User Manual

HeroChess Version 1.0

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Contents

I. 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 the 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, labelled 1 to 8.

Rook: A piece within the game that can only move vertically and horizontally across the board.

Queen: A piece within the game that can move in any direction on the board.

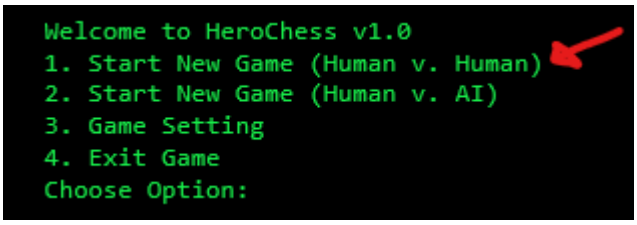
White: A term used to classify the player that will make the first move.

II. COMPUTER CHESS

A. Usage scenario

In HeroChess the user will be greeted with a numbered menu option 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" players to move. To make a move please choose the row and column for the chess piece to move to.

FIG. 2: Board

When White's move is made the pieces will updated 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 use to exit and quit the game.

B. 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.

C. 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 AI of the game is also available to play against at varying degrees of difficulty, and can also provide helpful hints for use in game. Certain player support such as a timer and take back moves, also serve to enhance the game experience when needed. The primary features and capabilities of the program are described in further detail below, in section **IV. Chess Program Functions and Feature**

III. INSTALLATION

A. 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.

The PuTTY Client does not have any special hardware or software requirements. The PuTTY client is compatible with any computer running Microsoft Windows 7, Windows 8.1, and Windows 10.

B. Setup and configuration

Setting up the HeroChess is very simple you must download the binary file made publicly available through https://github.uci.edu/EECS-22L-S-21-Team-Projects/Team19. once downloaded open the directory containing the binary file and run the command ./HeroChess, this should allow you to run and play the game through the command line. Note that the binary file might need xming if or when using and versions that require a graphical user interface.

C. Uninstalling

Users will be able to uninstall the HeroChess game executable files using "make clean" command along with the other supplement file created during the installation process. <screenshots> Close the SSH terminal to exit.

IV. CHESS PROGRAM FUNCTIONS AND FEATURES

A. 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.
The menu described should look something like the following:

1. Start New Game(Human v. Human)
2. Start New Game(Human v. AI)
3. Game Setting
4. Exit

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.

It is suggested that the user go to the 'Game Setting' first to see and possibly customize the features of their game (player color assignments, etc.).

B. 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 **3.10 Moves Log)**.

During each turn, the board is updated and printed to the screen along with a prompt 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 a3 (this would make a legal move on a white pawn one space forward). 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. This cycle of turns repeats until one or neither player wins.

C. Human v. AI Game

This is a two-player game between an interactive player (human) and an automatic player (computer). Before starting this game, the user is asked to choose the level of difficulty for the AI, such as beginner, intermediate, and expert (details on the AI difficulties are described in **3.8 Advanced Functions)**.

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 a3 (this would make a legal move on a white pawn one space forward). 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.

D. Game Settings

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

1. Game Type(Human v. Human or Human v. AI)
2. (white or black)
    - 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.
3. Default settings if the user chooses not to customize anything:
    - Human vs. Human Game
        (a) Player 1 - white (group of pieces that start at the bottom of the board)
        (b) Player 2 - black (group of pieces that start at the top of the board)
    - Human vs. AI
        (a) Player 1 - white, human player
        (b) Player 2 - black, computer player

E. Implementing the Official Rules of Chess

White is always first to move and players take turns alternately moving one piece at a time. Movement is required, but has no legal moves(illegal moves will be disabled by the program). The chessboard is made up of eight rows and eight columns for a total of 64 squares. The vertical files are labeled a through h. Similarly, the horizontal ranks are numbered from 1 to 8. In the initial position setup, the light queen is positioned on a light square and the dark queen is situated on a dark square.

FIG. 3: Initial board setup

The basic chess board is represented through a 2d grid of fixed size, with all initial conditions and positions hard coded into place (for the default configuration) and each piece is represented by either an icon (GUI vers.) or 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, which allows users to choose game parameters, initial setup, and AI levels. 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.

F. 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 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 game, and the current turn ends. The following essential moves and abilities of each piece, which will be represented accurately in game, are listed below

Pawn: The most numerous pieces that occupy the fore row 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.

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.

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.

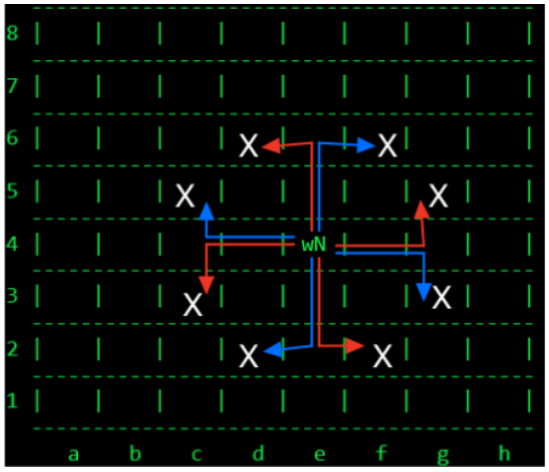
Knight: These pieces begin next to the rooks on the back row with all the other non-pawn pieces. The Knight is capable of only moving exactly two spaces in a horizontal or vertical direction, then must move exactly one space in a vertical or horizontal direction respectively. These pieces can uniquely 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.

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.

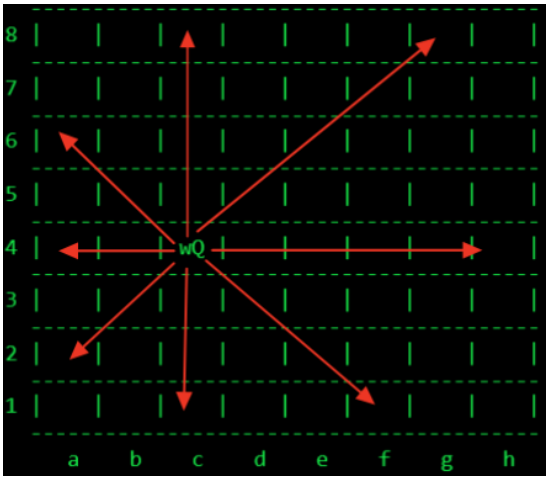
King: This is the most important 'piece' of the game and is capable of moving to exactly one space around it. This piece is unique in that it does not get captured, it can only be checked, meaning it can only be threatened with an imminent capture, forcing the threatened side to make some move to make 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. 4: Basic Moves

(a) Knight Moves



(b) Queen Moves

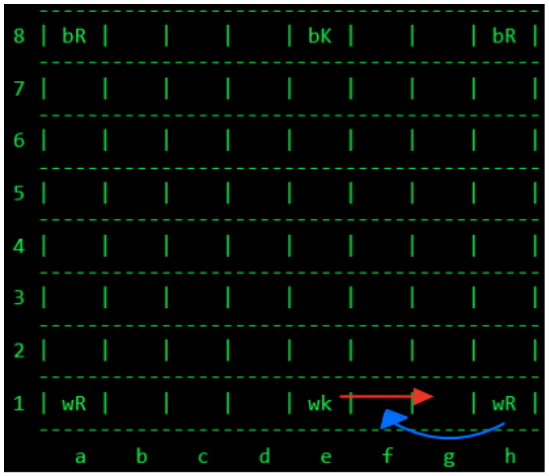


G. Special Moves

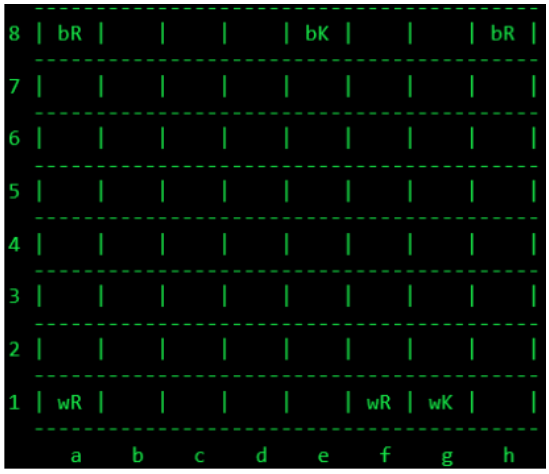
Castling: Is a special move in the game of chess where the king and the rook swap positions. Although this move is very useful there is many conditions that the users have to keep in mind when performing the move. First, A player can only castle when all pieces involved(Rook King) have not moved from 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. 5: Performing castling

(a) Part 1



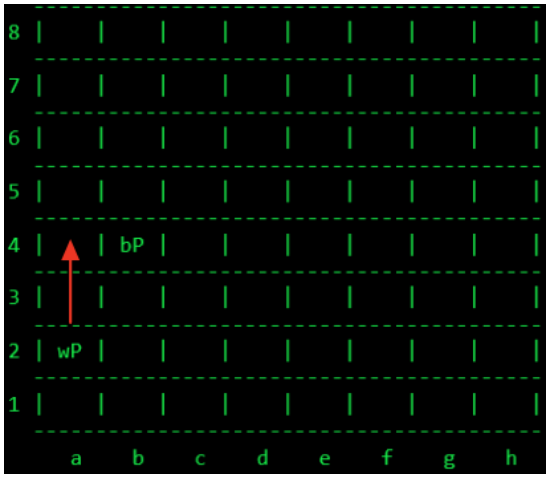
(b) Part 2



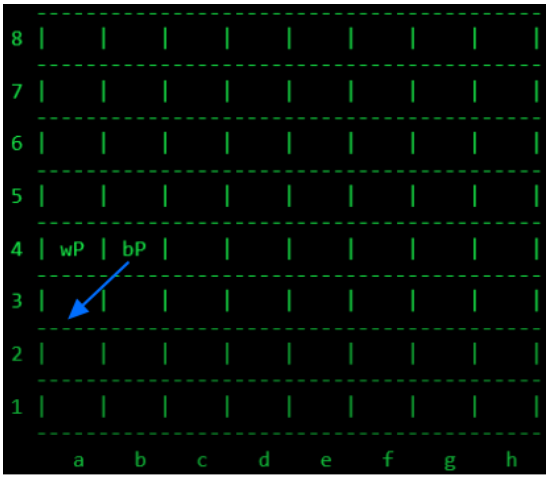
En passant: Is a special move where a pawn gets the right to capture the opponents pawn on the same rank if and only if the opponent has moved their pawn two squares. This move is also conditioned to one turn if the player does not choose to capture in the turn after the the opponent has made their move then the player looses the right to capture.

FIG. 6: Performing En Passant

(a) Part 1



(b) Part 2



Promotion: In chess is 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/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.

H. Advanced Functions

The user will have the option of undoing previous moves, including the opponent's moves, before it is the opponent's turn. They will also be able to choose how many moves they would like to undo. To undo a move, the user must enter "y" when asked if they would like to undo a move. They will then be asked how many moves they would like to undo. This number includes the opponent's moves. If the user would like to undo two of their moves, they must enter 3. If the user would like to undo the three of their moves, they must enter 5. It will then be the opponent's turn and the game will continue as normal.

There are 3 levels of difficulty for the AI, beginner, intermediate, and expert. The user will choose the level of difficulty of the AI after selecting option 2 of the main menu. The beginner-level AI will only allow the AI's pieces to move one space at a time. The AI's Queen, for example, will only be able to move diagonally, vertically, or horizontally one space. The user will also be given more time to make their move (1 minute 15 seconds). The intermediate level AI will capture any available pieces while still following the rules of chess. The time the user has to make a move will also change to the default time (less than 1 minute). The expert level AI will perform the special moves, castling and en passant, when the user's pieces are in the right condition.

Hints will be given to the players through a list of possible moves. The computer will present one or multiple moves that players can execute in order to win. The moves listed will not explicitly help the opposing player win. The moves will be computed after considering two turns ahead of the current turn.

I. Timer

This feature ensures that the computer player makes its moves within a reasonable amount of time (less than one minute per move).

J. 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.

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. .

K. 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.

V. COPYRIGHT

This installation is protected by U.S and international copyright laws. Reproduction and distribution of the project without written permission of the sponsor is prohibited.

VI. ERROR MESSAGES

Illegal Move: Attempted to move a piece to a space where it cannot occupy or cannot move to normally.

Out of bounds: Attempted to move a piece to a space outside the game board.

Incorrect input: Inputted something that did not register as a valid option or coordinate

Time's up: Waited too long to select a move, timer ran out for player's turn

Not your Piece: Attempted to move a piece that did not belong to the player of the current turn.

File write error: Some error while writing the playback data to a text file for storage.

Checked: The king is checked and the move selected does not remove the check.

VII. INDEX

[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.