# Rules for the Game of Tetress

## COMP30024 Artificial Intelligence

February, 2024

Get ready to battle your tetrominoes in Tetress, a thrilling board game that challenges even the most seasoned Tetris aficionados! Each piece placed is a step closer to victory or defeat, demanding tactical brilliance and foresight. Tetress isn't just a game; it's a battle of wits, a dance of squares in an infinite, yet paradoxically claustrophobic world. Will you block your opponent's path to victory, or will you succumb to be forever trapped in a spatial puzzle with no way out?

## Overview

Tetress is a two-player, perfect-information game played on an $11 \times 11$ "toroidal" board. The players (Red and Blue) take turns to place *tetrominoes*, vying to control the board and ultimately block the other from playing.

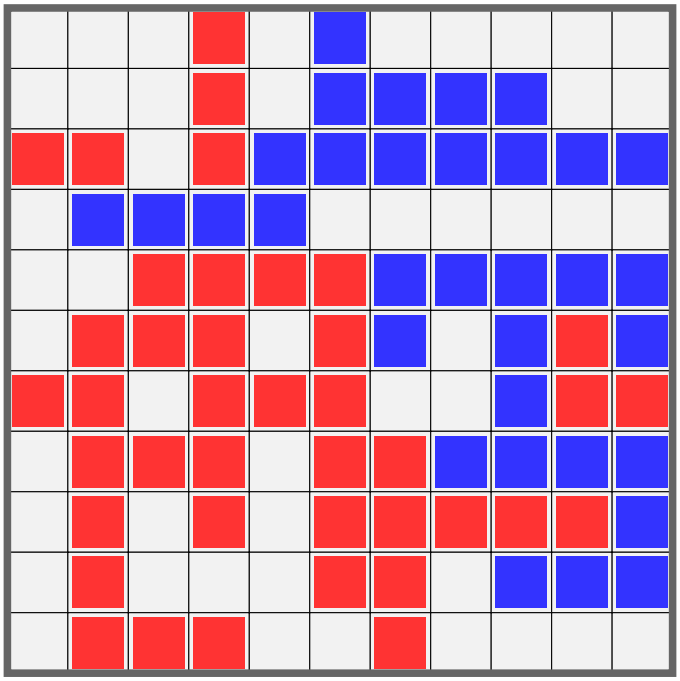


Figure 1: An example (in-progress) game of Tetress.

# Game Board

We use a two-dimensional coordinate system to describe positions on the game board (Figure 2). Formally, a valid board *coordinate* is an integer pair $(r, c)$, $0 \leq r \leq 10$, $0 \leq c \leq 10$, where $r$ is the *row* on the board and $c$ is the *column*. Despite there being a finite amount of "real estate", there are no actual "edges" of the game board. Rather, the board spans an infinitely *repeating* plane, looping to the other side of the board at the edges (mathematically speaking, this is topologically equivalent to a *torus*). For example, in Figure 2, notice how the coordinate $(10, 0)$ has two adjacent cells which wrap around to the other sides of the board – namely, $(10, 10)$ and $(0, 0)$.

This means that **all** coordinates on the board are directly *adjacent* to exactly four other coordinates (even those depicted as being on the "edge" of the board). For example, $(1, 2)$ is adjacent to: $(1, 3)$ (right), $(1, 1)$ (left), $(0, 2)$ (up) and $(2, 2)$ (down). Note that the other four "diagonal" cells, $(0, 1)$, $(0, 3)$, $(2, 1)$ and $(2, 3)$, are **not** considered adjacent for the purposes of subsequent discussions.

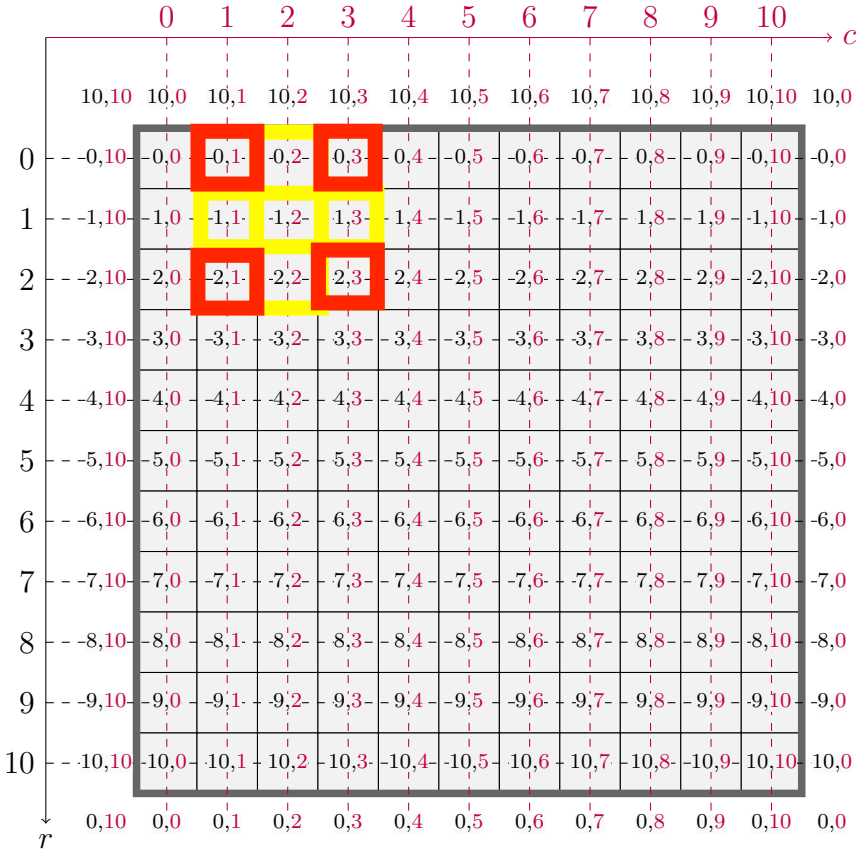



Figure 2: The coordinate system used on an Tetress game board.

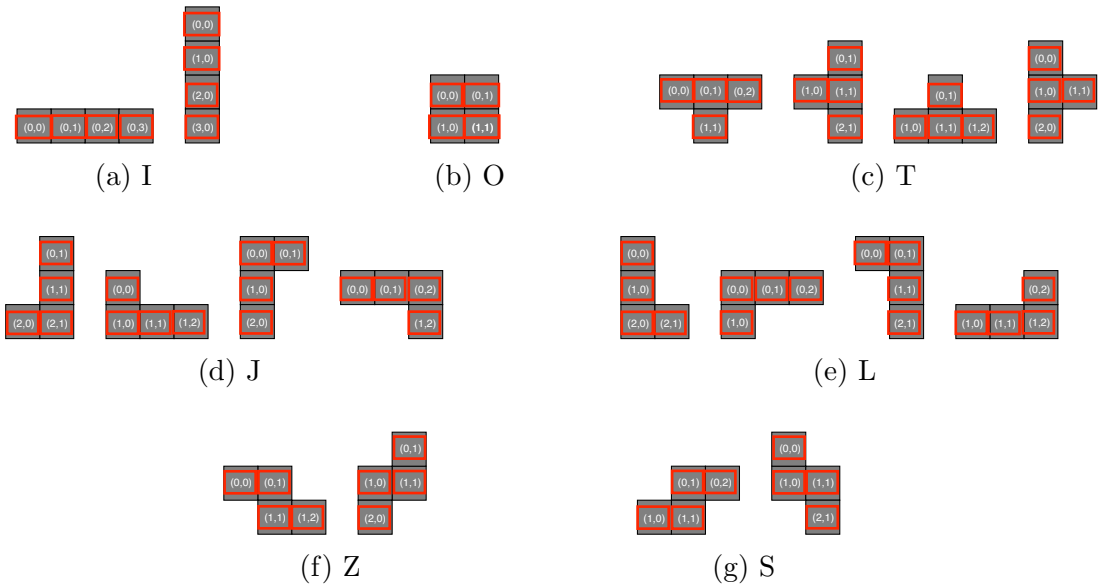
# Gameplay

Below is the high-level "sequence" for a typical game of Tetress. The following sections then describe the individual components of this sequence in detail.

- The game begins with an empty board and proceeds sequentially.
- By convention, Red starts. Throughout the game Red and Blue take turns to play PLACE actions:
  - A PLACE action involves playing a tetromino (four connected tokens) of the respective player's colour on the board.
  - After a turn is complete, if one or more horizontal and/or vertical "lines" of tokens are completed, all tokens on on the respective row(s) and/or column(s) are removed.
- The game ends when a player cannot play a valid PLACE action, or, a turn limit of 150 turns is reached.

# Actions

On their turn, a player must play a PLACE action, which involves placing a **tetromino** onto the game board. There are 7 tetromino shapes (I, O, T, J, L, S and Z) on a two-dimensional plane, which yield 19 "fixed" variations when taking into account all possible rotations (Figure 3). Yes, these are the same tetrominoes you'll come across when playing a game of Tetris!

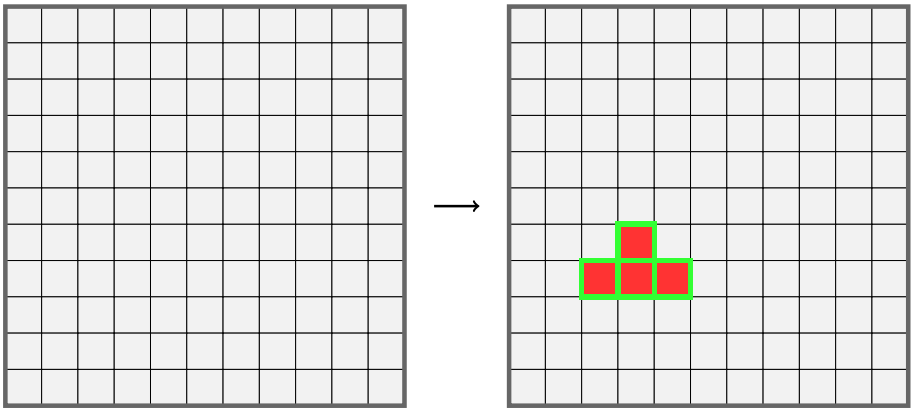


(a) I (b) O (c) T

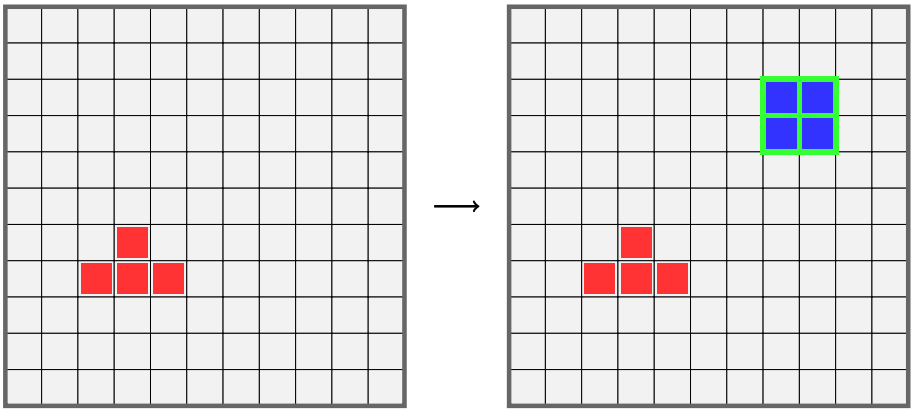
(d) J (e) L

(f) Z (g) S

Figure 3: All 19 "fixed" tetrominoes categorised by their respective shapes.



(a) Turn 1: Red plays PLACE$[(6,3),(7,2),(7,3),(7,4)]$



(b) Turn 2: Blue plays PLACE$[(2,7),(2,8),(3,7),(3,8)]$

Figure 4: An example showing two "opening" PLACE actions.

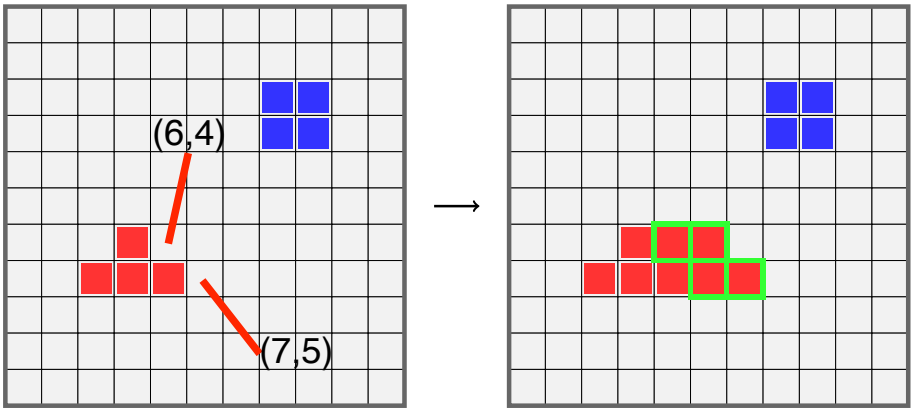
More formally, a *legal* PLACE action is defined by exactly **four** board coordinates whereby the following three conditions are satisfied:

1. All four coordinates must together form one of the 19 tetrominoes (Figure 3).
2. All four coordinates on the board must be unoccupied.
3. At least one coordinate must be directly **adjacent** to an already-placed token of the same colour, **unless** it is the player's first turn of the game.

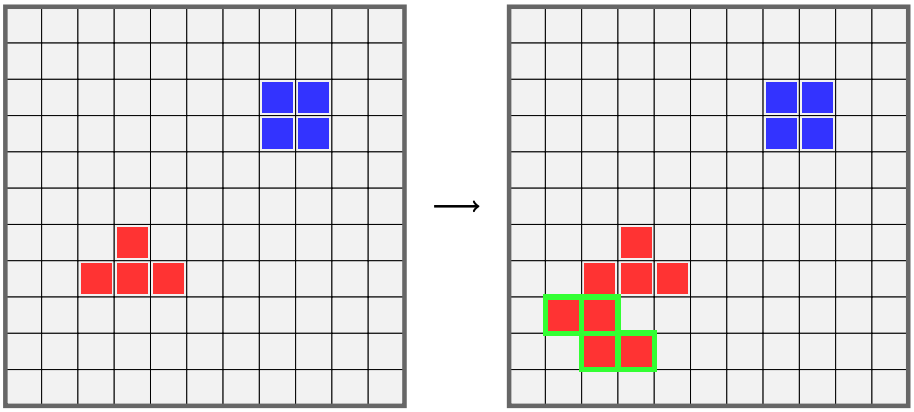
Figure 4 shows an example of two "opening" PLACE actions, noting that this is the only time in the game that condition three is excepted.

Figure 5 shows a few different ways Red could play a 'Z' tetromino on their turn. In all cases, the aforementioned conditions are satisfied, including condition three:

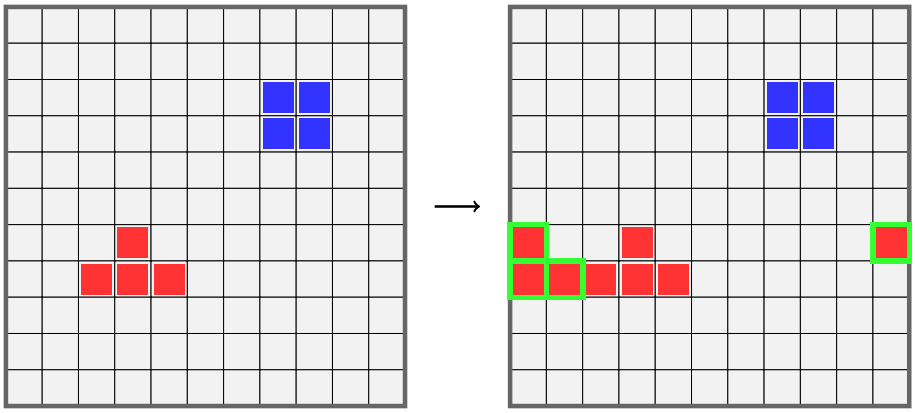
- In Figure 5a, both $(6,4)$ and $(7,5)$ contain Red tokens and are directly adjacent to $(6,3)$ and $(7,4)$ respectively.




(a) PLACE[$(6,4)$, $(6,5)$, $(7,5)$, $(7,6)$]



(b) PLACE[$(8,1)$, $(8,2)$, $(9,2)$, $(9,3)$]



(c) PLACE[$(6,10)$, $(6,0)$, $(7,0)$, $(7,1)$]

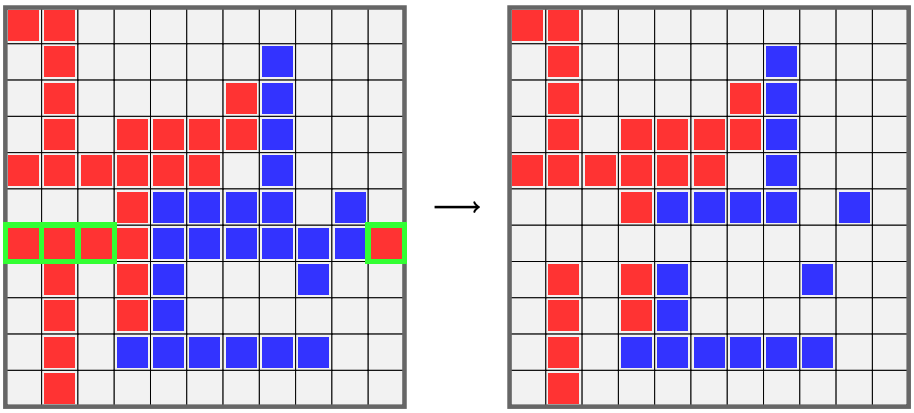
Figure 5: A few different ways Red could play a 'Z' piece on their next turn.

- In Figure 5b, cell $(7,2)$ contains a Red token and is directly adjacent to $(8,2)$.
- In Figure 5c, cell $(7,2)$ contains a Red token and is directly adjacent to $(7,1)$. In this case the upper-left token of the piece loops around to the other side of the board.

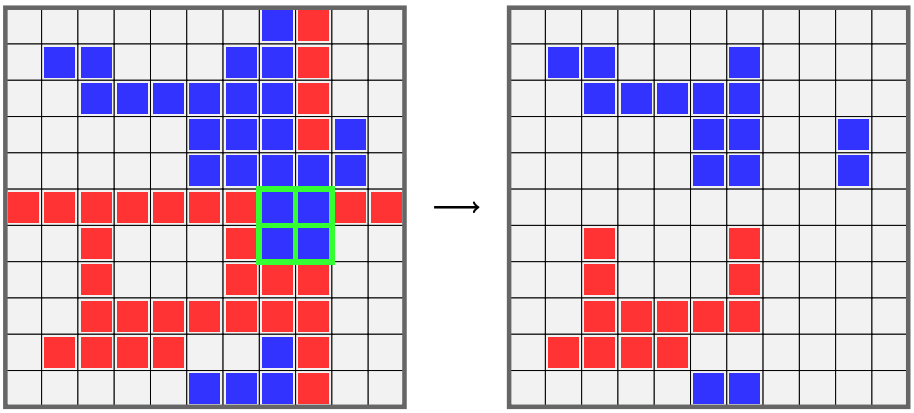
## Forming Lines

If one or more horizontal and/or vertical "lines" of 11 tokens are formed after an action is played, these are automatically removed, leaving behind empty cells (these may be re-used to place tetrominoes in subsequent turns). This can significantly shift the balance of pieces on the game board and is an important rule to be aware of in Tetress.

Figure 6 shows two example scenarios where this occurs. Notice how in 6b multiple lines are formed (one row and two columns), all of which end up getting removed.



(a) PLACE$[(6,0), (6,1), (6,2), (6,10)]$



(b) PLACE$[(5,7), (5,8), (6,7), (6,8)]$

Figure 6: Two example actions leading to completed "lines", and subsequent removal of tokens. The action which has just been played is highlighted on the left, and on the the resulting board state (*after* removal of the respective lines' tokens) is shown on the right.

## Ending the Game

A game of Tetress ends if one of the following two conditions is met:

1. A player cannot play a PLACE action (Figure 7). Their opponent is declared the winner.
2. There have been 150 actions played with no winner declared. The player with more tokens on the board is declared the winner (or if there is a tie, a **draw** is declared).

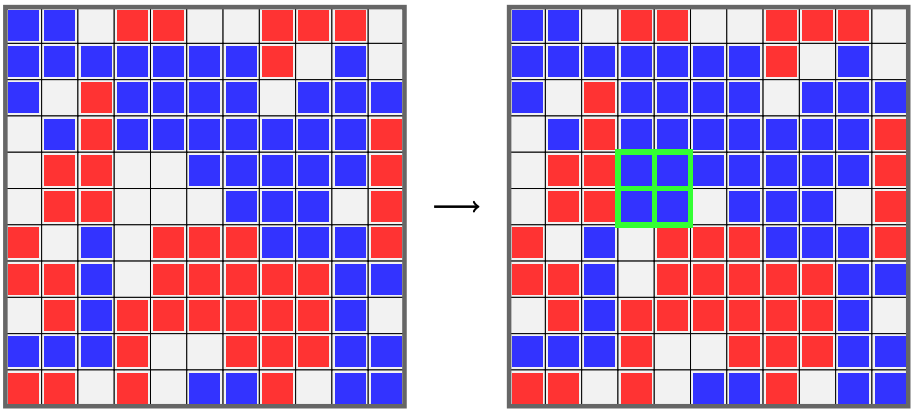


Figure 7: In this example, Blue plays PLACE$[(4,3),\ (4,4),\ (5,3),\ (5,4)]$. Notice that Red cannot place a piece on their turn, and hence Blue is declared the winner.