

Chess for students; written in Python

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Contents

1	Analysis	1
1.1	Introduction	1
1.2	Rules of Chess	1
1.2.1	The Game Board	2
1.2.2	Pawn	3
1.2.3	King	4
1.2.4	Bishop	5
1.2.5	Rook	6
1.2.6	Queen	6
1.2.7	Knight	7
1.2.8	Game States	7
1.3	Questionnaire	9
1.4	Setting	12
1.5	Users	12
1.6	System	12

1.7	Input	13
1.8	Processing	13
1.9	Output	13
1.10	Volumetrics	14
1.11	Problems with the Current System	16
1.12	Objectives	17
2	Documented Design	19
2.1	Introduction	19
2.2	Overall System Design	20
2.2.1	Input	20
2.2.2	Processing	21
2.2.3	Storage	21
2.2.4	Output	21
2.3	Hierarchy Charts	22
2.3.1	Top Level View	22
2.3.2	Second Level View	22
2.3.3	Third Level View	23
2.4	Code Design	24
2.4.1	Class Diagrams	24
2.4.2	File and Code Structure	25

2.4.3	Required Software	26
2.4.4	Code Documentation	26
2.5	Input Validation	36
2.6	Algorithm Commentary	36
2.6.1	Binary Search	37
2.6.2	Quicksort	37
2.6.3	Legal Move Calculation	39
2.7	User Interface	42
3	Testing	46
3.1	Introduction	46
3.2	Testing Plan	46
4	Evaluation	49
4.1	Introduction	49
4.2	User Feedback	49
4.2.1	User Acceptance Testing	49
4.2.2	Possible Improvements	51
A	Appendix	52
A.1	Analysis Research	52
A.2	Testing Evidence	53

A.3 Source Code	65
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List of Figures

1.1	The initial setup of a game of chess.	2
1.2	The possible moves a pawn can make.	3
1.3	The types of pieces that a pawn can be promoted to.	3
1.4	A board position in which en passant is possible.	4
1.5	The possible moves of a king.	4
1.6	Movement of king and rook during castling.	5
1.7	The possible moves of a bishop.	5
1.8	The possible moves of a rook.	6
1.9	The possible moves of a queen.	6
1.10	The possible moves of a knight.	7
1.11	An example of check.	8
1.12	An example of checkmate.	8
1.13	An example of stalemate.	9
2.1	Top level hierarchy chart.	22
2.2	Second level hierarchy chart: Gameplay.	22

2.3	Second level hierarchy chart: Game File Handling.	22
2.4	Third level hierarchy: Manage Table Clicks.	23
2.5	Third level hierarchy chart: Game Calculations.	23
2.6	Third level hierarchy chart: Manage Promotions.	23
2.7	Third level hierarchy chart: Save Game.	23
2.8	Third level hierarchy chart: Load Game.	23
2.9	Third level hierarchy chart: File Path.	24
2.10	Class diagram for Piece and its subclasses.	24
2.11	Class diagram for the controllers and model of the program.	25
2.12	Code structure of the program.	26
2.13	Source code for the recursive binary search algorithm.	37
2.14	Source code for the recursive quicksort algorithm.	38
2.15	Source code for the functions which calculate the legal moves.	39
2.16	Source code for the functions which calculate the legal moves.	40
2.17	Source code for the functions which calculate the legal moves.	41
2.18	UI of the main program.	42
2.19	The load dialog of the program.	43
2.20	A "Save As" dialog used to save a new game file.	44
2.21	A file chooser dialog used to choose the game file to load.	45
A.1	Table set out with equipment used by the chess club.	52

A.2	Whiteboard showing winners and losers of game.	53
A.3	Test 2 - white to move, black pieces are greyed out (not clickable).	53
A.4	Test 3 - legal moves of a queen.	54
A.5	Test 4 - legal moves of a king.	54
A.6	Test 5 - legal moves of a bishop.	55
A.7	Test 6 - legal moves of a knight.	55
A.8	Test 7 - legal moves of a rook.	56
A.9	Test 8 - legal moves of a pawn.	56
A.10	Test 9 - en passant move.	57
A.11	Test 10 - castling move.	57
A.12	Test 11 - dialog notifying user of check.	57
A.13	Test 12 - dialog notifying user of checkmate.	58
A.14	Test 13 - dialog notifying user of stalemate.	59
A.15	Test 14 - check that promotion works.	59
A.16	Test 15 - check that game saved only when required data is filled.	60
A.17	Test 16 - check that game saved only when required data is filled.	60
A.18	Test 17 - "Save as" dialog to save game.	60
A.19	Test 18 - dialog showing that game has been saved.	61
A.20	Test 19 - "Save as" dialog to save game.	61
A.21	Test 20 - check that game saved only when required data is filled.	61

A.22 Test 21 - check that existing games can be overwritten.	62
A.23 Test 22 - allow user to select the game file to load from.	63
A.24 Test 23 - check that list of games is shown.	64
A.25 Test 24 - check that game saved only when required data is filled.	64

List of Tables

1.1	Byte allocations for primitive data types in Python.	14
1.2	Bytes required for the storing of one chess game.	15
2.1	Table of information on input validation.	36
3.1	List of tests that been conducted and their results.	48

Analysis

1.1 Introduction

The goal of this project is to build a new system for a teacher who runs a chess club at Alleyn's School, London. In this section, research has been done to learn what the current system does. This research will inform me of what the new system that I will build should be able to do and what additional features it will provide over the current implementation. My research consisted of giving a questionnaire to the user and of researching the rules of chess.

1.2 Rules of Chess

As with any game, there are rules that have to be adhered to for a valid game to be played. For me to have a viable solution to the problem identified, the program I create must follow the rules of chess. Thus, in this section, I will discuss what these rules are.

1.2.1 The Game Board



Figure 1.1: The initial setup of a game of chess.

The initial starting position of the board contains all the types of pieces in the game: pawn, king, queen, bishop, knight and rook. From this point onwards, white is the first to move. Once white has completed a legal move it is then black's turn to do the same and the game continues until the game has reached the state of checkmate or stalemate, which will be explained in detail later. Only one piece can occupy a square on the board, thus a piece cannot take one of its own pieces but can capture opposing pieces as long as it isn't a king.

Note: when the types of moves that a certain type of piece can make are discussed below, it is assumed that when moved, it does not put the player who is moving the piece into check. In addition, it will be assumed that the move does not mean that the moving piece is in the same place. If this is the case then the move is illegal.

1.2.2 Pawn

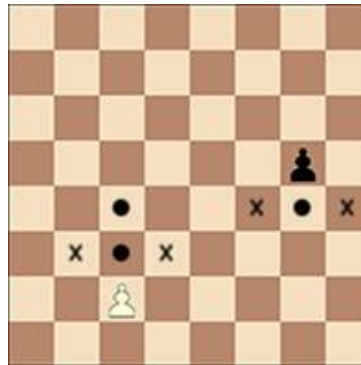


Figure 1.2: The possible moves a pawn can make.

The pawn is a type of piece and has two types of moves, depending on the situation. If the pawn is in the same space as its starting position then it can either move one or two spaces forward, given that there is no piece in the way of this movement. In any other position it is only able to move into the next square forward, as long as there is no other piece currently there. It is also able to capture any opposing pieces that are diagonally in front of it.

Promotion

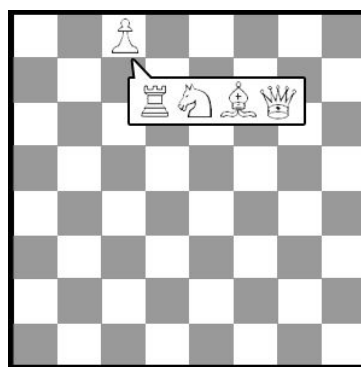


Figure 1.3: The types of pieces that a pawn can be promoted to.

When a pawn reaches the other side of the board the pawn must be changed to an additional piece that is a rook, knight, bishop or queen.

En Passant



Figure 1.4: A board position in which en passant is possible.

As can be seen above, if a pawn is moved two spaces forward such that it is horizontally adjacent to an opposing pawn once it is moved, the opposing pawn has an opportunity to capture the pawn and move to the 'x' marked on the diagram. When this opportunity occurs, whether it is taken or not, it cannot be done again by that player for the rest of the game.

1.2.3 King

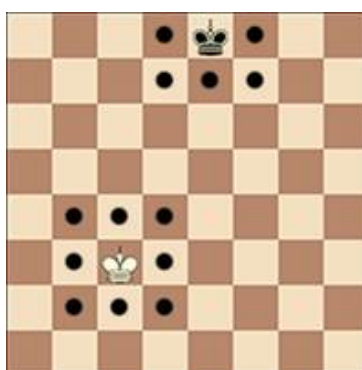


Figure 1.5: The possible moves of a king.

The king can move to any adjacent square provided that it is not in check once it completes the move. In addition it should not be adjacent diagonally, horizontally or vertically, to the opposing king after it has moved.

Castling

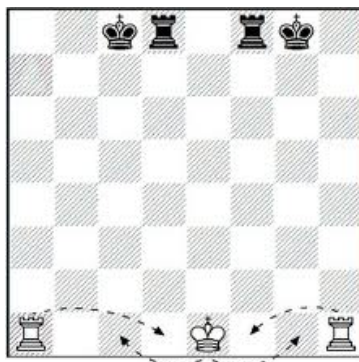


Figure 1.6: Movement of king and rook during castling.

Castling is a move (shown above) that can be performed only if the king and rook have not been moved before. For castling to be performed no pieces must be in the way of the king and the rook moving and any of the squares in between them must not be attacked by an opposing piece. The king cannot castle when it is under attack.

1.2.4 Bishop



Figure 1.7: The possible moves of a bishop.

The bishop can move diagonally in any direction. Thus, it can only move on the colour of squares that are the same as its starting position.

1.2.5 Rook



Figure 1.8: The possible moves of a rook.

The rook can move both vertically and horizontally in any direction.

1.2.6 Queen

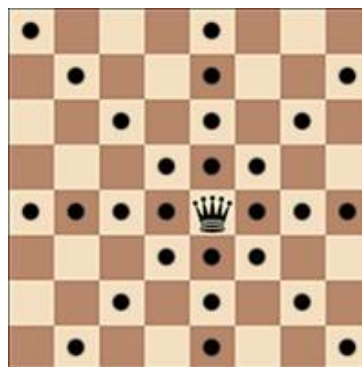


Figure 1.9: The possible moves of a queen.

The queen can both move anywhere diagonally, horizontally and vertically. In other words, a queen can be considered a combination of both the rook and the bishop.

1.2.7 Knight



Figure 1.10: The possible moves of a knight.

The knight has one of the more interesting moving patterns. It can move in what is known as an L-shape. To be more precise, the possible moves of a knight can be calculated by moving 2 along vertically and then 1 horizontally either side, and vice-versa. Its attacking moves do not include the path to its possible moves.

1.2.8 Game States

In chess there are 3 types of game states that differ from normal play and restrict what legal moves can be made. Two of those are permanent (end of game) states: checkmate and stalemate. The other is check and this means that only moves that take a player out of check can be made.

Check

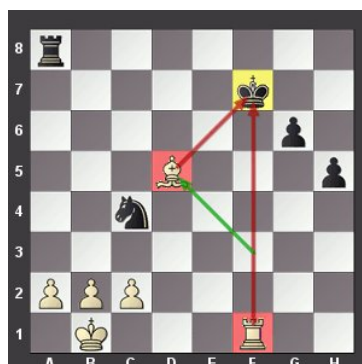


Figure 1.11: An example of check.

Check occurs when a piece moves such that it is attacking the opposing king. An attacking move is such that if we theoretically suppose that the king is a piece that can be captured by a piece, then it would be captured if the piece moved there. An example of this is the image seen above. An important note is that for pawns this means they cannot check a king if it is horizontally ahead of it, as a pawn cannot move there if we theoretically supposed that a king is able to be captured. However, it can if the king is diagonally adjacent in front of the pawn.

Checkmate

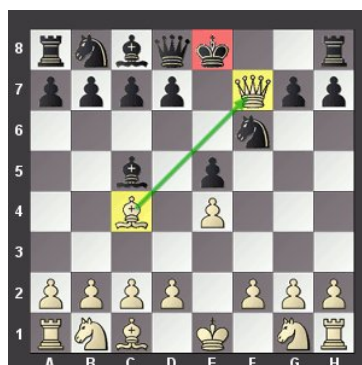


Figure 1.12: An example of checkmate.

Checkmate occurs when a player is put into check and cannot make a move that brings themselves out of check. The person who is in check is the loser of the game and thus the opposing player is the winner. A well-known example is the scholar's mate which can be seen above. The queen cannot be taken by any piece and the king has nowhere to move without still being in check. In addition, the king cannot take the queen as it will put itself in check to the bishop. Thus black concedes the game as it is in a state of checkmate.

Stalemate

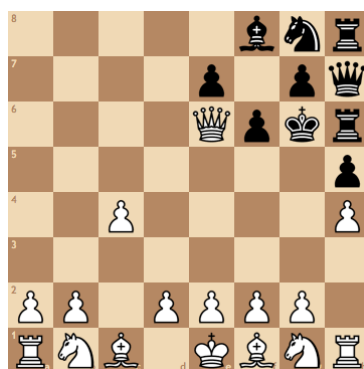


Figure 1.13: An example of stalemate.

Stalemate occurs when a player who is not in check cannot make any legal moves and thus the game cannot continue. Above is an example of a stalemate. It is black's turn to move but it has no legal moves to make. Any movements are either not available to make or expose the king to being in check to either the far-right pawn or the queen. When a stalemate occurs the game is declared as drawn and there are no winners or losers.

1.3 Questionnaire

As mentioned in section 1.1, a questionnaire would form part of my research. The teacher who runs the chess club is the one who has answered the following questionnaire. In this

questionnaire, it is determined what the current system does, the problems it has, and the objectives of the new system which I will be creating.

Explain the background of the current system.

I work at Alleyn's School in Dulwich as a teacher and run the chess club every Wednesday lunch. Pupils from ages 11-18 are allowed to play chess. Every year we run an inter-house chess competition, where each house of the school assembles a team together to determine which house is best at chess. Approximately 20 pupils show up to the club every week, with this number rising to about 50 during competitions. The inter-house chess competition is particularly popular and I run it once a year for about 4 or 5 weeks. The competition take place in two rooms in the Science Department. The competition is played on approximately 25 Chess Boards.

What kind of data is stored on the system and how is it processed?

When the chess competition happens, we must store data on the results of individual games. Specifically, we store the names of the player and the winner of each game. The game board used by the players serves as a way of recording the state of the game. The game board also serves as a way of making moves and seeing moves being made. The rules of the game are adhered to by the players themselves, as it is assumed that is in the best interest of each player to make sure that the other is not cheating. If a game overruns past lunchtime, then the players can take a picture of the board and then continue the game later. This information is currently displayed on the whiteboard during the lunchtime of the competition, and then is transferred to a word document which is sent via email to people who are interested in the results.

What problems does this current system have?

Firstly, there can be times where there are disagreements between two players over the game. The issues tend to be centred around possible cheating. It would be good to have a system where arguments over cheating would not occur. Secondly, there are many clubs and activities run at the school, which clash with chess club. This results in people

who cannot play chess with us even though they want to. It would be nice to be able to allow people to play chess outside of school hours. Thirdly, whilst a photo of the game board can be taken to allow the game to be continued elsewhere if it runs over lunch, information about whether en passant is still possible and whos move it is cannot be saved via a picture. In addition, when a chess competition occurs, many players are interested in seeing the results of certain games. However, as all games are stored on a word document, students are usually individually told or e-mailed the results of games if they are interested. It would be useful to have a system in place where interested parties can view the results of all chess games played in their own time.

What data would you like to be stored in a new system?

I would like for games to be stored. The data on each game should be such that it is possible to continue playing later. Thus, it must include the position of all the pieces on the board, the current game state (e.g. is a player in check?), whether en passant is possible and where it can occur, and whose turn it is. In addition, the names of both players must be stored, the number of moves made, when the last time the game was played and the name of the winner if there is one.

Could you outline the core requirements of the new system?

The new system should be able to identify all the legal moves of a given piece and display this information clearly to the user. In addition, the game must be able to identify changes in the state of the game and display these changes to the user when they occur. These requirements must be satisfied as it should be possible to play chess using this new system, where moves can be made and the results of these moves should be clearly shown. All games that are played must have the ability to be saved, including the names of the players, so that the game can be played at a later date. Thus, all games that are saved must be able to be easily loaded by the user.

1.4 Setting

The program was designed for the school's chess club and is open for students from year 7 to 13. Chess club currently runs weekly at lunchtimes (figure A.1) and is run by a school teacher. Every year a primarily student run inter-house chess competition, with each house having a team of avid chess players, takes place to determine which house has the best chess players. As a member of chess club I identified and researched problems with the current system that the club uses. I also consulted with the teacher about any problems that he has noted in the current system and have used this information to aid me in determining the objectives that I plan for the new system to implement.

1.5 Users

The primary users are those students who partake in the chess club and actively play chess amongst one another. It can also be used by the teacher that runs the club to record the results of games, which is paramount when there are competitions taking place. There is an additional benefit in that it can be played at any time and on any computer in the school area that has the program installed. This may be of good use to those who would like to play chess but are unable to go to the club due to other extra-curricular activities.

1.6 System

Currently most games that are played are not recorded because most are for recreational entertainment and so the result of the game is inconsequential, though results may be remembered by students and also may help in choosing players for the inter-house chess competition. Currently, when the inter-house chess competition happens the whiteboard (figure A.2) in the classroom is used to show players who they are playing against and when the game is finished the result is written to the right of the matchings. Then the

results are transferred to a word document and are stored by the teacher who runs the club.

1.7 Input

All the results of games to do with a competition are recorded in a word document and of course the movement of pieces is recorded on the board. All other games are not recorded at all and the location of pieces when a game is finished are generally not stored unless a student chooses to take a picture of the board.

1.8 Processing

Processing in the current system is fairly simple. Once a player has chosen where to move a piece, they pick it up and move it to the appropriate position on the board. If it is illegal it is assumed that the opponent will notice as it is in their best interest to not allow such a move. If that is the case then the piece is simply moved back to its place. The player who moves a piece also notes mentally if the piece that they have moved has resulted in a change in the state of the game.

1.9 Output

Output is simply where the player moves their piece on the board, which is visible to both players and any people watching. In addition, when a player moves a piece which results in the changing of the game state they must state this change openly to the opposing player.

1.10 Volumetrics

In this particular application it is hard to estimate the memory needed to store the data needed to play a game as the data required is dynamic. However, we can make some assumptions about the game and use this to estimate the memory required.

Firstly, I'll discuss the byte allocations that the Python programming language gives to certain objects and data structures:

Bytes	Type	Details
24	int	
24	bool	an instance of an int
52	str (unicode)	+4 byte per additional character.
72	list	+32 for first element, 8 thereafter.
280	dict	6th item increases to 1048; 22nd, 3352; 86th, 12568 *

Table 1.1: Byte allocations for primitive data types in Python.

Firstly, the game is stored in a 2D (8×8) list object, with each element of the list containing either an integer with value 0 or a Piece object. However, this is not how the data is stored in the JSON file. Instead, the JSON file mimics all the attributes of the `class Board(object)`, apart from the `board` attribute.

In the following table, a list of all the attributes of the board class are contained with the type that they will be stored as in the JSON file. This table will show how many bytes are required to store a game as an upper bound. It is assumed that the player names are 10 characters long, which is unlikely to be the case for one player, let alone two. In addition, it is assumed that no pieces are taken, as if that is the case, then the size of the file will inevitably be smaller.

Attribute	Type	Bytes	Occurence
id	int	24	1
player_one	str	$52 + 4 \times 8 = 84$ (assuming 10 characters).	1
player_two	str	$52 + 4 \times 8 = 84$ (assuming 10 characters).	1
last_played	str	$52 + 4 \times 10 = 92$ (in format dd/mm/yyyy)	1
turn	str	$52 + 4 \times 5 = 72$ ("White" or "Black")	1
move_num	int	24	1
winner	str	$52 + 4 \times 5 = 72$ ("White" or "Black")	1
colour_in_check	str	$52 + 4 \times 5 = 72$ ("White" or "Black")	1
is_stalemate	bool(int)	24	1
game_over	bool(int)	24	1
must_promote	bool(int)	24	1
enpassant_possible	dict	280	1
enpassant_possible['Black']	bool(int)	24	1
enpassant_possible['White']	bool(int)	24	1
enpassant_move	dict	280	1
enpassant_move['from']	list	$72 + 32 + 24 + 8 + 2 = 150$	1
enpassant_move['to']	list	$72 + 32 + 24 + 8 + 24 = 150$	1
enpassant_move['taken']	list	$72 + 32 + 24 + 8 + 24 = 150$	1
pieces	dict	280	1
pieces[*]	dict	280	5
pieces[*]['position']	list	$72 + 32 + 24 + 8 + 24 = 150$	32 (all pieces)
pieces[*]['colour']	str	$52 + 4 \times 5 = 72$ ("White" or "Black")	32 (all pieces)
pieces[*]['first_moved']	int	24	16 (all pawns)
pieces[*]['has_moved']	list	$72 + 32 + 24 + 8 + 24 = 150$	6 (rooks and kings)
Total		11,722 bytes	

Table 1.2: Bytes required for the storing of one chess game.

Whilst the following table helps to calculate the size of storing each game, it is not taken into account the overhead of the game list. Thus the formula, $f(x)$, where x is the number of games stored, for the upper bound in bytes of the JSON file is:

$$f(x) = (11722)x + (72 + 32) + 8(x - 1) = 11730x + 96$$

1.11 Problems with the Current System

The current system consists of chess boards with pieces and a word document if results want to be recorded. The main problem that was noticed was that as the club was only hosted on a single lunchtime a week, many games overran past lunchtime and so had to be stopped with no clear winner as the game had not finished. As the game was played on a physical board with pieces and the room that was used for the club is used for lessons as well, the current state of the game is not saved which resulted in the game effectively being cut short. This is incredibly frustrating, especially for higher-level players as their games tend to take longer to finish.

Another problem came from when in-school chess competitions occurred. These competitions required results to be recorded such that it could be determined who plays who in further rounds of the competition, i.e. what teams play against one another in the final. These are recorded at lunchtime on the board and then recorded later on a word document. There are of course problems with such a system. Firstly, results can easily be lost as it is held in one location. This also means that only one person can view the results at the time, unless the results are published in an e-mail which takes time to produce. In addition, it does not store the final state of the game when finished which may be of interest to students and teachers alike.

A problem that has been noted by students is that even though they are willing to attend chess club, many are unable to attend at lunchtimes on a certain day because they have other commitments and so end up not attending at all despite their desire to do so. Many students would like to be able to play chess games outside of club hours amongst each other with results recorded at school.

1.12 Objectives

After the analysis of the current system and the requirements that would be needed for an improved system I have created SMART (Specific, Measurable, Achievable, Realistic and Timely) objectives which make clear to me - the developer - what the client requires for their new system which has been determined to be feasible to complete and adheres to all of the letters of the SMART abbreviation.

The objectives of the new system are as follows:

1. The showing of an interactive chess board allowing movement of pieces by users which adheres to all chess rules.
 - (a) When program loads, show default chess starting position (a new game).
 - (b) Ensure only pieces of the moving player's corresponding colour are clickable.
 - (c) When a piece is clicked calculate all of its legal moves.
 - (d) After a piece is moved perform a check of the game state. If the state has changed (i.e. if a player has been put into check or the game has ended) then inform the user of this via a dialog.
 - (e) If the pawn has successfully reached the other side of the board, then open a dialog to let the user decide to what piece the pawn should be converted to.
2. Allow the editing of player's names via textboxes.
3. Allow a game that is currently in play to be saved.
 - (a) Allow user to choose where the game will be saved.
 - (b) If a game has been successfully saved, convey this information to the user via a dialog.
 - (c) If the player names have not been filled in, then do not save the game and inform the user that they have to fill in the names.

4. Allow a user to load a game and to continue to play it.
 - (a) Allow user to choose what file to load a game from.
 - (b) Display the list of games in a table to allow the user to know which game to choose.
 - i. Information that must be shown in the table: ID, name of player 1 and 2, winner, moves made, last played.
 - ii. Allow the user to sort the list of games based on parameters such as ID and the names of players.

Documented Design

2.1 Introduction

It has been decided that the new system will be a desktop application which can be used to play chess amongst two human players. It will be used by those who attend chess club to not only play games but to save, load and continue playing them. This program is to be developed in Python and for the graphical user interface Qt has been chosen, with the Pyside library serving as a python wrapper around the Qt GUI framework.

It will consist of a visual representation of a chess board which is held in a table GUI element. This will allow players to move pieces via clicking on a piece and then on the place it wants to move the piece to. It will contain several buttons, which all serve different functions. There will be functionality to start a new game and to save, and load, existing games. Saving a game will work by converting a python dictionary into JSON format and saving it in an existing JSON file by adding it to an array of dictionaries (games). If this file does not exist then the program will allow the user to select a location for a new JSON file to be created. This location will be saved as a setting so that the program can find this location again whenever it is relaunched.

Loading a game will open the JSON file from the location path specified by the user and scans the array of games, showing them as a table in a dialog so that the user can choose which game to open. If the location of the file does not exist, then the user will be given

the option of locating a different pre-existing JSON file to open from if it exists.

As already mentioned, the JSON file will hold an array of games. A game contains the data needed to load a game: pieces and their positions, total moves, state of the game and other variables that are used to determine whether certain moves are possible, such as castling. Each game will have a unique ID which will allow users to load games that haven't been finished and to carry them on. For the program's loading and saving feature to be most useful for the school's chess club, it is best to store the JSON file in the school's shared area such that all games can be loaded and saved from any computer that has this program installed.

2.2 Overall System Design

2.2.1 Input

The first type of input is selecting a piece on the board by clicking on a cell in the 8×8 table that contains a piece corresponding to the player's colour. At this point processing occurs and moves that are legal are added as cells that can be clicked on the table. After this, if a cell is clicked that is not a player's piece then the last clicked piece is moved to that location. If a cell is clicked that is a player's piece the process described above is repeated.

The second type of input is the player name's that must be set if the game is to be saved. Both names can be edited via 2 separate GUI TextEdit components.

The third type of input is to do with saving and loading games. A dialog asking for the location of a JSON file (or where to save it) allows the user to select the game file for the program. When the Load Button' game is pressed a dialog is shown where the user can choose a game to play from the file via a table.

2.2.2 Processing

The amount element of processing occurs when pieces are moved on the board. Once a user has used the GUI interface to declare what piece to move and to where it should be moved the main element of processing occurs. When this is done the program calculates all the possible legal moves for the opposing player's pieces. Then the GUI edits the table (which represents the chess board) such that the opponent can only select a cell in the table which represents a piece and its respective legal moves. In addition the program checks the game state and sees whether a player has won, or whether they are in check or if the game has ended in stalemate. If the game state has changed the user is informed through a dialog.

2.2.3 Storage

All data that is required to load and save games is stored in public attributes of the Board class. When a game is saved these attributes are collated into a dictionary which is added to an array of games as a JSON file. When a game is loaded a new Board class is created where all the attributes of the loaded game are put into the class from the JSON dictionary.

2.2.4 Output

In terms of output there are three categories of output that the user will see. The first is of course the current board. The board has a visual representation of all the pieces on the correct parts of the board which is put into an 8x8 table with all cells of equal size.

The second category is the state of the game. When the state of the game changes after a move, such as a player being in check or the game is over due to checkmate/stalemate, then the user is informed of this change by a dialog that appears. This dialog has a button to dismiss it to allow the players to continue to interact with the rest of the program,

and forces users to acknowledge the change in game state.

The third category is the load dialog. The load dialog greets the user with list of games as rows on a table. The columns of the table give information about each game that is in the JSON file that the program reads from, such as the game ID, players, last played, moved made, winner etc.

2.3 Hierarchy Charts

2.3.1 Top Level View

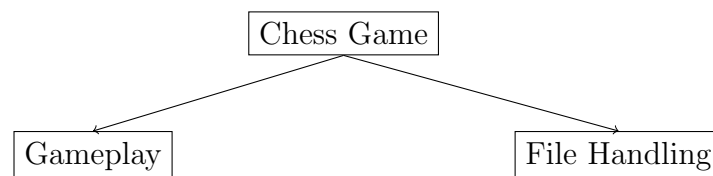


Figure 2.1: Top level hierarchy chart.

2.3.2 Second Level View

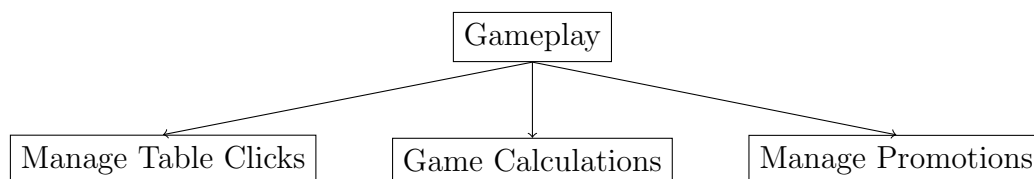


Figure 2.2: Second level hierarchy chart: Gameplay.

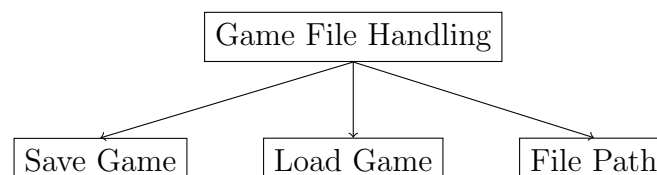


Figure 2.3: Second level hierarchy chart: Game File Handling.

2.3.3 Third Level View

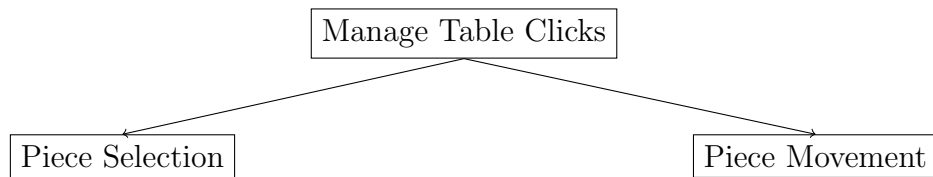


Figure 2.4: Third level hierarchy: Manage Table Clicks.

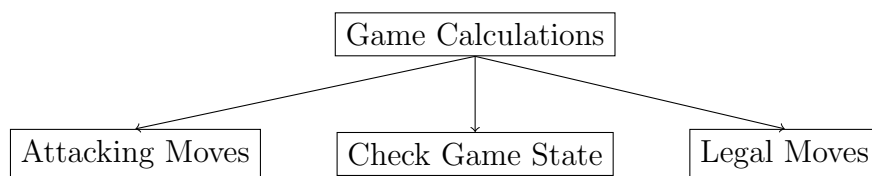


Figure 2.5: Third level hierarchy chart: Game Calculations.

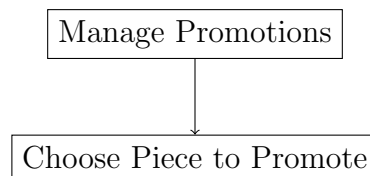


Figure 2.6: Third level hierarchy chart: Manage Promotions.

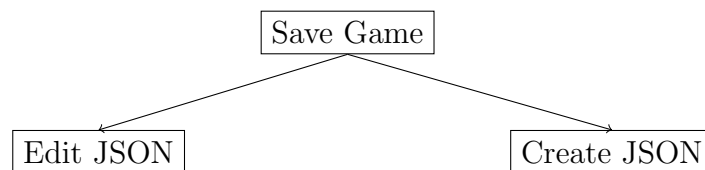


Figure 2.7: Third level hierarchy chart: Save Game.

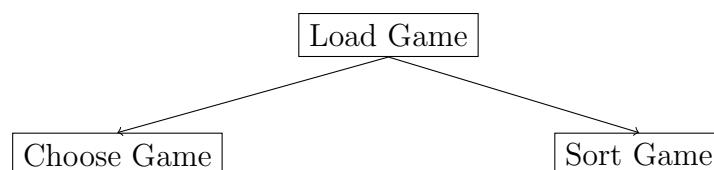


Figure 2.8: Third level hierarchy chart: Load Game.

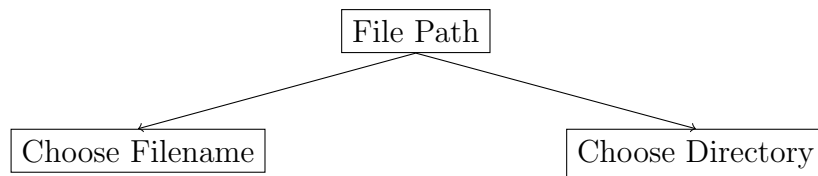


Figure 2.9: Third level hierarchy chart: File Path.

2.4 Code Design

2.4.1 Class Diagrams

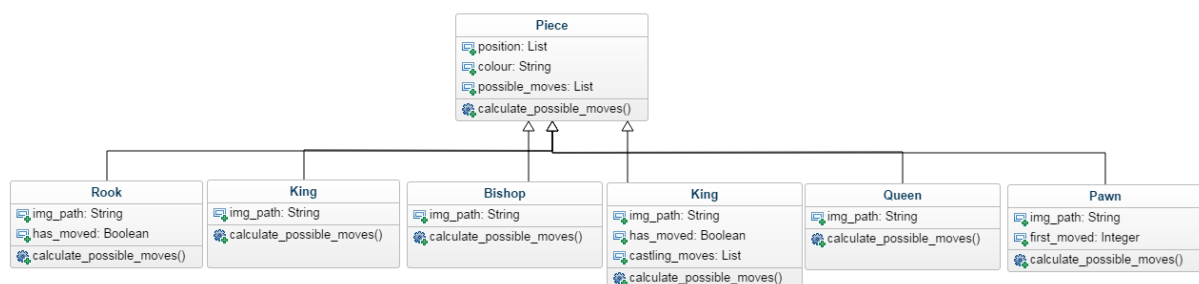


Figure 2.10: Class diagram for Piece and its subclasses.

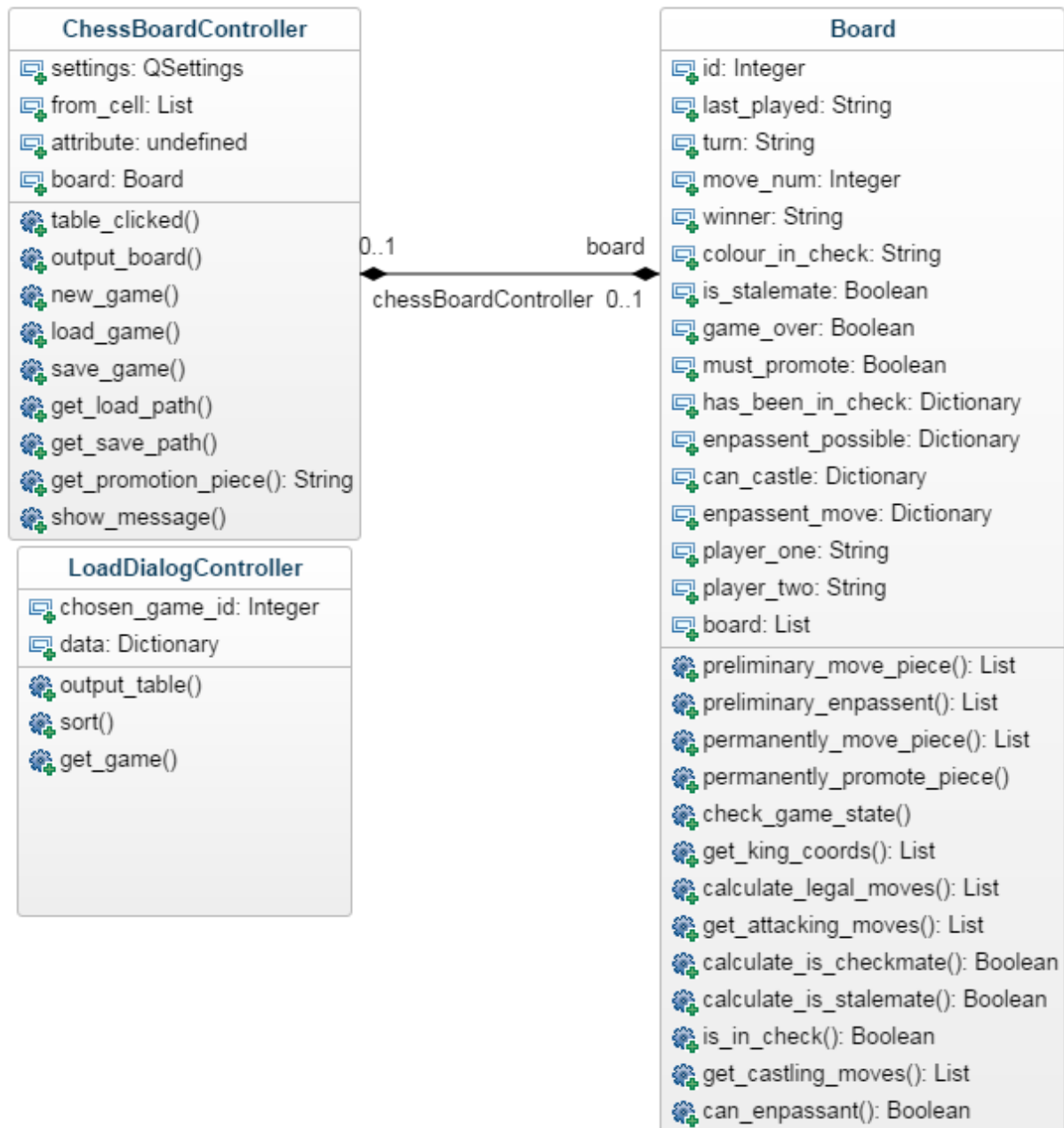


Figure 2.11: Class diagram for the controllers and model of the program.

2.4.2 File and Code Structure

As the program is in the form of a Graphical User Interface (GUI) I thought it would be appropriate to design my code around the Model-View-Controller (MVC) framework. The view of the MVC architecture is the definition of the GUI. The model is the logic of the game board and the controller is what accepts inputs and interactions with the view,

which converts them to commands to the model. The results of the model processing this data is then given back to the view by the controller. The .ui file type is the file that the Qt framework generates after editing of a GUI occurs in the Qt Designer application. These are then converted to .py by a command line utility pyside-uic. I then collated these files and put them into the views.py file.

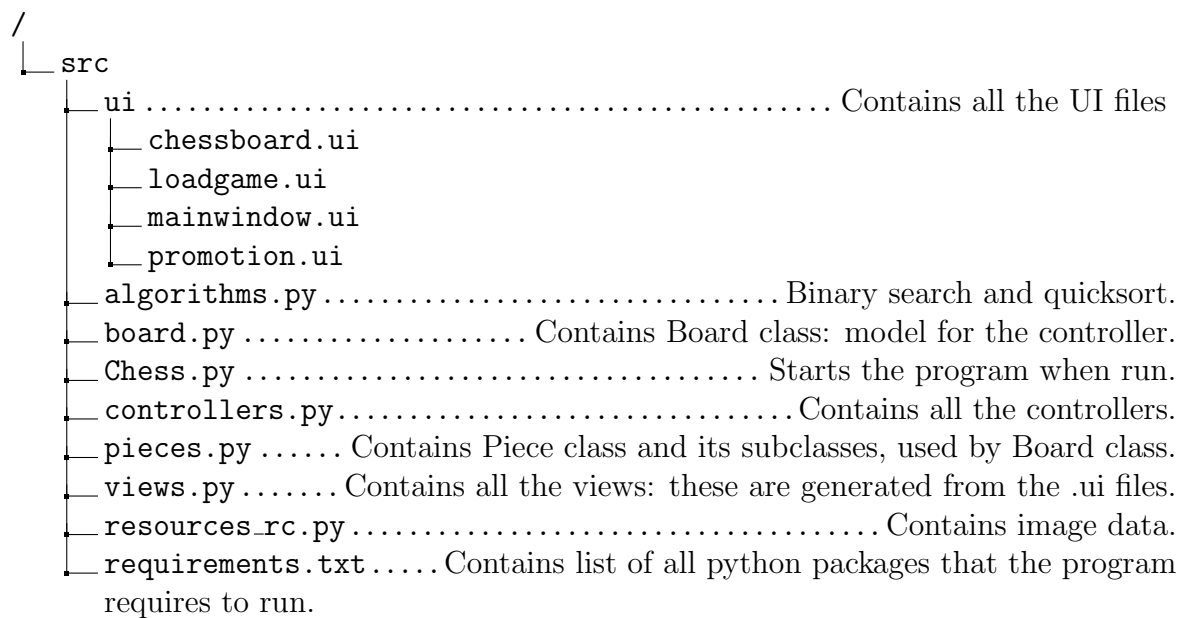


Figure 2.12: Code structure of the program.

2.4.3 Required Software

For this program to run via running the Chess.py file it is required that Python 3 up until 3.4 is installed on the computer that the program will be run from, anything higher is not supported. This is because the program relies on PySide being installed and it does not support versions newer than 3.4.

2.4.4 Code Documentation

In this section the comments to all the classes and functions in the program are shown. Views.py is not commented as it is simply a compilation of .ui files that have been compiled to Python classes and Chess.py is also not commented as it is simply boilerplate

code to get the GUI to run. Similarly, resources_qrc.py just contains image data of the chess pieces.

algorithms.py

```
def quick_sort(array, low, high):  
    """Sorts a list recursively.  
  
    Args:  
        array (list): the list to be sorted.  
        low (int): index of lowest item to be sorted.  
        high (int): index of highest item to be sorted.  
    """  
    def partition(array, low, high):  
        """Partitions array using a pivot value.  
  
        Args:  
            array (list): the list to be sorted.  
            low (int): index of lowest item to be sorted.  
            high (int): index of highest item to be sorted.  
  
        Returns:  
            The value of the pivot.  
        """  
    def binary_search(search_term, array):  
        """Searches for an item in an already sorted list.  
  
        Args:  
            search_term (str): term to be searched for in the list.  
            array (list): list to be searched.  
  
        Returns:  
            True if found, False otherwise.  
        """
```

board.py

```
class Board(object):  
    """Class which manages the pieces on the board.  
  
    This is the model for the ChessBoardController class.  
    The primary function of this class is to allow the controller to determine  
    the legal moves a given piece can make and to move pieces on the board, whilst  
    performing checks of the game state after every move.  
  
    Attributes:  
        id (int): the unique identifier for a particular game.  
        last_played (str): The date at which the game was last saved.  
        turn (str): The colour of the current player's turn.
```

```

    move_num (int): how many moves have been made in the game.
    winner (str): The name of the winner.
    colour_in_check (str): if a player is in check, their colour is held in this
→ variable.
    is_stalemate (bool): shows if game is in stalemate or not.
    game_over (bool): shows if game is over or not.
    must_promote (bool): true if a player must promote their pawn, false
→ otherwise.
    enpassant_possible (dict): shows if black and white can complete an en
→ passant move.
    enpassant_move (dict): stores the en passant move for both colours if they
→ exist.
    player_one (str): stores the name of the first player (white).
    player_two (str): stores the name of the second player (black).
    board (list): an 8*8 2D list which maps to pieces on the board.
"""

def __init__(self, game=None):
    """Loads a game if given one, otherwise initialises a new game.

    Args:
        game (dict): contains all data needed to load a game into a Board object.
    """

def new_board(self):
    """Creates a new board."""

def preliminary_move_piece(self, chess_board, old_coords, new_coords):
    """Will move a piece temporarily. e.g. used to see if piece puts itself in
→ check.

    Args:
        chess_board (list): the board to be used to move the piece.
        old_coords (list): coordinates of the piece to be moved.
        new_coords (list): coordinates of where the piece will be moved to.

    Returns:
        list: returns a chess board with the piece moved.
    """

def preliminary_enpassant(self, chess_board, old_coords, new_coords,
→ removed_coords):
    """Will perform enpassant temporarily e.g. used to see if piece puts itself
→ in check.

    Args:
        chess_board (list): the board to be used to move the piece.
        old_coords (list): coordinates of the piece to be moved.
        new_coords (list): coordinates of where the piece will be moved to.
        removed_coords (list): coordinates of the piece to be taken.

    Returns:
        list: returns a chess board with the piece moved.
    """

def permanently_move_piece(self, chess_board, old_coords, new_coords):
    """
    Moves a piece on the board permanently.

```

It will also check for change in game state (checkmate, check, stalemate).

Args:

chess_board (list): the board to be used to move the piece.

old_coords (list): coordinates of the piece to be moved.

new_coords (list): coordinates of where the piece will be moved to.

Returns:

list: returns a chess board with the piece moved.

"""

```
def permanently_promote_piece(self, type, coords):
```

"""Promotes a pawn to a piece of a certain type.

Args:

type (str): Name of the type of piece to promote to.

coords (list): coordinates of the pawn to be promoted.

"""

```
def check_game_state(self):
```

"""Completes a check of the state of the game."""

```
def get_king_coords(self, colour, board):
```

"""Finds the coords of the king depending on its colour.

Args:

colour (str): color of the king to find.

board (list): the board to find the kind from.

Returns:

list: coordinates of the king in the form [x,y] (0-based).

"""

```
def calculate_legal_moves(self, piece):
```

"""Gets all the legal moves of a piece and returns them.

Args:

piece (Piece): The piece to calculate the legal moves for.

Returns:

list: A list of all the legal moves a piece can make.

"""

```
def get_attacking_moves(self, piece, board):
```

"""

Get all the attacking moves of a piece and return them.

The difference between this function and get_legal_moves() is that

this shows you what pieces can force a check while the other functions

tells you whether the piece can move there.

Args:

piece (Piece): The piece to calculate the legal moves for.

board (board): board used to determine attacking moves.

Returns:

list: A list of all attacking moves a piece can make.

"""

```
def calculate_is_checkmate(self, colour, board):
    """Finds out if a player is in checkmate.

    Args:
        colour (str): Colour that we are checking for if they are in checkmate.
        board (list): the board of the game being played.

    Returns:
        bool: True if the game is in a state of checkmate, False otherwise.
    """

def calculate_is_stalemate(self, board):
    """Finds out if a game is in stalemate.

    Args:
        board (list): the board of the game being played.

    Returns:
        bool: True if the game is in a state of stalemate, False otherwise.
    """

def is_in_check(self, colour, possible_board):
    """Checks if the king of the corresponding colour is in check.

    Args:
        colour (str): colour that we are checking if they are in check.
        possible_board (list): the board of the game being played.

    Returns:
        bool: True if the player is in check, False otherwise.
    """

def get_castling_moves(self, king, original_board):
    """Finds castling moves, if they exist, for a given king.

    Args:
        king (King): the king that we are finding castling moves for.
        original_board (list): the board of the game being played.
    """

def can_enpassant(self, pawn, possible_board):
    """Checks if en passant is possible, and assigns the en passant move if so.

    Args:
        pawn (Pawn): the pawn that we are determining if it can perform en
    ↪ passant.
        possible_board (list): the board of the game being played.

    Raises:
        IndexError: raised when index is -1 or 8 as these indices do not exist in
    ↪ possible_board.
    """
```


controllers.py

```

class MainWindowController(QtGui.QMainWindow, views.MainWindow):
    """Controller for the main window of the application"""

class ChessBoardController(QtGui.QWidget, views.ChessBoard):
    """Controller for the chess board.
    Attributes pertaining to the views.ChessBoard class are not listed here as there
    ↪ are too many
    and they merely refer to Qt GUI Objects.

    Attributes:
        board (Board): instance of the Board class which serves as the model for the
    ↪ controller.
        settings (QSettings): a class used to store settings (namely file path) on
    ↪ the host computer.
        from_cell (list): stores the coordinates of the cell that was chosen to move
    ↪ from.
    """

    def __init__(self):
        """Initialises necessary variables, connects click events to methods and
        ↪ presents a new game to the user."""

    def table_clicked(self):
        """Handler for when table is clicked.

        When a piece has been selected to move then its legal moves are calculated.
        These moves are then made clickable and highlighted yellow.
        If a user selects any of the highlighted colours then the piece is
    ↪ transferred to that position
        and a check of the game state occurs where any changes are shown in a msg
    ↪ box.
        Promotions, if necessary, are called in this method.
        """

    def output_board(self, legal_moves=[]):
        """Output the board onto the GUI

        Uses the Board.board (2D list) to help populate the QTableWidgetItem table.
        All pieces of the moving player are made clickable on the table.
        In addition, if there are legal moves specified they are all made clickable.

        Args:
            legal_moves (list): list of the legal moves a piece can make.
        """

    def new_game(self):
        """Creates a new game with initial board setup."""

    def load_game(self):
        """Loads a game from a JSON file. If there is no JSON file the user is
        ↪ prompted for one.

        Raises:
            IOError: raised when there is an error loading a file.

```

```

        FileNotFoundError: raised when a file is not found.
        TypeError: raised when there is an error loading a file.
        KeyError: raised when there is corruption in the JSON file.
    """

    def save_game(self):
        """Saves a currently played game, either in an existing JSON file or a new
        ↪ one.

        Raises:
            IOError: raised when there is an error loading a file.
            FileNotFoundError: raised when a file is not found.
        """

    def get_load_path(self):
        """Gets the JSON file to load"""

    def get_save_path(self):
        """Gets the desired path and filename of the file to save."""

    def get_promotion_piece(self):
        """Gets the piece that needs to be promoted"""

    def show_message(self, msg):
        """If there are errors, they are shown in a message box.

        Args:
            msg (str): message for the user to be shown.
        """

class LoadDialogController(QtGui.QDialog, views.LoadDialog):
    """Controller for the load dialog

    When 'Load Game' is pressed the user is shown this dialog if a JSON file is found
    ↪ and has been loaded.
    The user is shown a table where they can sort the games and can also choose which
    ↪ game to load.

    Attributes:
        chosen_game_id (int): id of the game that was chosen
        data (dict): List of games.
    """

    def __init__(self, data):
        """Necessary variables are initialised and table is shown to the user."""

    def output_table(self):
        """List of games is shown to the user with this method."""

    def sort(self):
        """Sorts the list of games"""

    def get_game(self):
        """When game is chosen the ID is then found."""

```

pieces.py

```

class Piece(object):
    """Base class for all chess pieces

    Attributes:
        position (list): coordinates on the board in the form [x, y]
        colour (str): Colour of the piece, either "White" or "Black"
    """

    def __init__(self, position, colour):
        """This constructor initialises the class variables and also calculates all
        ↪ possible moves for the piece."""

        @position.setter
        def position(self, value):
            """ This setter calculates the new possible moves once the position has
            ↪ changed.

            Args:
                value (list): coordinates on the board in the form [x, y]
            """

    def calculate_possible_moves(self):
        """Shows us the coords it can go to assuming that there are no other pieces
        ↪ on the board

        Raises:
            NotImplementedError: Method not overridden in subclass.
        """

class Rook(Piece):
    """Class for a Rook

    Attributes:
        position (list): coordinates on the board in the form [x, y]
        colour (str): colour of the piece, either "White" or "Black"
        img_path (str): path to the image of the piece
        has_moved (bool): Denotes whether the piece has moved before.
    """

    def __init__(self, position, colour, has_moved=False):
        """
        This constructor initialises the class variables and also calculates all possible
        ↪ moves for the piece.
        In addition the image path is added.
        """

    def calculate_possible_moves(self):
        """Calculates all the possible moves for a rook in a certain position."""

class Knight(Piece):
    """Class for a Knight

    Attributes:

```

```
    position (list): coordinates on the board in the form [x, y]
    colour (str): colour of the piece, either "White" or "Black"
    img_path (str): path to the image of the piece
    """

    def __init__(self, position, colour):
        """
        This constructor initialises the class variables and also calculates all
        ↪ possible moves for the piece.
        In addition the image path is added as an attribute self.img_path.
        """

    def calculate_possible_moves(self):
        """Calculates all the possible moves for a knight in a certain position."""

class Bishop(Piece):
    """Class for a Bishop

    Attributes:
        position (list): coordinates on the board in the form [x, y]
        colour (str): colour of the piece, either "White" or "Black"
        img_path (str): path to the image of the piece
        """

    def __init__(self, position, colour):
        """
        This constructor initialises the class variables and also calculates all possible
        ↪ moves for the piece.
        In addition the image path is added as an attribute self.img_path.
        """

    def calculate_possible_moves(self):
        """Calculates all the possible moves for a bishop in a certain position."""

class Queen(Piece):
    """Class for a Queen

    Attributes:
        position (list): coordinates on the board in the form [x, y]
        colour (str): colour of the piece, either "White" or "Black"
        img_path (str): path to the image of the piece
        """

    def __init__(self, position, colour):
        """
        This constructor initialises the class variables and also calculates all
        ↪ possible moves for the piece.
        In addition the image path is added as an attribute self.img_path.
        """

    def calculate_possible_moves(self):
        """Calculates all the possible moves for a queen in a certain position."""

class King(Piece):
    """Class for a King
```

```

Attributes:
    position (list): coordinates on the board in the form [x, y].
    colour (str): colour of the piece, either "White" or "Black".
    img_path (str): path to the image of the piece.
    has_moved (bool): denotes whether piece has moved or not.
    castling_moves (list): list of all castling moves possible.
    """

def __init__(self, position, colour, has_moved=False, castling_moves=[]):
    """
    This constructor initialises the class variables and also calculates all
    ↪ possible moves for the piece.
    In addition the image path is added as an attribute self.img_path.
    """

    def calculate_possible_moves(self):
        """Calculates all the possible moves for a king in a certain position."""

class Pawn(Piece):
    """Class for a Pawn

    Attributes:
        position (list): coordinates on the board in the form [x, y]
        colour (str): colour of the piece, either "White" or "Black"
        img_path (str): path to the image of the piece
        first_moved (int): denotes at what stage (move) in the game the the piece was
    ↪ first moved.
    """

    def __init__(self, position, colour, first_moved=0):
        """
        This constructor initialises the class variables and also calculates all
    ↪ possible moves for the piece.
        In addition the image path is added as an attribute self.img_path.
        """

    def calculate_possible_moves(self):
        """Calculates all the possible moves for a pawn in a certain position."""

```

2.5 Input Validation

Field	Validation	Description	Error Message
Player names	Presence	Check for their presence	"Please fill in the player names"
Path to JSON file	Valid	Checks that file exists at specified location	"File not found"
Name of new JSON file	Presence/Valid	Must not contain special characters	"File not saved"
Game to load	Presence	Make sure ID corresponds to existing game	Game not loaded
Move to make	Move legality	Checks if a proposed move is valid	Illegal moves are not marked yellow and are not clickable on the table

Table 2.1: Table of information on input validation.

2.6 Algorithm Commentary

In this section, algorithms used in the code base that are considered complex are fully explained.

2.6.1 Binary Search

```
1     def binary_search(search_term, array):
2         """Searches for an item in an already sorted list.
3
4         Args:
5             search_term (str): term to be searched for in the list.
6             array (list): list to be searched.
7
8         Returns:
9             True if found, False otherwise.
10        """
11        half_array = int(len(array)/2)
12        if search_term == array[half_array]:
13            return True
14        elif len(array) == 1:
15            return False
16        elif search_term > array[half_array]:
17            return binary_search(search_term, array[half_array:])
18        else:
19            return binary_search(search_term, array[:half_array])
```

Figure 2.13: Source code for the recursive binary search algorithm.

As can be noted, this algorithm is a recursive function, with recursive calls at lines 17 and 19. The function is given a sorted array and compares the middle value of the array to the search term. The base case is met when the search term is found (line 13) or if the length of the array to be searched is 1 **and** the search term is not found (line 15). If that is not the case then if the search term is larger than the middle value, then the left half of the array is passed into the same function. Otherwise the right half is passed into the same function. This carries on until the base case is met. When it is the value of `True` or `False` is passed up the call stack such that the first call of the function will return `True` or `False`.

2.6.2 Quicksort

Below is the code for the recursive quicksort algorithm:

```
1  def quick_sort(array, low, high):
2      """Sorts a list recursively.
3
4      Args:
5          array (list): the list to be sorted.
6          low (int): index of lowest item to be sorted.
7          high (int): index of highest item to be sorted.
8      """
9      def partition(array, low, high):
10         """Partitions array using a pivot value.
11
12         Args:
13             array (list): the list to be sorted.
14             low (int): index of lowest item to be sorted.
15             high (int): index of highest item to be sorted.
16
17         Returns:
18             The value of the pivot.
19         """
20         i = low + 1
21         pivot = array[low]
22         for j in range(low+1, high+1):
23             if array[j] < pivot:
24                 array[j], array[i] = array[i], array[j]
25                 i += 1
26         array[low], array[i-1] = array[i-1], array[low]
27         return i - 1
28
29     if low < high:
30         pivot = partition(array, low, high)
31         quick_sort(array, low, pivot-1)
32         quick_sort(array, pivot+1, high)
```

Figure 2.14: Source code for the recursive quicksort algorithm.

It can be noted that there is an inner function defined at line 9. Instead of defining it as another function I decided to use it as an inner function to avoid code repetition and because it has no use outside of the quicksort function. The function accepts an unsorted list, and the index of the lowest and highest element of the list to sort. The partition function is then called, where the pivot value is the first element in the list. The array is changed such that all elements smaller than the pivot are put before it, and all elements bigger are put after it. Then the quicksort function is called twice. Once for values below the pivot and for values after. Once the base case has been met for each recursive call, the list is sorted. It does not need to be returned as an array (list) in python is a mutable change and is thus changed in its scope.

2.6.3 Legal Move Calculation

The algorithm for the calculation of legal moves requires the use of three functions. I have chosen to only show parts of the functions relating to the business logic of legal moves for the Rook class as these functions are fairly large and showing the business logic for calculating legal moves for the Rook class is sufficient to illustrate how the algorithm works.

```
1     def calculate_possible_moves(self):
2         """Calculates all the possible moves for a rook in a certain position."""
3         self.possible_moves = []
4         for i in range(8):
5             if self.position[1] != i:
6                 self.possible_moves.append([self.position[0], i])
7             if self.position[0] != i:
8                 self.possible_moves.append([i, self.position[1]])
```

Figure 2.15: Source code for the functions which calculate the legal moves.

```

1      def get_attacking_moves(self, piece, board):
2      """
3      Get all the attacking moves of a piece and return them.
4      The difference between this function and get_legal_moves() is that
5      this shows you what pieces can force a check while the other functions
6      tells you whether the piece can move there.
7
8      Args:
9      piece (Piece): The piece to calculate the legal moves for.
10     board (board): board used to determine attacking moves.
11
12     Returns:
13     list: A list of all attacking moves a piece can make.
14     """
15     legal_moves = []
16     illegal_moves = []
17     illegal_moves.append(piece.position)
18     def get_legal_moves():
19         for move in piece.possible_moves:
20             if move not in illegal_moves:
21                 legal_moves.append(move)
22         return legal_moves
23     if isinstance(piece, Rook):
24         for move in piece.possible_moves:
25             # If there is a piece in the way
26             if board[move[0]][move[1]]:
27                 # If piece in the way is above
28                 if piece.position[0] > move[0]:
29                     # Then it cannot influence anything above that piece
30                     for i in range(move[0]):
31                         if [i, move[1]] not in illegal_moves:
32                             illegal_moves.append([i, move[1]])
33                 # If piece in the way is below
34                 elif piece.position[0] < move[0]:
35                     # Then it cannot influence anything below that piece
36                     for i in range(7, move[0], -1):
37                         if [i, move[1]] not in illegal_moves:
38                             illegal_moves.append([i, move[1]])
39                 # If piece in the way is to the left
40                 elif piece.position[1] > move[1]:
41                     # Then it cannot influence anything to the left
42                     for i in range(move[1]):
43                         if [move[0], i] not in illegal_moves:
44                             illegal_moves.append([move[0], i])
45                 # If piece in the way is to the right
46                 elif piece.position[1] < move[1]:
47                     # Then it cannot influence anything to the right
48                     for i in range(7, move[1], -1):
49                         if [move[0], i] not in illegal_moves:
50                             illegal_moves.append([move[0], i])
51     return get_legal_moves()

```

Figure 2.16: Source code for the functions which calculate the legal moves.

```

1      def calculate_legal_moves(self, piece):
2          """Gets all the legal moves of a piece and returns them.
3
4          Args:
5          piece (Piece): The piece to calculate the legal moves for.
6
7          Returns:
8          list: A list of all the legal moves a piece can make.
9          """
10         legal_moves = []
11         original_board = copy.deepcopy(self.board) # fixed the moving bug.
12         possible_legal_moves = self.get_attacking_moves(piece, original_board)
13         if not isinstance(piece, Pawn):
14             for move in possible_legal_moves:
15                 original_board = copy.deepcopy(self.board)
16                 if isinstance(original_board[move[0]][move[1]], Piece) and not
17                     ↪ isinstance(original_board[move[0]][move[1]], King):
18                     if not piece.colour == original_board[move[0]][move[1]].colour:
19                         possible_board = self.preliminary_move_piece(original_board,
20                             ↪ piece.position, move)
21                         if not self.is_in_check(piece.colour, possible_board):
22                             legal_moves.append(move)
23                     elif not isinstance(original_board[move[0]][move[1]], King):
24                         possible_board = self.preliminary_move_piece(original_board,
25                             ↪ piece.position, move)
26                         if not self.is_in_check(piece.colour, possible_board):
27                             legal_moves.append(move)
28         return legal_moves

```

Figure 2.17: Source code for the functions which calculate the legal moves.

In figure 2.15, the function uses the position of the Rook to store all the possible moves (assuming there are no other pieces on the board) in the attribute `Rook.possible_moves`, akin to figure 1.8.

In figure 2.16, attacking moves are generated from the possible moves. This is done by removing any possible moves which are blocked by another piece. This function is called by the function in figure 2.17 which then takes out any attacking moves which contain a King, a piece of the same colour or that puts the moving player into check.

2.7 User Interface

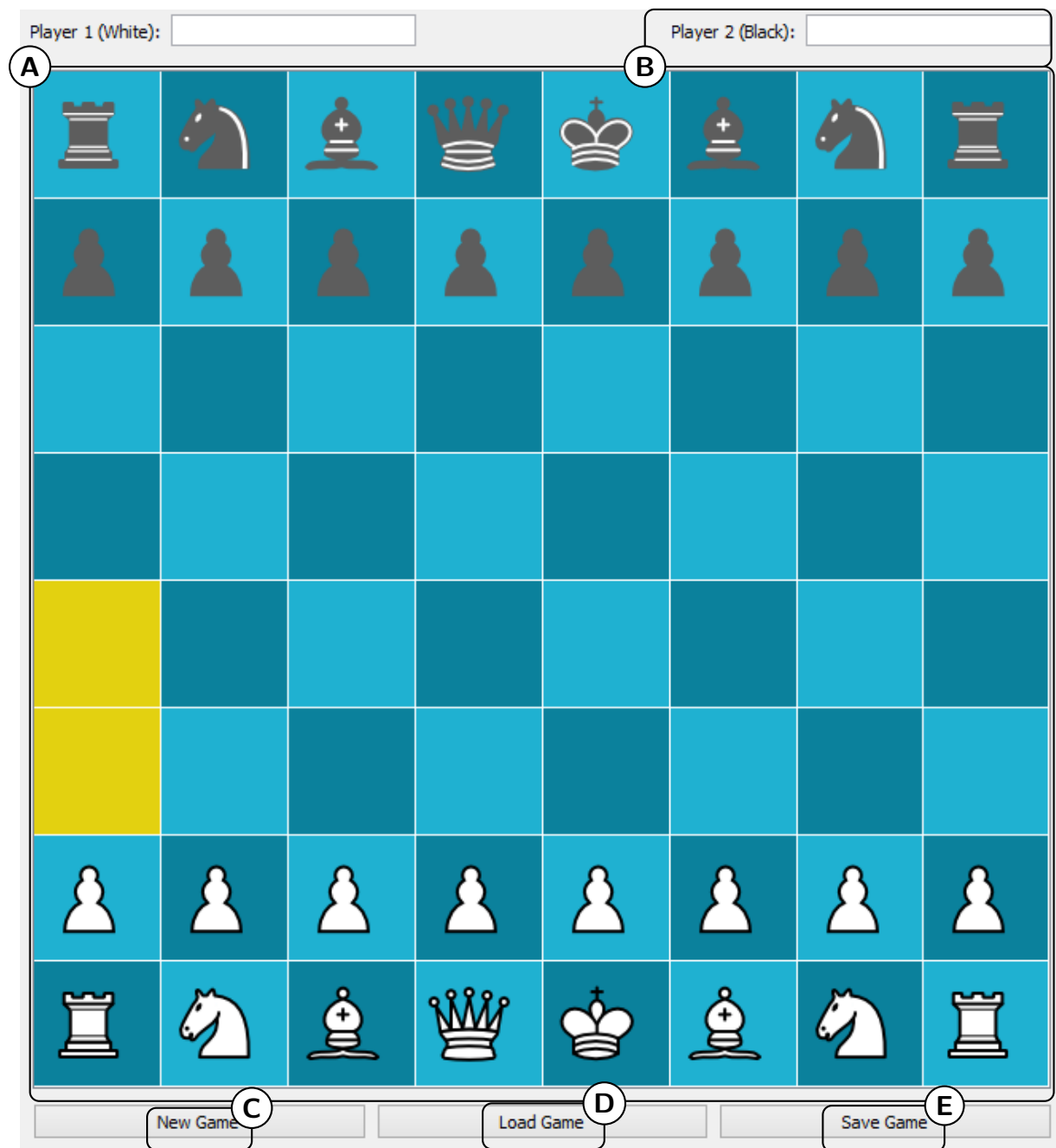


Figure 2.18: UI of the main program.

- (A) This is an 8×8 table where input is carried out by clicking a piece then clicking again to a place where the piece is desired to be moved to. Only pieces for the player that is currently moving can be clicked. When it is clicked, all of its legal moves are made yellow, and its cells are made clickable. All the cells of illegal moves

are made unclickable, which simplifies validations of moves proposed by a user.

(B) This is where the name of the second player (black) is added. To the left is where the name of the first player can be added.

(C) Pressing this button starts a new game, with the board the same as in figure 1.1.

(D) Pressing this button results in a dialog being shown, where the user can choose which game to load. If the game file is not found then the user will be prompted to insert the file's path.

(E) Pressing this button saves the game or prompts the user for a path to save the file in.

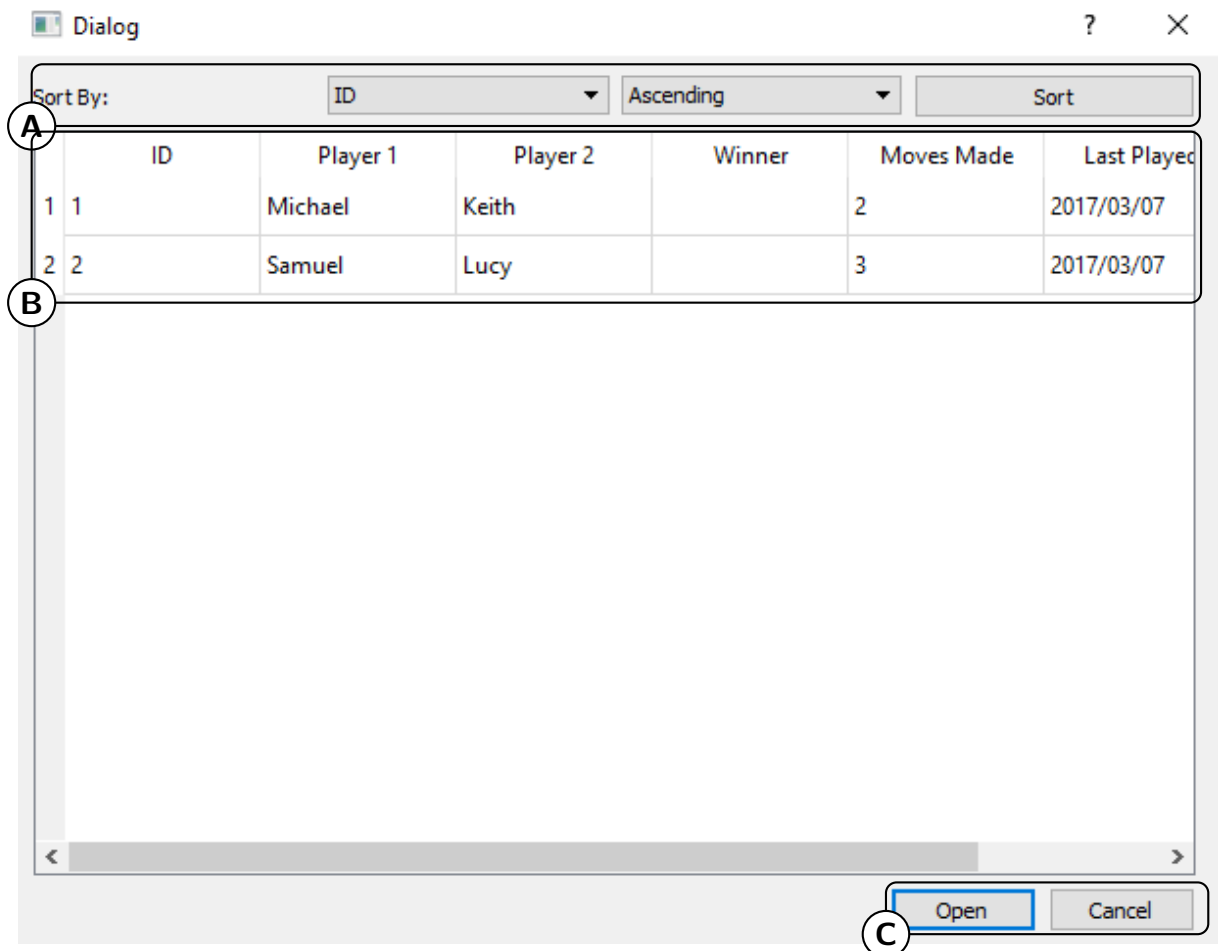


Figure 2.19: The load dialog of the program.

(A) This section comprises of two dropdown lists, one of which determines what to sort

the list of games by and the second determines whether they should be shown in ascending or descending order.

(B) This table shows the list of all of the games that are saved in the JSON file.

(C) The user can either cancel or open a game. For a game to be successfully loaded, the user must click on a game in the list and then press the 'Open' button.

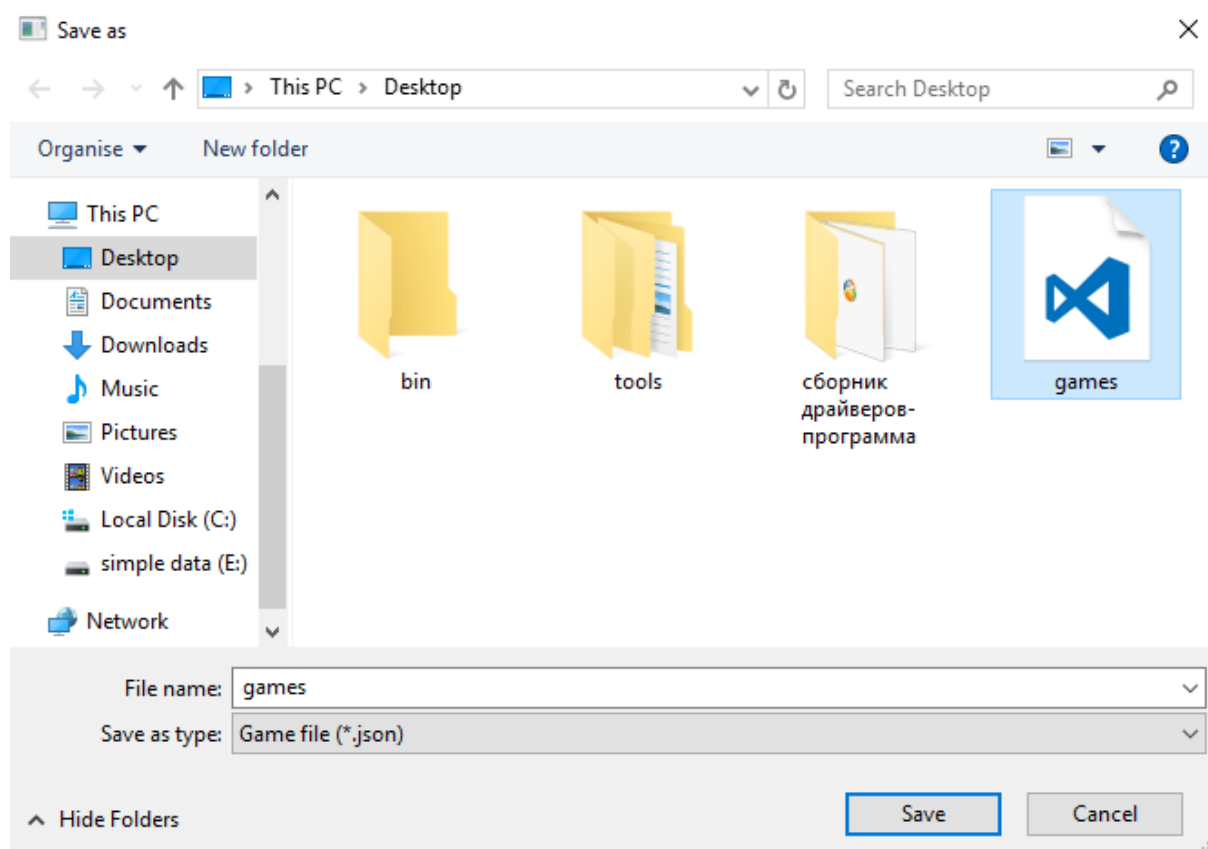


Figure 2.20: A "Save As" dialog used to save a new game file.

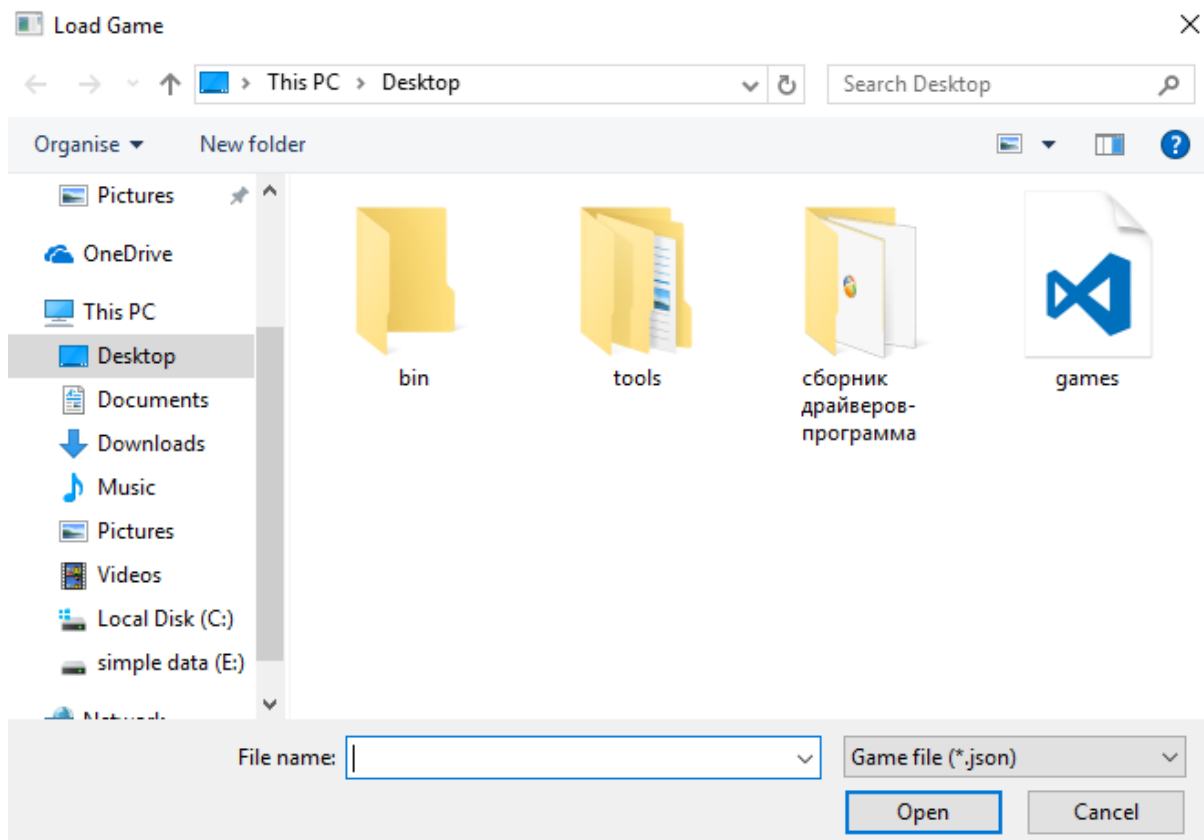


Figure 2.21: A file chooser dialog used to choose the game file to load.

Testing

3.1 Introduction

To be able to evaluate the effectiveness of the solution in its fulfilment of the objectives outlined in section 1.12 on page 17, it is necessary to conduct testing of the new system. Thus a test plan has been created, which when carried out, will determine whether the solution has met the requirements that have been agreed by the client and developer. The evidence (screen shots) of these tests have been included in the Appendix and start on page 52.

3.2 Testing Plan

ID	Obj ID	Test Data	Description	Expected Result	Evidence	Passed
1	1a	Start Program.	Check that program is usable.	A new game	Figure 2.18	Yes
2	1b	Click piece.	Check that other person's piece can't be moved	Not clickable.	Figure A.3	Yes
3	1c	Click queen.	Checks that the queen moves as expected	Legal moves shown in yellow.	Figure A.4	Yes

4	1c	Click king.	Checks that the king moves as expected	Legal moves shown in yellow.	Figure A.5	Yes
5	1c	Click bishop.	Checks that the bishop moves as expected	Legal moves shown in yellow.	Figure A.6	Yes
6	1c	Click knight.	Checks that the knight moves as expected	Legal moves shown in yellow.	Figure A.7	Yes
7	1c	Click rook.	Checks that the rook moves as expected	Legal moves shown in yellow.	Figure A.8	Yes
8	1c	Click pawn.	Checks that the pawn moves as expected	Legal moves shown in yellow.	Figure A.9	Yes
9	1c	Click pawn.	Checks that the pawn can do en passant	En passant move shown in yellow.	Figure A.10	Yes
10	1c	Click king.	Checks that king can castle	Castling move shown in yellow	Figure A.11	Yes
11	1d	Put player into check.	Correctly identifies change in game state	Dialog shown when game state changes.	Figure A.12	Yes
12	1d	Put player into checkmate.	Correctly identifies change in game state	Dialog shown when game state changes.	Figure A.13	Yes
13	1d	Put game into stalemate.	Correctly identifies change in game state	Dialog shown when game state changes.	Figure A.14	Yes
14	1e	Move pawn.	Checks that promotion feature works.	Dialog allowing user to choose a new piece.	Figure A.15	Yes
15	2	"Keith", "Michael"	Allows names of players to be added	Names correctly saved.	Figure A.16	Yes

16	2	"Simon", "Alice"	Allows names of players to be changed	Changed names correctly saved.	Figure A.17	Yes
17	3a	Press "Save Game" when there is no file path.	Allow a game that is currently in play to be saved	Dialog allowing file path to be chosen.	Figure A.18	Yes
18	3b	Press "Save Game" when there is a file path.	Allow a game that is currently in play to be saved	Dialog stating that game has been saved.	Figure A.19	Yes
19	3b	Press "Save Game" when there is a file path but no file there.	Allow a game that is currently in play to be saved	Dialog allowing file path to be chosen.	Figure A.20	Yes
20	3c	Press "Save Game" when player names are not filled.	Save only when required data is filled.	Dialog requesting that names be filled.	Figure A.21	Yes
21	4	Open existing game and make a move.	Check that existing games can be overwritten.	Game saved	Figure A.22	Yes
22	4a	Press "Load Game" when file does not exist.	Allow user to select the game file to load from.	Dialog requesting for path to file	Figure A.23	Yes
23	4bi	Press "Load Game"	Check that list of games is shown	Load dialog present.	Figure A.24	Yes
24	4bii	Choose parameters and press sort	Check that games can be sorted.	Correctly sorted list of games.	Figure A.25	Yes

Table 3.1: List of tests that been conducted and their results.

Evaluation

4.1 Introduction

The program has been tested against the objectives as can be seen in table 3.1. All tests were passed and I believe this is satisfactory to say that the objectives of the project have been met. In addition the user has been asked for feedback. In particular, the user was asked to determine whether the new system has met the SMART objectives that were agreed upon in section 1.12. Furthermore, the user explained what improvements could have been made to the new system.

4.2 User Feedback

4.2.1 User Acceptance Testing

The UAT involves the user testing the core functionality of the system to ensure it meets their requirements as specified in the SMART objectives. It is assumed that testing has already taken place and there are no major bugs. References to figures are made where it is deemed that it helps illustrate the point the user is trying to make.

The showing of an interactive chess board allowing movement of pieces by users which adheres to all chess rules. (Objective 1)

When the game first runs the default setting is a new game, the board is displayed ready to play with spaces for both players to enter names. The interface is very clear and intuitive. Selecting a piece results in all its legal moves being displayed in yellow in their corresponding cells. Legal moves are calculated correctly with no bugs noticed in this regard. When the game state changes, such as a player being put into check, this change is shown quickly to me via the use of a dialog. Special types of moves such as en passant, castling and promotion are implemented quickly and intuitive to perform.

Editing of player names (Objective 2)

Editing of the names of the two players is very simple to do and the textboxes to change names are clearly shown at the top of the program. When the game is saved changes in names are correctly saved.

Saving a game (Objective 3)

When saving the game I was afforded the opportunity to select the filename and path for the new game file. Once this was done I was informed that the game was successfully saved. As I continued playing I periodically saved the game, which was seamless and each time I was informed of its success. In addition, I could create completely new games and save them in the same game file.

Loading a game (Objective 4)

Loading games that I had previously played was a simple procedure. I was shown a list of all the games that were saved and could sort them in ascending/descending order based on a wide range of parameters. Once I chose a game it loaded quickly and could continue playing it. Saving changes worked correctly.

Overall evaluation

This project definitely meets all the objectives that were agreed to at the start of the project. Thus, I have no suggestions in terms of features that could be added to meet the current requirements. However, there are some things outside of the scope of the

requirements that would be nice to have. Due to the ubiquity of tablets and smartphones, it would be nice to have an application that would work on those form factors, not just on a laptop or personal computer. In addition, it would be nice if there was a server for the storage of games, so that students could play outside of the school system in their own time.

4.2.2 Possible Improvements

The user identified that he would like to see this new system to be ported to handheld devices and for the storage of games to be held on a server, to allow games to be played anywhere at any time. To do this a website could be created which would allow any device that has access to the internet and a browser the ability to play chess online. A web server such as NGINX can be set up, where Python could be used for the back-end code which connects to a MySQL database. This MySQL database can store all the games played. A REST API could be created such that it can be easy to make a front-end interface for all types of devices. The chess board can be displayed using HTML/CSS and can be interacted with via the help of JavaScript. There should be client and server validation of moves. This solution would allow the program to become usable on more than the desktop and thus would be an improvement over my current solution.

Appendix

A.1 Analysis Research



Figure A.1: Table set out with equipment used by the chess club.

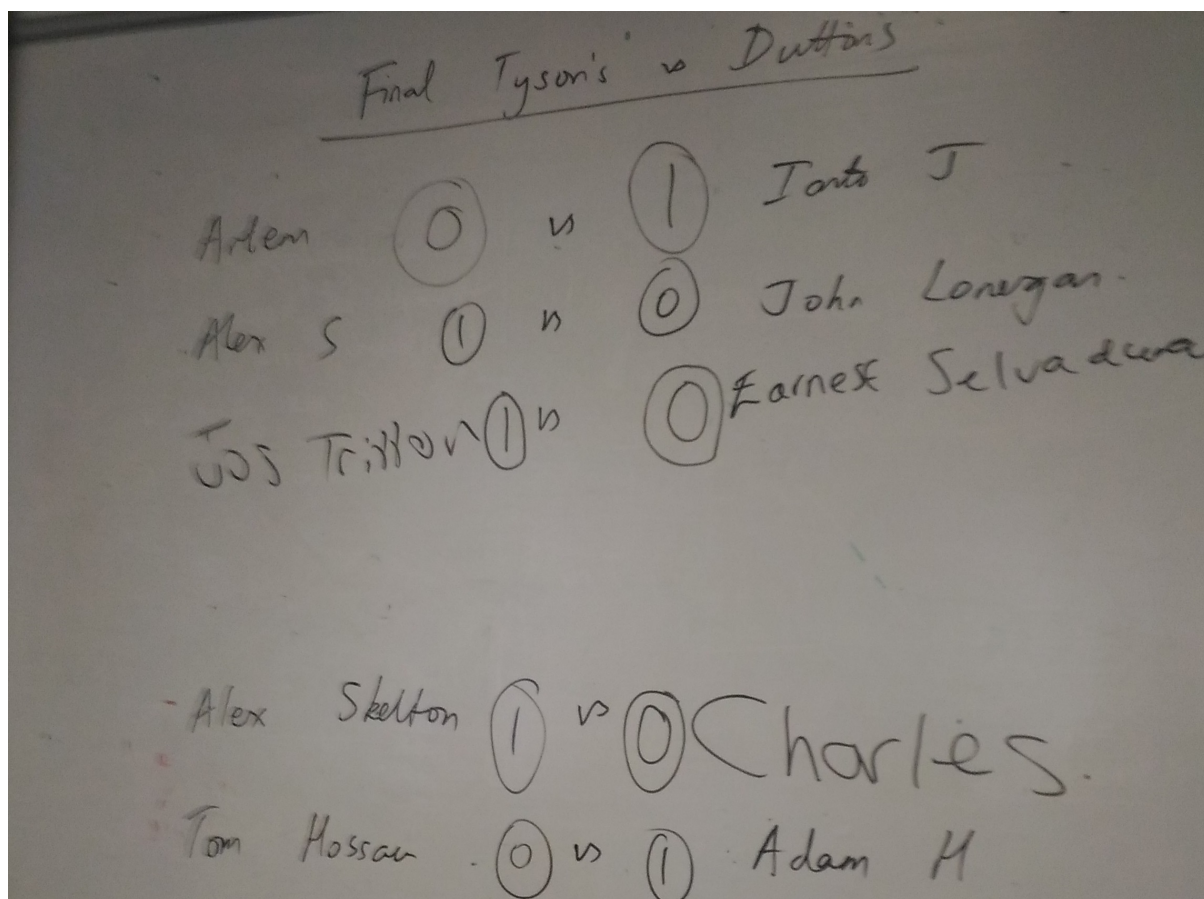


Figure A.2: Whiteboard showing winners and losers of game.

A.2 Testing Evidence

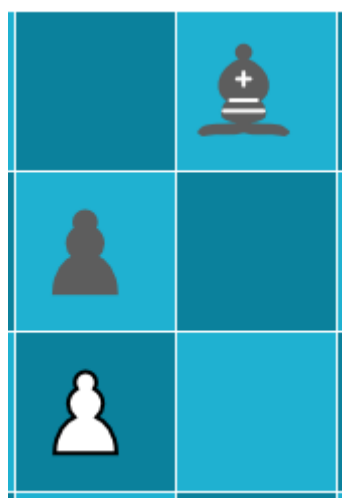


Figure A.3: Test 2 - white to move, black pieces are greyed out (not clickable).

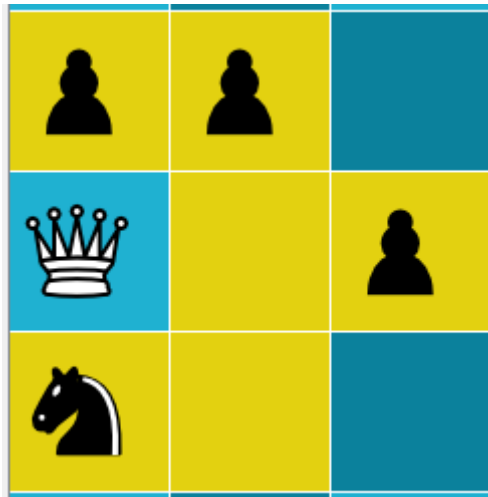


Figure A.4: Test 3 - legal moves of a queen.

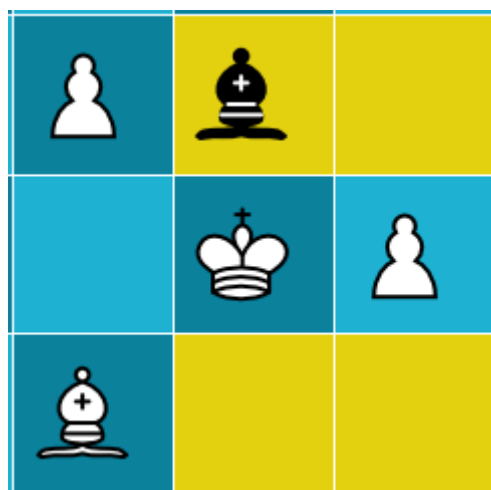


Figure A.5: Test 4 - legal moves of a king.

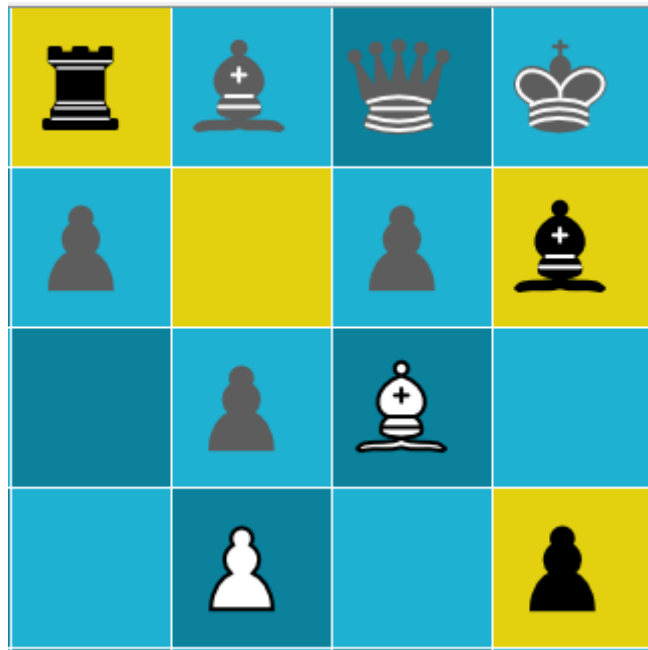


Figure A.6: Test 5 - legal moves of a bishop.

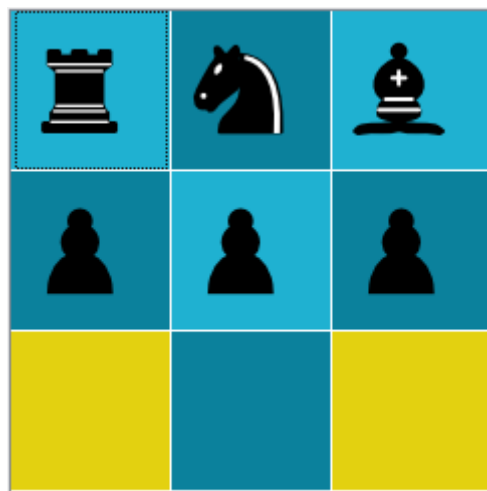


Figure A.7: Test 6 - legal moves of a knight.

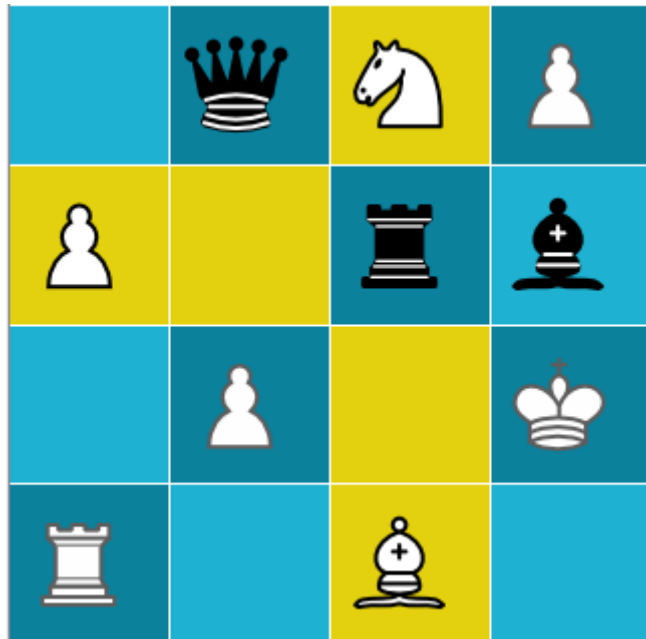


Figure A.8: Test 7 - legal moves of a rook.

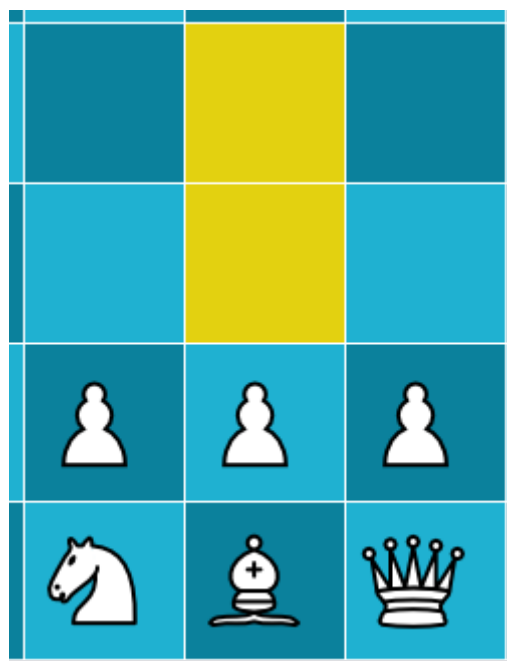


Figure A.9: Test 8 - legal moves of a pawn.

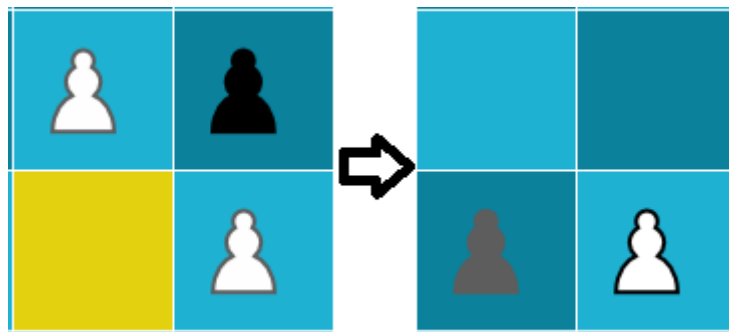


Figure A.10: Test 9 - en passant move.

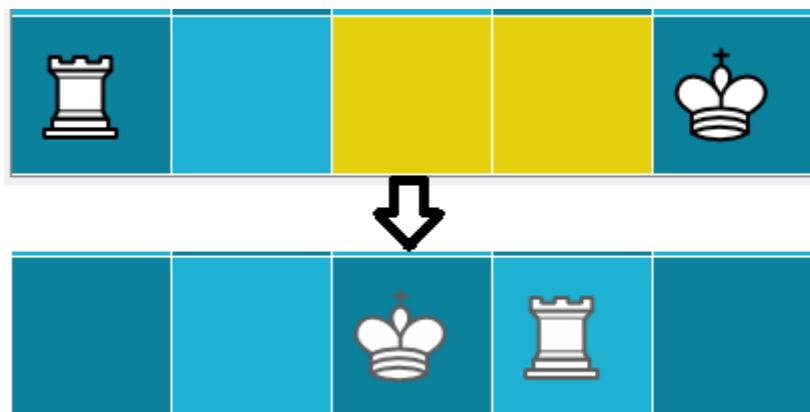


Figure A.11: Test 10 - castling move.

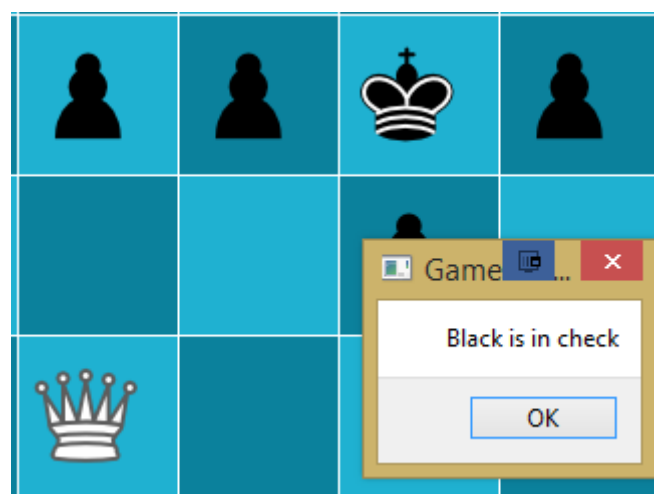


Figure A.12: Test 11 - dialog notifying user of check.



Figure A.13: Test 12 - dialog notifying user of checkmate.



Figure A.14: Test 13 - dialog notifying user of stalemate.

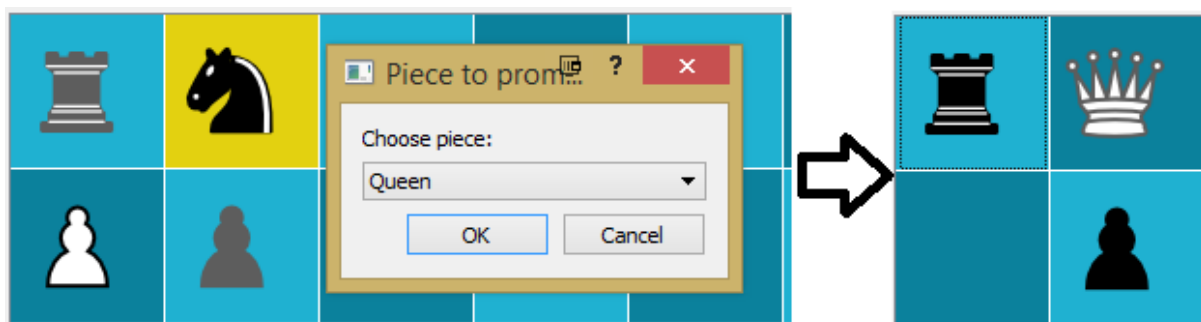


Figure A.15: Test 14 - check that promotion works.

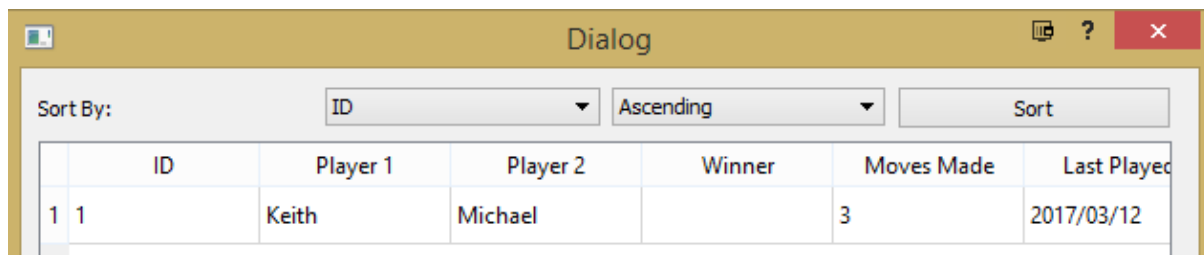


Figure A.16: Test 15 - check that game saved only when required data is filled.

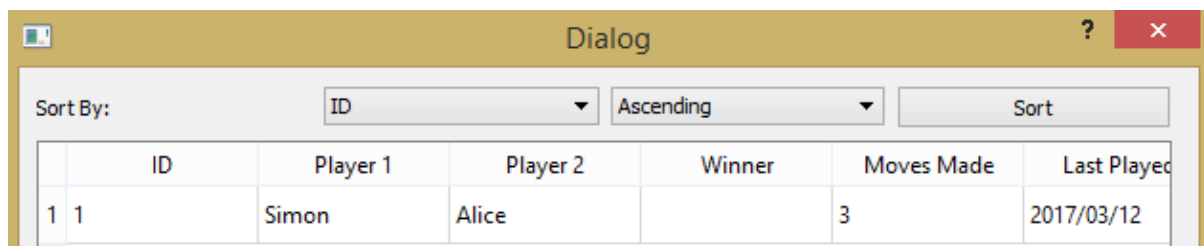


Figure A.17: Test 16 - check that game saved only when required data is filled.

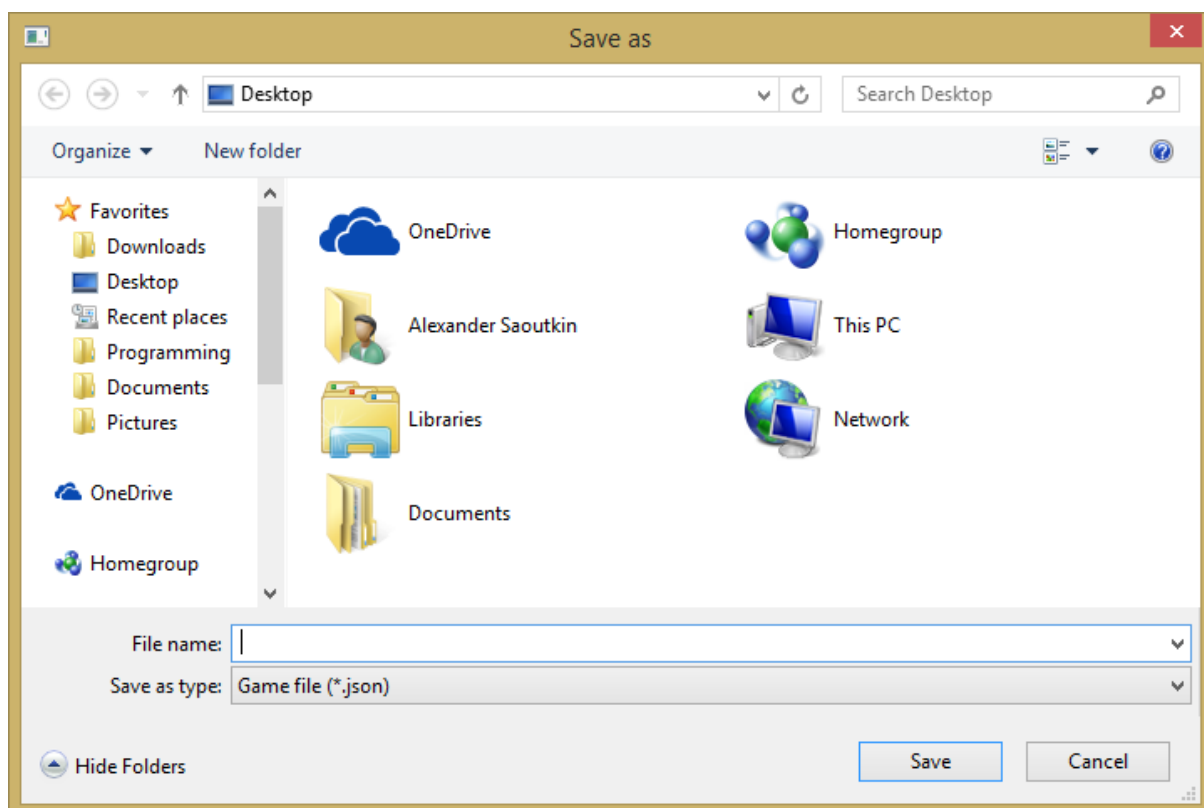


Figure A.18: Test 17 - "Save as" dialog to save game.

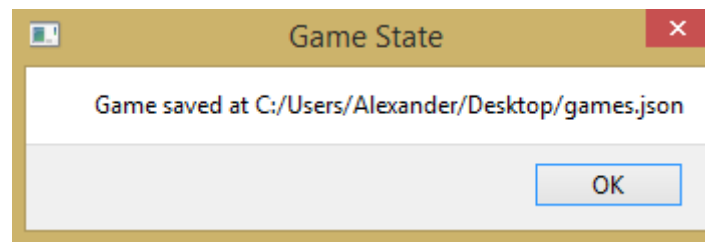


Figure A.19: Test 18 - dialog showing that game has been saved.

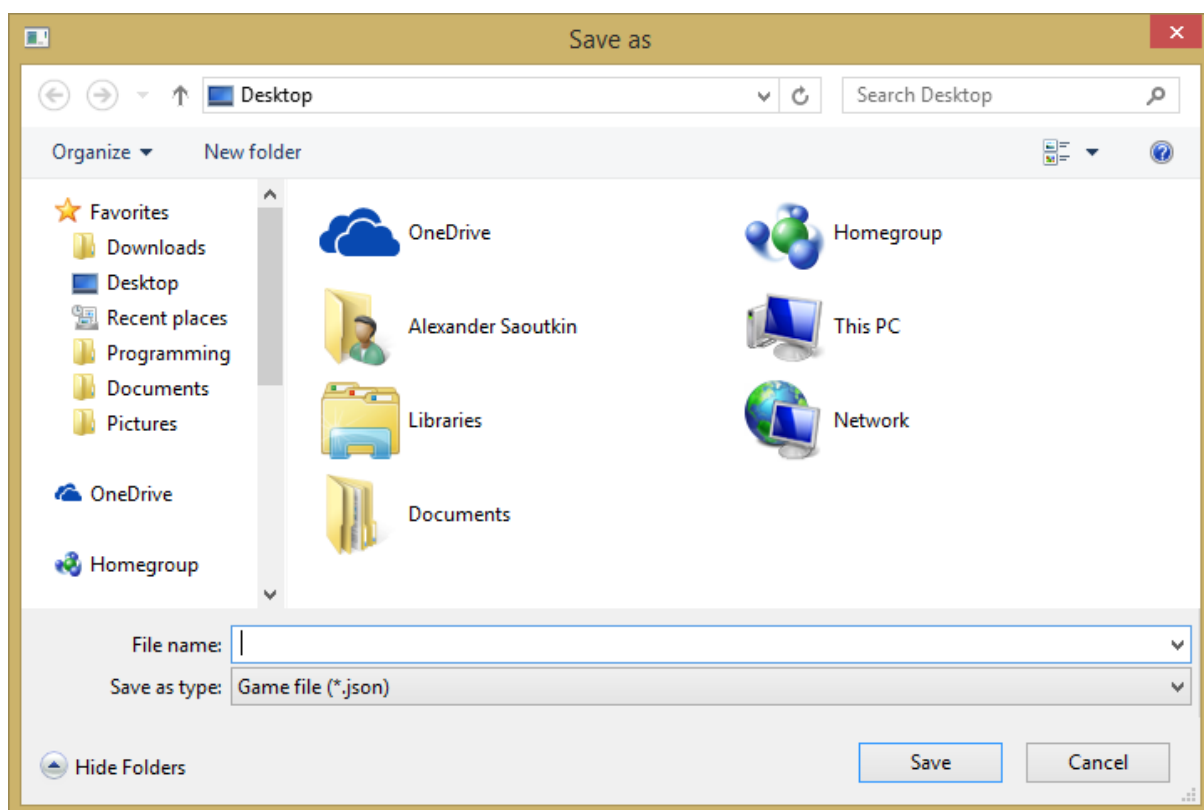


Figure A.20: Test 19 - "Save as" dialog to save game.

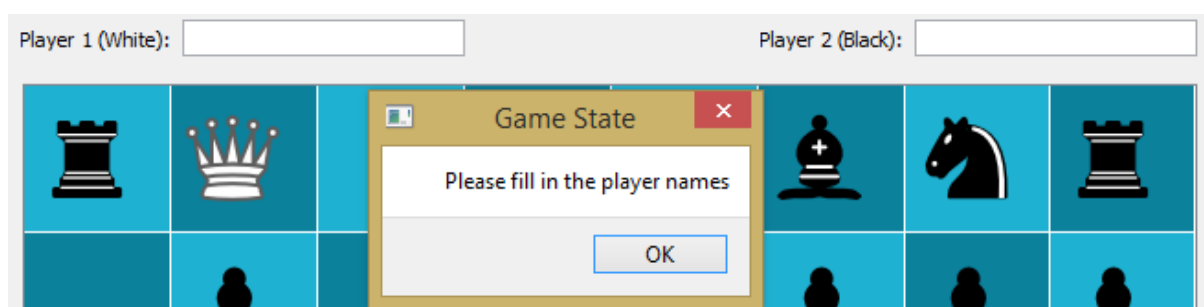


Figure A.21: Test 20 - check that game saved only when required data is filled.

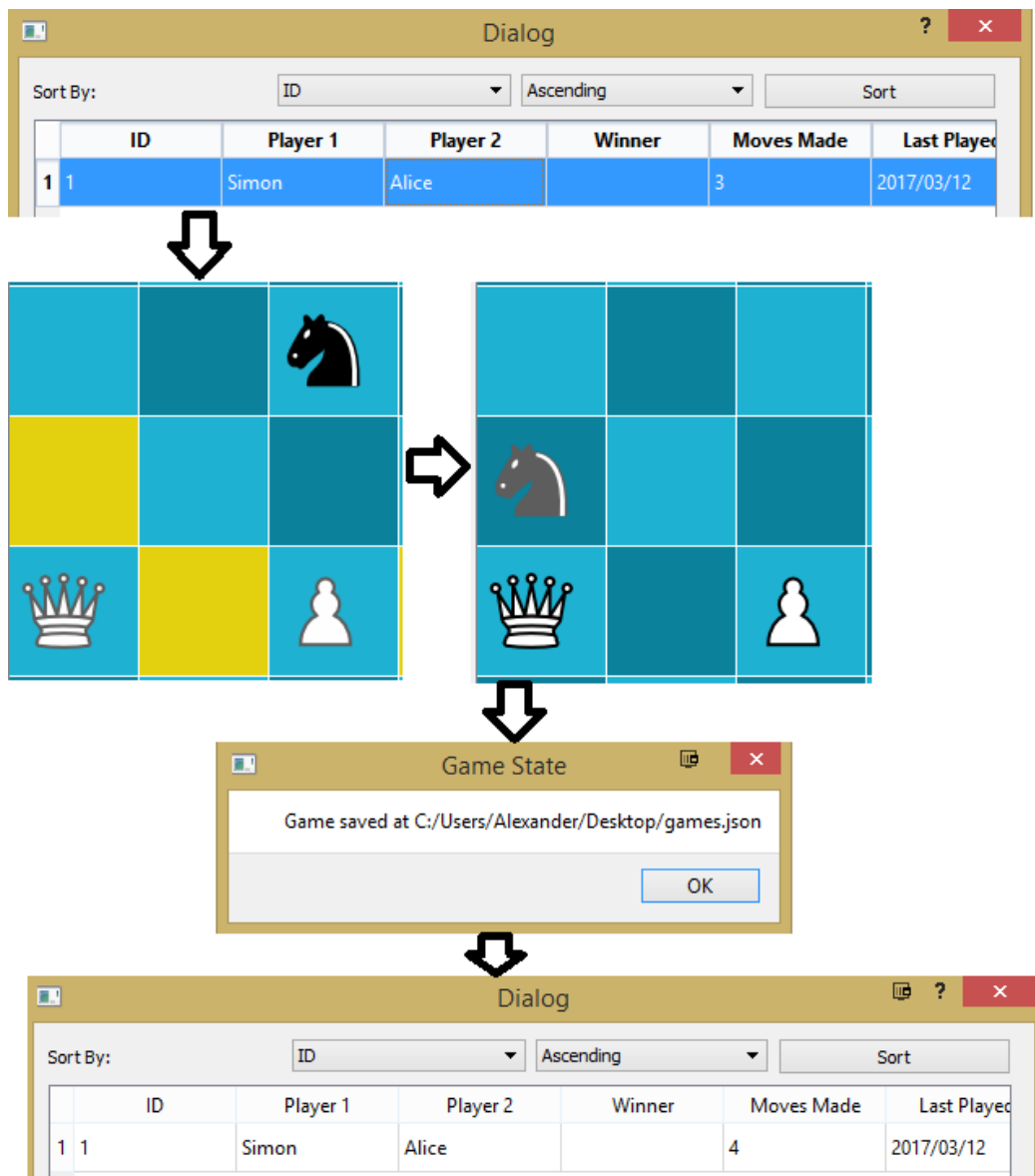


Figure A.22: Test 21 - check that existing games can be overwritten.

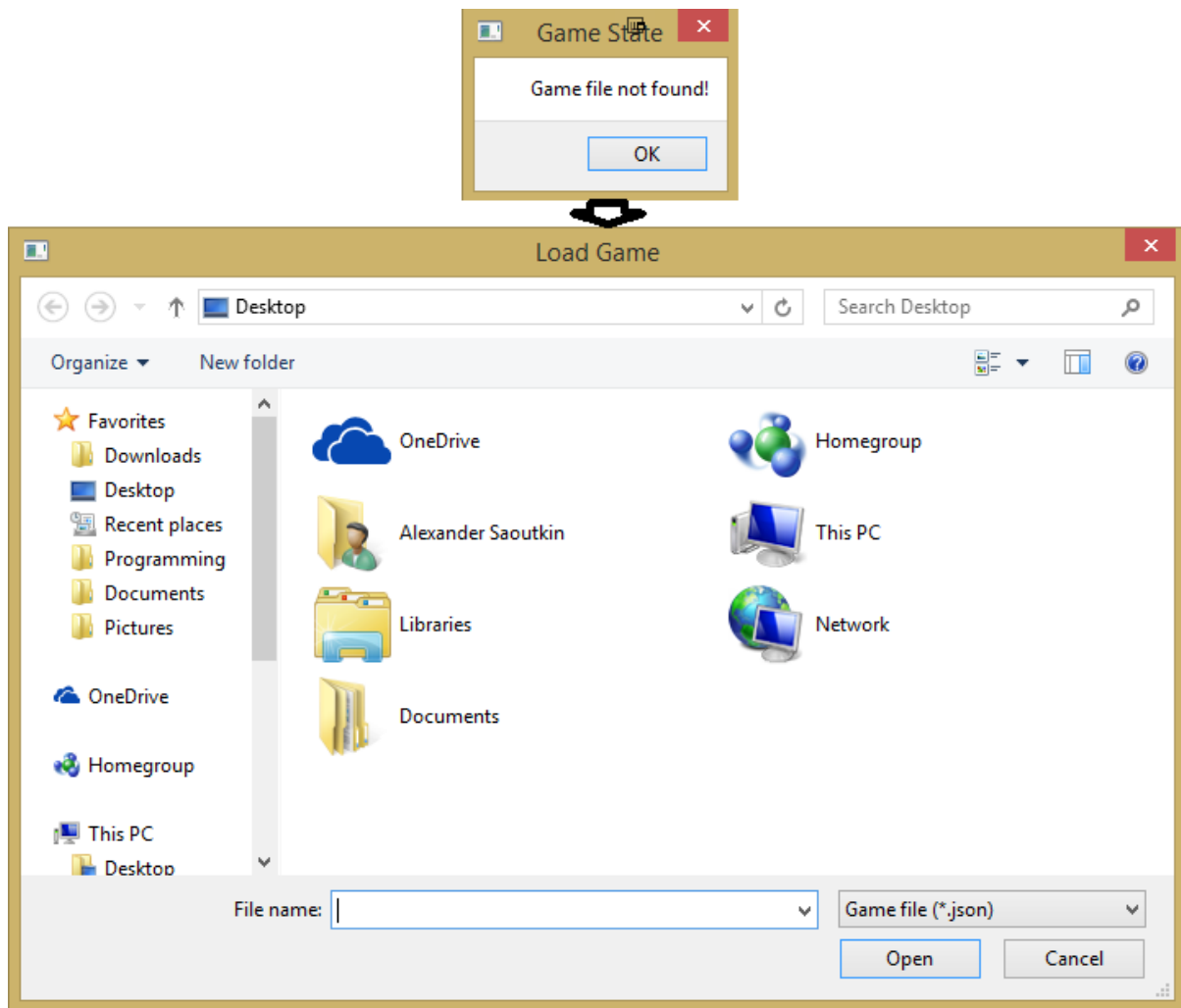


Figure A.23: Test 22 - allow user to select the game file to load from.

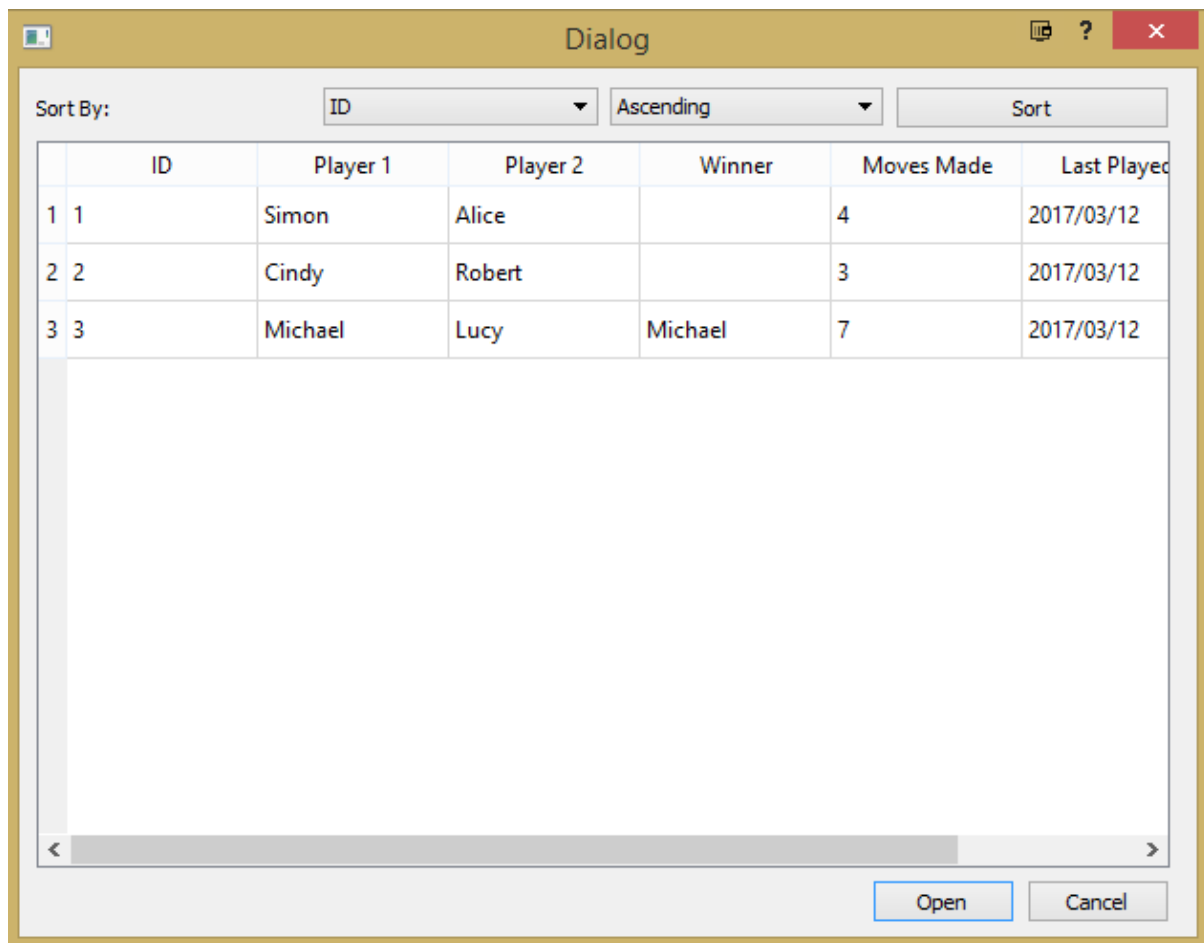


Figure A.24: Test 23 - check that list of games is shown.

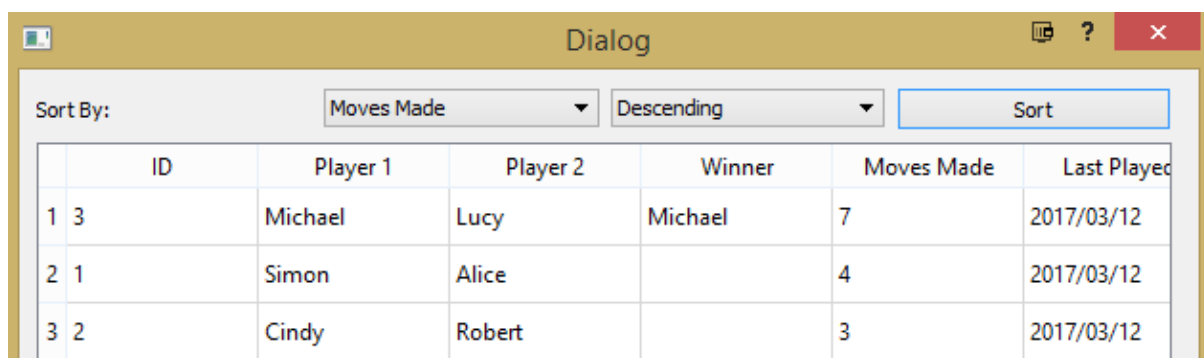


Figure A.25: Test 24 - check that game saved only when required data is filled.

A.3 Source Code

board.py

```

1  from pieces import *
2  import copy
3  __author__ = "Alexander Saoutkin"
4
5
6  class Board(object):
7      """Class which manages the pieces on the board.
8
9      This is the model for the ChessBoardController class.
10     The primary function of this class is to allow the controller to determine
11     the legal moves a given piece can make and to move pieces on the board, whilst
12     performing checks of the game state after every move.
13
14     Attributes:
15         id (int): the unique identifier for a particular game.
16         last_played (str): The date at which the game was last saved.
17         turn (str): The colour of the current player's turn.
18         move_num (int): how many moves have been made in the game.
19         winner (str): The name of the winner.
20         colour_in_check (str): if a player is in check, their colour is held in this
↪ variable.
21         is_stalemate (bool): shows if game is in stalemate or not.
22         game_over (bool): shows if game is over or not.
23         must_promote (bool): true if a player must promote their pawn, false
↪ otherwise.
24         enpassant_possible (dict): shows if black and white can complete an en
↪ passant move.
25         enpassant_move (dict): stores the en passant move for both colours if they
↪ exist.
26         player_one (str): stores the name of the first player (white).
27         player_two (str): stores the name of the second player (black).
28         board (list): an 8*8 2D list which maps to pieces on the board.
29     """
30
31     def __init__(self, game=None):
32         """Loads a game if given one, otherwise intialises a new game.
33
34         Args:
35             game (dict): contains all data needed to load a game into a Board object.
36         """
37         if game is not None:
38             self.id = game['id']
39             self.last_played = game['last_played']
40             self.turn = game['turn']
41             self.move_num = game['move_num']
42             self.winner = game['winner']
43             self.colour_in_check = game['colour_in_check']
44             self.is_stalemate = game['is_stalemate']
45             self.game_over = game['game_over']
46             self.must_promote = game['must_promote']
47             self.enpassant_possible = {

```

```

48         'Black': game['enpassant_possible']['Black'],
49         'White': game['enpassant_possible']['White']
50     }
51     self.enpassant_move = {
52         'from': game['enpassant_move']['from'],
53         'to': game['enpassant_move']['to'],
54         'taken': game['enpassant_move']['taken']
55     }
56     self.player_one = game['player_one']
57     self.player_two = game['player_two']
58     self.board = [[0 for x in range(8)] for y in range(8)]
59     for piece in game['pieces']['queens']:
60         self.board[piece['position'][0]][piece['position'][1]] = \
61             Queen(piece['position'], piece['colour'])
62     for piece in game['pieces']['knights']:
63         self.board[piece['position'][0]][piece['position'][1]] = \
64             Knight(piece['position'], piece['colour'])
65     for piece in game['pieces']['bishops']:
66         self.board[piece['position'][0]][piece['position'][1]] = \
67             Bishop(piece['position'], piece['colour'])
68     for piece in game['pieces']['kings']:
69         self.board[piece['position'][0]][piece['position'][1]] = \
70             King(piece['position'],
71                 piece['colour'], piece['has_moved'], ['castling_moves'])
72     for piece in game['pieces']['pawns']:
73         self.board[piece['position'][0]][piece['position'][1]] = \
74             Pawn(piece['position'], piece['colour'], piece['first_moved'])
75     for piece in game['pieces']['rooks']:
76         self.board[piece['position'][0]][piece['position'][1]] = \
77             Rook(piece['position'], piece['colour'], piece['has_moved'])
78     else:
79         self.id = None
80         self.last_played = None
81         self.turn = "White"
82         self.move_num = 1
83         self.winner = ""
84         self.colour_in_check = ""
85         self.is_stalemate = False
86         self.game_over = False
87         self.must_promote = False
88         self.enpassant_possible = {
89             'Black': True,
90             'White': True
91         }
92         self.enpassant_move = {
93             'from': [],
94             'to': [],
95             'taken': []
96         }
97         self.player_one = ""
98         self.player_two = ""
99         self.new_board()
100
101     def new_board(self):
102         """Creates a new board."""
103         self.board = []
104         # Black side of the board
105         row = [

```

```

106         Rook([0, 0], "Black"),
107         Knight([0, 1], "Black"),
108         Bishop([0, 2], "Black"),
109         Queen([0, 3], "Black"),
110         King([0, 4], "Black"),
111         Bishop([0, 5], "Black"),
112         Knight([0, 6], "Black"),
113         Rook([0, 7], "Black")
114     ]
115     self.board.append(row)
116     row = [
117         Pawn([1, 0], "Black"),
118         Pawn([1, 1], "Black"),
119         Pawn([1, 2], "Black"),
120         Pawn([1, 3], "Black"),
121         Pawn([1, 4], "Black"),
122         Pawn([1, 5], "Black"),
123         Pawn([1, 6], "Black"),
124         Pawn([1, 7], "Black")
125     ]
126     self.board.append(row)
127     # Add empty space
128     for i in range(4):
129         row = [0 for x in range(8)]
130         self.board.append(row)
131     # Add white pieces
132     row = [
133         Pawn([6, 0], "White"),
134         Pawn([6, 1], "White"),
135         Pawn([6, 2], "White"),
136         Pawn([6, 3], "White"),
137         Pawn([6, 4], "White"),
138         Pawn([6, 5], "White"),
139         Pawn([6, 6], "White"),
140         Pawn([6, 7], "White")
141     ]
142     self.board.append(row)
143     row = [
144         Rook([7, 0], "White"),
145         Knight([7, 1], "White"),
146         Bishop([7, 2], "White"),
147         Queen([7, 3], "White"),
148         King([7, 4], "White"),
149         Bishop([7, 5], "White"),
150         Knight([7, 6], "White"),
151         Rook([7, 7], "White")
152     ]
153     self.board.append(row)
154
155     def preliminary_move_piece(self, chess_board, old_coords, new_coords):
156         """Will move a piece temporarily. e.g. used to see if piece puts itself in
157             ↪ check.
158
159         Args:
160             chess_board (list): the board to be used to move the piece.
161             old_coords (list): coordinates of the piece to be moved.
162             new_coords (list): coordinates of where the piece will be moved to.

```

```

163     Returns:
164         list: returns a chess board with the piece moved.
165     """
166     chess_board[new_coords[0]][new_coords[1]] =
167         ↪ copy.deepcopy(chess_board[old_coords[0]][old_coords[1]])
168     chess_board[old_coords[0]][old_coords[1]] = 0
169     if isinstance(chess_board[new_coords[0]][new_coords[1]], Piece):
170         chess_board[new_coords[0]][new_coords[1]].position = [new_coords[0],
171             ↪ new_coords[1]]
172         chess_board[new_coords[0]][new_coords[1]].calculate_possible_moves()
173     return chess_board
174
175 def preliminary_enpassant(self, chess_board, old_coords, new_coords,
176     ↪ removed_coords):
177     """Will perform enpassant temporarily e.g. used to see if piece puts itself
178     ↪ in check.
179
180     Args:
181         chess_board (list): the board to be used to move the piece.
182         old_coords (list): coordinates of the piece to be moved.
183         new_coords (list): coordinates of where the piece will be moved to.
184         removed_coords (list): coordinates of the piece to be taken.
185
186     Returns:
187         list: returns a chess board with the piece moved.
188     """
189     chess_board[new_coords[0]][new_coords[1]] =
190         ↪ copy.deepcopy(chess_board[old_coords[0]][old_coords[1]])
191     chess_board[old_coords[0]][old_coords[1]] = 0
192     chess_board[removed_coords[0]][removed_coords[1]] = 0
193     if isinstance(chess_board[new_coords[0]][new_coords[1]], Piece):
194         chess_board[new_coords[0]][new_coords[1]].position = [new_coords[0],
195             ↪ new_coords[1]]
196         chess_board[new_coords[0]][new_coords[1]].calculate_possible_moves()
197     return chess_board
198
199 def permanently_move_piece(self, chess_board, old_coords, new_coords):
200     """
201     Moves a piece on the board permanently.
202     It will also check for change in game state (checkmate, check, stalemate).
203
204     Args:
205         chess_board (list): the board to be used to move the piece.
206         old_coords (list): coordinates of the piece to be moved.
207         new_coords (list): coordinates of where the piece will be moved to.
208
209     Returns:
210         list: returns a chess board with the piece moved.
211     """
212     if not self.game_over:
213         # Performs enpassant if conditions are met.
214         if old_coords == self.enpassant_move['from'] and new_coords ==
215             ↪ self.enpassant_move['to'] and self.enpassant_possible[self.turn]:
216             chess_board[self.enpassant_move['to'][0]][self.enpassant_move['to'][1]
217                 ↪ ] =
218                 ↪ copy.deepcopy(chess_board[old_coords[0]][old_coords[1]])
219             chess_board[old_coords[0]][old_coords[1]] = 0

```

```

211         chess_board[self.enpassant_move['taken'][0]][self.enpassant_move['tak
    ↪     en'][1]] =
    ↪     0
212     if isinstance(chess_board[new_coords[0]][new_coords[1]], Piece):
213         chess_board[new_coords[0]][new_coords[1]].position =
    ↪     [new_coords[0], new_coords[1]]
214         chess_board[new_coords[0]][new_coords[1]].calculate_possible_move
    ↪     s()
215     self.enpassant_possible[self.turn] = False
216     self.enpassant_move['from'] = []
217     self.enpassant_move['to'] = []
218     self.enpassant_move['taken'] = []
219     elif isinstance(chess_board[old_coords[0]][old_coords[1]], King):
220         chess_board[new_coords[0]][new_coords[1]] =
    ↪     copy.deepcopy(self.board[old_coords[0]][old_coords[1]])
221         chess_board[old_coords[0]][old_coords[1]] = 0
222         # If legal move is castling move, perform castling...
223         if new_coords in
    ↪     chess_board[new_coords[0]][new_coords[1]].castling_moves:
224             if old_coords[0] == 0:
225                 if new_coords[1] == 2:
226                     chess_board[0][3] = copy.deepcopy(self.board[0][0])
227                     chess_board[0][3].position = [0, 3]
228                     chess_board[0][3].calculate_possible_moves()
229                     chess_board[0][0] = 0
230                 else:
231                     chess_board[0][5] = copy.deepcopy(self.board[0][7])
232                     chess_board[0][5].position = [0, 5]
233                     chess_board[0][5].calculate_possible_moves()
234                     chess_board[0][7] = 0
235             else:
236                 if new_coords[1] == 2:
237                     chess_board[7][3] = copy.deepcopy(self.board[7][0])
238                     chess_board[7][3].position = [7, 3]
239                     chess_board[7][3].calculate_possible_moves()
240                     chess_board[7][0] = 0
241                 else:
242                     chess_board[7][5] = copy.deepcopy(self.board[7][7])
243                     chess_board[7][5].position = [7, 5]
244                     chess_board[7][5].calculate_possible_moves()
245                     chess_board[7][7] = 0
246         else:
247             # if enpassant possible but not done, then can never be done again.
248             if self.enpassant_move['from'] and self.enpassant_move['to']:
249                 self.enpassant_possible[self.turn] = False
250                 self.enpassant_move['from'] = []
251                 self.enpassant_move['to'] = []
252                 self.enpassant_move['taken'] = []
253             chess_board[new_coords[0]][new_coords[1]] =
    ↪     copy.deepcopy(self.board[old_coords[0]][old_coords[1]])
254             chess_board[old_coords[0]][old_coords[1]] = 0
255         if isinstance(chess_board[new_coords[0]][new_coords[1]], Pawn):
256             chess_board[new_coords[0]][new_coords[1]].first_moved = self.move_num
257             if chess_board[new_coords[0]][new_coords[1]].colour == "Black" and
    ↪     new_coords[0] == 7:
258                 self.must_promote = True
259             elif chess_board[new_coords[0]][new_coords[1]].colour == "White" and
    ↪     new_coords[0] == 0:

```

```

260         self.must_promote = True
261
262     elif isinstance(chess_board[new_coords[0]][new_coords[1]], Rook) or
263         ↪ isinstance(chess_board[new_coords[0]][new_coords[1]], King):
264         # Won't work for rook when castling, but that doesn't matter as king
265         ↪ has already moved, so can't castle anyway
266         chess_board[new_coords[0]][new_coords[1]].has_moved = True
267     self.move_num += 1
268     if self.move_num % 2 == 0:
269         self.turn = "Black"
270     else:
271         self.turn = "White"
272     if isinstance(chess_board[new_coords[0]][new_coords[1]], Piece):
273         chess_board[new_coords[0]][new_coords[1]].position = [new_coords[0],
274         ↪ new_coords[1]]
275         chess_board[new_coords[0]][new_coords[1]].calculate_possible_moves()
276     return chess_board
277
278 def permanently_promote_piece(self, type, coords):
279     """Promotes a pawn to a piece of a certain type.
280
281     Args:
282     type (str): Name of the type of piece to promote to.
283     coords (list): coordinates of the pawn to be promoted.
284     """
285     colour = self.board[coords[0]][coords[1]].colour
286     if type == "Queen":
287         self.board[coords[0]][coords[1]] = Queen(coords, colour)
288         self.board[coords[0]][coords[1]].position = coords
289         self.board[coords[0]][coords[1]].calculate_possible_moves()
290     elif type == "Knight":
291         self.board[coords[0]][coords[1]] = Knight(coords, colour)
292         self.board[coords[0]][coords[1]].position = coords
293         self.board[coords[0]][coords[1]].calculate_possible_moves()
294     elif type == "Rook":
295         self.board[coords[0]][coords[1]] = Rook(coords, colour)
296         self.board[coords[0]][coords[1]].position = coords
297         self.board[coords[0]][coords[1]].calculate_possible_moves()
298     elif type == "Bishop":
299         self.board[coords[0]][coords[1]] = Bishop(coords, colour)
300         self.board[coords[0]][coords[1]].position = coords
301         self.board[coords[0]][coords[1]].calculate_possible_moves()
302     self.must_promote = False
303
304 def check_game_state(self):
305     """Completes a check of the state of the game."""
306     if self.calculate_is_checkmate(self.turn, self.board):
307         self.game_over = True
308         if self.turn == "Black":
309             if self.player_one:
310                 self.winner = self.player_one
311             else:
312                 self.winner = "White"
313         else:
314             if self.player_two:
315                 self.winner = self.player_two
316             else:
317                 self.winner = "Black"

```



```

315         elif self.is_in_check(self.turn, self.board):
316             self.colour_in_check = self.turn
317         elif self.calculate_is_stalemate(self.board):
318             self.is_stalemate = True
319             self.game_over = True
320         else:
321             self.colour_in_check = ""
322
323
324     def get_king_coords(self, colour, board):
325         """Finds the coords of the king depending on its colour.
326
327         Args:
328             colour (str): color of the king to find.
329             board (list): the board to find the kind from.
330
331         Returns:
332             list: coordinates of the king in the form [x,y] (0-based).
333         """
334         for x in range(8):
335             for y in range(8):
336                 if isinstance(board[x][y], King) and board[x][y].colour == colour:
337                     return [x, y]
338
339     def calculate_legal_moves(self, piece):
340         """Gets all the legal moves of a piece and returns them.
341
342         Args:
343             piece (Piece): The piece to calculate the legal moves for.
344
345         Returns:
346             list: A list of all the legal moves a piece can make.
347         """
348         legal_moves = []
349         original_board = copy.deepcopy(self.board) # fixed the moving bug.
350         possible_legal_moves = self.get_attacking_moves(piece, original_board)
351         if not isinstance(piece, Pawn):
352             for move in possible_legal_moves:
353                 original_board = copy.deepcopy(self.board)
354                 if isinstance(original_board[move[0]][move[1]], Piece) and not
355                     ↪ isinstance(original_board[move[0]][move[1]], King):
356                     if not piece.colour == original_board[move[0]][move[1]].colour:
357                         possible_board = self.preliminary_move_piece(original_board,
358                             ↪ piece.position, move)
359                         if not self.is_in_check(piece.colour, possible_board):
360                             legal_moves.append(move)
361                     elif not isinstance(original_board[move[0]][move[1]], King):
362                         possible_board = self.preliminary_move_piece(original_board,
363                             ↪ piece.position, move)
364                         if not self.is_in_check(piece.colour, possible_board):
365                             legal_moves.append(move)
366             if isinstance(piece, King):
367                 original_board = copy.deepcopy(self.board)
368                 self.get_castling_moves(piece, original_board)
369                 if piece.castling_moves:
370                     for move in piece.castling_moves:
371                         legal_moves.append(move)
372         else:

```

```

370     # vertical legal moves for pawn
371     if piece.colour == "White":
372         if piece.position[0] > 0 and not isinstance(original_board[piece.position[0]-1][piece.position[1]],
373             ↪ Piece):
374             possible_board = self.preliminary_move_piece(original_board,
375                 ↪ piece.position, [piece.position[0]-1, piece.position[1]])
376             if not self.is_in_check(piece.colour, possible_board):
377                 legal_moves.append([piece.position[0]-1, piece.position[1]])
378             original_board = copy.deepcopy(self.board)
379             if piece.position[0] == 6 and not isinstance(original_board[piece.position[0]-2][piece.position[1]],
380                 ↪ Piece):
381                 possible_board = self.preliminary_move_piece(original_board,
382                     ↪ piece.position, [piece.position[0]-2, piece.position[1]])
383                 if not (self.is_in_check(piece.colour, possible_board) or isinstance(original_board[piece.position[0]-1][piece.position[1]],
384                     ↪ Piece)):
385                     legal_moves.append([piece.position[0]-2, piece.position[1]])
386             else:
387                 if piece.position[0] < 7 and not isinstance(original_board[piece.position[0]+1][piece.position[1]],
388                     ↪ Piece):
389                     possible_board = self.preliminary_move_piece(original_board,
390                         ↪ piece.position, [piece.position[0]+1, piece.position[1]])
391                     if not self.is_in_check(piece.colour, possible_board):
392                         legal_moves.append([piece.position[0]+1, piece.position[1]])
393                     original_board = copy.deepcopy(self.board)
394                     if piece.position[0] == 1 and not isinstance(original_board[piece.position[0]+2][piece.position[1]],
395                         ↪ Piece):
396                         possible_board = self.preliminary_move_piece(original_board,
397                             ↪ piece.position, [piece.position[0]+2, piece.position[1]])
398                         if not (self.is_in_check(piece.colour, possible_board) or isinstance(original_board[piece.position[0]+1][piece.position[1]],
399                             ↪ Piece)):
400                             legal_moves.append([piece.position[0]+2, piece.position[1]])
401                 # When pawn moves diagonally to take piece
402                 for move in possible_legal_moves:
403                     original_board = copy.deepcopy(self.board)
404                     if isinstance(original_board[move[0]][move[1]], Piece) and not
405                         ↪ isinstance(original_board[move[0]][move[1]], King):
406                         possible_board = self.preliminary_move_piece(original_board,
407                             ↪ piece.position, move)
408                         if not self.is_in_check(piece.colour, possible_board):
409                             legal_moves.append(move)
410                 # If enpassant is possible, adds as a possible move.
411                 self.can_enpassant(piece, original_board)
412                 if self.enpassant_move['to']:
413                     legal_moves.append(self.enpassant_move['to'])
414             return legal_moves
415
416 def get_attacking_moves(self, piece, board):
417     """
418     Get all the attacking moves of a piece and return them.
419     The difference between this function and get_legal_moves() is that
420     this shows you what pieces can force a check while the other functions
421     tells you whether the piece can move there.

```

```

410
411     Args:
412         piece (Piece): The piece to calculate the legal moves for.
413         board (board): board used to determine attacking moves.
414
415     Returns:
416         list: A list of all attacking moves a piece can make.
417     """
418     legal_moves = []
419     illegal_moves = []
420     illegal_moves.append(piece.position)
421     def get_legal_moves():
422         for move in piece.possible_moves:
423             if move not in illegal_moves:
424                 legal_moves.append(move)
425         return legal_moves
426     if isinstance(piece, Rook):
427         for move in piece.possible_moves:
428             # If there is a piece in the way
429             if board[move[0]][move[1]]:
430                 # If piece in the way is above
431                 if piece.position[0] > move[0]:
432                     # Then it cannot influence anything above that piece
433                     for i in range(move[0]):
434                         if [i, move[1]] not in illegal_moves:
435                             illegal_moves.append([i, move[1]])
436                 # If piece in the way is below
437                 elif piece.position[0] < move[0]:
438                     # Then it cannot influence anything below that piece
439                     for i in range(7, move[0], -1):
440                         if [i, move[1]] not in illegal_moves:
441                             illegal_moves.append([i, move[1]])
442                 # If piece in the way is to the left
443                 elif piece.position[1] > move[1]:
444                     # Then it cannot influence anything to the left
445                     for i in range(move[1]):
446                         if [move[0], i] not in illegal_moves:
447                             illegal_moves.append([move[0], i])
448                 # If piece in the way is to the right
449                 elif piece.position[1] < move[1]:
450                     # Then it cannot influence anything to the right
451                     for i in range(7, move[1], -1):
452                         if [move[0], i] not in illegal_moves:
453                             illegal_moves.append([move[0], i])
454         return get_legal_moves()
455     elif isinstance(piece, Bishop):
456         for move in piece.possible_moves:
457             if board[move[0]][move[1]]:
458                 counter = 0
459                 # If piece in the way is north-west
460                 if piece.position[0] > move[0] and piece.position[1] > move[1]:
461                     # Then it cannot influence anything north-west
462                     while move[0]-counter != 0 and move[1]-counter != 0:
463                         counter += 1
464                 if [move[0]-counter, move[1]-counter] not in
465                     ↪ illegal_moves:
466                     ↪ illegal_moves.append([move[0]-counter,
467                                             ↪ move[1]-counter])

```

```

466         # If piece in the way is north-east
467         elif piece.position[0] > move[0] and piece.position[1] < move[1]:
468             # Then it cannot influence anything north-east
469             while move[0]-counter != 0 and move[1]+counter != 7:
470                 counter += 1
471                 if [move[0]-counter, move[1]+counter] not in
472                     ↪ illegal_moves:
473                     illegal_moves.append([move[0]-counter,
474                                             ↪ move[1]+counter])
475             # If piece in the way is south-west
476             elif piece.position[0] < move[0] and piece.position[1] > move[1]:
477                 # Then it cannot influence anything south-west
478                 while move[0]+counter != 7 and move[1]-counter != 0:
479                     counter += 1
480                     if [move[0]+counter, move[1]-counter] not in
481                         ↪ illegal_moves:
482                         illegal_moves.append([move[0]+counter,
483                                                 ↪ move[1]-counter])
484             # If piece in the way is south-east
485             elif piece.position[0] < move[0] and piece.position[1] < move[1]:
486                 # Then it cannot influence anything south-east
487                 while move[0]+counter != 7 and move[1]+counter != 7:
488                     counter += 1
489                     if [move[0]+counter, move[1]+counter] not in
490                         ↪ illegal_moves:
491                         illegal_moves.append([move[0]+counter,
492                                                 ↪ move[1]+counter])
493         return get_legal_moves()
494     # This function is a combination of Rook and Bishop
495     elif isinstance(piece, Queen):
496         for move in piece.possible_moves:
497             if board[move[0]][move[1]]:
498                 counter = 0
499                 # If piece in the way is above
500                 if piece.position[0] > move[0] and piece.position[1] == move[1]:
501                     # Then it cannot influence anything above it
502                     for i in range(move[0]):
503                         if [i, move[1]] not in illegal_moves:
504                             illegal_moves.append([i, move[1]])
505                 # If piece in the way is below
506                 elif piece.position[0] < move[0] and piece.position[1] == move[1]:
507                     # Then it cannot influence below it...
508                     for i in range(7, move[0], -1):
509                         if [i, move[1]] not in illegal_moves:
510                             illegal_moves.append([i, move[1]])
511                 # If piece in the way is to the left
512                 elif piece.position[1] > move[1] and piece.position[0] == move[0]:
513                     # Then it cannot influence anything to the left of it
514                     for i in range(move[1]):
515                         if [move[0], i] not in illegal_moves:
516                             illegal_moves.append([move[0], i])
517                 # If piece in the way is to the right
518                 elif piece.position[1] < move[1] and piece.position[0] == move[0]:
519                     # Then it cannot influence anything to the right of it
520                     for i in range(7, move[1], -1):
521                         if [move[0], i] not in illegal_moves:
522                             illegal_moves.append([move[0], i])
523         # If piece in the way is north-west

```

```

518         elif piece.position[0] > move[0] and piece.position[1] > move[1]:
519             # Then it cannot influence anything north-west
520             while move[0]-counter != 0 and move[1]-counter != 0:
521                 counter += 1
522                 if [move[0]-counter, move[1]-counter] not in
523                     ↪ illegal_moves:
524                     illegal_moves.append([move[0]-counter,
525                                             ↪ move[1]-counter])
526             # If piece in the way is north-east
527             elif piece.position[0] > move[0] and piece.position[1] < move[1]:
528                 # Then it cannot influence anything north-east
529                 while move[0]-counter != 0 and move[1]+counter != 7:
530                     counter += 1
531                     if [move[0]-counter, move[1]+counter] not in
532                         ↪ illegal_moves:
533                     illegal_moves.append([move[0]-counter,
534                                             ↪ move[1]+counter])
535             # If piece in the way is south-west
536             elif piece.position[0] < move[0] and piece.position[1] > move[1]:
537                 # Then it cannot influence anything south-west
538                 while move[0]+counter != 7 and move[1]-counter != 0:
539                     counter += 1
540                     if [move[0]+counter, move[1]-counter] not in
541                         ↪ illegal_moves:
542                     illegal_moves.append([move[0]+counter,
543                                             ↪ move[1]-counter])
544             # If piece in the way is south-east
545             elif piece.position[0] < move[0] and piece.position[1] < move[1]:
546                 # Then it cannot influence anything south-east
547                 while move[0]+counter != 7 and move[1]+counter != 7:
548                     counter += 1
549                     if [move[0]+counter, move[1]+counter] not in
550                         ↪ illegal_moves:
551                     illegal_moves.append([move[0]+counter,
552                                             ↪ move[1]+counter])
553             return get_legal_moves()
554         elif isinstance(piece, Pawn):
555             if piece.colour == "White":
556                 if piece.position[0] > 0 and piece.position[1] > 0:
557                     if isinstance(board[piece.position[0]-1][piece.position[1]-1],
558                                     ↪ Piece):
559                         if board[piece.position[0]-1][piece.position[1]-1].colour ==
560                             ↪ "Black":
561                             legal_moves.append([piece.position[0]-1,
562                                                     ↪ piece.position[1]-1])
563                 if piece.position[0] > 0 and piece.position[1] < 7:
564                     if isinstance(board[piece.position[0]-1][piece.position[1]+1],
565                                     ↪ Piece):
566                         if board[piece.position[0]-1][piece.position[1]+1].colour ==
567                             ↪ "Black":
568                             legal_moves.append([piece.position[0]-1,
569                                                     ↪ piece.position[1]+1])
570             elif piece.colour == "Black":
571                 if piece.position[0] < 7 and piece.position[1] < 7:
572                     if isinstance(board[piece.position[0]+1][piece.position[1]+1],
573                                     ↪ Piece):
574                         if board[piece.position[0]+1][piece.position[1]+1].colour ==
575                             ↪ "White":

```

```

560         legal_moves.append([piece.position[0]+1,
                               ↪ piece.position[1]+1])
561     if piece.position[0] < 7 and piece.position[1] > 0:
562         if isinstance(board[piece.position[0]+1][piece.position[1]-1],
                               ↪ Piece):
563             if board[piece.position[0]+1][piece.position[1]-1].colour ==
                               ↪ "White":
564                 legal_moves.append([piece.position[0]+1,
                                       ↪ piece.position[1]-1])
565     return legal_moves
566 elif isinstance(piece, Knight):
567     return piece.possible_moves
568 elif isinstance(piece, King):
569     return piece.possible_moves
570 else:
571     return legal_moves
572
573 def calculate_is_checkmate(self, colour, board):
574     """Finds out if a player is in checkmate.
575
576     Args:
577         colour (str): Colour that we are checking for if they are in checkmate.
578         board (list): the board of the game being played.
579
580     Returns:
581         bool: True if the game is in a state of checkmate, False otherwise.
582     """
583     if self.is_in_check(colour, board):
584         for row in board:
585             for piece in row:
586                 if isinstance(piece, Piece) and piece.colour == colour:
587                     if self.calculate_legal_moves(piece):
588                         return False
589             return True
590     else:
591         return False
592
593 def calculate_is_stalemate(self, board):
594     """Finds out if a game is in stalemate.
595
596     Args:
597         board (list): the board of the game being played.
598
599     Returns:
600         bool: True if the game is in a state of stalemate, False otherwise.
601     """
602     if not self.is_in_check("White", board) and not self.is_in_check("Black",
                               ↪ board):
603         for row in board:
604             for piece in row:
605                 if isinstance(piece, Piece) and piece.colour == self.turn:
606                     if self.calculate_legal_moves(piece):
607                         return False
608             return True
609     else:
610         return False
611
612 def is_in_check(self, colour, possible_board):

```

```

613         """Checks if the king of the corresponding colour is in check.
614
615     Args:
616         colour (str): colour that we are checking if they are in check.
617         possible_board (list): the board of the game being played.
618
619     Returns:
620         bool: True if the player is in check, False otherwise.
621     """
622     king_coords = self.get_king_coords(colour, possible_board)
623     for x in range(8):
624         for y in range(8):
625             if isinstance(possible_board[x][y], Piece) and
626                 ↪ possible_board[x][y].colour != colour:
627                 if king_coords in self.get_attacking_moves(possible_board[x][y],
628                 ↪ possible_board):
629                     return True
630     return False
631
632 def get_castling_moves(self, king, original_board):
633     """Finds castling moves, if they exist, for a given king.
634
635     Args:
636         king (King): the king that we are finding castling moves for.
637         original_board (list): the board of the game being played.
638     """
639     king.castling_moves = []
640     if not king.has_moved and not self.is_in_check(king.colour, self.board):
641         if king.colour == "Black":
642             if isinstance(original_board[0][0], Rook):
643                 if original_board[0][0].colour == "Black" and not
644                 ↪ original_board[0][0].has_moved and not(original_board[0][2]
645                 ↪ or original_board[0][3]):
646                     original_board = copy.deepcopy(self.board)
647                     possible_board = self.preliminary_move_piece(original_board,
648                     ↪ king.position, [king.position[0], king.position[1]-1])
649                     if not self.is_in_check(king.colour, possible_board):
650                         original_board = copy.deepcopy(self.board)
651                         possible_board =
652                         ↪ self.preliminary_move_piece(original_board,
653                         ↪ king.position, [king.position[0],
654                         ↪ king.position[1]-2])
655                     if not self.is_in_check(king.colour, possible_board):
656                         king.castling_moves.append([king.position[0],
657                         ↪ king.position[1]-2])
658             if isinstance(original_board[0][7], Rook):
659                 if original_board[0][7].colour == "Black" and not
660                 ↪ original_board[0][7].has_moved and not(original_board[0][5]
661                 ↪ or original_board[0][6]):
662                     original_board = copy.deepcopy(self.board)
663                     possible_board = self.preliminary_move_piece(original_board,
664                     ↪ king.position, [king.position[0], king.position[1]+1])
665                     if not self.is_in_check(king.colour, possible_board):
666                         original_board = copy.deepcopy(self.board)
667                         possible_board =
668                         ↪ self.preliminary_move_piece(original_board,
669                         ↪ king.position, [king.position[0],
670                         ↪ king.position[1]+2])

```



```

656         if not self.is_in_check(king.colour, possible_board):
657             king.castling_moves.append([king.position[0],
658                                         ↪ king.position[1]+2])
659     else:
660         if isinstance(original_board[7][0], Rook):
661             if original_board[7][0].colour == "White" and not
662                 ↪ original_board[7][0].has_moved and not(original_board[7][2]
663                 ↪ or original_board[7][3]):
664                 original_board = copy.deepcopy(self.board)
665                 possible_board = self.preliminary_move_piece(original_board,
666                 ↪ king.position, [king.position[0], king.position[1]-1])
667                 if not self.is_in_check(king.colour, possible_board):
668                     original_board = copy.deepcopy(self.board)
669                     possible_board =
670                 ↪ self.preliminary_move_piece(original_board,
671                 ↪ king.position, [king.position[0],
672                 ↪ king.position[1]-2])
673                 if not self.is_in_check(king.colour, possible_board):
674                     king.castling_moves.append([king.position[0],
675                     ↪ king.position[1]-2])
676         if isinstance(original_board[7][7], Rook):
677             if original_board[7][7].colour == "White" and not
678                 ↪ original_board[7][7].has_moved and not(original_board[7][5]
679                 ↪ or original_board[7][6]):
680                 original_board = copy.deepcopy(self.board)
681                 possible_board = self.preliminary_move_piece(original_board,
682                 ↪ king.position, [king.position[0], king.position[1]+1])
683                 if not self.is_in_check(king.colour, possible_board):
684                     original_board = copy.deepcopy(self.board)
685                     possible_board =
686                 ↪ self.preliminary_move_piece(original_board,
687                 ↪ king.position, [king.position[0],
688                 ↪ king.position[1]+2])
689                 if not self.is_in_check(king.colour, possible_board):
690                     king.castling_moves.append([king.position[0],
691                     ↪ king.position[1]+2])
692
693     def can_enpassant(self, pawn, possible_board):
694         """Checks if en passant is possible, and assigns the en passant move if so.
695
696         Args:
697             pawn (Pawn): the pawn that we are determining if it can perform en
698             ↪ passant.
699             possible_board (list): the board of the game being played.
700
701         Raises:
702             IndexError: raised when index is -1 or 8 as these indices do not exist in
703             ↪ possible_board.
704         """
705         if self.enpassant_possible[pawn.colour] and ((pawn.position[0] == 4 and
706             ↪ pawn.colour == "Black") or (pawn.position[0] == 3 and pawn.colour ==
707             ↪ "White")):
708             try:
709                 if isinstance(possible_board[pawn.position[0]][pawn.position[1]-1],
710                 ↪ Pawn):
711                     if possible_board[pawn.position[0]][pawn.position[1]-1].first_mov_
712                         ↪ ed == self.move_num -
713                         ↪ 1:

```



```

692         if pawn.colour == "Black":
693             temp_board = self.preliminary_enpassant(possible_board,
                ↪ pawn.position, [pawn.position[0] + 1,
                ↪ pawn.position[1] - 1], [pawn.position[0],
                ↪ pawn.position[1] - 1])
694             if self.is_in_check("Black", temp_board):
695                 return False
696             else:
697                 self.enpassant_move['from'] = pawn.position
698                 self.enpassant_move['to'] = [pawn.position[0] + 1,
                ↪ pawn.position[1] - 1]
699                 self.enpassant_move['taken'] = [pawn.position[0],
                ↪ pawn.position[1] - 1]
700                 return True
701         else:
702             temp_board = self.preliminary_enpassant(possible_board,
                ↪ pawn.position, [pawn.position[0] - 1,
                ↪ pawn.position[1] - 1], [pawn.position[0],
                ↪ pawn.position[1] - 1])
703             if self.is_in_check("White", temp_board):
704                 return False
705             else:
706                 self.enpassant_move['from'] = pawn.position
707                 self.enpassant_move['to'] = [pawn.position[0] - 1,
                ↪ pawn.position[1] - 1]
708                 self.enpassant_move['taken'] = [pawn.position[0],
                ↪ pawn.position[1] - 1]
709                 return True
710         else:
711             return False
712     except IndexError:
713         pass
714     try:
715         if isinstance(possible_board[pawn.position[0]][pawn.position[1]+1],
                ↪ Pawn):
716             if possible_board[pawn.position[0]][pawn.position[1]+1].first_move == self.move_num -
                ↪ 1:
717                 if pawn.colour == "Black":
718                     temp_board = self.preliminary_enpassant(possible_board,
                        ↪ pawn.position, [pawn.position[0] + 1,
                        ↪ pawn.position[1] + 1], [pawn.position[0],
                        ↪ pawn.position[1] + 1])
719                     if self.is_in_check("Black", temp_board):
720                         return False
721                     else:
722                         self.enpassant_move['from'] = pawn.position
723                         self.enpassant_move['to'] = [pawn.position[0] + 1,
                        ↪ pawn.position[1] + 1]
724                         self.enpassant_move['taken'] = [pawn.position[0],
                        ↪ pawn.position[1] + 1]
725                         return True
726                     else:
727                         temp_board = self.preliminary_enpassant(possible_board,
                        ↪ pawn.position, [pawn.position[0] - 1,
                        ↪ pawn.position[1] + 1], [pawn.position[0],
                        ↪ pawn.position[1] + 1])
728                         if self.is_in_check("White", temp_board):

```

```

729         return False
730     else:
731         self.enpassant_move['from'] = pawn.position
732         self.enpassant_move['to'] = [pawn.position[0] - 1,
733                                     ↪ pawn.position[1] + 1]
734         self.enpassant_move['taken'] = [pawn.position[0],
735                                     ↪ pawn.position[1] + 1]
736         return True
737     else:
738         return False
739     except IndexError:
740         pass
741     return False
742 else:
743     return False

```

Chess.py

```

1  import sys
2  import controllers
3  from PySide import QtGui, QtCore
4
5  if __name__ == "__main__":
6      app = QtGui.QApplication(sys.argv)
7      win = controllers.MainWindowController()
8
9      app.connect(app, QtCore.SIGNAL("lastWindowClosed()"), app, QtCore.SLOT("quit()"))
10     app.exec_()

```

controllers.py

```

1  import copy
2  import datetime
3  import json
4  import re
5  from builtins import IOError, FileNotFoundError, TypeError
6
7  from PySide import QtGui, QtCore
8
9  import algorithms
10 import views
11 from board import Board
12 from pieces import *
13
14
15 class MainWindowController(QtGui.QMainWindow, views.MainWindow):
16     """Controller for the main window of the application"""
17     def __init__(self):
18         super(MainWindowController, self).__init__()
19         self.setupUi(self)
20         self.setCentralWidget(ChessBoardController())
21         self.show()
22

```

```

23
24 class ChessBoardController(QtGui.QWidget, views.ChessBoard):
25     """Controller for the chess board.
26     Attributes pertaining to the views.ChessBoard class are not listed here as there
    ↪ are too many
27     and they merely refer to Qt GUI Objects.
28
29     Attributes:
30     board (Board): instance of the Board class which serves as the model for the
    ↪ controller.
31     settings (QSettings): a class used to store settings (namely file path) on
    ↪ the host computer.
32     from_cell (list): stores the coordinates of the cell that was chosen to move
    ↪ from.
33
34     """
35     def __init__(self):
36         """Initialises necessary variables, connects click events to methods and
        ↪ presents a new game to the user."""
37         super(ChessBoardController, self).__init__()
38         self.setupUi(self)
39         self.board = Board()
40         self.settings = QtCore.QSettings("ComputingProjectAlex", "Chess")
41         self.from_cell = []
42         self.chess_board.horizontalHeader().setResizeMode(QtGui.QHeaderView.Stretch)
43         self.chess_board.verticalHeader().setResizeMode(QtGui.QHeaderView.Stretch)
44         self.chess_board.horizontalHeader().hide()
45         self.chess_board.verticalHeader().hide()
46         self.output_board()
47         self.chess_board.itemClicked.connect(self.table_clicked)
48         self.new_btn.clicked.connect(self.new_game)
49         self.save_btn.clicked.connect(self.save_game)
50         self.load_btn.clicked.connect(self.load_game)
51
52     def table_clicked(self):
53         """Handler for when table is clicked.
54
55         When a piece has been selected to move then its legal moves are calculated.
56         These moves are then made clickable and highlighted yellow.
57         If a user selects any of the highlighted colours then the piece is
    ↪ transferred to that position
58         and a check of the game state occurs where any changes are shown in a msg
    ↪ box.
59         Promotions, if necessary, are called in this method.
60         """
61         row = self.chess_board.currentRow()
62         column = self.chess_board.currentColumn()
63         if not self.from_cell and column != -1 and row != -1: # Piece is selected
64             self.from_cell = [row, column]
65             self.output_board(self.board.calculate_legal_moves(self.board.board[row][ ]
        ↪ column]))
66         elif self.from_cell and column != -1 and row != -1: # Piece is moved
67             if self.board.board[row][column]:
68                 if self.board.board[self.from_cell[0]][self.from_cell[1]].colour ==
        ↪ self.board.board[row][column].colour:
69                     self.from_cell = [row, column]
70                     self.output_board(self.board.calculate_legal_moves(self.board.boa
        ↪ rd[row][column]))

```

```

71         else:
72             self.board.board =
73                 ↪ self.board.permanently_move_piece(self.board.board,
74                 ↪ self.from_cell, [row, column])
75             if self.board.must_promote:
76                 self.board.permanently_promote_piece(self.get_promotion_piece(),
77                 ↪ (), [row,
78                 ↪ column])
79             self.board.check_game_state()
80             self.output_board()
81             self.from_cell = []
82             if self.board.game_over and self.board.is_stalemate:
83                 self.show_message("Game is a draw. No one wins")
84             elif self.board.game_over:
85                 self.show_message("{} is the
86                 ↪ winner".format(self.board.winner))
87             elif self.board.colour_in_check:
88                 self.show_message("{} is in
89                 ↪ check".format(self.board.colour_in_check))
90         else:
91             self.board.board =
92                 ↪ self.board.permanently_move_piece(self.board.board,
93                 ↪ self.from_cell, [row, column])
94             if self.board.must_promote:
95                 self.board.permanently_promote_piece(self.get_promotion_piece(),
96                 ↪ [row, column])
97             self.board.check_game_state()
98             self.output_board()
99             self.from_cell = []
100             if self.board.game_over and self.board.is_stalemate:
101                 self.show_message("Game is a draw. No one wins")
102             elif self.board.game_over:
103                 self.show_message("{} is the winner".format(self.board.winner))
104             elif self.board.colour_in_check:
105                 self.show_message("{} is in
106                 ↪ check".format(self.board.colour_in_check))
107
108 def output_board(self, legal_moves=[]):
109     """Output the board onto the GUI
110
111     Uses the Board.board (2D list) to help populate the QTableWidgetItem table.
112     All pieces of the moving player are made clickable on the table.
113     In addition, if there are legal moves specified they are all made clickable.
114
115     Args:
116         legal_moves (list): list of the legal moves a piece can make.
117     """
118     self.chess_board.clear()
119     self.chess_board.setRowCount(8)
120     self.chess_board.setColumnCount(8)
121     for y in range(8):
122         for x in range(8):
123             if self.board.board[y][x]:
124                 if self.board.turn == "Black" and self.board.board[y][x].colour
125                 ↪ == "Black":
126                     item = QtGui.QTableWidgetItem()
127                     item.setSizeHint(QtCore.QSize(80, 80))
128                     item.setData(QtCore.Qt.DecorationRole,

```

```

118         QtGui.QPixmap(":/pieces/{}".format(self.board.board[y][x].img_path))
119     if (x+y) % 2 == 0:
120         item.setBackground(QtGui.QBrush(QtGui.QColor(31, 177,
121             ↪ 209))) # light
122     else:
123         item.setBackground(QtGui.QBrush(QtGui.QColor(11, 129,
124             ↪ 156))) # dark
125     item.setFlags(QtCore.Qt.ItemIsEnabled)
126     self.chess_board.setItem(y, x, item)
127 elif self.board.turn == "White" and self.board.board[y][x].colour
128     ↪ == "White":
129     item = QtGui.QTableWidgetItem()
130     item.setSizeHint(QtCore.QSize(80, 80))
131     item.setData(QtCore.Qt.DecorationRole,
132         QtGui.QPixmap(":/pieces/{}".format(self.board.board[y][x].img_path))
133     if (x+y) % 2 == 0:
134         item.setBackground(QtGui.QBrush(QtGui.QColor(31, 177,
135             ↪ 209))) # light
136     else:
137         item.setBackground(QtGui.QBrush(QtGui.QColor(11, 129,
138             ↪ 156))) # dark
139     item.setFlags(QtCore.Qt.ItemIsEnabled)
140     self.chess_board.setItem(y, x, item)
141 else:
142     item = QtGui.QTableWidgetItem()
143     item.setSizeHint(QtCore.QSize(80, 80))
144     item.setData(QtCore.Qt.DecorationRole,
145         QtGui.QPixmap(":/pieces/{}".format(self.board.board[y][x].img_path))
146     if (x+y) % 2 == 0:
147         item.setBackground(QtGui.QBrush(QtGui.QColor(31, 177,
148             ↪ 209))) # light
149     else:
150         item.setBackground(QtGui.QBrush(QtGui.QColor(11, 129,
151             ↪ 156))) # dark
152     if [y, x] in legal_moves:
153         item.setFlags(QtCore.Qt.ItemIsEnabled)
154         item.setBackground(QtGui.QBrush(QtGui.QColor(227, 209,
155             ↪ 16))) # highlight legal moves
156     else:
157         item.setFlags(QtCore.Qt.NoItemFlags)
158         self.chess_board.setItem(y, x, item)
159 elif [y, x] in legal_moves:
160     item = QtGui.QTableWidgetItem()
161     item.setSizeHint(QtCore.QSize(80, 80))
162     item.setBackground(QtGui.QBrush(QtGui.QColor(227, 209, 16))) #
163     ↪ highlight legal moves
164     item.setFlags(QtCore.Qt.ItemIsEnabled)
165     self.chess_board.setItem(y, x, item)
166 else:
167     item = QtGui.QTableWidgetItem()
168     item.setSizeHint(QtCore.QSize(80, 80))
169     if (x+y) % 2 == 0:
170         item.setBackground(QtGui.QBrush(QtGui.QColor(31, 177, 209)))
171         ↪ # light
172     else:

```

```

163         item.setBackground(QtGui.QBrush(QtGui.QColor(11, 129, 156)))
164             ↪ # dark
165         item.setFlags(QtCore.Qt.NoItemFlags)
166         self.chess_board.setItem(y, x, item)
167
168     def new_game(self):
169         """Creates a new game with initial board setup."""
170         self.board = Board()
171         self.from_cell = []
172         self.output_board()
173
174     def load_game(self):
175         """Loads a game from a JSON file. If there is no JSON file the user is
176             ↪ prompted for one.
177
178         Raises:
179         IOError: raised when there is an error loading a file.
180         FileNotFoundError: raised when a file is not found.
181         TypeError: raised when there is an error loading a file.
182         KeyError: raised when there is corruption in the JSON file.
183         """
184         try:
185             data = None
186             with open(self.settings.value('json_location')) as json_file:
187                 data = json.load(json_file)
188             game_loader = LoadDialogController(data)
189             game_loader.exec()
190             game = []
191             if game_loader.chosen_game_id != 0:
192                 for temp_game in data['games']:
193                     if game_loader.chosen_game_id == temp_game['id']:
194                         game = temp_game
195                         break
196             self.board = Board(game)
197             self.player_one_edit.setText(game['player_one'])
198             self.player_two_edit.setText(game['player_two'])
199             self.board.check_game_state()
200             self.output_board()
201             if self.board.game_over and self.board.is_stalemate:
202                 self.show_message("Game is a draw. No one wins")
203             elif self.board.game_over:
204                 self.show_message("{} is the winner".format(self.board.winner))
205             elif self.board.colour_in_check:
206                 self.show_message("{} is in
207                     ↪ check".format(self.board.colour_in_check))
208         except (IOError, FileNotFoundError, TypeError):
209             self.show_message("Game file not found!")
210             self.get_load_path()
211             if self.settings.value:
212                 self.show_message("Press Load game again.")
213         except (KeyError):
214             self.show_message("Data file is corrupt. Please choose another file")
215             self.get_load_path()
216             if self.settings.value:
217                 self.load_game("Press Load game again.")
218
219     def save_game(self):

```

```

217         """Saves a currently played game, either in an existing JSON file or a new
218         ↪ one.
219
220     Raises:
221         IOError: raised when there is an error loading a file.
222         FileNotFoundError: raised when a file is not found.
223     """
224     if self.player_one_edit.text() != "" and self.player_two_edit.text() != "":
225         self.board.player_one = self.player_one_edit.text()
226         self.board.player_two = self.player_two_edit.text()
227         self.board.check_game_state()
228         if self.board.winner == "White":
229             self.board.winner = self.player_one_edit.text()
230         elif self.board.winner == "Black":
231             self.board.winner = self.player_one_edit.text()
232         now = datetime.datetime.now()
233         year = str(now.year)
234         month = int(now.month)
235         day = int(now.day)
236         if month < 10:
237             month = "0" + str(month)
238         else:
239             month = str(month)
240         if day < 10:
241             day = "0" + str(day)
242         else:
243             day = str(day)
244         game = {
245             'id': self.board.id,
246             'last_played': str(year + "/" + month + "/" + day),
247             'turn': self.board.turn,
248             'move_num': self.board.move_num,
249             'winner': self.board.winner,
250             'colour_in_check': self.board.colour_in_check,
251             'is_stalemate': self.board.is_stalemate,
252             'game_over': self.board.game_over,
253             'must_promote': self.board.must_promote,
254             'enpassant_possible': {
255                 'Black': self.board.enpassant_possible['Black'],
256                 'White': self.board.enpassant_possible['White']
257             },
258             'enpassant_move': {
259                 'from': self.board.enpassant_move['from'],
260                 'to': self.board.enpassant_move['to'],
261                 'taken': self.board.enpassant_move['taken']
262             },
263             'player_one': self.board.player_one,
264             'player_two': self.board.player_two,
265             'pieces': {
266                 'kings': [],
267                 'queens': [],
268                 'knights': [],
269                 'bishops': [],
270                 'rooks': [],
271                 'pawns': []
272             }
273         }
274         for row in self.board.board:

```

```

274         for field in row:
275             if field:
276                 if isinstance(field, Queen):
277                     piece = {
278                         'position': field.position,
279                         'colour': field.colour
280                     }
281                     game['pieces']['queens'].append(piece)
282                 elif isinstance(field, Bishop):
283                     piece = {
284                         'position': field.position,
285                         'colour': field.colour
286                     }
287                     game['pieces']['bishops'].append(piece)
288                 elif isinstance(field, Knight):
289                     piece = {
290                         'position': field.position,
291                         'colour': field.colour
292                     }
293                     game['pieces']['knights'].append(piece)
294                 elif isinstance(field, Rook):
295                     piece = {
296                         'position': field.position,
297                         'colour': field.colour,
298                         'has_moved': field.has_moved
299                     }
300                     game['pieces']['rooks'].append(piece)
301                 elif isinstance(field, King):
302                     piece = {
303                         'position': field.position,
304                         'colour': field.colour,
305                         'has_moved': field.has_moved,
306                         'castling_moves': field.castling_moves
307                     }
308                     game['pieces']['kings'].append(piece)
309                 elif isinstance(field, Pawn):
310                     piece = {
311                         'position': field.position,
312                         'colour': field.colour,
313                         'first_moved': field.first_moved
314                     }
315                     game['pieces']['pawns'].append(piece)
316         if self.settings.value('json_location'):
317             try:
318                 data = None
319                 with open(self.settings.value('json_location')) as json_file:
320                     data = json.load(json_file)
321                 id_list = [x['id'] for x in data['games']]
322
323                 algorithms.quick_sort(id_list, 0, len(id_list)-1)
324                 if game['id']:
325                     if algorithms.binary_search(game['id'], id_list):
326                         for x in range(len(data['games'])):
327                             if game['id'] == data['games'][x]['id']:
328                                 data['games'][x] = game
329                     else:
330                         game['id'] = id_list[-1] + 1
331                         self.board.id = id_list[-1] + 1

```



```

332         data['games'].append(game)
333     else:
334         game['id'] = id_list[-1] + 1
335         self.board.id = id_list[-1] + 1
336         data['games'].append(game)
337         with open(self.settings.value('json_location'), 'w') as jsonfile:
338             json.dump(data, jsonfile, indent=4, separators=(',', ':'))
339             self.show_message("Game saved at
340                               ↪ {}".format(self.settings.value('json_location')))
341         except (IOError, FileNotFoundError):
342             self.show_message("Error: File not found")
343             self.settings.setValue("json_location", "")
344             self.save_game()
345     else:
346         self.get_save_path()
347         if self.settings.value('json_location'):
348             data = {'games': []}
349             game['id'] = 1
350             self.board.id = 1
351             data['games'].append(game)
352             try:
353                 with open(self.settings.value('json_location'), 'w') as
354                     ↪ jsonfile:
355                     json.dump(data, jsonfile, indent=4, separators=(',', ':'))
356                     self.show_message("Game saved at
357                                       ↪ {}".format(self.settings.value('json_location')))
358             except (FileNotFoundError, OSError):
359                 self.show_message("File not saved. Invalid file name.")
360                 self.settings.setValue("json_location", "")
361     else:
362         self.show_message("Please fill in the player names")
363
364 def get_load_path(self):
365     """Gets the JSON file to load"""
366     filepath = QtGui.QFileDialog().getOpenFileName(self, "Load Game",
367     ↪ QtCore.QDir.homePath(), "Game file (*.json)")
368     if filepath[0]:
369         self.settings.setValue("json_location", filepath[0])
370     else:
371         self.settings.setValue("json_location", "")
372         self.show_message("File not chosen.")
373
374 def get_save_path(self):
375     """Gets the desired path and filename of the file to save."""
376     filepath = QtGui.QFileDialog().getSaveFileName(self, "Save as",
377     ↪ QtCore.QDir.homePath(), "Game file (*.json)")
378     if filepath[0]:
379         self.settings.setValue("json_location", filepath[0])
380     else:
381         self.settings.setValue("json_location", "")
382         self.show_message("File not saved")
383
384 def get_promotion_piece(self):
385     """Gets the piece that needs to be promoted"""
386     choice = ["", False]
387     while not choice[1]:
388         choice = QtGui.QInputDialog.getItem(self, "Piece to promote", "Choose
389         ↪ piece:", ["Queen", "Knight", "Rook", "Bishop"], 0, False)

```

```
384         return choice[0]
385
386     def show_message(self, msg):
387         """If there are errors, they are shown in a message box.
388
389         Args:
390             msg (str): message for the user to be shown.
391             """
392         msg_box = QtGui.QMessageBox()
393         msg_box.setWindowTitle("Game State")
394         msg_box.setText(msg)
395         msg_box.exec_()
396
397
398     class LoadDialogController(QtGui.QDialog, views.LoadDialog):
399         """Controller for the load dialog
400
401         When 'Load Game' is pressed the user is shown this dialog if a JSON file is found
402         ↪ and has been loaded.
403
404         The user is shown a table where they can sort the games and can also choose which
405         ↪ game to load.
406
407         Attributes:
408             chosen_game_id (int): id of the game that was chosen
409             data (dict): List of games.
410             """
411
412     def __init__(self, data):
413         """Necessary variables are initialised and table is shown to the user."""
414         super(LoadDialogController, self).__init__()
415         self.setupUi(self)
416         self.chosen_game_id = 0
417         self.data = data
418         self.output_table()
419         self.results_table.setSelectionBehavior(QtGui.QAbstractItemView.SelectRows)
420         self.results_table.setSelectionMode(QtGui.QAbstractItemView.SingleSelection)
421         self.sort_btn.clicked.connect(self.sort)
422
423     def output_table(self):
424         """List of games is shown to the user with this method."""
425         self.results_table.setRowCount(0)
426         self.buttonBox.accepted.connect(self.get_game)
427         i = 0
428         for game in self.data['games']:
429             identifier = QtGui.QTableWidgetItem()
430             identifier.setText(str(game['id']))
431             player_one = QtGui.QTableWidgetItem()
432             player_one.setText(game['player_one'])
433             player_two = QtGui.QTableWidgetItem()
434             player_two.setText(game['player_two'])
435             winner = QtGui.QTableWidgetItem()
436             winner.setText(game['winner'])
437             moves_made = QtGui.QTableWidgetItem()
438             moves_made.setText(str(game['move_num']-1))
439             last_played = QtGui.QTableWidgetItem()
440             last_played.setText(game['last_played'])
441             self.results_table.insertRow(i)
442             self.results_table.setItem(i, 0, identifier)
```

```

440         self.results_table.setItem(i, 1, player_one)
441         self.results_table.setItem(i, 2, player_two)
442         self.results_table.setItem(i, 3, winner)
443         self.results_table.setItem(i, 4, moves_made)
444         self.results_table.setItem(i, 5, last_played)
445         i += 1
446
447     def sort(self):
448         """Sorts the list of games"""
449         sorted_games = []
450         if self.sortby_box.currentText() == "Ascending":
451             if self.sort_type.currentText() == "ID":
452                 array = []
453                 for x in range(self.results_table.rowCount()):
454                     array.append(int(self.results_table.item(x, 0).text()))
455                 algorithms.quick_sort(array, 0, len(array)-1)
456                 sorted_games = [None] * len(array)
457                 for i in range(len(array)):
458                     for j in range(len(self.data['games'])):
459                         if array[i] == self.data['games'][j]['id']:
460                             sorted_games[i] = copy.deepcopy(self.data['games'][j])
461                             self.data['games'][j]['id'] = None
462                             break
463             elif self.sort_type.currentText() == "Player 1":
464                 array = []
465                 for x in range(self.results_table.rowCount()):
466                     array.append(self.results_table.item(x, 1).text())
467                 algorithms.quick_sort(array, 0, len(array)-1)
468                 sorted_games = [None] * len(array)
469                 for i in range(len(array)):
470                     for j in range(len(self.data['games'])):
471                         if array[i] == self.data['games'][j]['player_one']:
472                             sorted_games[i] = copy.deepcopy(self.data['games'][j])
473                             self.data['games'][j]['player_one'] = None
474                             break
475             elif self.sort_type.currentText() == "Player 2":
476                 array = []
477                 for x in range(self.results_table.rowCount()):
478                     array.append(self.results_table.item(x, 2).text())
479                 algorithms.quick_sort(array, 0, len(array)-1)
480                 sorted_games = [None] * len(array)
481                 for i in range(len(array)):
482                     for j in range(len(self.data['games'])):
483                         if array[i] == self.data['games'][j]['player_two']:
484                             sorted_games[i] = copy.deepcopy(self.data['games'][j])
485                             self.data['games'][j]['player_two'] = None
486                             break
487             elif self.sort_type.currentText() == "Winner":
488                 array = []
489                 for x in range(self.results_table.rowCount()):
490                     array.append(self.results_table.item(x, 3).text())
491                 algorithms.quick_sort(array, 0, len(array)-1)
492                 sorted_games = [None] * len(array)
493                 for i in range(len(array)):
494                     for j in range(len(self.data['games'])):
495                         if array[i] == self.data['games'][j]['winner']:
496                             sorted_games[i] = copy.deepcopy(self.data['games'][j])
497                             self.data['games'][j]['winner'] = None

```

```

498             break
499     elif self.sort_type.currentText() == "Moves Made":
500         array = []
501         for x in range(self.results_table.rowCount()):
502             array.append(int(self.results_table.item(x, 4).text()))
503         algorithms.quick_sort(array, 0, len(array)-1)
504         sorted_games = [None] * len(array)
505         for i in range(len(array)):
506             for j in range(len(self.data['games'])):
507                 if int(array[i])+1 == self.data['games'][j]['move_num']:
508                     sorted_games[i] = copy.deepcopy(self.data['games'][j])
509                     self.data['games'][j]['move_num'] = None
510                     break
511     elif self.sort_type.currentText() == "Last Played":
512         array = []
513         for x in range(self.results_table.rowCount()):
514             array.append(self.results_table.item(x, 5).text())
515         algorithms.quick_sort(array, 0, len(array)-1)
516         sorted_games = [None] * len(array)
517         for i in range(len(array)):
518             for j in range(len(self.data['games'])):
519                 if array[i] == self.data['games'][j]['last_played']:
520                     sorted_games[i] = copy.deepcopy(self.data['games'][j])
521                     self.data['games'][j]['last_played'] = None
522                     break
523     else:
524         if self.sort_type.currentText() == "ID":
525             array = []
526             for x in range(self.results_table.rowCount()):
527                 array.append(int(self.results_table.item(x, 0).text()))
528             algorithms.quick_sort(array, 0, len(array)-1)
529             array = array[::-1] # reverse list
530             sorted_games = [None] * len(array)
531             for i in range(len(array)):
532                 for j in range(len(self.data['games'])):
533                     if array[i] == self.data['games'][j]['id']:
534                         sorted_games[i] = copy.deepcopy(self.data['games'][j])
535                         self.data['games'][j]['id'] = None
536                         break
537         elif self.sort_type.currentText() == "Player 1":
538             array = []
539             for x in range(self.results_table.rowCount()):
540                 array.append(self.results_table.item(x, 1).text())
541             algorithms.quick_sort(array, 0, len(array)-1)
542             array = array[::-1] # reverse list
543             sorted_games = [None] * len(array)
544             for i in range(len(array)):
545                 for j in range(len(self.data['games'])):
546                     if array[i] == self.data['games'][j]['player_one']:
547                         sorted_games[i] = copy.deepcopy(self.data['games'][j])
548                         self.data['games'][j]['player_one'] = None
549                         break
550         elif self.sort_type.currentText() == "Player 2":
551             array = []
552             for x in range(self.results_table.rowCount()):
553                 array.append(self.results_table.item(x, 2).text())
554             algorithms.quick_sort(array, 0, len(array)-1)
555             array = array[::-1] # reverse list

```

```

556         sorted_games = [None] * len(array)
557         for i in range(len(array)):
558             for j in range(len(self.data['games'])):
559                 if array[i] == self.data['games'][j]['player_two']:
560                     sorted_games[i] = copy.deepcopy(self.data['games'][j])
561                     self.data['games'][j]['player_two'] = None
562                     break
563         elif self.sort_type.currentText() == "Winner":
564             array = []
565             for x in range(self.results_table.rowCount()):
566                 array.append(self.results_table.item(x, 3).text())
567             algorithms.quick_sort(array, 0, len(array)-1)
568             array = array[::-1] # reverse list
569             sorted_games = [None] * len(array)
570             for i in range(len(array)):
571                 for j in range(len(self.data['games'])):
572                     if array[i] == self.data['games'][j]['winner']:
573                         sorted_games[i] = copy.deepcopy(self.data['games'][j])
574                         self.data['games'][j]['winner'] = None
575                         break
576         elif self.sort_type.currentText() == "Moves Made":
577             array = []
578             for x in range(self.results_table.rowCount()):
579                 array.append(int(self.results_table.item(x, 4).text()))
580             algorithms.quick_sort(array, 0, len(array)-1)
581             array = array[::-1] # reverse list
582             sorted_games = [None] * len(array)
583             for i in range(len(array)):
584                 for j in range(len(self.data['games'])):
585                     if int(array[i])+1 == self.data['games'][j]['move_num']:
586                         sorted_games[i] = copy.deepcopy(self.data['games'][j])
587                         self.data['games'][j]['move_num'] = None
588                         break
589         elif self.sort_type.currentText() == "Last Played":
590             array = []
591             for x in range(self.results_table.rowCount()):
592                 array.append(self.results_table.item(x, 5).text())
593             algorithms.quick_sort(array, 0, len(array)-1)
594             array = array[::-1] # reverse list
595             sorted_games = [None] * len(array)
596             for i in range(len(array)):
597                 for j in range(len(self.data['games'])):
598                     if array[i] == self.data['games'][j]['last_played']:
599                         sorted_games[i] = copy.deepcopy(self.data['games'][j])
600                         self.data['games'][j]['last_played'] = None
601                         break
602         self.data['games'] = sorted_games
603         self.output_table()
604
605     def get_game(self):
606         """When game is chosen the ID is then found."""
607         if self.results_table.currentRow() != -1:
608             self.chosen_game_id =
609                 ↪ int(self.results_table.item(self.results_table.currentRow(),
610                 ↪ 0).text())
609         else: # if no game selected
610             self.chosen_game_id = 0 # Will not attempt to load game if it is 0.

```

pieces.py

```

1  __author__ = "Alexander Saoutkin"
2
3
4  class Piece(object):
5      """Base class for all chess pieces"""
6
7      Attributes:
8          position (list): coordinates on the board in the form [x, y]
9          colour (str): Colour of the piece, either "White" or "Black"
10     """
11
12     def __init__(self, position, colour):
13         """This constructor initialises the class variables and also calculates all
14         ↪ possible moves for the piece."""
15         self.position = position
16         self.colour = colour
17         self.possible_moves = []
18         self.calculate_possible_moves()
19
20         @property
21         def position(self):
22             return self.position
23
24         @position.setter
25         def position(self, value):
26             """ This setter calculates the new possible moves once the position has
27             ↪ changed.
28
29             Args:
30                 value (list): coordinates on the board in the form [x, y]
31             """
32             self.position = value
33             self.calculate_possible_moves()
34
35     def calculate_possible_moves(self):
36         """Shows us the coords it can go to assuming that there are no other pieces
37         ↪ on the board
38
39         Raises:
40             NotImplementedError: Method not overridden in subclass.
41         """
42         raise NotImplementedError
43
44
45     class Rook(Piece):
46         """Class for a Rook"""
47
48         Attributes:
49             position (list): coordinates on the board in the form [x, y]
50             colour (str): colour of the piece, either "White" or "Black"
51             img_path (str): path to the image of the piece
52             has_moved (bool): Denotes whether the piece has moved before.
53         """
54
55         def __init__(self, position, colour, has_moved=False):
56             """

```

```

54         This constructor initialises the class variables and also calculates all
↪ possible moves for the piece.
55         In addition the image path is added.
56         """
57         super().__init__(position, colour)
58         self.img_path = "{}_rook.png".format(self.colour.lower())
59         self.has_moved = has_moved
60
61     def calculate_possible_moves(self):
62         """Calculates all the possible moves for a rook in a certain position."""
63         self.possible_moves = []
64         for i in range(8):
65             if self.position[1] != i:
66                 self.possible_moves.append([self.position[0], i])
67             if self.position[0] != i:
68                 self.possible_moves.append([i, self.position[1]])
69
70
71 class Knight(Piece):
72     """Class for a Knight
73
74     Attributes:
75     position (list): coordinates on the board in the form [x, y]
76     colour (str): colour of the piece, either "White" or "Black"
77     img_path (str): path to the image of the piece
78     """
79
80     def __init__(self, position, colour):
81         """
82         This constructor initialises the class variables and also calculates all
↪ possible moves for the piece.
83         In addition the image path is added as an attribute self.img_path.
84         """
85         super().__init__(position, colour)
86         self.img_path = "{}_knight.png".format(self.colour.lower())
87
88     def calculate_possible_moves(self):
89         """Calculates all the possible moves for a knight in a certain position."""
90         self.possible_moves = []
91         potential_moves = [[self.position[0] + 2, self.position[1] + 1],
92                             [self.position[0] + 2, self.position[1] - 1],
93                             [self.position[0] - 2, self.position[1] + 1],
94                             [self.position[0] - 2, self.position[1] - 1],
95                             [self.position[0] + 1, self.position[1] + 2],
96                             [self.position[0] + 1, self.position[1] - 2],
97                             [self.position[0] - 1, self.position[1] + 2],
98                             [self.position[0] - 1, self.position[1] - 2]]
99         for move in potential_moves:
100             if 7 >= move[0] >= 0 and 7 >= move[1] >= 0:
101                 self.possible_moves.append(move)
102
103
104 class Bishop(Piece):
105     """Class for a Bishop
106
107     Attributes:
108     position (list): coordinates on the board in the form [x, y]
109     colour (str): colour of the piece, either "White" or "Black"

```



```

110         img_path (str): path to the image of the piece
111         """
112     def __init__(self, position, colour):
113         """
114         This constructor initialises the class variables and also calculates all
↪ possible moves for the piece.
115         In addition the image path is added as an attribute self.img_path.
116         """
117         super().__init__(position, colour)
118         self.img_path = "{}_bishop.png".format(self.colour.lower())
119
120     def calculate_possible_moves(self):
121         """Calculates all the possible moves for a bishop in a certain position."""
122         self.possible_moves = []
123         on_edge = False
124         counter = 0
125         # Dont' bother iterating to the right if already on the edge
126         if self.position[0] is 7 or self.position[1] is 7:
127             on_edge = True
128         # Find all positions diagonally to south-east.
129         while not on_edge:
130             counter += 1
131             self.possible_moves.append([self.position[0]+counter,
↪ self.position[1]+counter])
132             if self.position[0]+counter is 7 or self.position[1]+counter is 7:
133                 on_edge = True
134         counter = 0
135         on_edge = False
136         # Dont' bother iterating to the right if already on the edge
137         if self.position[0] is 0 or self.position[1] is 0:
138             on_edge = True
139         # Find all positions diagonally to north-west
140         while not on_edge:
141             counter += 1
142             self.possible_moves.append([self.position[0]-counter,
↪ self.position[1]-counter])
143             if self.position[0]-counter is 0 or self.position[1]-counter is 0:
144                 on_edge = True
145         counter = 0
146         on_edge = False
147         # Find all positions diagonally to north-east
148         if self.position[0] is 0 or self.position[1] is 7:
149             on_edge = True
150         while not on_edge:
151             counter +=1
152             self.possible_moves.append([self.position[0]-counter,
↪ self.position[1]+counter])
153             if self.position[0]-counter is 0 or self.position[1]+counter is 7:
154                 on_edge = True
155         counter = 0
156         on_edge = False
157         # Find all positions diagonally to south-west
158         if self.position[0] is 7 or self.position[1] is 0:
159             on_edge = True
160         while not on_edge:
161             counter +=1
162             self.possible_moves.append([self.position[0]+counter,
↪ self.position[1]-counter])

```



```

163         if self.position[0]+counter is 7 or self.position[1]-counter is 0:
164             on_edge = True
165
166
167 class Queen(Piece):
168     """Class for a Queen
169
170     Attributes:
171         position (list): coordinates on the board in the form [x, y]
172         colour (str): colour of the piece, either "White" or "Black"
173         img_path (str): path to the image of the piece
174     """
175     def __init__(self, position, colour):
176         """
177         This constructor initialises the class variables and also calculates all
178  $\hookrightarrow$  possible moves for the piece.
179         In addition the image path is added as an attribute self.img_path.
180         """
181         super().__init__(position, colour)
182         self.img_path = "{}_queen.png".format(self.colour.lower())
183
184     def calculate_possible_moves(self):
185         """Calculates all the possible moves for a queen in a certain position."""
186         self.possible_moves = []
187         on_edge = False
188         counter = 0
189         # Do not bother iterating if already on the edge
190         if self.position[0] is 7 or self.position[1] is 7:
191             on_edge = True
192         # Find all positions diagonally to south-east.
193         while not on_edge:
194             counter += 1
195             self.possible_moves.append([self.position[0]+counter,
196  $\hookrightarrow$  self.position[1]+counter])
197             if self.position[0]+counter is 7 or self.position[1]+counter is 7:
198                 on_edge = True
199         counter = 0
200         on_edge = False
201         if self.position[0] is 0 or self.position[1] is 0:
202             on_edge = True
203         # Find all positions diagonally to north-west
204         while not on_edge:
205             counter += 1
206             self.possible_moves.append([self.position[0]-counter,
207  $\hookrightarrow$  self.position[1]-counter])
208             if self.position[0]-counter is 0 or self.position[1]-counter is 0:
209                 on_edge = True
210         counter = 0
211         on_edge = False
212         # Find all positions diagonally to north-east
213         if self.position[0] is 0 or self.position[1] is 7:
214             on_edge = True
215         while not on_edge:
216             counter +=1
217             self.possible_moves.append([self.position[0]-counter,
218  $\hookrightarrow$  self.position[1]+counter])
219             if self.position[0]-counter is 0 or self.position[1]+counter is 7:
220                 on_edge = True

```

```

217         counter = 0
218         on_edge = False
219         # Find all positions diagonally to south-west
220         if self.position[0] is 7 or self.position[1] is 0:
221             on_edge = True
222         while not on_edge:
223             counter +=1
224             self.possible_moves.append([self.position[0]+counter,
225                                         ↪ self.position[1]-counter])
226             if self.position[0]+counter is 7 or self.position[1]-counter is 0:
227                 on_edge = True
228         # Find all positions horizontally and vertically
229         for i in range(8):
230             if self.position[1] != i:
231                 self.possible_moves.append([self.position[0], i])
232             if self.position[0] != i:
233                 self.possible_moves.append([i, self.position[1]])
234
235 class King(Piece):
236     """Class for a King
237
238     Attributes:
239         position (list): coordinates on the board in the form [x, y].
240         colour (str): colour of the piece, either "White" or "Black".
241         img_path (str): path to the image of the piece.
242         has_moved (bool): denotes whether piece has moved or not.
243         castling_moves (list): list of all castling moves possible.
244     """
245     def __init__(self, position, colour, has_moved=False, castling_moves=[]):
246         """
247         This constructor initialises the class variables and also calculates all
248         ↪ possible moves for the piece.
249         In addition the image path is added as an attribute self.img_path.
250         """
251         super().__init__(position, colour)
252         self.img_path = "{}_king.png".format(self.colour.lower())
253         self.has_moved = has_moved
254         self.castling_moves = castling_moves
255
256     def calculate_possible_moves(self):
257         """Calculates all the possible moves for a king in a certain position."""
258         self.possible_moves.clear()
259         potential_moves = []
260         potential_moves.append([self.position[0]+1, self.position[1]+1])
261         potential_moves.append([self.position[0]+1, self.position[1]-1])
262         potential_moves.append([self.position[0]+1, self.position[1]])
263         potential_moves.append([self.position[0]-1, self.position[1]+1])
264         potential_moves.append([self.position[0]-1, self.position[1]-1])
265         potential_moves.append([self.position[0]-1, self.position[1]])
266         potential_moves.append([self.position[0], self.position[1]+1])
267         potential_moves.append([self.position[0], self.position[1]-1])
268         for move in potential_moves:
269             if move[0] <= 7 and move [0] >= 0 and move[1] <= 7 and move[1] >= 0:
270                 self.possible_moves.append(move)
271
272 class Pawn(Piece):

```

```

273     """Class for a Pawn
274
275     Attributes:
276         position (list): coordinates on the board in the form [x, y]
277         colour (str): colour of the piece, either "White" or "Black"
278         img_path (str): path to the image of the piece
279         first_moved (int): denotes at what stage (move) in the game the the piece was
↪ first moved.
280     """
281     def __init__(self, position, colour, first_moved=0):
282         """
283         This constructor initialises the class variables and also calculates all
↪ possible moves for the piece.
284         In addition the image path is added as an attribute self.img_path.
285         """
286         super().__init__(position, colour)
287         self.img_path = "{}_pawn.png".format(self.colour.lower())
288         self.first_moved = first_moved
289
290     def calculate_possible_moves(self):
291         """Calculates all the possible moves for a pawn in a certain position."""
292         self.possible_moves.clear()
293         if self.colour == "White":
294             self.possible_moves.append([self.position[0]-1, self.position[1]])
295         else:
296             self.possible_moves.append([self.position[0]+1, self.position[1]])

```

views.py

```

1  from PySide import QtCore, QtGui
2  import resources_rc
3
4  class MainWindow(object):
5      def setupUi(self, MainWindow):
6          MainWindow.setObjectName("MainWindow")
7          MainWindow.resize(660, 742)
8          self.centralwidget = QtGui.QWidget(MainWindow)
9          self.centralwidget.setObjectName("centralwidget")
10         MainWindow.setCentralWidget(self.centralwidget)
11         self.menubar = QtGui.QMenuBar(MainWindow)
12         self.menubar.setGeometry(QtCore.QRect(0, 0, 660, 21))
13         self.menubar.setObjectName("menubar")
14         MainWindow.setMenuBar(self.menubar)
15         self.statusbar = QtGui.QStatusBar(MainWindow)
16         self.statusbar.setObjectName("statusbar")
17         MainWindow.setStatusBar(self.statusbar)
18
19         self.retranslateUi(MainWindow)
20         QtCore.QMetaObject.connectSlotsByName(MainWindow)
21
22     def retranslateUi(self, MainWindow):
23         MainWindow.setWindowTitle(QtGui.QApplication.translate("Chess for students",
↪         "Chess for students", None, QtGui.QApplication.UnicodeUTF8))
24
25     class ChessBoard(object):
26         def setupUi(self, Form):

```

```

27     Form.setObjectName("Form")
28     Form.resize(661, 728)
29     self.horizontalLayoutWidget = QtGui.QWidget(Form)
30     self.horizontalLayoutWidget.setGeometry(QtCore.QRect(9, 10, 641, 31))
31     self.horizontalLayoutWidget.setObjectName("horizontalLayoutWidget")
32     self.horizontalLayout = QtGui.QHBoxLayout(self.horizontalLayoutWidget)
33     self.horizontalLayout.setContentsMargins(0, 0, 0, 0)
34     self.horizontalLayout.setObjectName("horizontalLayout")
35     self.player_one_label = QtGui.QLabel(self.horizontalLayoutWidget)
36     self.player_one_label.setObjectName("player_one_label")
37     self.horizontalLayout.addWidget(self.player_one_label)
38     self.player_one_edit = QtGui.QLineEdit(self.horizontalLayoutWidget)
39     self.player_one_edit.setObjectName("player_one_edit")
40     self.horizontalLayout.addWidget(self.player_one_edit)
41     spacerItem = QtGui.QSpacerItem(40, 20, QtGui.QSizePolicy.Expanding,
42     ↪ QtGui.QSizePolicy.Minimum)
43     self.horizontalLayout.addItem(spacerItem)
44     self.player_two_label = QtGui.QLabel(self.horizontalLayoutWidget)
45     self.player_two_label.setObjectName("player_two_label")
46     self.horizontalLayout.addWidget(self.player_two_label)
47     self.player_two_edit = QtGui.QLineEdit(self.horizontalLayoutWidget)
48     self.player_two_edit.setObjectName("player_two_edit")
49     self.horizontalLayout.addWidget(self.player_two_edit)
50     self.horizontalLayoutWidget_2 = QtGui.QWidget(Form)
51     self.horizontalLayoutWidget_2.setGeometry(QtCore.QRect(10, 690, 641, 41))
52     self.horizontalLayoutWidget_2.setObjectName("horizontalLayoutWidget_2")
53     self.horizontalLayout_2 = QtGui.QHBoxLayout(self.horizontalLayoutWidget_2)
54     self.horizontalLayout_2.setContentsMargins(0, 0, 0, 0)
55     self.horizontalLayout_2.setObjectName("horizontalLayout_2")
56     self.new_btn = QtGui.QPushButton(self.horizontalLayoutWidget_2)
57     self.new_btn.setObjectName("new_btn")
58     self.horizontalLayout_2.addWidget(self.new_btn)
59     self.load_btn = QtGui.QPushButton(self.horizontalLayoutWidget_2)
60     self.load_btn.setObjectName("load_btn")
61     self.horizontalLayout_2.addWidget(self.load_btn)
62     self.save_btn = QtGui.QPushButton(self.horizontalLayoutWidget_2)
63     self.save_btn.setObjectName("save_btn")
64     self.horizontalLayout_2.addWidget(self.save_btn)
65     self.chess_board = QtGui.QTableWidget(Form)
66     self.chess_board.setGeometry(QtCore.QRect(10, 50, 640, 640))
67     sizePolicy = QtGui.QSizePolicy(QtGui.QSizePolicy.Fixed,
68     ↪ QtGui.QSizePolicy.Fixed)
69     sizePolicy.setHorizontalStretch(0)
70     sizePolicy.setVerticalStretch(0)
71     sizePolicy.setHeightForWidth(self.chess_board.sizePolicy().hasHeightForWidth(
72     ↪ ))
73     self.chess_board.setSizePolicy(sizePolicy)
74     self.chess_board.setAutoFillBackground(False)
75     self.chess_board.setLineWidth(1)
76     self.chess_board.setEditTriggers(QtGui.QAbstractItemView.NoEditTriggers)
77     self.chess_board.setTabKeyNavigation(False)
78     self.chess_board.setProperty("showDropIndicator", False)
79     self.chess_board.setDragDropOverwriteMode(False)
80     self.chess_board.setAlternatingRowColors(False)
81     self.chess_board.setSelectionMode(QtGui.QAbstractItemView.SingleSelection)
82     self.chess_board.setSelectionBehavior(QtGui.QAbstractItemView.SelectItems)
83     self.chess_board.setTextElideMode(QtCore.Qt.ElideMiddle)
84     self.chess_board.setVerticalScrollMode(QtGui.QAbstractItemView.ScrollPerItem)

```

```

82     self.chess_board.setGridStyle(QtCore.Qt.NoPen)
83     self.chess_board.setCornerButtonEnabled(True)
84     self.chess_board.setObjectName("chess_board")
85     self.chess_board.setColumnCount(8)
86     self.chess_board.setRowCount(8)
87     item = QtGui.QTableWidgetItem()
88     self.chess_board.setVerticalHeaderItem(0, item)
89     item = QtGui.QTableWidgetItem()
90     self.chess_board.setVerticalHeaderItem(1, item)
91     item = QtGui.QTableWidgetItem()
92     self.chess_board.setVerticalHeaderItem(2, item)
93     item = QtGui.QTableWidgetItem()
94     self.chess_board.setVerticalHeaderItem(3, item)
95     item = QtGui.QTableWidgetItem()
96     self.chess_board.setVerticalHeaderItem(4, item)
97     item = QtGui.QTableWidgetItem()
98     self.chess_board.setVerticalHeaderItem(5, item)
99     item = QtGui.QTableWidgetItem()
100    self.chess_board.setVerticalHeaderItem(6, item)
101    item = QtGui.QTableWidgetItem()
102    self.chess_board.setVerticalHeaderItem(7, item)
103    item = QtGui.QTableWidgetItem()
104    self.chess_board.setHorizontalHeaderItem(0, item)
105    item = QtGui.QTableWidgetItem()
106    self.chess_board.setHorizontalHeaderItem(1, item)
107    item = QtGui.QTableWidgetItem()
108    self.chess_board.setHorizontalHeaderItem(2, item)
109    item = QtGui.QTableWidgetItem()
110    self.chess_board.setHorizontalHeaderItem(3, item)
111    item = QtGui.QTableWidgetItem()
112    self.chess_board.setHorizontalHeaderItem(4, item)
113    item = QtGui.QTableWidgetItem()
114    self.chess_board.setHorizontalHeaderItem(5, item)
115    item = QtGui.QTableWidgetItem()
116    self.chess_board.setHorizontalHeaderItem(6, item)
117    item = QtGui.QTableWidgetItem()
118    self.chess_board.setHorizontalHeaderItem(7, item)
119    self.chess_board.horizontalHeader().setVisible(False)
120    self.chess_board.horizontalHeader().setStretchLastSection(False)
121    self.chess_board.verticalHeader().setVisible(True)
122    self.chess_board.verticalHeader().setDefaultSectionSize(30)
123    self.chess_board.verticalHeader().setHighlightSections(False)
124
125    self.retranslateUi(Form)
126    QtCore.QMetaObject.connectSlotsByName(Form)
127
128    def retranslateUi(self, Form):
129        Form.setWindowTitle(QtGui.QApplication.translate("Form", "Form", None,
130            ↪ QtGui.QApplication.UnicodeUTF8))
131        self.player_one_label.setText(QtGui.QApplication.translate("Form", "Player 1
132            ↪ (White):", None, QtGui.QApplication.UnicodeUTF8))
133        self.player_two_label.setText(QtGui.QApplication.translate("Form", "Player 2
134            ↪ (Black):", None, QtGui.QApplication.UnicodeUTF8))
135        self.new_btn.setText(QtGui.QApplication.translate("Form", "New Game", None,
136            ↪ QtGui.QApplication.UnicodeUTF8))
137        self.load_btn.setText(QtGui.QApplication.translate("Form", "Load Game", None,
138            ↪ QtGui.QApplication.UnicodeUTF8))

```

```

134     self.save_btn.setText(QtGui.QApplication.translate("Form", "Save Game", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
135     self.chess_board.verticalHeaderItem(0).setText(QtGui.QApplication.translate("
    ↪     Form", "New Row", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
136     self.chess_board.verticalHeaderItem(1).setText(QtGui.QApplication.translate("
    ↪     Form", "New Row", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
137     self.chess_board.verticalHeaderItem(2).setText(QtGui.QApplication.translate("
    ↪     Form", "New Row", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
138     self.chess_board.verticalHeaderItem(3).setText(QtGui.QApplication.translate("
    ↪     Form", "New Row", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
139     self.chess_board.verticalHeaderItem(4).setText(QtGui.QApplication.translate("
    ↪     Form", "New Row", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
140     self.chess_board.verticalHeaderItem(5).setText(QtGui.QApplication.translate("
    ↪     Form", "New Row", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
141     self.chess_board.verticalHeaderItem(6).setText(QtGui.QApplication.translate("
    ↪     Form", "New Row", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
142     self.chess_board.verticalHeaderItem(7).setText(QtGui.QApplication.translate("
    ↪     Form", "New Row", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
143     self.chess_board.horizontalHeaderItem(0).setText(QtGui.QApplication.translate
    ↪     ("Form", "New Column", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
144     self.chess_board.horizontalHeaderItem(1).setText(QtGui.QApplication.translate
    ↪     ("Form", "New Column", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
145     self.chess_board.horizontalHeaderItem(2).setText(QtGui.QApplication.translate
    ↪     ("Form", "New Column", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
146     self.chess_board.horizontalHeaderItem(3).setText(QtGui.QApplication.translate
    ↪     ("Form", "New Column", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
147     self.chess_board.horizontalHeaderItem(4).setText(QtGui.QApplication.translate
    ↪     ("Form", "New Column", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
148     self.chess_board.horizontalHeaderItem(5).setText(QtGui.QApplication.translate
    ↪     ("Form", "New Column", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
149     self.chess_board.horizontalHeaderItem(6).setText(QtGui.QApplication.translate
    ↪     ("Form", "New Column", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
150     self.chess_board.horizontalHeaderItem(7).setText(QtGui.QApplication.translate
    ↪     ("Form", "New Column", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
151
152     class LoadDialog(object):
153         def setupUi(self, Dialog):
154             Dialog.setObjectName("Dialog")
155             Dialog.resize(616, 454)
156             self.verticalLayoutWidget = QtGui.QWidget(Dialog)
157             self.verticalLayoutWidget.setGeometry(QtCore.QRect(0, 0, 611, 451))
158             self.verticalLayoutWidget.setObjectName("verticalLayoutWidget")

```



```

159     self.verticalLayout = QtGui.QVBoxLayout(self.verticalLayoutWidget)
160     self.verticalLayout.setSizeConstraint(QtGui.QLayout.SetNoConstraint)
161     self.verticalLayout.setContentsMargins(-1, -1, -1, 4)
162     self.verticalLayout.setObjectName("verticalLayout")
163     self.horizontalLayout = QtGui.QHBoxLayout()
164     self.horizontalLayout.setContentsMargins(0, 0, 0, 0)
165     self.horizontalLayout.setObjectName("horizontalLayout")
166     self.label = QtGui.QLabel(self.verticalLayoutWidget)
167     self.label.setObjectName("label")
168     self.horizontalLayout.addWidget(self.label)
169     self.sort_type = QtGui.QComboBox(self.verticalLayoutWidget)
170     self.sort_type.setObjectName("sort_type")
171     self.sort_type.addItem("")
172     self.sort_type.addItem("")
173     self.sort_type.addItem("")
174     self.sort_type.addItem("")
175     self.sort_type.addItem("")
176     self.sort_type.addItem("")
177     self.horizontalLayout.addWidget(self.sort_type)
178     self.sortby_box = QtGui.QComboBox(self.verticalLayoutWidget)
179     self.sortby_box.setObjectName("sortby_box")
180     self.sortby_box.addItem("")
181     self.sortby_box.addItem("")
182     self.horizontalLayout.addWidget(self.sortby_box)
183     self.sort_btn = QtGui.QPushButton(self.verticalLayoutWidget)
184     self.sort_btn.setObjectName("sort_btn")
185     self.horizontalLayout.addWidget(self.sort_btn)
186     self.verticalLayout.addLayout(self.horizontalLayout)
187     self.results_table = QtGui.QTableWidget(self.verticalLayoutWidget)
188     self.results_table.setEnabled(True)
189     sizePolicy = QtGui.QSizePolicy(QtGui.QSizePolicy.Expanding,
190     ↪ QtGui.QSizePolicy.Expanding)
191     sizePolicy.setHorizontalStretch(0)
192     sizePolicy.setVerticalStretch(0)
193     sizePolicy.setHeightForWidth(self.results_table.sizePolicy().hasHeightForWidth)
194     ↪ h())
195     self.results_table.setSizePolicy(sizePolicy)
196     self.results_table.setAutoFillBackground(False)
197     self.results_table.setFrameShadow(QtGui.QFrame.Sunken)
198     self.results_table.setEditTriggers(QtGui.QAbstractItemView.NoEditTriggers)
199     self.results_table.setWordWrap(True)
200     self.results_table.setRowCount(0)
201     self.results_table.setObjectName("results_table")
202     self.results_table.setColumnCount(6)
203     self.results_table.setRowCount(0)
204     item = QtGui.QTableWidgetItem()
205     self.results_table.setHorizontalHeaderItem(0, item)
206     item = QtGui.QTableWidgetItem()
207     self.results_table.setHorizontalHeaderItem(1, item)
208     item = QtGui.QTableWidgetItem()
209     self.results_table.setHorizontalHeaderItem(2, item)
210     item = QtGui.QTableWidgetItem()
211     self.results_table.setHorizontalHeaderItem(3, item)
212     item = QtGui.QTableWidgetItem()
213     self.results_table.setHorizontalHeaderItem(4, item)
214     item = QtGui.QTableWidgetItem()
215     self.results_table.setHorizontalHeaderItem(5, item)
216     self.verticalLayout.addWidget(self.results_table)

```

```

215     self.buttonBox = QtGui.QDialogButtonBox(self.verticalLayoutWidget)
216     self.buttonBox.setOrientation(QtCore.Qt.Horizontal)
217     self.buttonBox.setStandardButtons(QtGui.QDialogButtonBox.Cancel |
    ↪     QtGui.QDialogButtonBox.Open)
218     self.buttonBox.setObjectName("buttonBox")
219     self.verticalLayout.addWidget(self.buttonBox)
220
221     self.retranslateUi(Dialog)
222     QtCore.QObject.connect(self.buttonBox, QtCore.SIGNAL("accepted()"),
    ↪     Dialog.accept)
223     QtCore.QObject.connect(self.buttonBox, QtCore.SIGNAL("rejected()"),
    ↪     Dialog.reject)
224     QtCore.QMetaObject.connectSlotsByName(Dialog)
225
226     def retranslateUi(self, Dialog):
227         Dialog.setWindowTitle(QtGui.QApplication.translate("Dialog", "Dialog", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
228         self.label.setText(QtGui.QApplication.translate("Dialog", "Sort By:", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
229         self.sort_type.setItemText(0,
230                                     QtGui.QApplication.translate("Dialog", "ID", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
231         self.sort_type.setItemText(1, QtGui.QApplication.translate("Dialog", "Player
    ↪     1", None,
232                                                                     QtGui.QApplication
    ↪     .UnicodeUTF8))
233         self.sort_type.setItemText(2, QtGui.QApplication.translate("Dialog", "Player
    ↪     2", None,
234                                                                     QtGui.QApplication
    ↪     .UnicodeUTF8))
235         self.sort_type.setItemText(3, QtGui.QApplication.translate("Dialog",
    ↪     "Winner", None,
236                                                                     QtGui.QApplication
    ↪     .UnicodeUTF8))
237         self.sort_type.setItemText(4, QtGui.QApplication.translate("Dialog", "Moves
    ↪     Made", None,
238                                                                     QtGui.QApplication
    ↪     .UnicodeUTF8))
239         self.sort_type.setItemText(5, QtGui.QApplication.translate("Dialog", "Last
    ↪     Played", None,
240                                                                     QtGui.QApplication
    ↪     .UnicodeUTF8))
241         self.sortby_box.setItemText(0, QtGui.QApplication.translate("Dialog",
    ↪     "Ascending", None,
242                                                                     QtGui.QApplicatio
    ↪     n.UnicodeUTF
    ↪     8))
243         self.sortby_box.setItemText(1, QtGui.QApplication.translate("Dialog",
    ↪     "Descending", None,
244                                                                     QtGui.QApplicatio
    ↪     n.UnicodeUTF
    ↪     8))
245         self.sort_btn.setText(QtGui.QApplication.translate("Dialog", "Sort", None,
    ↪     QtGui.QApplication.UnicodeUTF8))
246         self.results_table.setSortingEnabled(False)
247         self.results_table.horizontalHeaderItem(0).setText(
248             QtGui.QApplication.translate("Dialog", "ID", None,
    ↪     QtGui.QApplication.UnicodeUTF8))

```



```
249     self.results_table.horizontalHeaderItem(1).setText(  
250         QtGui.QApplication.translate("Dialog", "Player 1", None,  
           ↳ QtGui.QApplication.UnicodeUTF8))  
251     self.results_table.horizontalHeaderItem(2).setText(  
252         QtGui.QApplication.translate("Dialog", "Player 2", None,  
           ↳ QtGui.QApplication.UnicodeUTF8))  
253     self.results_table.horizontalHeaderItem(3).setText(  
254         QtGui.QApplication.translate("Dialog", "Winner", None,  
           ↳ QtGui.QApplication.UnicodeUTF8))  
255     self.results_table.horizontalHeaderItem(4).setText(  
256         QtGui.QApplication.translate("Dialog", "Moves Made", None,  
           ↳ QtGui.QApplication.UnicodeUTF8))  
257     self.results_table.horizontalHeaderItem(5).setText(  
258         QtGui.QApplication.translate("Dialog", "Last Played", None,  
           ↳ QtGui.QApplication.UnicodeUTF8))
```