

What is this, and how can you help?

The following pages contain a short and dense article about a board game. I am writing this (and similar texts for some other games) for basically two reasons:

1. I want to popularise cool board games which are less popular than they should be.
2. There are many accounts (books, online pages etc.) that just give the rules. In order to encourage more people to give them a shot, I'd like to go into a little depth: elementary tactics, problems etc. Hopefully, this helps drawing some future players!

I'm a moderately advanced Go player (1 dan) but not nearly an expert on any of the games I am writing about. Therefore, I will be happy and very grateful for all kinds of feedback. If you think I am way off the mark, please tell me! Remember, the more specific your feedback, the more I can improve the article.

Here are some features that the text is still lacking, but ideally would have:

1. **Problems:** Please have a good look at the problems in the text. Are they well-posed? Do you have ideas for other and/or better problems? (Customarily, problems have unique solutions. I'm not even sure if my current problems have this property.)
2. **More heuristics:** good strategy games have heuristics that allow players to break up the complexity into more manageable pieces. There's not much literature on these games, so I've been starting out in the most simple fashion. If you are using other concepts in your games, please tell me!
3. **Example positions:** if you have encountered a particularly surprising move (by yourself, an opponent, or someone else), feel free to send me the position; most easily as screenshot or LittleGolem link.

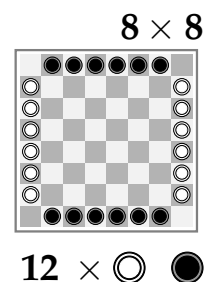
I already got some feedback through LG and BGG, and the articles have greatly benefited from that. If you would like to comment, these are the best options:

- right in this thread,
- an email to dploog@math.fu-berlin.de. Please mention the game in the subject.

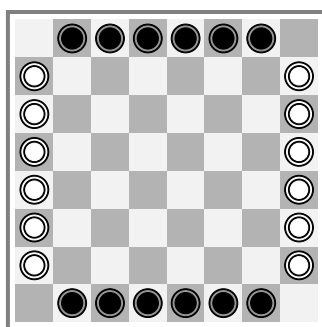
Many thanks for reading this!

May 16, 2019

LINES OF ACTION



The game takes place on a checkered 8×8 board, with 12 black and white stones. Initial position: the black stones are on the top and bottom rows, the white stones on the left-most and right-most columns; the corner squares being free. A *clump* is a maximal set of connected pieces of one colour (called a chain elsewhere in this book). The basic goal is get one's stones into a single clump.



initial position

Black begins. The turn of a player consists of **moving** a stone of that colour, where

- movement is along a straight line, vertical or horizontal or diagonal;
- length of the move in a direction is the number of *all* stones on that line;
- the moving stone may jump over, but not land on, stones of that colour;
- the moving stone may end on, but not jump over, stones of the other colour;
- ending on a square with an opposing stone **captures** that stone.

Win and loss conditions are checked in this order:

1. Loss: a player is unable to move.
2. Loss: a player's move causes a repeated position.
3. Win by unification: the player's move creates a single clump.

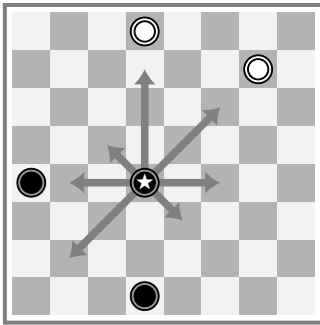


Remarks about the rules

- If a stone is alone on a line, it can move to an adjacent square in that direction.
- The inventor Claude Soucie made clear his dislike of draws. The above rules reflect this, declaring stalemate and repeated position as losses, and simultaneous unification as win for the moving player.
- A player wins by having a single, movable stone on the board. In other word, capturing the penultimate stone without forming a single chain gives the win away.
- Almost all games end positively, with one side forming a single chain. Stalemate and simultaneous unification sometimes come up.

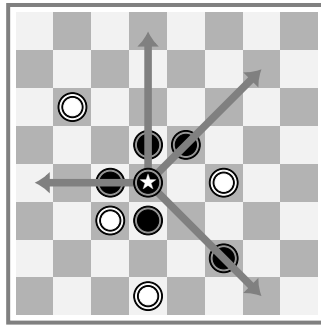
Claude Soucie (1962 (?))

Diagrams explaining the rules



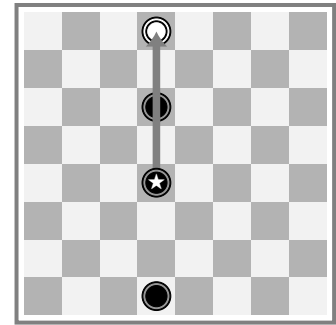
All movement options for ♀.

Stones can move in any direction, by exactly the number of stones on that line.



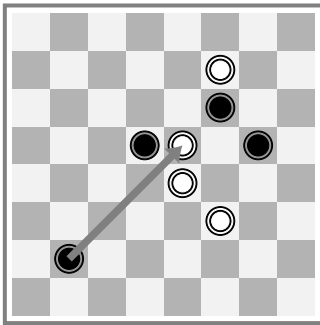
All movement options for ♀.

A stone can jump over pieces of the same colour but not over opposing pieces.

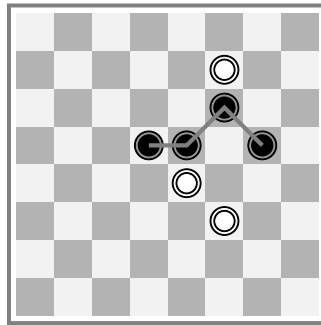


A capturing move of ♀.

A stone can jump on and capture opposing pieces, but cannot jump on pieces of the same colour.



before



after

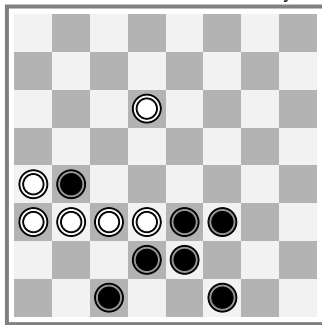
Black wins: this move unifies all black stones into a single chain.

If a capturing move simultaneously unifies the stones of both colours, this is a win for the active player.

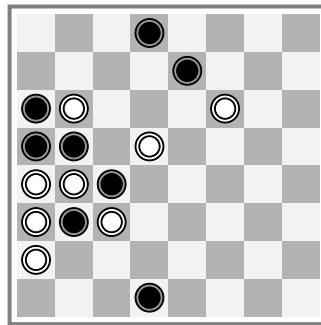


Three easy endgame problems.

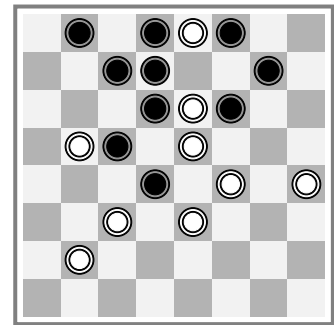
As a first practice with the rules and especially the winning condition, consider these three positions. If you find the first move, the rest will be easy.



Problem 1. White to play



Problem 2. White to play



Problem 3. Black to play

Two fundamental principles

In traditional parlance of LINES OF ACTION, maximally connected chains of stones of one colour are called *clumps*. So each side has two clumps initially, and the game is won by achieving a single clump. This does not mean that players should avoid moves breaking up their clumps. These are the two basic lessons:

1. Capturing opposing stones is often a good idea.
2. The initial lines of stones are very weak.

Material advantage is valuable. The following line of thought is natural, but misleading: because it is seemingly easier to unify a smaller number of stones, you should hesitate to capture opposing stones, and rejoice when your own stones are captured. However, this is almost completely wrong! While there are cases when a capturing move is bad, very often material superiority is desirable: with more pieces, you have higher mobility (more pieces to move), better defense (more pieces to block with) and greater flexibility (more ways to connect those pieces).

Capturing and the benefits of material superiority.
 In Problem 4, you are to choose the best capturing move.
 In Problem 5, Black can unify right away. The goal is to demonstrate the flexibility from having many more stones by getting three stones in the lower left quadrant first. You can create variants of this problems yourself.
 In Problem 6, White only needs to catch up with one last straggler. But Black's material superiority can prevent this.

Problem 4. Black to capture

Problem 5. Black to unify with at least three stones on * squares

Problem 6. Black to play

Weakness of the starting position. Because the stones are initially already nicely lined up, it is tempting to leave one side be, and only move pieces from the other half. This strategy occurs naturally to anyone starting to play LINES OF ACTION, and is called the *cross-rush*. It is warned against already in Betza's 1979 article [A]. Besides sacrificing a lot of flexibility — by refusing to move half of the player's force —, this strategy suffers from the weaknesses of the pieces in their initial position:

1. They are susceptible to blocks, and can at worst even get walled in.
2. They are susceptible to cuts, which hurt most if a stone in the middle is captured.
3. These stones have low mobility, with fewer available directions.

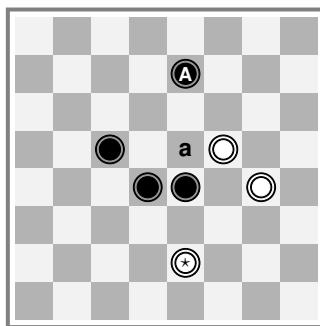
If stones in their starting position get walled off, then they tend to have to make painful moves along the edge, just to obtain minimal mobility.

Tactical concepts

Built-in asymmetry and blocks. The peculiar movement rule of LINES OF ACTION has a mechanical flavour and seems like it might require constant counting. However, the number of pieces is small, and players will quickly get a good feeling for movement. A curious effect is that there are four different ways to prevent a threatened stone from being captured:

1. capture the attacking piece;
2. move the attacked piece;
3. move another piece anywhere onto the line of attack (not just between attacker and defender);
4. move another piece off the line of attack.

Another special feature is that pieces can be *pinned* from afar, i.e. moving them will incur an immediate loss.



ⓐ is pinned: if relocated, Black will win by moving Ⓐ to a.

In LINES OF ACTION, asymmetric positions occur regularly, because stones can jump over stones of the same but not of the other colour.



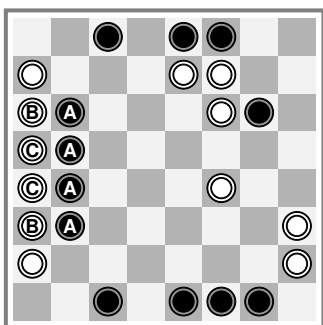
symmetric: ① and ② can capture each other



asymmetric: ① can capture ② but not vice versa

In the right-hand position, ● is blocking ⓐ. This reduces the mobility of the white piece whereas Black can still attack it!

Walls. Several blocking piece side by side can constitute a *wall*. The following diagram shows an example:



In this position, the three Ⓐ stones form a wall. They have the greatest effect on the two ⓐ pieces which are unable to move whatsoever. Moreover, the wall also has some effect on the two ⓑ stones, which are restricted to a single available direction.

Note how Black's wall helps in unifying the upper and lower parts of the black starting position. Also observe how Black has moved pieces from both sides whereas White has only moved pieces from the right-hand column yet — an ill-fated cross-rush attempt.

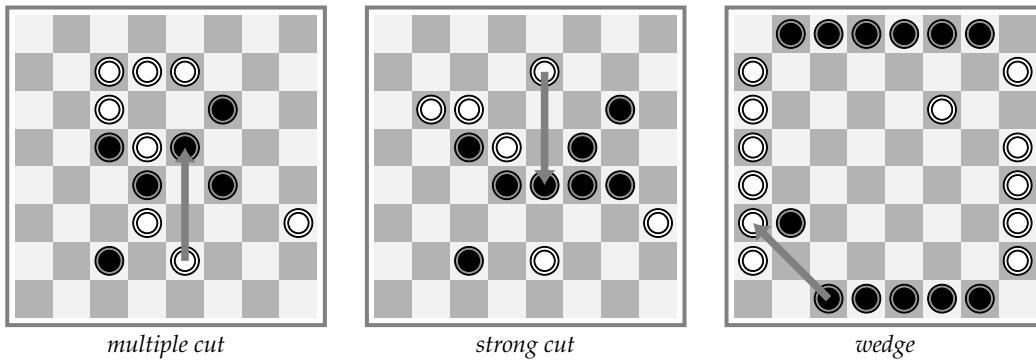
Finally, we remark that Black can attempt to attack White's feeble file because pieces can jump over pieces of the same colour. Especially ⓐ are interesting targets: capturing one of them will split the left-hand line in two clumps of sizes 2 and 3. This maneuver will be discussed below.

Building walls is particularly easy against stones which are still at the border. This is one of the reasons why the initial position is so weak.

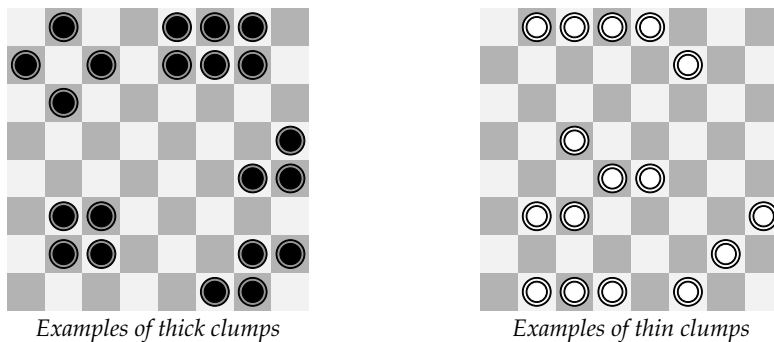
Black, as the starting player, has an advantage in setting up walls. As usual in board games, the best reply when faced with a threat is often not to react, i.e. avoid being forced. Here, when faced with a wall, ponder the formation of your own wall. Quite frequently, both sides create walls. This leads to longer games, and White is by no means relegated to a worse experience in this tug-of-war. Another valid option is to attack the wall.

Cuts and wedges. Naturally, a *cut* is a capturing move increasing the opponent's clump count. Not all cuts are effective. Broadly speaking, a cut becomes more relevant with any of these properties:

1. *Multiple cut*: The opposing clump is now split into three or more clumps.
2. *Strong cut*: The remaining clumps are not just single stones.
3. *Wedge*: Some stones of the remaining clumps are blocked.



Thickness. Sometimes, a clump, or part of it, is so well connected that it cannot be cut. This desirable property is called *thickness*. In [C], this is called ‘compact’ instead, and the evaluation function of the computer program MIA [F] uses a simplified version, by searching for 2×2 boxes of stones of the same colour, called a ‘quad’. The opposite is, naturally, *thinness*. As we explain below, it is not necessarily bad but it makes matters more delicate. Thickness is a relative measure, and a move may make a clump thicker even though it can still be cut elsewhere.



Thick clumps have fantastic resiliency against being split. However, it is impossible to play without thin clumps. A pragmatic approach is this: when deciding between two reasonable moves, and one of them improves thickness, then put higher weight on that move.

An indirect benefit of many thick shapes is surprising mobility. Stones in a larger thick clump can often move and still be connected to that clump. Moreover, along various lines of movement, there will be several stones in the clump, and this often enables strong attacks. Finally, a thick shape can make it easier to lead straggling stones towards unification. On the other hand, a thin clump with the same number of stones will cover much space. Hence thin formations may enable very fast unification, and this can be decisive. Altogether, the choice between thickness or thinness depends subtly on circumstances, and we couldn’t give general recommendations. As a crude rule of thumb, we’ll say that, strategically speaking, the player with the inferior position is more likely to play riskily and with thinner clumps.

Three harder endgame problems *Black to move and win!*

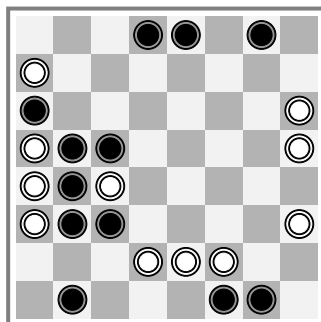
Problem 7.

Problem 8.

Problem missing!

Strategic concepts

Centre of mass. This high level notion has been defined and explained by Ralph Betza [A], picked up again (presumably independently) by Kerry Handscomb [C] (as ‘focal group’), and codified for the MIA program [F] (it is also computationally expensive).



The black centre of mass is the thick size six clump.

The centre of mass is the area where stones of a player tend to gravitate to. Hence, the concept just expresses that it is generally quicker to move the minority towards the majority rather than the other way around. The centre is very fluid: during a game, from tactical threats and interaction with the opponent, the centre can grow, shrink, shift or dissolve. Wall openings tend to create pronounced centres right away. On the other hand, a position may have no clearly visible centre of mass. This happens more often with thin, diagonal structures.

Often, but not always, the centres for both players are close to each other. As usual in mind games, a natural instinct should be to resist the opponent’s plans. An example from *LINES OF ACTION* is building your own wall instead of escaping from the wall your opponent has built. Another one is to create your own centre of mass rather than go with the one of the opponent.

Algorithmically speaking, the centre of mass, computed geometrically by averaging over all coordinates of stones from one side, is only the first step. We want to know strongly concentrated pieces are around this centre. See [F] for details. There they also mention the empirical fact that it is detrimental if the centre of mass is in the geometric middle of the board — it is better placed closer to the edge. (This way, pieces can be attacked from fewer directions.)

[Ideas for problems on centre of mass welcome!](#)

Flexibility. In the sources, this notion is used with several meanings. We will take it to refer to two things: (1) how many stones can usefully move?, and (2) how many different relevant squares can be reached? Often, inflexibility is felt painfully, when no stone can move to an important rank, file or square. Note that for this concept, fewer stones generally mean lesser flexibility.

As one aspect, we recover Betza’s notion of balance, by which he refers to something seemingly different: in the beginning, moving stones from both initial clumps. However, trying this in a game shows quickly that the stones will be a lot more active. This does not even take into the account getting rid of any allusions to the cross-rush (a kind of mental flexibility).

A position with scattered stones can be highly flexible! By contrast, here is a common tactical source of inflexibility.



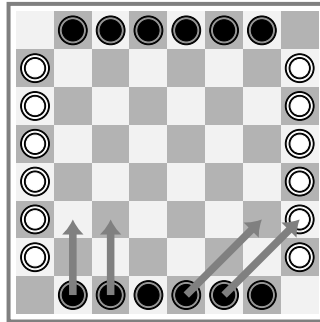
Stones blocking each other: none of these black stones can move horizontally.

A quiet move of just a single step can often improve a situation considerably.

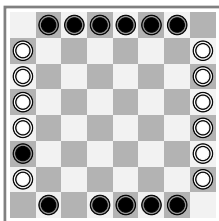
Distance, circumference, connection speed. These are not pressing issues in the early game, but will come up later in the game. By *distance*, we mean how many stragglers there are, i.e. isolated stones, and how far they are from the centre of mass. Similarly, if a player has a position without a clear centre of mass, e.g. two distant sizeable clumps, then this handicap may be referred to as *diameter*.

In these, and other late-game, situations, the focus is on how fast a unified clump can be established. We emphasise again that *LINES OF ACTION* tends to become a race only — if at all — in the final stage.

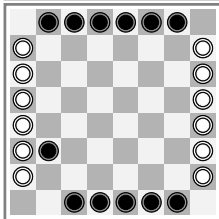
Opening In principle, an opening library for LINES OF ACTION might exist, especially with good computer programs available. However, I am not aware of any, and we will be brief. The next diagram shows all first moves (up to symmetry) which (1) cannot be captured right away and (2) are not along the first line:



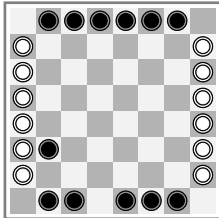
We will have a short look at each of these moves:



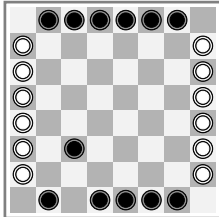
The cross-corner capture. Many players seem to think this is the weakest of the four moves. It does capture a stone, which is generally beneficial. On the other hand, the single stone **a2** is not blocked at all, and the capturing stone is in a remote position. Later in the game, cross-corner captures become a very important tactical option.



This move is often the beginning of a wall strategy. Some natural follow-up moves are the captures **c1-a3** and **d1-a4**. A good reply for White is the symmetric **a2-c2** which prevents both the long capture on **a4** and makes the short capture on **a3** meaningless. Another interesting follow-up for Black is **c1-c3**, enabling another pressing diagonal move, **e1-b4**.



A very popular move, going even more strongly for a wall. It has natural continuations **b1-b4** and **b8-b5**. If not prevented, Black can pile up stones on **b3, b4, b5, b6, c4, c5** in this fashion, creating a thick wall. A very typical reaction is the symmetric **a5-c7**: it gets one stone off the first column and prepares to build a wall on the upper side (naturally, because it is still complete).



The most centre-oriented move. It has nice subsequent moves **e1-b4**, **b1-b3** and **c8-c6**.



1. Kerry Handcomb's 'shotgun' (AGM1)
2. Kerry Handcomb's cool corner move (AGM1)
3. Mention bridge strategy?
4. MIA: concentration, centralisation, central quads, mobility, walls, connectedness, uniformity. (Not material!)

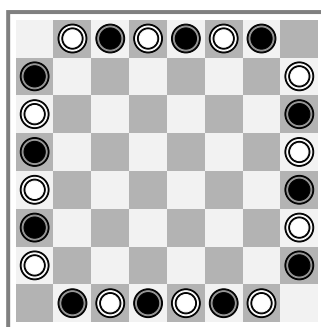
History

LINES OF ACTION was invented by Claude Soucie in the early 1960s in New York; the precise year is not known. The game first appeared to a larger audience in Sid Sackson's book *A Gamut of Games* [14]. The first edition of [14], published 1969, declared simultaneous unification as a draw. In the preface to the second edition, Sid Sackson writes: "Claude Soucie and I are all that remain of the N.Y.G.A. At his request, I have corrected an error in the rules for LINES OF ACTION, eliminating possible draws." (N.Y.G.A. = New York Gaming Association).

The game soon drew some attraction, including tournaments and play by mail, and in his 1979 article series [A], Ralph Betza already speaks of the "old school". By approximately the 1990s, it had secured the status of a modern classic among abstract board games.

LINES OF ACTION has an interesting computer history. Someone at the Stanford university wrote a computer program playing LINES OF ACTION, around 1975. There are several programs player stronger than humans, and with computer championships. Rules for computer tournaments slightly differ by declaring simultaneous unification as a win for the moving player and by declaring stalemate as a forced pass (but not loss). Infinitely repeated positions have come up in one game. Computer tournament rules declare threefold repetition to be draw.

There are a number of variants. We mention the following alternate starting position, suggested by the author:



*Alternative initial position
'scrambled eggs'*

Solutions to the problems

Problem 1. *a4-c2*. Black threatens to connect with either *b4-d4* or *c1-c3*, and the solution is the only way to prevent this.

Problem 2. *b6-c5+*. This threatens *f6-e6++* and *f6-d4++*, and Black cannot prevent both. If White makes any other move, then Black *e7:b4*.

Problem 3. *b8-b4*.

Problem 4. *c6:e6*, because this move prevents White *e8-e4+* and enables Black *e1:e5*.

We quickly go through the other capturing moves in the problem position: *e1:e5* looks attractive because it cuts at the vital point; however, it is refuted by *e8:e4*. The captures *b2:b4* and *c6-e8* are horrible moves, for they enable a white win in the next turn. There are two more captures, but *f2:d4* loses to *e8-e4*, and *f1:f4* is counteracted by *b4:f4*.

Problem 5.

Problem 6. *f7-e6*

Problem 7. *e4-d5*. Problem from a training match Mona vs. YL (2000).

1 ... *a2-a3*. 2 *d4-c5*; *e5-d4*. 3 *d1-c2*; *b5-d3*. 4 *c2-b3*; *d4-b4*. 5 *b3-a4*; *d3-b5*. 6 *a4-a6*; *f5-f6*. 7 *a6-b7*; *f6-d8*. 8 *e6-d7*; *a3-a4*. 9 *b7-a6*; *d6-b6*. 10 *d5-c6*; *b4-b7*. 11 *d7:b7* ++ 1-0.

Problem 8. *b4-d4*. Problem and solution by Phil Cohen; from the reprint of Ralph Betza's *New Ideas in LOA* (NOSTalgia 1978) in 'Anything but Chess' by Tracy Cobbs.

There are three moves that prevent Black's winning move *b8-b7*. Of these, two are easy to handle: 1. ... *a6:c8*. 2. *b8-b7++* and ... *e5:b8*. 2. *c3:a5+*, *a7-c7*; 3. *d8-e7+*, *c7-f4*; 4. *c8-g8++*. The most forceful, though outwardly least promising, is 1. ... *a3-b2*. Many replies should work (*b8-b6*: 2. *c8:a6*, *c5:f8*. 3. *e6-d7++*; 2. *c3:a5* but the most straightforward seems to be 2. *e8:e5+*, to which there are two replies:

2. ... *f7-e8*; 3. *f8-f7+++*, *a6:c8*; 4. *f7-d7++*.

2. ... *a6:c8*; 3. *e5-e7++*, *a5:d5*; 4. *b8:d6* threatening *d6-e5+++++* which wins at once against all but seven moves:

4. ... *c8:e6* or *f7-g6* or *b2-a3*: 5. *d4-b4++*.

4. ... *c8-b7*; 5. *d4-g7+*, *d5-any*; 6. *c4:f7++*.

4. ... *a7:d4*; 5. *c3-b4+*.

4. ... *a7-d7*; 5. *c4-b5+*.

4. ... *a7-b8*; 5. *e7-e5+*, *f7-e7*; 6. *d8-c7++*.

Problem 9.

Literature

- [A] Ralph Betza: *New ideas on LOA*, NOSTalgia 221–225 (1979?), 5 pages.
 - [B] Kerry Handscomb: *Lines of Action: strategic ideas I*, Abstract Games Magazine 1 (2000), 3 pages.
 - [C] Kerry Handscomb: *Lines of Action: strategic ideas II*, Abstract Games Magazine 2 (2000), 2 pages.
 - [D] Kerry Handscomb: *Lines of Action: strategic ideas III*, Abstract Games Magazine 3 (2000), 2 pages.
 - [E] Claude Chaunier: *Lines of Action: strategic ideas IV*, Abstract Games Magazine 5 (2001), 3 pages.
 - [F] M.H.M. Winands, H.J. van den Herik, J.W.H.M. Uiterwijk: *An evaluation function for Lines of Action*, Advances in Computer Games (2004), 12 pages.
 - [G] Mark H.M. Winands, Yngvi Björnsson, Jahn-Takeshi Saito: *Monte-Carlo tree search in Lines of Action*, (), 12 pages.
- Commented games:
1. Fabio Dulcich comments: Paul Yearout vs Fabio Dulcich (1993):
<https://boardgamegeek.com/blogpost/74680/lines-action-paul-yearout-vs-fabio-dulcich-1993>
 2. Walter Sandsquish comments: Walt Roessner vs Ralph Betza:
<https://boardgamegeek.com/blogpost/74995/lines-action-walt-roessner-vs-ralph-betza>
 3. Fred Kok comments: Ragnar Wikman vs Fred Kok (1997):
<https://boardgamegeek.com/blogpost/75750/lines-action-ragnar-wikman-vs-fred-kok-london-1997>
 4. Fred Kok comments: Fred Kok vs Patrick Mouchet:
<https://boardgamegeek.com/blogpost/75581/lines-action-fred-kok-vs-patrick-mouchet>
- Mark Winand's LOA page: <https://dke.maastrichtuniversity.nl/m.winands/loa/>