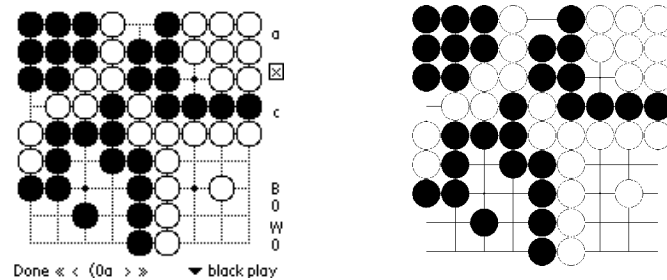


# Shared life in Go: an overview



**ICOB 2005, Myongji Univ, Seoul**

**20-21 October 2005**

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# 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)

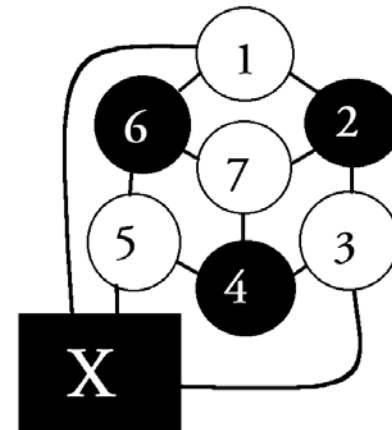
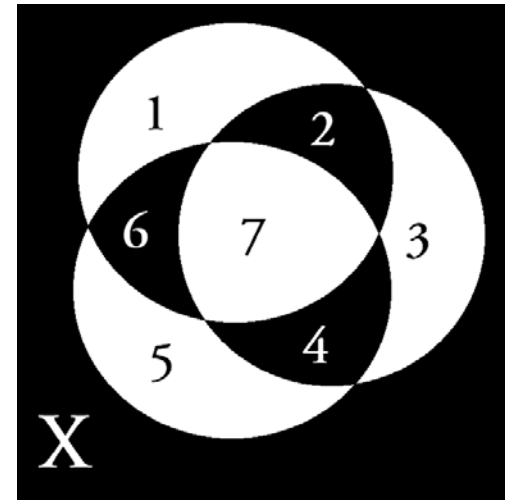
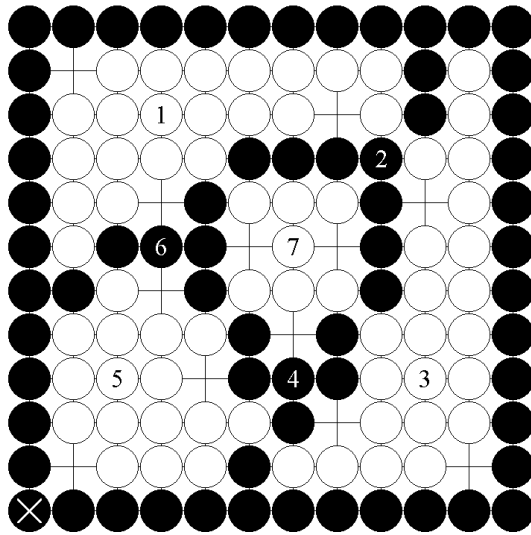
- Chess – Bratko & Michie, 1980. (**K**ing and **R**ook) v (**K**ing and **K**night) – KRKN – endgame
  - Collaboration:
    - AI researchers
    - Computers – to create/supply database
    - Chess masters
  - Result:
    - Change rules of Chess – # moves without capture
    - Heuristics: corrected, 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

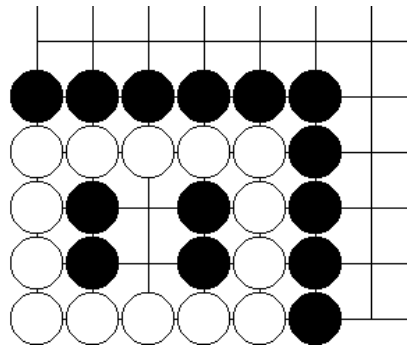


		Black			
		4	6	2	X
White	1	0	1	1	1
	3	1	0	1	1
	5	1	1	0	1
	7	1	1	1	0

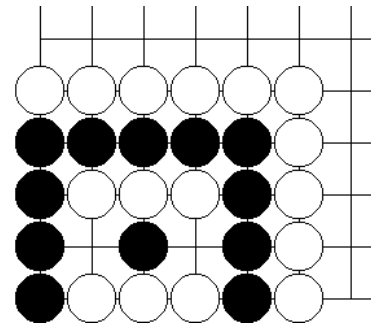
# Shared life – *seki/ bik* (1)

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

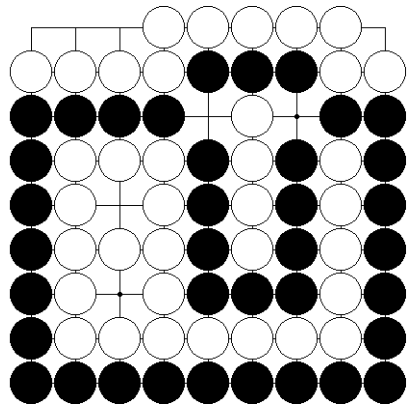
# Shared life – seki/ *bik* (2)



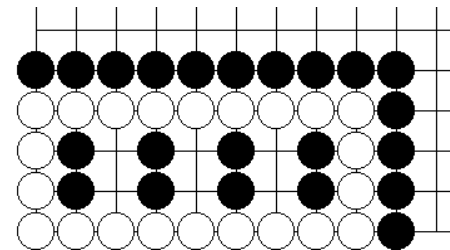
**Fig 2: 2-1 shared**



**Fig 3: 2-2 shared**



**Fig 4: 3-1 shared**



**Fig 5: Non-removable threats**

# Shared life – seki/ *bik* (3)

Non-symmetric liberties

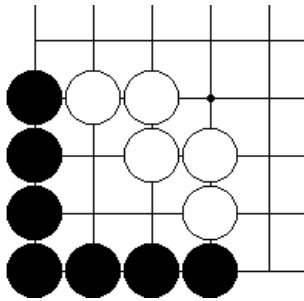


Fig 6a

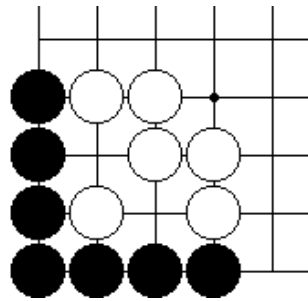


Fig 6b

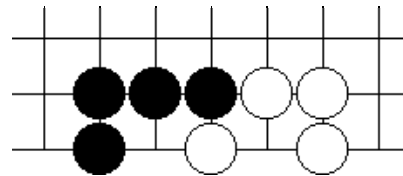


Fig 6c: complex

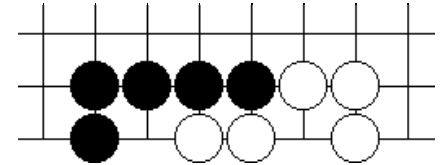


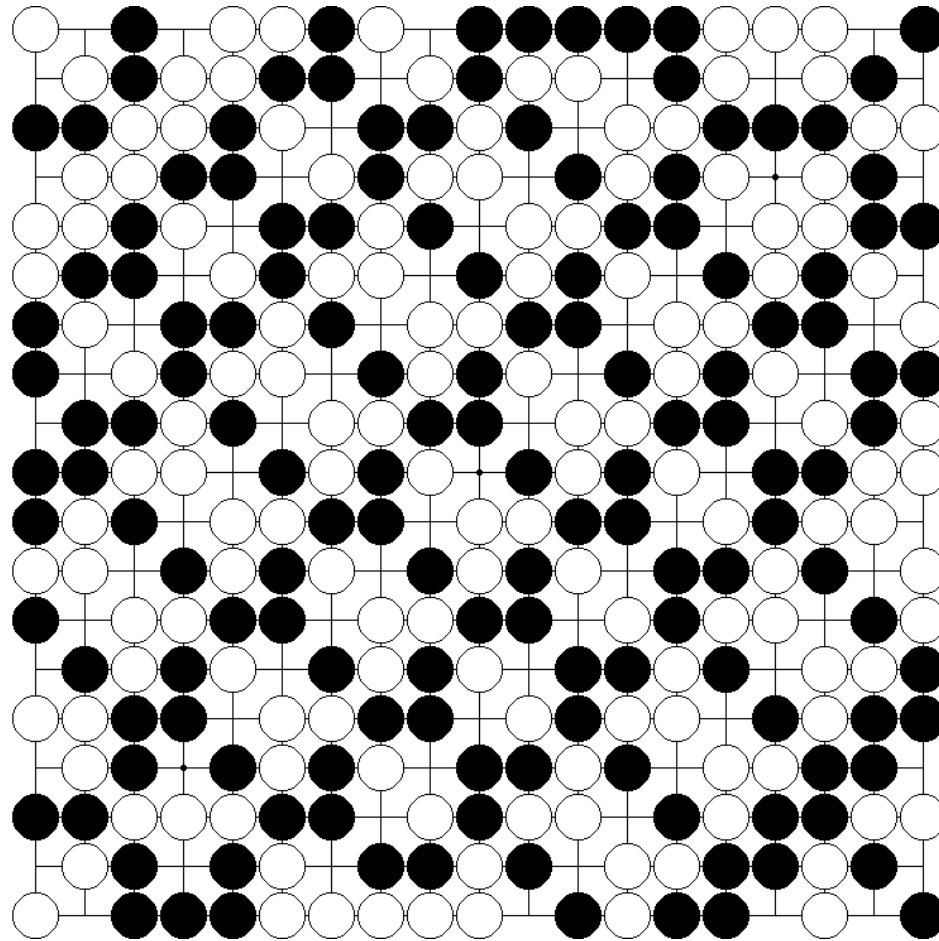
Fig 6d: complex

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)



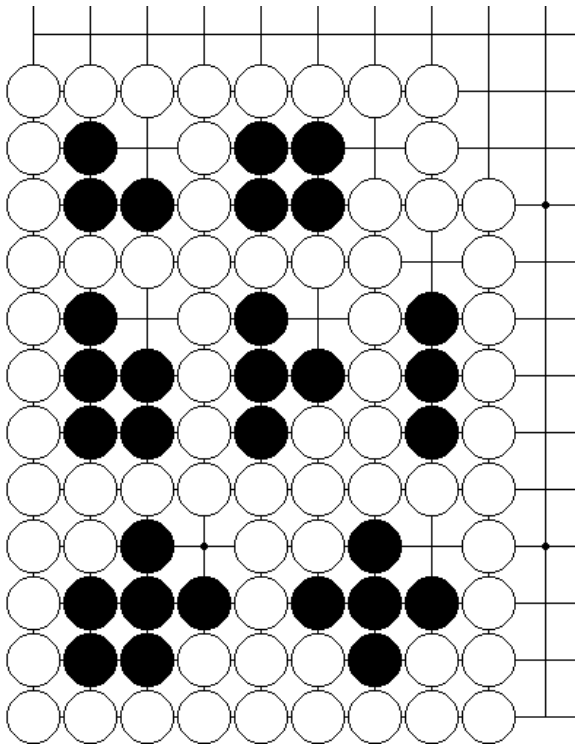
**Fig 7: Hungerink's 129-chain seki/ *bik* (max on 19x19?)**

# Seki/ *bik* with Capture

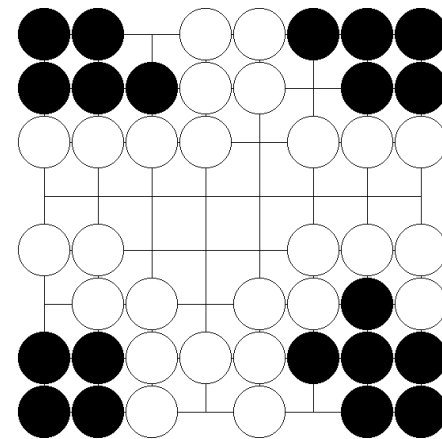
- Fight for eyes, and liberties – (usually) not points
- Many varieties of seki/ *bik* – capture gives ... e.g.
  - Two eyes with ko/ *pae*
  - One eye + some liberties (maybe ko, various)
  - No eyes + some liberties (maybe ko, various) ...
- ( Initial capture – immediate, or delayed?
  - Delayed capture 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*

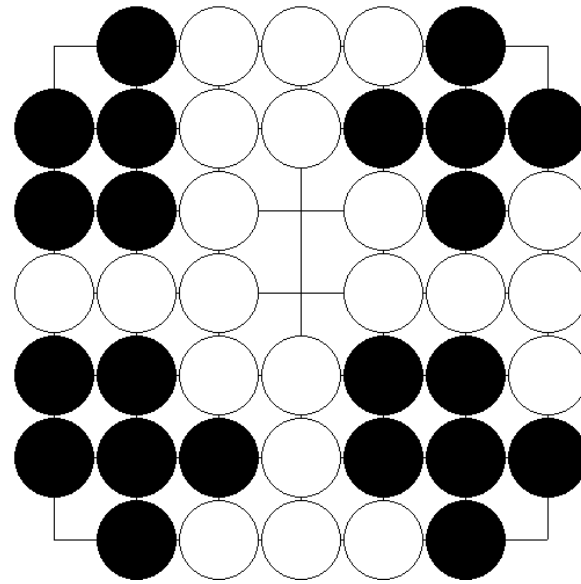
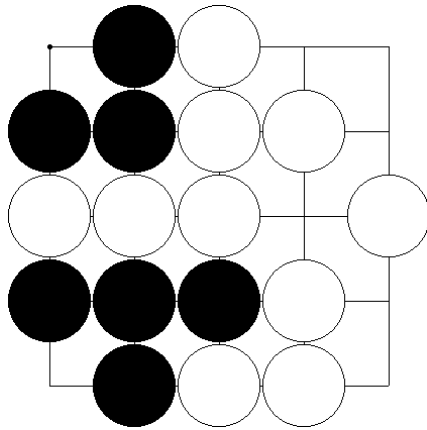


**Centre/edge**



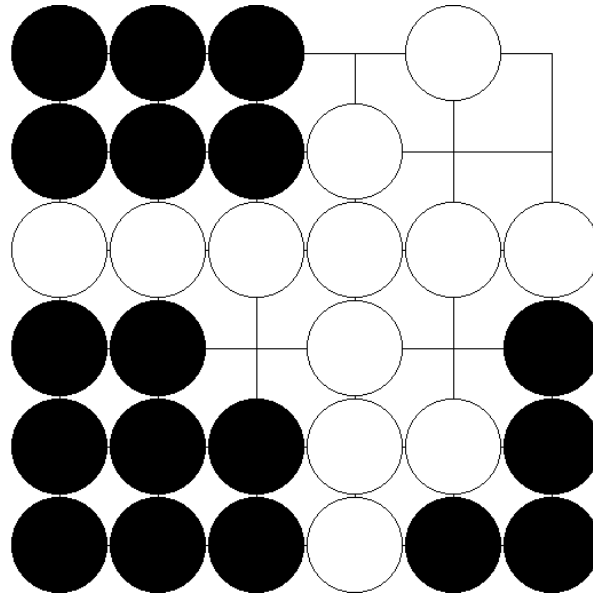
**Corner (different)**

# Simple capture – nakade/ *chijung* (2)



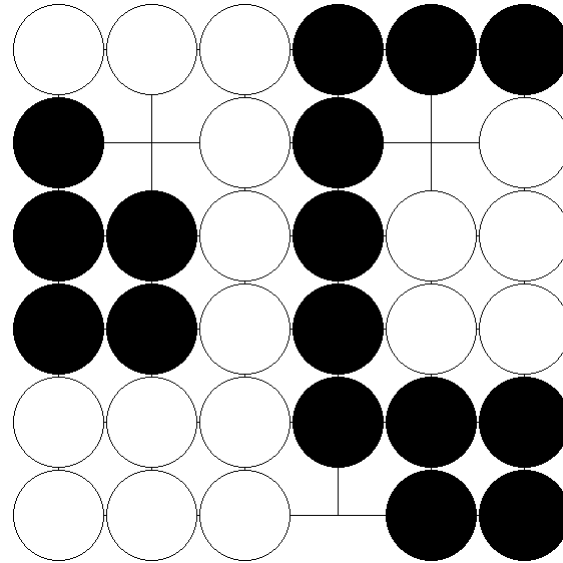
Corner components: 1-1 empty  
White needs extra “external” liberty

# Simple capture – nakade/ *chijung* (3)



Complex corner nakade/ *chijung* components

# Simple capture – nakade/ *chijung* (4)

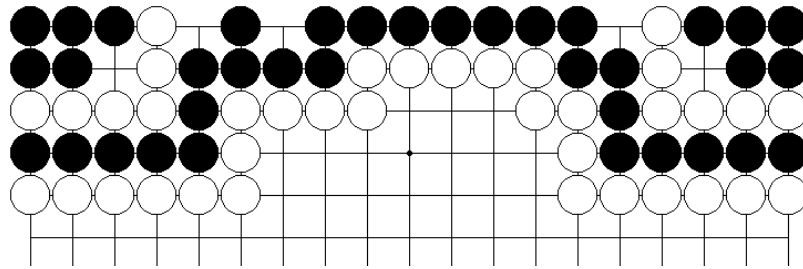


- Simple seki/ *bik* with nakade/ *chijung* captures ...
- Groups must have captures of same value

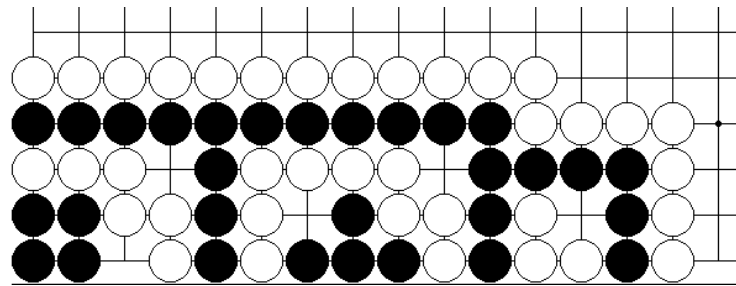
# Simple capture – nakade/ *chijung* (5)

- [[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)

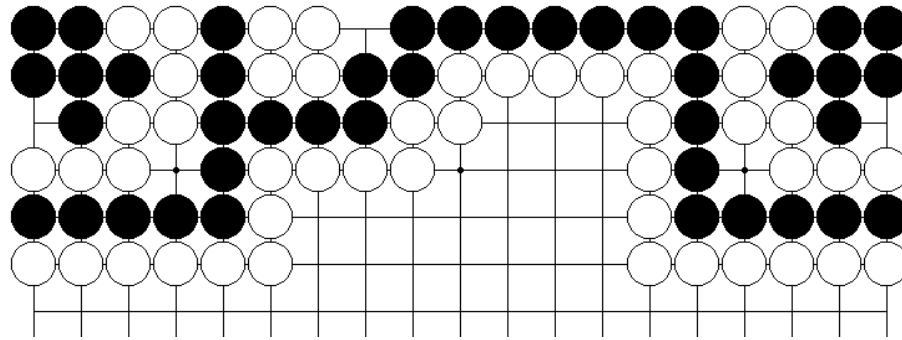


**Fig 8: Equal 1-3: unstable (White + 14)**

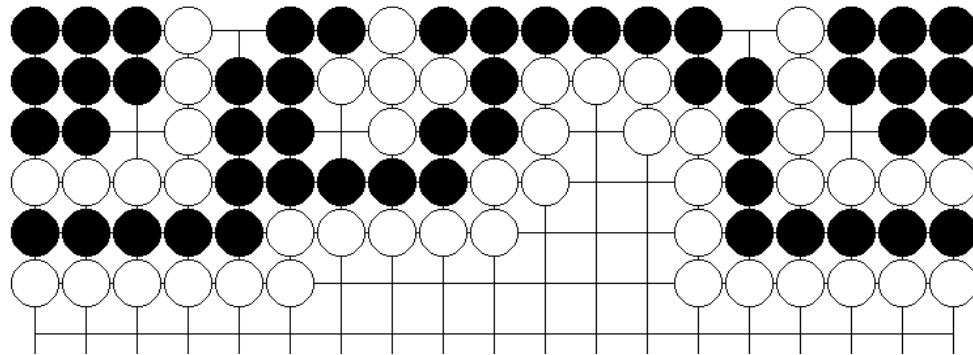


**Fig 9: Equal 2-4 – possible unstable (White + 11) [[Feldmann2005](#)]**

# Simple capture – nakade/ *chijung* (7)

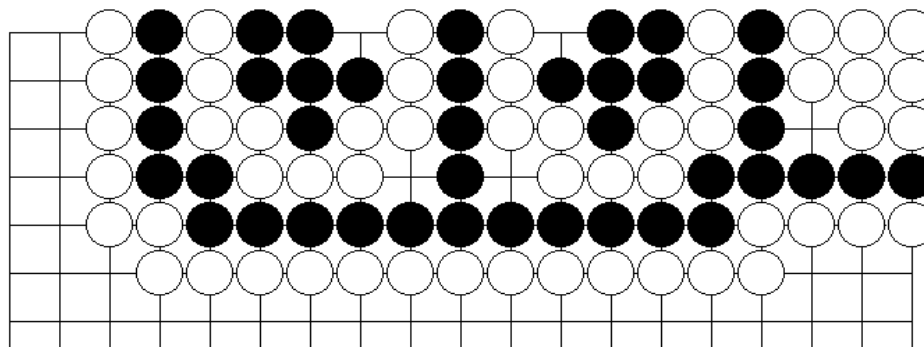


**Fig 10: Equal 4-6: unstable (White + 17)**

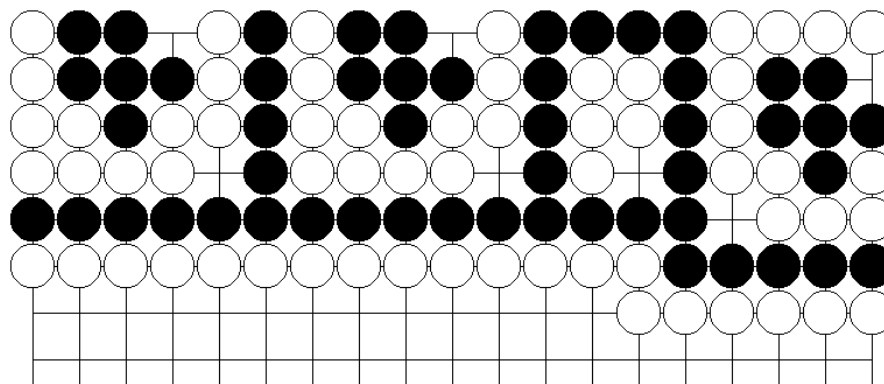


**Fig 11: Equal 7-9: seki/Black dead (ko/*pae*)**

# Simple capture – nakade/ *chijung* (8)



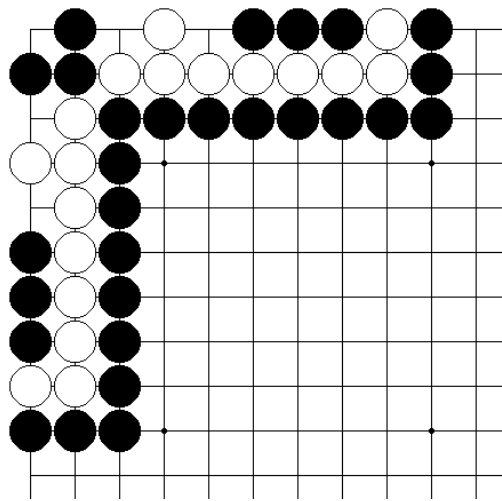
**Fig 12: Equal 9-11: seki/ White dead (ko/*pae*)**



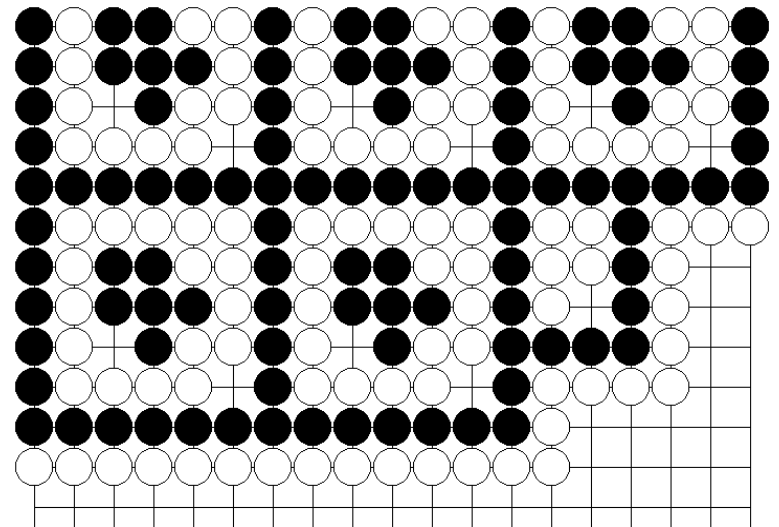
**Fig 13: Seki: Largest centre/edge combo ([Feldmann2005](#))**

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

Not seki, but better if opponent plays first!

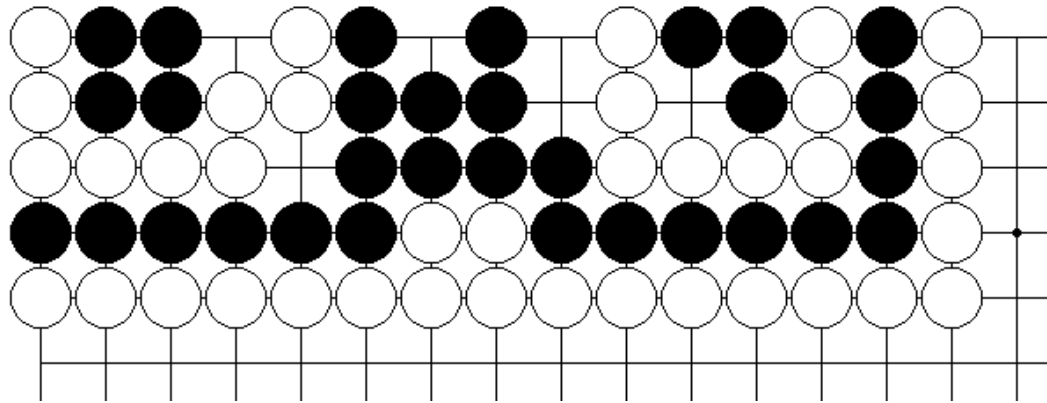


**Fig 14a: One-or-two-die  
(well known)**

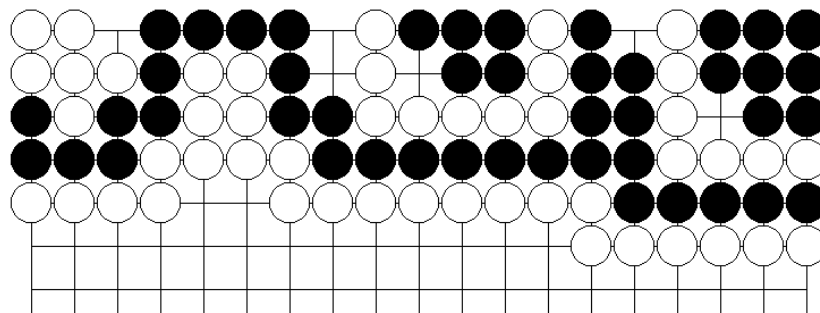


**Fig 14b: Four-or-five-die  
(new -- 1 of 4 centre/edge)**

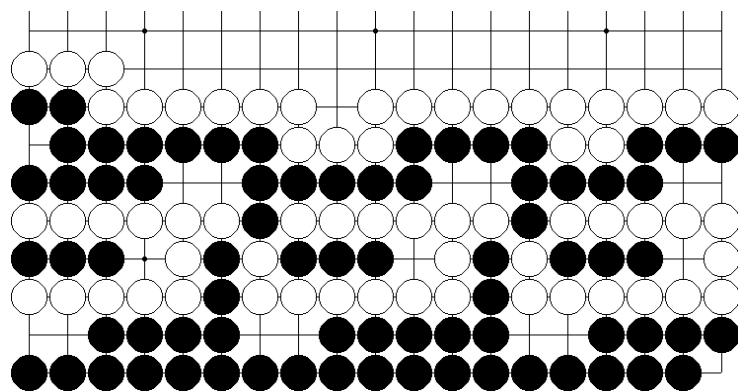
# Simple capture – nakade/ *chijung* (10)



# 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)

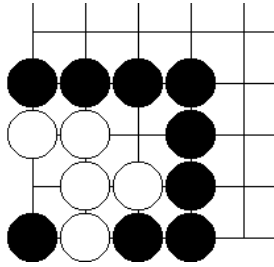
- [[Fearnley2005b](#)]: more multiple group combinations
- Further work needed: (
  - Complete  $m$  black versus  $n$  white ...
  - Complex corner nakade/ *chijung*
  - More complicated topologies
  - Role of suicide, if Chinese *rules*

# Capture, Immediate Recapture (CIR)

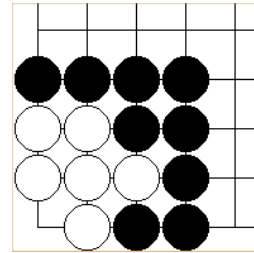
- Two-sided, mutual, capture possible
- ... Recapture:
  - Immediate: CIR
  - Delayed: CDR – **C**apture, **D**elayed **R**ecapture
- CIR
  - Snapback (*uttegaeshi/ hwangyeok*) – except as *special*, below
  - Hanezeki/ *jeochim bik* – in-line capture/recapture
  - *Special* snapback – Figs 19 & 20,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

# CIR – Snapback/ *Hwangyeok* (1)

Special:

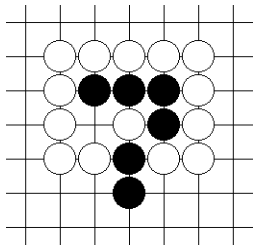


**Fig 19: pre 1-eye**

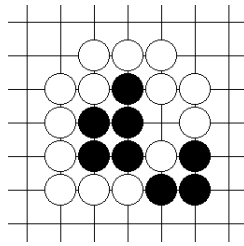


**Fig 20: Flower 6**

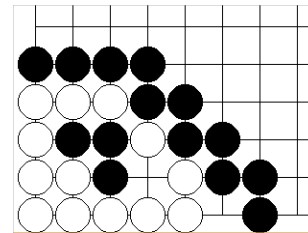
- Fig 21 – no use; Figs 22-23 – useful



**Fig 21: in-line**



**Fig 22 diagonal**



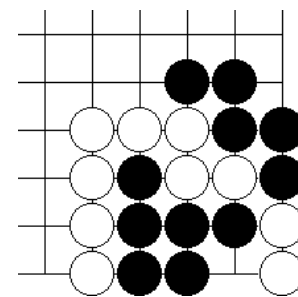
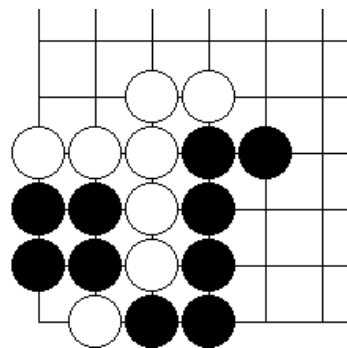
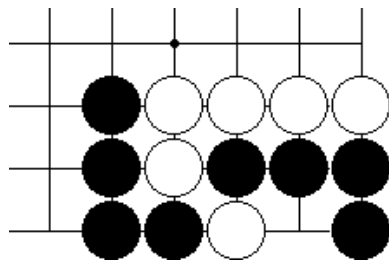
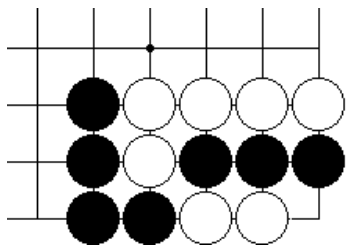
**Fig 23: ko-for-life**

# 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) )

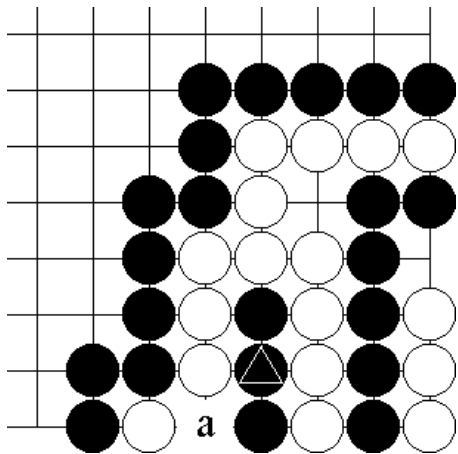


Fig 28: XuanXuan QiJing (1347)

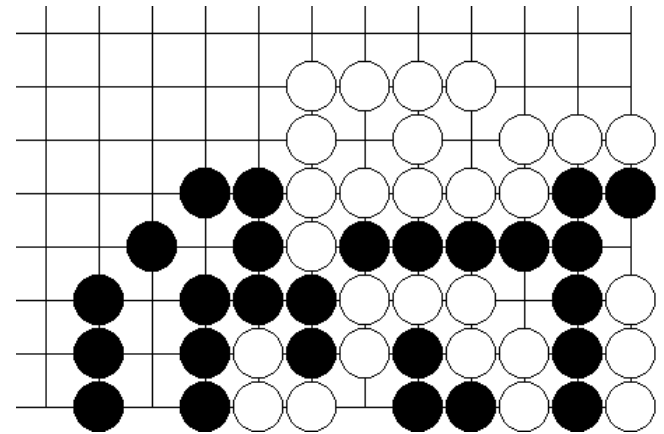
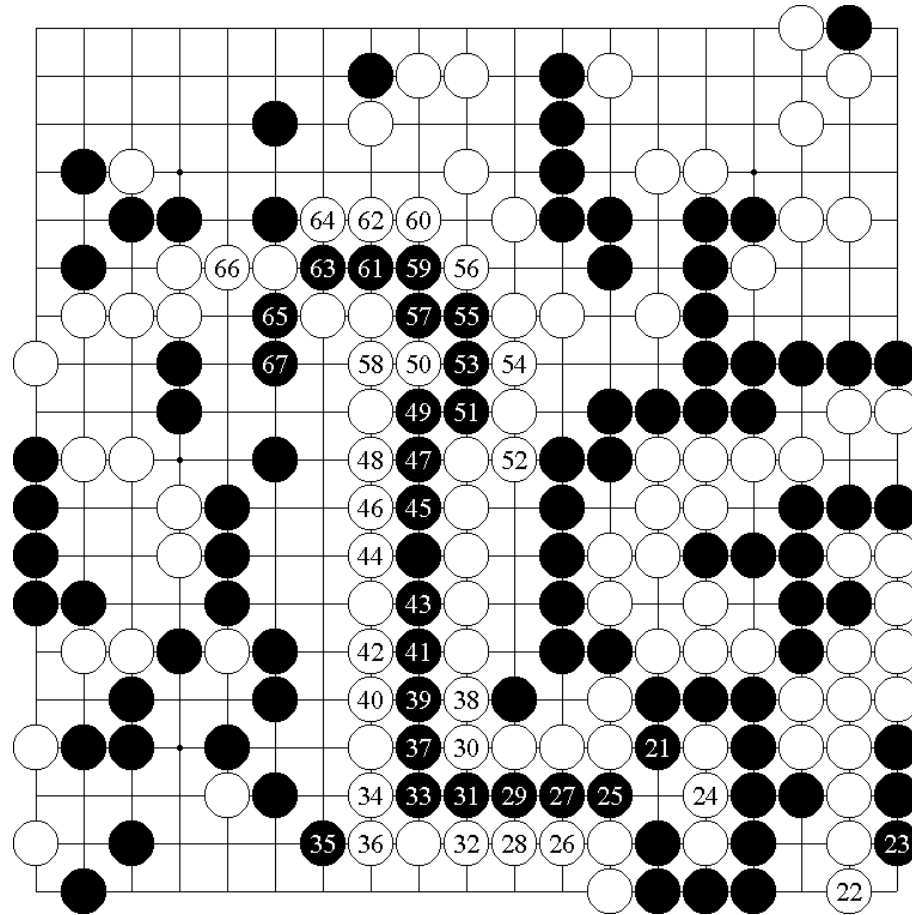


Fig 29: Shimada (1958)

# CIR – hanezeki/ *jeochim bik* (2)



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

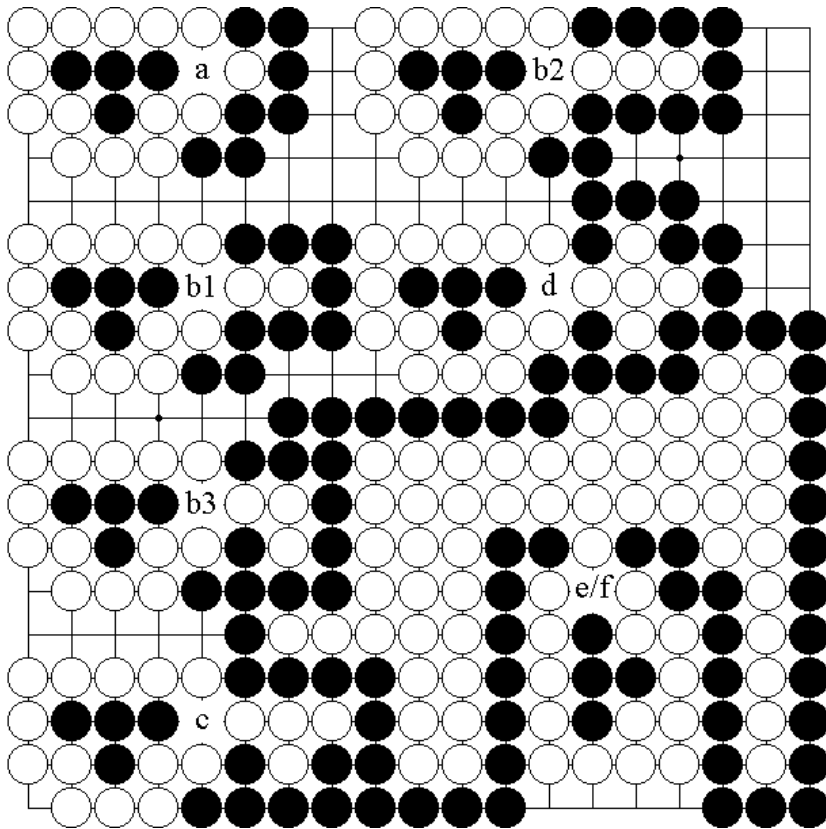
# CIR – hanezeki/ *jeochim bik* (3)

- 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

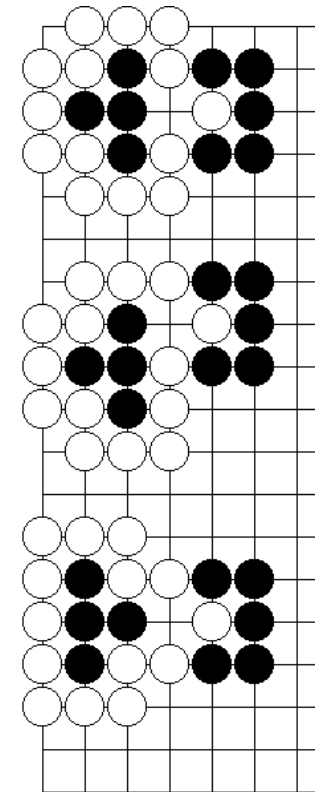
# CIR – hanezeki/ *jeochim bik* (4)

- [[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**

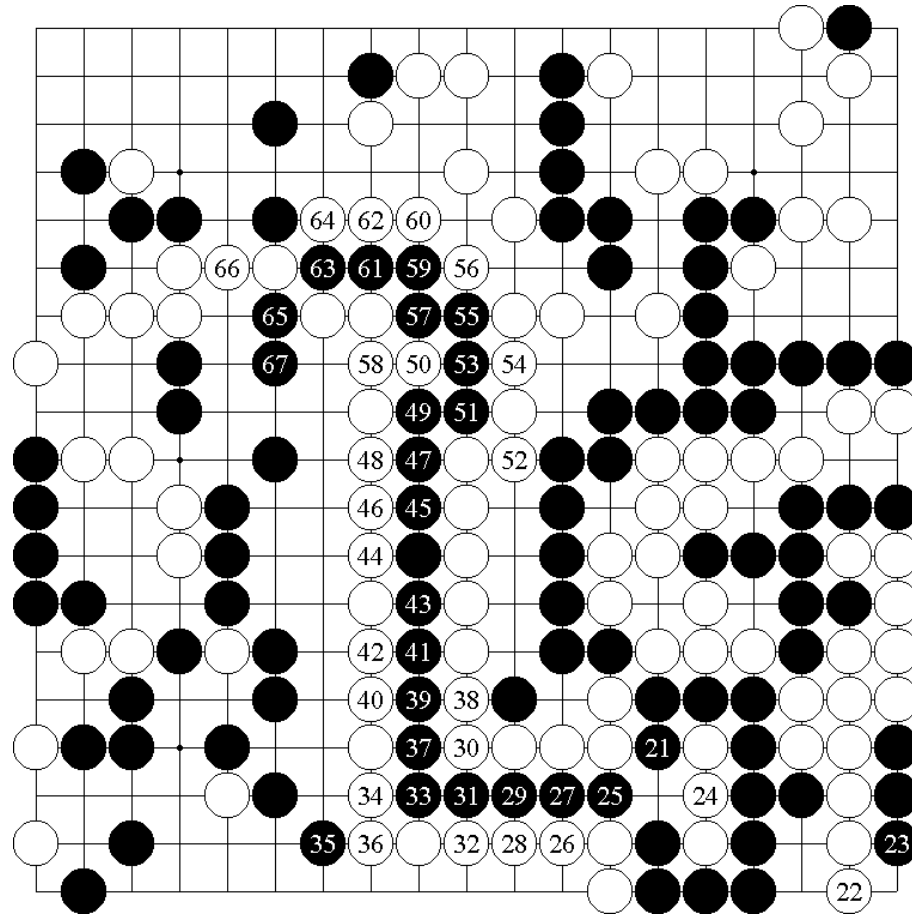
# (CIR – hanezeki/ *jeochim bik* (6)

- 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/ jeochim 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 ...

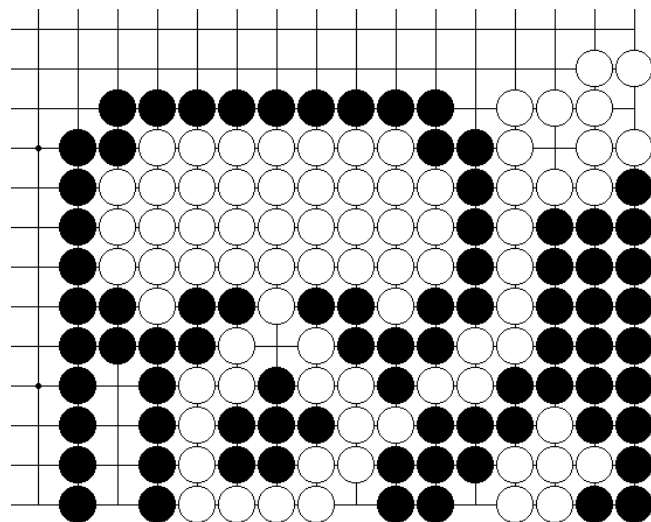
# CIR – hanezeki/ *jeochim bik* (8)



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

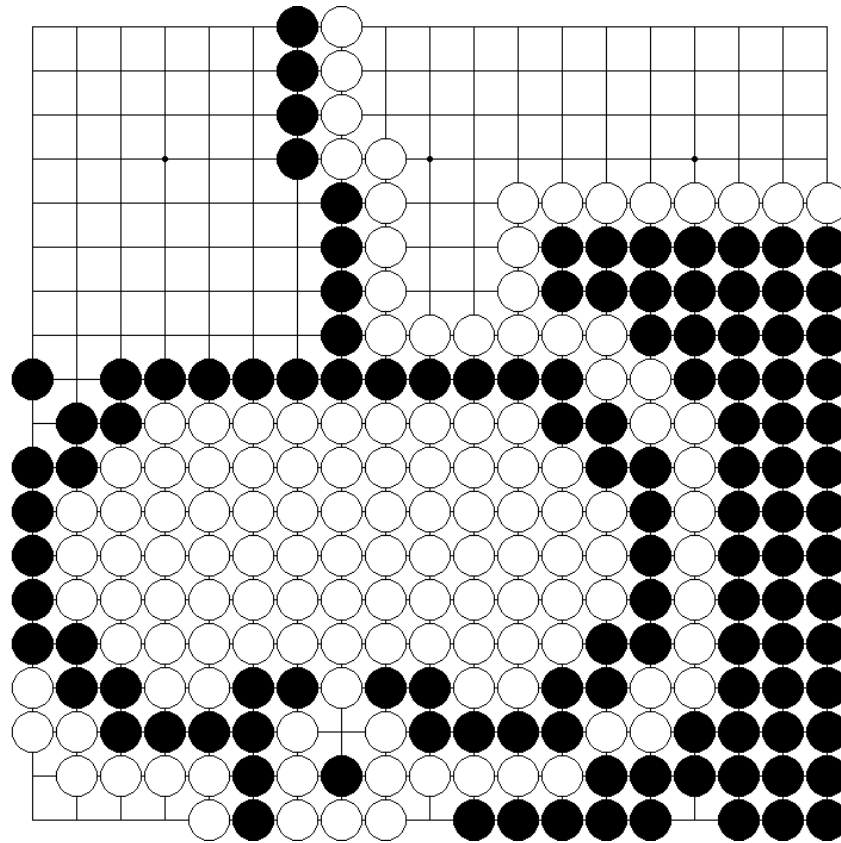
# (CIR – hanezeki/ *jeochim bik* (9)

- 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?**

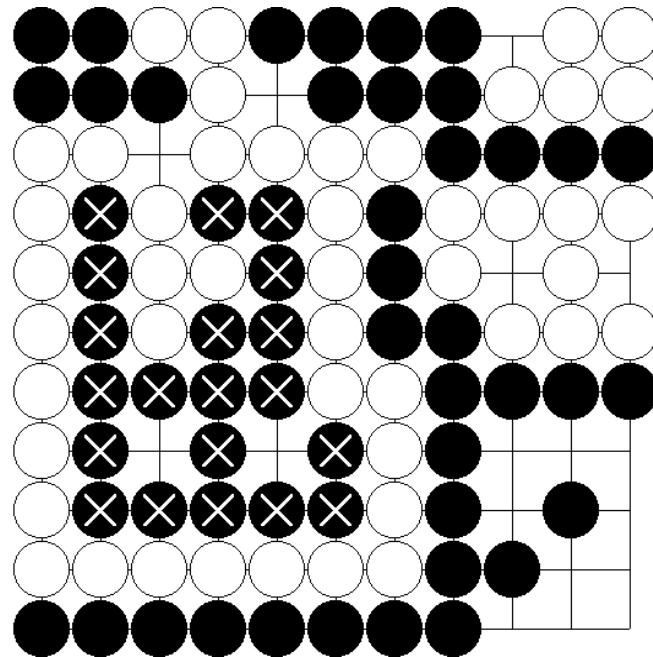
(CIR – hanezeki/ *jeochim bik* (10)



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

# CIR – hanezeki/ *jeochim bik* (11)

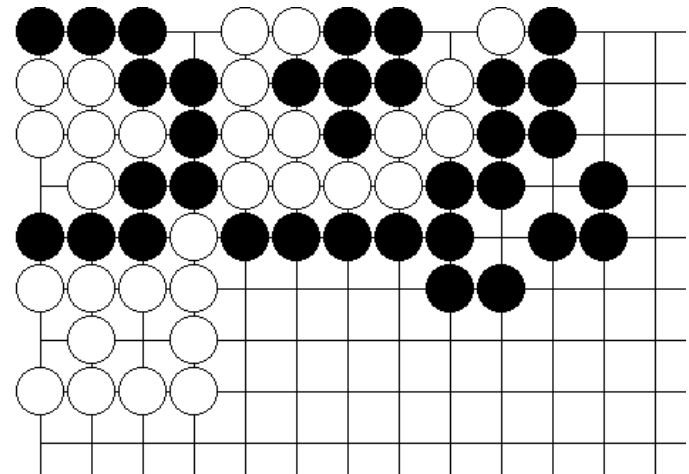
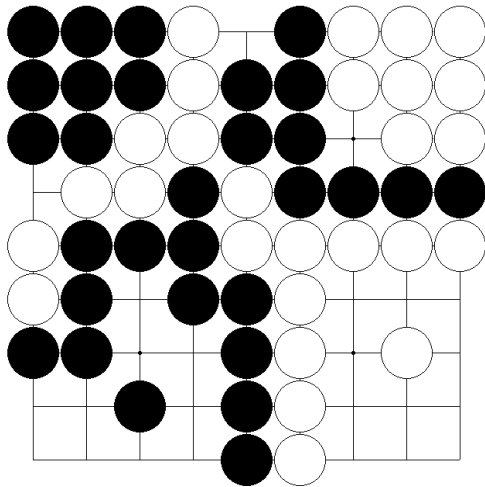
- Wrap-around: *possible* with all in centre;  
*necessary* for some in corner – example Fig 37



**Fig 37: Wrap-around**

# CIR – hanezeki/ *jeochim bik* (12)

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

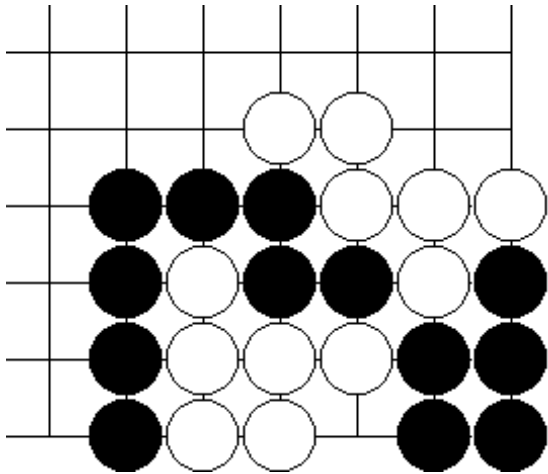


**Fig 38: Double Murashima's ko**

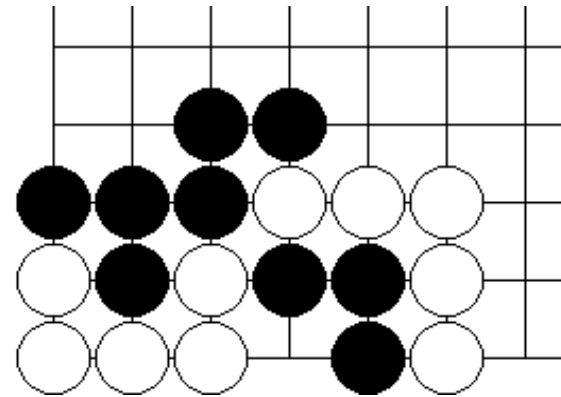
**(Fig 39: Need most ko threats (10/9))**

# 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

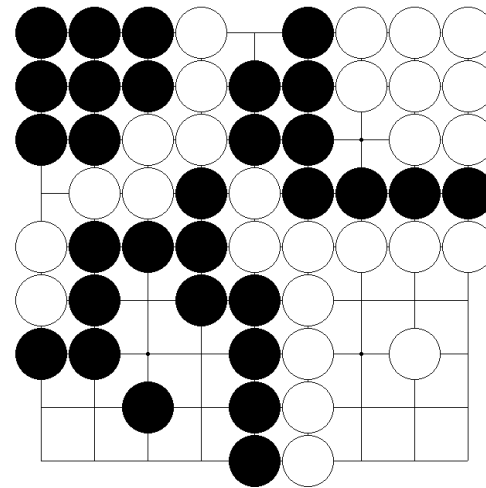
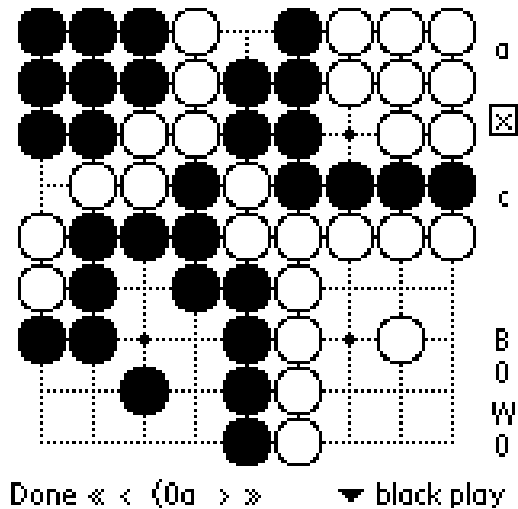
# Conclusions and further work (3)

- 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?