

Types of Basic Ko

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Abstract

All basic kos are classified into the major types disturbing ko, fighting ko, and semi-stable ko. These and subtypes of disturbing ko and semi-stable ko are defined. Every type's definition sets conditions for whether the open player, closed player, open opponent, and closed opponent, respectively, can create uncapturable life or a two-eye-formation on the ko necessarily. Further definitions, suggestions for future research, and examples are given.

Preface

Traditional, informal go theory has known some ko types, overlooked other ko types, and been very ambiguous about what distinguishes every two ko types from each other. Ing made the first noteworthy attempt of defining the ko types known to traditional go theory by suggesting a new major classification for them. However, his so called definitions were ambiguous, incomplete, and illogical. Later, value-based mathematical theories have contributed to an understanding of different ko types but without trying to separate them all from each other. Until now this task has still awaited a solution.

This paper is a major step forwards towards a complete classification and formal definition of all ko types. However, the task is very difficult and mighty even for the author, who laid significant parts of the necessary fundament on the rules level and study of kos. Therefore the offered definitions still need to be tested against many more examples. A subclassification of fighting kos, a top-down definition of disturbing kos not accidentally including any semi-stable kos or fighting kos, and an extension to big ko strings are for future research.

The scepticist asks: Why are formal definitions of go terms any good? Current players may easily live without them because the current level of research does not allow easy application for the purpose of strength improvement yet. So far traditional go theory, value-based mathematical theories, and computer go have been the major ways of trying to solve the game of go in the long run. Formal definitions of go terms are a fourth such way. Thus far its achievements have been only modest because this field of go research is relatively new, there have been only few researchers, and even fewer have made noteworthy amounts of contributions. Earlier definitions are about the rules of play, "strategy", force, life and death, eye, group, region, etc. Much of this may seem uninteresting because it is on a very basic level of playing skill. Things will change in the foreseeable future though: During the following years or decades, higher level terms will follow: ko threat, aji, thickness, efficiency, attack, etc. Even more importantly on the next level of abstraction, strategic decision making will be suggested by definitions, too. In principle, the potential is revolutionary when understanding of language of go terms will reach that level where knowledge of a word almost equals much deeper insight in decision making. Contrarily, today there are words but the player is left alone with his decision of how to apply them and often enough also with finding some useful rough understanding of a term at all.

A specific application of definitions of ko types is to rules using such terms. Ing Ko Rules, New Ko Rules, and the supplementary ko rule of the World Mind Sports Games 2008 benefit from that. However, the author would rather wish such rules would never be used because the definitions are many times as long as the rules, which thus remain impractical. Some leading tournament organizers have refused to use formal definitions of ko types at all; this is irresponsible though because then their half-understanding is only on an esoteric level of belief in rare precedents while

the much more profound understanding on the level of formal definitions is treated as forbidden fruits. Wisdom is not spread by political priests hiding things but by freely published theory and explained derived application.

Basic kos are classified into the three major types Disturbing Ko, Semi-stable Ko, and Fighting Ko plus the emergency type Default Unknown Ko. Fighting Kos are not subclassified yet. As already Ing discovered, Disturbing Ko on the second level is either Disturbing Death or Disturbing Life. There is a third level though, which Ing saw but could not decipher clearly yet: A Disturbing Death is either a Dead Ko, a Double Disturbing Death, or a Closed Death; a Disturbing Life is either an active disturbing life, an inactive disturbing life, or a 1-eye-flaw. Also Semi-stable Kos have subtypes.

Ing ran into ambiguity also because he tried to combine several kos as a ko-position. The author relies on a different, conceptually easier approach: each ko's type is determined for itself. Besides each ko type depends on something understood easily - the possibilities of creation of uncapturable life on the ko. This approach has become possible only after the relatively recent definitions of "force", "two-eye-formation", and "uncapturable string".

Go is not so easy to allow the most beautiful definitions one would desire. Semi-stable Kos come in as a special major type. Kos adjacent to sekis demand reference to uncapturable besides two-eye-formation. Different types of "force" are necessary to distinguish the ko types properly from each other and to cope with local threats. The latter also demand careful distinction of Double Disturbing Death from Fighting Ko. Active Disturbing Life and Inactive Disturbing Life rely on two-eye-formation only rather than on uncapturable life. Active Disturbing Life does not behave exactly as Inactive Disturbing Life and furthermore needs to be distinguished carefully from 1-eye-flaw. This has led to the discovery of the default restriction rules, which Ing and others might have presumed without ever having been able to spell out the existence of their assumption or even its contents.

Quite some years ago, the author discovered Dead Ko as a ko type - now he can define it. He also noticed the existence of Closed Death under the Basic-Fixed-Ko Rules but was unaware of this being a ko type of its own deserving a name.

Usage of the definitions is mighty and modular: They accept - with a few restrictions - an arbitrary given ruleset and an arbitrary or empty history of ko bans as inputs. Hence the occurrence of different ko types for the same positions under different rulesets or with different game sequences to a considered position can be studied, too.

The roughly estimated frequency of ko types in actual games is worth remarking:

- 1:1 - fighting ko
- 1:3 - dead ko
- 1:300 - double disturbing death
- 1:10,000 - active disturbing life
- 1:50,000 - inactive disturbing life
- never - semi-stable ko
- never - 1-eye-flaw
- never - closed death

Presuppositions and New Fundamental Definitions

- A *ko* is a basic-ko currently in the position as such.
- Each ko has a type of its own independently of other kos.

- *on the ko* is on both intersections of the ko.
- An *open player* is a player for whom the ko is open.
- A *closed player* is a player for whom the ko is closed.
- The *history-bans* is the set of ko bans prior to the start of analysis.
- The *start-position* is either the current-position or the current-position modified by a capture in the analysed ko.
- The *1-play-rule* prohibits a cycle consisting of 1 play.
- The *basic-ko-rule* prohibits immediate recapture in a basic-ko.
- The *fixed-ko-rule* prohibits a play to leave position A and create position B if an earlier play left position A and created position B.
- The *3-pass-rule* ends the game in case of 3 successive passes.
- The *cycle-end-rule* ends the game when a) a situational cycle starting at the start-position occurs and b) a recapture in a basic-ko after exactly 2 successive, intervening passes does not occur.
- The *default restriction rules* are the 1-play-rule, the basic-ko-rule, the fixed-ko-rule, the 3-pass-rule, the cycle-end-rule.
- Given a position, the possibly empty history-bans, and a ruleset that has or implies the 2-move-rule, that lets each sequence be finite, and that is without exceptional game ends. Definitions may override some of the given things.
- *uncapturable life* on a ko is a two-eye-formation or an uncapturable string on the ko.
- Whether a string is uncapturable is checked under the given rules without history-bans prior to the start of analysis and without history-bans created during analysis.
- *force* is defined analogous to the Japanese 2003 Rules version 35a. Other terms (move = play or pass, basic ko, intersection, position, ko ban, recreation, cycle, ending [the game], ruleset, given rules, sequence, exceptional game end, ko-capture, legal, open ko, closed ko, moving first, moving second, two-eye-formation, uncapturable) not defined here again are as defined in other obvious texts.
- A player can *play-force* something if he can force the something so that until then he makes only plays.
- A player can *pass-force* something if he can force the something so that until then he makes at least one play and at least one pass.
- For a ko, a player can *virtual-force* something if he can force the something while exceptionally he may always make a ko-capture on this ko immediately after the opponent's ko-capture on this ko during the analysis unless that ko-capture was preceded by the player's ko-capture on a different ko during the analysis.

Definitions for Disturbing Death

Dead Ko

A *dead ko* is a ko for a player so that

- the **open player** moving first **can** virtual-force uncapturable life of his on the ko,
- the **closed player** moving first **can** virtual-force uncapturable life of his on the ko,
- the **open opponent** moving first **cannot** virtual-force uncapturable life of his on the ko, and

- the **closed opponent** moving first **cannot** virtual-force uncapturable life of his on the ko

Double Disturbing Death

A *double disturbing death* is a ko for a player so that

- the **open player** moving first **can** virtual-force uncapturable life of his on the ko,
- the **closed player** moving first **can** virtual-force uncapturable life of his on the ko,
- the **open opponent** moving first **can** virtual-force uncapturable life of his on the ko, and
- the **closed opponent** moving first **cannot** virtual-force uncapturable life of his on the ko.

Closed Death

A *closed death* is a ko for a player so that

- the **open player** moving first **can** virtual-force uncapturable life of his on the ko,
- the **closed player** moving first **cannot** virtual-force uncapturable life of his on the ko,
- the **open opponent** moving first **can** virtual-force uncapturable life of his on the ko, and
- the **closed opponent** moving first **cannot** virtual-force uncapturable life of his on the ko.

Disturbing Death

A *disturbing death* is one of dead ko, double disturbing death, closed death.

Definitions for Disturbing Life

Active Disturbing Life

An *active disturbing life* is a ko for a player so that

- the **open player** moving first **cannot** virtual-force a two-eye-formation of his on the ko,
- the **closed player** moving first **cannot** virtual-force a two-eye-formation of his on the ko,
- the **open opponent** moving first **can** virtual-force a two-eye-formation of his on the ko,
- the **closed opponent** moving first **cannot** virtual-force a two-eye-formation of his on the ko, and
- - under default restriction rules - the **closed opponent** moving first **cannot** virtual-force a two-eye-formation of his on the ko.

1-Eye-Flaw

A *1-eye-flaw* is a ko for a player so that

- the **open player** moving first **cannot** virtual-force uncapturable life of his on the ko,
- the **closed player** moving first **cannot** virtual-force uncapturable life of his on the ko,
- the **open opponent** moving first **can** virtual-force uncapturable life of his on the ko,
- the **closed opponent** moving first **cannot** virtual-force uncapturable life of his on the ko, and
- - under default restriction rules - the **closed opponent** moving first **can** virtual-force uncapturable life of his on the ko.

Inactive Disturbing Life

An *inactive disturbing life* is a ko for a player so that

- the **open player** moving first **cannot** virtual-force a two-eye-formation of his on the ko,
- the **closed player** moving first **cannot** virtual-force a two-eye-formation of his on the ko,
- the **open opponent** moving first **cannot** virtual-force a two-eye-formation of his on the ko

- and
- the **closed opponent** moving first **cannot** virtual-force a two-eye-formation of his on the ko.

Disturbing Life

A *disturbing life* is one of active disturbing life, inactive disturbing life, 1-eye-flaw.

Definition of Disturbing Ko

A *disturbing ko* is either a disturbing death or a disturbing life.

Definition of Fighting Ko

A *fighting ko* is a ko for a player so that

- the **open player** moving first **can** virtual-force uncapturable life of his on the ko,
- the **closed player** moving first **can** virtual-force uncapturable life of his on the ko,
- the **open opponent** moving first **can** virtual-force uncapturable life of his on the ko, and
- the **closed opponent** moving first **can** virtual-force uncapturable life of his on the ko.

Definitions for Semi-Stable Ko

Semi-Stable Ko

A *semi-stable ko* is a ko for a player and under default restriction rules so that

- it is neither a disturbing ko nor a fighting ko,
- the player moving first **cannot play-force** uncapturable life of his on the ko, and
- the open or closed player moving first **can pass-force a cycle or** uncapturable life of his on the ko.

Molasses Open Kill

A *molasses open kill* is a semi-stable ko under the given rules so that

- the **open player** moving first **can force** uncapturable life of his on the ko and
- the **closed opponent** moving **second cannot force** uncapturable life of his on the ko.

Molasses Closed Kill

A *molasses closed kill* is a semi-stable ko under the given rules so that

- the **open player** moving first **cannot force** uncapturable life of his on the ko and
- the **closed opponent** moving **second can force** uncapturable life of his on the ko.

Molasses Life

A *molasses life* is a semi-stable ko under the given rules so that

- the **open player** moving first **cannot force** uncapturable life of his on the ko and
- the **closed opponent** moving **second cannot force** uncapturable life of his on the ko.

Unknown Semi-Stable Ko

An *unknown semi-stable ko* is a semi-stable ko that is of none of the other semi-stable ko types.

Definition of Default Unknown Ko

A *default unknown ko* is a ko that is of none of the other ko types.

Summarizing Conclusions

Propositions

Corollary 1:

A disturbing death has these conditions:

- the **open player** moving first **can** virtual-force uncapturable life of his on the ko,
- the **closed opponent** moving first **cannot** virtual-force uncapturable life of his on the ko.

Corollary 2:

A fighting ko has 0, a disturbing death has 1 or 2, a disturbing life has 3 or 4 open | closed player | opponent cannot-conditions for the given rules. Apart from default unknown kos, only semi-stable kos depend on pass-force.

Corollary 3:

No ko can belong to two different types of all the subtypes of disturbing ko and the type fighting ko.

Proof:

If active / inactive disturbing life were defined with "uncapturable life" instead of "two-eye-formation", it would be a more general definition. The proof is obvious for all definitions with "uncapturable life". QED.

Overview on Disturbing Kos and Fighting Kos

Y = yes (can), N = no (cannot), (.) = under default restriction rules.

Ko Type	Open Player	Closed Player	Open Opponent	Closed Opponent
dead ko	Y	Y	N	N
dead ko [swapped players]	N	N	Y	Y
double disturbing death	Y	Y	Y	N
double disturbing death [swapped players]	Y	N	Y	Y
closed death	Y	N	Y	N
active disturbing life	N	N	Y	N (N)
1-eye-flaw	N	N	Y	N (Y)
inactive disturbing life	N	N	N	N
fighting ko	Y	Y	Y	Y

Notes: All types differ from each other. N prefers closed to open; the other types do not seem to exist under - for rules experts - well-known restriction rulesets. Besides the Y / N distinction, there is also the uncapturable life / two-eye-formation distinction, which is not shown in the table. The 1-eye-flaw warns us that more special types with special conditions might exist. Closed death and the

active / inactive distinction of disturbing life might already be the last discovered important disturbing ko types.

Notes

Comments

- One should not forget that so far the ko type definitions apply to basic kos only.
- A definition's "player" or "player [...] opponent" allow the player to be either Black or White. So both cases might have to be checked for a possible application of the definition but at least one fulfilled case suffices.
- Not all ko types occur under all rulesets but all definitions can be applied under all rulesets.
- The definitions say nothing about perfect middle game or endgame play.
- The history-bans, a proceeding game, or more outside liberties might change a ko's type (with otherwise the same shape). Quite like during a game a group's life and death status can change from life to death or vice versa, ko types are dynamic, too.
- A difference between active and inactive disturbing life is that only in an active disturbing life one player's non-ko string(s) can already be reduced to one liberty temporarily.
- In inactive disturbing lives, cycles are not as big as one might expect because the opponent can connect some ko stone(s).
- The name closed death shall suggest that either closed player's stones are dead.
- virtual-force is like giving one of the players arbitrarily many and big so called ko threats for the ko considered in a definition. In value-based theory, the related term is "ko master".
- The default restriction rules prohibit 1-play-cycles so that, under rules allowing suicide, a single stone suicide cannot be abused to end the game.

Research History

- It was a mistake for Ing terms to make an attempt of relying on breath types. Instead, in principle, breath types might be derived only after first classifying ko types.

Completion of Current Research

- There should be proofs that no semi-stable ko can be of more than one type or a disturbing ko or fighting ko. Afterwards the defensive "neither disturbing ko nor fighting ko" condition might be removed.
- The definitions have to be checked against many more examples, e.g., multi-stage fighting ko with local threats.

Future Research

- There should be an extension to big ko strings. So far ko types for bigger ko strings have to be defined separately. The definition of ko will help.
- In positions with triple or quadruple ko stones, to include all the small and big ko mouths' intersections might require a term of "point cycle set" that relies on force and score-improvements rather than on force and reduction to uncapturable lives.
- A subclassification of fighting kos is very desirable.

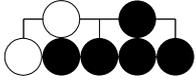
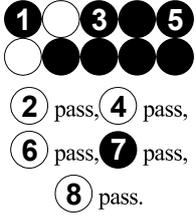
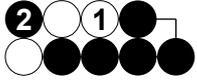
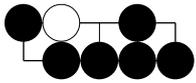
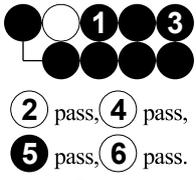
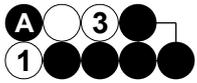
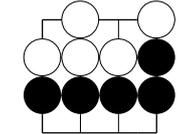
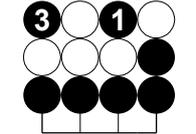
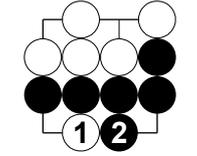
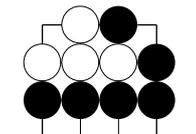
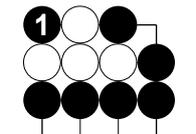
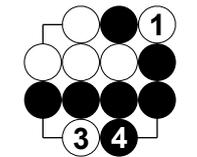
- A subclassification of some of the disturbing ko types might be considered.
- Relations to ko terms of value-based theory should be drawn.
- One would like to define the grouping term "disturbing ko" first before its subtypes, i.e., have a top-down definition of disturbing kos not accidentally including any semi-stable kos or fighting kos.
- When new types of unknown kos should be discovered, the summarizing definitions might have to be altered accordingly.
- Symmetry of the definitions demands further ko types to be discovered or proofs of their non-existence. Further research might make it necessary to improve on the current definitions.
- One should study whether types similar to active / inactive disturbing lifes, with "uncapturable life" instead of "a two-eye-formation" everywhere in their texts and excluding active / inactive disturbing life as a condition, exist.
- It is unknown whether the name double disturbing death is chosen well, i.e., whether such kos exist that involve relevant cycles through more or less than two kos altogether.
- One might classify rulesets also due to their effects on existence of ko types or the relation between shapes and their ko types.
- Define second layer ko types for those kos that change its first layer ko type when some particular other ko-capture(s) are made. Include all such changing first layer kos among the second layer fighting kos. - Alternative: Study a ko's adjacent strings and their transformation to uncapturable life.
- Define Ing style ko position via forcing of cycle sets / point cycle sets.
- Does a semi-stable fighting ko exist? Maybe molasses ko under yet other ko rules.
- John Tromp's two asymmetrical semi-stable kos with 5 or 7 plays, respectively, in between single passes should be studied.
- Test whether closed death exists, e.g., under positional superko and 2 ending passes.

Examples

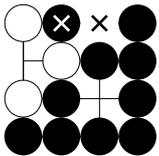
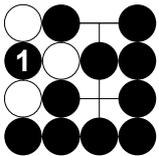
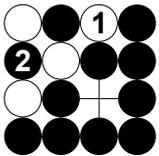
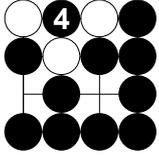
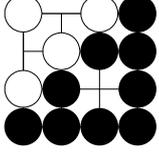
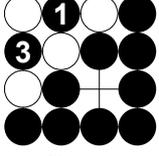
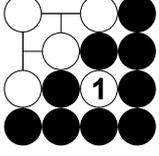
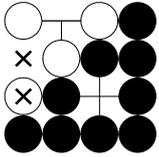
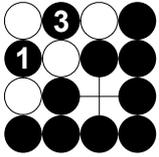
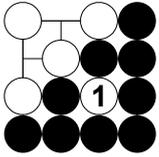
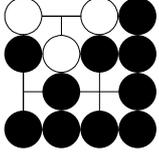
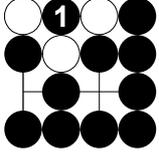
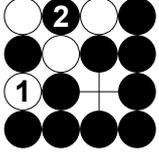
- In the examples, only some hypothetical-sequences (and often only one) are shown but the obvious rest of most long sequences is not shown. If a definition prescribes it, then the first player to move in a hypothetical-sequence may also be the last to move in the alternation leading to the example position. As a consequence of the Basic-Fixed-Ko-Rules, normally basic ko recapture is allowed after intervening passes but the same recycling after positional repetition is prohibited. If there is more than one ko on the board, then the studied ko is marked.

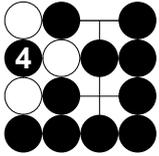
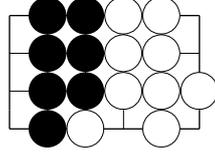
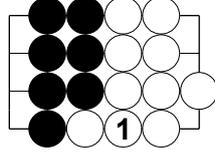
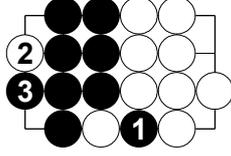
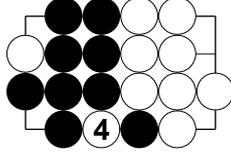
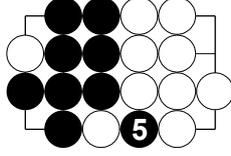
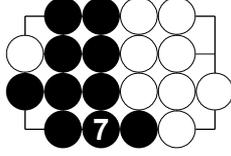
Examples for Basic-Fixed-Ko-Rules and 3 Ending Passes

Dead Ko

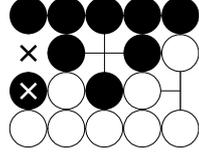
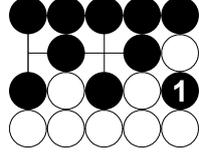
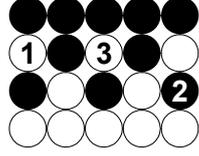
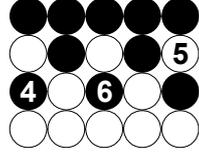
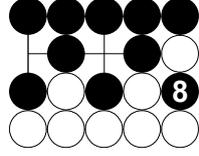
<p>Example 1A</p> 	 <p>② pass, ④ pass, ⑥ pass, ⑦ pass, ⑧ pass.</p> <p>The closed player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>The open opponent White moving first cannot virtual-force white uncapturable life.</p>
<p>Example 1B</p> 	 <p>② pass, ④ pass, ⑤ pass, ⑥ pass.</p> <p>The open player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>② pass, ④ at A.</p> <p>The closed opponent White moving first cannot virtual-force white uncapturable life.</p>
<p>Example 2A</p> 	 <p>② pass.</p> <p>The closed player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>③ pass, ④ pass, ⑤ pass.</p> <p>The open opponent White moving first cannot virtual-force white uncapturable life.</p>
<p>Example 2B</p> 	 <p>The open player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>② pass, ⑤ pass, ⑥ pass, ⑦ pass.</p> <p>The closed opponent White moving first cannot virtual-force white uncapturable life.</p>

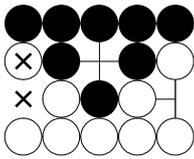
Double Disturbing Death

 <p>Example 1A. The considered ko is marked.</p>	 <p>The open player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>③ pass.</p> <p>The closed opponent White moving first cannot virtual-force white uncapturable life on the ko. At 3, White may not recapture 2 because virtual-force for the study of the upper ko entitles him only immediate recapture on the upper ko.</p>
 <p>(continuation)</p>		
 <p>Example 1B</p>	 <p>② pass.</p> <p>The closed player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>The open opponent White moving first can virtual-force white uncapturable life on the ko.</p>
 <p>Example 2A</p>	 <p>② pass.</p> <p>The closed player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>The open opponent White moving first can virtual-force white uncapturable life on the ko.</p>
 <p>Example 2B</p>	 <p>The open player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>③ pass.</p> <p>The closed opponent White moving first cannot virtual-force white uncapturable life on the ko. At 3, White may not recapture 2 because virtual-force for the study of the left ko entitles him only immediate recapture on the left ko.</p>

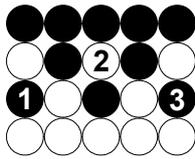
 <p>(continuation)</p>		
 <p>Counter-example 3</p>	 <p>The closed player White can virtual-force white uncapturable life on the ko.</p>	 <p>The closed opponent Black moving first can virtual-force black uncapturable life on the ko.</p>
 <p>(continuation)</p>	 <p>⑥ pass. (continuation) Virtual-force allows Black, who is the one virtual-forcing, immediate recapture on the ko. White does not have this privilege.</p>	 <p>(continuation)</p>

Closed Death

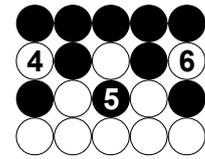
 <p>Example 1A. The considered ko is marked.</p>	 <p>The open player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>The closed opponent White moving first cannot virtual-force white uncapturable life.</p>
 <p>⑦ pass. (continuation) At 5, the special virtual-forcing right does not apply to the left ko because 3 was also a ko-capture in a different ko.</p>	 <p>(continuation)</p>	



Example 1B. The considered ko is marked.

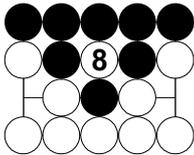


The closed player Black moving first cannot virtual-force black uncapturable life.

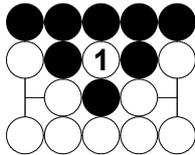


7 pass.

(continuation)
At 5, the special virtual-forcing right does not apply to the left ko because 3 was also a ko-capture in a different ko.

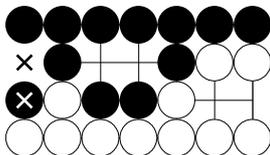


(continuation)

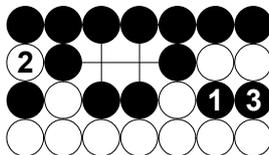


The open opponent White moving first can virtual-force white uncapturable life on the ko.

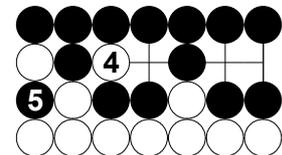
Note: Under Positional Superko, a ko in a standard triple ko is not a closed death but a fighting ko.



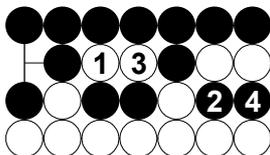
Example 2A



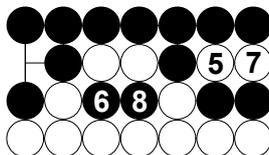
The open player Black moving first can virtual-force black uncapturable life on the ko.



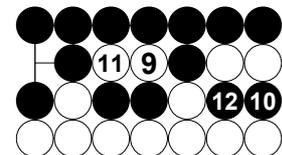
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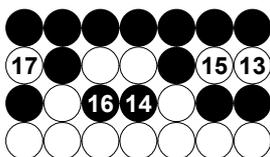
The closed opponent White moving first cannot virtual-force white uncapturable life.



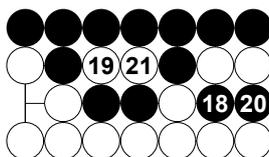
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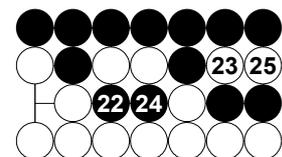
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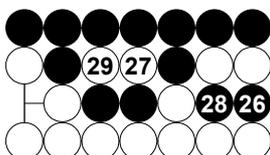
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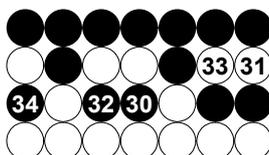
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(continuation)

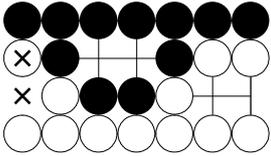


(continuation)

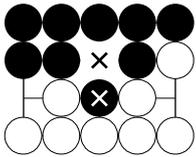
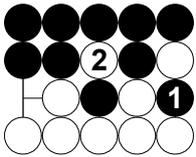
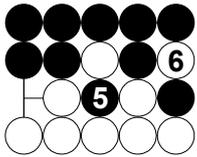
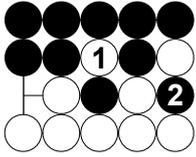
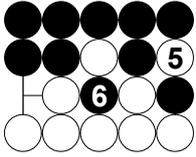
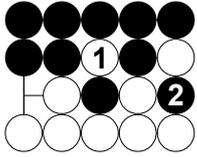
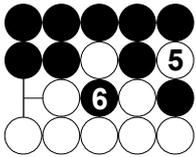
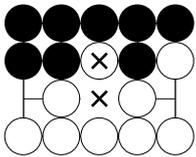
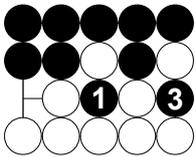
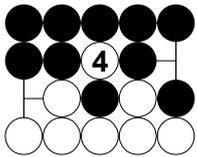


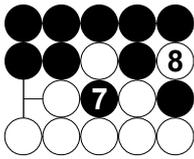
(continuation)
35 pass, 36 pass, 37 pass.

Note: If White varies the timing of ko captures, Black can still apply the same strategy of continuing play, delaying ko capture as long as possible, and symmetric answer to White's placement of a throw-in. Therefore White runs out of plays first.

 <p>Example 2B</p>	<p>By symmetry, the open opponent White moving first can virtual-force white uncapturable life on the ko. By symmetry, the closed player Black moving first cannot virtual-force black uncapturable life.</p>	<p>Notes: The special virtual-force right has not been used to virtual-force. This is a defensive approach appropriate in view of a likely later generalization from ko-captures to cycle-plays also for big kos. - Under Positional Superko, a ko in this triple ko is not a closed death but a fighting ko.</p>
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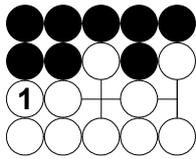
Active Disturbing Lives

 <p>Example 1A. The considered ko is marked.</p>	 <p>3 pass, 4 pass. The open player Black moving first cannot virtual-force a black two-eye-formation on the ko.</p>	 <p>7 pass, 8 pass, 9 pass. (continuation)</p>
 <p>3 pass, 4 pass. The closed opponent White moving first cannot virtual-force a white two-eye-formation on the ko.</p>	 <p>7 pass, 8 pass, 9 pass. (continuation) At 7, virtual-force does not allow White to recapture 6 because that ko-capture was preceded by White's ko-capture 5 elsewhere.</p>	 <p>3 pass, 4 pass. Under default restriction rules, the closed opponent White moving first cannot virtual-force a white two-eye-formation on the ko.</p>
 <p>Continuation. 5 is allowed by the cycle-end-rule. 6 invokes the game end by the cycle-end-rule.</p>		
 <p>Example 1B. The considered ko is marked.</p>	 <p>2 pass. The closed Black moving first cannot virtual-force a black two-eye-formation on the ko.</p>	 <p>5 pass, 6 pass. (continuation) At 5, virtual-force does not allow Black to recapture 4 because that ko-capture was preceded by Black's ko-capture 3 elsewhere.</p>

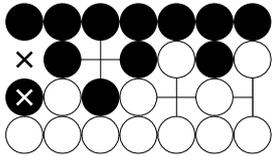


9 pass, 10 pass,
11 pass.

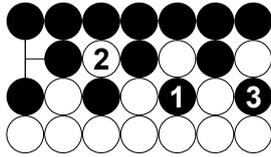
(continuation)



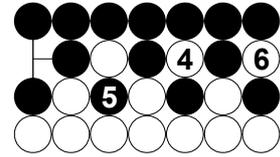
The open opponent White moving first can virtual-force a white two-eye-formation on the ko.



Example 2A. The considered ko is marked.

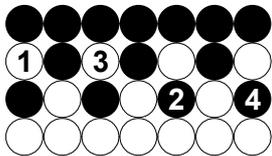


The open player Black moving first cannot virtual-force a black two-eye-formation on the ko.

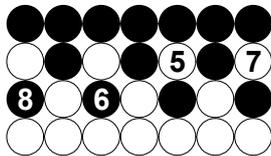


7 pass, 8 pass, 9 pass.

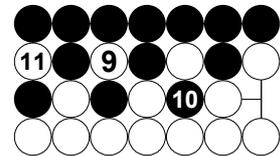
(continuation)



The closed opponent White cannot virtual-force a white two-eye-formation on the ko.

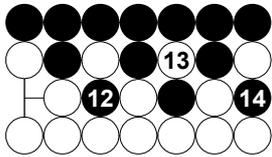


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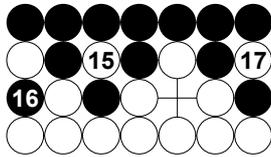


(continuation)

Alternatively for 9, virtual-force would not allow White to recapture the ko-capture 8 because that was preceded by White's ko-capture 7 elsewhere.

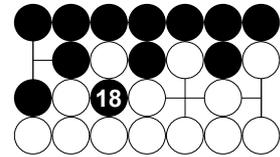


(continuation)



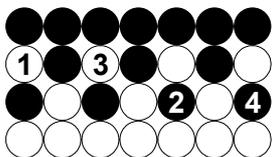
(continuation)

At 17, virtual-force does not allow White to recapture 16 because that ko-capture was preceded by White's ko-capture 15 elsewhere.

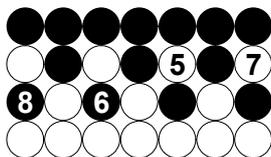


19 pass, 20 pass, 21 pass.

(continuation)

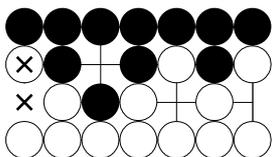


Under default restriction rules, the closed opponent White moving first cannot virtual-force a white two-eye-formation on the ko.

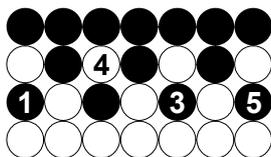


(continuation)

Since 8 ends the game, one does not need to consider where 9 might have been played legally.

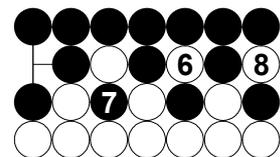


Example 2B. The considered ko is marked.



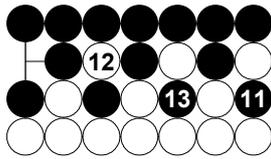
2 pass.

The closed player Black moving first cannot virtual-force a black two-eye-formation on the ko.

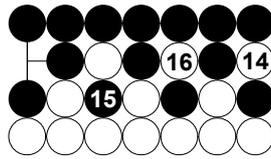


9 pass, 10 pass.

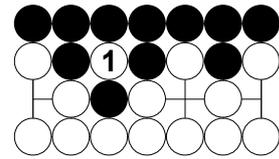
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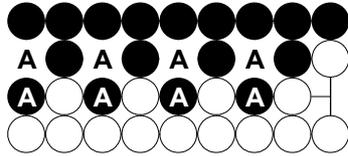
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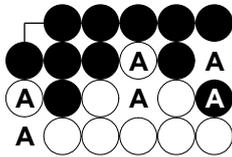
17 pass, 18 pass, 19 pass.
(continuation)



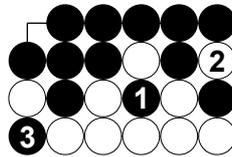
The open opponent White moving first can virtual-force a white two-eye-formation on the ko.



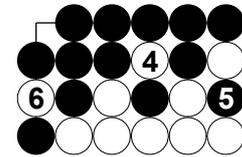
Example 3: Each of the A kos is an active disturbing life. Only the open opponent Black moving first can virtual-force a black two-eye-formation on the ko.



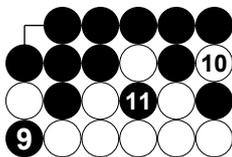
Example 4A: Each of the A kos is an active disturbing life. The following study verifies this for the right ko. For either other ko, the same sequences can be used but player and opponent need to be swapped in an application of the definition.



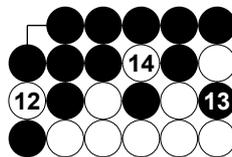
The open player Black moving first cannot virtual-force a black two-eye-formation on the right ko. At 3, virtual-force does not allow Black to recapture 2 because that ko-capture was preceded by Black's ko-capture 1 elsewhere.



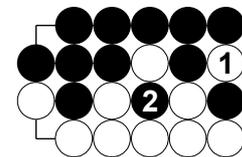
7 pass, 8 pass.
(continuation)



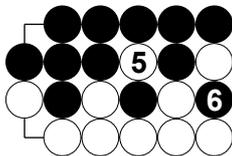
(continuation)
At 11, virtual-force does not allow Black to recapture 10 because that ko-capture was preceded by Black's ko-capture 9 elsewhere.



15 pass, 16 pass,
17 pass.
(continuation)

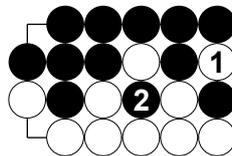


3 pass, 4 pass.
The closed opponent White cannot virtual-force a white two-eye-formation on the right ko.



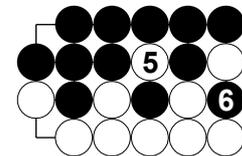
7 pass, 8 pass,
9 pass.

(continuation)
At 7, virtual-force does not allow White to recapture 6 because that ko-capture was preceded by White's ko-capture 5 elsewhere.

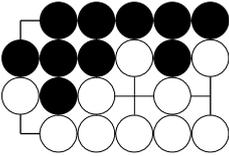
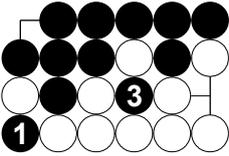
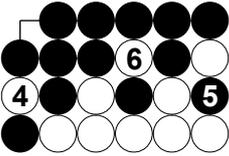
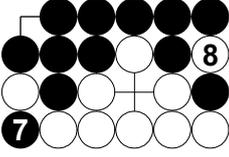
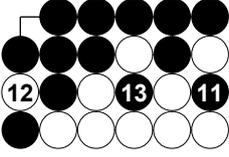
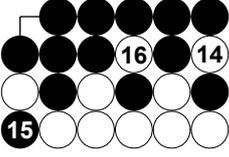
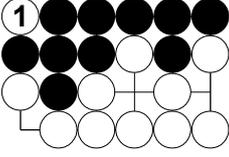
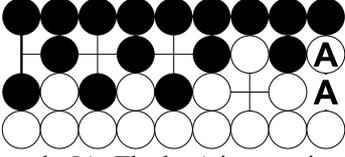
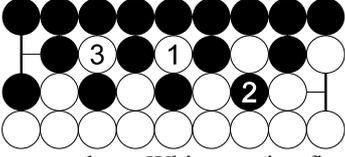
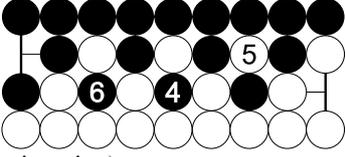
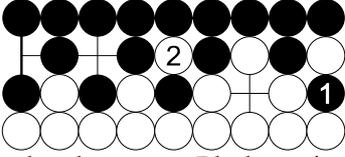
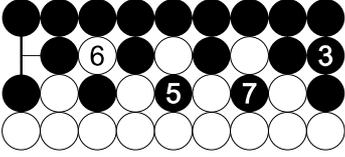
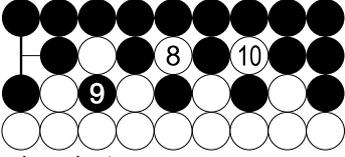
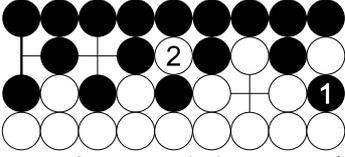
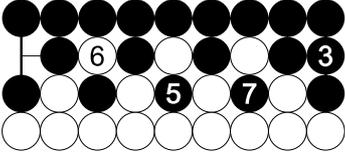
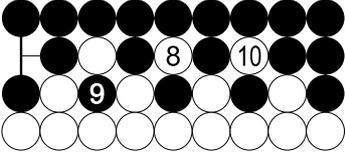


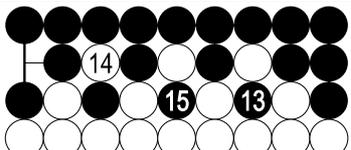
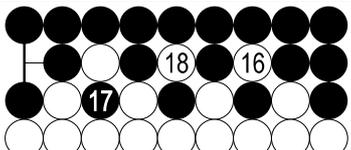
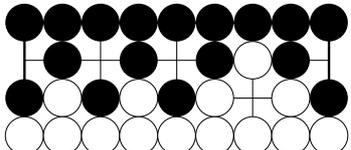
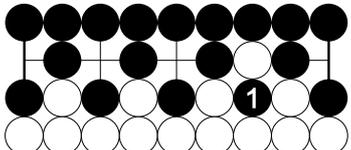
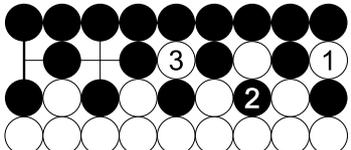
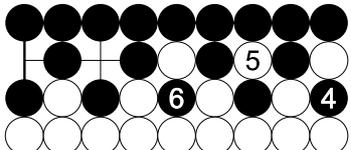
3 pass, 4 pass.

Under default restriction rules, the closed opponent White moving first cannot virtual-force a white two-eye-formation on the right ko.

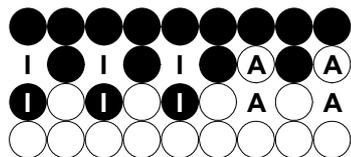
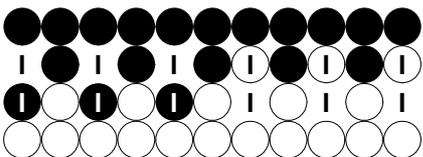
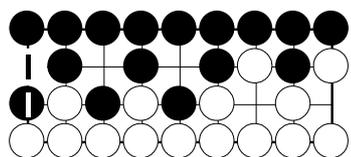
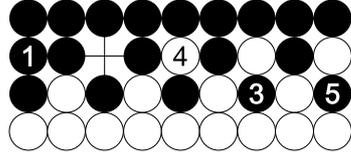
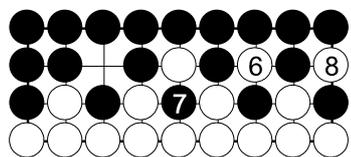
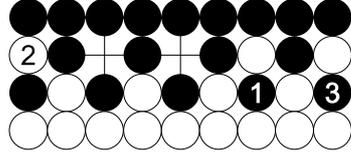
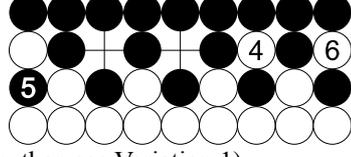
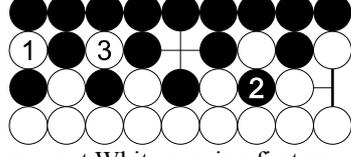


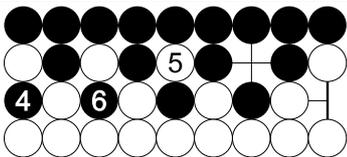
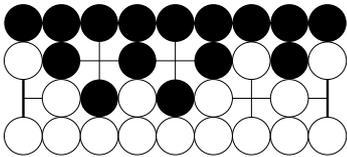
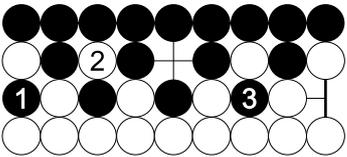
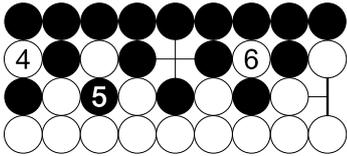
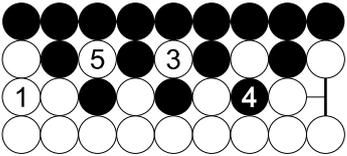
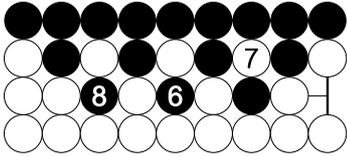
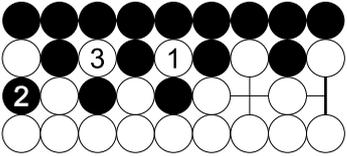
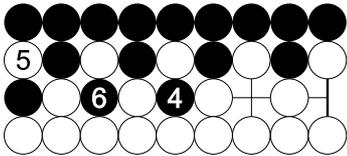
(continuation)
5 does not end the game by the cycle-end-rule. Since 6 ends the game, one does not need to consider where 7 might have been played legally.

 <p>Example 4B</p>	 <p>② pass.</p> <p>The closed player Black moving first cannot virtual-force a black two-eye-formation on the right ko.</p>	 <p>(continuation)</p>
 <p>⑦ pass, ⑧ pass.</p> <p>(continuation)</p> <p>At 9, virtual-force does not allow Black to recapture 8 because that ko-capture was preceded by Black's ko-capture 7 elsewhere.</p>	 <p>(continuation)</p>	 <p>⑬ pass, ⑭ pass, ⑮ pass.</p> <p>(continuation)</p> <p>At 15, virtual-force does not allow Black to recapture 14 because that ko-capture was preceded by Black's ko-capture 13 elsewhere.</p>
 <p>The open opponent White moving first can virtual-force a white two-eye-formation on the right ko.</p>		
 <p>Example 5A: The ko A is an active disturbing life.</p>	 <p>The open player White moving first cannot virtual-force a white two-eye-formation on the right ko.</p>	 <p>(continuation)</p>
 <p>The closed opponent Black moving first cannot virtual-force a black two-eye-formation on the right ko.</p>	 <p>④ pass.</p> <p>(continuation)</p>	 <p>(continuation)</p>
 <p>Under default restriction rules, the closed opponent Black moving first cannot virtual-force a black two-eye-formation on the right ko.</p>	 <p>④ pass.</p> <p>(continuation)</p>	 <p>⑪ pass, ⑫ pass.</p> <p>Continuation. 10, 11, 12 do not invoke the cycle-end-rule because the cycle does not end at the current-position.</p>

 <p>13 is allowed by the basic-ko-rule and the fixed-ko-rule. 14 and 15 are allowed by the fixed-ko-rule.</p>	 <p>19 pass, 20 pass, 21 pass.</p>	<p>16 to 18 are allowed by the fixed-ko-rule. 19 at 5 is prohibited by the basic-ko-rule and the fixed-ko-rule. 19 at 7 is prohibited by the fixed-ko-rule. 21 at 5 or 7 is prohibited by the fixed-ko-rule. Compare the moves 5 and 13, respectively.</p>
 <p>Example 5B</p>	 <p>The open opponent Black moving first can virtual-force a black two-eye-formation on the right ko.</p>	 <p>The closed player White moving first cannot virtual-force a white two-eye-formation on the right ko.</p>
 <p>(continuation)</p>		

Inactive Disturbing Life

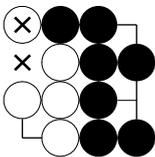
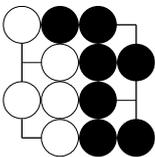
 <p>Example 1: Each of the I kos is an inactive disturbing life. Each of the A kos is an active disturbing life.</p>	 <p>Example 2: Each of the I kos is an inactive disturbing life.</p>
 <p>Example 3A: The ko I is an inactive disturbing life.</p>	 <p>2 pass. The open player Black moving first cannot virtual-force a black two-eye-formation on the ko: Variation 1.</p>
 <p>(continuation)</p>	 <p>Variation 2</p>
 <p>(continuation, then see Variation 1)</p>	 <p>The closed opponent White moving first cannot virtual-force a white two-eye-formation on the ko.</p>

 <p>(continuation)</p>	
 <p>Example 3B</p>	 <p>The closed player Black moving first cannot virtual-force a black two-eye-formation on the ko.</p>
 <p>(continuation)</p>	 <p>2 pass. The open opponent White moving first cannot virtual-force a white two-eye-formation on the ko: Variation 1</p>
 <p>(continuation)</p>	 <p>Variation 2</p>
 <p>(continuation, then see Variation 1)</p>	

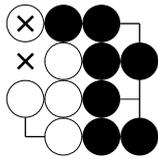
Examples under Positional Superko and 2 Ending Passes

1-Eye-Flaw

The example ko is **not** a **dead ko**.

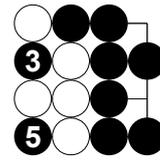
 <p>Counter-example 1: White has just captured in the ko, i.e., the history-bans includes a prohibition to recreate the previous position with a black ko stone.</p>	<p>Due to the given rules, the closed player moving first cannot virtual-force uncapturable life of his on the ko. This contradicts the definition's applied condition that the closed player moving first can virtual-force uncapturable life of his on the ko. - In a different variation, Black might fill an eye of his own but then White would capture him and Black never gets a chance to establish black uncapturable life.</p>	 <p>1 pass, 2 pass.</p>
--	--	--

The example ko is **not** an **active disturbing life**. In the relevant condition, the given rules positional superko and 2 ending passes are overridden by the default restriction rules.



Counter-example 1: White has just captured in the ko, i.e., the history-bans includes a prohibition to recreate the previous position with a black ko stone.

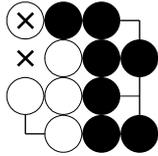
Under default restriction rules, the closed opponent Black moving first **can** virtual-force a black two-eye-formation on the ko. This contradicts the definition's applied condition that, **under default restriction rules,** the closed opponent Black moving first **cannot** virtual-force a black two-eye-formation on the ko.



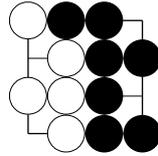
- ① pass,
- ② pass,
- ④ pass.

3 does not end the game by the cycle-end-rule.

The example ko is a **1-eye-flaw**.

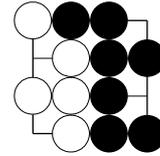


Example 1A: White has just captured in the ko, i.e., the history-bans includes a prohibition to recreate the previous position with a black ko stone.



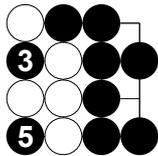
- ① pass.

The open player White moving first cannot virtual-force white uncapturable life on the ko. Note that White does neither have a two-eye-formation nor an uncapturable string on both intersections of the ko.



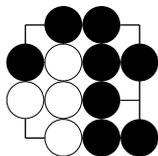
- ① pass.

The closed opponent Black moving first cannot virtual-force black uncapturable life on the ko.

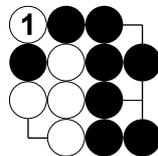


- ① pass,
- ② pass,
- ④ pass.

Under default restriction rules, the closed opponent Black moving first **can** virtual-force black uncapturable life on the ko. 3 does not end the game by the cycle-end-rule.

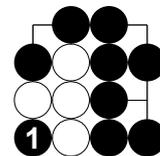


Example 1B



- ② pass,
- ③ pass.

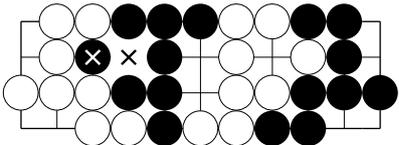
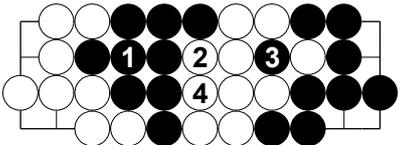
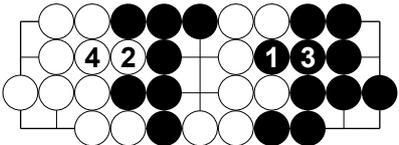
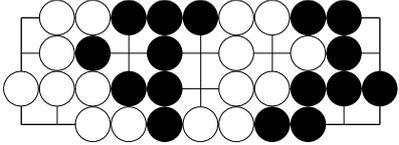
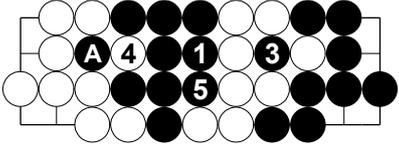
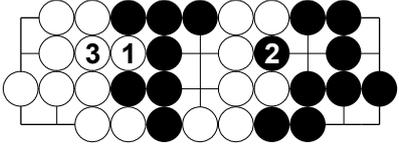
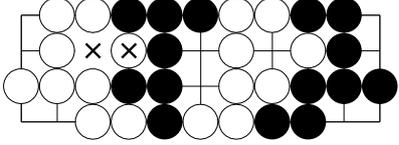
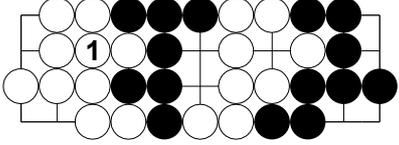
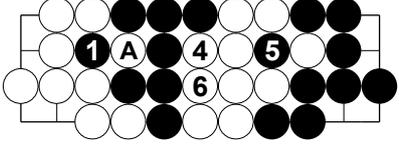
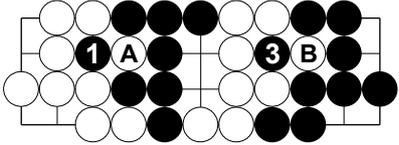
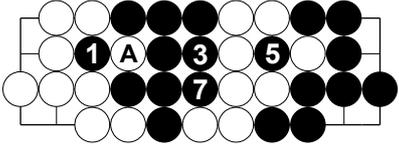
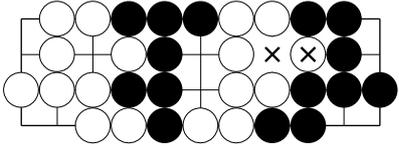
The closed player White moving first cannot virtual-force white uncapturable life on the ko. Note that White does neither have a two-eye-formation nor an uncapturable string on both intersections of the ko.

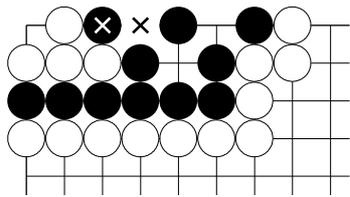


- ①

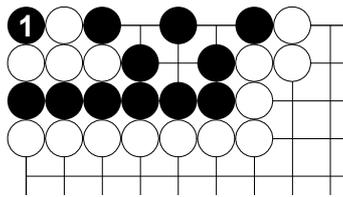
The open opponent Black moving first **can** virtual-force black uncapturable life on the ko.

Dead Ko

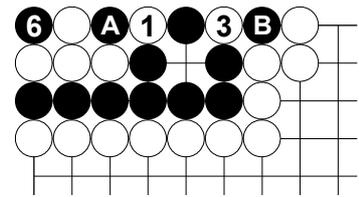
 <p>Example 1A. The considered ko is marked.</p>	 <p>The open opponent Black moving first cannot virtual-force black uncaptureable life on the left ko: Variation 1.</p>	 <p>Variation 2. At 3, virtual-force does not allow Black to recapture on 4 because the ko-capture 2 was preceded by Black's ko-capture 1 elsewhere.</p>
 <p>① pass, ② pass.</p> <p>Variation 3. Black has not got uncaptureable life on the left ko because there is neither a two-eye-formation nor an uncaptureable string, which would cover both intersections of the ko.</p>	 <p>② pass, ⑥ at A.</p> <p>Variation 4. At 5, virtual-force does not allow Black to recapture on A because the ko-capture 4 was preceded by Black's ko-capture 3 elsewhere.</p>	 <p>The closed player White moving first can virtual-force white uncaptureable life on the ko.</p>
 <p>Example 1B. The considered ko is marked.</p>	 <p>The open player White moving first can virtual-force white uncaptureable life on the ko.</p>	 <p>② pass, ③ at A.</p> <p>The closed opponent Black moving first cannot virtual-force black uncaptureable life on the left ko: Variation 1.</p>
 <p>② pass, ④ at A, ⑤ at B, ⑥ at ①.</p> <p>Variation 2. At 5, virtual-force does not allow Black to recapture on 1 because the ko-capture 4 was preceded by Black's ko-capture 3 elsewhere.</p>	 <p>② pass, ④ pass, ⑥ at A, ⑧ at ①.</p> <p>Variation 3. At 7, virtual-force does not allow Black to recapture on 1 because the ko-capture 6 was preceded by Black's ko-capture 5 elsewhere.</p>	<p>By symmetry, also the right ko is a dead ko.</p>
 <p>Counter-example 2. The considered ko is marked.</p>	<p>See under double disturbing death.</p>	



Example 3A. The considered ko is marked.

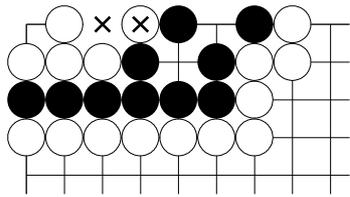


The open player Black moving first can virtual-force black uncapturable life on the ko.

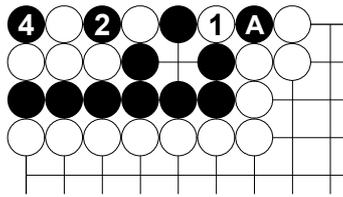


2 pass, 4 at A, 5 at B.

The closed opponent White moving first **cannot** virtual-force white uncapturable life on the ko. At 5, virtual-force does not allow White to recapture on 1 because the ko-capture 4 was preceded by White's ko-capture 3 elsewhere.

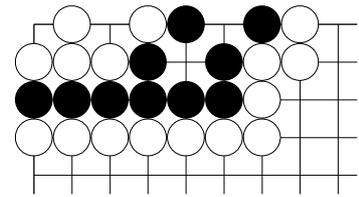


Example 3B. The considered ko is marked.



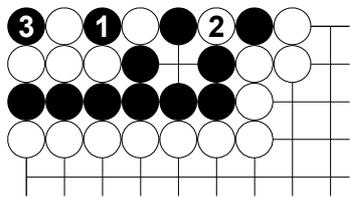
3 at A.

The open opponent White moving first **cannot** virtual-force white uncapturable life on the ko: Variation 1. At 3, virtual-force does not allow White to recapture the ko-capture 2 because it was preceded by White's ko-capture 1 elsewhere.

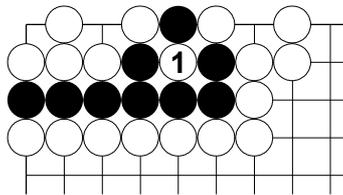


1 pass, 2 pass.

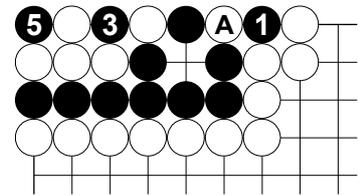
Variation 2. White has not got uncapturable life on the left ko.



The closed player Black moving first can virtual-force black uncapturable life on the ko.

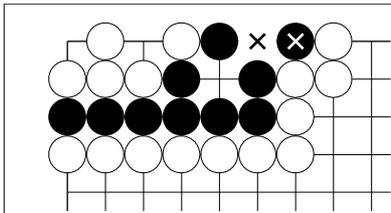


The open player White moving first can virtual-force white uncapturable life on the ko.

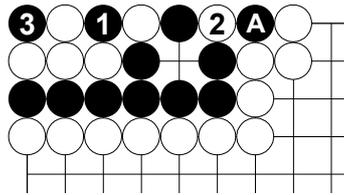


2 pass, 4 at A, 5 at 1.

The closed opponent Black moving first **cannot** virtual-force black uncapturable life on the ko. At 5, virtual-force does not allow Black to recapture on 1 because the ko-capture 4 was preceded by Black's ko-capture 3 elsewhere.

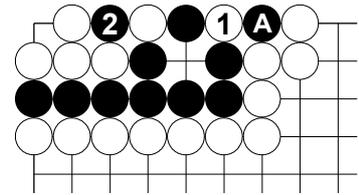


Example 4B. The considered ko is marked.



④ at A.

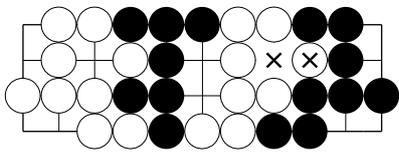
The open opponent Black moving first **cannot** virtual-force black uncaptureable life on the ko. At 3, virtual-force does not allow Black to recapture on A because the ko-capture 2 was preceded by Black's ko-capture 1 elsewhere.



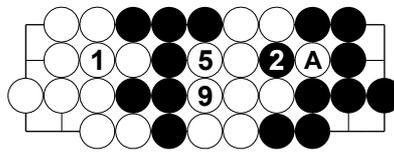
③ at A.

The closed player White moving first can virtual-force white uncaptureable life on the ko.

Double Disturbing Death

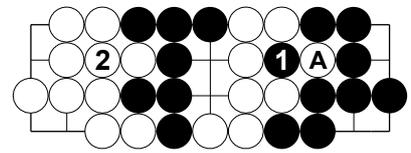


Example 1A. The considered ko is marked.



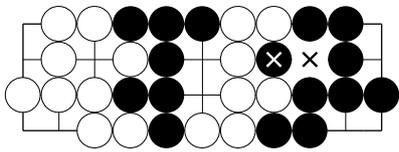
③ at A, ④ pass, ⑥ at ②, ⑦ at A, ⑧ pass, ⑩ at ②, ⑪ at A, ⑫ pass, ⑬ at ②.

The open opponent White moving first can virtual-force white uncaptureable life on the ko. At 3, 7, 11, virtual-force allows White to recapture immediately.

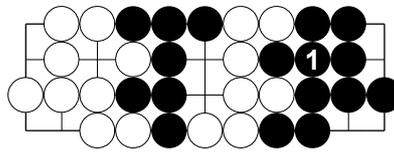


③ at A.

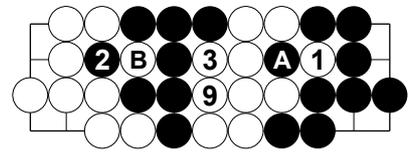
The closed player Black moving first can virtual-force black uncaptureable life on the ko.



Example 1B. The considered ko is marked.

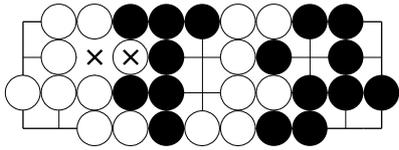


The open player Black moving first can virtual-force black uncaptureable life on the ko.

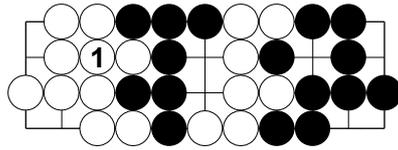


④ at A, ⑤ at ①, ⑥ pass, ⑦ at B, ⑧ at A, ⑩ at ①.

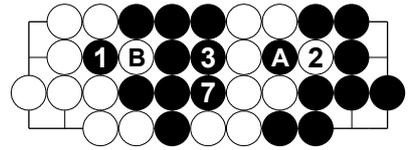
The closed opponent White moving first **cannot** virtual-force white uncaptureable life on the right ko. At 5, virtual-force allows White to recapture immediately. At 9, virtual-force does not allow White to recapture immediately after the ko-capture 8 because White's preceding play 7 has been a ko-capture.



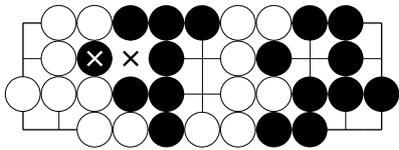
Example 2A. The considered ko is marked. (By symmetry, the right ko is also a double disturbing death.)



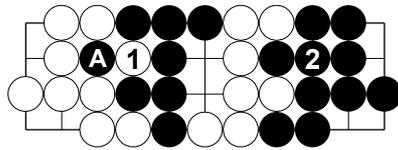
The open player White moving first can virtual-force white uncapturable life on the left ko.



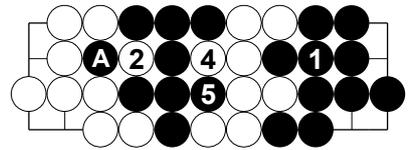
④ pass, ⑤ at A, ⑥ at B, ⑧ at ①. The closed opponent Black moving first **cannot** virtual-force black uncapturable life on the left ko. 2 is White's strongest move. 3 is stronger than any so called tenuki elsewhere. At 7, virtual-force does not allow Black to recapture immediately after the ko-capture 6 because Black's preceding play 5 has been a ko-capture.



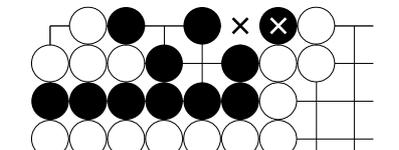
Example 2B. The considered ko is marked.



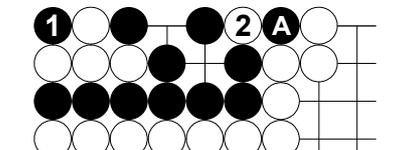
③ at A. The closed player White moving first can virtual-force white uncapturable life on the left ko.



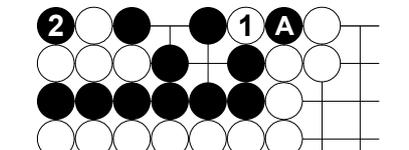
③ at A, ⑥ at ②, ⑦ at A, ⑧ pass, ⑨ at ②. The open opponent Black moving first can virtual-force black uncapturable life on the left ko. At 3 and 7, virtual-force allows Black to recapture immediately.



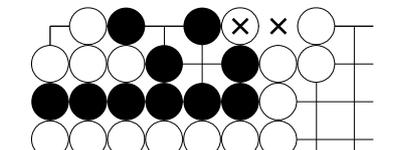
Example 3A. The considered ko is marked.



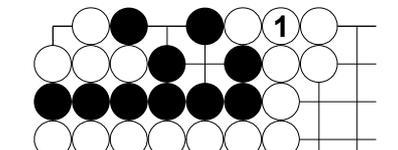
③ at A, ④ pass, ⑤ at ②. The open opponent Black moving first can virtual-force black uncapturable life on the right ko. At 3, virtual-force allows Black to recapture immediately.



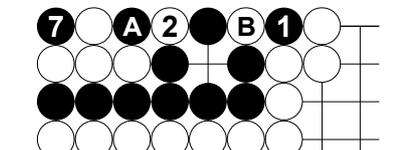
③ at A. The closed player White moving first can virtual-force white uncapturable life on the right ko.



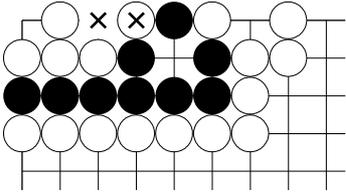
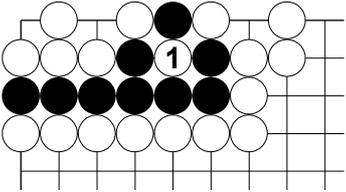
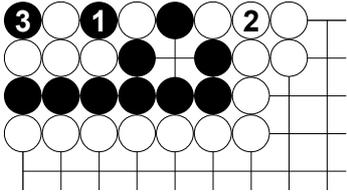
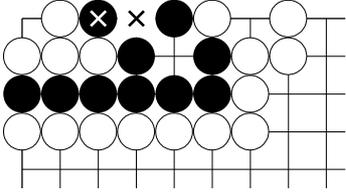
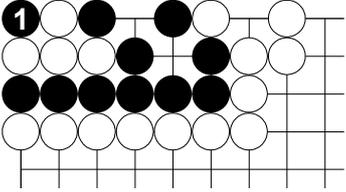
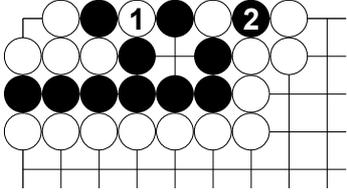
Example 3B. The considered ko is marked.



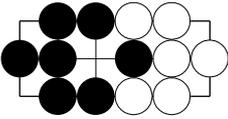
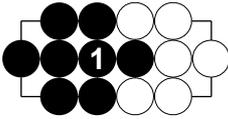
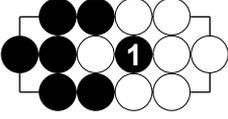
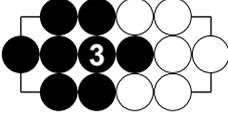
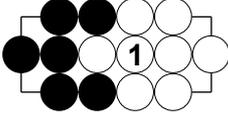
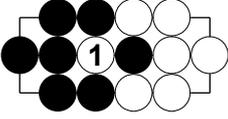
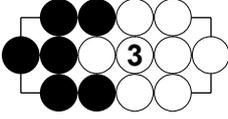
The open player White moving first can virtual-force white uncapturable life on the right ko.

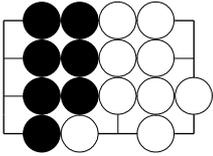
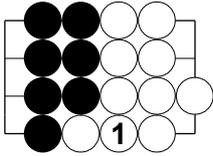
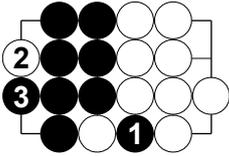
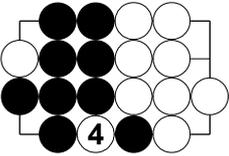
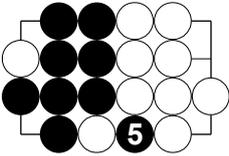
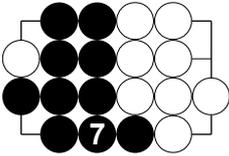
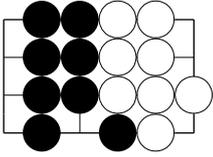
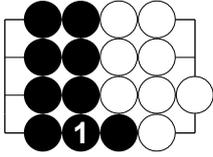
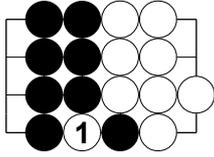
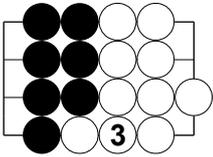
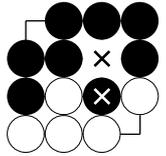
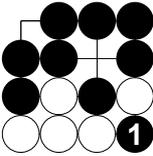
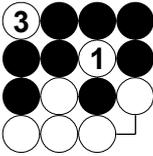


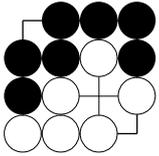
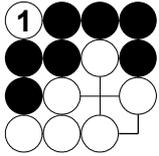
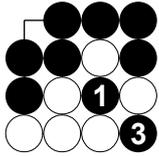
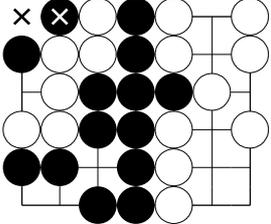
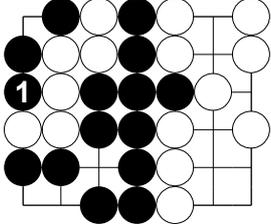
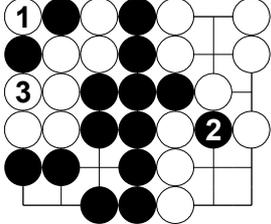
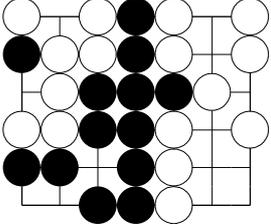
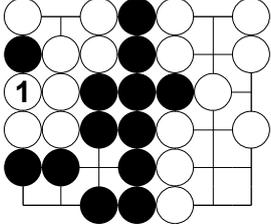
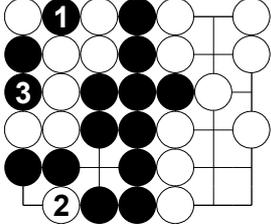
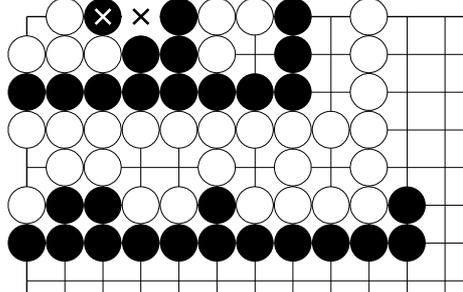
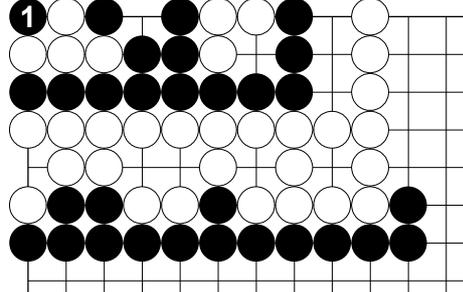
④ pass, ⑤ at A, ⑥ at B, ⑧ at ①. The closed opponent Black moving first **cannot** virtual-force black uncapturable life on the right ko. At 7, virtual-force does not allow Black to recapture immediately after the ko-capture 6 because Black's preceding play 5 has been a ko-capture.

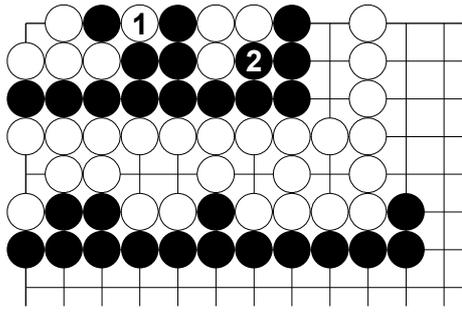
 <p>Example 4A. The considered ko is marked.</p>	 <p>The open opponent White moving first can virtual-force white uncapturable life on the left ko.</p>	 <p>The closed player Black moving first can virtual-force black uncapturable life on the left ko.</p>
 <p>Example 4B. The considered ko is marked.</p>	 <p>The open player Black moving first can virtual-force black uncapturable life on the left ko.</p>	 <p>③ pass, ④ pass. The closed opponent White moving first cannot virtual-force white uncapturable life on the left ko. If White plays 3 as a so called tenuki instead, it does not help, either.</p>

Fighting Ko

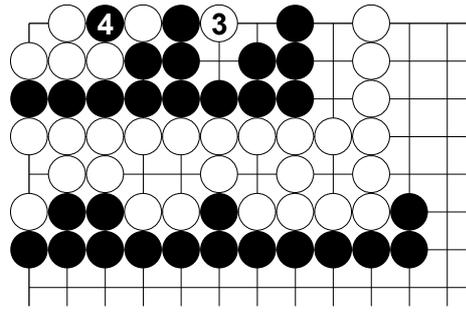
 <p>Example 1</p>		 <p>② pass, ③ pass. The open player Black moving first can virtual-force black uncapturable life on the ko.</p>
 <p>② pass. The closed player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>④ pass, ⑤ pass. (continuation)</p>	 <p>② pass, ③ pass. The open opponent White moving first can virtual-force white uncapturable life on the ko.</p>
 <p>② pass. The closed opponent White moving first can virtual-force white uncapturable life on the ko.</p>	 <p>④ pass, ⑤ pass. (continuation)</p>	

 <p>Example 2A.</p>	 <p>The open player White moving first can virtual-force white uncapturable life on the ko.</p>	 <p>The closed opponent Black moving first can virtual-force black uncapturable life on the ko.</p>
 <p>(continuation)</p>	 <p>(continuation) 6 pass. Virtual-force allows Black, who is the one virtual-forcing, immediate recapture on the ko. White does not have this privilege.</p>	 <p>(continuation)</p>
 <p>Example 2B</p>	 <p>The open opponent Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>2 pass. The closed player White moving first can virtual-force white uncapturable life on the ko.</p>
 <p>(continuation)</p>		
 <p>Example 3A. The considered ko is marked.</p>	 <p>The open player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>2 pass. The closed opponent White moving first can virtual-force white uncapturable life on the ko. It is immaterial for the definition of fighting ko whether the pass Black 2 is a so called ko threat.</p>

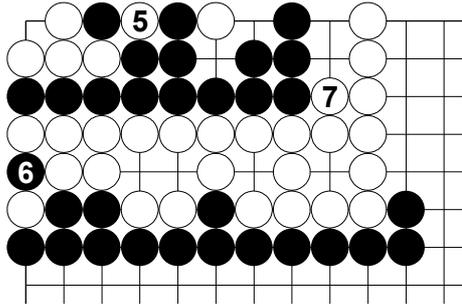
 <p>Example 3B</p>	 <p>The open opponent White moving first can virtual-force white uncapturable life on the ko.</p>	 <p>The closed player Black moving first can virtual-force black uncapturable life on the ko.</p>
 <p>Example 4A. The considered ko is marked. It is a ko; the definition of fighting ko is not interested in traditional titles like bent-4-in-the-corner.</p>	 <p>The open player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>The closed opponent White moving first can virtual-force white uncapturable life on the ko. It is immaterial for the definition of fighting ko whether Black 2 makes a so called ko threat on the board.</p>
 <p>Example 4B.</p>	 <p>The open opponent White moving first can virtual-force white uncapturable life on the ko.</p>	 <p>The closed player Black moving first can virtual-force black uncapturable life on the ko. It is immaterial for the definition of fighting ko whether White 2 plays somewhere else on the board.</p>
 <p>Example 5A. The considered ko is marked. It is a so called approach ko with so called internal ko threats.</p>	 <p>The open player Black moving first can virtual-force black uncapturable life on the ko.</p>	



The closed opponent White moving first can virtual-force white uncapturable life on the ko.

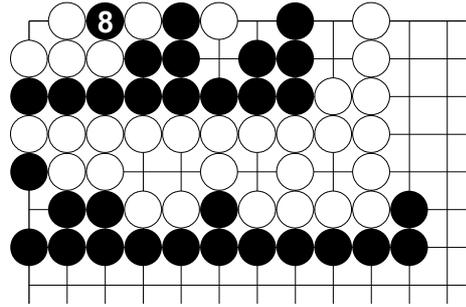


(continuation)

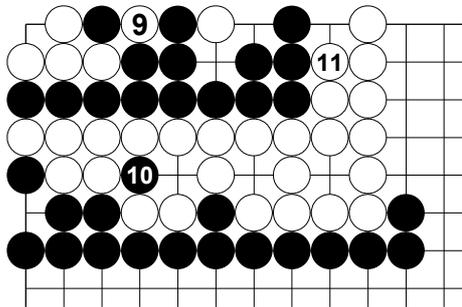


(continuation)

At 5, virtual-force allows White, who is the one virtual-forcing, immediate recapture on the ko. Black does not have this privilege. White ignores 6 because the definition of fighting ko does not require him to answer a so called ko threat.

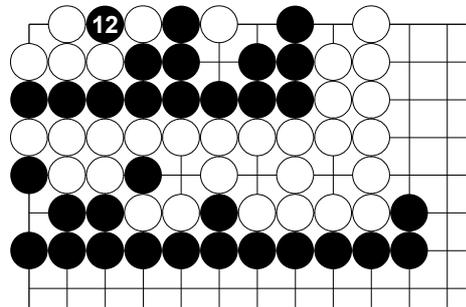


(continuation)

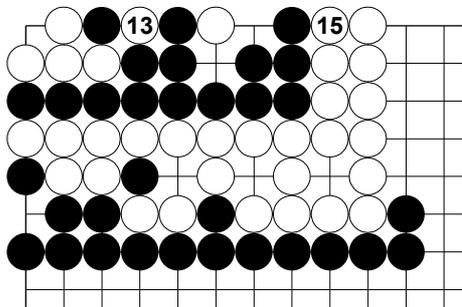


(continuation)

At 9, virtual-force allows White, who is the one virtual-forcing, immediate recapture on the ko. White ignores 10.



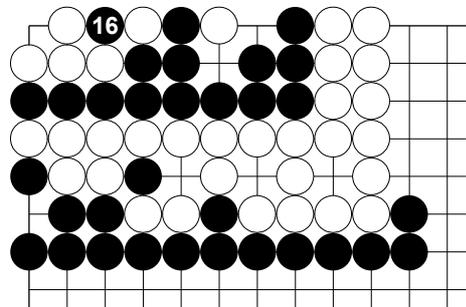
(continuation)



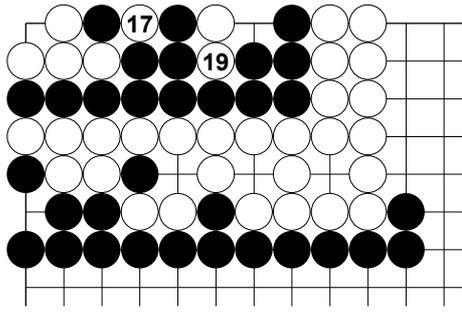
14 pass.

(continuation)

At 13, virtual-force allows White, who is the one virtual-forcing, immediate recapture on the ko.



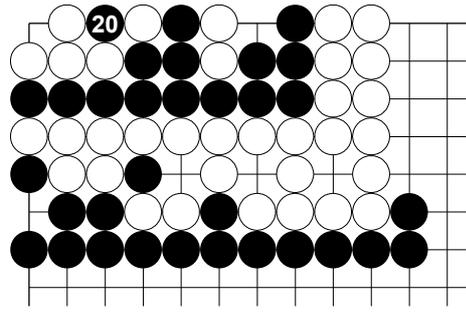
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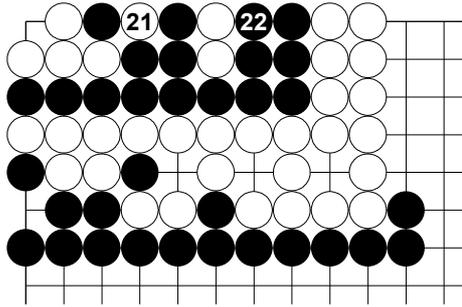
18 pass.

(continuation)

At 17, virtual-force allows White, who is the one virtual-forcing, immediate recapture on the ko.

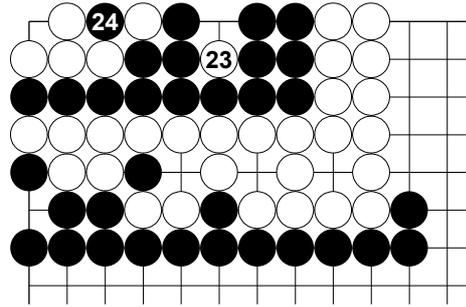


(continuation)

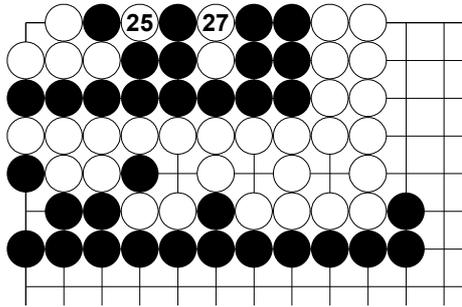


(continuation)

At 21, virtual-force allows White, who is the one virtual-forcing, immediate recapture on the ko.



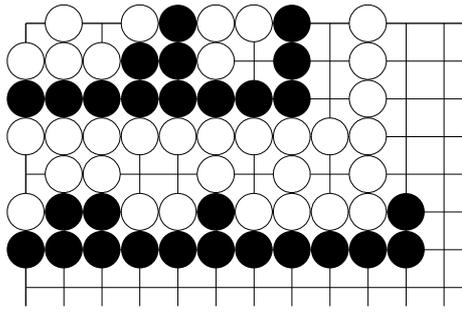
(continuation)



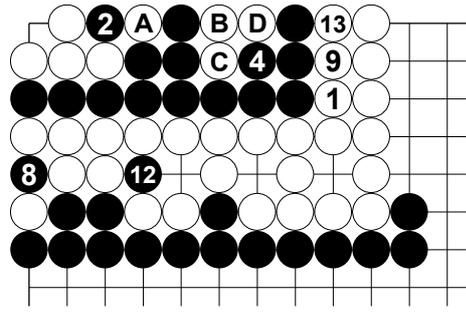
26 pass.

(continuation)

At 25, virtual-force allows White, who is the one virtual-forcing, immediate recapture on the ko.

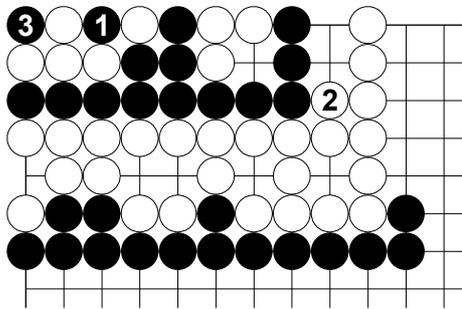


Example 5B

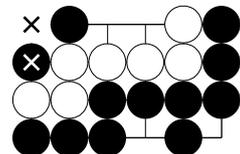


3 at A, 5 at B, 6 at 2, 7 at A, 10 at 2,
 11 at A, 14 at 2, 15 at A, 16 pass, 17 at C,
 18 at 2, 19 at A, 20 at D, 21 at C, 22 at 2,
 23 at A, 24 pass, 25 at B.

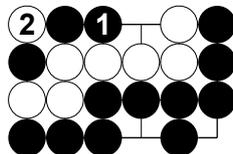
The open opponent White moving first can virtual-force white uncapturable life on the ko. Virtual-force allows White, who is the one virtual-forcing, immediate recapture on the ko at A.



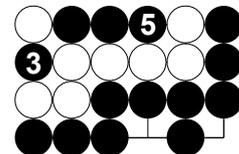
The closed player Black moving first can virtual-force black uncapturable life on the ko.



Example 6A. This is a ko with a so called internal approach play.



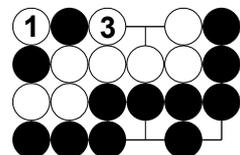
The open player Black moving first can virtual-force black uncapturable life on the ko.



4 pass.

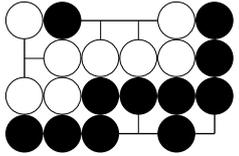
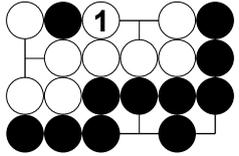
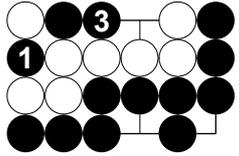
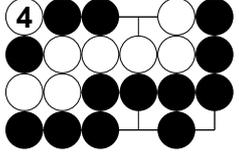
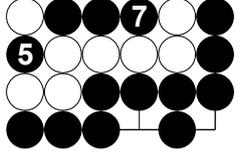
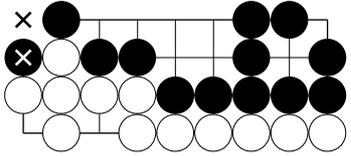
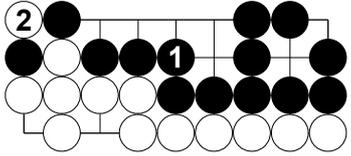
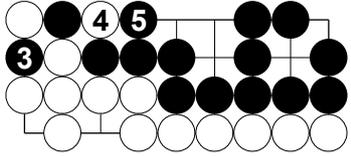
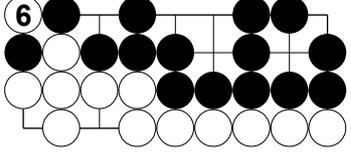
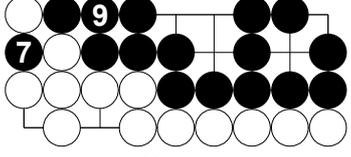
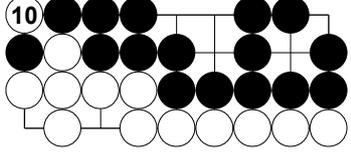
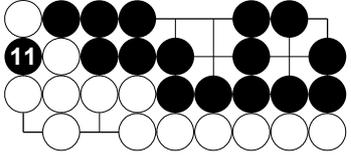
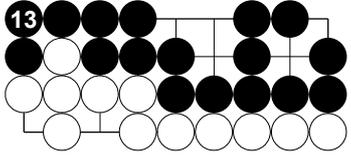
(continuation)

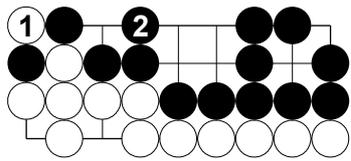
At 3, virtual-force allows Black, who is the one virtual-forcing, immediate recapture on the ko.



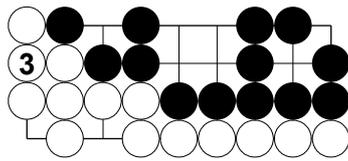
2 pass.

The closed opponent White moving first can virtual-force white uncapturable life on the ko.

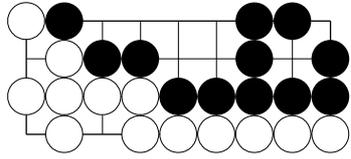
 <p>Example 6B</p>	 <p>The open opponent White moving first can virtual-force white uncaptureable life on the ko.</p>	 <p>② pass. The closed player Black moving first can virtual-force black uncaptureable life on the ko.</p>
 <p>(continuation)</p>	 <p>⑥ pass. (continuation) At 5, virtual-force allows Black, who is the one virtual-forcing, immediate recapture on the ko.</p>	
 <p>Example 7A. This is a ko with so called teire approach plays. In a practical game on a big board, Black might have some so called ko threats more than White.</p>	 <p>The open player Black moving first can virtual-force black uncaptureable life on the ko.</p>	 <p>(continuation) At 3, virtual-force allows Black, who is the one virtual-forcing, immediate recapture on the ko.</p>
 <p>(continuation)</p>	 <p>⑧ pass. (continuation) At 7, virtual-force allows Black, who is the one virtual-forcing, immediate recapture on the ko.</p>	 <p>(continuation)</p>
 <p>⑫ pass. (continuation) At 11, virtual-force allows Black, who is the one virtual-forcing, immediate recapture on the ko.</p>	 <p>(continuation)</p>	



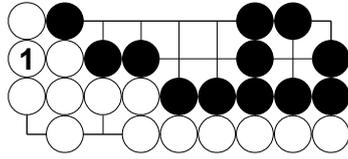
The closed opponent White moving first can virtual-force white uncapurable life on the ko.



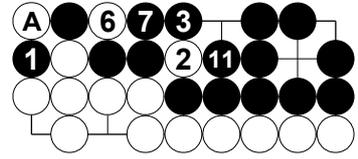
(continuation)



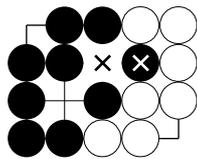
Example 7B



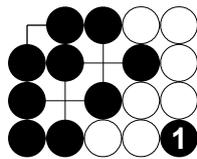
The open opponent White moving first can virtual-force white uncapurable life on the ko.



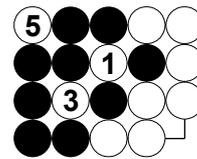
4 at A, 5 at 1, 8 at A, 9 at 1, 10 pass, 12 at A, 13 at 1, 14 pass, 15 at 6, 16 at A, 17 at 1, 18 pass, 19 at A.
The closed player Black moving first can virtual-force black uncapurable life on the ko. At 5, 9, 13, 17, virtual-force allows Black, who is the one virtual-forcing, immediate recapture on the ko.



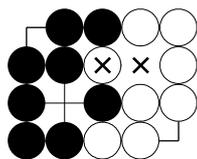
Example 8A. This ko is a so called 2-stage ko.



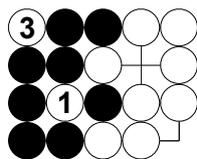
The open player Black moving first can virtual-force black uncapurable life on the ko.



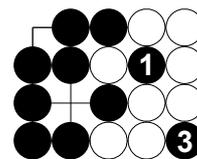
2 pass, 4 pass.
The closed opponent White moving first can virtual-force white uncapurable life on the ko.



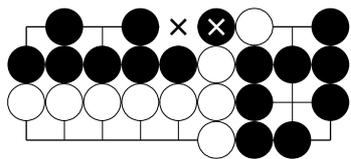
Example 8B. The considered ko is marked.



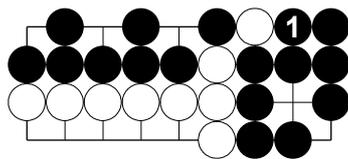
2 pass.
The open opponent White moving first can virtual-force white uncapurable life on the ko.



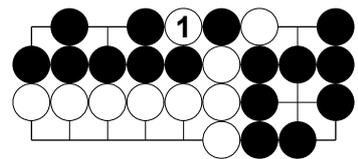
2 pass.
The closed player Black moving first can virtual-force black uncapurable life on the ko.



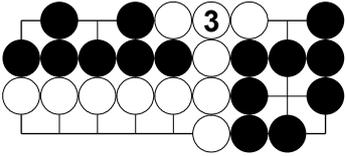
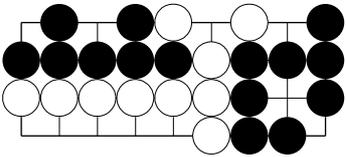
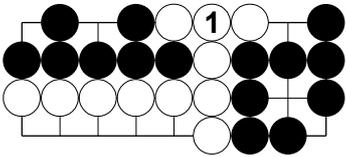
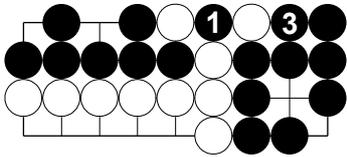
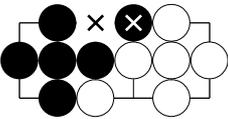
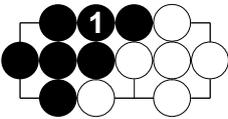
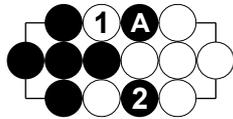
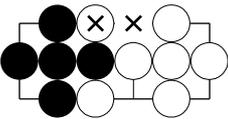
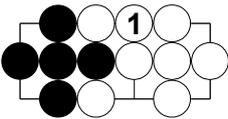
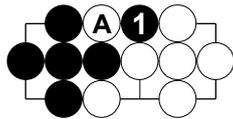
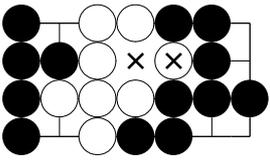
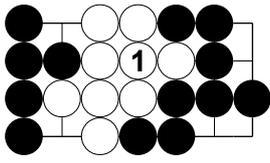
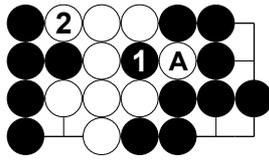
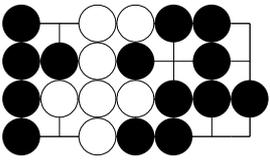
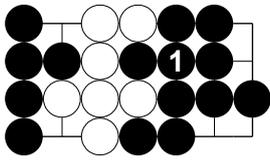
Example 9A

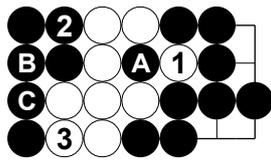


The open player Black moving first can virtual-force black uncapurable life on the ko.



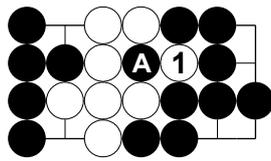
2 pass.
The closed opponent White moving first can virtual-force white uncapurable life on the ko.

 <p>(continuation)</p>		
 <p>Example 9B</p>	 <p>The open opponent White moving first can virtual-force white uncapturable life on the ko.</p>	 <p>② pass. The closed player Black moving first can virtual-force black uncapturable life on the ko.</p>
 <p>Example 10A. The considered ko is marked.</p>	 <p>The open player Black moving first can virtual-force black uncapturable life on the upper ko.</p>	 <p>③ at A. The closed opponent White moving first can virtual-force white uncapturable life on the upper ko.</p>
 <p>Example 10B. The considered ko is marked.</p>	 <p>The open opponent White moving first can virtual-force white uncapturable life on the upper ko.</p>	 <p>② pass, ③ at A. The closed player Black moving first can virtual-force black uncapturable life on the upper ko.</p>
 <p>Example 11A. This is ko is next to a so called seki shape.</p>	 <p>The open player White moving first can virtual-force white uncapturable life on the ko.</p>	 <p>③ at A. The closed opponent Black moving first can virtual-force black uncapturable life on the ko.</p>
 <p>Example 11B</p>	 <p>The open opponent Black moving first can virtual-force black uncapturable life on the ko.</p>	<p>The closed player White moving first can virtual-force white uncapturable life on the ko:</p>



④ at A, ⑤ at ①,
⑥ at B, ⑦ at C, ⑧ at A,
⑨ at ①, ⑩ pass, ⑪ at A.

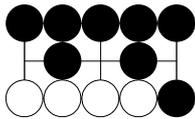
Variation 1. At 5 and 9, virtual-force allows White, who is the one virtual-forcing, immediate recapture on the ko.



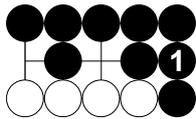
② pass, ③ at A.

Variation 2.

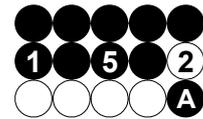
In an actual game, Black to move would try to fight and win the ko to get seki. White to move would first dissolve the seki and leave the ko for much later to be fought as a so called basic endgame ko. After White's seki dissolving play, Black's privilege of ko-capturing once in so called sente does not dissolve the ko yet either and Black will also leave the ko for a late so called endgame fight about it. Hence fighting ko is a good assessment of ko type.



Example 12A. This is a so called seki with a so called internal ko.

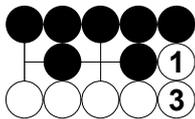


The open player Black moving first can virtual-force black uncapturable life on the ko. Variation 1.



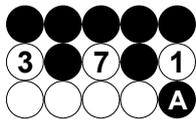
③ at A, ④ pass.

Variation 2. At 3, virtual-force allows Black to recapture immediately.



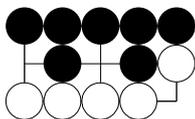
② pass.

The closed opponent White moving first can virtual-force white uncapturable life on the ko: Variation 1.

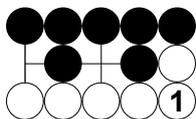


② pass, ④ at A,
⑤ at ①,
⑥ pass.

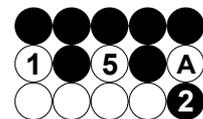
Variation 2. At 5, virtual-force allows White to recapture immediately.



Example 12B

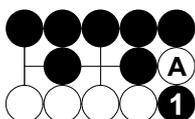


The open opponent White moving first can virtual-force white uncapturable life on the ko: Variation 1.



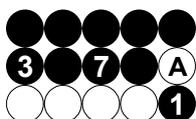
③ at A, ④ pass.

Variation 2. At 3, virtual-force allows White to recapture immediately.



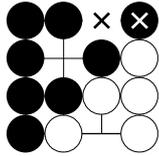
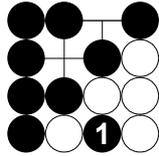
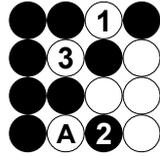
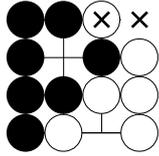
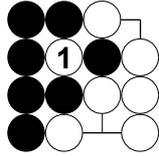
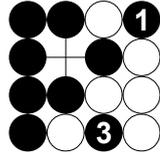
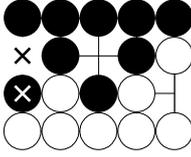
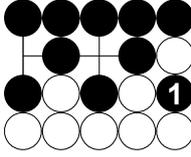
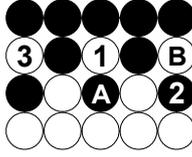
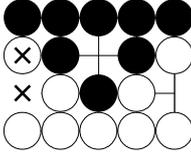
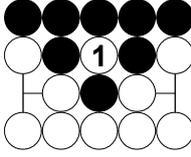
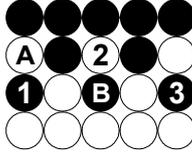
② pass, ③ at A.

The closed player Black moving first can virtual-force black uncapturable life on the ko. Variation 1.



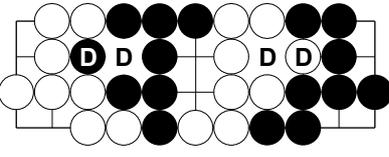
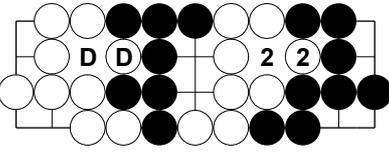
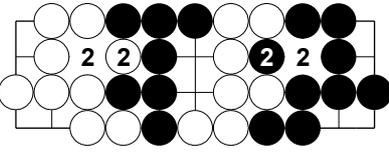
② pass, ④ at A,
⑤ at ①,
⑥ pass.

Variation 2. At 5, virtual-force allows Black to recapture immediately.

 <p>Example 13A. This is a so called pendulum ko.</p>	 <p>The open player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>④ pass, ⑤ at A.</p> <p>The closed opponent White moving first can virtual-force white uncapturable life on the ko.</p>
 <p>Example 13B. The considered ko is marked. - Note: Also the lower ko is a fighting ko.</p>	 <p>The open opponent White moving first can virtual-force white uncapturable life on the ko.</p>	 <p>② pass.</p> <p>The closed player Black moving first can virtual-force black uncapturable life on the ko.</p>
 <p>Example 14A. This is a so called triple ko. The considered ko is marked. - Notes: On the right, there is currently no ko. Every ko temporarily occurring as such in a triple ko is a fighting ko.</p>	 <p>The open player Black moving first can virtual-force black uncapturable life on the ko.</p>	 <p>④ at A, ⑤ at B, ⑥ pass, ⑦ at ①.</p> <p>The closed opponent White moving first can virtual-force white uncapturable life on the ko. At 6, positional superko prohibits Black to ko-capture 3.</p>
 <p>Example 14B. The considered ko is marked.</p>	 <p>The open opponent White moving first can virtual-force white uncapturable life on the ko.</p>	 <p>④ at A, ⑤ at B, ⑥ pass, ⑦ at ①.</p> <p>The closed player Black moving first can virtual-force black uncapturable life on the ko. At 6, positional superko prohibits White to ko-capture 3.</p>

Summary of Shapes with Changing Ko Types due to Ko-Captures Elsewhere

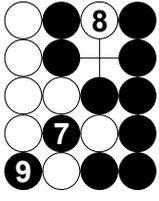
D = dead ko
2 = double disturbing death

		
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Examples for Molasses Ko

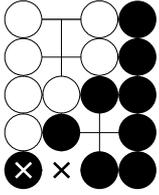
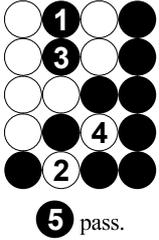
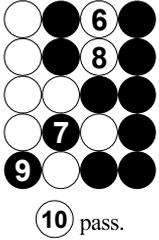
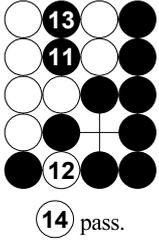
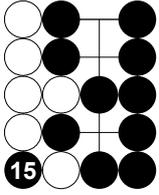
Verification of Semi-Stable Ko

 <p>Example 1</p>	 <p>Under default restriction rules, Black moving first cannot play-force black uncapurable life on the ko.</p>	 <p>(continuation)</p>
 <p>5 pass. Under default restriction rules, the open player Black moving first can pass-force a cycle.</p>	 <p>(continuation)</p>	 <p>5 pass, 6 pass. Under default restriction rules and if White does not cooperate with creating a cycle, the open player Black moving first can pass-force black uncapurable life on the ko.</p>

 <p>Continuation. 7 does not end the game by the cycle-end-rule.</p>	<p>Conclusion: The ko is a semi-stable ko.</p>	
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Basic-Fixed-Ko Rules and 3 Ending Passes

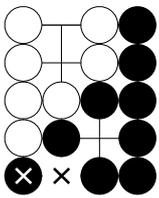
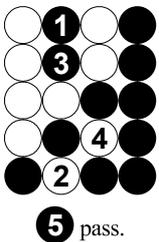
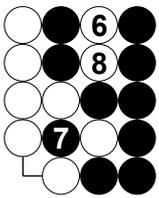
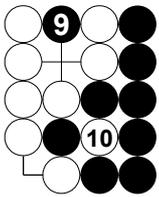
The molasses ko is a molasses open kill.

 <p>Example 1</p>	 <p>5 pass. The open player Black moving first can force black uncapturable life on the ko.</p>	 <p>10 pass. (continuation)</p>
 <p>14 pass. (continuation)</p>	 <p>15 (continuation)</p>	<p>In particular the same sequence shows that the closed opponent White moving second cannot force white uncapturable life on the ko.</p>

Note: The closed player Black moving first cannot force black uncapturable life on the ko. This, however, is immaterial for the definition and is not shown here.

Positional Superko and 2 Ending Passes

The molasses ko is a molasses closed kill.

 <p>Example 1</p>	 <p>5 pass. The open player Black moving first cannot force black uncapturable life on the ko.</p>	 <p>(continuation)</p>
 <p>(continuation)</p>	<p>In particular the same sequence shows that the closed opponent White moving second can force white uncapturable life on the ko.</p>	

Notes: The closed player Black moving first cannot force black uncapturable life on the ko. This, however, is immaterial for the definition and is not shown here. Under 3 successive ending passes, the closed player Black moving first can force black uncapturable life on the ko.

Situational Superko and 2 Ending Passes

The molasses ko is a molasses life.

<p>Example 1</p>	<p>5 pass.</p> <p>The open player Black moving first cannot force black uncapturable life on the ko.</p>	<p>10 pass.</p> <p>(continuation) Move 9 is legal: Just after move 9, it is White's turn. Just before move 1, it was Black's turn.</p>
<p>13 pass.</p> <p>(continuation)</p>	<p>5 pass.</p> <p>The closed opponent White moving second cannot force white uncapturable life on the ko.</p>	<p>10 pass, 11 pass.</p> <p>(continuation) Move 9 is legal: Just after move 9, it is White's turn. Just before move 1, it was Black's turn.</p>

Notes: The closed player Black moving first cannot force black uncapturable life on the ko. This, however, is immaterial for the definition and is not shown here. Under 3 successive ending passes, the closed player Black moving first can force black uncapturable life on the ko.

Changes Log

Versions 7-11

- Default restriction rules and their rules.
- Correct examples and their comments accordingly.
- Alter remark about big kos.

Version 6

- Parts of the preface.
- Remove informal descriptions of ko rules.
- Definitions of active / inactive disturbing life: replace uncapturable life by two-eye-formation.
- Correct propositions, comments on example diagrams and other details accordingly.
- Remove top-down approach.

Version 5

- First published version.