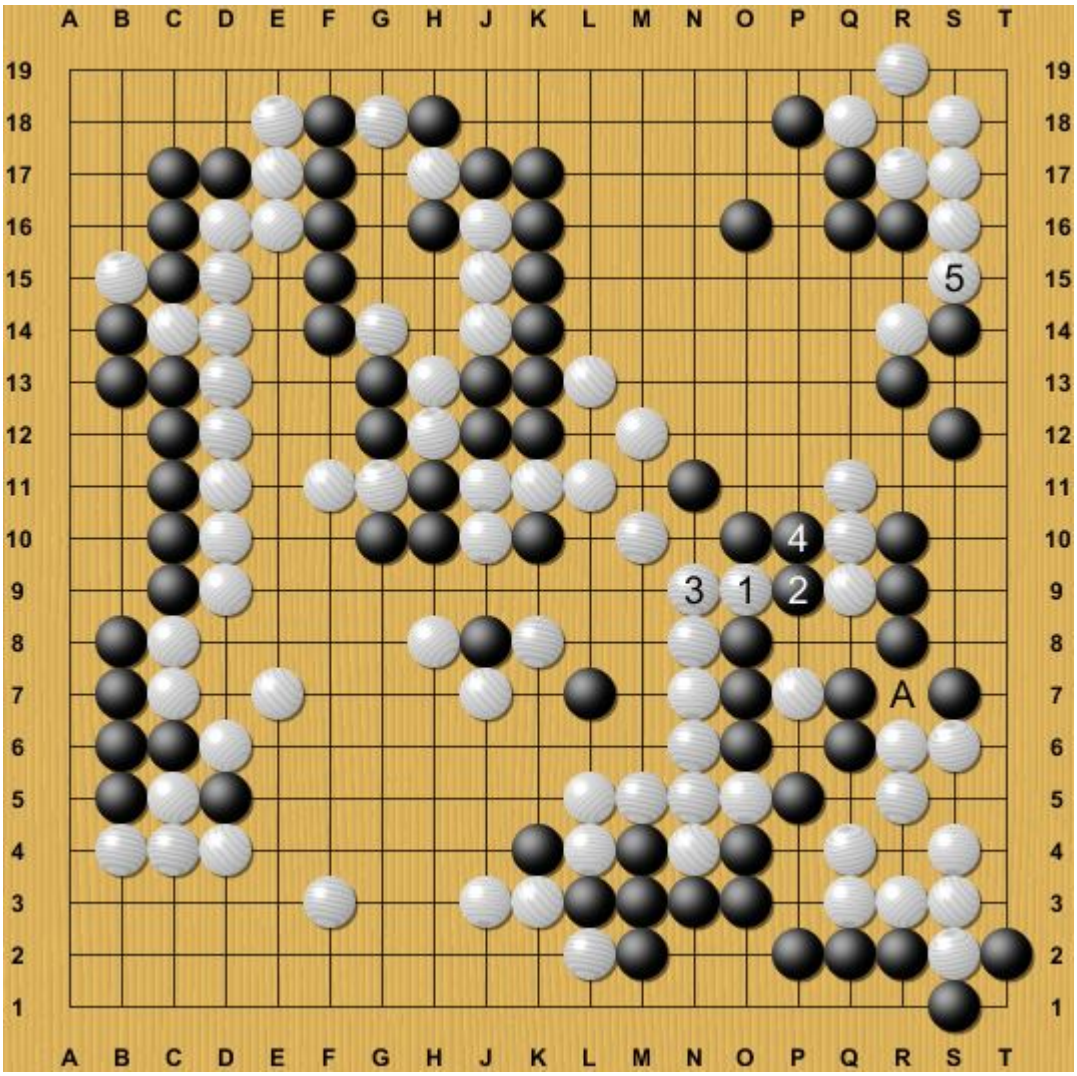
Diagram 25



Zhou Ruiyang suddenly realised that, when White pushes through at 8, Black can play the well-timed peep at 9. White has no choice but to respond at 10. Now Black settles the left as before, but with 9 in place, White has no way to save the three stones on the right. We looked many times for another way, but White has no alternatives from beginning to end.

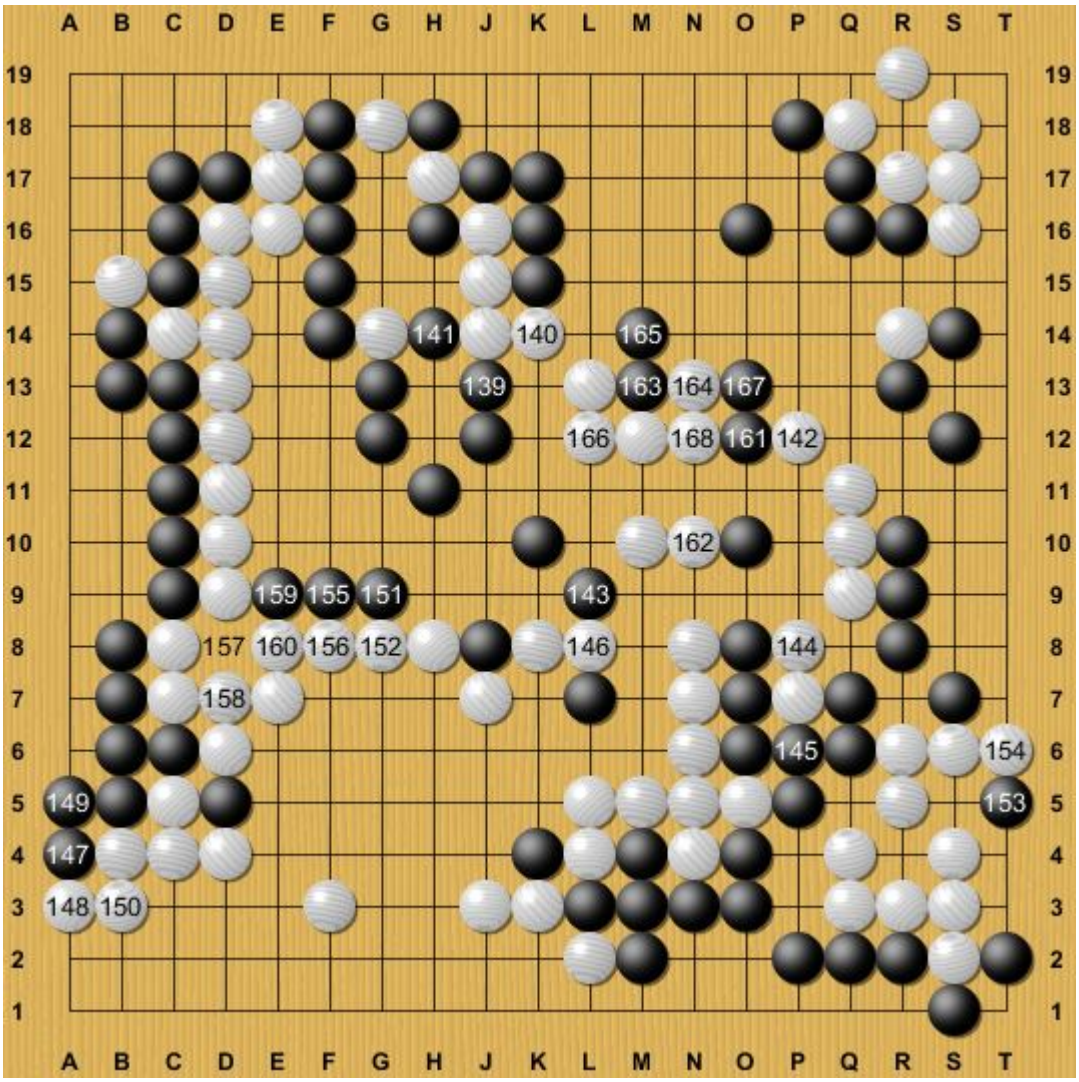
Suddenly a very simple idea struck us: even if the three stones die, is White actually losing?

Diagram 26



Dead they may be, but White can still take advantage of the aji from the three stones to wedge at 1 and force at 5. Black is at a loss to answer. Because of the wedge at A, Black cannot get much locally, while White still profits handsomely in the centre. Surprisingly, even capturing the three stones turns out to be no good for Black.

Moves 139-168

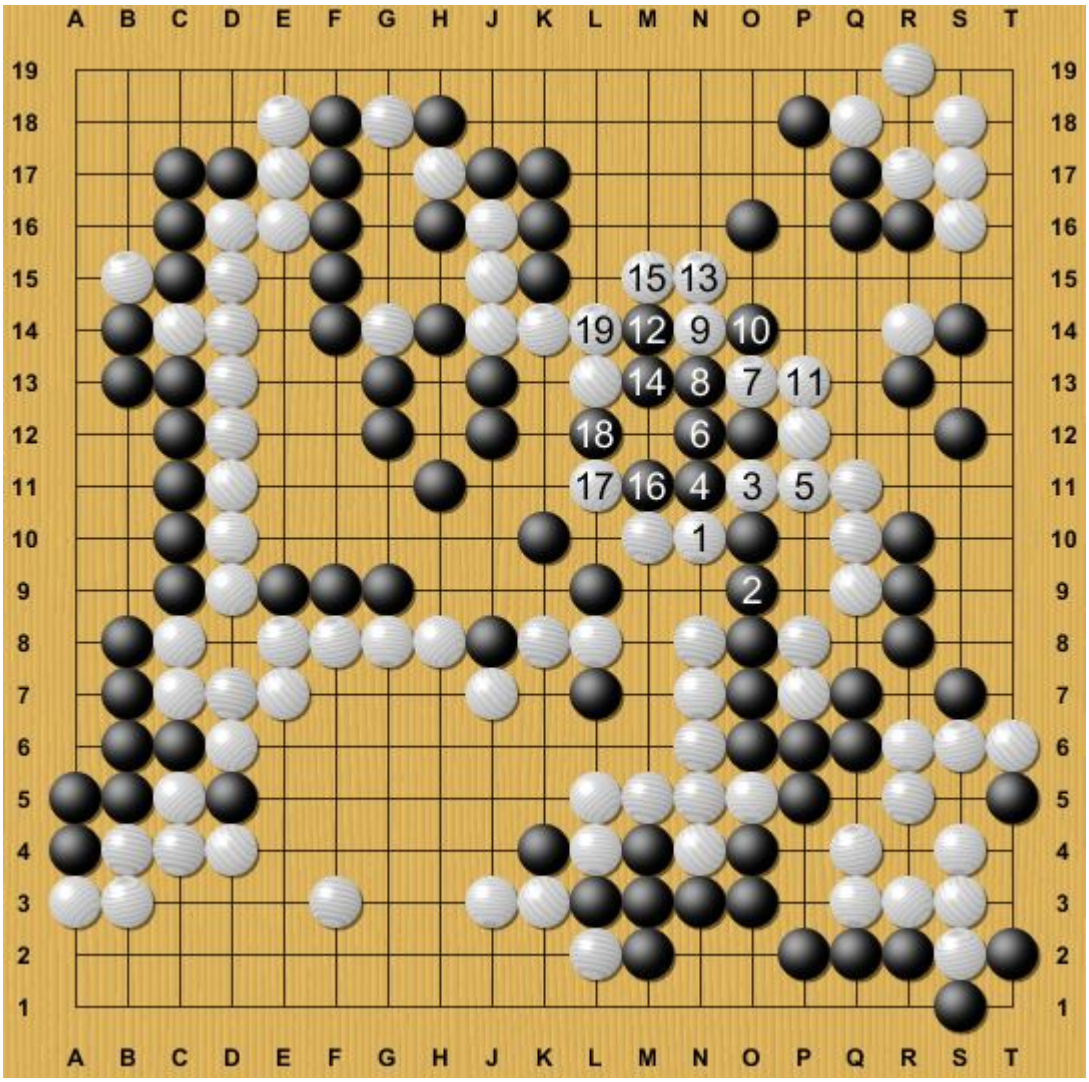


In light of the above variation, Black ultimately chose to atari at 139, and this was the point of no return. Thanks to White's extra stone at 140, the kosumi at 142 manages to connect up the whole centre. This is a huge loss for Black! Both sides understand the situation now, and White's win rate shoots up to 65%.

Black 153 is an absolute loss, probably a reflection of Black's desperation. 161 is the last real try for a comeback, but White refutes it with the tesuji of 162. See diagram 27.

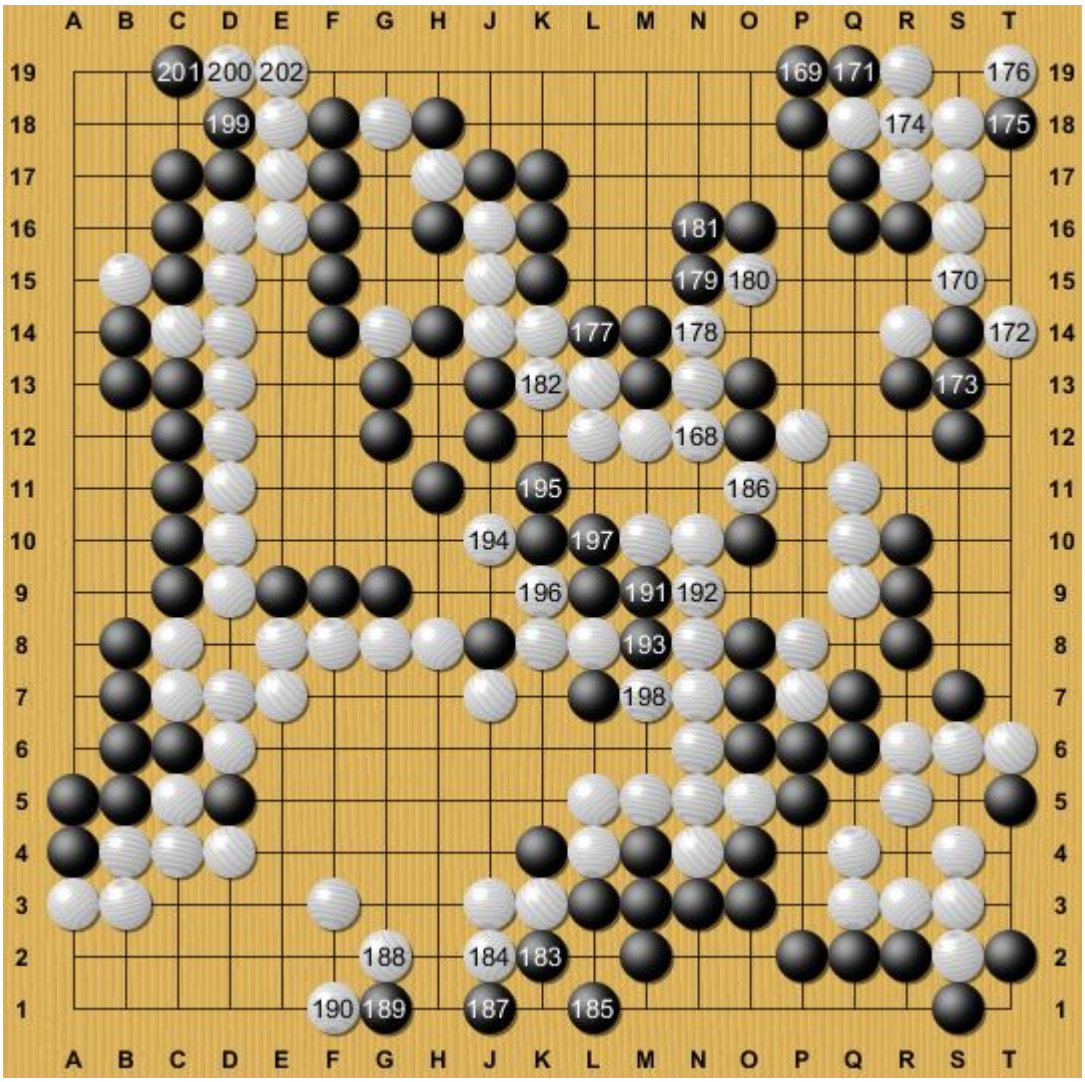
By move 168, White's win rate has risen to 80%. Black has no chance of victory.

Diagram 27



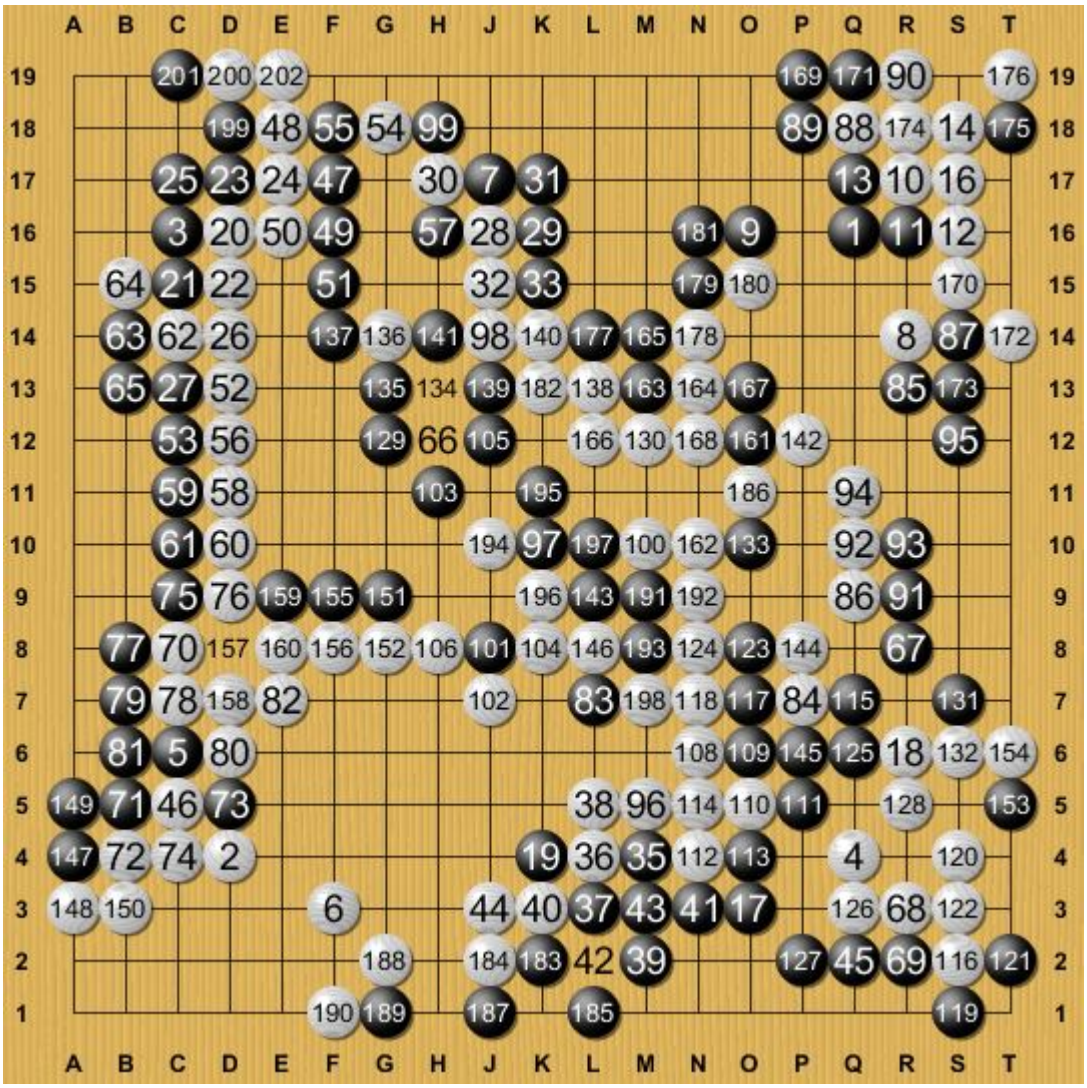
If Black stubbornly connects at 2, White wedges at 3, then encloses the group with 7. Through 19, Black is dead.

Moves 169 - 202



The game is already decided, so there is not much to say about the following moves. Black resigns at 202.

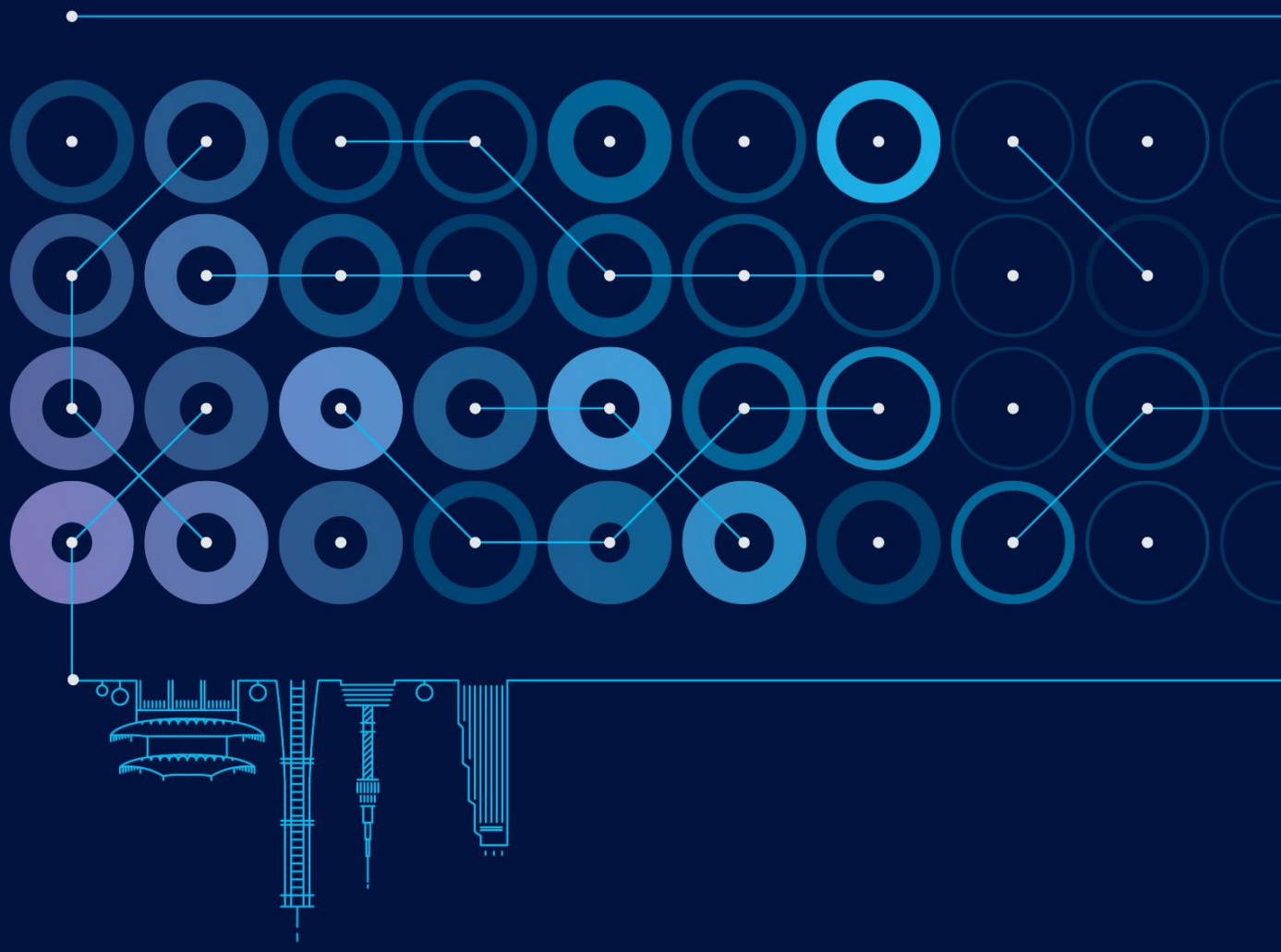
Recap



The most interesting aspects of this game are White's extremely creative attachment in the corner at 20, and the stubborn attachment on the top side at 28. Although we cannot say for sure that these are good moves, they are without a doubt inspiring and eye-opening. With moves like these to learn from, we can look forward to AlphaGo's innovations bringing greater diversity to Go.

I would like to thank Gu Li and Zhou Ruiyang once more for their vigorous, precise, and tireless analysis. The variations in the centre were incredibly complex, and we spent many hours in particular investigating White's critical exchange at 136. I feel deep respect for the dedication these two world champions showed to the pursuit of perfection on the Go board.

Finally, I must say that in a game as rich as this one, there are surely many details we have not yet explored. If you have the time and inclination, please play out these fascinating games yourself, and you will be sure to reap the benefit of many new discoveries.



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