

Leiserchess 2016

A Laser-Chess Game

Charles E. Leiserson

October 31, 2016

Leiserchess (pronounced “LYE-sir-chess”) **2016** 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 2016 (henceforth just Leiserchess) for the term final project in Fall 2016. 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 in that there are only two kinds of pieces — Kings and Pawns — and all pieces move the same way. A deeper complexity arises from the dynamics of how pieces interact, however, because the Kings 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

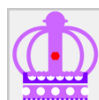
Leiserchess is played on an 8x8 square board. Each player has one King and seven Pawns:



Tangerine
King



Tangerine
Pawn



Lavender
King

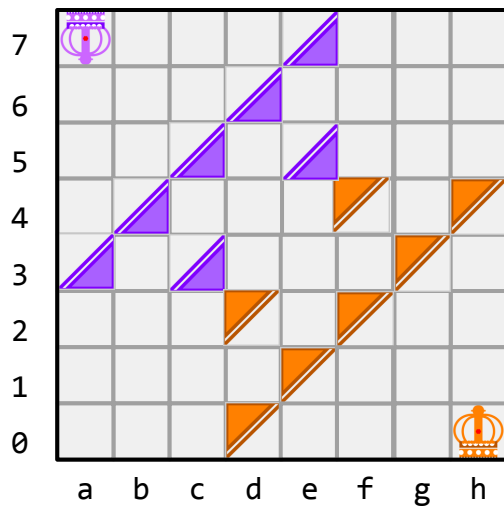


Lavender
Pawn

The King contains a laser that can be activated to shoot out of its front. Each Pawn contains a mirror oriented at a 45-degree angle to the ranks and files of the board, which can reflect the beam of the laser from rank to file or vice versa.

Opening Position

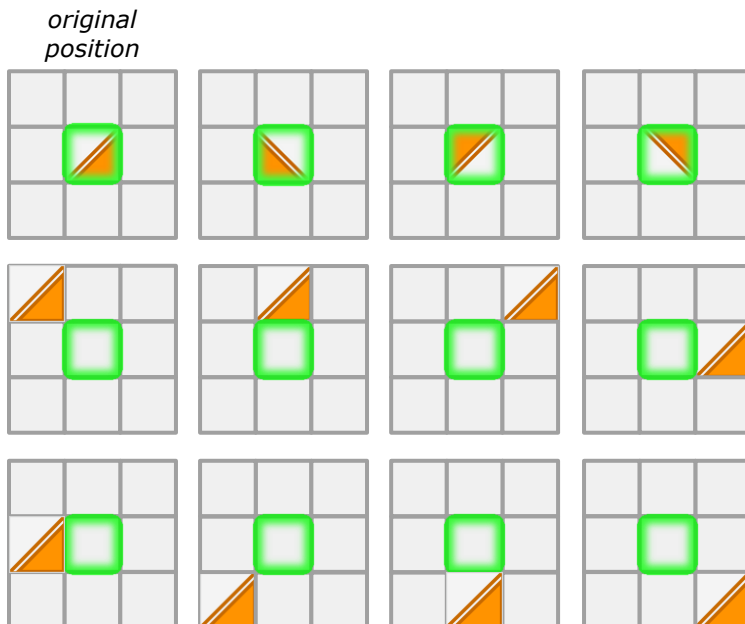
Play begins with the following starting position:



Rules

Tangerine moves first, and then play alternates between the two players. A player can only move his or her own pieces, not the opponent's. All pieces in Leiserchess move the same, whether King or Pawn. A turn has two parts: moving and firing the laser.

Moving. For the first part of a turn, a player on move chooses a piece and either rotates it or moves it to an adjacent square in any of the eight compass directions while maintaining its orientation. You can rotate a piece by 90, 180, or 270 degrees. You cannot both rotate a piece and move it in the same turn. The following diagram shows a Pawn on a square and its 11 possible moves:

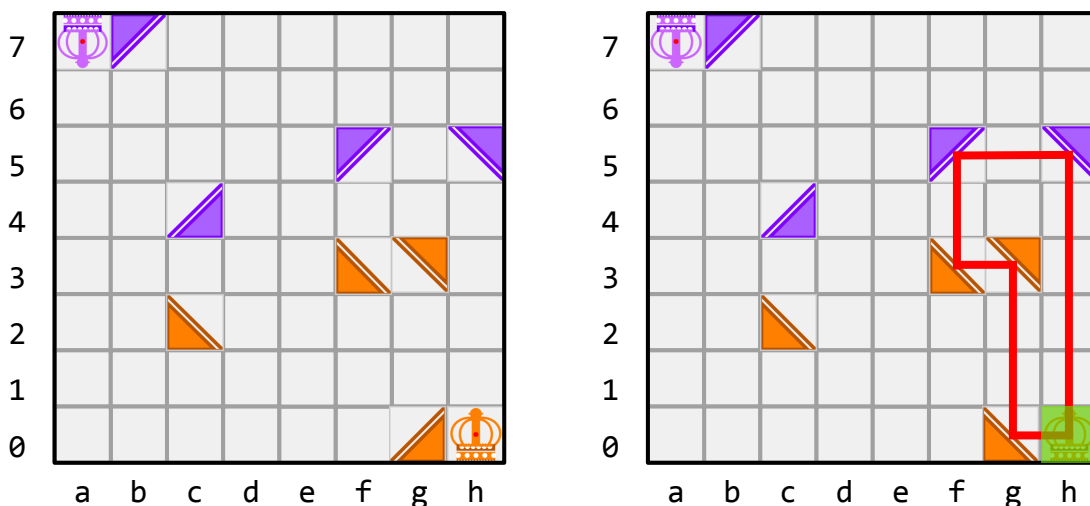


The swap rule. If another piece — your opponent’s or your own — occupies the destination square, the two pieces swap positions, maintaining their orientations.

The null move. A player can make a “null” move, in which no piece is actually moved, as long as firing the laser zaps a piece (of either side). If no piece is zapped, the null move is illegal.

Firing the laser. For the second part of a turn, the player fires the laser, which shoots out of the top of the King. The beam can safely bounce off the mirrored surfaces of Pawns, but if the laser “zaps” an opaque (nonmirrored) side of a piece, the zapped piece is removed from the board, no matter which player owns it. (Yes, you can zap your own Pawns and even commit suicide!) After a zapped piece is removed, the laser continues to fire, tracing a new path from the King and possibly zapping more Pawns, until it either hits a King or goes off the board. If a player’s King is zapped, the game is over, and the player loses.

After a player moves, whether making a normal move or a null move, he or she must *always* fire the laser, even if it is self-destructive. For example, in the position shown below on the left, if Tangerine unwisely rotates the Pawn on g0 clockwise 90 degrees, as shown in the position on the right, it zaps its own King on h0:



Pinning Pawns. The laser does more than just zap. A Pawn in the line of sight of the enemy King’s laser is pinned and cannot move (or even rotate). For example, in the figure on the left above, if it is Lavender’s turn to move, Lavender cannot move the Pawns on f5 and h5, because Tangerine’s laser would bounce off their mirrors. Your own laser never pins your own Pawns, only your enemy’s Pawns. A piece can swap with a pinned Pawn, however, but it must be an unpinned Pawn that initiates the move.

The Ko rule. To help ensure that the game makes progress, Leiserchess has a “Ko” rule similar to the Ko rule in the game of Go. The Leiserchess Ko rule says that a move is illegal if (1) it does not change the position or (2) it returns the position to the position immediately prior to the current position. Such illegal moves can occur in three common ways:

1. A player attempts to play a null move that causes no piece to be zapped, thereby repeating the same position.
2. A player attempts to swap two Pawns that have the same orientation, and no piece is zapped, thereby repeating the same position.
3. After the opponent has swapped a piece with a player, the player attempts to swap them back, and no piece is zapped, thereby repeating the position before the first swap.

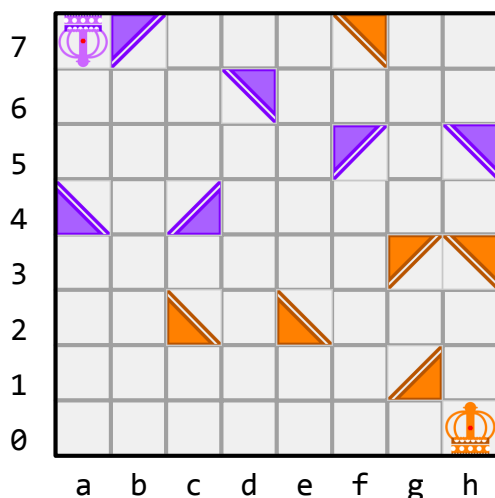
Draws. A draw occurs (1) if there have been 50 moves by each side without a Pawn being zapped; (2) if the same position repeats itself three times with the same side on move; or (3) if the two players agree to a draw.

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. Ideally, use a “delay” clock, such as a Fischer clock. Free chess-clock applications are available for many smart phones.

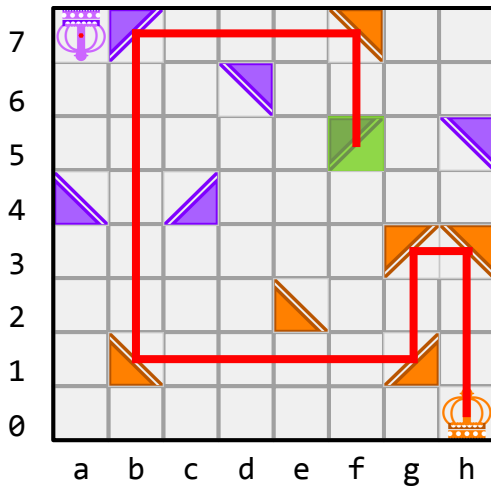
Learning Leiserchess

To learn the game, start by clearing the board of all Pawns, and play with just the two Kings, one in each corner of the board. You will discover that this endgame situation can always be won by one of the two players, who can force the enemy King to the edge and zap it. Playing this endgame will give you a feeling for the power of the laser-slinging Kings. Afterwards, go on to play normal games.

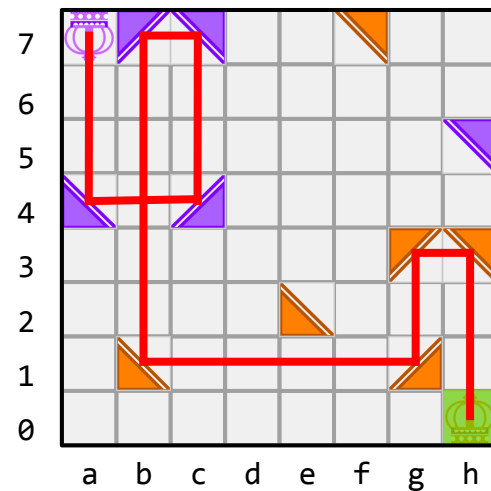
Tactics. Despite the simplicity of the rules, Leiserchess has remarkably interesting tactics. For a King to zap the enemy King, it risks opening itself up to counterattack, and so shots must be artfully composed. For example, consider the following position with Tangerine to move:



Tangerine can zap the Lavender Pawn at f5 by moving its Pawn on c2 to b1:



Doing so results in immediate disaster, however, as Lavender counters by moving its Lavender Pawn on d6 to c7, zapping the Tangerine King, and winning the game:



The Pawns at b7, b1, g1, g3, and h3, which Tangerine used to reflect the laser to zap the Lavender Pawn at f5, are now used by Lavender in the reverse direction to zap the Tangerine King. Watch out for poison Pawns!

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 tactical issues.

Strategy. Strategy is required for a player with a dominant position to prevail over the opponent. Without a thoughtful plan, the dominant player may not be able to engineer a zap. Although Leiserchess is a young game, some strategic elements have begun to emerge from games played so far:

- Keep some Pawns in the neighborhood of your own King. A “naked” King is generally easy to zap.

- Avoid letting your opponent pin your Pawns. Although it may be helpful to interpose your own Pawn between the enemy King and one of his or her Pawns to prevent your own King from being zapped, you sacrifice your Pawn's mobility.
- Try to limit the mobility of the enemy King by threatening to attack the squares next to it. That is, be in a position to attack the enemy King should it move to an adjacent square.
- As the Kings move toward the center, a Pawn on the edge of the board can easily find itself unable to "cooperate" with other pieces in directing the path of the laser, rendering the Pawn next to useless.
- If the enemy King tries to "hunker down" by surrounding itself with its Pawns, you can invade with your Pawns to disrupt the enemy King's defensive position.

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 identified 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 King is identified by 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 King is similar, except lower-case letters are used. A Tangerine Pawn is identified by NE, SE, SW, and NW, depending on whether its mirror is facing northeast, southeast, southwest, or northwest, and similarly, using lower case, for the Lavender Pawns. The numbers 1 through 8 indicate consecutive empty squares, and a forward slash separates ranks. After the board description, the letter W or B (for White and Black, the traditional chess colors), 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:

```
ss3nw3/3nw4/2nw1nw3/1nw3SE1SE/nw1nw3SE1/3SE1SE2/4SE3/3SE3NN W
```

Games can be recorded using the following simple notation:

- If a piece is rotated, write down the square holding the piece followed by either "L" for counterclockwise, "R" for a clockwise, or "U" for a 180-degree rotation, e.g., "g2R".
- If a piece is moved to an adjacent square, write down the source square followed by the destination square, e.g., "h3g4".
- A null move is denoted by "moving" the King to its own square, e.g., "h0h0".
- Record the outcome of the game as 1-0 (Tangerine wins), 0-1 (Lavender wins), or 1/2-1/2 (draw).

Here is an example of a recorded game:

	Tangerine	Lavender
1.	h4g5	a3a2
2.	g3R	a2a1
3.	e1U	b4R
4.	f4e3	c3R
5.	d0d1	d6U
6.	f2L	a1b1
7.	d1U	b4c4
8.	g3f3	a7b6
9.	h0g1	e7e6
10.	e3f2	b1b0
11.	g5f4	e5L
12.	e1e0	e5f4

	Tangerine	Lavender
13.	h4g6	a3a3
14.	g3R	a2a2
15.	e1U	b4R
16.	f4e4	c3R
17.	d0d2	d6U
18.	f2L	a1b2
19.	d1U	b4c5
20.	g3f4	a7b7
21.	h0g2	e7e7
22.	e3f3	b1b1
23.	g5f5	e5L
0-1		

Feedback

Please email questions or comments to leiserchess@gmail.com. Thank you, and I hope you will enjoy Leiserchess!