User Manual

HeroChess Version 1.0

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Contents

Glossary of Chess Terms

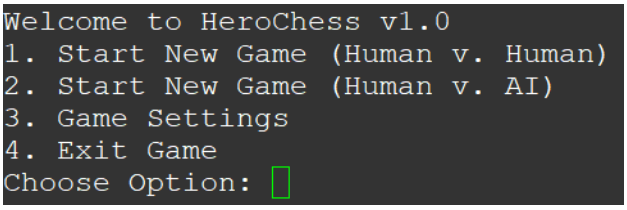
Bishop: A piece within the game that can only move diagonally across the board
Black: Classification for the player who will move second when beginning the game.
Capture: When a capturing chess piece is capable of moving into the space that is occupied by an opposing chess piece, the opposing chess piece can be removed from the game and the capturing piece moves into its previously held space. This is referred to as capture and is the primary means of advancing the game.
Castling: A special move in the game of chess where the king and rook are moved simultaneously. It is important to note that this move is only allowed if both pieces have not made a move and the king has two spaces available towards his left or right. This move may not be performed if the king is in check or if there is another piece blocking the areas where the king and rook would perform this move through. To perform the move, move the king two spaces in the desired direction(left or right) and swap the rook to the first square from the king's original position. If you start as white you could castle by moving the king from e1 to g1 and rook from h1 to f1.
Check: Designates that a chess piece is able to capture the king, forcing the targeted opponent to necessarily make a move to prevent the attack from happening. The resulting move must not leave the king open to any additional checks.
Checkmate: Designates that a check has been made, and the opponent is unable to make any moves that would protect the king from additional checks. This condition wins the game.
En passant: A special pawn capture that can only occur immediately after a pawn makes a move of two squares from its starting square, and it could have been captured by an enemy pawn had it advanced only one square. The opponent captures the just-moved pawn "as it passes" through the first square.
File: The 8 vertical columns on the board, labeled 'a' through 'h'
King: King can move in any direction in steps of one. It is important that the king stays out of check and uses its special moves with other pieces to win the game.
Knight: A knight can move in L shapes that are made up of two squares forward and one step to the side.
Pawn: Can only move forward on the board. Can choose to advance one or two spaces only on the first move. After the first move the pawn must move one space. The pawn can only capture diagonally.
Promotion: When a pawn has moved to the opposite edge of the board and cannot advance any further, it may be turned into any other game piece excluding the king.
Rank: The eight horizontal rows on the board, labeled 1 to 8.
Rook: A piece within the game that can only move vertically and horizontally across the board.
Rooking: A simultaneous move (the only one in chess) whereby a previously unmoved King moves 2 squares toward an unmoved Rook and the Rook is moved to the other side of the King
Queen: A piece within the game that can move in any direction on the board
White: A term used to classify the player that will make the first move

1 Computer Chess

1.1 Usage Scenario

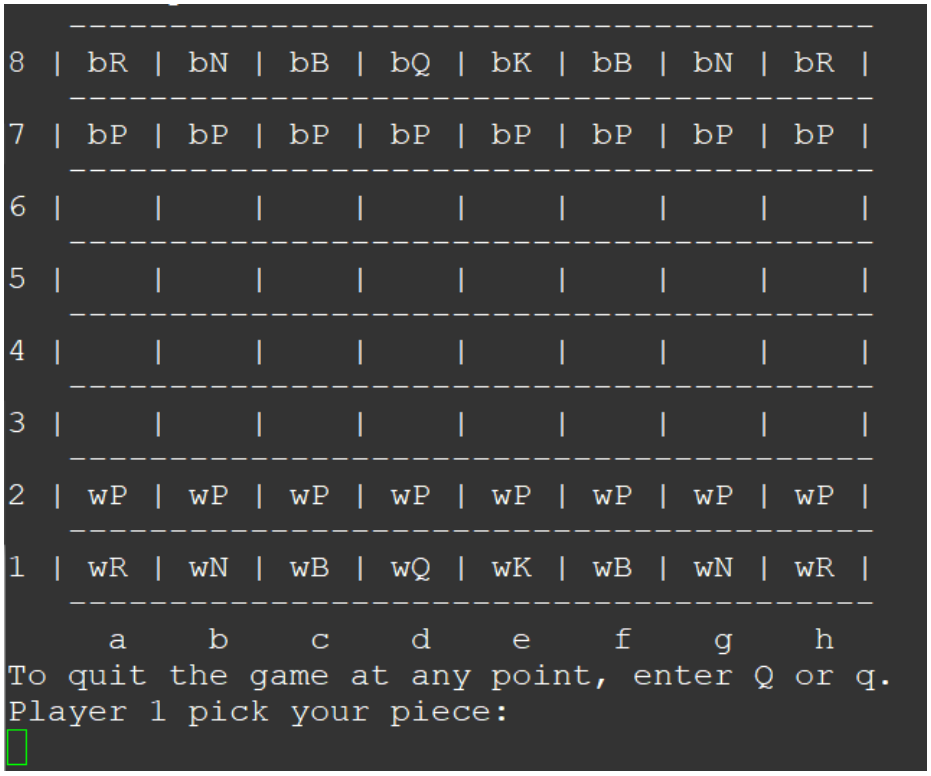
In HeroChess the user will be greeted with a numbered menu options screen. To begin a game users will choose the first option Human v. Human by typing in 1 into the screen.

FIG. 1: Starting a game



Once in the game, a board should appear along with a prompt asking for the "White" player to move. To make a move please choose the row and column for the chess piece to move to.

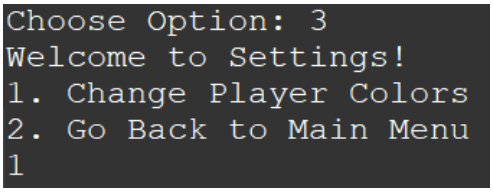
FIG. 2: White player is asked to make a move, in this case, Player 1 has the white pieces.



When White's move is made the pieces will update accordingly. After "Black" should be prompted to make a move, this process will continue until someone wins. choosing option 2 in the menu screen will work similarly except that the computer will be making the moves for either "White" or "Black" depending on which character the user chooses.

To change the setting please choose the respective number in the menu option. Similarly, the menu screen offers an exit option which users can choose to exit and quit the game.

FIG. 3: Settings Menu



1.2 Goals

For this project, our aim is to produce a functional means of playing chess through a virtual board. This entails creating a game board, game pieces, managing legal and illegal moves, and checking win conditions at a minimum. This project must be able to produce some command line or GUI visual representation of the game and the user inputs should reflect accurate changes in the game and stop players from making illegal moves. The game should stop upon a viable 'checkmate' when necessary

Additional goals include creating a rudimentary AI to play against, as well as human vs human support. A readable log to record each game should be available as well and play it back accurately.

Some other goals, if time permits, include allowing the computer to play against itself, or a human, the ability to withdraw moves, a timer for moves, the ability to begin from a preset board, and hints at optimal move choices.

All the following benchmarks will be documented and approached with good programming in mind as a collaborative effort.

1.3 Features

This program includes the standard chess board and representations for the game pieces expected of a typical chess game. Primary features include error handling when illegal inputs are made, automatic checks for win conditions, all official available move capabilities, and some representation of the board. These will be represented through console messages and user prompts. Less vital features include playback support as well as computer opponents, and the ability to play tournaments with other players, the data for which will be stored in save files for the viewing of any player.

The human player can play a game against another human at the same computer or they can play against an AI. Certain player support like undoing a move or quitting at any point of the game serve to enhance the game experience when needed. The primary features and capabilities of the program are described in further detail below, in section **3. Chess Program Functions and Features**

2 Installation

2.1 System Requirements

In using any version of HeroChess users will want to access the EECS Linux Servers. Users are recommended to have the Linux version CentOS 6.10 and perhaps even Xming if the graphical user interface is included.

2.2 Setup and configuration

1. Setup

Download a SSH client with terminal support.

1. Create a directory where the game will run as needed
    - From the command line, run the command mkdir <directory path>
    - Linux example: /EECS22L
2. Get the latest version
    - From the command line, run the command git pull
3. Extract the file
    - From the command line, run the command

Use "UCI student ID"@crystalcove.eecs.uci.edu or team""@crystalcove.eecs.uci.edu

Other servers: bondi.eecs.uci.edu, laguna.eecs.uci.edu, zuma.eecs.uci.edu

All 4 servers will work fine to run the game.

Set the port to 22 and connection type to SSH.

2. Configuration

Configuration files and their purpose:
ai.c - Contains functions for the automated player gameplay
ai.h - Contains declarations of functions in ai.c
board.c - Contains definitions of structs and functions pertaining to the board
board.h - Contains declarations of structs and functions in board.c
game.c - Contains functions for game algorithms and win conditions
game.h - Contains declarations of functions in game.c
main.c - Contains main game function and print menu function
move.c - Contains definitions of structs and functions relating to moves
move.h - Contains declarations of structs and functions in move.c
movelist.c - Contains definitions of functions related to the list of moves
movelist.h -Contains declarations of structs and functions in movelist.c
piece.c - Contains definitions of structs and functions related to the chess pieces
piece.h - Contains declarations of structs and functions in piece.c
replay.c - Contains definitions of functions related to printing the game replay text file
replay.h - Contains declarations of functions in replay.c
settings.c - Contains definitions of functions related to player and game handling
settings.h - Contains declarations of functions in settings.c
tree.c - Contains definitions of structs and functions pertaining to tree implementation
tree.h - Contains declarations of struct and functions in tree.c
makefile - Required. Contains the compilation command along with shared libraries.

2.3 Uninstalling

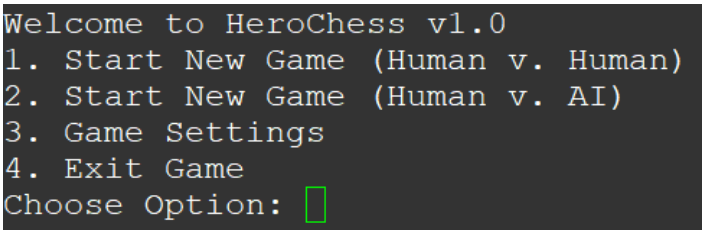
Users will be able to uninstall the Chess game executable files by being in the directory called `Chess_V1.0_src` and using the ”make clean” command.

3 Chess Program Functions and Features

3.1 Main Menu

The user is presented with a variety of options at the start of each game. This menu is interactive and therefore, the user must select one of the options to start a game. To select, the user must type the number of the option on their keyboard and press enter. Entering a character or number apart from 1-4 would enable an error. Details of each menu option are described in the succeeding sections.

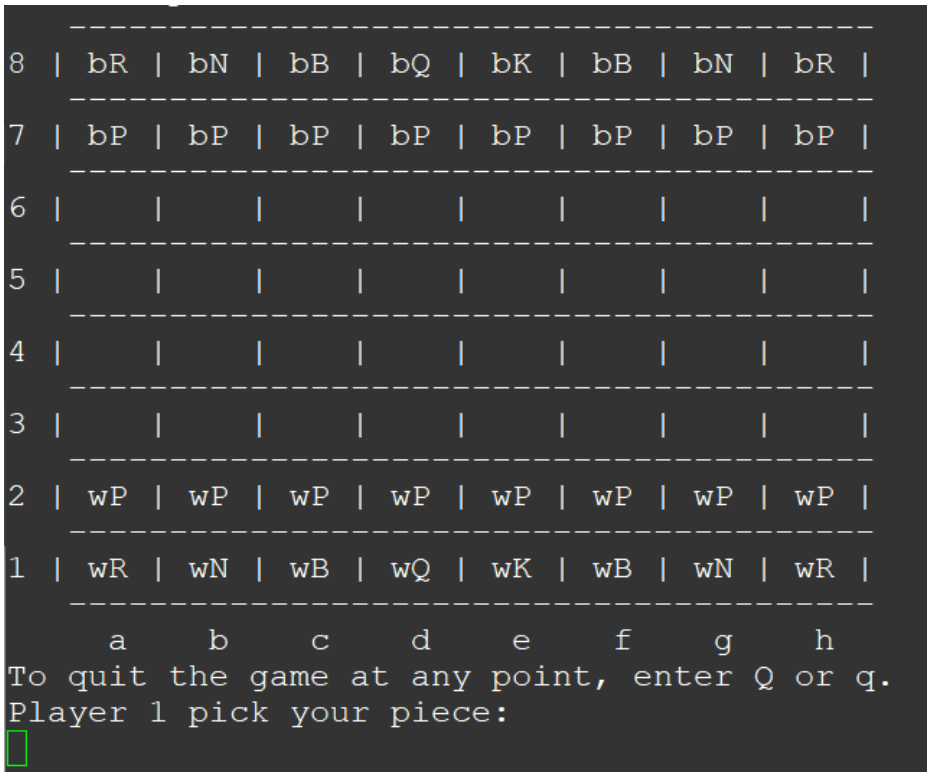
FIG. 6: Main Game Menu



3.2 Human v. Human Game

This is a two-player game between two interactive players using the same computer. Each player is given a turn to input their move (details on how current positions are tracked are explained in **3.9 Moves Log**.

FIG. 7: Blank Board for Human v. Human (HvH)



During each turn, the board is updated and printed to the screen along with prompts asking the next user to enter their move. To enter a valid move, the user must enter two positions on the same line: the current position of the piece they want to move and the position they want the piece to move to. These positions have to be entered in a [lowercase letter][number] format, i.e. a2.
The two prompts that appear to the user for a move are the following:

1. The first will say ”Player 1/2 pick your piece:”.
2. The first will say ”Where would you like to move this piece?”.

Once a move is entered and before the updated board is printed, the computer checks if the piece is allowed to make the entered move according to the rules of chess. If the piece is not allowed to follow the player's entered move, then this situation would be considered an illegal move and therefore would not be allowed onto the updated board. Cases wherein a player enters an illegal move can also be described as moves that are outside the board's bounds and/or not typed in the [letter][number] format. If any of these conditions are met during a player's turn, an error message would appear. The player who entered the invalid entry will still be on their turn after the error message and will once again be prompted to enter a valid move.
In cases where either players want to quit the game, they can enter 'Q' or 'q' for any of the prompts to quit the game at any time. A reminder for this is printed under every game board.

FIG. 8.1: Quitting the game during the pick-a-piece prompt.

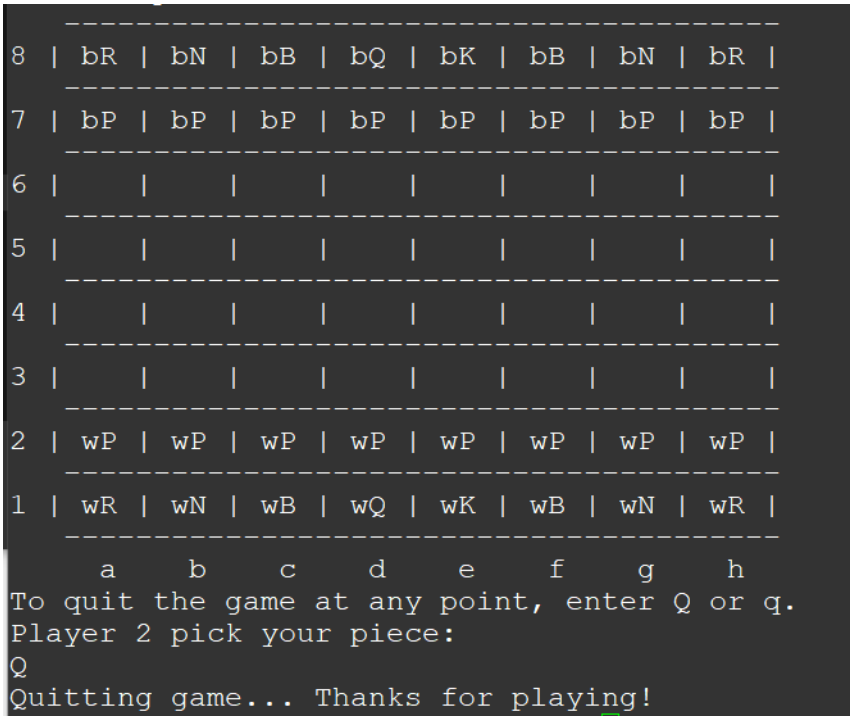
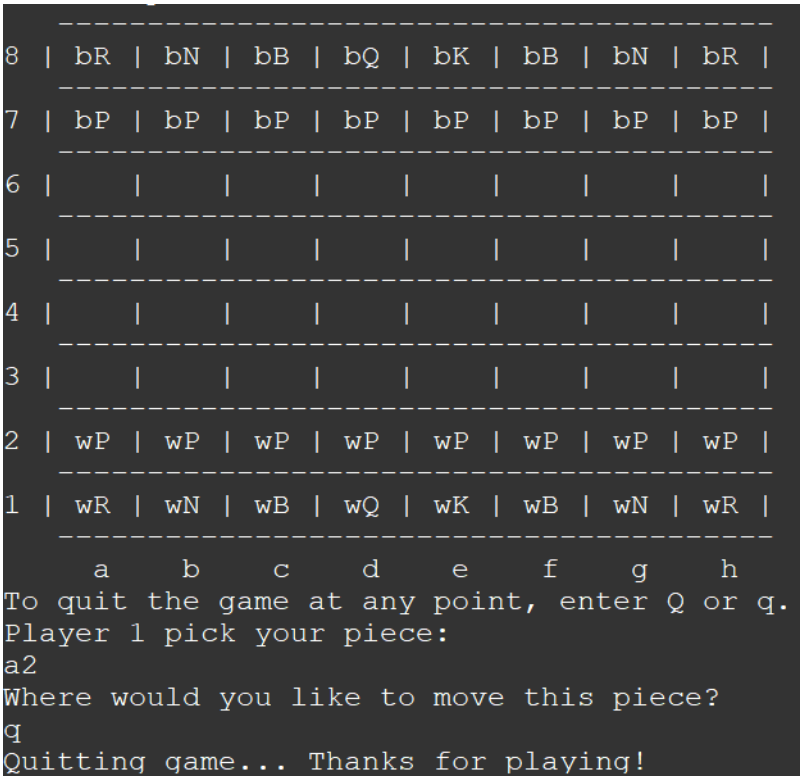
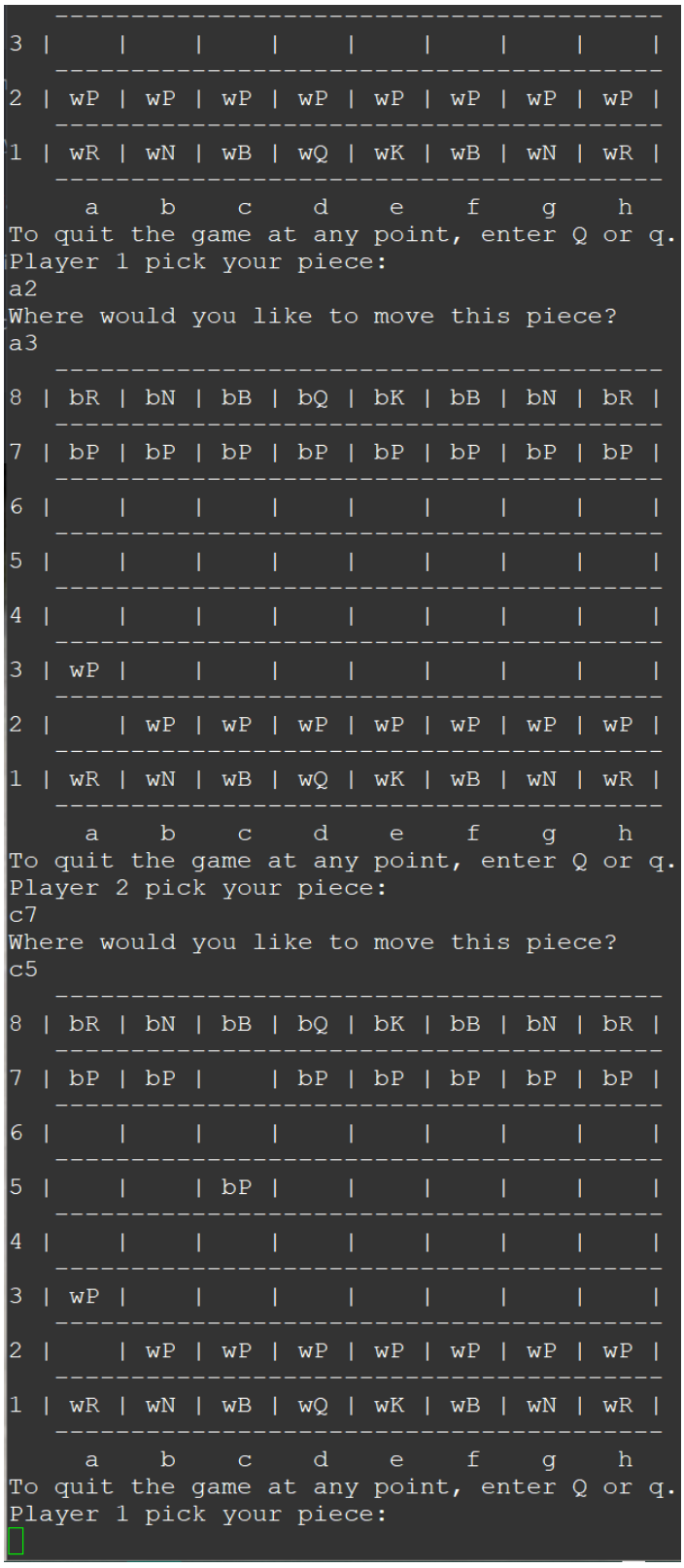


FIG. 8.2: Quitting the game during the pick-a-location prompt.



Below, **Fig. 9** shows basic game play for a HvH game.

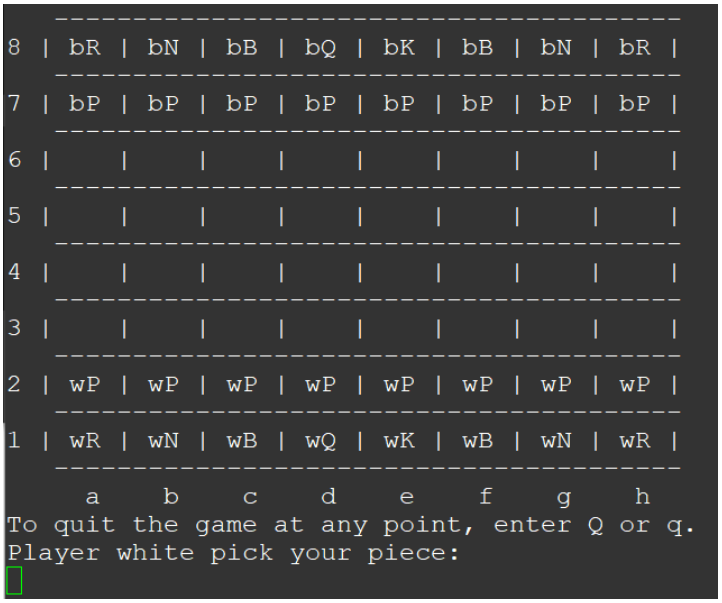
FIG. 9: HvH Game



3.3 Human v. AI Game

This is a two-player game between an interactive player (human) and an automatic player (computer).

FIG. 10: Blank Board for Human v. AI (HvAI)



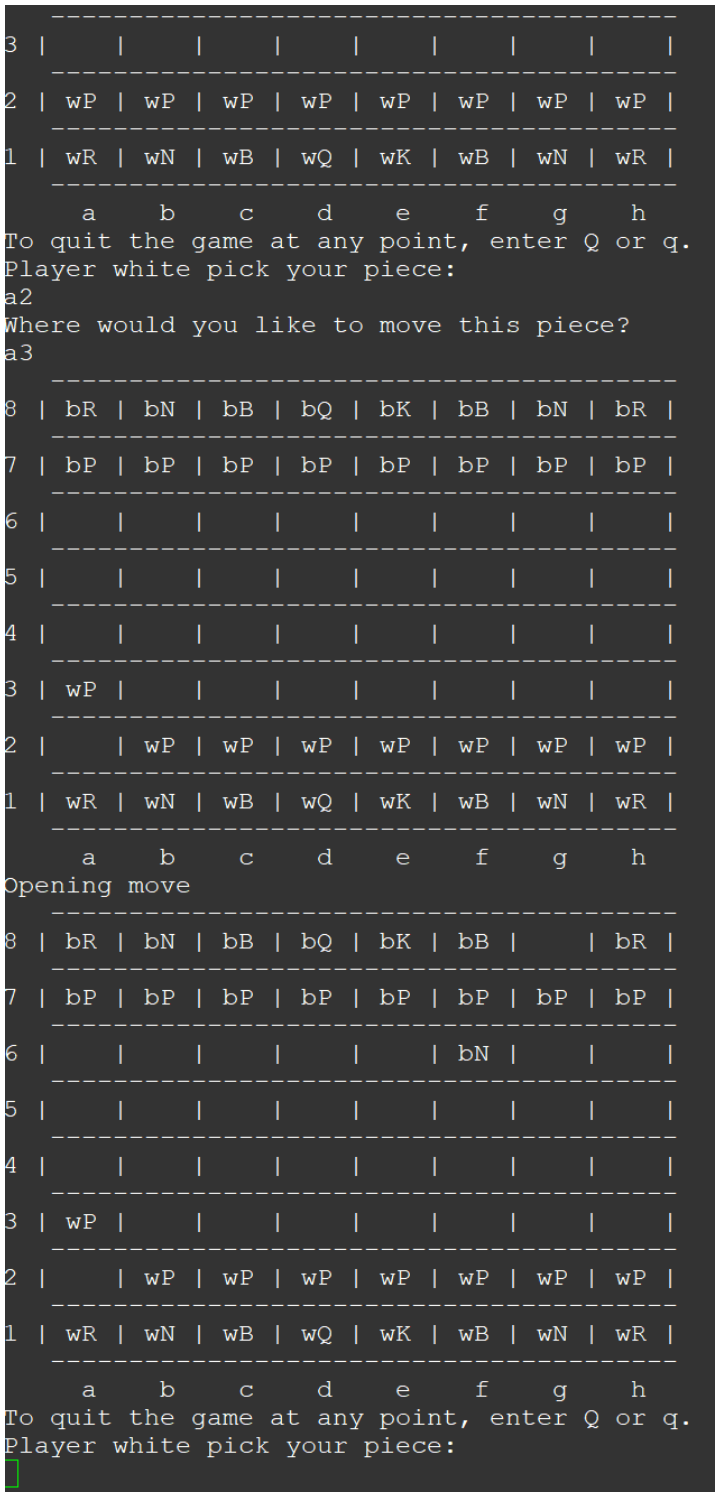
Similar to the Human v. Human Game, the game is played in turns between players. Each turn consists of an updated board and a message prompting a user to enter a valid move for one of their pieces. Since the human player is the only one actually interacting with the game, they must make sure that they enter valid inputs into the game. The player must always first enter the position of the piece they want to move and then the new position they want the piece to move to. Additionally, these positions must be typed in the format [lowercase letter][number], i.e. a2. After the human player enters their move, the new board printed will reflect the human player move and the computer move.

The human player will then be prompted to enter the position of the piece they want to move. An illegal move is made when the piece is not allowed to move to the position directed by the user (as according to the rules of chess), the entered position(s) is outside the board's bounds, and/or the entered position(s) is not typed in the correct format. Any of these cases would result in an error message and a prompt asking the user to enter a valid input.

As such, the human player and computer player keep taking turns until one or neither of them win the game. Only for the Human vs. AI players will be asked if they want to undo the last move and go back to the previous turn. The user will take back the move they put in their current turn, and the AI move that came before will be undone. This function activates after the player and AI make at least one move each. Just like the Human v. Human game, the human can enter 'Q' or 'q' for any of the prompts to quit the game at any time.

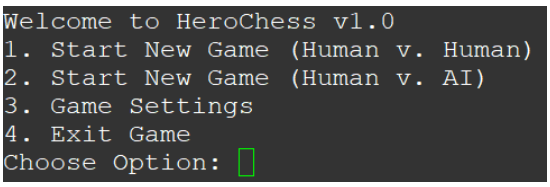
Below, **Fig. 11** shows basic game play for a HvAI game.

FIG. 11: HvAI Game



3.4 Game Setting

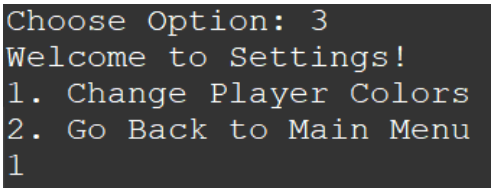
FIG. 12: Main Game Menu



Before any game, the user is given the option to customize the following features:

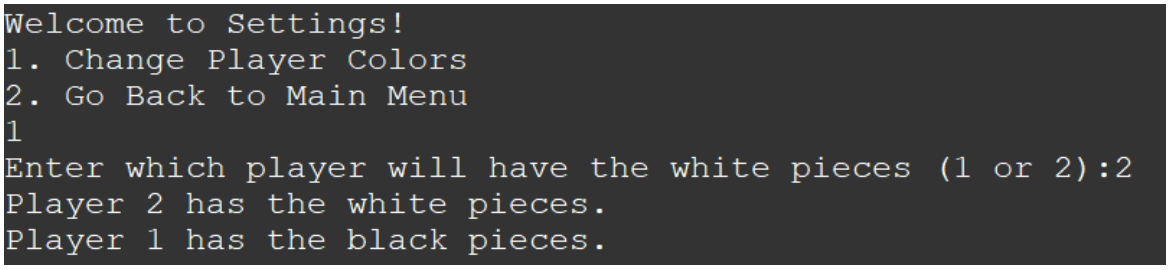
1. Game Type (Human vs. Human or Human vs. AI) - Options 1 or 2 in Main Menu
2. Player Color (white or black) - Option 3 in Main Menu (Game Settings)

FIG. 13: Main Settings Menu



- Technically, it's the number corresponding to the colors that is directly changed by the user, since the settings prompt asks the user to enter the player number they want to assign to a color.
- This option also determines which group of pieces the player will have control over throughout the game. This assignment is predetermined by the color selection.
- At the start of a game, black would assign the player to all the pieces on the top portion of the board and white would assign the player to all the pieces on the bottom portion.

FIG. 14: What the user sees when they have to set the player numbers:



3.5 Implementing the Official Rules of Chess

The basic chess board is represented through a 2d grid of fixed size, with all initial conditions and positions hardcoded into place (for the default configuration) and each piece is represented by a 2 character code corresponding to color and character (e.g bP is 'black Pawn'). This grid is also used to check for valid movements in the form of out of bounds errors and other invalid inputs.

Each chess piece does have its own internal data of what moves are 'legal' for that particular piece at that particular position (explained in **3.6 Basic Moves**), represented as a set of mathematical operations that would translate to movement on the 2d board. Along with the basic movement mechanics, this also includes moves such as castling (which can only be done from initial positions) and double pawn movement (which also only can be done from initial position). The relevant data is contained within each piece and modified as the game progresses, and does not persist between games. Other special moves, such as promotion, are handled through separate checks as needed.

The base settings of the game are set to a default, but can be modified through a separate file. These settings also help keep track of valid rules and custom criteria as needed.

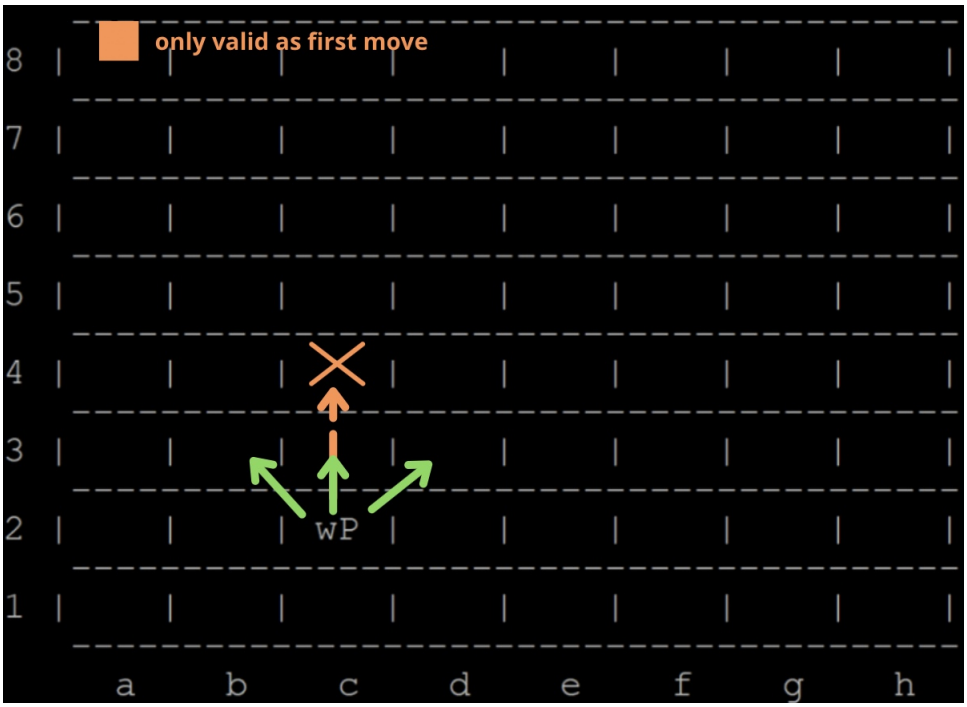
Finally, the win conditions of the board are checked regularly. Centered about each king, the program automatically scans for potential checks every round and sends a warning to the respective users when it occurs. The game, through a set of checks, ensures that any subsequent move made necessarily ends the check. The checkmate, or win condition, of the game is tested following any successful check in the form of an exhaustive scan over all relevant possible moves, and in the event that all still lead to a check, the game is considered won.

3.6 Basic Moves

Although every piece in chess is distinct in its own capabilities, they all share the common ability to move to any available space in a piece-specific way, provided that it is not occupied by a friendly piece, and (with the exception of a pawn), can capture any opposing piece that is in a spot that it can otherwise occupy in one move. Following a capture, the piece moves into the space of the opposing piece it just captured, the captured piece is removed from the game, and the current turn ends. The following essential moves and abilities of each piece, which will be represented accurately in the game, are listed below.

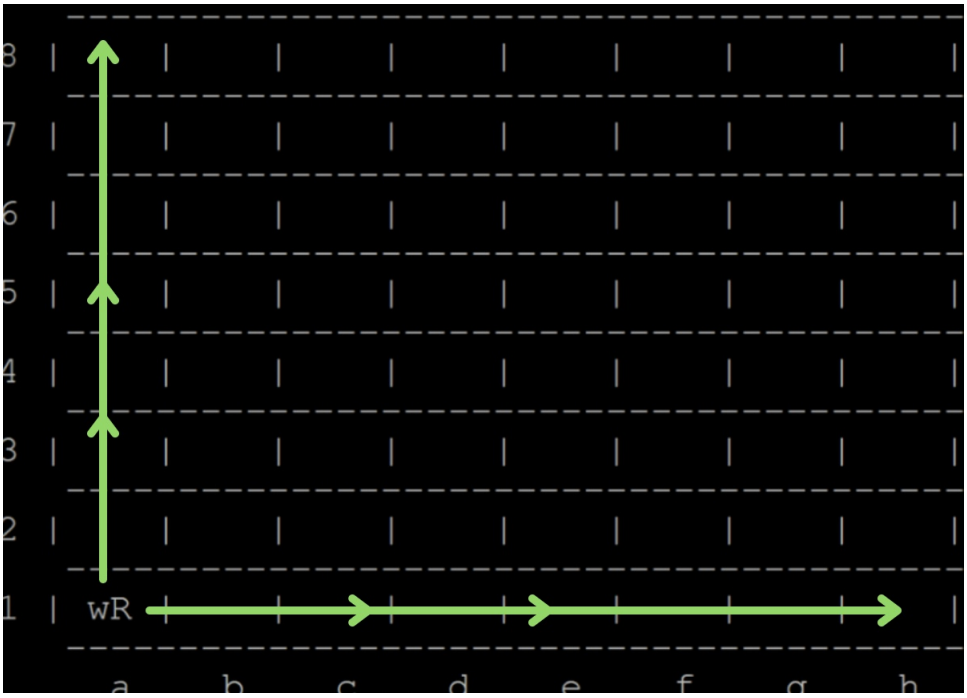
Pawn: The most numerous pieces that occupy the forerow of each side. They are capable of moving only one space directly forward towards the opposing side, unless they have not moved at all in which case they can move two spaces forward instead. They can not capture pieces directly in front of them, but rather can only capture pieces directly one square forward and one square left or right to them (diagonally forward). These also can be used for the special move, Promotion.

FIG. 15: Allowed Pawn Moves:



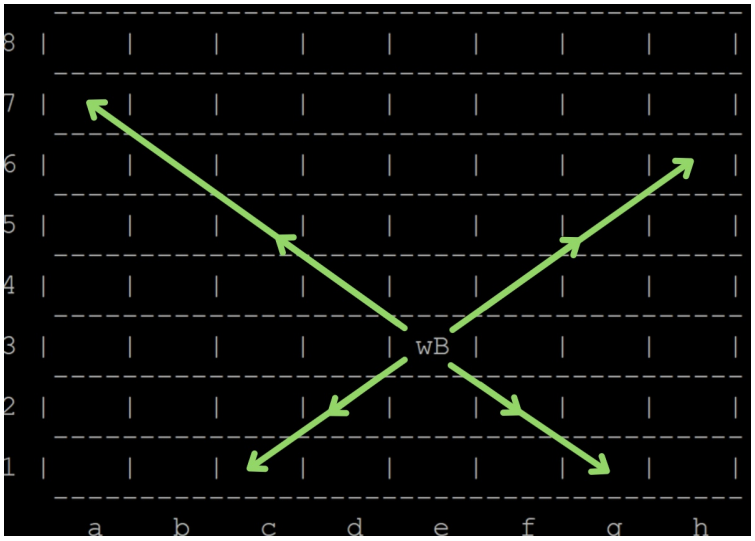
Rook: The pieces that begin on the far corners of the board, these Rooks can only move in directly horizontal or directly vertical motions. They are used in the special move of Castling.

FIG. 16: Allowed Rook Moves:



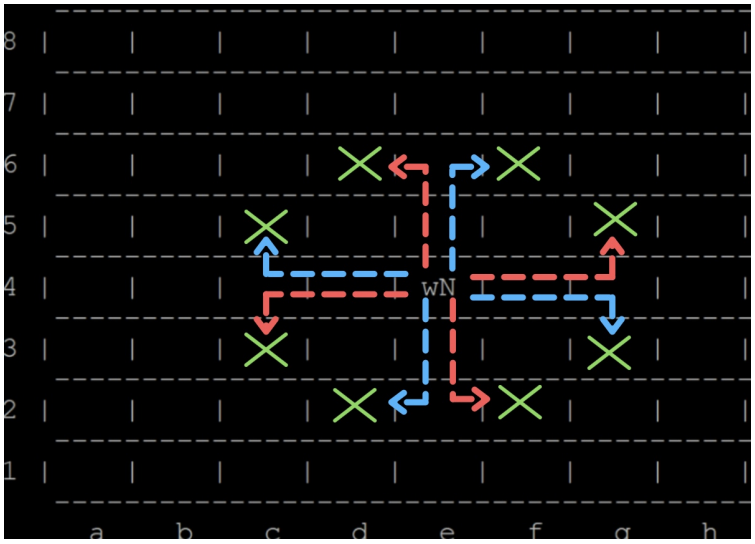
Bishop: These pieces are directly next to the king and queen and are capable of only diagonal movement, so for every square left or right they advance, they necessarily must also advance one square forwards or backwards.

FIG. 17: Allowed Bishop Moves:



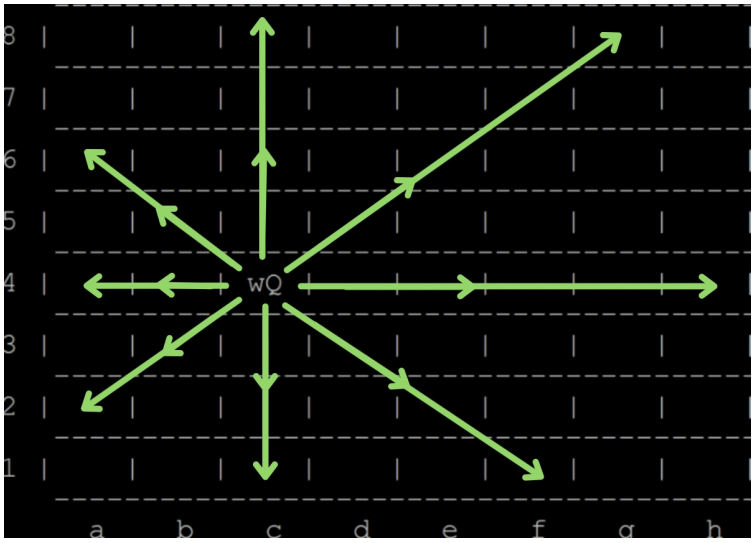
Knight: These pieces begin next to the rooks on the back row with all the other non-pawn pieces. The Knight is capable of only moving exactly two spaces in a horizontal or vertical direction, then must move exactly one space in a vertical or horizontal direction respectively. These pieces can uniquely move past, or 'jump' over any pieces between its current position and the one it would occupy, whether or not those pieces are opposing or friendly.

FIG. 18: Allowed Knight Moves:



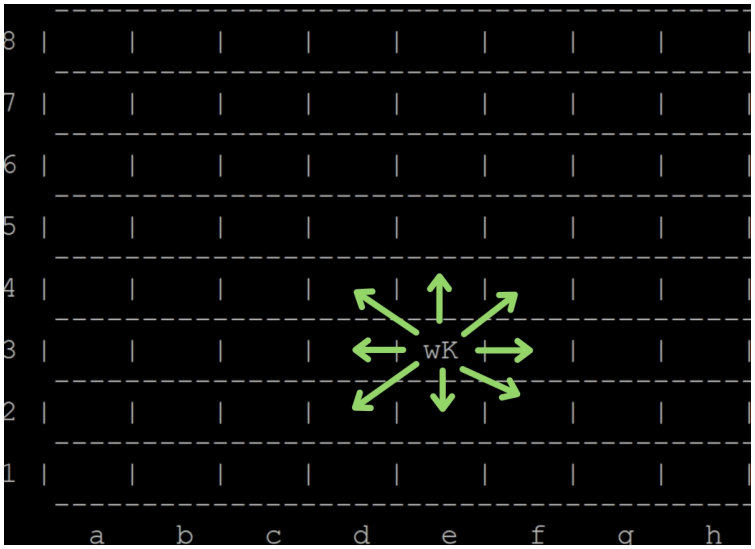
Queen: This piece is capable of moving in a diagonal or horizontal or vertical motion to any distance, much like a combination of the bishop and rook. It is always adjacent to the king in the beginning of the game.

FIG. 19: Allowed Queen Moves:



King: This is the most important 'piece' of the game and is capable of moving to exactly one space around it. This piece is unique in that it does not get captured, it can only be checked, meaning it can only be threatened with an imminent capture, forcing the threatened side to make some move to make the king no longer threatened with capture, or no longer 'checked'. The object of the game is to make it impossible to escape the check for the opposing side, or to create a 'checkmate'.

FIG. 20: Allowed King Moves:



3.7 Special Moves

Castling: A special move in the game of chess where the king and the rook swap positions. Although this move is very useful, there are many conditions that the users have to keep in mind when performing the move. First, a player can only castle when all pieces involved (rook, king) have not moved from their starting positions. Second, the king must have two spaces available in the direction of a rook. Third, the spaces in between the rook and the king may not be monitored or blocked by any pieces of the respective opponent. Finally, the king may not castle if it is in check.

FIG. 21.1: Performing Castling:

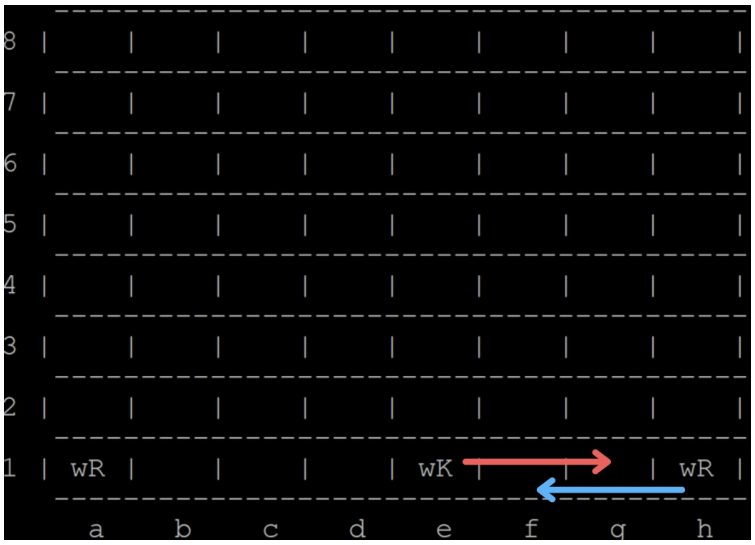
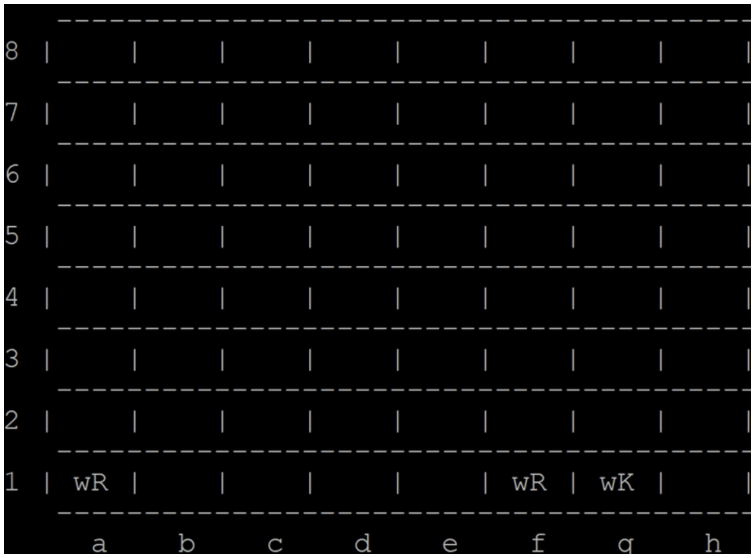


FIG. 21.2: Performing Castling:



En Passant: A special move where a pawn gets the right to capture the opponent's pawn on the same rank if and only if the opponent has moved their pawn two squares. This move is also conditioned to one turn; if the player does not choose to capture in the turn after the opponent has made their move, then the player loses the right to capture.

FIG. 22.1: Performing En Passant:

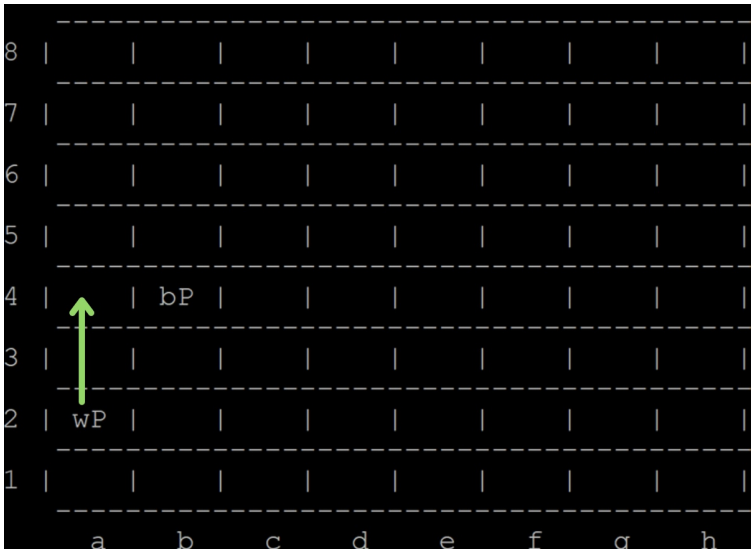
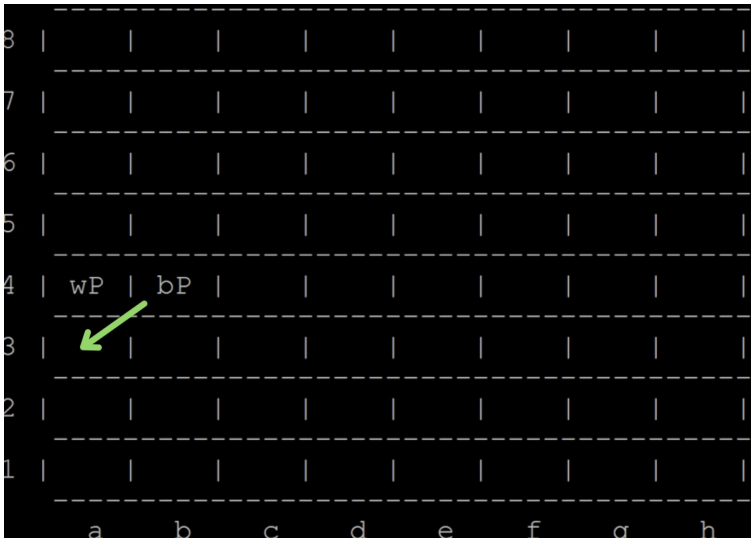


FIG. 22.2: Performing En Passant:

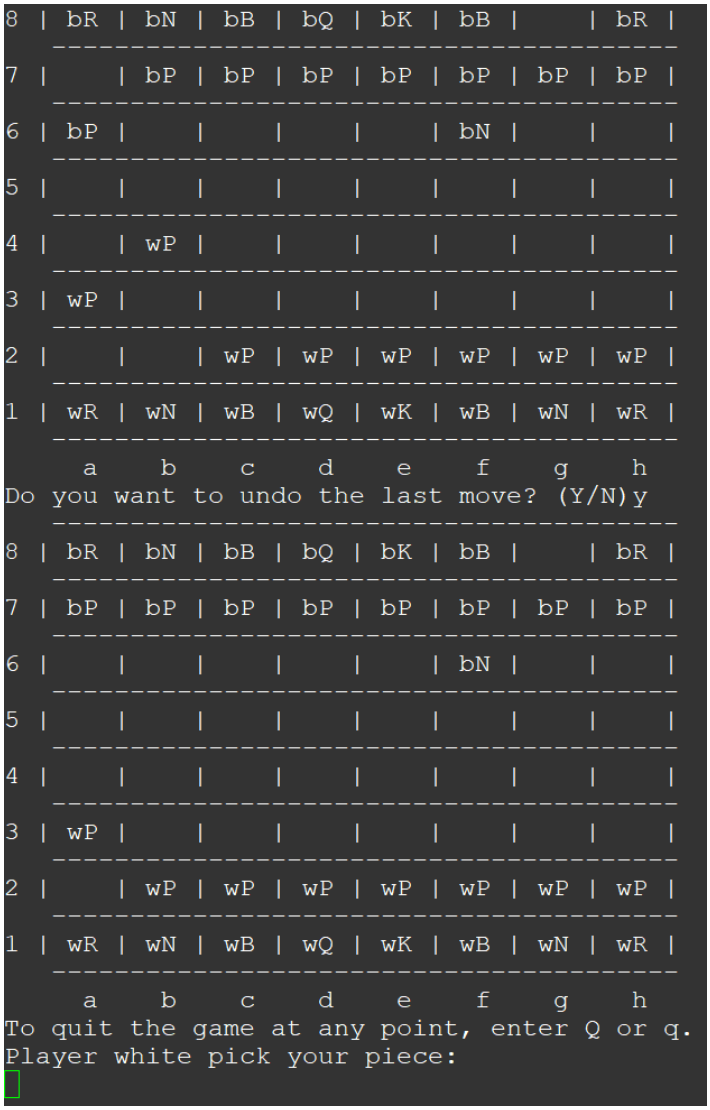


Promotion: A rule that requires a pawn that reaches the opposite end of the board to be replaced by the player's choice. The piece cannot be a king or pawn. The choice of the new piece is not limited to the pieces that are already captured. Therefore, two or more units of a kind is possible.

3.8 Advanced Functions

Undo Moves: For human vs. AI game mode, undo feature will be enabled after the human and AI make at least one move each. The human player will be asked if they want to "roll back" to their previous turn. If they enter Y for yes, the board will essentially reset to the both players' turns before the current state. Human players will be able to make a better move since they know how AI will play compared to the previous move.

FIG. 23: Undo Move:



3.9 Moves Log

A text file will be created and available to the user, after the chess game is over, with all the moves from the game. This feature will also allow the user to take back moves by keeping track of the position of the board at every move. The moves log will contain: basic program/file information such as the version number, file name, date, and time. Moreover, the text file should contain general information about the settings such as the character and color of each player. The file will clearly show the winner of the game and a moves list. To get a better sense of how the game is played out the file will show the still frame of the board at every single move as an exact replay of the game played.

FIG. 24: Replay Text File:

```
#HeroChess
Version: v1.0
Filename: replay 2021-5-11 5:7:20.txt
Date: 2021/5/11 5:7:20

Player 1
Player 2

////////////////////////////////
Player 1 moved from E2 to E4.
   ---------------------------------------
8 | bR | bN | bB | bQ | bK | bB | bN | bR |
   ---------------------------------------
7 | bP | bP | bP | bP | bP | bP | bP | bP |
   ---------------------------------------
6 |    |    |    |    |    |    |    |    |
   ---------------------------------------
5 |    |    |    |    |    |    |    |    |
   ---------------------------------------
4 |    |    |    |    | wP |    |    |    |
   ---------------------------------------
3 |    |    |    |    |    |    |    |    |
   ---------------------------------------
2 | wP | wP | wP | wP |    | wP | wP | wP |
   ---------------------------------------
1 | wR | wN | wB | wQ | wK | wB | wN | wR |
   ---------------------------------------
     a    b    c    d    e    f    g    h
Player 2 moved from E7 to E5.
   ---------------------------------------
8 | bR | bN | bB | bQ | bK | bB | bN | bR |
   ---------------------------------------
7 | bP | bP | bP | bP |    | bP | bP | bP |
   ---------------------------------------
6 |    |    |    |    |    |    |    |    |
   ---------------------------------------
5 |    |    |    |    | bP |    |    |    |
   ---------------------------------------
4 |    |    |    |    | wP |    |    |    |
   ---------------------------------------
3 |    |    |    |    |    |    |    |    |
   ---------------------------------------
2 | wP | wP | wP | wP |    | wP | wP | wP |
```

This feature will contain important information about the board by keeping track of the board at every position. Furthermore, each piece themselves will contain relevant information about it's color and movement at any given time.

3.10 Tournament Support

Players can have a tournament with other competitors. The board will follow the specific format that the Chess games from other UCI teams use. The game has networking features to interact with other client inputs.

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Error Messages

"Error. Try again":

- Illegal Move: Attempted to move a piece to a space where it cannot occupy or cannot move to normally.
- Incorrect input: Inputted something that did not register as a valid option or coordinate
- Not your Piece: Attempted to move a piece that did not belong to the player of the current turn.
- Out of bounds: Attempted to move a piece to a space outside the gameboard

"Error: Out of bounds column option":

User input in the form of [letter][number] does not correspond to a column labeled in the board, a-g.

"Out of memory! Aborting...":

- Cannot create new piece because of no memory
- Cannot create new move entry for list
- Cannot create new list
- Cannot create new node
- Cannot create empty node

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References

[1] "Play Ches Online vs Cpu Play Chess Against Computer Expert-Chess-Strategies.com - Hr.prodaja2021.com." n.d., hr.prodaja2021.com/content?c=play ches online vs cpuid=2. Accessed 27 April 2021.