

Leiserchess 2021

A Laser-Chess Game

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Leiserchess (pronounced “LYE-sir-chess”) **2021** is a two-player laser-chess game similar to [Laser Chess](#), [Khet](#), and previous versions of Leiserchess. The teaching staff of the MIT class 6.172 *Performance Engineering of Software Systems* developed Leiserchess 2021 (henceforth just Leiserchess) for the term final project in Fall 2021. The students are given a working implementation of a program to play Leiserchess, and their job is to make it run as fast as possible and otherwise improve its playing ability.

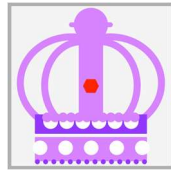
On the surface, Leiserchess is much simpler than Laser Chess or Khet. There are only two kinds of pieces — Monarchs and Pawns — and all pieces move the essentially the same way. A deeper complexity arises from the dynamics of how pieces interact, however, because the Monarchs carry their own lasers to shoot at each other and at each other’s Pawns. The result is an entertaining and challenging game that involves both tactics and strategy.

Pieces and Board

Leiserchess is played by two players, **Tangerine** and **Lavender**, on an 8-by-8 square board. The 64 squares of the board can be labeled using chess **algebraic notation**. The vertical columns of squares, called **files**, are labeled **a** through **h** from left to right, and the horizontal rows of squares, called **ranks**, are numbered **0** to **7** from bottom to top, giving each square a unique coordinate consisting of a letter and a number. Each player possesses one Monarch and four Pawns, and there are seven Mercenary Pawns that can be conscripted temporarily by either side:



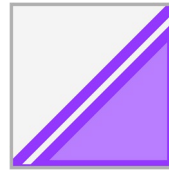
Tangerine
Monarch



Lavender
Monarch



Tangerine
Pawn



Lavender
Pawn

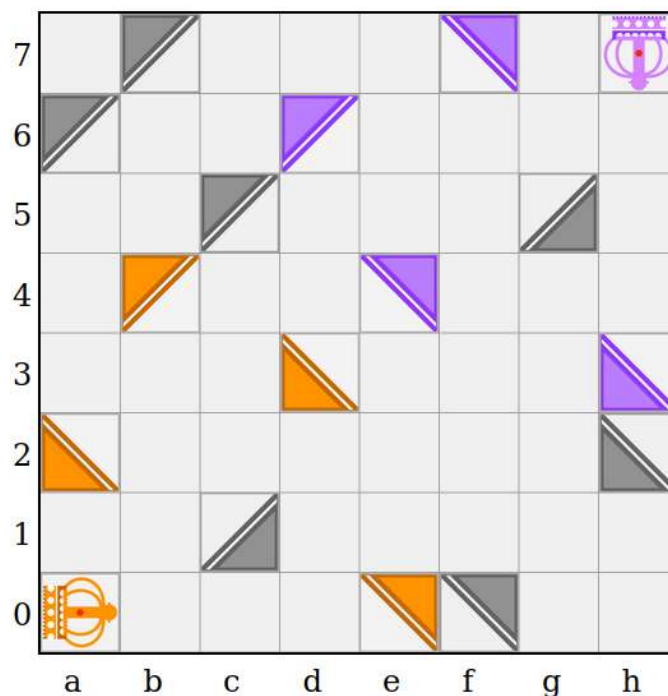


Mercenary
Pawn

The front of the Monarch (shown graphically as coming out of the top of the Monarch's crown) contains a laser that shoots at the end of the player's turn. The hypotenusal side of a Pawn is a mirror oriented at a 45-degree angle to the ranks and files of the board. The Pawns' mirrors deflect the path of the laser beam from rank to file and vice versa. Monarchs may deflect their laser off Pawns of any color.

Opening Position

Play begins with the following starting position:

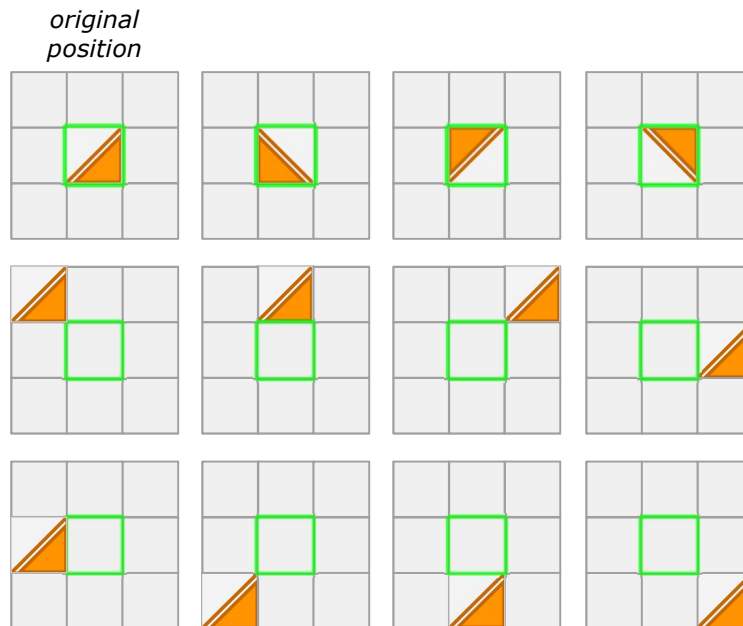


Rules

Tangerine moves first, and then play alternates. A player may move only her or his pieces or a **controlled** Mercenary. A Mercenary is controlled by a player if the Mercenary's mirror lies on the path of the player's Monarch's laser at the beginning of the turn (not if a solid side would be hit by the laser).

A turn comprises two parts: moving and zapping (firing the Monarch's laser).

Moving. For the first part of a turn, the player on move chooses a piece. For a Pawn, the piece can either rotate by 90, 180, or 270 degrees or move to an empty adjacent square in any of the 8 compass directions, yielding 11 possible moves, as shown in the following figure:



The 11 possible moves of a Pawn.

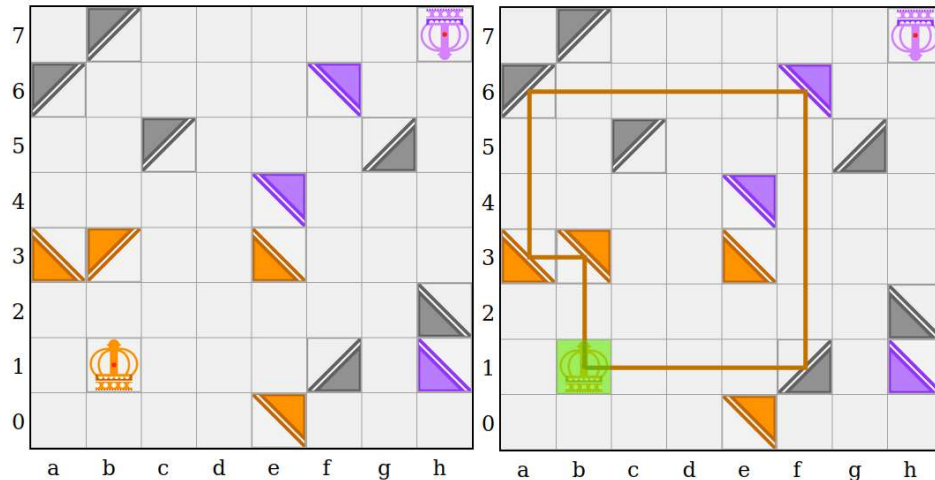
The player may only choose not to move or rotate any piece for their turn — a **null move** — only if the Monarch zaps a piece for the second part of the turn. Thus, for any legal move, the board must change.

Crashing. If a Pawn moves onto the square occupied by another Pawn, the Pawns **crash** and both are removed from the board. If a Monarch moves onto the square of another Pawn, only the Pawn is removed. Moving a piece onto the square of a Monarch is illegal.

Zapping. For the second part of a turn, the player fires the laser, which shoots out the front of the Monarch, possibly bouncing off the mirrored surfaces of Pawns, and eventually either continuing harmlessly off the edge of the board or **zapping** a

Monarch or a nonmirrored surface of a Pawn. If the laser zaps a Monarch, the game is over, and the player who owns the zapped Monarch loses. (Yes, you can commit suicide!) If the laser zaps a nonmirrored side of a Pawn, the zapped Pawn is removed from the board. Zapping occurs after any crashing has resolved in the first part of the turn, making it possible for up to 3 pieces to be removed in a single turn.

After a player moves, he or she must *a/ways* fire the laser, even if it is self-destructive. In the example below, Tangerine realizes that if something isn't done, its Pawn on **e3** will be destroyed by its own Monarch's laser.



Tangerine unwisely rotates the Pawn on **b3** clockwise. Sadly, in the second part of the move, the Tangerine Monarch fires its laser and zaps itself, committing suicide.

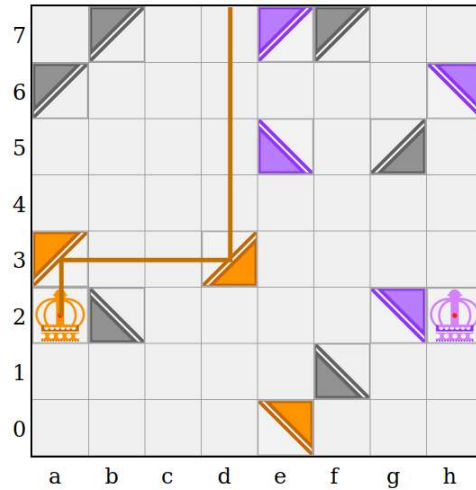
Draw. A draw occurs (1) if there have been 50 moves by each side without a Pawn being zapped; (2) if the same position repeats itself three times with the same player on move; or (3) if the two players agree to a draw. In computer play, rule (3) is usually ignored. A tournament director (or 6.172 staff) may also adjudicate a game as a draw if the total number of moves exceeds a preannounced limit and change the number 50 in draw rule (1). Unlike Chess, there is no draw from a lack of legal moves.

Time control. As players become skilled, they tend to think longer. A chess clock (see http://en.wikipedia.org/wiki/Time_control) can be used to keep the pace up. In 6.172, we use a Fischer clock where an increment of time is added to the clock after every move. Free chess-clock applications are available for many smart phones.

Learning Leiserchess

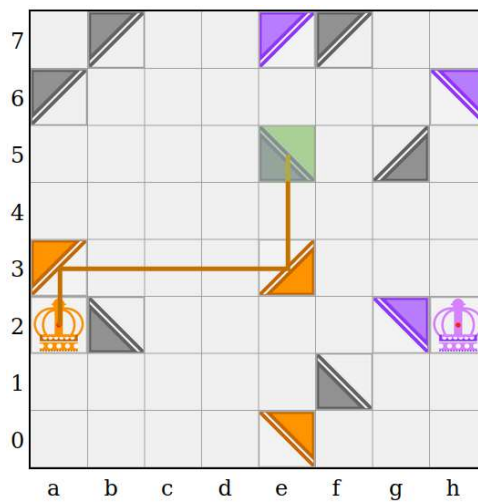
To learn the game, start by clearing the board of all Pawns, and play with just the two Monarchs, one in each corner of the board. You will discover that one of the two players can always force the enemy Monarch to the edge and zap it. Playing this endgame will give you a feeling for the power of the laser-slinging Monarchs. After you've mastered Monarch-on-Monarch play, you'll find it easier to learn to play the normal game, where Pawns deflect the laser beam.

Tactics. Despite the simplicity of the rules, Leiserchess has remarkably interesting tactics. For a Monarch to zap the enemy Monarch, it risks opening itself up to counterattack, and so shots must be artfully composed. For example, take the following configuration:



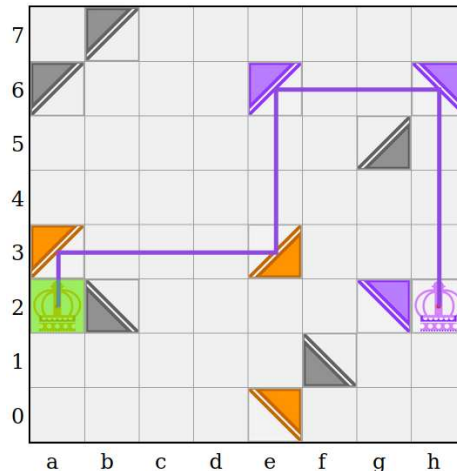
Tangerine to Move

Moving a Pawn from **d3** to **e3**, Tangerine is able to destroy the Lavender Pawn at **e5**.



Tangerine captures **e5**

Doing so results in immediate disaster, however, as Lavender counters by moving its Pawn on **e7** to **e6**, zapping the Tangerine Monarch, and winning the game:



Lavender counters with e6

The Pawns at a3 and e3, which deflected Tangerine’s laser to zap the Lavender Pawn, are now employed by Lavender in the reverse direction to zap the Tangerine Monarch. Don’t get hoisted by your own petard!

This kind of tactic illustrates the emergent complexity inherent in Leiserchess, where the interaction of simple pieces engenders complex behavior. The reverse-path nature of mirrors — “If you can see me, I can see you!” — produces a wealth of tactics to exploit and be wary of.

Often, what becomes important in Leiserchess is the *threat* of zapping rather than the actual act of zapping. As a result, the actual area that your Monarch’s laser covers may not be too important. What tends to matter is the area that *could* be covered if you combine a move action with a Monarch zap. Similarly, the *threat* of a crash can be more important than the actual occurrence of a crash.

Strategy. A player can attain a dominant position by moving their pieces strategically so that they can eventually engineer a tactical zap. Although Leiserchess is a young game, some strategic elements have begun to emerge from games played thus far:

- Try to keep some Pawns near your Monarch. A “naked” Monarch is generally easier to zap than one with bodyguards. Also, try to move some Pawns near the enemy Monarch, the better to deflect your laser to zap it. But watch out not to let your opponent use your own Pawn’s mirror against you!
- Obtain a central position for your Monarch relative to your opponent’s Monarch, especially as the endgame approaches. After most of the Pawns are eliminated, a centralized Monarch can more easily chase down and zap an edge-lurking opponent.
- Keep Pawns active. As the Monarchs move toward the center, a Pawn on the edge of the board can easily find itself unable to “cooperate” with other Pawns

in directing the path of the laser, rendering the Pawn on the edge next to useless.

- Limit the mobility of the enemy Monarch by threatening to attack the squares next to it. That is, make yourself ready to attack the enemy Monarch should it move to an adjacent square.
- Move Mercenaries close to your opponent's Pawns so that you can eventually crash the Mercenary with one of your opponent's Pawns. That will help to preserve your own Pawn count while decreasing your opponent's.
- Keep your own Pawns alive! Although Mercenaries are powerful in the middle game, they slowly lose power as the endgame approaches. Due to the difficulty of recruiting Mercenaries, it's hard to zap the enemy Monarch with only a Mercenary.

Recording Board Positions and Games

Board positions can be recorded using a modified [Forsyth-Edwards notation \(FEN\)](#). From Tangerine's point of view, list the pieces rank by rank, starting with rank 7 and ending with rank 0. Within each rank, describe the contents of each square from a to h as follows. Each piece is encoded by a two-letter sequence describing the way it is facing, where upper case letters stand for Tangerine, and lower-case letters stand for Lavender. The Tangerine Monarch is encoded as **NN**, **EE**, **SS**, and **WW**, depending on whether it is facing north (toward the higher-numbered ranks), east (toward higher-lettered files), south, or west. The Lavender Monarch is similar, using lower-case letters: **nn**, **ee**, **ss**, and **ww**. A Tangerine Pawn is encoded as **NE**, **SE**, **SW**, and **NW**, depending on whether its mirror is facing northeast, southeast, southwest, or northwest, and similarly, using lower case **ne**, **se**, **sw**, and **nw**, for the Lavender Pawns. For Mercenary Pawns, they are handled with lowercase letters prefixed with a **\$**. The numbers **1** through **8** indicate consecutive empty squares, and a forward slash separates ranks. After the board description, either the letter **W** or **B** (for White and Black, the traditional chess colors) follows, depending on whether Tangerine has the next move in the position, or Lavender, respectively. For example, the opening position can be described with the following FEN string:

```
1$se3sw1ss/$se2se4/2$se3$nw1/1SE2sw3/3NE3ne/NE6$ne/2$nw5/EE3SW$sw2 W
```

Games can be recorded using the following simple notation:

- If a piece is rotated, write down the square holding the piece followed by
 - **L** for a counterclockwise rotation — e.g., **g2L**;
 - **R** for a clockwise rotation— e.g., **g2R**;
 - **U** for a 180-degree rotation — e.g., **g2U**.
- If a piece is moved to an adjacent square, write down the source square followed by the destination square — e.g., **h3g4**.

- To record the null move, move the Monarch to its own square — e.g., **a2a2**. (Remember that a null move is illegal unless something is zapped.)
- Record the outcome of the game as **1-0** (Tangerine wins), **0-1** (Lavender wins), or **1/2-1/2** (draw).

Here's an example of a recorded game:

1. e0R h3L	10. a3R d5L	19. c4d5 f5U
2. e0e1 d6R	11. b7b6 d5d4	20. d5e4 g5R
3. d3R h3g2	12. e1f2 g3g4	21. e4U f5e5
4. a0b0 f7f6	13. f2g3 e7e6	22. b3b4 c5L
5. f0g0 h7h6	14. g3h3 g4h4	23. b0c1 g5f6
6. d3e4 g2g3	15. h3h2 h5g5	24. c1b2
7. b4c4 f6e7	16. h2g3 d4d3	1-0
8. a2a3 d6d5	17. a3b2 h4g3	
9. b0L h6h5	18. b2b3 e6f5	

Feedback

Please email questions or comments to 6.172-staff-f21@mit.edu. Thank you, and we hope you enjoy Leiserchess 2021!