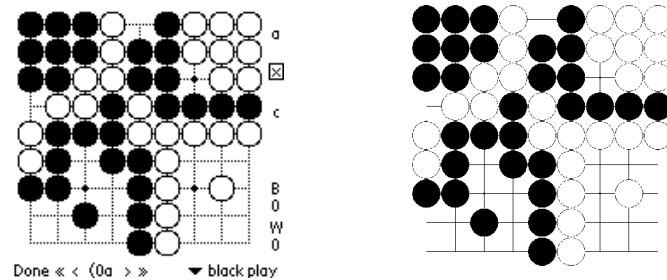


Shared life in Go: an overview



ICOB 2005, Myongji Univ, Seoul

20-21 October 2005

Harry Fearnley

hf@goban.demon.co.uk

Outline

- Catalogues/databases – a “good thing”
- What work done already?
- How to do it: e.g. *hanezeki/ jeochim bik*
- Much more work needed
- Show some new *seki/ bik*

Structure (1)

- Reduced paper – 30%
- Abstract, Introduction
 - Goal: Full catalogue/database of seki/ *bik*
 - Catalogues very desirable – computers & people
 - Limited work – manual, not computer search
 - Chess research (Bratko & Michie) – lessons?
- Independent life – compare with seki

Structure (2)

- Shared life (*seki/ bik/ shuang huo*)
 - No capture
 - Capture: (generalized) *nakade/ chijung*
 - **Capture, Immediate Re-capture (CIR)**
 - Snapback/ *hwangyeok*, *hanezeki/ jeochim bik*, other
 - Capture: other
- Conclusions, extensions, and further work

Abstract

- Many distinct types of seki
- Goal: systematic construction of full catalogue/database of seki/*bik*
- What components are available?
- Sketch way forward & outline some results

Introduction (1)

- Catalogues: existing – e.g.
 - joseki/ *jungsuk* ? – high level, incomplete catalogue
 - Combinatorial Games Theory (CGT): “rooms”, “corridors” – amateur beats pro in selected endgame! Low level, “complete” – points values ...
- Catalogues needed: Eyes, liberties, & cycles/ “loopy” positions (ko/ *pae*, etc.)

Introduction (2)

- Use of catalogues:
 - Help humans play (1 game/1,000?), and learn (perhaps computer-assistant)
 - Build into programs – more “knowledge”
 - Train/test computer programs – improve algorithms
 - *Discover new things!* See later ...

Introduction (3)

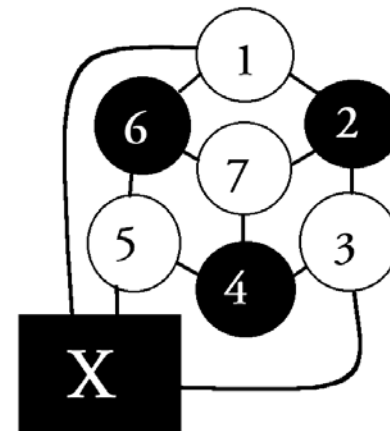
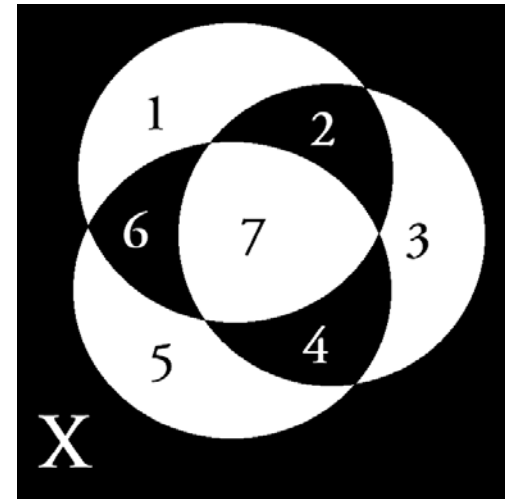
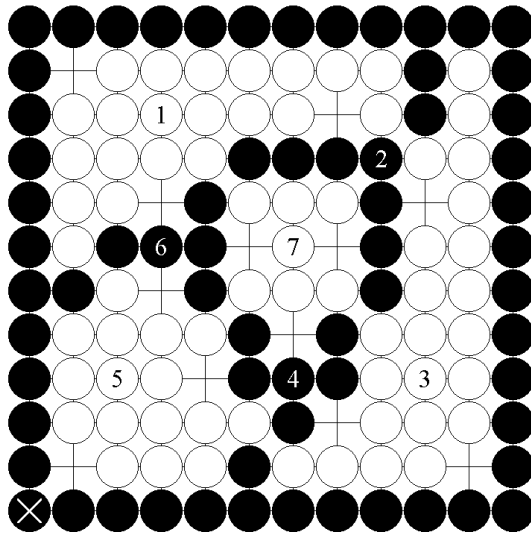
- Chess – Bratko & Michie, 1980. (**K**ing and **R**ook) v (**K**ing and **K**night) – KRKN – endgame
 - Collaboration:
 - AI researchers
 - Computers – to create/supply database
 - Chess masters
 - Result:
 - Change rules of Chess – # moves without capture
 - Heuristics: corrected, and much smaller: 1 book → 1 page!
- Go – nothing comparable yet ...

Independent Life (1)

- Independent life simpler than seki – fewer possible configurations
- No catalogue of all configurations of 2-eyed groups
- Some results known – e.g. 1-6 groups [Fearnley2003], and [Hungerink](#)'s 31-group (max possible on 19x19)
- Importance: only topology (relationships between groups) – not size, or shape

Independent Life (2)

board, map, graph, & matrix



| | | Black | | | |
|-------|---|-------|---|---|---|
| | | 4 | 6 | 2 | X |
| White | 1 | 0 | 1 | 1 | 1 |
| | 3 | 1 | 0 | 1 | 1 |
| | 5 | 1 | 1 | 0 | 1 |
| | 7 | 1 | 1 | 1 | 0 |

Shared life – *seki/ bik* (1)

- More complicated than independent life, especially where capture possible
- Liberties shared by many groups/chains

Shared life – seki/ *bik* (2)

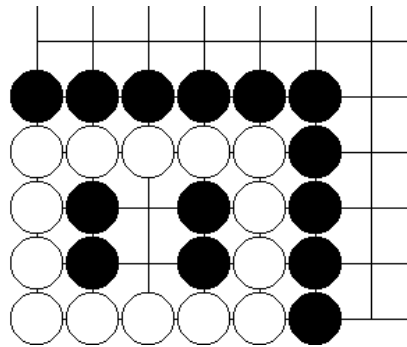


Fig 2: 2-1 shared

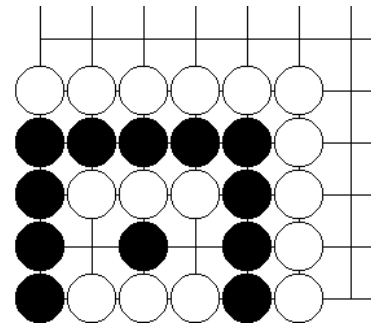


Fig 3: 2-2 shared

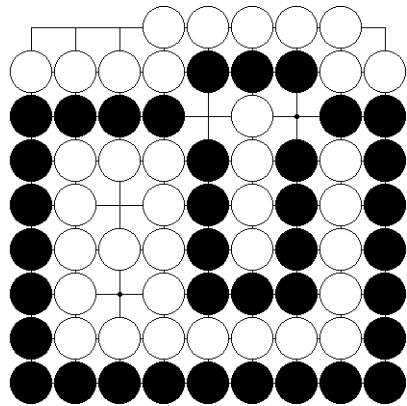


Fig 4: 3-1 shared

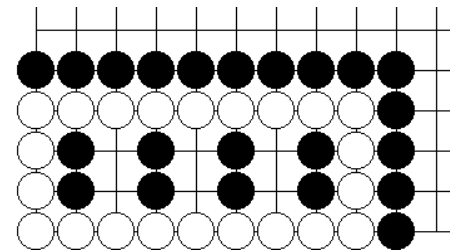


Fig 5: Non-removable threats

Shared life – seki/ *bik* (3)

Non-symmetric liberties

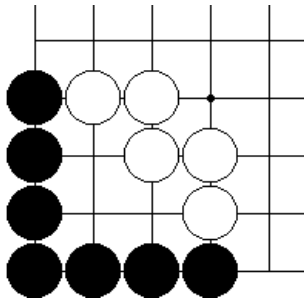


Fig 6a

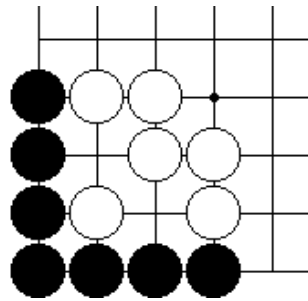


Fig 6b

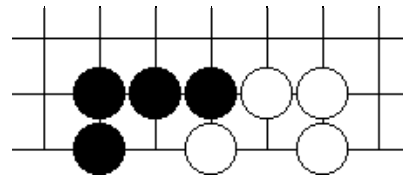


Fig 6c: complex

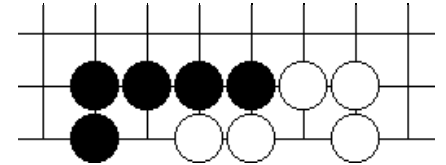


Fig 6d: complex

Fig 6: Non-symmetric “shared” liberties

No Capture (1)

- Gurvich & Gol'berg [[Gurvich1981](#)]:
 - Only fully-connected seki/ *bik* – *not* as Fig 4.
They use graphs and seki matrices
- No published catalogue
- [Hungerink](#) 129-chain seki (Fig 7)

No Capture (2)

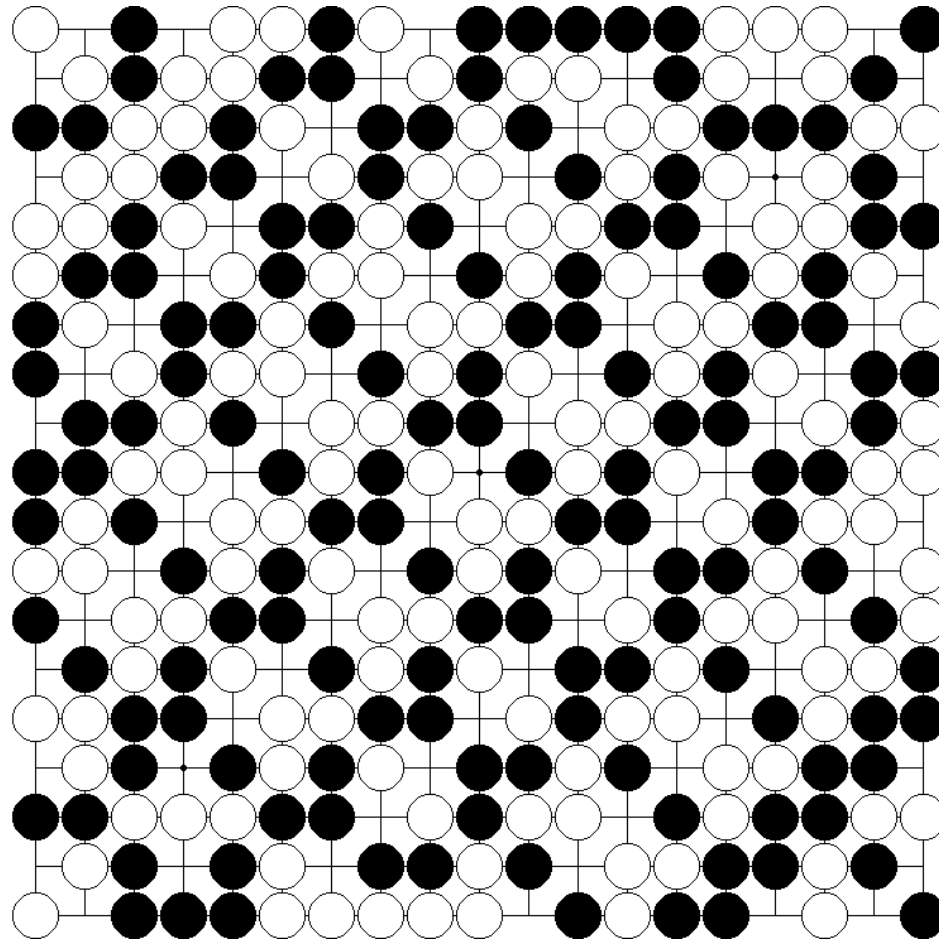


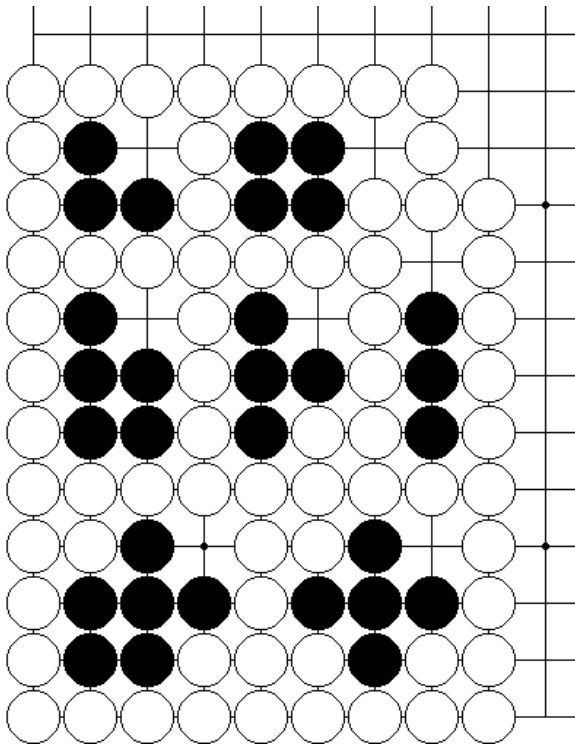
Fig 7: Hungerink's 129-chain seki/ *bik* (max on 19x19?)

Seki/ *bik* with Capture

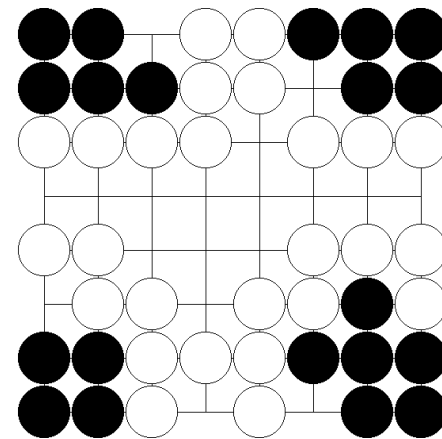
- Fight for eyes, and liberties – (usually) not points
- Many varieties of seki/ *bik* – capture gives ... e.g.
 - Two eyes with ko/ *pae*
 - One eye + some liberties (maybe ko, various)
 - No eyes + some liberties (maybe ko, various) ...
- (Initial capture – immediate, or delayed?
 - Delayed capture not fully catalogued yet
- (Need to count number, and size, of eyes; number, and type (normal/ ko/ ...), of liberties

Simple capture – nakade/ *chijung* (1)

Build from components – also hanezeki/ *jeochim bik*

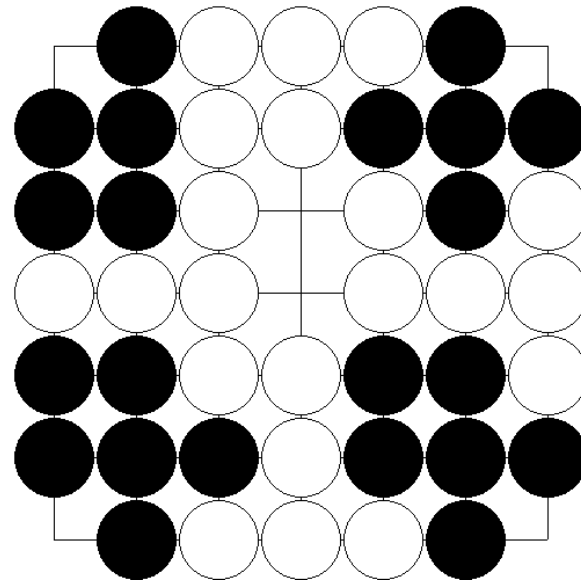
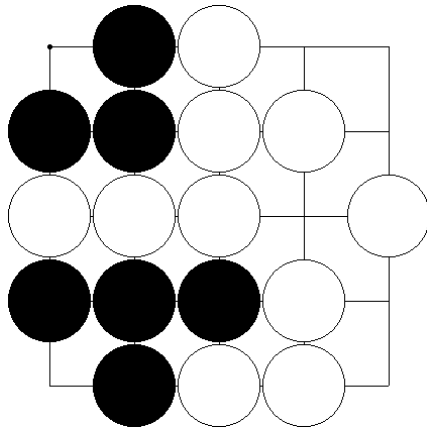


Centre/edge



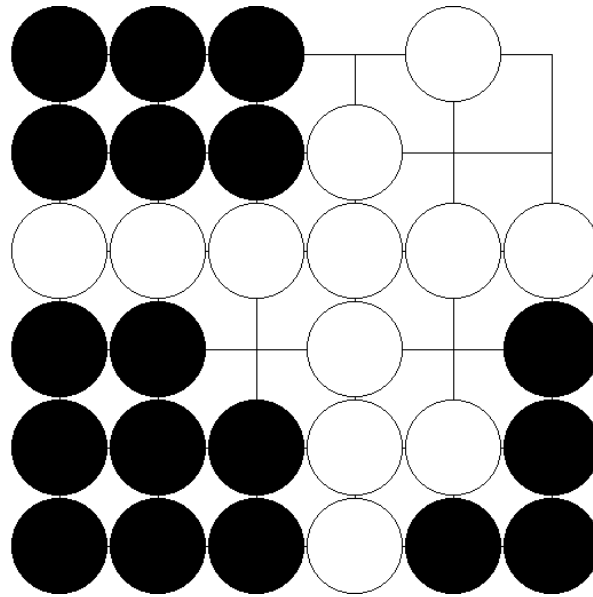
Corner (different)

Simple capture – nakade/ *chijung* (2)



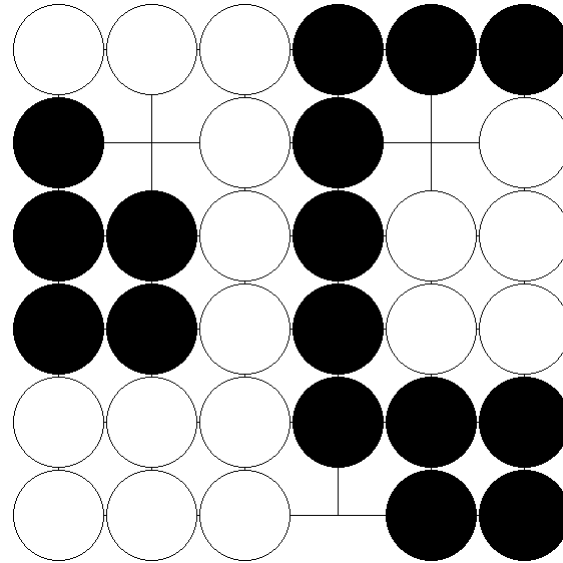
Corner components: 1-1 empty
White needs extra “external” liberty

Simple capture – nakade/ *chijung* (3)



Complex corner nakade/ *chijung* components

Simple capture – nakade/ *chijung* (4)



- Simple seki/ *bik* with nakade/ *chijung* captures ...
- Groups must have captures of same value

Simple capture – nakade/ *chijung* (5)

- [[Fearnley2005b](#)] : All seki with one Black group versus several White groups
- Built from components seen earlier
- Captures give 0, 1, 2, 3, 4, 4 (or 1 + ko/*pae*), 6, 6 (or 1 + ko), 7, 9 (or 3 + ko), and 11 liberties/ *hwallo*
- Some seki unstable – one player can safely capture stones – other cannot

Simple capture – nakade/ *chijung* (6)

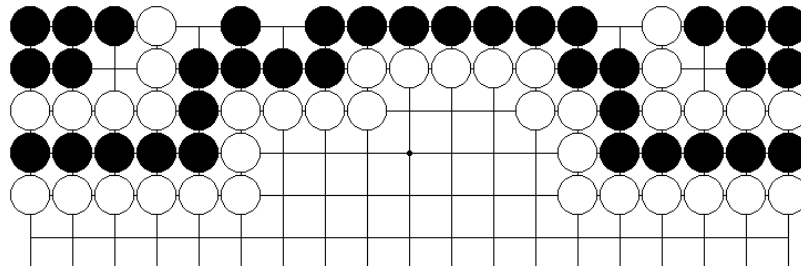


Fig 8: Equal 1-3: unstable (White + 14)

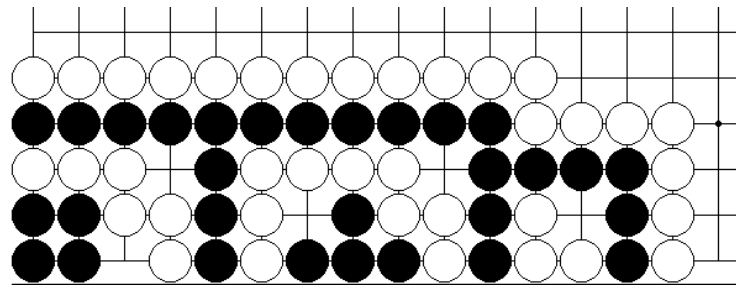


Fig 9: Equal 2-4 – possible unstable (White + 11) [[Feldmann2005](#)]

Simple capture – nakade/ *chijung* (7)

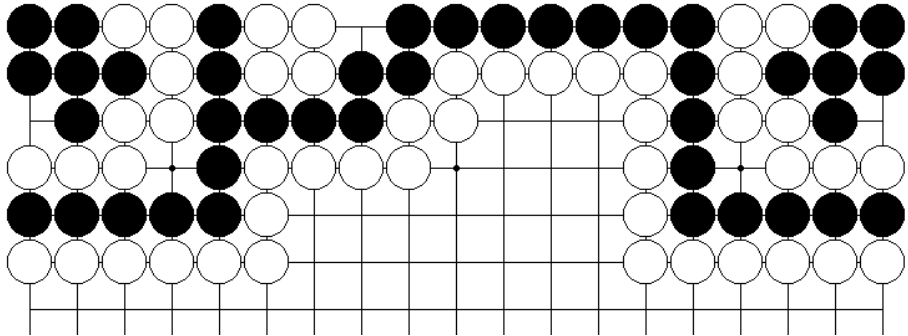


Fig 10: Equal 4-6: unstable (White + 17)

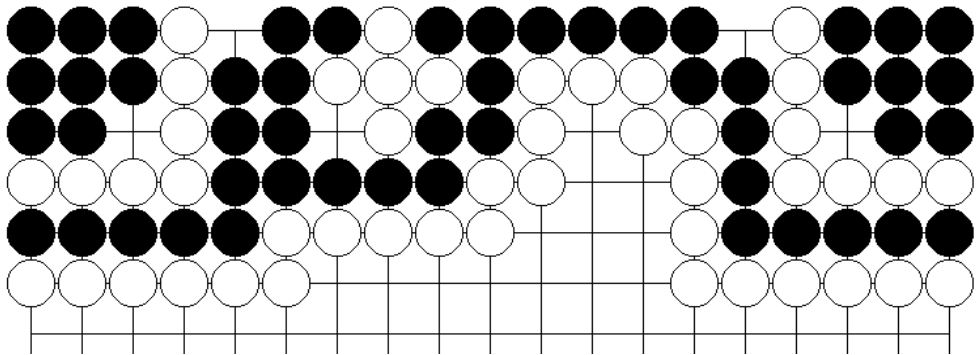


Fig 11: Equal 7-9: seki/Black dead (ko/pae)

Simple capture – nakade/ *chijung* (8)

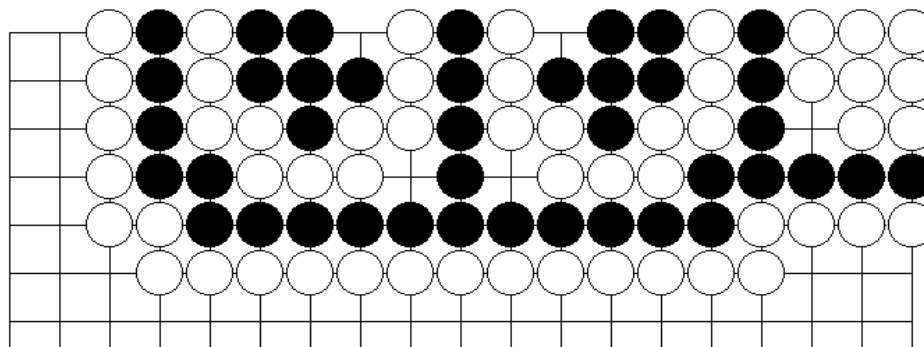


Fig 12: Equal 9-11: seki/ White dead (ko/*pae*)

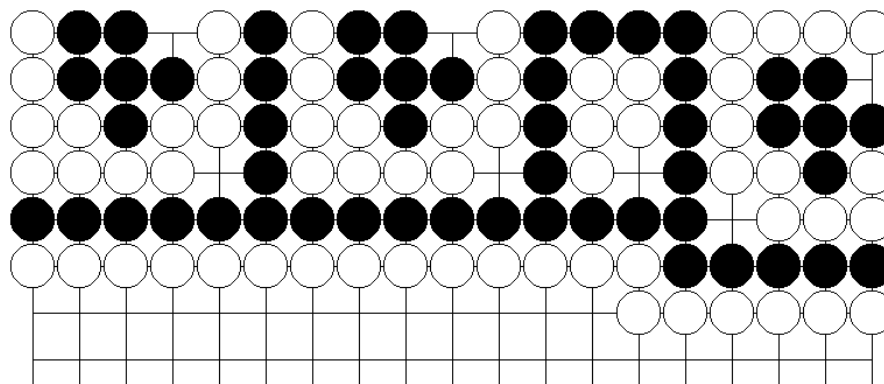
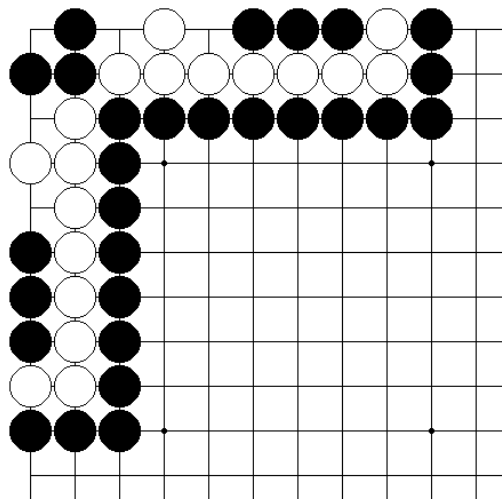


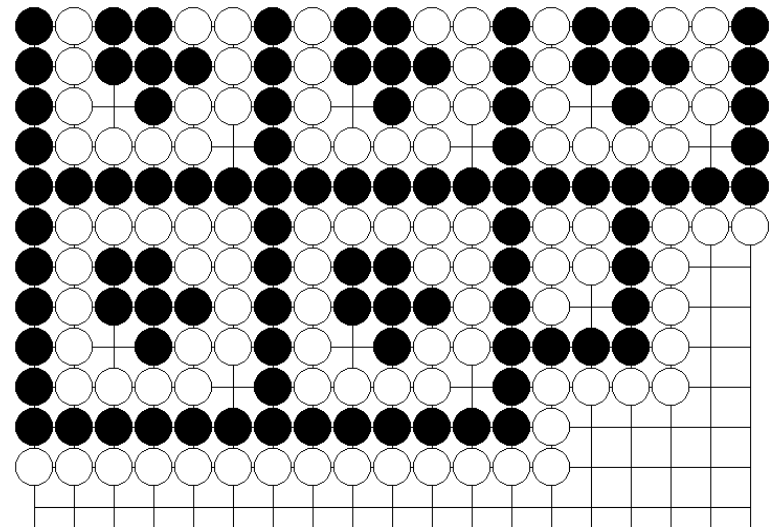
Fig 13: Seki: Largest centre/edge combo ([Feldmann2005](#))

(Simple capture – nakade/ *chijung* (9))

Not seki, but better if opponent plays first!



**Fig 14a: One-or-two-die
(well known)**



**Fig 14b: Four-or-five-die
(new -- 1 of 4 centre/edge)**

Simple capture – nakade/ *chijung* (10)

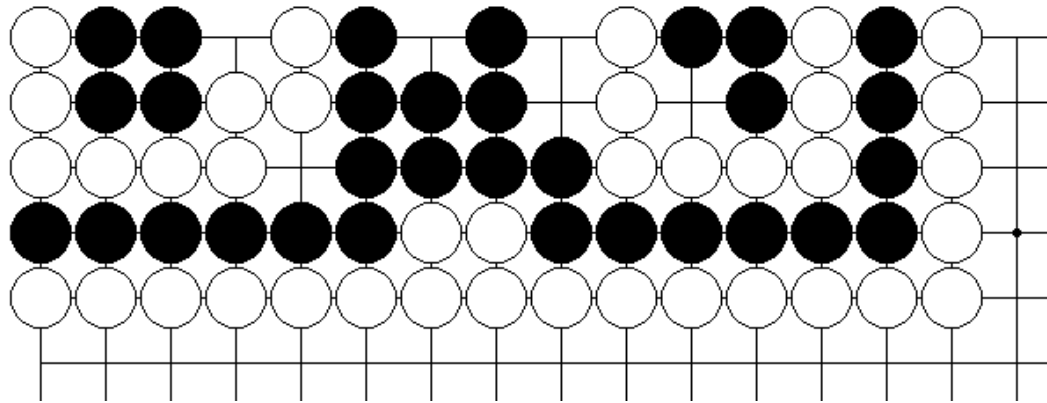


Fig 15: Unequal 1-2-4: terminal ([Feldmann2005](#))

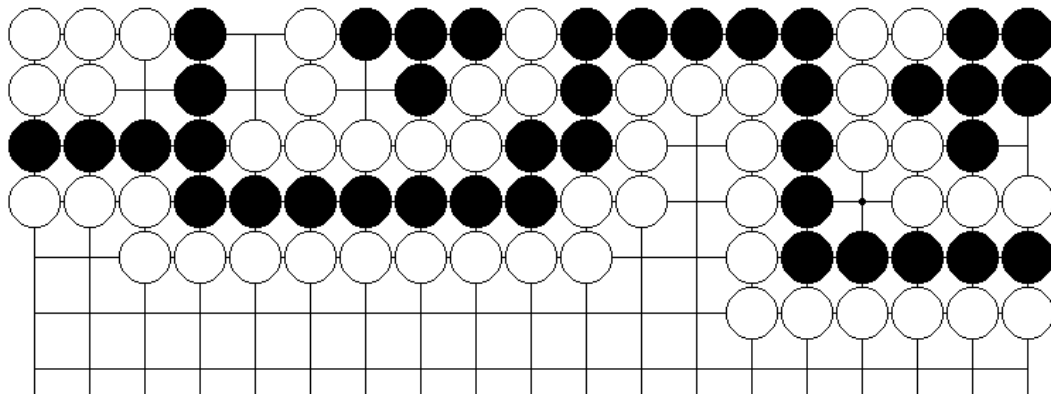


Fig 16: Unequal 3-4-6: terminal

Simple capture – nakade/ *chijung* (11)

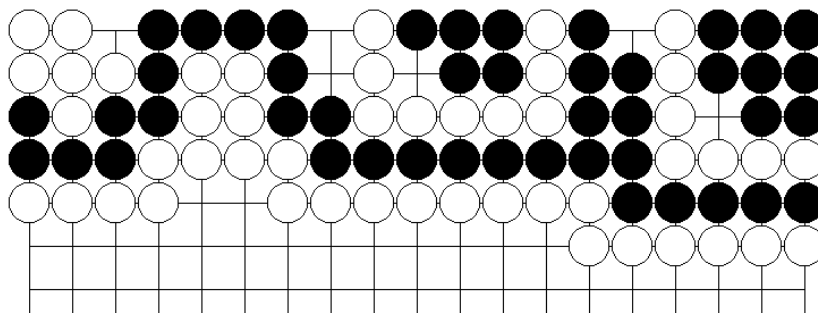


Fig 17: Unequal seki/ Black dies (ko/ *pae*)

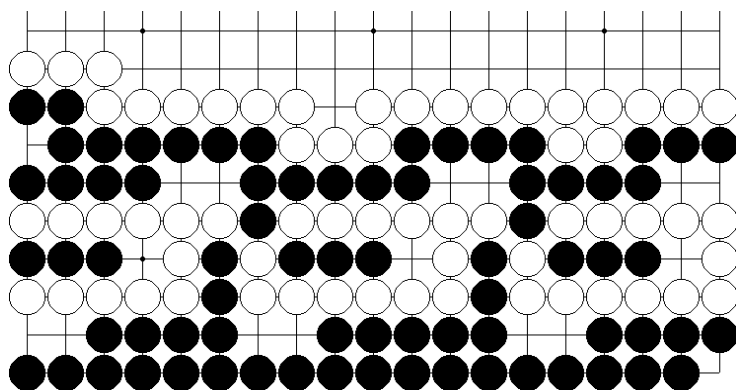


Fig 18: 2 black v 3 white: 1-3 : seki

Simple capture – nakade/ *chijung* (12)

- [[Fearnley2005b](#)]: more multiple group combinations
- Further work needed: (
 - Complete m black versus n white ...
 - Complex corner nakade/ *chijung*
 - More complicated topologies
 - Role of suicide, if Chinese *rules*

Capture, Immediate Recapture (CIR)

- Two-sided, mutual, capture possible
- ... Recapture:
 - Immediate: CIR
 - Delayed: CDR – **C**apture, **D**elayed **R**ecapture
- CIR
 - Snapback (*uttegaeshi/ hwangyeok*) – except as *special*, below
 - Hanezeki/ *jeochim bik* – in-line capture/recapture
 - *Special* snapback – Figs 19 & 20, and [Fearnley2004]

CIR – Snapback/ *Hwangyeok* (1)

Special:

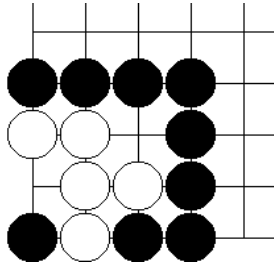


Fig 19: pre 1-eye

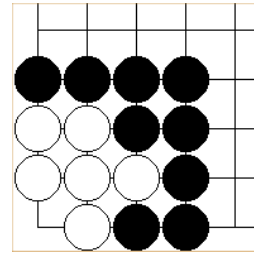


Fig 20: Flower 6

- Fig 21 – no use; Figs 22-23 – useful

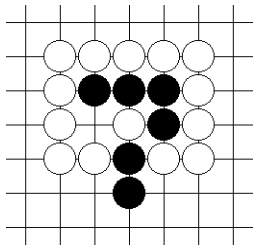


Fig 21: in-line

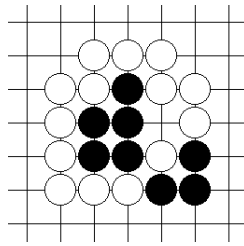


Fig 22 diagonal

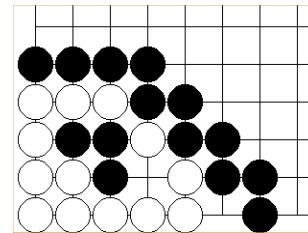


Fig 23: ko-for-life

CIR – Snapback/ *Hwangyeok* (2)

- No systematic study of *seki/ bik* with snapback/ *hwangyeok*
- Full catalogue of eyes + liberties in snapback – should be easy ...

CIR – Snapback/ *Hwangyeok* (3)

- Special property of corner – Figs 24-27
 - Related to CDR – discussed later

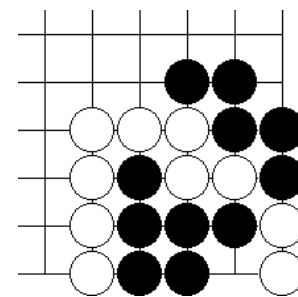
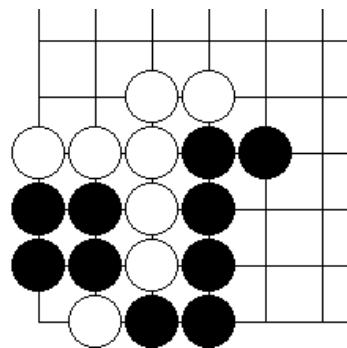
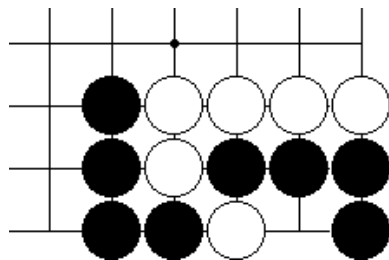
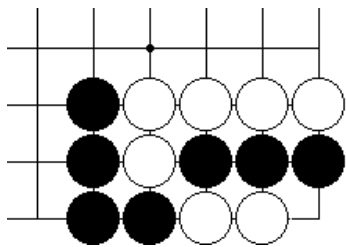


Fig 24: pre-snapback

Fig 25: snapback

Fig 26: TSM

Fig 27: half-snapback

CIR – hanezeki/ *jeochim bik* (1)

- Known 650+ years – XuanXuan QiJing/
Hyun hyun ki kyung (1347). (Others known
– e.g. Shimada’s Igo no Suri (1958), and
Igo Hatsuyoron (1713))

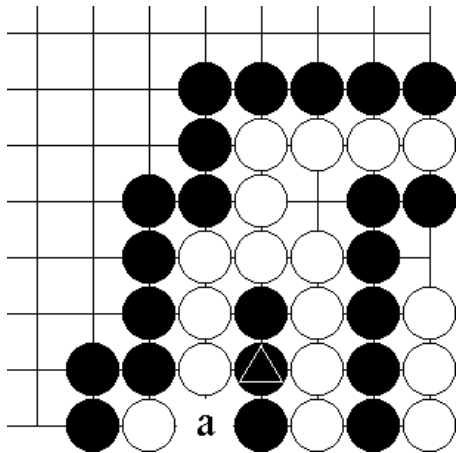


Fig 28: XuanXuan QiJing (1347)

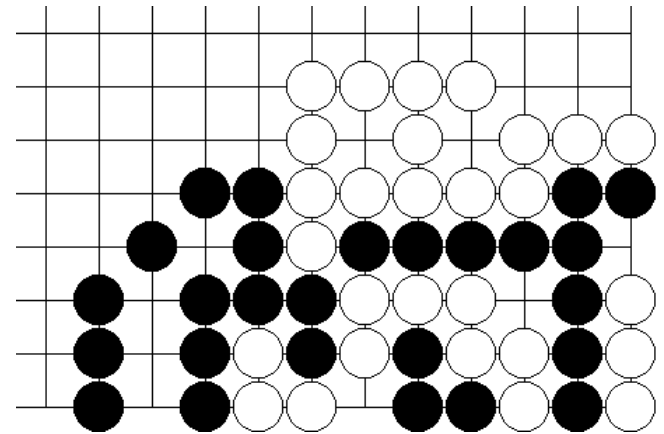


Fig 29: Shimada (1958)

CIR – hanezeki/ *jeochim bik* (2)

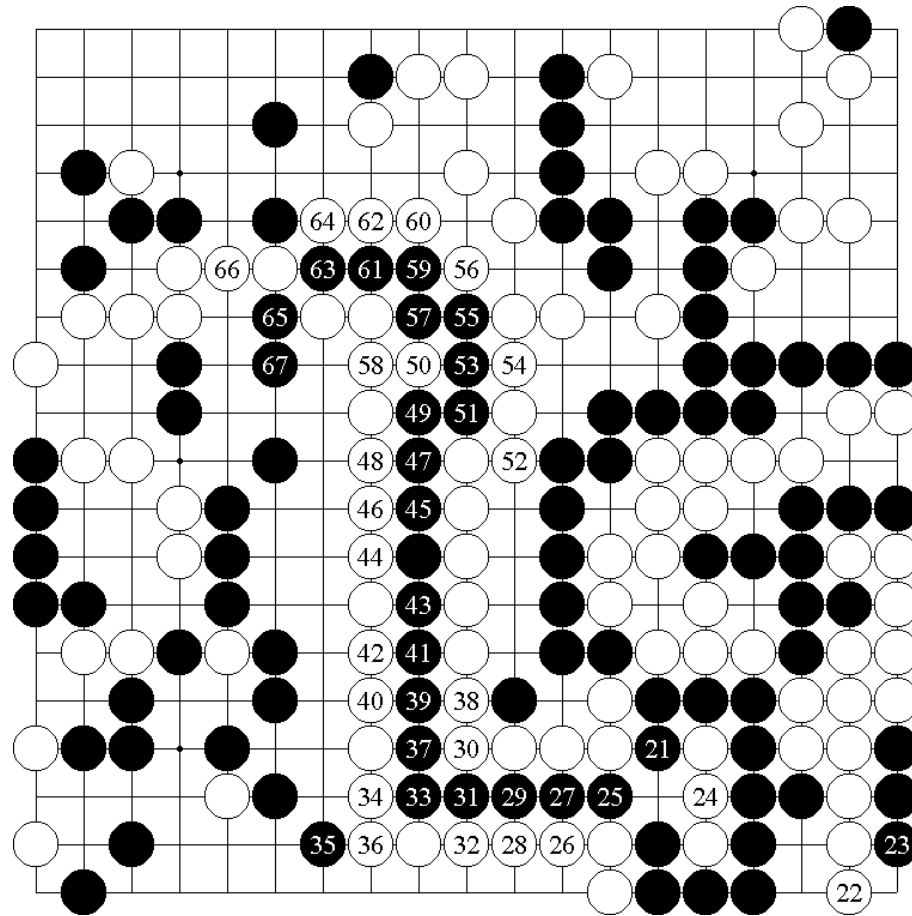


Fig 30: Igo Hatsuyoron (1713) *Wiki Balyangron*

CIR – hanezeki/ *jeochim bik* (3)

- Generalize shapes in Figs 28-30
- Two components:
 - Ordinary nakade/ *chijung*
 - Special mutual-capture component
 - (Equivalent to nakade for White, but if Black captures, White can re-capture
 - Capture/re-capture must be bad for Black
 - (... may depend on size of first captured group

CIR – hanezeki/ *jeochim bik* (4)

- [[Fearnley2005a](#)] – complete analysis
- 130 configurations – 20 corner only
- Extra 87 with ko/ *pae* – 28 corner only
 - *Wrap-around* not counted
- (Nakade of 3-8 stone captures. Hanezeki with 5-6 stones unusual – likely to have ko)

CIR – hanezeki/ *jeochim bik* (5)

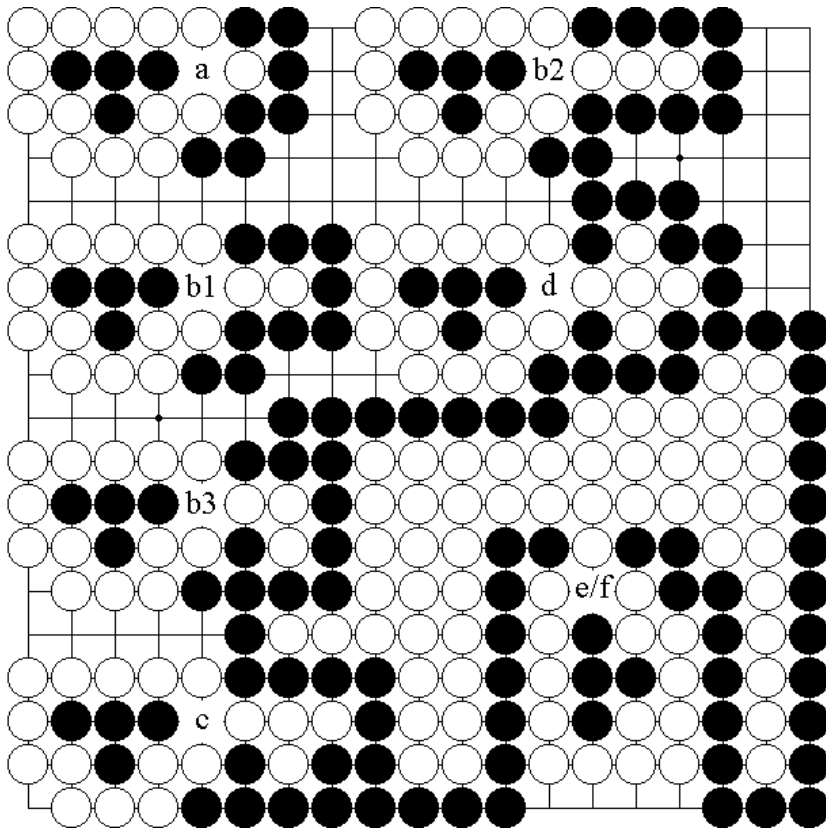


Fig 32: Hat-4: all shapes/sizes captures

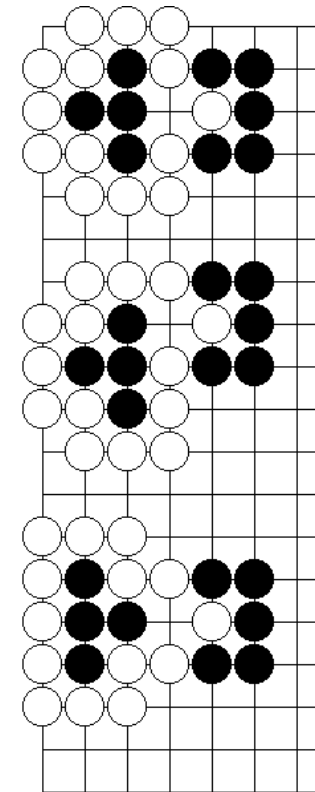


Fig 33 – Hat-4 other orientations

(CIR – hanezeki/ *jeochim bik* (6)

- Hat 4 – example
- Fig 32:
 - **a, b1, b2, b3**: hanezeki with ko
 - **c-f**: simple hanezeki
- Fig 33:
 - Top:
 - **a**: Black wins – not hanezeki
 - **b-f**: normal hanezeki (no ko!)
 - Middle & bottom: same as Fig 32

CIR – hanezeki/ jechochim bik (7)

- Construction: 3-way combine – each nakade capture (including complex corner nakade), in all orientations, with each distinct recapturable component.
- Note: many recapturable components (almost) equivalent – Fig 30 (Igo Hatsuyoron), 20-stone capture same as 2-stone, or 3-stone capture ...

CIR – hanezeki/ *jeochim bik* (8)

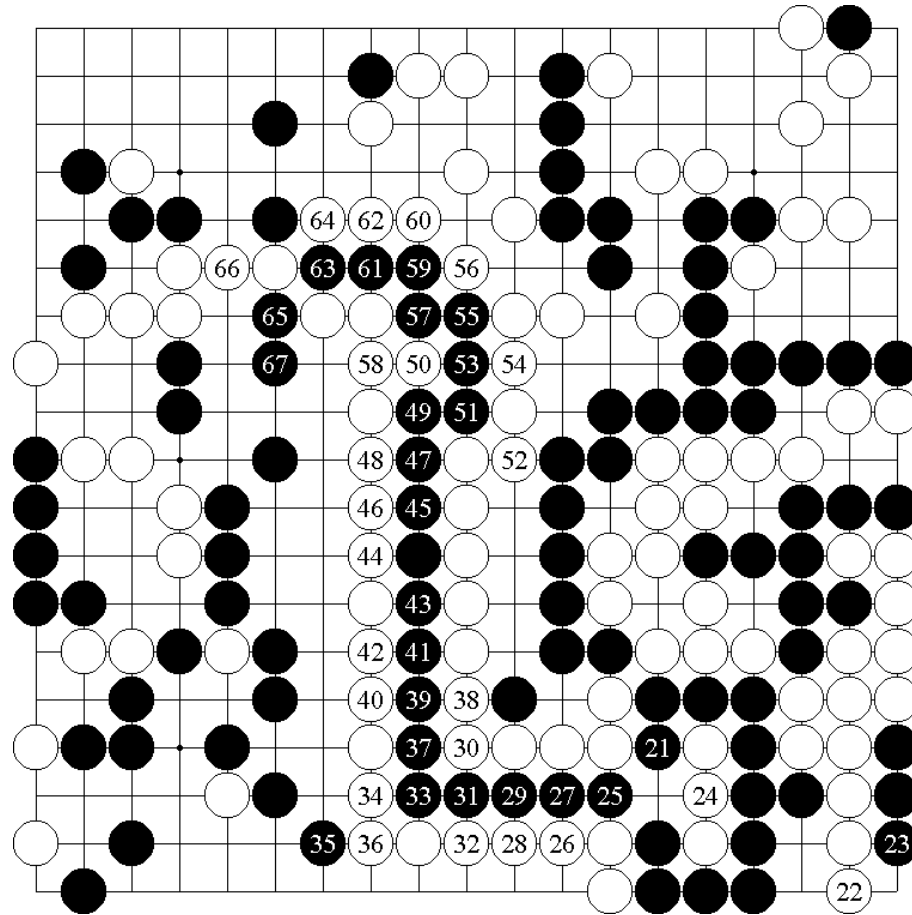


Fig 30: Igo Hatsuyoron (1713)
Wiki Balyangron

(CIR – hanezeki/ *jeochim bik* (9)

- Can usually create hanezeki with **a-d** (1-5 stone)
- Need **e** (or **f**) for one orientation of hammer-5, and all flower-6 (*hana roku/ maehwayukgung*)

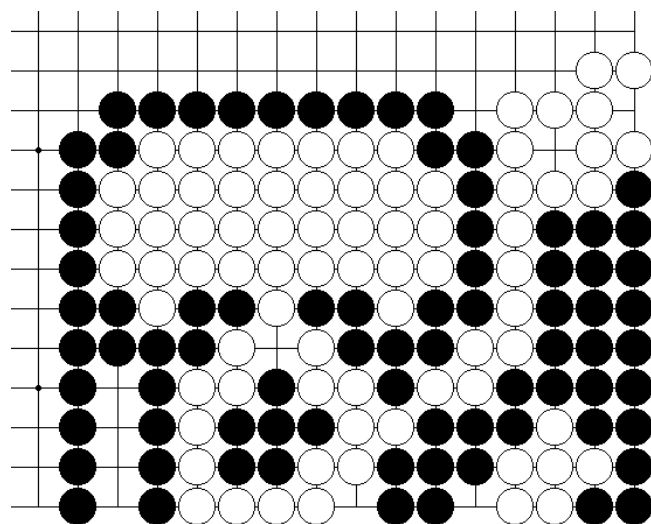


Fig 34: Smallest “largest” hanezeki?

(CIR – hanezeki/ *jeochim bik* (10)

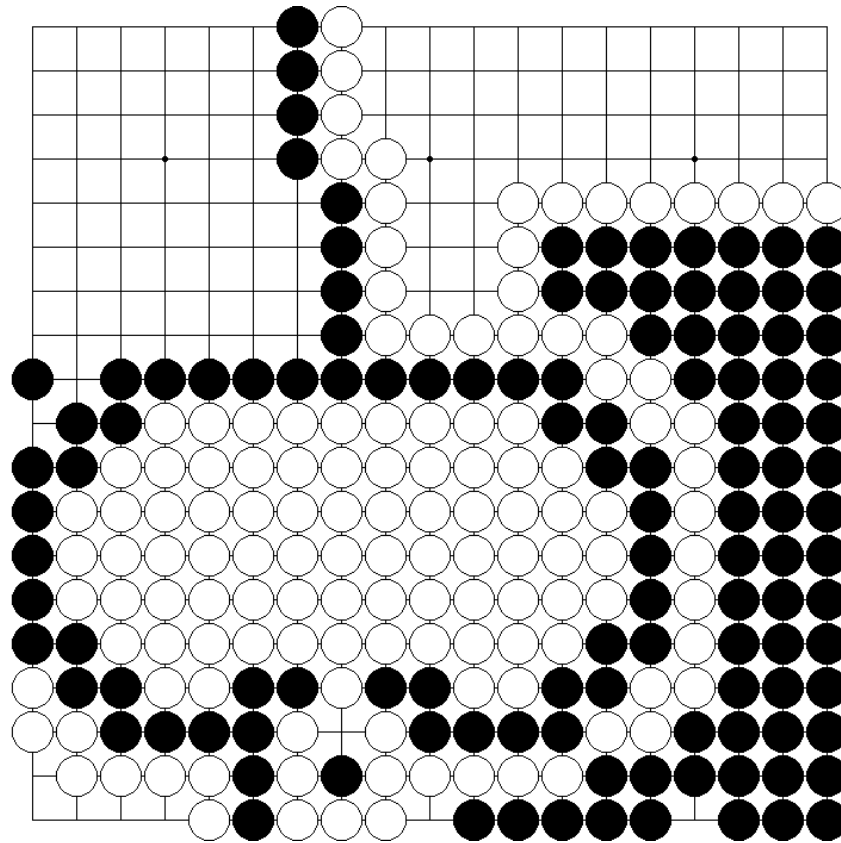


Fig 36: Not hanezeki – should White/Black capture?

CIR – hanezeki/ *jeochim bik* (11)

- Wrap-around: *possible* with all in centre;
necessary for some in corner – example Fig 37

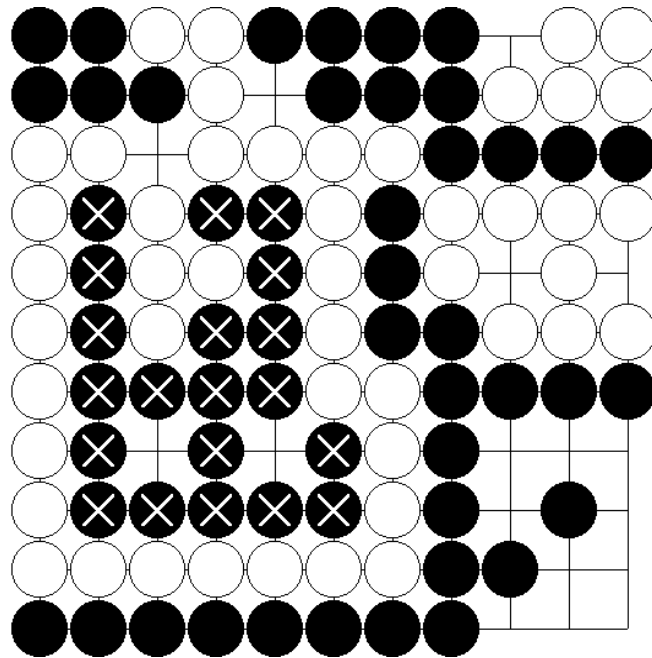


Fig 37: Wrap-around

CIR – hanezeki/ *jeochim bik* (12)

- Fig 38: Unusual unstable hanezeki; White defence is double-ko; Black profit from initial capture ...

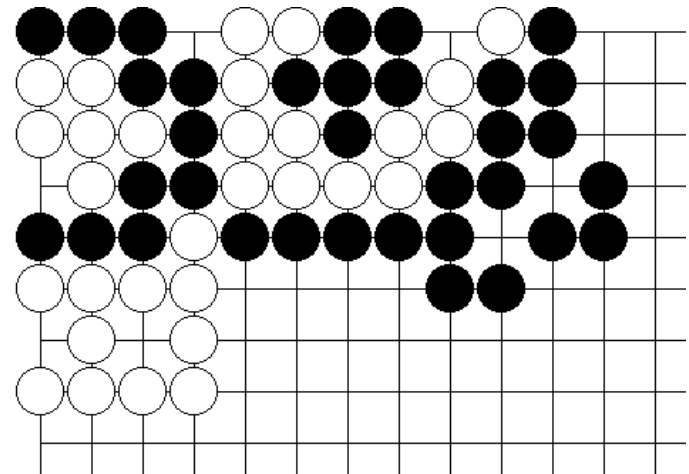
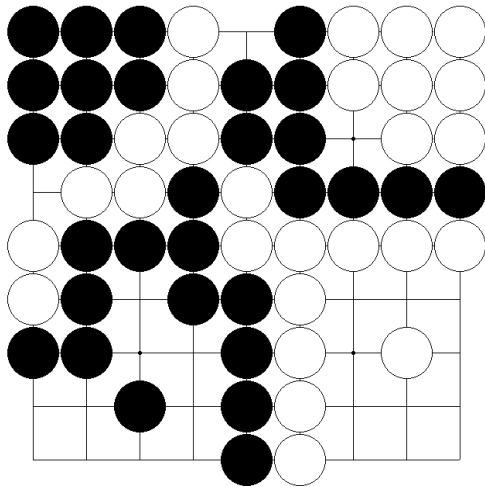


Fig 38: Double Murashima's ko

(Fig 39: Need most ko threats (10/9))

Capture, Delayed Recapture (CDR)

- Mutual immediate capture possible – not guarantee independent life – attack eye-space ...

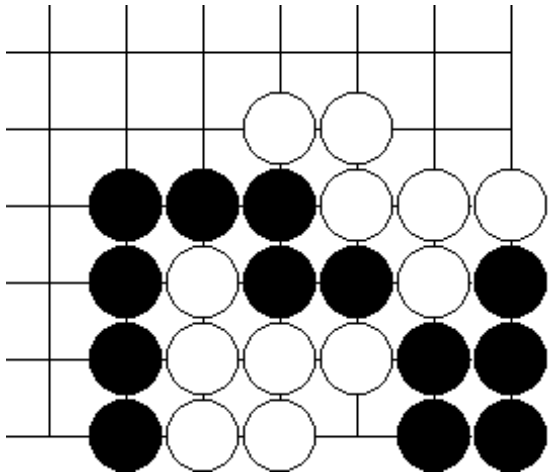


Fig 40: CDR

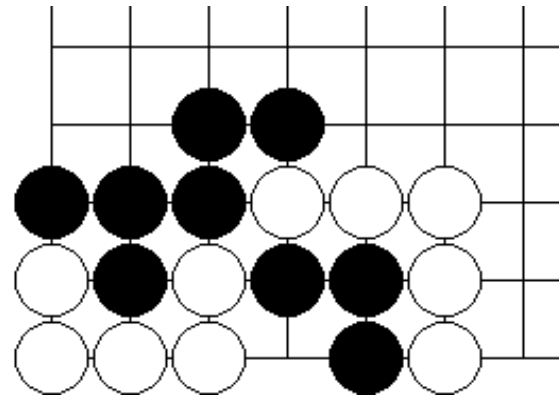


Fig 41: eye v 2-eyes-with-ko

Capture, Delayed Recapture (2)

- No complete catalogue known
- First: find all captures which do not guarantee life ...
- (Corner, and cutting points, help make killable 7-nakade, with 2 (or more) stones inside
- Can combine with other CDR, and/or CIR

Conclusions and further work (1)

- Seki – need to maximize *both eyes and liberties*
- [[Landman1995](#)] extends CGT ideas of ([Berlekamp1994], [[Müller1996](#)]) to eyes – includes liberties, ko, and seki (only 2 groups)
- Major challenge: integrate eyes and liberties into fully unified framework ... calculate eye-liberty values separately for all components of (potential) seki

Conclusions and further work (2)

- Much more work needed
- First – complete analysis with immediate captures
- Next – extend to delayed *initial* capture
- (... non-symmetric liberties; mutual delayed capture ...)
- Computerized search – catalogue dead, and minimal live, shapes – our components

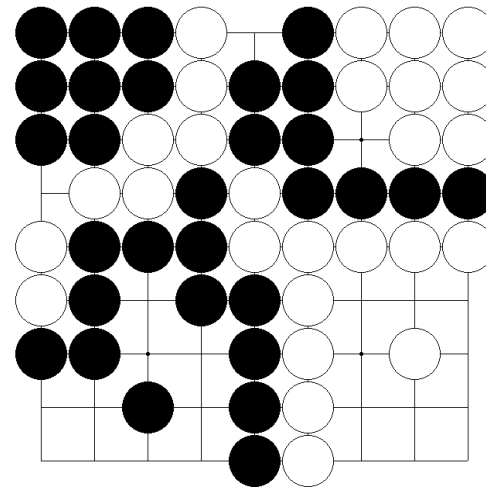
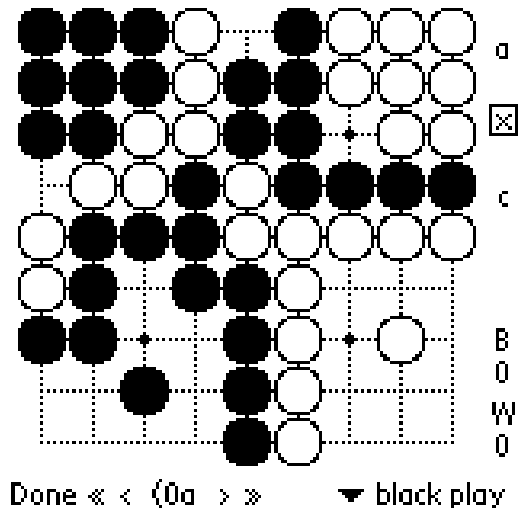
Conclusions and further work (3)

- Allow initial loopy/cyclic positions (*ko/pae*)
- (Extend work of [[Gurvich1981](#)] to find all simple fully-connected seki?)
- ... more hopeful: extend CGT techniques of [[Berlekamp1994](#)], [[Landman1995](#)], and others

Review

- Catalogues/databases – a “good thing”
- What work done already?
- How to do it: e.g. *hanezeki/jeochim bik*
- Much more work needed
- Saw some new *seki/ bik*

Updates, etc



Further work relating to this paper will appear at

[http:// www.goban.demon.co.uk/go/seki/overview/overview.html](http://www.goban.demon.co.uk/go/seki/overview/overview.html)

Questions?