Abstract: Shared life in Go – generalized nakade captures

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Abstract: The game of go [weiqi (Chinese/C)/ baduk (Korean/K)] has a number of distinct types of shared life – known as seki (Japanese/J) [shuang1 huo2 (C)/ bik (K)]. We examine positions where both players may make (big-eye/nakade) captures which do not guarantee independent life. Both players will usually prefer not to make a capture. We provide a systematic treatment, and describe several unpublished examples.

Introduction

Here we consider only those positions which involve one particular type of capture – one-sided, generalized big-eye/nakade (chijungsu(K)/zhong1 shou3(C)) capture. After such a capture, the player making the capture does not make guaranteed independent life – two eyes, or a seki with an internal lump of stones. We consider various combinations of these, and show which are stable configurations of shared life, and which not. We assume a basic Chinese method of counting, and deal almost entirely with "terminal" positions.

Capture

In shared life we sometimes find stones which can be captured – perhaps, on the next move. In the simplest of such situations each capture is one-sided – i.e. if Black can capture some white stones, then those white stones (if left not captured) cannot themselves capture any black stones. When the stones are captured, the capturer (Black, say) cannot be sure of making independent life. Of the one-sided captures, the simplest types can not lead to ko(jie(C)/ pae(K)). These types are the centre/edge nakade, and the simple corner nakade. Captures of complex corner nakade may lead to ko – to remain as seki, the defender must have non-removable ko-threats elsewhere.

Simple capture

One-, and two-, stone capture can usually be ignored – we consider the capture of more than two stones. The most well-known such captures are the "nakade" captures of 3-6 stones in the centre/edge of the board. Some of the 4-6 stone captures give fewer liberties in the corner. Some simple corner nakade have an eye of their own – i.e. the 1-1 point is empty. There are six such cases – an extra "external"/shared liberty is required -- captures are equivalent to 2, 3, 4, and 6 liberties.

Complex corner nakade

The complex, corner captures all involve the possibility of ko – sometimes the attacker has the choice, sometimes the defender has the choice. These positions are bent-four-in-the-corner, Murashima's ko (see corners in Fig 4), and rectangular six. We examine two further positions which contain an eye -- *step four*, and *butterfly seven* – they may challenge Japanese rulesets, but cannot be used in simple seki.

The building blocks

We have now collected several different captures which give varying numbers of internal liberties: 0 (no eye, no capture!); 1 (one point eye, or 1-, or 2-, stone capture); 2 (3-stone capture, or 2x2-block in corner); 3 (four 5-stone corner captures, corner 4-nakade with eye); 4 (normal 4-stone nakade); 4/1&k- (bent 4 in the corner); 6 (Flower six in the corner, and flower-six nakade with eye); 6/1&k- (rectangular six in the corner); 7 (normal 5-nakade); 9/3k (Murashima's Ko – Fig 1); 11 (normal flower 6 nakade). We use combinations of these building blocks to construct sekis

One against one

If Black has a single eye containing such a nakade shape, opposed to a single white group, and there are no external liberties, then it is fairly easy to see that the condition for the position to be a stable seki is that Black and White surround nakade of the same size – i.e. having the same number of internal liberties (not always equivalent to captures of the same size/shape lump!). Complex nakade (corner only) may give ko as an alternative to seki.

One against many

We now consider one black group versus several white groups. We have to consider how many liberties each group has. If a configuration is really one of shared life, then we know that a *minimum* requirement is that, for each group, the *total* number of (both internal/eye and external) liberties must be equal to the total number for all groups *with which it shares liberties*. If a group touches another, but does not share liberties with it then it is not part of the *same* seki configuration. This means that all such inter-related groups must have the same *total* number of liberties. Consider the case where we have one black group in a fight with several (n) white groups with (w_1, w_2, …, w_n) respectively internal liberties, and sharing (l_1, l_2, …, l_n) liberties with the black group, which has b internal liberties. We do not include the case when b = 0 (i.e. Black has zero internal liberties) – considered separately. If all (internal and external) liberties were the same then the condition for seki would be that, for each white group:

$w_i + 2* l_i = b + sum\_of\_all(l_j) + n$ { $w_i > b > 0, n > 1$ } . . . . . Equation 1.m

All groups and liberties the same

In the simple case where all the w_i's are the same ($w_1 = w_2 = \ldots = w_n = w$), and all the shared liberties are equal to one ($l_1 = l_2 = \ldots = l_n = 1$), we get $w+2 = b + 2*n$. This gives the conditions

(n = 2, w = b+2), (n = 3, w = b+4), (n = 4, w = b+6), …

The above condition deals with case where either White, or Black, starts an attack by playing on shared liberties. Black never wants to start an attack by capturing (playing on an internal liberty). When White starts the attack by playing an internal liberty, Black's defence is to play on as many of these internal liberties as possible. If the black group, and this white group, now have nakade of the same size, then Black has created a temporary stalemate between the two groups – now Black can eventually kill all the white groups. If Black cannot do this then the black group dies. With this extra condition added to those above, the only remaining possibilities are:

- n = 2, w = b+2, giving:

  (w=3, b=1), unstable seki – Fig 1 - White plays at any time to get a terminal seki, and gets 14 points;

  (w=4 , b=2), possible unstable seki – Fig 2 – if either (or both) of the black lumps is the pyramid-4 shape, then White captures eight black stones, and obtains another seki, gaining 11 points -- see also [Feldmann2005a];

  (w=6, b=4), simple seki – Fig 3;

  (w=9, b=7), Fig 4: White choice – seki, or ko to kill Black;

  (w=11, b=9), not a seki – Black wins - white liberty shortage(damezumari(J)/ gong-bae-me-u-gi(K)).
- n = 3, w = b+4, gives the single case (w=11, b=7) – Fig 5 – see also [Feldmann2005a].

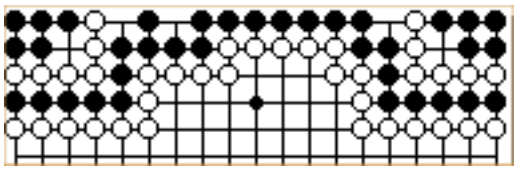

Fig 1: Equal 1-3

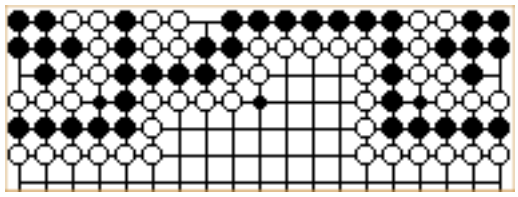

Fig 2: Equal 4-6

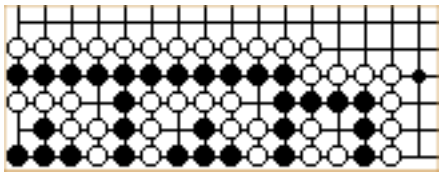

Fig 3: Possible unstable seki

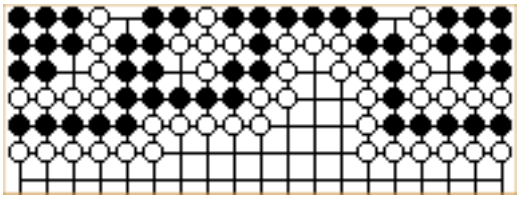

Fig 4: Equal 7-9

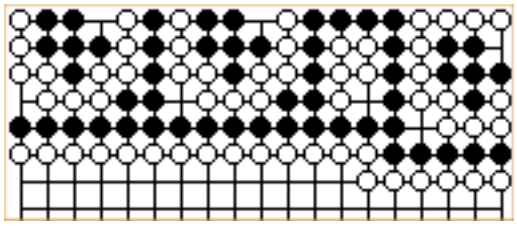

Fig 5: Largest centre/edge combination

Fig 6a is unusual -- if White plays first then all white stones die, whereas if Black plays first then one white group lives – Black decides which one lives. Four other configurations exhibit similar behaviour. The most extreme example is shown in Fig 6b. We tabulate outcomes of all positions involving centre/edge nakade only.

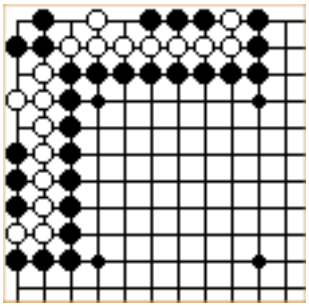

Fig 6a: One-or-two die

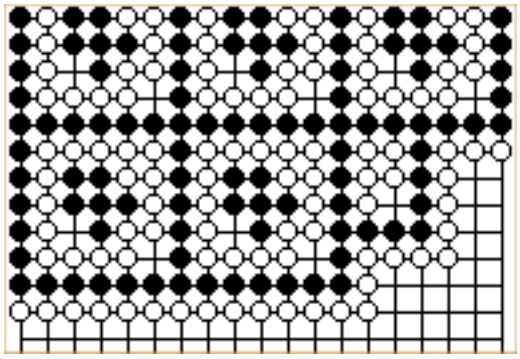

Fig 6b: Four-or-five die

Different sized captures; different shared liberties

One against two

In Equation 1.m, with two white groups, and $l_1 = 1$, $l_2 = 2$, we get:

$b+5 = w_1+2 = w_2+4 \rightarrow w_1 = b+3$, and $w_2 = b+1$, and similarly, if ($l_1 = 2, 3, \ldots$; $l_2 = l_1+1$), …

Other combinations of values of l_1, and l_2, are not possible -- this would give $w_i <= b$, which violates a condition. White's only possible attack is first to capture; Black's defence is to take those internal liberties, and to threaten a temporary seki. This gives us three families of seki:
1) $b = 1, w_1 = 4, w_2 = 2, l_1 = l, 2, 3, \ldots, l_2 = l_1+l$ – seki – Fig 7 -- see also [Feldmann2005a]
2) $b = 3, w_1 = 6, w_2 = 4, l_1 = l, 2, 3, \ldots, l_2 = l_1+l$ – simple seki – see Fig 8
3) $b = 6, w_1 = 9, w_2 = 7, l_1 = l, 2, 3, \ldots, l_2 = l_1+l$ – Fig 9 - White is safe, but can kill Black with ko.

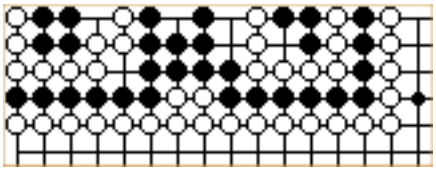

Fig 7: Unequal 1-2-4

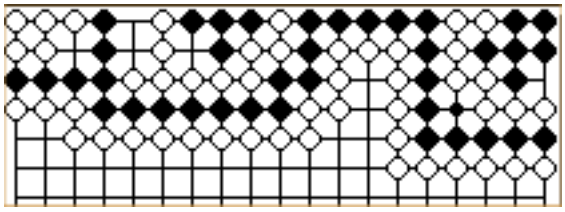

Fig 8: Unequal 3-4-6

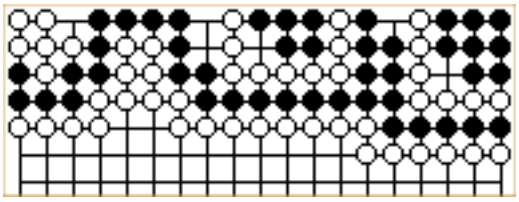

Fig 9: Unequal 6-7-9

In the three families above, the only ones which are terminal seki occur when $l_1 = l$. When $l_1 > l$ we have $(l_1 - l)$ one-sided, non-removable, ko threats for Black.

Further analyses and conclusions
We continue the above analysis – of unequal groups and liberties – for one black group simultaneously against many white ones. We further extend all the previous analyses from one black group to two, or more, black groups – e.g. consider Fig 10, below. We consider more aspects of the involvement of ko, including complex corner nakade involved in fights with bigger nakade (with, or without, ko). More work remains to be done -- both including more complicated topologies, and with more groups.

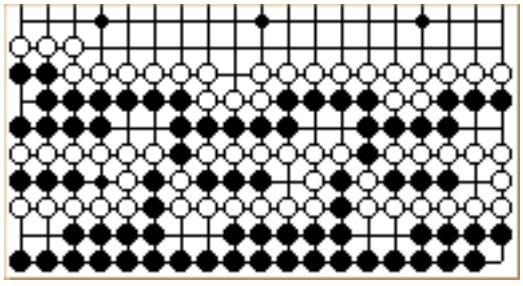

Fig 10: 2 black versus 3 white : 1-3