Phase 2: Pentominoes

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Introduction

“If Tetris has taught me anything it's that errors pile up and accomplishments disappear" - Unknown

Overview of Phase 2

1) Design a UI for a Tetris-style game using the Pentomino pieces from Phase 1
   - With the ability to move/rotate pieces and a high score tracker
2) Implement a bot capable of efficiently playing our game
3) Find an optimal order of pentominoes that will lead the bot to a high score

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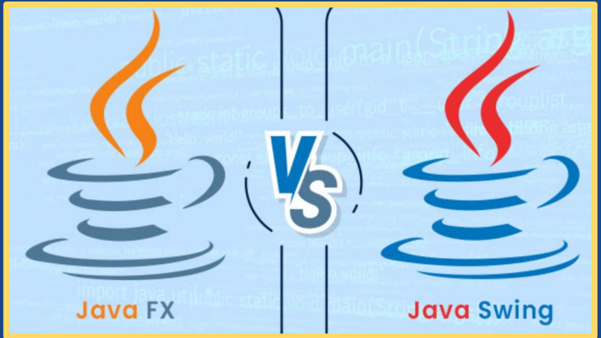
Creating UI

"The shorter way to do many things is to only do one thing at a time." - Mozart

Why Java Swing?

- We preferred Java Swing as it is more lightweight and doesn't need any extra configurations.

- Swing components provided us higher level inbuilt functionalities, allowing us to write a more organized program.



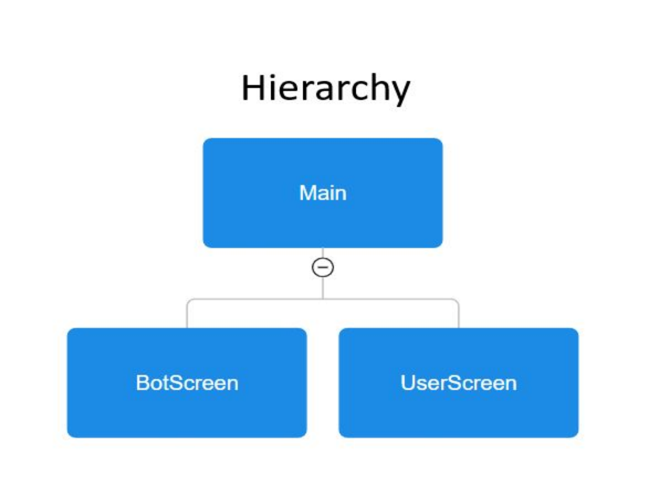
GUI implementation

- We prioritized functionality and logic rather than visual aesthetic

- Key components: a game board display, showing the score and high-score, a preview of the next pentomino

- We used a multi-frame layout

- Included double-buffering



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The Game

"Hello, IT. Have you tried turning it off and on again?" - IT Crowd

Characteristics

- The requirements asked for a functional 5x12 tetris game

- The player must be able to rotate the pentominoes and move them

- Lines are cleared when they are full, and the pieces of this cleared line fall down by 1 block

- Points are accumulated per lines cleared

“Falling” Method

- Frame rates are used to determine the speed of the block fall
- The block drops one line per game tick (frame)
- Finding the right speed to make the game playable was tricky (11 fps)
- This sequence repeats itself so the game can keep playing

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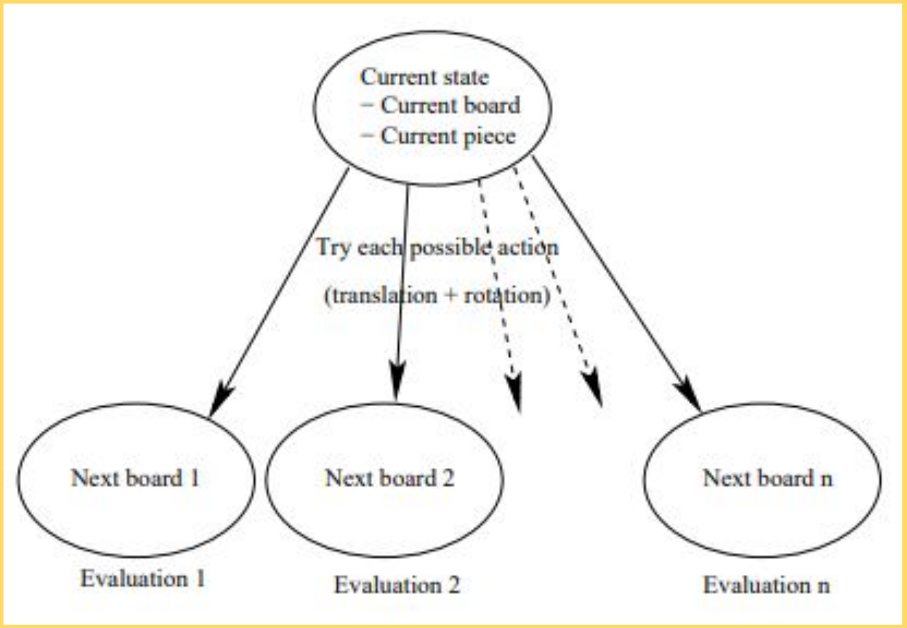
Bot Implementation

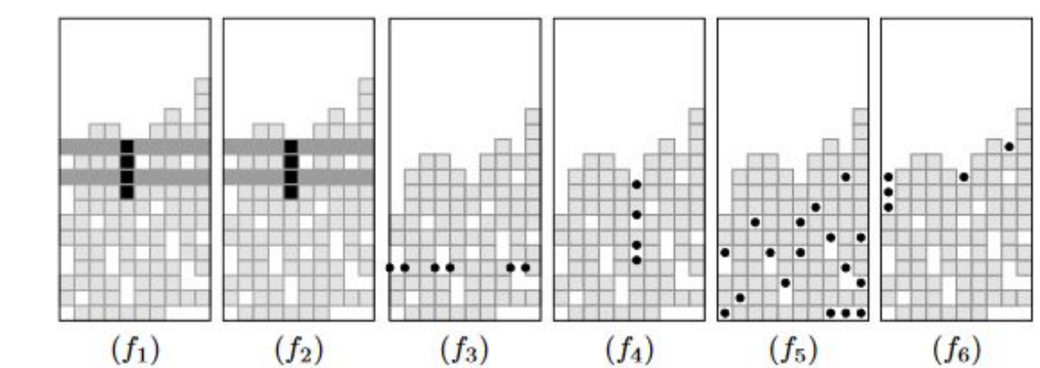
Bot Decision-Making Process

- The bot checks each possible placement of the block on the field and evaluates the state
- Using a custom evaluation formula using different weights, it calculates the evaluation
- Then it places the block with the highest evaluation



Evaluation Process

- We created 6 function features:
  - Eroded Pieces
  - Landing Height
  - Row Transition
  - Col Transition
  - Number of holes
  - Cumulative Holes



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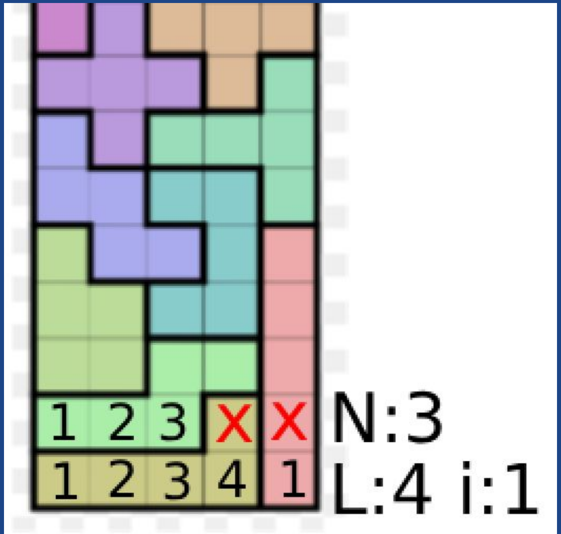
The Best Sequence

Heuristic Approach

- The algorithm uses a solved pentomino puzzle (using phase 1's project)
- Starts at the bottom row and goes up
- Compares the frequency that a specific block occupies in that row
- Skips the ones that are already in the sequence
- And puts the ones with the highest frequency first in the sequence
- If they have the same frequency, it checks its height and chooses the lowest one to put next in the sequence



Drawback: does not work for all puzzles (see diagram)

Sequence found: [L, V, U, 1, N, F, X, Z, W, P, T, Y]

Brute Force Approach

- First we shuffle the 12 distinct pieces
- The bot will play with those 12 pieces and records the score
- If the bot can take more pieces we feed it the same 12 pieces again
- This repeats until it loses, then it records the score
- If the bot is in a loop and never stops, this means we have found a sequence that in theory allows for an infinite score

Drawback: the bot may encounter the same 12 pieces (very unlikely)

Sequence found using the bot: [L, W, V, T, P, U, X, F, Z, N, 1, Y]

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Conclusion

Conclusion

We got:

- Working game!
- Working bot! (and sequence)

We could have:

- Read up more on different options before starting to code
- Improve the UI
- More systematically developing the weights of the algorithm

What We Learned

- Working with game-loops (implementing Java Runnable Threads)
- Designing a UI with different sections using specific layouts in Swing
- Developing evaluation functions and implement a bot that can determine the best moves
- Splitting the code work-load on a complex project
- Time management and effective team-work

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