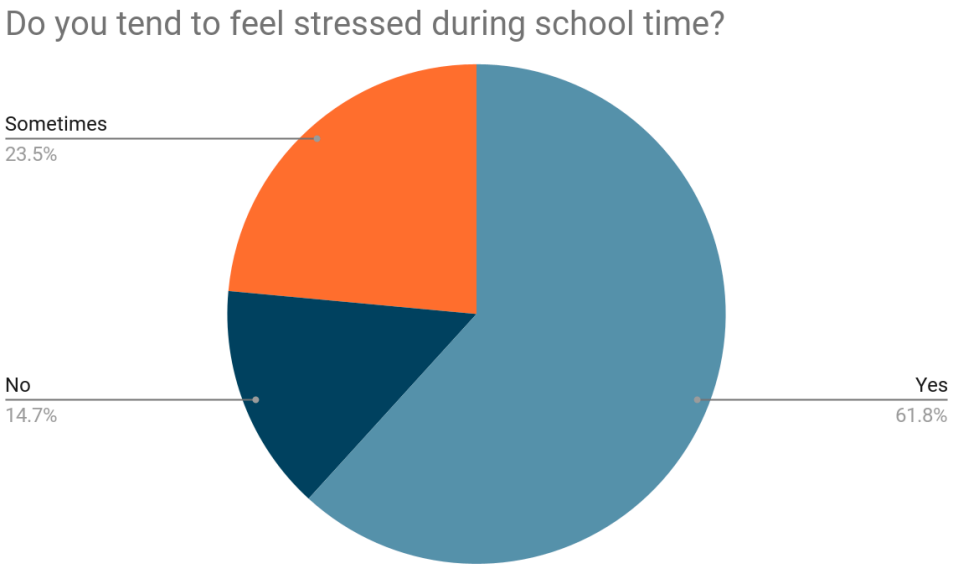
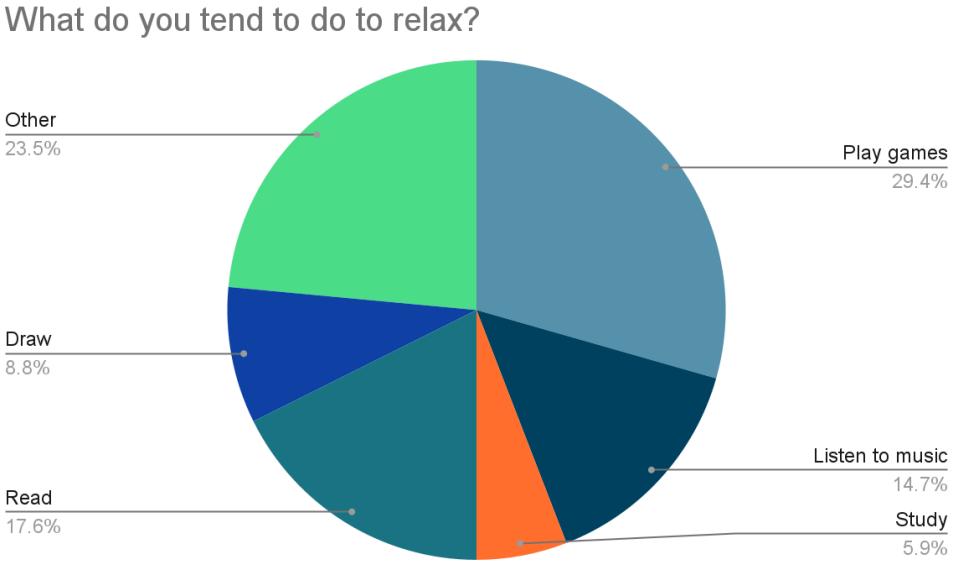
Contents

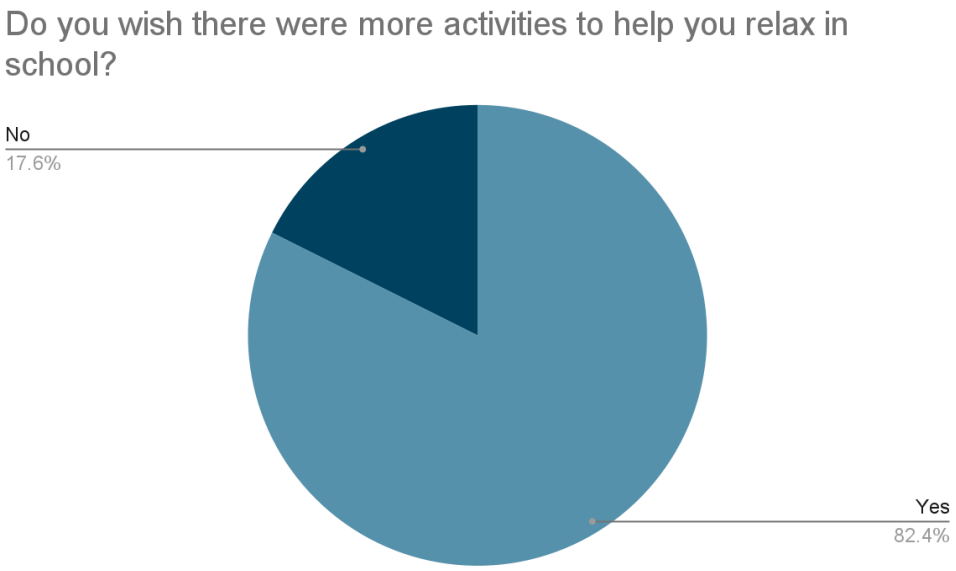
Analysis of the problem

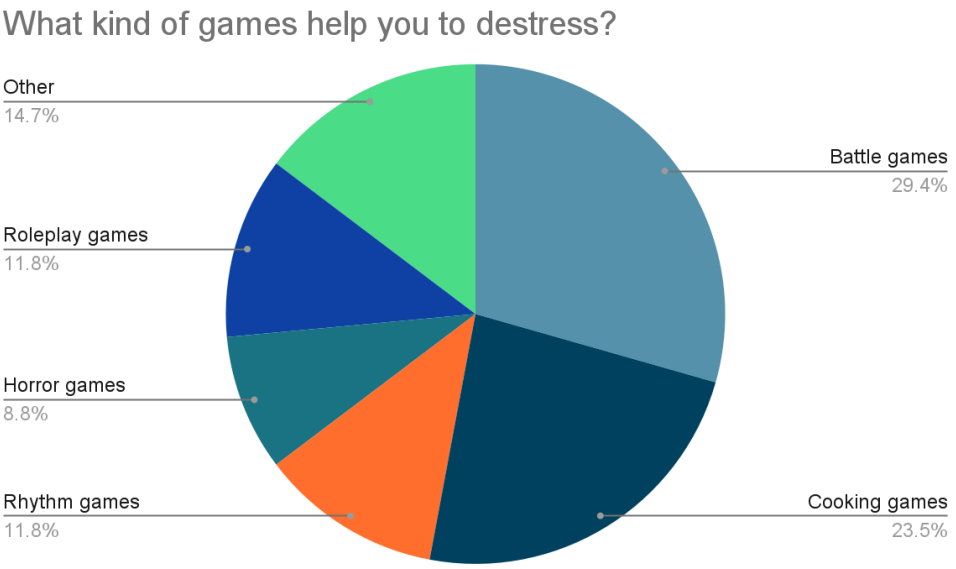
Problem Identification

Students studying for GCSE and A level exams are often working hard in content heavy lessons at school in order to prepare for their exams with only 15-30 minute breaks between long double lessons may want something to help them relax and have fun in their breaks, especially if there aren't any suitable clubs or activities to attend. I asked students currently in Year 10 to 13 some questions about stress and what they do to relax and these were the results.









From this data, it can be seen that GCSE and A Level students do desire a form of relaxation between their lessons, and playing games is a popular form of relaxation. As battle games are a favoured choice of game to help these students destress, I have decided to make a 2D fighter game to help solve this problem.

This problem can be solved with computational methods such as abstraction. Unneeded features of a potential 2D fighter game could be abstracted such as complex character design or world design. Unnecessary information can be abstracted to solve the problem such as detailed graphics, and information can be abstracted from the users about for example how the characters move other than because of the user using the arrow keys.

This problem can be solved with computational methods such as decomposition. A top down design diagram can be used to split the large problem into smaller sub-problems, and functions can be used within the code to solve these smaller sub-problems. Components of the problem can be decomposed into smaller subproblems and can determine the components of the 2D fighter game and be made into different procedures and functions, which can be reused.

Preconditions for playing the game can be determined such as the need for a keyboard with WASD and arrow keys as well as any other necessary keys that must be inputted. Decisions must be made within the solution such as scoring priorities when players attack simultaneously, or how to display the game and how this would affect the player. Sub-problems decomposed into the same level may be able to be worked on simultaneously such as scoring and health priorities.

Inputs may include characters the players may select, as well as the keyboard inputs the players use to move or attack, and buttons on screen pressed in order to pause or restart the game, for example. Outputs may include displaying the selected characters on screen, and making the characters move or attack on screen when a key is pressed on the keyboard, and making the game stop and start again on screen when prompted by the button pressed. Calculations to be made could include decreasing an opponent's health when attacked, and the distance the opponent is away from the player so that if the player is too far away from them, they will be unable to attack. These all ensure that the 2D fighter game is easy to play and includes the main features of fighting games.

Specific hardware such as keyboards would need to be used to interact with the solution, as well as a suitable operating system for the software to run on. The game will be run offline on the operating system, and would need to be interacted with by the user with the use of the keyboard keys and the mouse. This requires a computational approach as the user would be interacting with a computer.

Using decomposition to create a top-down design diagram to specify what functions and procedures need to be used in the solution means that it can be represented as an algorithm. The top-down design diagram will also help to see what parts of the problem may take more time than others, therefore can help to make sure the problem can be solved within a reasonable timescale. As I will be using Python to code the solution, the problem will also be solved at low/zero cost, as all school computers already have Python installed. All of these features ensure that the problem is computable.

Stakeholders

GCSE and A Level students who are not allowed to use their phones in school can come to a computer room at break and lunch and play this game with each other or against a computer to relieve tension and cool off without using their phones and breaking the school rules. This solution will give them an activity to do during school that will help them destress and have fun, especially as, as shown in the survey, students desire more activities in school that will

help them relax. As games are the most preferred way to relax and battle games are the most popular games to help students destress in this sample of students, a 2D fighter game is appropriate to their needs. By researching similar fighting games, I can find out what sort of features are suitable to these students and which features will be able to be coded within a reasonable timescale.

Teachers and parents can supervise gameplay as well as benefit from calmer, more relaxed students and children that can focus better on their work after cooling off. This solution will not only help students to feel more relaxed in the classroom, but teachers will be able to have a more focussed class as the students have been given an opportunity to destress and get their minds off things during break or lunch, which is especially beneficial when it comes to looming exams where it is imperative that students are focussed and ready to learn. Parents will also be able to help their children to revise better at home after they have been given the opportunity to destress and not constantly have the thought of their exams on their mind.

Game developers may also benefit from more people being interested in gaming, and in particular fighting games. This may increase demand for these games, making them more popular, especially as a way to destress, therefore game developers of such games may benefit from more people playing their games.

Research the problem

Similar existing solutions are described below:

Street Fighter (1987)
Players compete in one-one matches against computer-controlled opponents or in a single match against another player. Each match has three rounds in which the player must knock out the opponent within 30 seconds. If a match ends before a fighter is knocked out, the fighter with the greater amount of energy left is the round's winner.

To defeat the opponent, the player must win two rounds and then will proceed to the next battle. If the third round ends in a tie, the computer will win by default, or both players will lose. Against a computer, the losing player can continue against the same opponent. A second player can interrupt a single-player match and challenge the first player to a new match.

Attacks consist of six attack buttons, three punch buttons, and three kick buttons of different speeds and strengths: light, medium and heavy. A joystick is used to move left or right, and to jump, crouch and block. The player can perform a variety of attacks from standing, jumping or crouching positions with different combinations of attack buttons along with the joystick. There are three special techniques that require a specific series of inputs.
Single-player mode consists of a series of battles against two opponents in each country for a total of five countries.

The player takes control of a single character named Ryu, and the second player takes control of Ryu's rival Ken. Both characters have the same basic moves and special techniques.

I like the aspect of being able to play against both a computer and a second player. This would allow students to play not only with their friends, but also give students the opportunity to destress even if they do not have someone to play with. I also like how there are a number of rounds and a time limit. This would make the gameplay more interesting and exciting for players when playing against an opponent, as they can defeat their opponent in different ways, such as having more health or energy than them when the time runs out. I like how there are different types of attacks. This diversifies the gameplay, which in turn will make the game more fun for players as they can perform a selection of attacks.

I would like to have a more diverse character selection so that players are able to have more choice, however I could use the aspect of having the same basic moves and special techniques between characters, so that the gameplay isn't confusing, especially for students who aren't experienced in battle games but still want the opportunity to destress with their friends.

Super Smash Bros.
The aim of players is to launch their opponents off the stage and out of bounds. Characters have a damage total which increases as they take damage, which is represented by a percentage value up to 999%. The higher the percentage, the stronger knockback the player endures from enemy attacks. To knock out an opponent, the player must knock the character out of the stage's boundaries. When knocked off stage, the character can attempt to recover by using jumping moves and abilities to return. Some characters vary in weight, with lighter characters easier to launch.

One button is used for standard attacks, and another button is used for special attacks. Different types of moves can be performed by holding the directional controls up, down, to the side, or in a neutral position while pressing the attack or special button. Each character has four types of ground attacks, mid-air attacks and special attacks, as well as a chargeable "Smash Attack" on the ground which is more powerful than other attacks. When characters are hit by attacks, a hitstun is received which temporarily stops the player from being able to perform any attacks, which allows combos to be performed upon the stunned character. A shield button is used to allow players to put up a defensive shield which weakens with repeated use and if broken, renders the player unable to move. The three basic actions (attacking, grabbing and shielding) use a rock-paper-scissors analogy: attacking beats grabbing, grabbing beats shielding, and shielding beats attacking. An action called edge-guarding can be performed when a player knocks another player off the main platform, and the player that has been knocked off will try to recover by trying to jump back onto the stage and avoiding the other players' edge-guarding.

Players use battle items to assist them in battle, which they can adjust before matches which includes battering items to hit opponents, throwing items and shooting items.

Recovery items can be used to reduce the character's damage percentage by varying amounts. Some special items can be used to release another character onto the battlefield to temporarily assist the player. A "Smash Ball" allows the character to perform a character-specific attack when broken called a "Final Smash".

There are two different modes: Time and Stock. Time mode uses a point-based system, where players earn points for knocking out their opponents and lose points for being knocked out or falling off the stage themselves. At the end of the time limit set, the player with the most points wins the match. Stock mode/Survival mode uses a life-based system where players are given a set number of lives (stock), and a life is lost whenever the character is knocked out, and they are eliminated when all lives are lost. The winner is the last player standing after all other players have been eliminated, or if a time-limit has been applied, the winner is the player with the most lives left once time runs out. If there is a tie, a Sudden Death match takes place where each player is given a starting damage percentile of 300% which makes it easier for them to be launched off stage, and the last player standing will be the winner. This is repeated if the match ends in another tie.

There are multiple playable characters. Players are able to customise existing characters with altered movesets and abilities, as well as making their own avatar – a Mii – that can be given three different fighting styles.

I like that there are a selection of different characters to choose from with different abilities and attacks. As mentioned before, this allows players to have a more diversified gameplay, and gives them the ability to choose how they would like to play, which would help them to relax as they can play in a way that is preferred to them. I like how different buttons are used for different attacks as well as the ability to charge more powerful attacks. This allows for a more engaging gameplay where players can attack their opponents with a range of different attacks with different effects on the opponent, making it more fun for students who want to beat their friends.

I would like to have a more battle-like gameplay rather than knocking opponents offstage, as specified in the survey. I like the idea of having a combination of a life-based and time limit system. This would allow for players to be defeated in different ways as mentioned earlier, by either losing all of their health or by having the least amount of health when the time runs out. This makes it more fun for players as they can try to defeat their opponent in different ways.

Marvel Super Heroes vs. Street Fighter

This game uses a one-on-one tag team format. The player chooses a team of two fighters each with their own health bar. The first selected character is controlled by the player and the second character remains off-screen as a support character.

Combinations of joystick movements and button presses are used to perform various moves to deplete the opponent's health. The first player to completely drain the opponent's health is the winner. If the time runs out, the player with the most health wins.

The player can summon their support character to perform a special move without changing the currently-controlled character. This gives new possibilities for combos during battle.

I like the combination of having two different ways to win: by defeating your opponent, or having the most health after a time limit has been reached, as mentioned earlier.

I don't think I would implement support characters as it may be too time consuming but I could potentially add in combination attacks with different key inputs for different characters, allowing for more choice and a more enticing battle where players can perform a range of different attacks against their opponent.

Naruto: Ultimate Ninja Storm

This game has a transformation mode that can be activated after a player loses a certain amount of health. The health requirement for each character is based on how powerful the transformation is. When activated, the character gains new abilities, speed and stronger attacks.

Players can use the d-pad to use preset items during battle that can damage the opponents or apply different buffs to the player, or to lower the opponent's defence.

The player can perform a variety of attacks with different combinations of attack buttons. There are special techniques that require a specific combination of inputs.

Players can customise their special attacks and select two support characters to use in a match. The support characters can be called upon during battle to perform a skill, and are then put on a cooldown until they can be used again.

An energy meter is used to charge special attacks. Players are unable to use a special attack if they have insufficient energy. Energy can be charged by holding a button during battle. When both players use their special attack at the same time, both players have to press a button shown on screen as fast as possible in order to knock away their opponent.

If the player performs this ultimate attack, both players either input button commands, mash a certain button or spin the analogue stick the fastest within the time limit. If the attacking player wins, the opponents will be hit and about a third of their health bar is taken away. If the defending player wins, they escape without major damage.

There are 25 playable characters that can also be used as a support character.

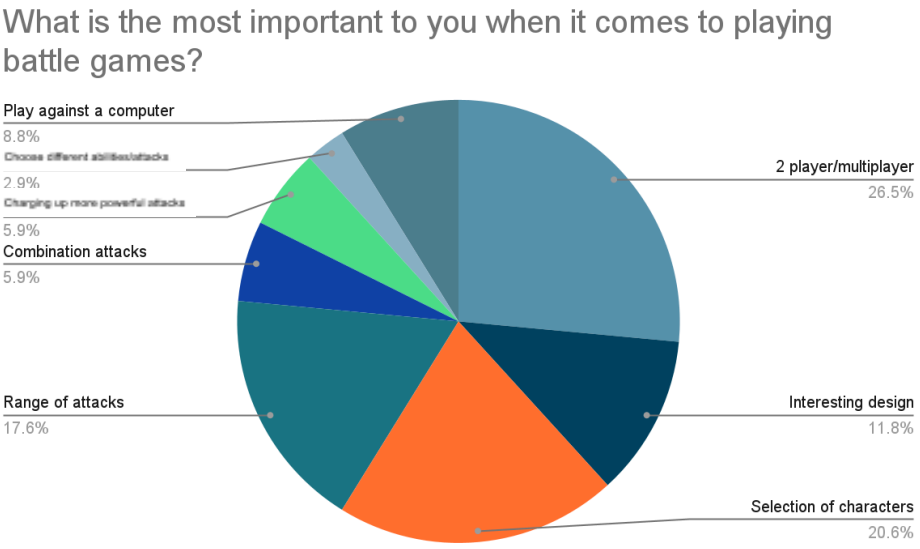
I like the wide variety of characters to choose from and would like to implement a character selection screen, as this would give players more choice in how they would like to play, and make it so that both players do not get mixed up with each other on screen. I like the ability to be able to do special attacks with certain inputs. I think this would make the game more fun as players can try different combinations of attacks against their opponents and see

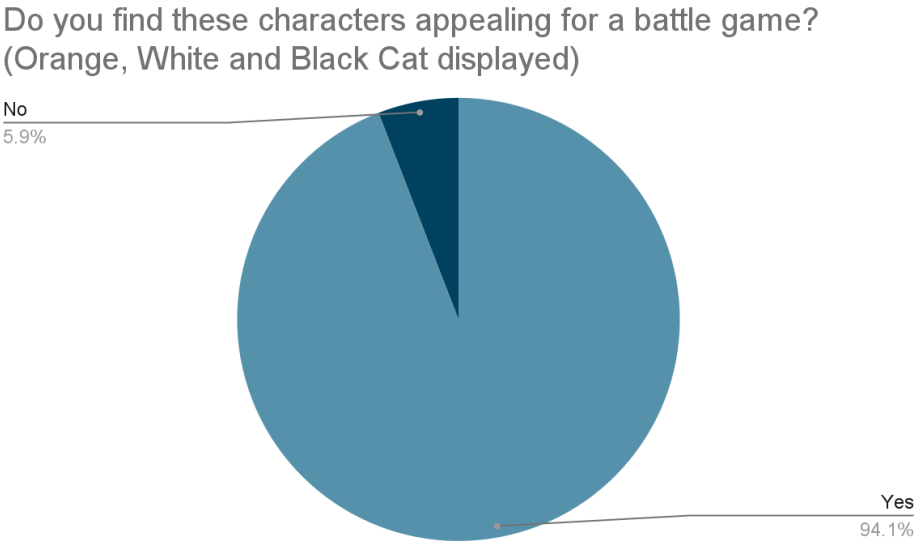
which attacks are the most effective. I also like the energy metre system and having to charge up energy to be able to use special attacks, which would make the battle more engaging and make it last longer, as well as help students to strategise their attacks and how they might try to inflict more damage onto their opponent, so that the game isn't too relaxing and the students are still ready to go back to lesson with sharp minds after break or lunch.

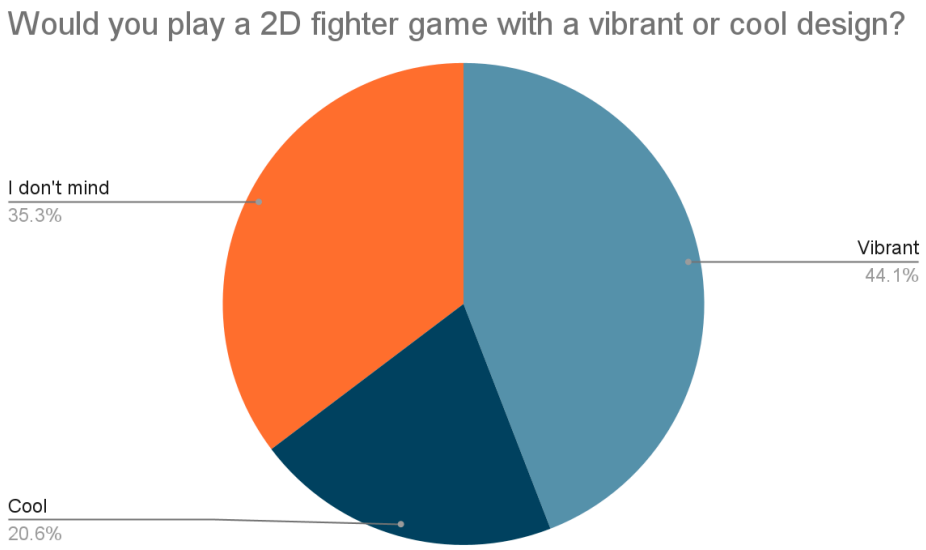
I don't think I would implement a special mode for when players lose a certain amount of health, or the use of support characters, as these might be quite time consuming or could clutter the game screen as I am creating a 2D fighter game rather than a 3D fighter game like the one described, potentially making the game more stressful to play instead. The clash mode may be a good idea for when players attack at the same time, and processing considerations must be made such as cooldown times for attacks for example so that players do not constantly attack at the same time. This would also make the battle last longer and encourage students to strategise their approach to defeating their opponent.

Specify the proposed solution

After surveying potential users (GCSE and A Level students) on their preferred battle game requirements, this is what I found:







As seen from this user survey, a preferred 2D battle game would be one that has the ability to play against a computer or against friends, has a selection of characters and a range of attacks, with a vibrant design. Using the results of this survey, I shall list out the requirements for my solution below.

Design of the program:

Requirement	Explanation
Starting page with start button	An engaging and enticing starting page invites the player into playing the game
A 'How to play' button on the starting page	Clear instructions are needed to show the controls for both player 1 and player 2 so that the players know how to play the game
A settings menu on the starting page	The player will have the ability to change the amount of rounds they would like to play in a game, or to adjust the time limit within a round: 60 seconds, 90 seconds, 120 seconds or no time limit. This gives players the choice that best suits them on how they want to play that will help them to relax the most

During battle, a pause button, which, when clicked with the mouse, brings up three buttons: 'Retry', 'Back to character selection' and 'Back to starting page'	If any player needs to stop the game or would like to try again or stop playing, which is helpful if players need to leave and would like to continue their battle later
After battle, a button to retry, go back to character selection, and go back to starting page	Reduces the amount work the user will need to put in if they would like to start another battle, change the settings or stop playing, which also helps to save time especially at break time or lunchtime where time is limited
Character selection page with the ability to choose between two different special attacks	Gives the players more options to enhance their playing experience and play in a way that is more fun for them
Energy meter for each player displayed during battle	Players can see how much energy they have and can use for special or ultimate attacks to try and defeat their opponent quicker
Health bar for each character displayed during battle	Players can see how much health they or their opponent have left and can potentially strategise their next moves in this way

Functionality of the program:

Requirement	**Explanation**
Movement using WASD for player 1 and arrow keys for player 2	The characters can move left or right, jump, or guard to evade attacks
Three different types of attacks: normal attack, special attack and ultimate attack with three different keyboard inputs	The characters can have their own special and ultimate attacks which creates a unique experience for the player and allows more diversity when it comes to character selection and avoids confusion during battle
Buttons on screen to be clicked with the mouse	E.g. pause, start buttons etc. Allows for ease of use and saves time especially during break or lunch time where time is limited, as users won't have to restart the program again
Ability to change the amount of rounds in a game or the time limit in the settings	Gives more options to the player on how they would like to optimise their gameplay experience and make it more fun or relaxing for them

Start button on starting page brings the player into the character selection page	Makes it easy for the player to instantly start playing and saves students time
Energy meter for each character	Allows for a more engaging and fun battle which lasts longer in order to help students to wind down. Must be charged up using a key input during battle so that a certain amount of energy is used for a special attack and an increased amount for ultimate attacks in order to deal more damage to the opponent to defeat them quicker
Health bar for each character	Determines which player will win. The player with the least amount of health when the time runs out, or the player who loses all of their health loses. Allows players to see how much health they have remaining so that they can plan out their next moves and keep students minds awake and focussed for lessons

Hardware and software required for the program:

Requirement	**Explanation**
Standard peripherals: computer or laptop with a keyboard and mouse	The player needs a basic computer to be able to play and navigate the game. A keyboard is needed in order to use the different keys to be inputted to perform different attacks and moves. A mouse or touchpad will be needed in order to click the buttons on screen
Windows, Mac or Linux operating system	These are the operating systems that are supported by Python, as the code will be written in Python
Python with Tkinter	The program will run on Python using the Tkinter GUI

Success criteria for the program:

Criteria	**How to evidence**
Main starting page with start button, instructions on how to play, settings	Screenshot of the main starting page that shows where the ‘How to play’ and

	settings button are
Engaging and vibrant design	Screenshots of the windows with bright colours and appealing fonts, characters and world design
Visible pause button during battle with pause symbol	Screenshot of the battle screen with a pause button visible and not drowned out by the background
Settings menu on a separate page	Screenshot of the settings menu that is separate from the starting page, showing the ability to change the amount of rounds and the time limit in a game
Instructions on a separate page, shows which keys are used for player 1 and player 2	Screenshot of the instructions of how to play separate from the starting page, detailing the movement (jump, left, right, guard), normal attack, special attack and ultimate attack buttons for both player one and player two
Character selection on a separate page	Screenshot of the character selection with the option to play against a computer or against another player in character selection and a button to press to change the second player (opponent) into player two, where the default is against a computer

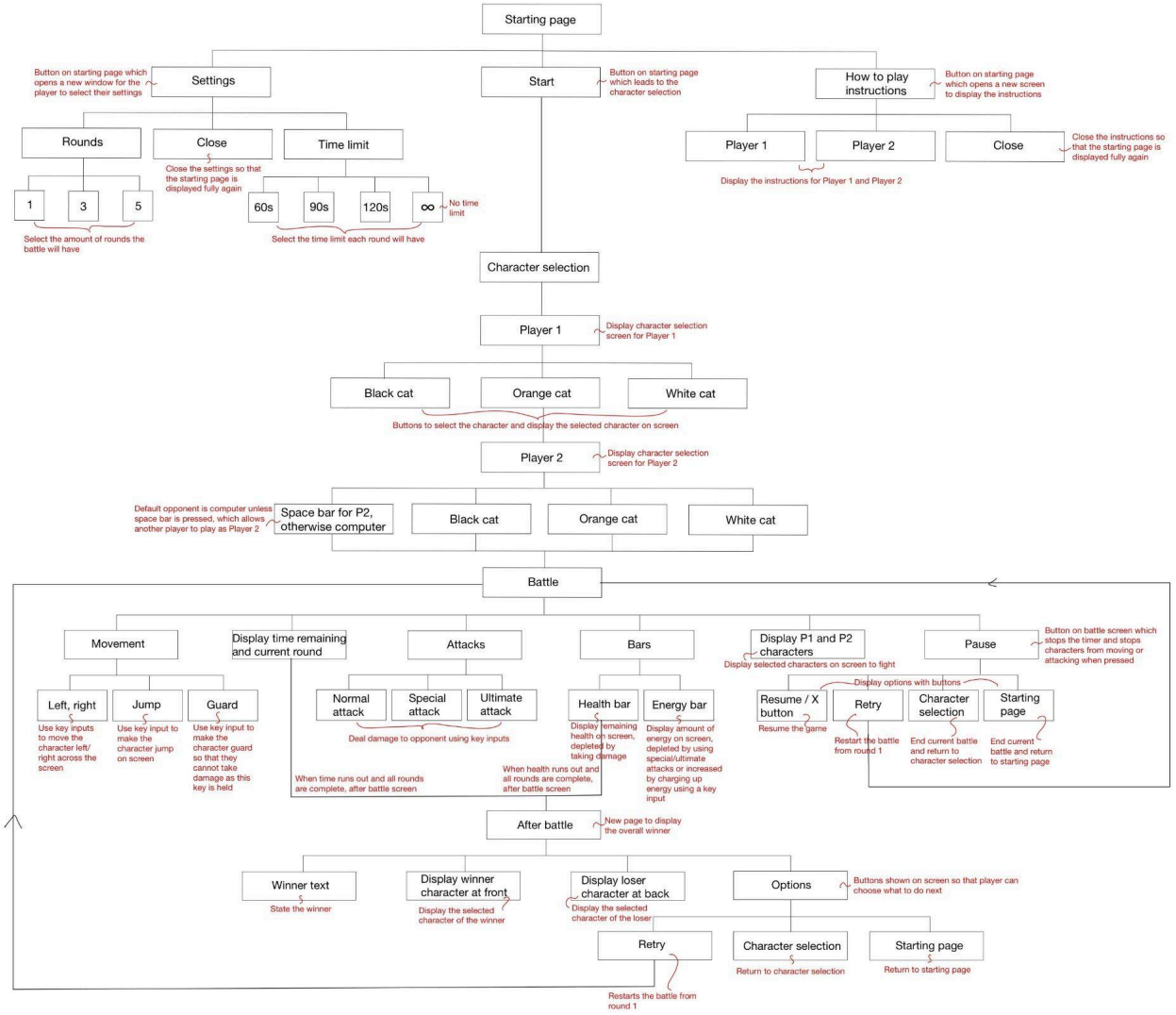
Limitations:

Potential limitations of the game may include that the game can only be run on a computer or laptop with Python installed. This limits the amount of people who can play the game, especially students who might want to play the game at home but do not have a PC with Python. Another limitation is that the game will only be available in English. Though the game will mostly be playable even without knowledge of English, some players may find the health and energy bars confusing if they have no prior knowledge of similar fighting games with similar bars.

Design of the solution

Decompose the solution

Using a top down design diagram, I have decomposed the solution into small sub-programs to be coded in the game, shown below, and have used this to detail the class diagrams to code the solution using object-oriented programming, using flowcharts to demonstrate how the algorithm will work.



- Battle

	Orange	Description	Explanation
Attributes	- image	Stores the image of the character	The selected character image is displayed on the battle screen
	- x	Stores the x location of the character	To be used when making the character move and jump
	- y	Stores the y location of the character	To be used when making the character move and jump
	+ damage1	Stores the damage of the character	The correct damage amount depletes the opponent's health when an attack is performed
	+ guarding1	Checks if the character is guarding	The character cannot take damage when guarding
Methods	+ move_left()	Moves the character image left by 10 pixels	Allows for quick movement across the screen in order to attack or evade attacks
	+ move_right()	Moves the character image right by 10 pixels	Allows for quick movement across the screen in order to attack or evade attacks
	+ getLeft()	Returns the coordinates of the left side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getTop()	Returns the	To be used when

		coordinates of the top side of the character image	calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getRight()	Returns the coordinates of the right side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getBottom()	Returns the coordinates of the bottom side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ jump()	Makes the character image jump by 50 pixels	Makes it easier for players to evade attacks or get closer to their opponent to attack
	+ guard()	Makes the character guard so they cannot take damage	Creates a more interesting battle experience as players can strategise and time when they should guard or attack
	+ unguard()	Makes the character unguard so they can take damage	The character is able to attack their opponent again
	+ calcEnergy()	Increases the character's energy by 10 if their	Charges up the character's energy so that they can

		energy does not equal 500, otherwise their energy remains at 500	perform special or ultimate attacks against their opponent to inflict more damage
	+ normalAtk()	Stores 20 in the attribute damage1 and inflicts this amount of damage onto the opponent	Lower damage attack that does not require energy so that players can still attack even if they don't have any energy remaining
	+ specialAtk()	If the character's energy is greater than or equal to 50, consumes 50 energy and stores 70 in the attribute damage1 and inflicts this amount of damage onto the opponent, otherwise returns false if they do not have enough energy	Inflicts a greater amount of damage upon the opponent to defeat them quicker
	+ ultAtk()	If the character's energy is greater than or equal to 100, consumes 100 energy and stores 135 in the attribute damage1 and inflicts this amount of damage onto the opponent, otherwise returns false if they do not have enough energy	Inflicts a greater amount of damage upon the opponent to defeat them quicker
	+ takeDamage()	If the character's health is greater than the damage inflicted upon	Makes the character take damage that is inflicted upon

		them, their health is decreased by the amount of damage inflicted upon them, otherwise their health will equal 0	them by the opponent and ensures the character is defeated when their health drops to 0

	Orange2	**Description**	**Explanation**
Attributes	- image	Stores the image of the character	The selected character image is displayed on the battle screen
	- x	Stores the x location of the character	To be used when making the character move and jump
	- y	Stores the y location of the character	To be used when making the character move and jump
	+ damage2	Stores the damage of the character	The correct damage amount depletes the opponent's health when an attack is performed
	+ guarding2	Checks if the character is guarding	The character cannot take damage when guarding
Methods	+ move_left()	Moves the character image left by 10 pixels	Allows for quick movement across the screen in order to attack or evade attacks
	+ move_right()	Moves the character image right by 10 pixels	Allows for quick movement across the screen in order to attack or evade attacks
	+ getLeft()	Returns the	To be used when

		coordinates of the left side of the character image	calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getTop()	Returns the coordinates of the top side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getRight()	Returns the coordinates of the right side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getBottom()	Returns the coordinates of the bottom side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ jump()	Makes the character image jump by 50 pixels	Makes it easier for players to evade attacks or get closer to their opponent to attack
	+ guard()	Makes the character guard so they cannot take damage	Creates a more interesting battle experience as players can strategise and time when they

			should guard or attack
	+ unguard()	Makes the character unguard so they can take damage	The character is able to attack their opponent again
	+ calcEnergy()	Increases the character's energy by 10 if their energy does not equal 500, otherwise their energy remains at 500	Charges up the character's energy so that they can perform special or ultimate attacks against their opponent to inflict more damage
	+ normalAtk()	Stores 20 in the attribute damage2 and inflicts this amount of damage onto the opponent	Lower damage attack that does not require energy so that players can still attack even if they don't have any energy remaining
	+ specialAtk()	If the character's energy is greater than or equal to 50, consumes 50 energy and stores 70 in the attribute damage2 and inflicts this amount of damage onto the opponent, otherwise returns false if they do not have enough energy	Inflicts a greater amount of damage upon the opponent to defeat them quicker
	+ ultAtk()	If the character's energy is greater than or equal to 100, consumes 100 energy and stores 135 in the attribute damage2 and inflicts this amount of	Inflicts a greater amount of damage upon the opponent to defeat them quicker

		damage onto the opponent, otherwise returns false if they do not have enough energy	
	+ takeDamage()	If the character's health is greater than the damage inflicted upon them, their health is decreased by the amount of damage inflicted upon them, otherwise their health will equal 0	Makes the character take damage that is inflicted upon them by the opponent and ensures the character is defeated when their health drops to 0

	White	**Description**	**Explanation**
Attributes	- image	Stores the image of the character	The selected character image is displayed on the battle screen
	- x	Stores the x location of the character	To be used when making the character move and jump
	- y	Stores the y location of the character	To be used when making the character move and jump
	- damage1	Stores the damage of the character	The correct damage amount depletes the opponent's health when an attack is performed
	+ guarding1	Checks if the character is guarding	The character cannot take damage when guarding
Methods	+ move_left()	Moves the character image	Allows for quick movement across

		left by 10 pixels	the screen in order to attack or evade attacks
	+ move_right()	Moves the character image right by 10 pixels	Allows for quick movement across the screen in order to attack or evade attacks
	+ getLeft()	Returns the coordinates of the left side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getTop()	Returns the coordinates of the top side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getRight()	Returns the coordinates of the right side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getBottom()	Returns the coordinates of the bottom side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ jump()	Makes the character image	Makes it easier for players to evade

		jump by 50 pixels	attacks or get closer to their opponent to attack
	+ guard()	Makes the character guard so they cannot take damage	Creates a more interesting battle experience as players can strategise and time when they should guard or attack
	+ unguard()	Makes the character unguard so they can take damage	The character is able to attack their opponent again
	+ calcEnergy()	Increases the character's energy by 10 if their energy does not equal 500, otherwise their energy remains at 500	Charges up the character's energy so that they can perform special or ultimate attacks against their opponent to inflict more damage
	+ normalAtk()	Stores 35 in the attribute damage1 and inflicts this amount of damage onto the opponent	Lower damage attack that does not require energy so that players can still attack even if they don't have any energy remaining
	+ specialAtk()	If the character's energy is greater than or equal to 50, consumes 50 energy and stores 60 in the attribute damage1 and inflicts this amount of damage onto the opponent, otherwise returns false if they do not have enough energy	Inflicts a greater amount of damage upon the opponent to defeat them quicker

	+ ultAtk()	If the character's energy is greater than or equal to 100, consumes 100 energy and stores 130 in the attribute damage1 and inflicts this amount of damage onto the opponent, otherwise returns false if they do not have enough energy	Inflicts a greater amount of damage upon the opponent to defeat them quicker
	+ takeDamage()	If the character's health is greater than the damage inflicted upon them, their health is decreased by the amount of damage inflicted upon them, otherwise their health will equal 0	Makes the character take damage that is inflicted upon them by the opponent and ensures the character is defeated when their health drops to 0

	White2	**Description**	**Explanation**
Attributes	- image	Stores the image of the character	The selected character image is displayed on the battle screen
	- x	Stores the x location of the character	To be used when making the character move and jump
	- y	Stores the y location of the character	To be used when making the character move and jump
	+ damage2	Stores the damage of the character	The correct damage amount depletes the opponent's health

			when an attack is performed
	+ guarding2	Checks if the character is guarding	The character cannot take damage when guarding
Methods	+ move_left()	Moves the character image left by 10 pixels	Allows for quick movement across the screen in order to attack or evade attacks
	+ move_right()	Moves the character image right by 10 pixels	Allows for quick movement across the screen in order to attack or evade attacks
	+ getLeft()	Returns the coordinates of the left side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getTop()	Returns the coordinates of the top side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getRight()	Returns the coordinates of the right side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getBottom()	Returns the coordinates of the	To be used when calculating the

		bottom side of the character image	distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ jump()	Makes the character image jump by 50 pixels	Makes it easier for players to evade attacks or get closer to their opponent to attack
	+ guard()	Makes the character guard so they cannot take damage	Creates a more interesting battle experience as players can strategise and time when they should guard or attack
	+ unguard()	Makes the character unguard so they can take damage	The character is able to attack their opponent again
	+ calcEnergy()	Increases the character's energy by 10 if their energy does not equal 500, otherwise their energy remains at 500	Charges up the character's energy so that they can perform special or ultimate attacks against their opponent to inflict more damage
	+ normalAtk()	Stores 35 in the attribute damage2 and inflicts this amount of damage onto the opponent	Lower damage attack that does not require energy so that players can still attack even if they don't have any energy remaining
	+ specialAtk()	If the character's energy is greater than or equal to 50, consumes 50 energy and stores 60 in the attribute	Inflicts a greater amount of damage upon the opponent to defeat them quicker

		damage2 and inflicts this amount of damage onto the opponent, otherwise returns false if they do not have enough energy	
	+ ultAtk()	If the character's energy is greater than or equal to 100, consumes 100 energy and stores 130 in the attribute damage2 and inflicts this amount of damage onto the opponent, otherwise returns false if they do not have enough energy	Inflicts a greater amount of damage upon the opponent to defeat them quicker
	+ takeDamage()	If the character's health is greater than the damage inflicted upon them, their health is decreased by the amount of damage inflicted upon them, otherwise their health will equal 0	Makes the character take damage that is inflicted upon them by the opponent and ensures the character is defeated when their health drops to 0

	Black	**Description**	**Explanation**
Attributes	- image	Stores the image of the character	The selected character image is displayed on the battle screen
	- x	Stores the x location of the character	To be used when making the character move and jump

	- y	Stores the y location of the character	To be used when making the character move and jump
	+ damage1	Stores the damage of the character	The correct damage amount depletes the opponent's health when an attack is performed
	+ guarding1	Checks if the character is guarding	The character cannot take damage when guarding
Methods	+ move_left()	Moves the character image left by 10 pixels	Allows for quick movement across the screen in order to attack or evade attacks
	+ move_right()	Moves the character image right by 10 pixels	Allows for quick movement across the screen in order to attack or evade attacks
	+ getLeft()	Returns the coordinates of the left side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getTop()	Returns the coordinates of the top side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getRight()	Returns the coordinates of the right side of the	To be used when calculating the distance between

		character image	the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getBottom()	Returns the coordinates of the bottom side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ jump()	Makes the character image jump by 50 pixels	Makes it easier for players to evade attacks or get closer to their opponent to attack
	+ guard()	Makes the character guard so they cannot take damage	Creates a more interesting battle experience as players can strategise and time when they should guard or attack
	+ unguard()	Makes the character unguard so they can take damage	The character is able to attack their opponent again
	+ calcEnergy()	Increases the character's energy by 10 if their energy does not equal 500, otherwise their energy remains at 500	Charges up the character's energy so that they can perform special or ultimate attacks against their opponent to inflict more damage
	+ normalAtk()	Stores 25 in the attribute damage1 and inflicts this amount of damage onto the opponent	Lower damage attack that does not require energy so that players can still attack even if they don't

			have any energy remaining
	+ specialAtk()	If the character's energy is greater than or equal to 50, consumes 50 energy and stores 50 in the attribute damage1 and inflicts this amount of damage onto the opponent, otherwise returns false if they do not have enough energy	Inflicts a greater amount of damage upon the opponent to defeat them quicker
	+ ultAtk()	If the character's energy is greater than or equal to 100, consumes 100 energy and stores 150 in the attribute damage1 and inflicts this amount of damage onto the opponent, otherwise returns false if they do not have enough energy	Inflicts a greater amount of damage upon the opponent to defeat them quicker
	+ takeDamage()	If the character's health is greater than the damage inflicted upon them, their health is decreased by the amount of damage inflicted upon them, otherwise their health will equal 0	Makes the character take damage that is inflicted upon them by the opponent and ensures the character is defeated when their health drops to 0

	Black2	**Description**	**Explanation**

Attributes	- image	Stores the image of the character	The selected character image is displayed on the battle screen
	- x	Stores the x location of the character	To be used when making the character move and jump
	- y	Stores the y location of the character	To be used when making the character move and jump
	+ damage2	Stores the damage of the character	The correct damage amount depletes the opponent's health when an attack is performed
	+ guarding2	Checks if the character is guarding	The character cannot take damage when guarding
Methods	+ move_left()	Moves the character image left by 10 pixels	Allows for quick movement across the screen in order to attack or evade attacks
	+ move_right()	Moves the character image right by 10 pixels	Allows for quick movement across the screen in order to attack or evade attacks
	+ getLeft()	Returns the coordinates of the left side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getTop()	Returns the coordinates of the top side of the	To be used when calculating the distance between

		character image	the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getRight()	Returns the coordinates of the right side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ getBottom()	Returns the coordinates of the bottom side of the character image	To be used when calculating the distance between the two players so that the opponent only takes damage if the attacker is close enough to them
	+ jump()	Makes the character image jump by 50 pixels	Makes it easier for players to evade attacks or get closer to their opponent to attack
	+ guard()	Makes the character guard so they cannot take damage	Creates a more interesting battle experience as players can strategise and time when they should guard or attack
	+ unguard()	Makes the character unguard so they can take damage	The character is able to attack their opponent again
	+ calcEnergy()	Increases the character's energy by 10 if their energy does not equal 500,	Charges up the character's energy so that they can perform special or ultimate attacks

		otherwise their energy remains at 500	against their opponent to inflict more damage
	+ normalAtk()	Stores 25 in the attribute damage2 and inflicts this amount of damage onto the opponent	Lower damage attack that does not require energy so that players can still attack even if they don't have any energy remaining
	+ specialAtk()	If the character's energy is greater than or equal to 50, consumes 50 energy and stores 50 in the attribute damage2 and inflicts this amount of damage onto the opponent, otherwise returns false if they do not have enough energy	Inflicts a greater amount of damage upon the opponent to defeat them quicker
	+ ultAtk()	If the character's energy is greater than or equal to 100, consumes 100 energy and stores 150 in the attribute damage2 and inflicts this amount of damage onto the opponent, otherwise returns false if they do not have enough energy	Inflicts a greater amount of damage upon the opponent to defeat them quicker
	+ takeDamage()	If the character's health is greater than the damage inflicted upon them, their health is decreased by	Makes the character take damage that is inflicted upon them by the opponent and

		the amount of damage inflicted upon them, otherwise their health will equal 0	ensures the character is defeated when their health drops to 0

	Game	Description	Explanation
Attributes	- master	Stores the game screen	The game will be displayed on this screen
	- bg	Stores the background image of the starting page	This image will be displayed on the starting page when the program is run
	+ timeLimit	Stores the default time limit (90)	Sets the default time limit as 90 in case the player does not choose a time limit
	+ rounds	Stores the default amount of rounds (3)	Sets the default number of rounds to 3 in case the player does not choose an amount of rounds
	+ selection1	Stores the default character selection to be validated (0)	Ensures the player does not start the game without selecting a character
	+ selection2	Stores the default character selection to be validated (0)	Ensures the player does not start the game without selecting a character
	+ winners	Stores the winner of each round in the list	To calculate the overall winner after all rounds

			have been completed
	+ actualWinner	Stores the actual winner after all rounds are completed	Counts how many times each player has won by how many times they have been stored in the list in order to calculate the overall winner
	- settings	Stores the settings button	Can be clicked on the starting screen to display a window where the player can choose the time limit they would like each round to be and the amount of rounds they would like to play to allow more choice of how players would like to play and relax
	- instructions	Stores the instructions button	Can be clicked on the starting screen to display a window that shows each key input needed to play the game and what they do so that players know how to play
	- start	Stores the start button	Clicked on the starting screen to immediately take the player to the character selection for easy and quick

			use
Methods	+ howToPlay()	Creates a new window which displays the instructions for each player on how to play	Displays a window that shows each key input needed to play the game and what they do so that players know how to play
	+ options()	Creates a new window which has different buttons for the amount rounds and the amount of time each round will be	Displays a window where the player can choose the time limit they would like each round to be and the amount of rounds they would like to play to allow more choice of how players would like to play and relax
	+ oneRound()	Stores 1 in the attribute rounds	Only 1 round is played when selected by the player
	+ threeRound()	Stores 3 in the attribute rounds	3 rounds are played when selected by the player
	+ fiveRound()	Stores 5 in the attribute rounds	5 rounds are played when selected by the player
	+ sixty()	Stores 60 in the attribute timeLimit	Each round is 60 seconds when selected by the player
	+ ninety()	Stores 90 in the attribute timeLimit	Each round is 90 seconds when selected by the player

	+ one20()	Stores 120 in the attribute timeLimit	Each round is 120 seconds when selected by the player
	+ infinite()	Stores ‘infinite’ in the attribute timeLimit	Each round has no time limit when selected by the player
	+ charaSelect1()	Displays three buttons with the three different characters, where the user selects a button in order to choose a character for the first player	Allows the player to select a character to allow for more choice and so that players do not get mixed up with their characters on the battle screen
	+ charaSelect2()	Displays three buttons with the three different characters, where the user selects a button in order to choose a character for the second player	Allows the player to select a character to allow for more choice and so that players do not get mixed up with their characters on the battle screen
	+ oChar1()	Stores 1 in the attribute selection1 when the user presses the Orange Cat button, which then displays the character details to the user	Ensures the player’s character selection is stored so that the correct character is displayed on the battle screen
	+ oChar2()	Stores 1 in the attribute selection2 when the user	Ensures the player’s character selection is

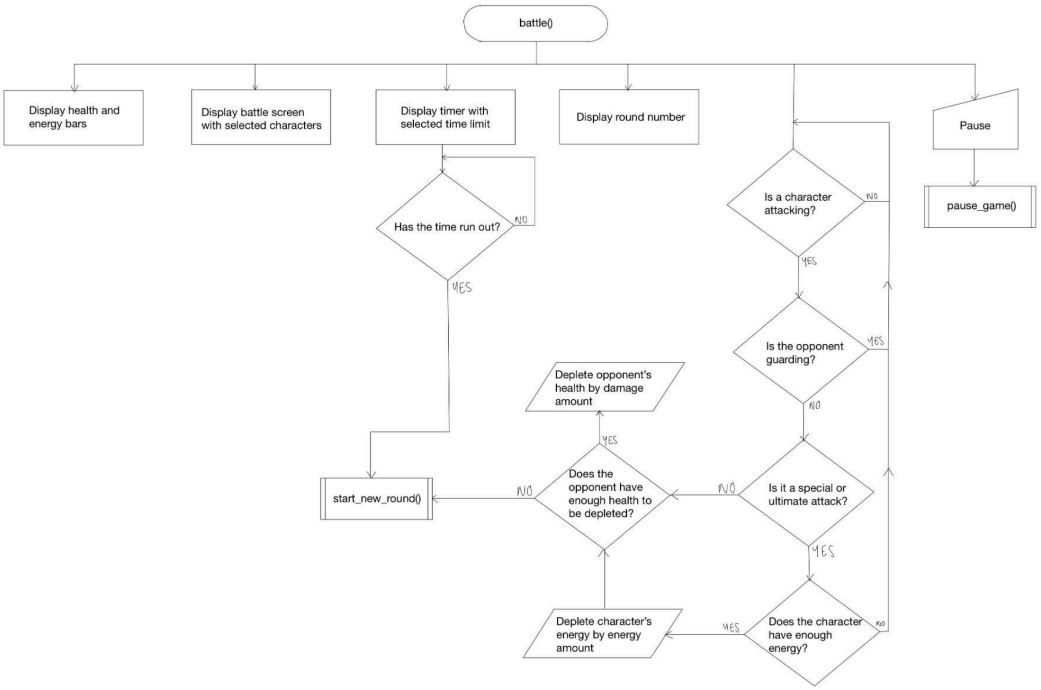
		presses the Orange Cat button, which then displays the character details to the user	stored so that the correct character is displayed on the battle screen
	+ wChar1()	Stores 2 in the attribute selection1 when the user presses the White Cat button, which then displays the character details to the user	Ensures the player's character selection is stored so that the correct character is displayed on the battle screen
	+ wChar2()	Stores 2 in the attribute selection2 when the user presses the White Cat button, which then displays the character details to the user	Ensures the player's character selection is stored so that the correct character is displayed on the battle screen
	+ bChar1()	Stores 3 in the attribute selection1 when the user presses the Black Cat button, which then displays the character details to the user	Ensures the player's character selection is stored so that the correct character is displayed on the battle screen
	+ bChar2()	Stores 3 in the attribute selection2 when the user presses the Black Cat button, which	Ensures the player's character selection is stored so that the correct character is

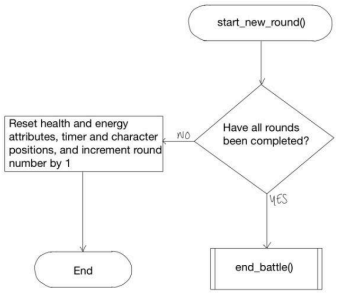
		then displays the character details to the user	displayed on the battle screen
	+ battle()	Starts the battle	Displays the battle screen with the correct characters, time limit and round number on screen
	+ start_timer()	Starts the timer	Counts down to 0 so that if a character isn't defeated, the next round is started (or the battle is ended if all rounds are complete)
	+ update_timer()	Updates the timer on screen	Counts down to 0 so that if a character isn't defeated, the next round is started (or the battle is ended if all rounds are complete)
	+ pause_game()	Pauses the game	Stops the characters from moving or attacking and pauses the timer, and displays a frame on screen with options the player may like to take
	+ resume_game()	Resumes the game	Allows the characters to move and attack again, and resumes the timer

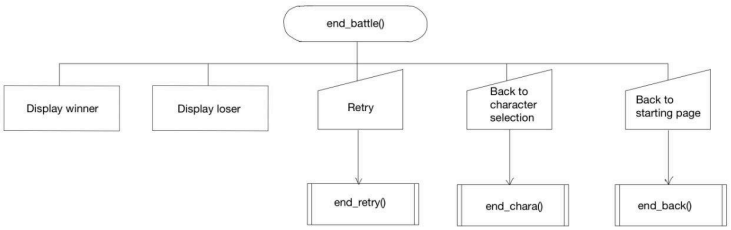
	+ show_pause_frame()	Shows the pause frame when the pause button is clicked	Displays the options the player may like to take
	+ instructions()	Displays the instructions again when a button is clicked in the pause frame	Reminds the player how to play if they forget or did not check on the starting screen
	+ hide_pause_frame()	Hides the pause frame	Removes the pause frame off screen when the game is resumed as it is no longer needed
	+ pause_timer()	Pauses the timer when the game is paused	Ensures the time does not run out when the player is not playing
	+ resume_timer()	Resumes the timer when the game is unpaused	Enures the battle continues as normal once the game is unpaused
	+ pause_characters()	Stops the characters from moving or attacking when the game is paused	Ensures the characters cannot attack their opponent when a player isn't playing or looking at the instructions for example
	+ resume_characters()	Allows the characters to move and attack again when the game is unpaused	Enures the battle continues as normal once the game is unpaused
	+ retry()	Restarts the battle again if 'Retry' is	Players can start again if needed

		selected on the pause frame	
	+ start_new_round()	Starts a new round after the end of one, or otherwise leads to the after battle screen if all rounds are complete	Ensures the selected amount of rounds is played
	+ end_battle()	Displays the after battle screen with the winners, as well as the options to retry, go back to character selection or go back to the starting page	Makes sure the players know who has won and gives them options to choose from of what they would like to do next
	+ end_retry()	Restarts the battle again if ‘Retry’ is selected on the after battle screen	Players can play again with the current selected characters and settings if the would like
	+ end_chara()	Goes back to the character selection if ‘Character selection’ is selected in the after battle screen	Players can choose different characters to play again
	+ end_back()	Goes back to the starting page if ‘Starting page’ is selected in the after battle screen	Players can change their settings on the starting screen to have a different battle experience
	+ battle_chara()	Goes back to the character selection if ‘Character selection’ is	Players can choose different characters if they would like to switch their

		selected in the pause frame	characters
	+ battle_back()	Goes back to the starting page if ‘Starting page’ is selected in the pause frame	Players can change their settings on the starting screen if they would like to change them



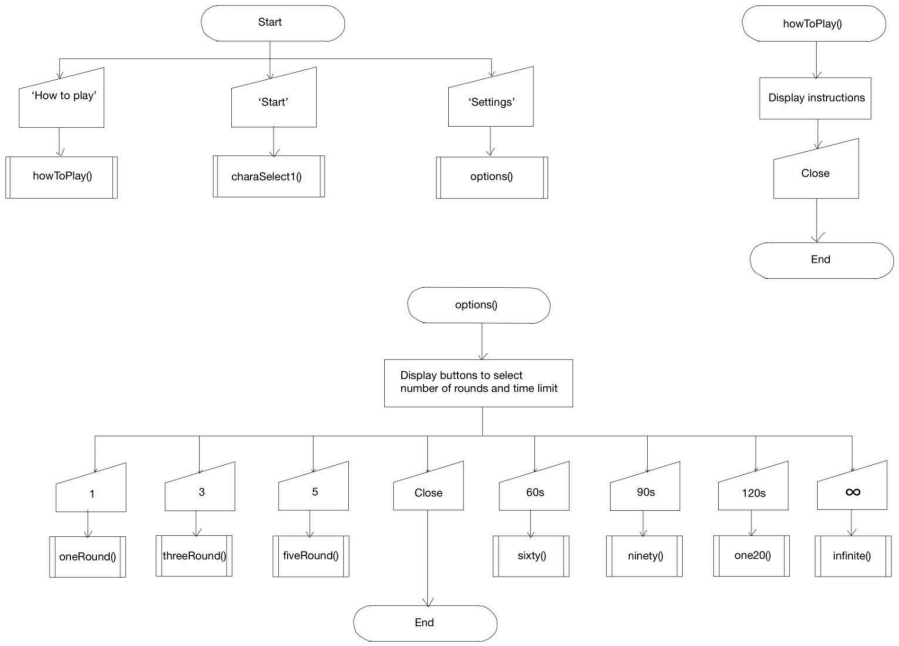




- Starting page

Attribute name	Type	Size (range of possible values)	Description	Explanation

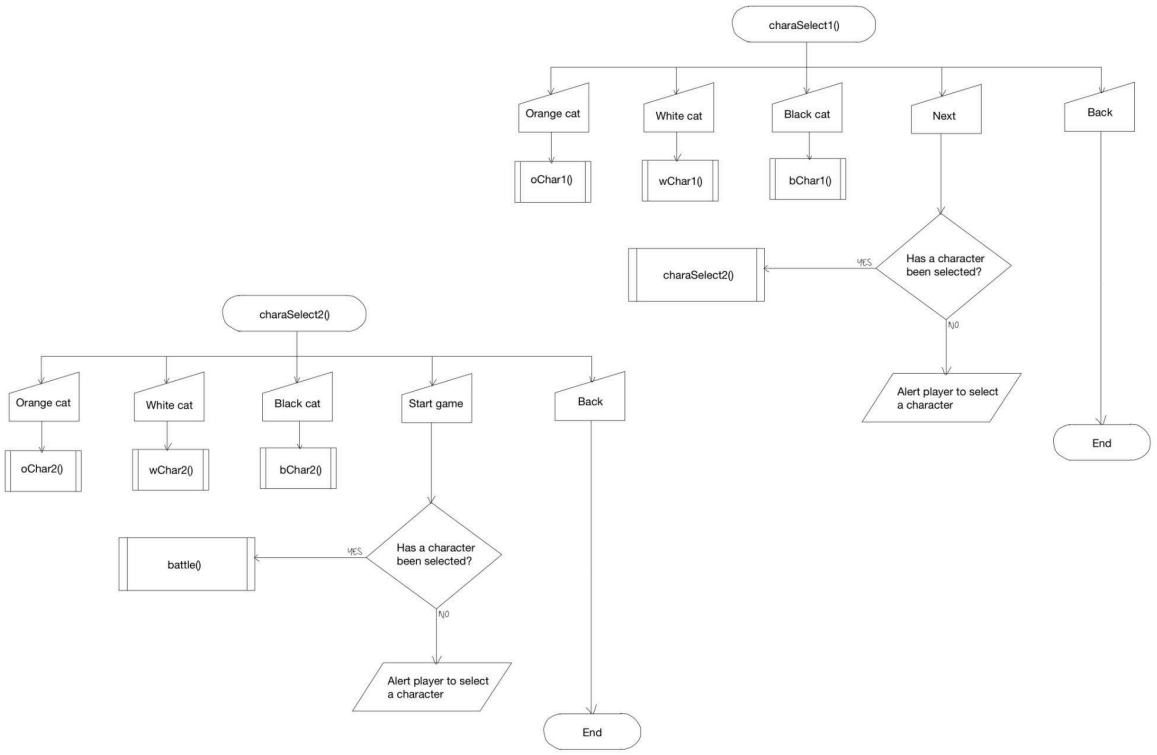
+ timeLimit	Integer	60, 90, 120	Stores the value of the time selected in the settings (this determines the length of time each round will be)	Ensures the player's choice of time limit is stored and displayed on the battle screen
+ rounds	Integer	1, 3, 5	Stores the value of the rounds selected in the settings (this determines the amounts of rounds the battle will have)	Ensures the player's choice of the amount of rounds they would like to play is stored so that that amount of rounds is played



- Character Selection

Attribute name	Type	Size (range of possible values)	Description	Explanation
+ selection1	Integer	0,1,2,3	Stores the value of the character selection for Player 1 in the character selection (selection1=1 for Orange Cat, selection1=2 for White Cat, selection1=3 for Black Cat)	Ensures the player's character selection is stored so that the correct character is displayed on the battle screen

+ selection2	Integer	0,1,2,3	Stores the value of the character selection for Player 2 in the character selection (selection2=1 for Orange Cat, selection2=2 for White Cat, selection2=3 for Black Cat)	Ensures the player's character selection is stored so that the correct character is displayed on the battle screen



Describe the solution

- Design objectives
    - The design objectives are similar to the requirements specified previously. The game will start with a vibrant and enticing starting page as preferred by potential users, with three different buttons: a settings button, which opens a new window with buttons to change the amount of rounds in a battle and buttons to change how long the rounds will be; a 'How to Play' button, which opens a new window and displays in a simple format the key inputs needed for both Player 1 and Player 2 so that players know how to play; and a start button, which leads to the character selection for Player 1 for quick and easy use.
    - The character selection will have a selection of three different characters, displaying their different attacks and their damage amounts in a box so users have more choice in what character they would like to play. This would then

lead to the character selection for Player 2, displayed similarly, and then this would lead into the battle.
    - The battle will display the characters selected by the players, as well as their health and energy bars at the top of the screen and the timer and the rounds remaining between each players' bars so that players are aware of how much time, health and energy they have remaining and can strategise their next moves from there. When the time runs out or a player is defeated, it will lead to the after battle page, where the players will have three different options: retry, return to character selection and return to starting page, which gives them the choice of whether they would like to play again with the same characters or settings or change them.

- Aesthetic considerations
    - The screen size will be moderately sized in order to fit most screens (863x600 pixels)
    - There will be three different characters: an orange cat, a black cat and a white cat to give players a choice of what character they would like to play as well as make sure characters don't get mixed up on the battle screen
    - Each page within the game will follow a similar colour scheme of blue, orange, pink, purple and green for a vibrant design that was preferred by potential users
    - In battle, Player 1 will be facing right and Player 2 will be facing left so that players can easily tell who is who
    - In battle, the characters will be approximately 100x120 pixels to make sure they are not too big or too small on the screen size
    - When moving, the characters will move 10 pixels at a time so that characters can move quickly across the screen to attack or evade attacks

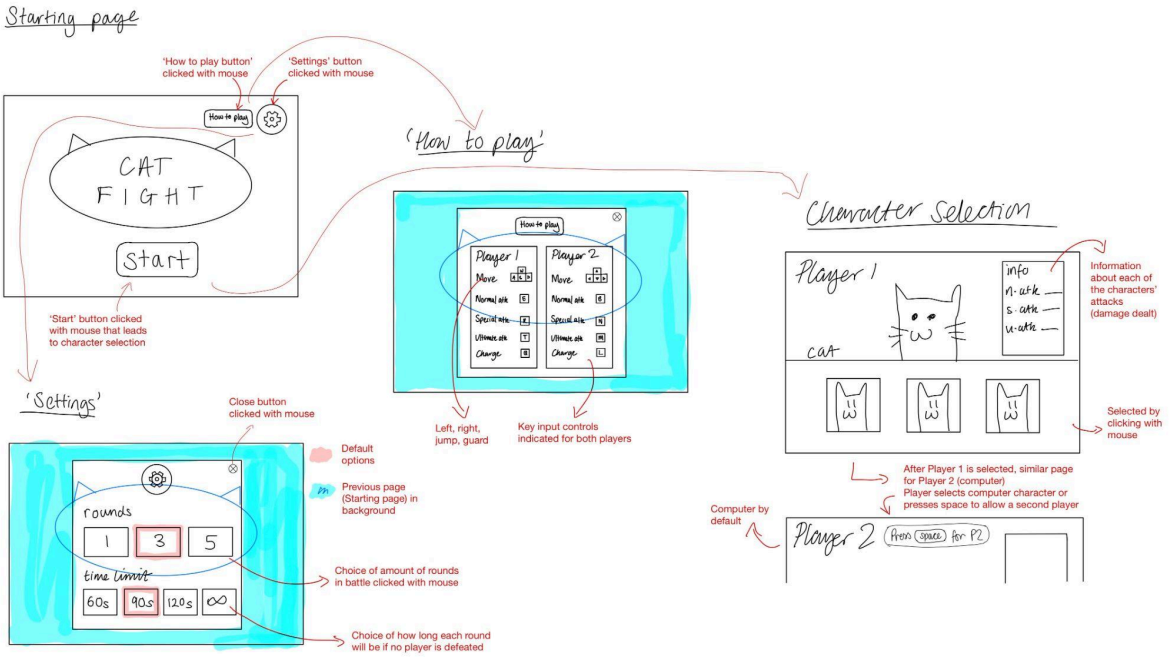
- Input considerations
    - The player will be able to choose how many rounds they would like to play to give them more choice to play in a way that will help them to destress
    - The player will be able to choose how much time they would like the round(s) to be to give them more choice to play in a way that will help them to destress
    - The players will be able to choose which character they would like to play as to give players a choice of what character they would like to play as well as make sure characters don't get mixed up on the battle screen
    - The players will be able to control the movement of the characters left, right and up using the arrow keys (Player 2) and WASD keys (Player 1) as these are keys that are commonly used to move characters
    - The players will be able to use key inputs to perform three different attacks on their opponents: normal attack, special attack and ultimate attack, as well as to recharge their energy and have the ability to guard to give a more enticing battle experience that lasts longer

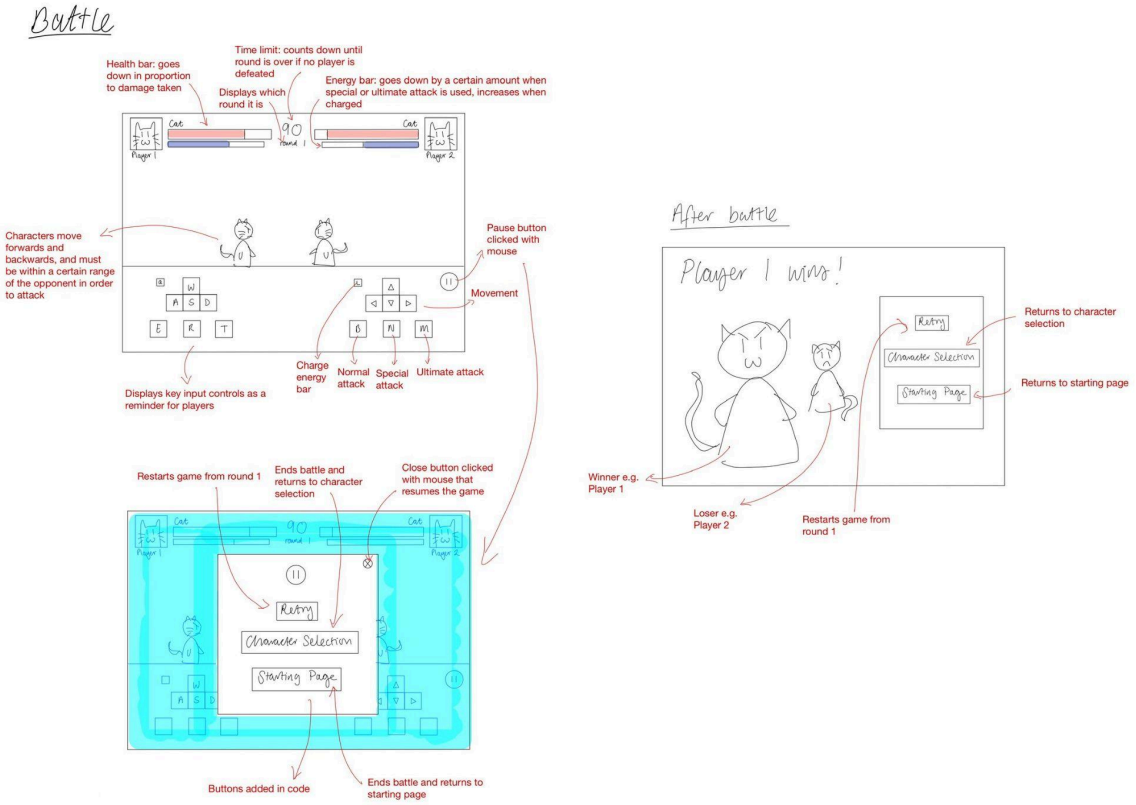
    - The player will be able to view a ‘How to Play’ screen that opens in a new window by clicking a button that is on the initial starting screen so that players can easily access the instructions
    - The player will be able to view and change the settings that opens in a new window by clicking a button that is on the initial starting screen so that players can easily change their settings before starting the battle
    - The player will be able to go back to the initial starting screen from the character selection screen and will be able to go back to initial starting screen, character selection screen or battle after a battle has ended so that players can change their characters or settings if they would like to
    - The players will be able to pause the battle, and through this, will be able to retry, go back to the character selection or go back to the starting page, which gives players the choice of what they would like to do rather than just having a resume button

- Processing considerations
    - When a character is attacked, their health will go down by the amount of damage dealt by the attack
    - When a character uses a special attack or an ultimate attack, their energy will go down by a certain amount
    - When a player uses a key input to recharge their energy, their energy will go up by 10
    - The characters must not be able to go off-screen to ensure that the battle only happens on-screen
    - The characters should only be able to attack within a certain distance of their opponent, which ensures that players cannot continuously keep attacking each other
    - The battle will end when a character is defeated (their health is equal to 0), when time runs out, or when the players manually end it through the pause button options
    - The winner of each round must be recorded in order to declare a final winner by the end of all of the rounds

- Output considerations
    - The current round will be displayed
    - The time remaining will be displayed
    - The amount of health each player has remaining will be displayed
    - The amount of energy each player has will be displayed
    - Which characters are playing that have been chosen by the players will be displayed
    - Instructions on how to play the game will be displayed during battle and also through a button on the starting screen

- Interface design


Starting page
'How to play button' clicked with mouse
'Settings' button clicked with mouse
How to play
CAT FIGHT
Start
'Start' button clicked with mouse that leads to character selection
'How to play'
Player 1
Player 2
Move
Normal atk
Special atk
Ultimate atk
Charge
Left, right, jump, guard
Key input controls indicated for both players
Character Selection
Player 1
cat
info
n-atk
s-atk
u-atk
Information about each of the characters' attacks (damage dealt)
Selected by clicking with mouse
After Player 1 is selected, similar page for Player 2 (computer)
Player selects computer character or presses space to allow a second player
Computer by default
Player 2
Press space for P2
'Settings'
Close button clicked with mouse
Default options
Previous page (Starting page) in background
rounds
1
3
5
time limit
60s
90s
120s
∞
Choice of amount of rounds in battle clicked with mouse
Choice of how long each round will be if no player is defeated


Battle
Health bar: goes down in proportion to damage taken
Time limit: counts down until round is over if no player is defeated
Displays which round it is
Energy bar: goes down by a certain amount when special or ultimate attack is used, increases when charged
Cat
Player 1
Player 2
90
round 1
Characters move forwards and backwards, and must be within a certain range of the opponent in order to attack
Pause button clicked with mouse
Movement
Displays key input controls as a reminder for players
Charge energy bar
Normal attack
Special attack
Ultimate attack
Restarts game from round 1
Ends battle and returns to character selection
Close button clicked with mouse that resumes the game
Retry
Character Selection
Starting Page
Buttons added in code
Ends battle and returns to starting page
After battle
Player 1 wins!
Retry
Character Selection
Starting Page
Returns to character selection
Returns to starting page
Winner e.g. Player 1
Loser e.g. Player 2
Restarts game from round 1

Describe the approach to testing

I have created a table below which lays out which parts of my code are to be tested throughout the development process.

Function being tested	Method of input	Input	Expected result
Character selection	Button clicked on the character selection screen	Orange Cat button clicked (selection(1 or 2) = 1)	The orange cat character will appear on the battle screen to be played by the user
		White Cat button clicked (selection = 2)	The white cat character will appear on the battle screen to be played by the user
		Black Cat button clicked (selection = 3)	The black cat character will appear on the battle screen to be played by the user

		No button clicked	The user will prompted with an alert message to select a character before moving onto the next screen
Character movement	Pressing a button on the keyboard	A	Player 1 will move left
		D	Player 1 will move right
		W	Player 1 will jump
		S	Player 1 will guard (They will not be able to take damage)
		Left	Player 2 will move left
		Right	Player 2 will move right
		Up	Player 2 will jump
		Down	Player 2 will guard (They will not be able to take damage)
Collision with borders	When in battle, head into a border of the game screen using the directional buttons on the keyboard	D (Player 1)/Right (Player 2) to direct the characters to the right border of the game screen	The characters will not be able to move past the borders of the game screen and will stop moving at the border.
		A (Player 1)/Left (Player 2) to direct the characters to the left border of the game screen	
Collision with opponent	When in battle, head into the direction of the opposing player using the directional buttons on the keyboard	Directional buttons on the keyboard used to direct the characters to their opponents	The characters will not be able to move past each other and will stop moving when the border of one character touches the border

			of the other
Character using normal attack	Pressing a button on the keyboard	E (Player 1)/ B (Player 2)	Damage will be dealt to the opponent by the normal attack damage amount of the player and the opponent's health will decrease by this much
Character using special attack	Pressing a button on the keyboard	R (Player 1)/ N (Player 2)	The player's energy will decrease by 50 and damage will be dealt to the opponent by the special attack damage amount of the player, decreasing the opponent's health by this much
Character using ultimate attack	Pressing a button on the keyboard	T (Player 1)/ M (Player 2)	The player's energy will decrease by 100 and damage will be dealt to the opponent by the special attack damage amount of the player, decreasing the opponent's health by this much
Character recharging energy	Pressing a button on the keyboard	Q (Player 1)/ L (Player 2)	The player's energy will increase by 10 if the energy bar is not full, otherwise their energy will remain at 500
Displaying instructions	Clicking the 'How to play' button on the starting screen	N/A	Displays a new window with the instructions on the key inputs for both Player 1 and Player 2
Displaying settings	Clicking the 'Settings' button on	N/A	Displays a new window with the

	the starting screen		options for the amount of rounds and the time limit in battle
Selecting amount of rounds	Button clicked in settings	‘1’ button clicked (rounds = 1)	One round will be played during battle
		‘3’ button clicked (rounds = 3)	Three rounds will be played during battle, and the player who wins the most rounds will win
		‘5’ button clicked (rounds = 5)	Five rounds will be played during battle, and the player who wins the most rounds will win
		No button clicked	The rounds will be set to a default of three rounds
Selecting the time limit of the rounds	Button clicked in settings	‘60’ button clicked	Each round will have timer of 60 seconds
		‘90’ button clicked	Each round will have timer of 90 seconds
		‘120’ button clicked	Each round will have timer of 120 seconds
		‘∞’ button clicked	Each round will continue for an infinite amount of time and will only end when a character is defeated
		No button clicked	The default time limit will be set to 90 seconds
Selecting the pause button	Button clicked during battle	N/A	Pauses the game so that characters are unable to move or attack and displays a window with options to retry,

			return to character selection or return to the starting page, and can cross off the window to resume
Selecting the ‘Retry’ button	Button clicked after pausing or after battle	N/A	Restarts the battle from the start with full energy and health bars
Selecting the ‘Character Selection’ button	Button clicked after pausing or after battle	N/A	Ends the current battle and returns to the character selection
Selecting the ‘Starting Page’ button	Button clicked after pausing or after battle	N/A	Ends the current battle and returns to the starting page

Developing the solution

Iterative development process

To begin the development process, I used my top down design structure on page 15 to break down this process into different key stages, which I will describe below, highlighting any problems I faced and how they were resolved, as well as indicating which test each part of the development corresponds to in the testing section on page 75.

1) Create the starting page

Firstly, I made a basic starting interface including a settings button with the ability to change the time limit and the amount of rounds in battle, a ‘How to play’ button which displays the key input controls for each player, and a start button which takes the player to character selection.

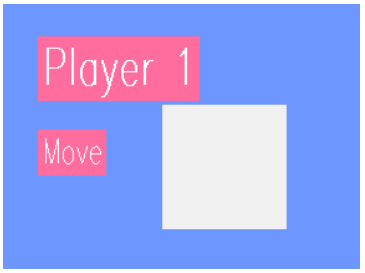
For the settings button, I created a subroutine named `options` as shown partially below, which displays a new window with more buttons to change the time limit and the rounds (Test 9). Each button has a command in order to run a different subroutine, for example if the user were to choose a sixty second time limit and press the button ‘60’, the subroutine `time60` would run (line 18), which would store the integer 60 in the global variable `timeLimit` (line 20) (Test 11). I made `timeLimit` a global variable so that it could be used later in order to implement the player’s choice of the time limit. At first, I implemented the settings through Tkinter’s Toplevel widget, which created a new window, however I realised that the integers in the `timeLimit` and `rounds` variables didn’t store correctly, therefore I decided to display the settings in a frame on screen and hid the frame with a close button (line 19) using Tkinter’s `pack_forget` method, which was closer to my initial design.

```
01  def options():
02          sett = Frame(root, bg='#6D97FF')
03          sett.pack(fill="both", expand="yes")
04          top = Label(sett, text = "Settings", bg='#FF6D9E',
05          fg='white', font=('Modern 30 bold'))
06          top.pack(pady=20)
07
08          timeLimit = Label(sett, text="Time limit",
09          bg='#FF6D9E',
10          fg='white', font=('Modern 25 bold'))
11          timeLimit.pack(pady=120)
12          time60 = Button(sett, text='60s', fg='white',
13          bg='#FF6D9E',
14          bd=1, font=('Modern 15 bold'),
15                        command = sixty, height=2, width=8)
```

```
16          time60.place(x=160,y=440)
17          close = Button(sett, text='X', fg='white',
18          bg='#FF746C', bd=1, font=('Modern 20 bold'),
19          command = sett.pack_forget, height=1, width=4)
20          close.place(x=750, y=20)
21
22  def sixty():
23          global timeLimit
24          timeLimit = 60
```

For the 'How to play' button, I created a subroutine named `howToPlay`, which displays a frame with the controls of each player shown (Test 8). Initially, I struggled to make images of the key input controls I wanted to display show up, and what would come up was a blank space in the place of the image as shown below using the code below.

```
01  wasd = PhotoImage(file="wasd.png")
02  wasd_label = Label(inst, image=wasd,
03  bd=0)
    wasd_label.place(x=200, y=180)
```



After some research, I realised that my error was due to assigning the image '`wasd`' to the label '`wasd_label`' directly in line 02, however in Tkinter, when using the PhotoImage class to load an image, it needs to be retained by keeping a reference to it, otherwise the image won't display. Therefore, to correct this error, I added a reference to the PhotoImage object using the line: `wasd.image = wasd`.

For the start button, I created a subroutine called `charaSelect1`, which takes the player to a new page, for player 1 to select their character.

2) Create the character selection

Next, I made a character selection for player 1 in the `charaSelect1` subroutine by coding three different buttons for each of the characters, each with their own subroutine command in order to display the image of the character on screen, along with their character information such as their attack damage, in order to help the user make a better choice of which character they would like to play (Test 1). For example, when clicked, the button named orange with a picture of Orange Cat displayed would perform subroutine `oChar1` as shown below, which would make the global variable `selection1` equal to 1 (line 03) and display the image of Orange Cat (line 09) and its details (lines 11-22). I made `selection1` a global variable so that the user's choice of character could be retained through an `if` statement later in the code.

```
01  def oChar1():
02          global selection1
03          selection1 = 1
04
05          photo = PhotoImage(file="oCS2.png")
06          photo.image = photo
07          photo_label = Label(start, image=photo,
08          bg='#FF6D9E',bd=0)
09          photo_label.place(x=260, y=30)
10
11          details = Label(start, text = "Details",
12  bg='#68ffa9',
13          fg='#DA6BFF', font=('Modern 20 bold'))
14          details.place(x=600, y=45)
15          nAtk = Label(start, text = "Normal Attack      20",
16          bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
17          nAtk.place(x=600, y=110)
18          sAtk = Label(start, text = "Special Attack      70",
19          bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
20          sAtk.place(x=600, y=180)
21          uAtk = Label(start, text = "Ultimate Attack    135",
22          bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
            uAtk.place(x=600, y=250)
```

A ‘Next’ button then leads to the character selection for player 2 in the subroutine `charaSelect2`, which works the same. The ‘Start game’ button then leads the players into battle through the `battle` subroutine with the command `battle` (line 08). The ‘Back’ button takes the player back to the previous screen using Tkinter’s `destroy` method (line 08).

```
01  back = Button(player2, text='Back', fg='#DA6BFF',
02         bg='#68ffa9', bd=1, font=('Modern 17 bold'),
03         command = player2.destroy, height=1, width=8)
04  back.place(x=40,y=160)
05
06  toGame = Button(player2, text='Start game', fg='#DA6BFF',
07           bg='#68ffa9', bd=1, font=('Modern 17 bold'),
08           command = battle, height=2, width=12)
09  toGame.place(x=40,y=230)
```

Similarly to before, I struggled to display the characters’ pictures on the buttons correctly, and they would show up as a blank button. This was similarly rectified by adding a reference to the PhotoImage object.

3) Write the battle code

As I had initially written the code for the starting page and character selection using a procedural programming approach, before I started writing the battle code, I decided to use an object-oriented programming approach and therefore coded the battle separately, and decided to add in the rest of the code into the main `Game` class later to save time and scrolling through code.

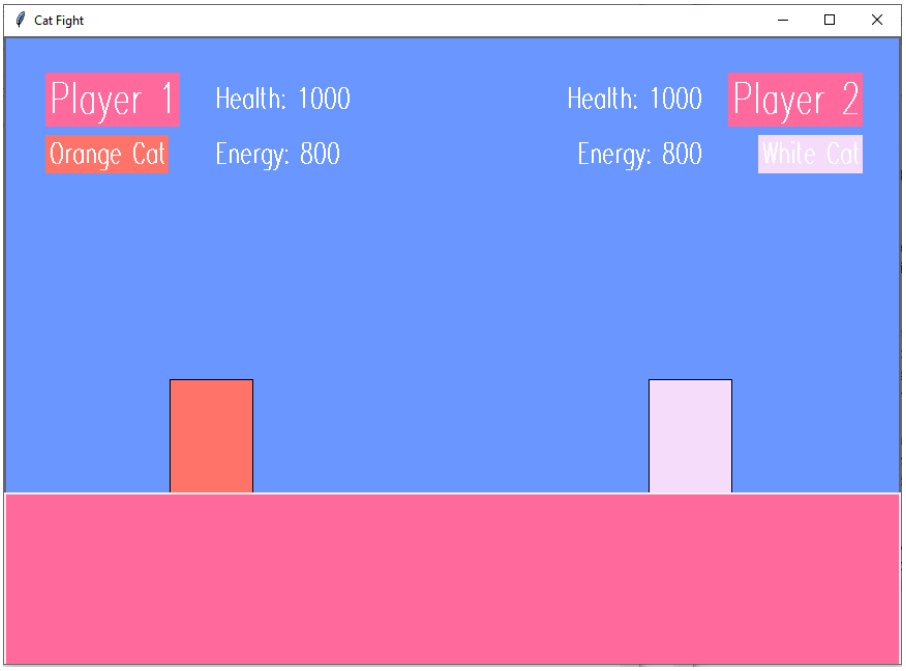
For the battle, I had to ensure that only the characters selected by the players would show up on the battle screen. To do this, I made the `selection1` attribute for player 1 and the `selection2` attribute for player 2, in their respective character selections, public attributes, so that I could use an `if` statement in the `battle` method in order to call the correct character object, as shown partially below (line 01).

I made a class for each character as well as a duplicate of them for player 1 and player 2. For example, when `selection1` is set to 1, an instance of the `Orange` class would be instantiated (line 06). When `selection2` is set to 1, an instance of the `Orange2` class would be instantiated (line 29). I initially only had a single `Orange`, `White` and `Black` class, but then realised this caused problems when it came to binding different keys for both players, as well as when both players selected the same character, therefore I made a duplicate that uses the other player's keys (lines 11-14 and lines 26-29).

```
01      if selection1 == 1:
02              pOrange = Label(play, text = "Orange Cat",
03              bg='#FF746C', fg='white', font=('Modern 20
04  bold'))
05              pOrange.place(x=40, y=95)
06              self.items = {}
07              self.orange = Orange(self.canvas, 200, 390)
08              self.items[self.orange.item] = self.orange
09
10              self.hud = None
11              self.canvas.focus_set()
12              self.canvas.bind('<a>',
13                               lambda _:
14  self.orange.move(-10))
15              self.canvas.bind('<d>',
16                               lambda _: self.orange.move(10))
17
18       if selection2 == 1:
19              pOrange = Label(play, text = "Orange Cat",
20              bg='#FF746C', fg='white', font=('Modern 20
21  bold'))
22              pOrange.place(x=712, y=95)
23              self.items = {}
```

```
24              self.orange2 = Orange2(self.canvas, 663, 390)
25              self.items[self.orange2.item] = self.orange2
26
27              self.hud = None
28              self.canvas.focus_set()
29              self.canvas.bind('<Left>',
                                 lambda _:
    self.orange2.move(-10))
                self.canvas.bind('<Right>',
                                 lambda _:
    self.orange2.move(10))
```

Initially, I struggled to make the images of the characters show up and move with the arrow keys when an object of them was instantiated (Test 1 and 2). In order to save time, I decided to start coding the battle with the characters as blocks instead of images as shown below and in the code above (line 06 and 21), so that I could focus on developing the game instead.



When I came back to making the characters show up as images, I realised that my error was that I was using Tkinter's Label widget which I had used previously to make images show up. However, I learned that these labels could not be moved using key inputs. Therefore, to rectify this problem, I used Tkinter's `create_image` method, in order to display the image at the specified coordinates on the canvas, when the character object was instantiated, as shown below in line 01. This allowed me to then bind the keys to the object and made the character's image move on the canvas with them (lines 02-04).

```
01      self.orange = Orange(self.canvas, 200, 380,
02  "oFight.png")
03      self.master.bind("<w>", self.orange.jump)
```

```
04      self.master.bind("<a>", self.orange.move_left)
        self.master.bind("<d>", self.orange.move_right)
```

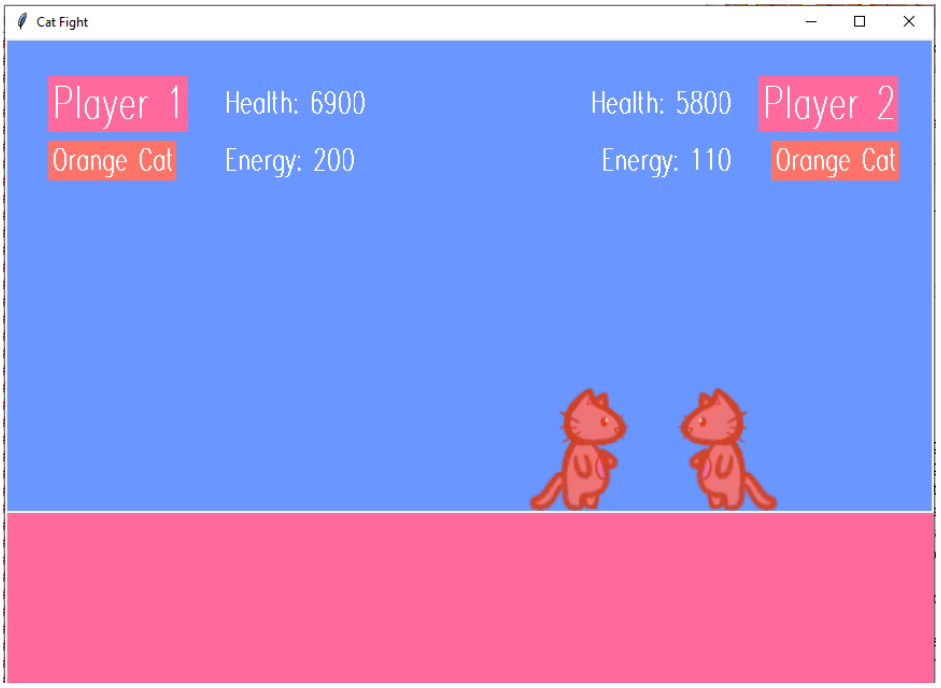
The next thing I needed to do was bind the different key inputs to the characters' attacks, and make sure that these attacks would decrease the opponent's health by a certain amount and, if needed, decrease the character's amount of energy for the attack and display this amount on the screen (Test 4, 5, 6, 7). To do this, I made the `damage1` attribute for player 1 and the `damage2` attribute for player 2 public attributes so that in their individual `takeDamage` methods, their health would decrease by the amount inflicted by the opponent, as shown below (line 03). Each character has individual methods for each of their attacks, for example a `normalAtk` method, as well as a method to calculate their energy `calcEnergy`. Each attack method has individual integers stored in the `damage1`/`damage2` attribute, which is different for each character.

```
01      def takeDamage(self, damage2):
02          if self.health1 >= damage2:
03              self.health1 -= damage2
04          else:
05              self.health1 = 0
```

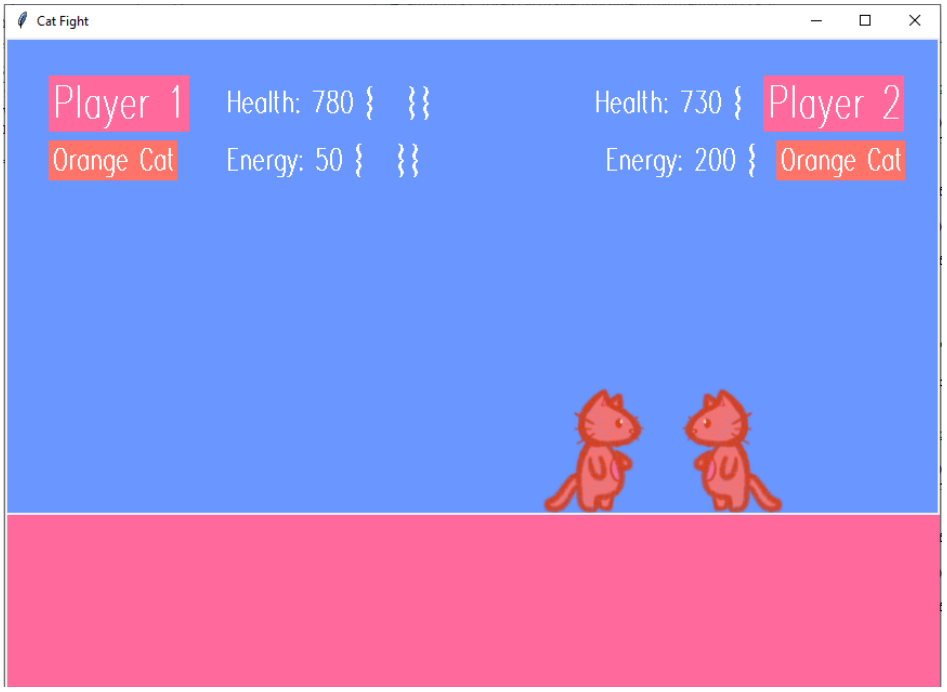
I also made sure that the damage they take wouldn't decrease their health to a number less than 0, by making them take damage only when their health is greater than or equal to the damage inflicted (line 02 above), otherwise their health would equal 0 (line 05 above). I also had to make sure that the characters had enough energy to perform their special or ultimate attacks by using an `if` statement so that they only use these attacks if their energy is greater than or equal to the energy required as shown below in line 02, otherwise the attack would not be carried out and the opponent would not take damage.

```
01      def specialAtk(self):
02          if self.energy1 >= 50:
03              self.energy1 -= 50
04              damage1 = 70
05              if selection2 == 1:
06                  Orange2.takeDamage(self, damage1)
```

To display the correct amount of energy and health on the battle screen, I used the Label widget to create a new label displaying what is stored in the health or energy attributes every time the values changed. This brought a problem of the labels overlapping each other as shown below, which not only made it seem like the wrong number was being displayed even if the right number was stored in the variable, but also made it very confusing for the players as the number on screen seemed incorrect.



As seen in the screenshot above, the numbers displayed are definitely incorrect as the maximum health is 1000, therefore the numbers that should be displayed are 690 and 580. To fix this, I decided to simply add a string of spaces after the text in each health or energy label, for example: `lHealth = Label(self.canvas, text = ('Health:', self.health1, '    '))`. This resulted in curly brackets being shown on screen as displayed below, but as this overall solved the problem, I decided to leave it as that in order to save time.



After that, I needed to make a timer. To do this, I imported the time module for Tkinter and set the time limit to ninety at first, and then used the Label widget to show the time remaining on the battle screen. Initially, I struggled to make the default time to be set to 90 seconds while also making sure that if the player were to choose a different time limit, that this would be implemented instead. I had a problem where the timer would start at 90 seconds no matter what was stored in the `timeLimit` attribute.

In the old code below, I first made an `if` statement which checked if the `timeLimit` attribute had the string 'infinite' stored (line 01), which would be what the user chose. Then, I had another `if` statement within, which set the time limit to 90 if the `timeLimit` attribute was not equal to 60 or 120 (line 03), otherwise the time limit would be set to 60 (line 08) or 120 (line 12) respectively.

In the new code, I made the same `if` statement to check if `timeLimit` was not equal to 'infinite' (line 01) and then used a different `if` statement within, which instead checked if `timeLimit` was equal to 60 or 120 (line 02) and then set the time limit to what was stored in the attribute `timeLimit` (line 03), otherwise the time limit was set 90 (line 08). I also made an `else` statement for the outer `if` statement, which displays a different label on the battle screen if the `timeLimit` attribute is set to 'infinite', as there would be no timer (line 17).

Old code:

```
01      if timeLimit != 'infinite':
02              if timeLimit != 60 or timeLimit != 120:
03                  self.time_limit = 90
04                  self.start_time = None
05                  self.remaining_time = self.time_limit
06                  self.start_timer()
07              elif timeLimit == 60:
08                  self.time_limit = 60
09                  self.start_time = None
10                  self.remaining_time = self.time_limit
11                  self.start_timer()
12              elif timeLimit == 120:
13                  self.time_limit = 120
14                  self.start_time = None
15                  self.remaining_time = self.time_limit
16                  self.start_timer()
```

New code:

```
01      if timeLimit != 'infinite':
02              if timeLimit == 60 or timeLimit == 120:
```

```
03                  self.time_limit = timeLimit
04                  self.start_time = None
05                  self.remaining_time = self.time_limit
06                  self.start_timer()
07              else:
08                  self.time_limit = 90
09                  self.start_time = None
10                  self.remaining_time = self.time_limit
11                  self.start_timer()
12              self.timer_label = Label(self.master, text="",
13              font=('Modern 60 bold'), bg='#FF6D9E',
14             fg='white')
15              self.timer_label.place(x=410, y=40)
16              self.update_timer()
17          else:
18              self.timer_label = Label(self.master, text="∞",
19              font=('Modern 60 bold'), bg='#FF6D9E',
               fg='white')
                self.timer_label.place(x=410, y=40)
```

However, I then encountered this error when no button was pressed in the settings to choose a time limit.

```
    if timeLimit != 'infinite':
NameError: name 'timeLimit' is not defined
```

To fix this, I made the public attribute `timeLimit` equal to 90 in the constructor method of the `Game` class, which also set the default time limit to 90 seconds. The time limit could then be chosen by the player in the settings.

To make the pause button, I added a `pause_characters` method to the `Game` class, where I unbinded all of the key inputs so that they could not be used (Test 12). The `resume_characters` method was then used to bind all of the keys back onto the characters when the resume button is pressed. For the pause button overall, I made a new frame which appears on screen when the pause button is pressed, which would disappear after the player presses resume, using Tkinter's `place_forget` method.

Initially, I struggled with how to pause the timer on screen, and then make sure that it would resume from where the timer stopped. I used two methods within the `Game` class: `pause_timer` and `resume_timer`. I tried to use a `get` method to get the time the timer was paused at (line 03), and then use this to resume the timer at that time (line 12). However I realised that I could just use the attribute `self.paused` and make the timer either true or false in order to pause or resume the time. Therefore, I fixed this issue by changing the methods below:

Old code:

```
01      def pause_timer(self):
02          self.timer_paused = True
03          self.stopped_time = int(self.remaining_time.get())
04          self.paused_time = Label(self.master,
05          text=self.stopped_time, font=('Modern 60 bold'),
06          bg='#FF6D9E', fg='white')
07          self.paused_time.place(x=410, y=40)
08
09      def resume_timer(self):
10          if self.timer_paused:
11              self.paused_time.place_forget()
12              self.time_limit = self.stopped_time
13              self.start_time = None
14              self.start_timer()
15
16              self.timer_label = Label(self.master, text="",
17              font=('Modern 60 bold'), bg='#FF6D9E',
18  fg='white')
19              self.timer_label.place(x=410, y=40)
20
21              self.update_timer()
                self.timer_paused = False
```

New code:

```
01      def pause_timer(self):
02          self.paused = True
03
04      def resume_timer(self):
05          self.paused = False
```

I then added a ‘Retry’ button, ‘Back to character selection’ button and a ‘Back to starting page’ button onto the pause frame. At first, I set the command for the ‘Retry’ button to call a method called `retry` which would simply hide the pause frame and set `self.paused` to False in order to unpause the game, and then call the `battle` method again (Test 13). However, in doing this, the timer would overlap the old timer and go down quicker, and the characters would be unable to move. In order to fix this, I instead used the `retry` method to reset everything, including the health and energy attributes of the characters and the labels to display their health and energy. I then reset the timer as shown below by first checking if the time limit was not set to ‘infinite’ in the settings (line 01). This is so that the method wouldn’t try to reset a time limit that didn’t exist. I then stopped the current timer by checking if it was running, in which the `self.start_time` attribute would not be set to None (line 02). I then used Tkinter’s `after_cancel` function to stop the timer from updating after

1000 milliseconds (1 second) (line 03-04). The timer is then reset by setting the start time to None again (line 05) and then restarted with the `start_timer` method (line 07).

```
01      if timeLimit != 'infinite':
02           if self.start_time is not None:
03
04  self.master.after_cancel(self.master.after(1000,
05                self.update_timer))
06           self.start_time = None
07           self.remaining_time = self.time_limit
             self.start_timer()
```

As I was unsure about how to go about the 'Back to character selection' button and 'Back to starting page' button, I decided to go back and make the rounds work instead, in order to save time (Test 10). To do this, I created a `start_new_round` method in the `Game` class, which is called when a character's health is equal to 0 or when the timer ends. I then created a new attribute in the battle method called `self.round_no` and set it to 1, and made a label to display the round number on the battle screen so that it is visible to the player. I then made it so that in the `start_new_round` method shown below, it would use an `if` statement in order to check if `self.round_no` is equal to `rounds` (line 02), which is where the amount of rounds the user chose or the default amount of rounds if they didn't choose, and if so, would call the `end_battle` method (line 03) and end the current battle, which would ensure a new round wouldn't start if unneeded. Otherwise, in the `else` statement, the `self.round_no` attribute is incremented by 1 (line 26) and this is displayed on the battle screen using the label `self.round_label` (line 27). Similarly to the `retry` method, I reset everything: the health and energy attributes of the characters (lines 05-08), the labels to display their health and energy (lines 09-24) and the timer (lines 38-44). I also added into the `retry` method a reset to the round number, where `self.round_no` is set to 1 again.

```
01      def start_new_round(self):
02          if self.round_no == rounds:
03              self.end_battle()
04          else:
05              self.health1 = 1000
06              self.energy1 = 500
07              self.health2 = 1000
08              self.energy2 = 500
09              lHealth = Label(self.canvas, text = ('Health:',
10              self.health1, '   '), bg='#6D97FF', fg='white',
11              font=('Modern 20 bold'))
12              lHealth.place(x=200, y=42)
13              lEnergy = Label(self.canvas, text = ('Energy:',
14              self.energy1, '   '), bg='#6D97FF', fg='white',
15              font=('Modern 20 bold'))
```

```
16              lEnergy.place(x=200, y=95)
17              lHealth = Label(self.canvas, text = ('Health:',
18              self.health2, '   '), bg='#6D97FF', fg='white',
19              font=('Modern 20 bold'))
20              lHealth.place(x=540, y=42)
21              lEnergy = Label(self.canvas, text = ('Energy:',
22              self.energy2, '   '), bg='#6D97FF', fg='white',
23              font=('Modern 20 bold'))
24              lEnergy.place(x=550, y=95)
25
26              self.round_no += 1
27              self.round_label.config(text=f"Round
28              {self.round_no}")
29
30              self.start_label = Label(self.canvas, text="",
31              font=('Modern 70 bold'), bg='#FF6D9E',
32  fg='white')
33              self.start_label.place(x=260, y=200)
34              self.start_label.config(text=f"Round
35              {self.round_no} !")
36              self.start_label.after(2000,
37              self.start_label.place_forget)
38
39              if timeLimit != 'infinite':
40                  if self.start_time is not None:
41                       self.canvas.after_cancel(self.canvas.
42                       after(1000, self.update_timer))
43                  self.start_time = None
44                  self.remaining_time = self.time_limit
                    self.start_timer()
```

I then decided to go back to the actual battle between the characters. When I was initially struggling to make the character images show up and used coloured blocks in their place, I was also struggling with making it so that the characters would only attack within a certain distance of each other, and with how to detect collision so that the characters would not move past each other. At first, I decided to start with the collision detection first, with the method `check_collision` shown below, as I thought this would aid me in making the characters only attack within a certain distance. To do this, I tried to get the x coordinates of the character's images (lines 02-03), and then made an `if` statement in order to check if these character coordinates were touching (lines 05-08) and then return True if so, so that I could make the characters stop moving past each other with another method later.

```
01   def check_collision(self):
02
03  orange_coords=self.canvas.coords(self.orange.imageID)
```

```
04
05  white2_coords=self.canvas.coords(self.white2.imageID)
06
07          if (orange_coords[2] > white2_coords[0]and
08          orange_coords[0] < white2_coords[2]) or
09          (white2_coords[2] > orange_coords[0] and
10          white2_coords[0] < orange_coords[2]):
11              return True
             else:
                return False
```

However, I was met with this error within the `if` statement..

```
    orange_coords[2] > white2_coords[0]
IndexError: list index out of range
```

Despite my attempts to fix this, I constantly ended up with this error and decided against making the characters stop moving when they touched, as not only was this time consuming, it is also uncommon in battle games and I no longer thought it was necessary.

I then decided to focus on making it so that the characters could only attack within a certain distance of each other. To do this, I imported Tkinter's `math` module and added to each character's attack methods the attribute `distance`, which stores the Euclidean distance between the two character's coordinates on screen (lines 04-07 below), first checking which opponent is on screen using an `if` statement (line 03). I used `if` statements in each attack method so that the opponent would only take damage if they were within a certain distance of the attacker (line 08-09), otherwise nothing would happen. I decided to make the distances smaller for character attacks which dealt more damage, and bigger for character attacks that dealt less damage, in order to make the battle more fun and last longer. This can be seen below in Orange Cat's `normalAtk` method when they try to attack Orange2, which would be the opponent.

```
01   def normalAtk(self):
02          damage1 = 20
03          if selection2 == 1:
04              distance = math.sqrt((self.orange.getLeft() -
05              self.orange2.getRight()) ** 2 +
06              (self.orange.getTop() - self.orange2.getTop())
07  **
08              2)
09              if distance <= 425:
                    Orange2.takeDamage(self, damage1)
```

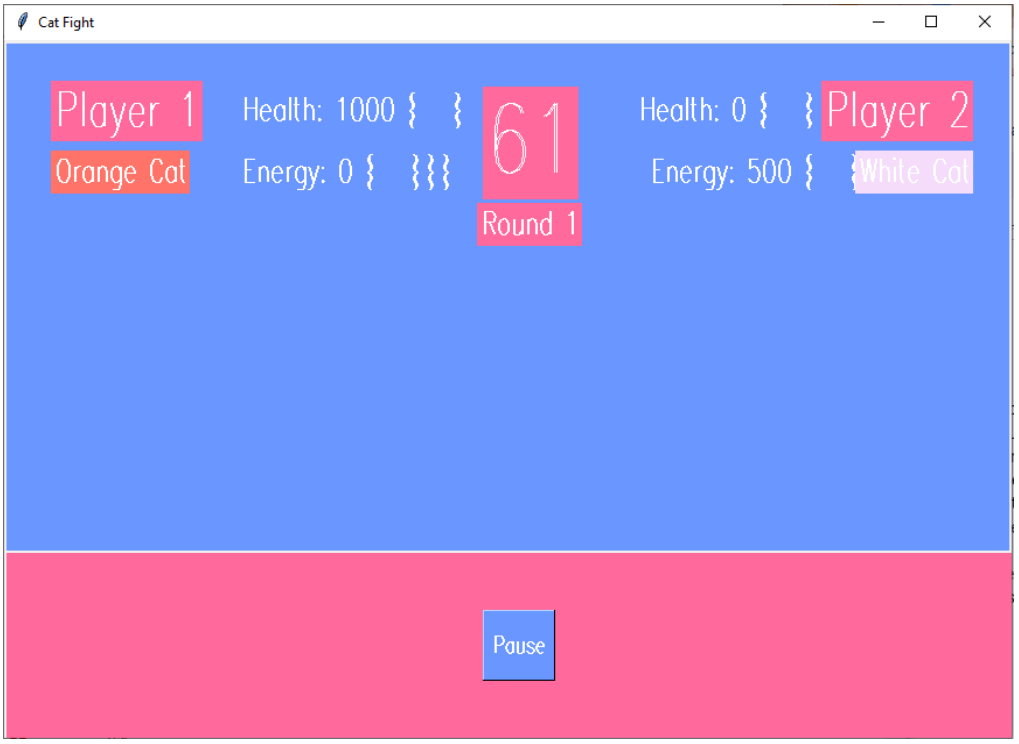
I decided to deal with the 'Back to character selection' button and 'Back to starting page' button on the pause frame after I dealt with the after battle screen, as similar buttons

needed to be used on both, therefore the pause frame buttons will be detailed in the 'Create the after battle screen' section below.

4) Create the after battle screen

I made an after battle screen to display the winner, as well as to give three different options for the user to choose from: a 'Retry' button, a 'Back to character selection' button and a 'Back to starting page' button. To do this, I created an `end_battle` method, which is called when either a character's health is equal to 0 on the final round of the battle, the time has run out on the final round of the battle, or when the round number is equal to the amount of rounds the player has chosen, so that another round wouldn't start and the battle would end.

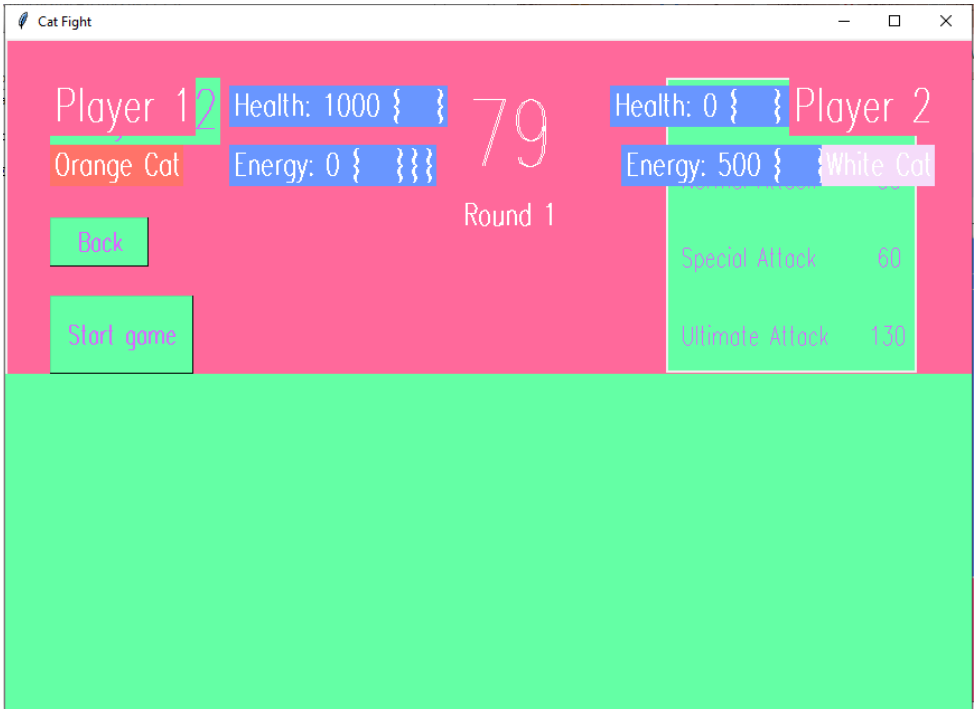
Initially, I struggled to actually make the after battle screen show up, as the items in the battle screen wouldn't disappear, as shown below.



Here, I tried to use Tkinter's `delete` function by using the line `self.canvas.delete("all")` in order to delete everything on the canvas, however only the characters would disappear, as everything else was placed onto the root window `self.master`, while only the characters were placed on the battle canvas. I then tried to use Tkinter's `destroy` function (line 01) and then made a new frame upon the root window `self.master`, as shown below (line 02).

```
01    self.canvas.destroy()
02    self.end = Frame(self.master, bg='#68ffa9')
03    self.end.pack(fill="both", expand=True)
```

However, this ended up only getting rid of the battle screen background as shown below, and revealed to me that the problem was that I had been using a frame for each screen which filled the previous screen, however for the battle, I had simply made a new canvas onto the root window.



This problem also interfered with the buttons on the after battle screen, because, as initially the screens such as the character selection screen had only been made to fill the starting page and not the battle screen, the button would then not be able to run the character selection method properly because the wrong screen was on display. This was also a problem with the 'Back to character selection' button and 'Back to starting page' button on the pause frame in the battle method.

In order to fix this, I first placed the battle canvas onto the player 2 character selection (the previous page which leads to the battle), rather than the root window `self.master` (line 02), and then placed the items that were on the battle screen onto the battle canvas `self.canvas`, rather than the root window, as shown below (line 06).

Old code:

```
01   def battle(self):
02           self.canvas = Canvas(self.master, bg='#6D97FF',
03           width=863, height=600)
04           self.canvas.pack()
05
06
```

```
07          rectangle = Canvas(self.master, width=863,
08  height=402,
            bg='#FF6D9E', bd=0)
            rectangle.place(x=0, y=439)
```

New code:

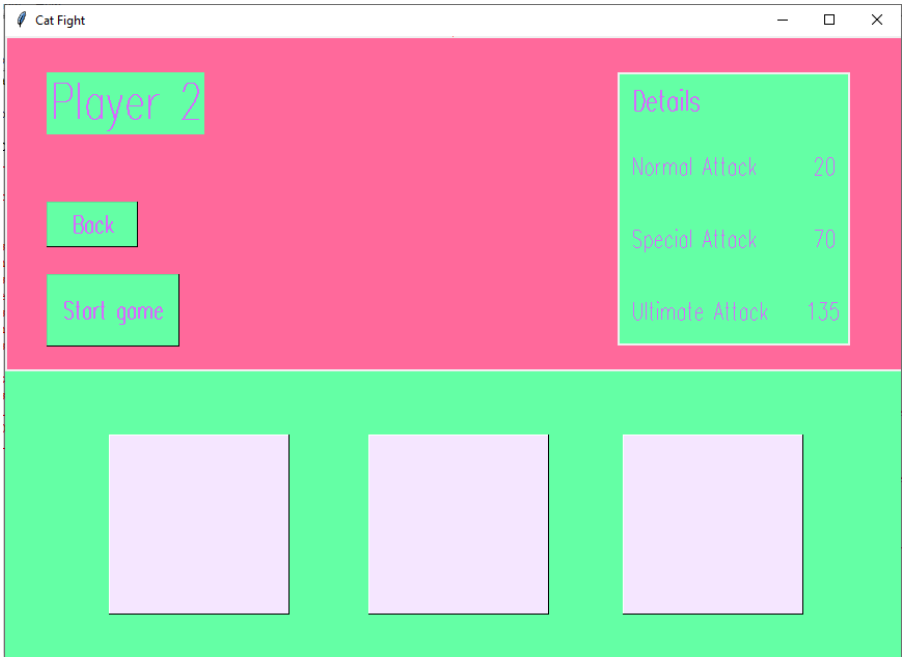
```
01   def battle(self):
02          self.canvas = Canvas(player2, bg='#6D97FF',
03  width=863,
04          height=600)
05          self.canvas.pack()
06
07          rectangle = Canvas(self.canvas, width=863,
08  height=402,
            bg='#FF6D9E', bd=0)
            rectangle.place(x=0, y=439)
```

This ensured that the battle screen could be closed using Tkinter's `destroy` function with the line `self.canvas.destroy()`, along with every item placed on it, as opposed to the entire window closing when the `destroy` function was used with the line `self.master.destroy()`. This was useful in getting the buttons on the after battle screen to work, which I will describe later on.

In order to make the after battle screen show up, I created a frame which was placed onto the battle canvas `self.canvas` with the lines below:

```
self.end = Frame(self.canvas, bg='#FF746C')
self.end.pack(fill="both", expand=True)
```

However, this was the result:



Instead of making a new screen with the background colour #FF746C, it would simply take the player back to the previous page of the battle: the character selection. I therefore added another frame on top of the player 2 character selection above with the lines below, which then displayed the after battle screen correctly.

```
self.end_screen = Frame(player2, bg='#FF746C')
self.end_screen.pack(fill="both", expand=True)
```

In order to display the winner on the after battle screen, I created an empty list called `winners` in the constructor method of the `Game` class, which either “Player 1”, “Player 2” or “Draw” was added to the list depending on the outcome of each round. I then used the `count` method to count the amount of wins each player had by counting how many times “Player 1” or “Player 2” appeared in the list, and stored them in their respective attributes `player1_wins` and `player2_wins`. I then used the `if` statement below to compare the amount of wins of each player (lines 01 and 07), to store an overall winner in the attribute `self.actualWinner` (lines 02 and 08). The winner is then displayed on the after battle screen using the label `winner_label`, or a draw is displayed otherwise.

```
01          if player1_wins > player2_wins:
02              self.actualWinner = "Player 1"
03              winner_label = Label(self.end_screen,
04  text="Player
05              1 wins!", font=('Modern 50 bold'), bg='#DA6BFF',
06              fg='white')
07              winner_label.place(x=20, y=20)
08          elif player1_wins < player2_wins:
09              self.actualWinner = "Player 2"
10
```

```
11              winner_label = Label(self.end_screen,
12  text="Player
13              2 wins!", font=('Modern 50 bold'), bg='#DA6BFF',
14              fg='white')
15              winner_label.place(x=20, y=20)
16          else:
17              self.actualWinner = "Draw"
18              winner_label = Label(self.end_screen,
                text="Draw!", font=('Modern 50 bold'),
                bg='#DA6BFF', fg='white')
                winner_label.place(x=20, y=20)
```

I then used the attribute `self.actualWinner` in an `if` statement as shown below (line 01) in order to display the winning (lines 03-07) and losing images (lines 09-13) of the correct characters on the end battle screen.

```
01          if self.actualWinner == "Player 1":
02              if selection1 == 1:
03                  winner = PhotoImage(file="oWin.png")
04                  winner.image = winner
05                  winner_label = Label(self.end_screen,
06                  image=winner, bg='#FF746C',bd=0)
07                  winner_label.place(x=10, y=130)
08                  if selection2 == 1:
09                      loser = PhotoImage(file="oLose.png")
10                      loser.image = loser
11                      loser_label = Label(self.end_screen,
12                      image=loser, bg='#FF746C',bd=0)
13                      loser_label.place(x=300, y=200)
```

After that, I decided to focus on the ‘Back to character selection’ and ‘Back to starting page’ buttons. First, I focussed on the ‘Back to character selection’ button on the after battle screen (Test 14). Initially, I created a button with the command `self.charaSelect1`, which I assumed would go back to the character selection by calling the `charaSelect1` method. However, as described earlier, the character selection screen had only been made to fill the starting page therefore the button would then not be able to run the character selection method properly because the wrong screen was on display (the after battle screen). Instead, as I had moved everything on the battle screen from the root window to the battle canvas as described earlier also, I decided to make a new method to be called with the button, called `end_chara`, shown below. This method uses the `destroy` function to remove the end screen (line 06), the battle screen (line 07), and the character selection for Player 2 (line 08), essentially bringing the player back to the character selection for Player 1 in this way. I also reset the character selections of Player 1 and Player 2 to 0 (lines 05-06) to ensure a choice is made again when it is validated.

```
01      def end_chara(self):
02           global selection1
03           global selection2
04           selection1 = 0
05           selection2 = 0
06           self.end_screen.destroy()
07           self.canvas.destroy()
08           player2.destroy()
```

I dealt with the 'Back to starting page' button in the same way, creating a new method called `end_back`, which also used the `destroy` function to remove the character selection for Player 1, bringing the player back to the starting screen, as well as resetting the character selections (Test 15).

I then made a new function called `end_retry` for the retry button on the after battle screen, which made a new battle canvas with the same name `self.canvas`, and placed everything from the `battle` canvas back on screen again. Although the method is almost identical to the `battle` method, I had to create this new method in order to reset the timer similarly to the `retry` method described earlier, as well as for the problem I ended up with below.

After retrying, the after battle screen from the previous battle would display underneath the new one as shown below (Test 13).

To fix this, I recognised it was because the after battle screen was being placed onto the wrong frame after the game was retried, and therefore I created a public attribute called

`check`, which is set to 1 in the original `battle` method, and set to 2 in the `end_retry` function. Then, I made an `if` statement as shown below which checked which screen the after battle screen should be placed on: the character selection screen for Player 2 if `check` stores 1 (line 02), or the previous after battle screen if `check` stores 2 (line 05).

```
01          if check == 1:
02              self.end_screen = Frame(player2, bg='#FF746C')
03              self.end_screen.pack(fill="both", expand=True)
04          elif check == 2:
05              self.end_screen = Frame(self.end_screen,
06              bg='#FF746C')
07              self.end_screen.pack(fill="both", expand=True)
```

Testing to inform development

I will now test the program using my test plan on page 50 from the design section, using videos to evidence.

Test number	Function being tested	Method of input	Input	Expected result	Actual result	Video evidence
Test 1	Character selection	Button clicked on the character selection screen	Orange Cat button clicked (selection(1 or 2) = 1)	The orange cat character will appear on the battle screen to be played by the user	As expected	https://youtu.be/HS3H_nnm98E
			White Cat button clicked (selection = 2)	The white cat character will appear on the battle screen to be played by the user	As expected	https://youtu.be/3J_tDjHZav0
			Black Cat button clicked (selection = 3)	The black cat character will appear on the battle screen to be played by the user	As expected	https://youtu.be/S2KpNdMyJNM
			No button clicked (selection = 0)	The user will prompted with an alert message to select a character before moving onto the next screen	As expected	https://youtu.be/PuzMeUbBgss
Test 2	Character movement	Pressing a button on the keyboard	A	Player 1 will move left	As expected	https://youtu.be/MdWMGbn2j3Y
			D	Player 1 will move right	As expected	https://youtu

						.be/MdWMGbn2j3Y
			W	Player 1 will jump	As expected	https://youtu.be/av2O2PwSDzY
			S	Player 1 will guard (They will not be able to take damage)	As expected	https://youtu.be/AfnZ6wFuXY0
			Left	Player 2 will move left	As expected	https://youtu.be/iEWwo0uXJhc
			Right	Player 2 will move right	As expected	https://youtu.be/iEWwo0uXJhc
			Up	Player 2 will jump	As expected	https://youtu.be/av2O2PwSDzY
			Down	Player 2 will guard (They will not be able to take damage)	As expected	https://youtu.be/cw69NPiSzTE
Test 3	Collision with borders	When in battle, head into a border of the game screen using the directional buttons on the keyboard	D (Player 1)/Right (Player 2) to direct the characters to the right border of the game screen	The characters will not be able to move past the borders of the game screen and will stop moving at the border.	The characters won't move off-screen, however when approaching the left border, half of the character image is able to go off-screen, and when	Player 1: https://youtu.be/MdWMGbn2j3Y Player 2: https://youtu

			A (Player 1)/Left (Player 2) to direct the characters to the left border of the game screen		approaching the right border, the character will stop before the border is reached.	.be/iEWwo0uXJhc
N/A	Collision with opponent	When in battle, head into the direction of the opposing player using the directional buttons on the keyboard	Directional buttons on the keyboard used to direct the characters to their opponents	The characters will not be able to move past each other and will stop moving when the border of one character touches the border of the other	During development, I decided that this was no longer necessary.	N/A
Test 4	Character using normal attack	Pressing a button on the keyboard	E (Player 1)/ B (Player 2)	Damage will be dealt to the opponent by the normal attack damage amount of the player and the opponent's health will decrease by this much	As expected	https://youtu.be/t2TxI0pFHws
Test 5	Character using special attack	Pressing a button on the keyboard	R (Player 1)/ N (Player 2)	The player's energy will decrease by 50 and damage will be dealt to the opponent by the special attack	As expected	https://youtu.be/K3mthgL1X5o

				damage amount of the player, decreasing the opponent's health by this much		
Test 6	Character using ultimate attack	Pressing a button on the keyboard	T (Player 1)/ M (Player 2)	The player's energy will decrease by 100 and damage will be dealt to the opponent by the special attack damage amount of the player, decreasing the opponent's health by this much	As expected	https://youtu.be/vgUMMV-bedE
Test 7	Character recharging energy	Pressing a button on the keyboard	Q (Player 1)/ L (Player 2)	The player's energy will increase by 10 if the energy bar is not full, otherwise their energy will remain at 500	As expected	https://youtu.be/8LxxmAN_now
Test 8	Displaying instructions	Clicking the 'How to play' button on the starting screen	N/A	Displays a new window with the instructions on the key inputs for both Player 1 and Player 2	As expected	https://youtu.be/aiR97YwNRIM
Test 9	Displaying settings	Clicking the 'Settings' button on	N/A	Displays a new window with the	As expected	https://youtu.be/W

		the starting screen		options for the amount of rounds and the time limit in battle		38I6cH1Sto
Test 10	Selecting amount of rounds	Button clicked in settings	‘1’ button clicked (rounds = 1)	One round will be played during battle	As expected	https://youtu.be/QucjGBnDeG4
			‘3’ button clicked (rounds = 3)	Three rounds will be played during battle, and the player who wins the most rounds will win	As expected	https://youtu.be/ymluSPd-3kU
			‘5’ button clicked (rounds = 5)	Five rounds will be played during battle, and the player who wins the most rounds will win	As expected	https://youtu.be/Mq0-xUX9iV0
			No button clicked	The rounds will be set to a default of three rounds	As expected	https://youtu.be/UHXkDeBZrbI
Test 11	Selecting the time limit of the rounds	Button clicked in settings	‘60’ button clicked	Each round will have timer of 60 seconds	As expected	https://youtu.be/XZ1ohb_xs-E
			‘90’ button clicked	Each round will have timer of 90 seconds	As expected	https://youtu.be/Bs3E3j-a-U4
			‘120’ button clicked	Each round will have timer of 120 seconds	As expected	https://youtu.be/LyFYMW

						DbpVs
			‘∞’ button clicked	Each round will continue for an infinite amount of time and will only end when a character is defeated	As expected	https://youtu.be/RvmC3-Fqmwg
			No button clicked	The default time limit will be set to 90 seconds	As expected	https://youtu.be/UHXkDeBZrbI
Test 12	Selecting the pause button	Button clicked during battle	N/A	Pauses the game so that characters are unable to move or attack and displays a window with options to retry, return to character selection or return to the starting page, and can cross off the window to resume	As expected, except ‘cross off to resume’ was replaced with a simple ‘Resume’ button for ease of use	https://youtu.be/hZYa_j8o1Z8
Test 13	Selecting the ‘Retry’ button	Button clicked after pausing or after battle	N/A	Restarts the battle from the start with full energy and health bars	As expected	https://youtu.be/ekNx2Abpj1Q
Test 14	Selecting the ‘Character Selection’ button	Button clicked after pausing or after battle	N/A	Ends the current battle and returns to the character selection	Sometimes works as expected, however sometimes the buttons do not work and the	https://youtu.be/CRufwAwLY7w

					player has to use the back button to return to the character selection from the starting page in order to select a character.	
Test 15	Selecting the 'Starting Page' button	Button clicked after pausing or after battle	N/A	Ends the current battle and returns to the starting page	As expected	https://youtu.be/yc4wdHEzFBI

By testing the program according to my test plan, I have shown that most of the features are functional. The unexpected results in test 3 do not greatly affect the gameplay, therefore, due to time constraints, I will leave this to be considered in the project's evaluation. However, for test 14, I managed to fix this simply by altering the `end_chara` and `battle_chara` methods which lead back to the character selection from the after battle screen and the battle screen respectively, by, instead of just going back to the character selection for player 1 using the `destroy` method as shown below (old code, lines 08 and 16), I used the `destroy` methods to go back to the starting page (new code, lines 09 and 19), and then called the character selection method again (new code, lines 10 and 20). This then ensures that the buttons are clickable, and also doesn't display a previously selected character on screen either.

Old code:

```
01      def end_chara(self):
02           global selection1
03           global selection2
04           selection1 = 0
05           selection2 = 0
06           self.end_screen.destroy()
07           self.canvas.destroy()
08           player2.destroy()
09
10      def battle_chara(self):
11           global selection1
12           global selection2
13           selection1 = 0
14           selection2 = 0
15           self.canvas.destroy()
```

```
16          player2.destroy()
```

New code:

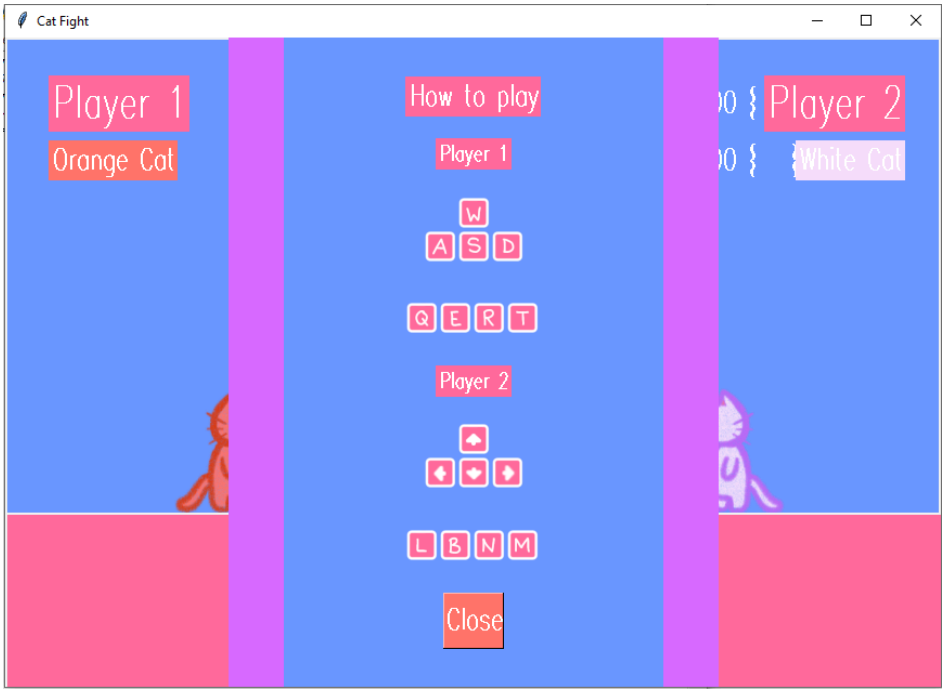
```
01      def end_chara(self):
02           global selection1
03           global selection2
04           selection1 = 0
05           selection2 = 0
06           self.end_screen.destroy()
07           self.canvas.destroy()
08           player2.destroy()
09           start.destroy()
10           self.charaSelect1()
11
12      def battle_chara(self):
13           global selection1
14           global selection2
15           selection1 = 0
16           selection2 = 0
17           self.canvas.destroy()
18           player2.destroy()
19           start.destroy()
20           self.charaSelect1()
```

After testing with potential users (GCSE and A Level students), key problems that they pointed out to me were:

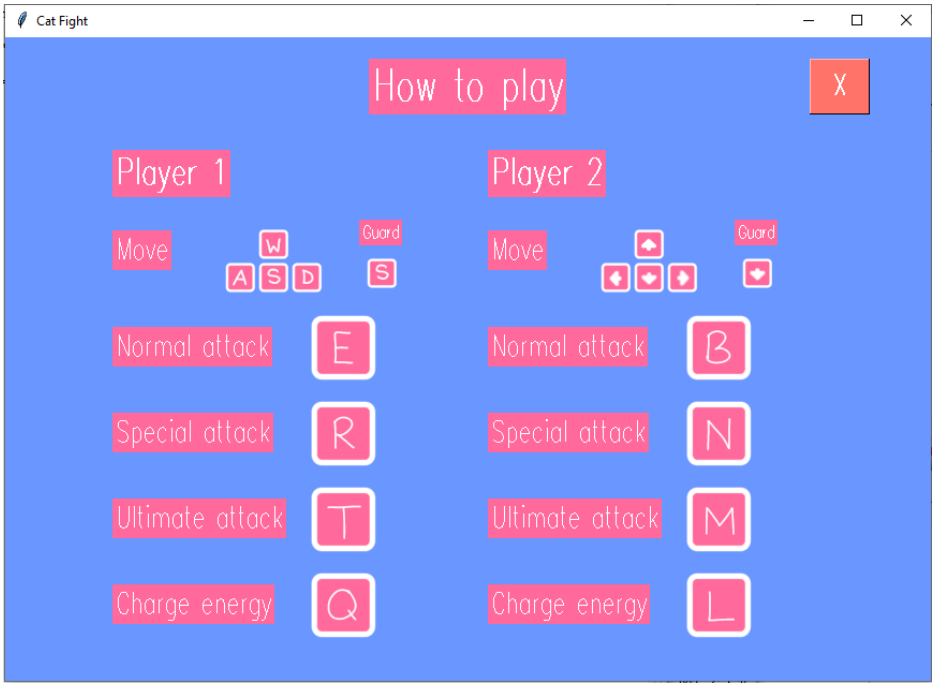
- After starting battle, it is easy to forget how to play as there is no reminder of the instructions
    - Players were also unaware that they could guard
- There is no indication of the winner after each round
- After each round, the characters' positions do not reset

I will detail how I fixed these below.

For the first problem, I originally planned to have the key inputs displayed at the bottom of the battle screen as detailed in the design section (page 49). However, in attempting to implement this, I found that the images of the keys would disappear when two or more keys were pressed simultaneously. I therefore decided to implement the instructions in battle in a different way: by adding a button in the pause frame called 'How to play' which details the instructions again, as shown below.



In the main ‘How to play’ button on the starting screen, I also added an extra instruction for the keys to guard, as shown below.



To solve the second problem, initially, I added in a label which disappears after two seconds to display the winner on screen, before ending the battle or starting the next round in the `start_new_round` method, with the code below, for example.

```
01          self.win = Label(self.canvas, text="Player 2 wins!",
```

```
02          font=('Modern 70 bold'), bg='#FF6D9E', fg='white')
03          self.win.place(x=200, y=200)
04          self.win.after(2000, self.win.place_forget)
```

However, due to the `after` method in line 04 being used multiple times in my `start_new_round` method (i.e. to display the round number at the start of the round and to update the timer), the rounds began to add up abnormally. Therefore, instead, I decided to display a new label that appears throughout the battle through all of the rounds, which indicates the winner of the last round, through the use of the `self.winners` list, which stores the winner of each round. I added this label shown below where each character's health is equal to 0, or where the time has run out, which leads to either 'Player 1', 'Player 2' or 'Draw' being stored in the `self.winners` list.

```
lose = Label(self.canvas, text=self.winners, font=('Modern 12'),
bg='#FF6D9E', fg='white')
```

To solve the third problem, in the `start_new_round` method, I 'reset' the character positions with the code below, by first deleting the current character off the screen (line 02), and then instantiating a new object of the character at the correct coordinates (line 03) and then binding the keys to the new object instead, shown partially below (lines 05-11).

```
01          if selection1 == 1:
02
03  self.orange.canvas.delete(self.orange.imageID)
04                  self.orange = Orange(self.canvas, 200, 380,
05                  "oFight.png")
06                  self.master.bind("<w>", self.orange.jump)
07                  self.master.bind("<a>",
08  self.orange.move_left)
09
10  self.master.bind("<d>",self.orange.move_right)
11                  self.master.bind("<KeyPress-s>",
                    self.orange.guard)
                    self.master.bind("<KeyRelease-s>",
                    self.orange.unguard)
```

Evaluation

Testing to inform evaluation

In order to clarify the satisfaction of my intended users (GCSE and A level students), I have created a questionnaire to see if users find my program user-friendly and suitable to them. The questionnaire, and the frequency of each users' responses after testing the finished solution are shown below.

Question	Answer (Y/N)	Comment
Were the instructions clear?	Y (8) N (0)	None
Were you easily able to tell what to do on each screen (e.g. starting screen, character selection screen)?	Y (8) N (0)	None
Was the gameplay fun and able to help you to destress?	Y (8) N (0)	None
Are you satisfied with the overall look of the game?	Y (8) N (0)	None
Was the battle easy to understand and play?	Y (8) N (0)	None
Were the characters easy to control?	Y (8) N (0)	Both players cannot move at the same time.
These are the problems outlined by users that I sought to resolve: ● After starting battle, it is easy to forget how to play as there is no reminder of the instructions ○ Players were also unaware that they could guard ● There is no indication of the winner after each round ● After each round, the characters' positions do not reset Do you believe that these problems have been fully resolved?	Y (8) N (0)	None
Are there any other problems that you believe still have to be fixed?	Y (0) N (8)	None

In this questionnaire, it can be seen that users' responses to the completed game are positive. The users are satisfied with the resolved problems, and agree that the game meets the design objectives. As there is a problem highlighted about the movement of both players, I will discuss this in the maintenance and development section on page 99.

Success of the solution

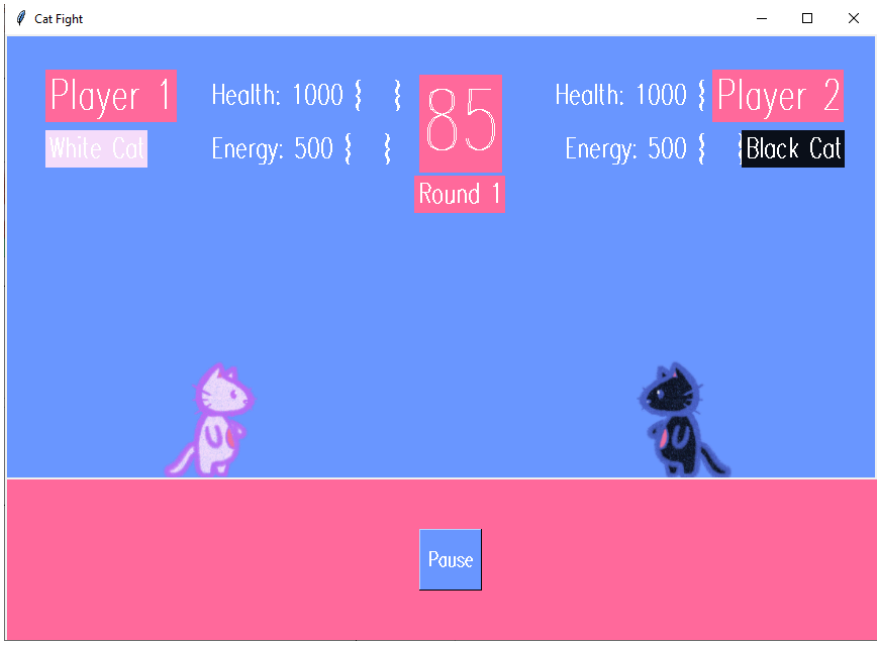
I will now compare my success criteria in the analysis section on page 13 to the finished program, detailing whether or not these criteria were met with test evidence.

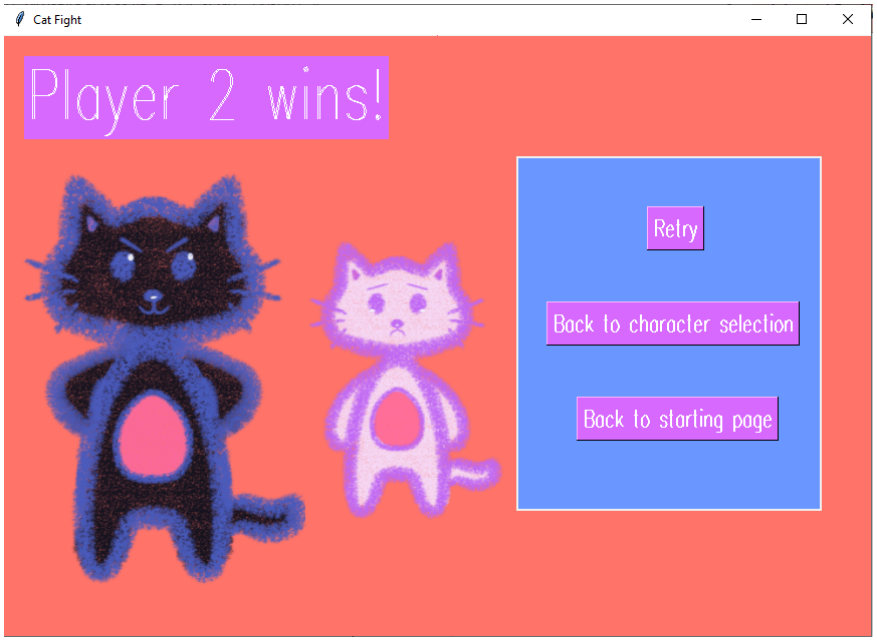
Criteria	How to evidence	Met or not met	Screenshot reference
Main starting page with start button, instructions on how to play, settings	Screenshot of the main starting page that shows where the 'How to play' and settings button are	Met	1
Engaging and vibrant design	Screenshots of the windows with bright colours and appealing fonts, characters and world design	Met	2
Visible pause button during battle with pause symbol	Screenshot of the battle screen with a pause button visible and not drowned out by the background	Met	3
Settings menu on a separate page	Screenshot of the settings menu that is separate from the starting page, showing the ability to change the amount of rounds and the time limit in a game	Met	4
Instructions on a separate page, shows which keys are used for player 1 and player 2	Screenshot of the instructions of how to play separate from the starting page, detailing the movement (jump, left, right, guard), normal attack, special attack, ultimate attack buttons for both player one and player two	Met	5
Character	Screenshot of the character	Partially met - Due	6

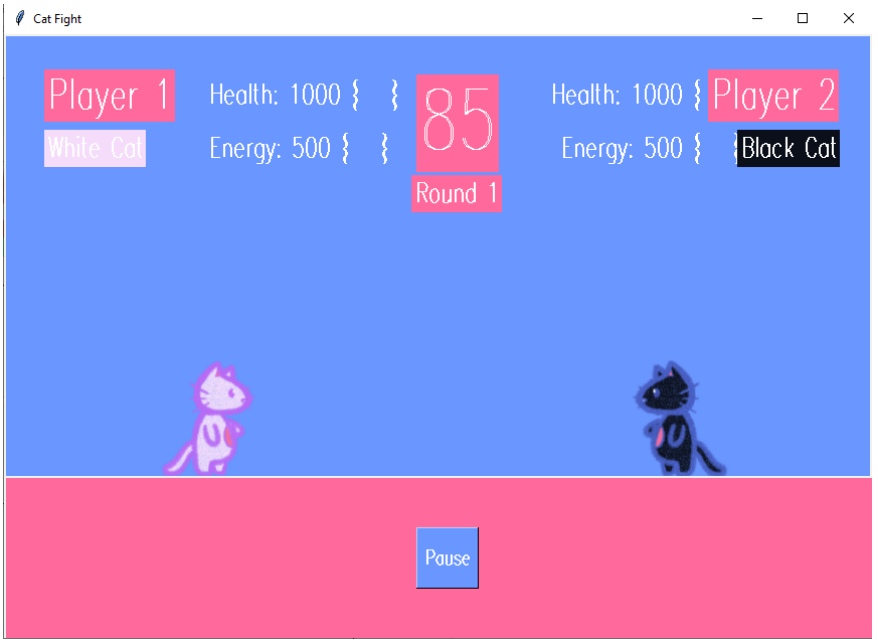
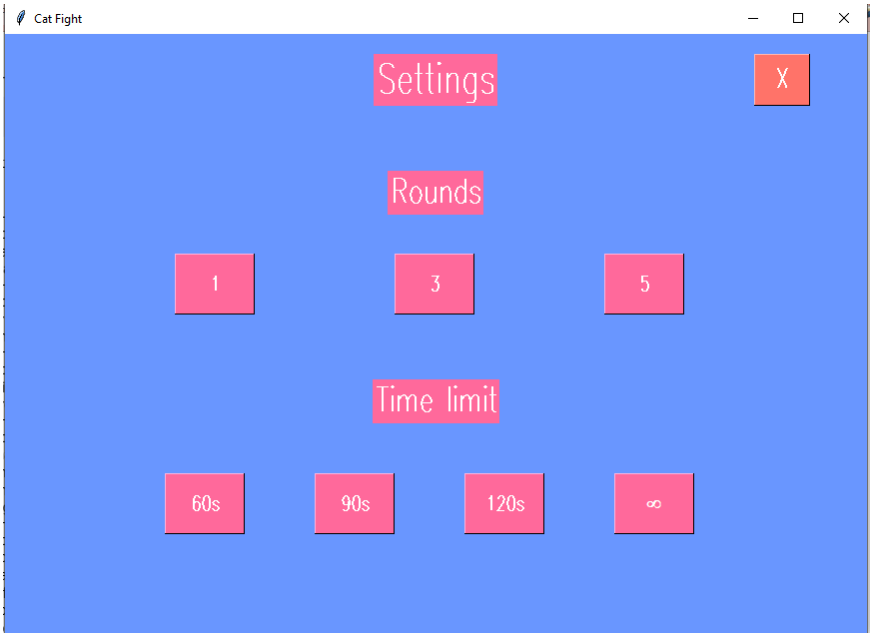
selection on a separate page	selection with the option to play against a computer or against another player in character selection, button to press to change the second player (opponent) into player two, default is against a computer	to time constraints, I did not add in an option to play against a computer, and I will detail this in the maintenance and development section on page 99.	

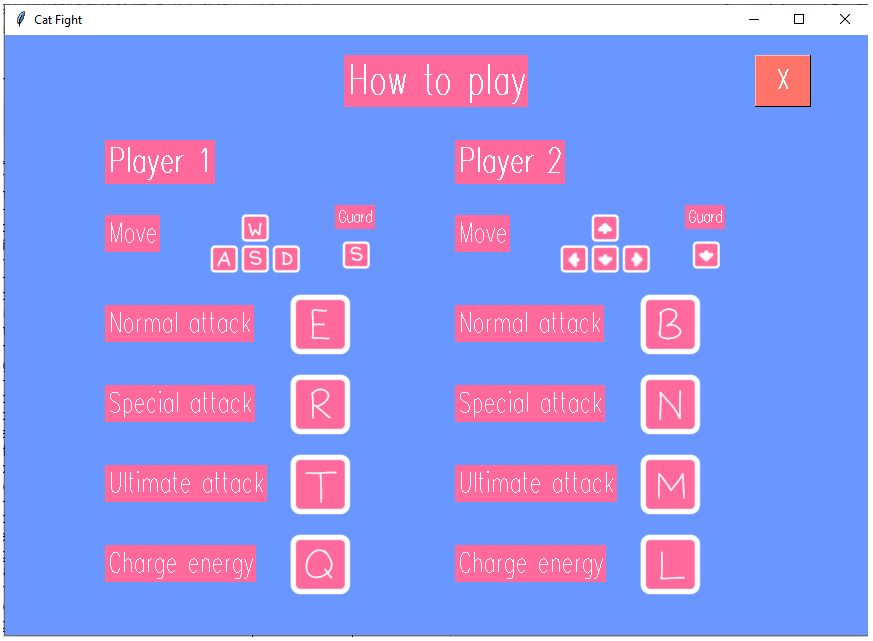
Screenshot reference	Screenshots
1	

2	 Cat Fight Settings How to play CAT FIGHT Start  Cat Fight Player 1 Back Next Details Normal Attack 35 Special Attack 60 Ultimate Attack 130


Cat Fight
Player 1
White Cat
Health: 1000
Energy: 500
85
Round 1
Health: 1000
Energy: 500
Player 2
Black Cat
Pause


Cat Fight
Player 2 wins!
Retry
Back to character selection
Back to starting page

3	 Cat Fight Player 1 White Cat Health: 1000 Energy: 500 85 Round 1 Health: 1000 Energy: 500 Player 2 Black Cat Pause
4	 Cat Fight Settings X Rounds 1 3 5 Time limit 60s 90s 120s ∞

5	 Cat Fight How to play X Player 1 Player 2 Move W A S D Guard S Move Guard Normal attack E Special attack R Ultimate attack T Charge energy Q Normal attack B Special attack N Ultimate attack M Charge energy L
6	 Cat Fight Player 1 Back Next Details Normal Attack 35 Special Attack 60 Ultimate Attack 130

Describe the final product

After having completed the game, I can conclude that most of the design objectives that were detailed in the design section on page 46 were met. The objectives 1c, 4d and 5f below were partially met, however in a different way than intended, which I will detail below to discuss each objective and explain why each of them were successfully met with evidence through the testing of the finished solution.

Requirement	Met or not met	Explanation of why the requirement was met/not met	Evidence
1a) The game will start with a vibrant and enticing starting page as preferred by potential users, with three different buttons: a settings button, which opens a new window with buttons to change the amount of rounds in a battle and buttons to change how long the rounds will be; a 'How to Play' button, which opens a new window and displays in a simple format the key inputs	Met	This requirement was met as the starting screen indeed did use vibrant colours, as well as having a settings button which opens a new frame to change the rounds and time limit, a 'How to play' button opening a new frame which displays the instructions simply, and a start button which leads to the character selection for Player 1.	https://youtu.be/T65GVzqiXZo

needed for both Player 1 and Player 2 so that players know how to play; and a start button, which leads to the character selection for Player 1 for quick and easy use.			
1b) The character selection will have a selection of three different characters, displaying their different attacks and their damage amounts in a box so users have more choice in what character they would like to play. This would then lead to the character selection for Player 2, displayed similarly, and then this would lead into the battle.	Met	There were indeed three characters to choose from, all with their individual damage amounts displayed upon selecting them, as well as a next button to lead to the character selection for Player 2, and a back button to go back to the previous page. This is similar for the character selection for Player 2, however with a 'Start' button which leads into the battle.	https://youtu.be/Jfz0-gMIcUI
1c) The battle will display the characters selected by the players, as well as their health and energy bars at the top of the screen and the timer and the rounds remaining between each players' bars so that players are aware of how much time, health and energy they have remaining and can strategise their next moves from there. When the time runs out or a player is defeated, it will lead to the after battle page, where the players will have three different options: retry, return to character selection and	Partially met	The battle does indeed display the characters selected by the players, as well as a timer with either the player's choice of time limit or the default, and the current round as chosen by the player or the default. However, instead of health and energy bars, instead I displayed the remaining health and energy with labels in a numeric form initially for testing to ensure the values stored in the attributes were changing correctly. However, due to time constraints, I was unable to figure out how to convert these bars to visually represent the remaining health and energy. When the time runs out or a player is defeated at the end of all the rounds, the players are indeed led to an after battle page with the options to retry,	Selected characters: Test 1 (page 73) Time limit: Test 11 (page 79) Rounds: Test 10 (page 79) Health labels: Test 4/5/6 (pages 77-78) Energy labels: Test 7 (page 78) After battle screen: Test 13/14/15 (pages 80-81)

return to starting page, which gives them the choice of whether they would like to play again with the same characters or settings or change them.		return to character selection or return to starting page.	
2a) The screen size will be moderately sized in order to fit most screens (863x600 pixels).	Met	The screen size was, as planned, 863x600 pixels, which was the size of my starting screen image.	This screen size can be seen throughout all testing videos and screenshots.
2b) There will be three different characters: an orange cat, a black cat and a white cat to give players a choice of what character they would like to play as well as make sure characters don't get mixed up on the battle screen.	Met	There were indeed three different characters: an orange, black and white cat. Players can select the same character, however, as Player 1 faces right and Player 2 faces left, the characters do not get mixed up.	Test 1 (page 75)
2c) Each page within the game will follow a similar colour scheme of blue, orange, pink, purple and green for a vibrant design that was preferred by potential users.	Met	This colour scheme was indeed followed throughout.	This colour scheme can be seen throughout all testing videos and screenshots.
2d) In battle, Player 1 will be facing right and Player 2 will be facing left so that players can easily tell who is who.	Met	Player 1 was indeed facing right and Player 2 facing left in battle.	This can be seen in multiple testing videos e.g. Test 2, Test 3 (pages 75-76)
2e) In battle, the characters will be approximately 100x120 pixels to make sure they are not too big or too small on the screen size.	Met	The characters were approximately 100x120 pixels, though I had planned to make them a little bigger in order to fit the screen better, but due to time constraints, I left them as is.	This can be seen in multiple testing videos e.g. Test 2, Test 3 (pages 75-76)

2f) When moving, the characters will move 10 pixels at a time so that characters can move quickly across the screen to attack or evade attacks.	Met	The characters indeed did move 10 pixels at a time when the keys are used, which ensures they aren't moving too fast or too slow.	Test 3 (page 76)
3a) The player will be able to choose how many rounds they would like to play to give them more choice to play in a way that will help them to destress.	Met	The player was able to choose how many rounds they wanted to play.	Test 10 (page 79)
3b) The player will be able to choose how much time they would like the round(s) to be to give them more choice to play in a way that will help them to destress.	Met	The player was able to choose the time limit of each round.	Test 11 (page 79)
3c) The players will be able to choose which character they would like to play as to give players a choice of what character they would like to play as well as make sure characters don't get mixed up on the battle screen.	Met	The players were indeed able to choose which character they would like to play as in the character selection.	Test 1 (page 75)
3d) The players will be able to control the movement of the characters left, right and up using the arrow keys (Player 2) and WASD keys (Player 1) as these are keys that are commonly used to move characters.	Met	The players were indeed able to control the movement in this way.	Test 2 (page 75)

3e) The players will be able to use key inputs to perform three different attacks on their opponents: normal attack, special attack and ultimate attack, as well as to recharge their energy and have the ability to guard to give a more enticing battle experience that lasts longer.	Met	The players were indeed able to use key inputs to perform these different attacks, guard and recharge their energy.	Guard: Test 2 (page 75) Normal attack: Test 4 (page 77) Special attack: Test 5 (page 77) Ultimate attack: Test 6 (page 78) Recharge energy: Test 7 (page 78)
3f) The player will be able to view a 'How to Play' screen that opens in a new window by clicking a button that is on the initial starting screen so that players can easily access the instructions.	Met	The 'How to play' button on the starting screen does open a new frame which displays the instructions simply.	https://youtu.be/T65GVzqiXZo
3g) The player will be able to view and change the settings that opens in a new window by clicking a button that is on the initial starting screen so that players can easily change their settings before starting the battle.	Met	The settings button on the starting screen does open a new frame to change the rounds and the time limit.	https://youtu.be/T65GVzqiXZo
3h)The player will be able to go back to the initial starting screen from the character selection screen and will be able to go back to the initial starting screen, character selection screen or battle after a battle has ended	Met	The player was able to go back to the initial starting screen from the character selection through the back buttons, and was able to go back to the starting page, character selection or battle (through the retry button) on the after battle page.	https://youtu.be/U-cPtOgjutw

so that players can change their characters or settings if they would like to.			
3i) The players will be able to pause the battle, and through this, will be able to retry, go back to the character selection or go back to the starting page, which gives players the choice of what they would like to do rather than just having a resume button.	Met	The players were indeed able to do this through the pause button in battle.	https://youtu.be/cPcT_u3qdJw
4a) When a character is attacked, their health will go down by the amount of damage dealt by the attack.	Met	This can be seen to be true as the health labels change when attacked.	Test 4/5/6 (pages 77-78)
4b) When a character uses a special attack or an ultimate attack, their energy will go down by a certain amount.	Met	This can be seen to be true as the energy labels change when attacking.	Test 5/6 (pages 77-78)
4c) When a player uses a key input to recharge their energy, their energy will go up by 10.	Met	The players were indeed able to recharge their energy using a key input, as evidenced in the testing section.	Test 7 (page 78)
4d) The characters must not be able to go off-screen to ensure that the battle only happens on-screen.	Partially met	The characters were able to go partially off-screen when moving left but stopped moving before going fully off-screen; and to the right border, the characters stopped moving just before the border of the screen.	Test 3 (page 76)
4e) The characters should only be able to attack within a certain distance of their opponent, which ensures that players	Met	The characters were indeed only able to perform different attacks within a certain distance of their opponent. This can be seen in the video where Orange Cat attempts to perform	https://youtu.be/efb0DtcN1as

cannot continuously keep attacking each other.		special or ultimate attacks, draining their energy, but does not drain White Cat's health as they are too far away.	
4f) The battle will end when a character is defeated (their health is equal to 0), when time runs out, or when the players manually end it through the pause button options.	Met	The battle did indeed end when a character was defeated or when the time ran out, leading to the after battle page after all rounds had been completed. The players were indeed able to manually end the battle through the pause button, the next screen depending on which button they pressed.	After battle page: https://youtu.be/QA-I2ZUkbpQ Pause button: https://youtu.be/cPcT_u3qdJw
4g) The winner of each round must be recorded in order to declare a final winner by the end of all of the rounds.	Met	The winner of each round was indeed recorded in a list as detailed in the testing section (page 84), in order to declare the final winner on the after battle screen by counting how many times they appear in the list. This list can be seen on screen when a player wins a round.	https://youtu.be/QIxJQFFi7qk
5a) The current round will be displayed.	Met	The current round was indeed displayed during battle.	https://youtu.be/QIxJQFFi7qk
5b) The time remaining will be displayed.	Met	The time remaining was indeed displayed during battle.	This can be seen in multiple videos displaying the battle, for example: https://youtu.be/QIxJQFFi7qk
5c) The amount of health each player has remaining will be displayed.	Met	The amount of health remaining was indeed displayed during battle.	Test 4/5/6 (pages 77-78)
5d) The amount of energy each player has will be displayed.	Met	The amount of energy remaining was indeed displayed during battle.	Test 7 (page 78)
5e) Which characters are playing that have been	Met	The characters chosen by the players were indeed displayed during battle.	Test 1 (page 75)

chosen by the players will be displayed.			
5f) Instructions on how to play the game will be displayed during battle and also through a button on the starting screen.	Partially met	The instructions were indeed displayed through a 'How to play' button in the starting screen, however, in battle, another similar button was used instead in the pause frame to display the instructions again, as shown in the testing section.	https://youtu.be/dO5S7j5a9_0

Maintenance and development

I shall now list the good and bad points of the completed program and note its limitations, and how these may be resolved in the future.

Good points:

- As concluded from the user questionnaire on page 85, the game can be seen as user-friendly and a way to destress
- The look of the completed game closely matches my initial design, and gained a positive response from players
- The instructions on how to play were deemed clear by the players in the questionnaire
- The battle was easy enough to play to help students relax and have fun
- All buttons and key inputs work as desired
- The program mostly functions as desired, with the exception of a few points which I will describe below

Bad points:

- The players are unable to move simultaneously, which makes the battle more difficult than intended
- There is no option to play against a computer as planned in my initial success criteria

Limitations and how they may be resolved:

The issue of the characters being unable to move simultaneously was a problem I did attempt to fix by attempting to change how Tkinter processes the events, by, instead of binding the keys directly to the moving methods, using the KeyPress and KeyRelease functions which I used for the guarding methods instead. However, this had no effect, therefore, due to time constraints, I was unable to solve this problem, as it may have required me to rewrite the methods of each character in order to let them move simultaneously.

Being able to play against a computer which would have allowed just a single player to play by themselves was again something I didn't implement due to time constraints, however this

could be considered a possible extension that could be implemented in a future version of the game.

Another possible extension to be considered is the ability to resize the game window. If the user does expand the window, the frames in the background can be seen, which was unintended, therefore this could be improved in the future.

The problem of the characters only moving just past the border of the screen or just before it is also an issue I did not resolve due to time constraints, as the overall main aim (for the characters to not move off-screen) was met. In future versions, this could be improved so that the characters remain strictly within the borders of the screen, from one edge to another.

Another extension could be the use of animations, so that it is easier for the player to understand what is happening on screen, as well as making the game more enticing. Once again, this was not implemented due to time constraints.

Bibliography

Tkinter tutorial documentation: https://tk-tutorial.readthedocs.io/_/downloads/en/latest/pdf/

Timer:
https://www.w3resource.com/python-exercises/tkinter/python-tkinter-events-and-event-handling-exercise-10.php

Display images:
https://stackoverflow.com/questions/31959379/how-to-insert-a-photo-into-a-tkinter-window-no-pil-of-pillow

Make character images move with arrow keys:
https://www.tutorialspoint.com/how-to-move-an-image-in-tkinter-canvas-with-arrow-keys

Pause and unpause timer: https://pyseek.com/2021/11/countdown-timer-in-python/

Appendix

Code:

```
from tkinter import *
from tkinter import messagebox
import time
import math

class Orange: #Create a class for the character Orange Cat
    def __init__(self, canvas, x, y, imagePath):
        global damage1 #Public attribute to be used in attack
methods
        global guarding1 #Public attribute to check if the
character is guarding
        guarding1 = False #Set to false initially as character
isn't guarding
        self.canvas = canvas
        self.image = PhotoImage(file=imagePath)
        self.imageID = self.canvas.create_image(200, 380,
image=self.image)
        self.imageWidth = self.image.width()
        self.imageHeight = self.image.height()

    def move_left(self, event):
        if self.getLeft() > 0: #Make sure left side of character
does not go past the left of the screen
            self.canvas.move(self.imageID, -10, 0) #Move the
character image left

    def move_right(self, event):
        if self.getRight() < self.canvas.winfo_width(): #Make sure
right side of character does not go past the right of the screen
            self.canvas.move(self.imageID, 10, 0) #Move the
character image right

    def getLeft(self):
        return self.canvas.coords(self.imageID)[0] #Get the
coordinates of the left side of the character image

    def getTop(self):
        return self.canvas.coords(self.imageID)[1] #Get the
coordinates of the top side of the character image

    def getRight(self):
        return self.canvas.coords(self.imageID)[0] +
self.imageWidth #Get the coordinates of the right side of the
character image
```

```
    def getBottom(self):
        return self.canvas.coords(self.imageID)[1] +
self.imageHeight #Get the coordinates of the bottom side of the
character image

    def jump(self, event):
        current_y = self.canvas.coords(self.imageID)[1] #Store the
current y coordinates of the character image
        jumpDistance = 50 #Store how many pixels for the character
to jump
        self.canvas.move(self.imageID, 0, -jumpDistance) #Make the
character move up by the value stored in jumpDistance
        self.canvas.after(200, lambda:
self.canvas.move(self.imageID, 0, jumpDistance)) #Return the
character back to its original position after 200ms

    def guard(self, event):
        global guarding1 #Public attribute to check if the
character is guarding
        guarding1 = True #Make the character guard

    def unguard(self, event):
        global guarding1
        guarding1 = False #Stop the character from guarding

    def calcEnergy(self):
        if self.energy1 != 500:
            self.energy1 += 10
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold')) #Display new value of self.energy1 on screen
            lEnergy.place(x=200, y=95)
        else:
            self.energy1 == 500 #Make sure value stored in
self.energy1 doesn't go above 500

    def normalAtk(self):
        damage1 = 20
        if selection2 == 1:
            distance = math.sqrt((self.orange.getLeft() -
self.orange2.getRight()) ** 2 + (self.orange.getTop() -
self.orange2.getTop()) ** 2) #Calculate distance between player 1
and player 2
            if distance <= 425: #Check if distance is close enough
to attack
                Orange2.takeDamage(self, damage1) #Opponent takes
damage if so
```

```
        elif selection2 == 2:
            distance = math.sqrt((self.orange.getLeft() -
self.white2.getRight()) ** 2 + (self.orange.getTop() -
self.white2.getTop()) ** 2)
            if distance <= 425:
                White2.takeDamage(self, damage1)
        elif selection2 == 3:
            distance = math.sqrt((self.orange.getLeft() -
self.black2.getRight()) ** 2 + (self.orange.getTop() -
self.black2.getTop()) ** 2)
            if distance <= 425:
                Black2.takeDamage(self, damage1)

    def specialAtk(self):
        if self.energy1 >= 50: #Check if energy is sufficient to
be able to perform attack
            self.energy1 -= 50 #Deplete energy regardless if close
enough to attack
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold')) #Update new value of self.energy1 on screen
            lEnergy.place(x=200, y=95)
            damage1 = 70
            if selection2 == 1:
                distance = math.sqrt((self.orange.getLeft() -
self.orange2.getRight()) ** 2 + (self.orange.getTop() -
self.orange2.getTop()) ** 2)
                if distance <= 300:
                    Orange2.takeDamage(self, damage1)
            elif selection2 == 2:
                distance = math.sqrt((self.orange.getLeft() -
self.white2.getRight()) ** 2 + (self.orange.getTop() -
self.white2.getTop()) ** 2)
                if distance <= 300:
                    White2.takeDamage(self, damage1)
            elif selection2 == 3:
                distance = math.sqrt((self.orange.getLeft() -
self.black2.getRight()) ** 2 + (self.orange.getTop() -
self.black2.getTop()) ** 2)
                if distance <= 300:
                    Black2.takeDamage(self, damage1)

    def ultAtk(self):
        if self.energy1 >= 100:
            self.energy1 -= 100
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
```

```
            lEnergy.place(x=200, y=95)
            damage1 = 135
            if selection2 == 1:
                distance = math.sqrt((self.orange.getLeft() -
self.orange2.getRight()) ** 2 + (self.orange.getTop() -
self.orange2.getTop()) ** 2)
                if distance <= 215:
                    Orange2.takeDamage(self, damage1)
            elif selection2 == 2:
                distance = math.sqrt((self.orange.getLeft() -
self.white2.getRight()) ** 2 + (self.orange.getTop() -
self.white2.getTop()) ** 2)
                if distance <= 215:
                    White2.takeDamage(self, damage1)
            elif selection2 == 3:
                distance = math.sqrt((self.orange.getLeft() -
self.black2.getRight()) ** 2 + (self.orange.getTop() -
self.black2.getTop()) ** 2)
                if distance <= 215:
                    Black2.takeDamage(self, damage1)

    def takeDamage(self, damage2):
        if guarding1 == False: #Check if character isn't guarding
            if self.health1 >= damage2: #Check if character has
enough health to take the full damage
                self.health1 -= damage2
                lHealth = Label(self.canvas, text = ('Health:',
self.health1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold')) #Update health on screen
                lHealth.place(x=200, y=42)
            else:
                self.health1 = 0 #Make sure health doesn't go
below 0
                lHealth = Label(self.canvas, text = ('Health:',
self.health1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold')) #Update health on screen
                lHealth.place(x=200, y=42)
                self.winners.append("Player 2") #Add Player 2 to
the list winners as Player 1 has lost (health=0)
                lose = Label(self.canvas, text=self.winners,
font=('Modern 12'), bg='#FF6D9E', fg='white') #Display the list on
screen to show who won the last round
                lose.place(x=320, y=180)
                self.start_new_round()

class Orange2:
    def __init__(self, canvas, x, y, imagePath):
        global damage2
```

```
        global guarding2
        guarding2 = False
        self.canvas = canvas
        self.image = PhotoImage(file=imagePath)
        self.imageID = self.canvas.create_image(675, 380,
image=self.image)
        self.imageWidth = self.image.width()
        self.imageHeight = self.image.height()

    def move_left(self, event):
        if self.getLeft() > 0:
            self.canvas.move(self.imageID, -10, 0)

    def move_right(self, event):
        if self.getRight() < self.canvas.winfo_width():
            self.canvas.move(self.imageID, 10, 0)

    def getLeft(self):
        return self.canvas.coords(self.imageID)[0]

    def getTop(self):
        return self.canvas.coords(self.imageID)[1]

    def getRight(self):
        return self.canvas.coords(self.imageID)[0] +
self.imageWidth

    def getBottom(self):
        return self.canvas.coords(self.imageID)[1] +
self.imageHeight

    def jump(self, event):
        current_y = self.canvas.coords(self.imageID)[1]
        jumpDistance = 50
        self.canvas.move(self.imageID, 0, -jumpDistance)
        self.canvas.after(500, lambda:
self.canvas.move(self.imageID, 0, jumpDistance))

    def guard(self, event):
        global guarding2
        guarding2 = True

    def unguard(self, event):
        global guarding2
        guarding2 = False

    def calcEnergy(self):
        if self.energy2 != 500:
```

```
            self.energy2 += 10
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=550, y=95)
            top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top2.place(x=700, y=35)
            pOrange = Label(self.canvas, text = "Orange Cat",
bg='#FF746C', fg='white', font=('Modern 20 bold'))
            pOrange.place(x=712, y=95)
        else:
            self.energy2 == 500

    def normalAtk(self):
        damage2 = 20
        if selection1 == 1:
            distance = math.sqrt((self.orange.getLeft() -
self.orange2.getRight()) ** 2 + (self.orange.getTop() -
self.orange2.getTop()) ** 2)
            if distance <= 425:
                Orange.takeDamage(self, damage2)
        elif selection1 == 2:
            distance = math.sqrt((self.white.getLeft() -
self.orange2.getRight()) ** 2 + (self.white.getTop() -
self.orange2.getTop()) ** 2)
            if distance <= 425:
                White.takeDamage(self, damage2)
        elif selection1 == 3:
            distance = math.sqrt((self.black.getLeft() -
self.orange2.getRight()) ** 2 + (self.black.getTop() -
self.orange2.getTop()) ** 2)
            if distance <= 425:
                Black.takeDamage(self, damage2)

    def specialAtk(self):
        if self.energy2 >= 50:
            self.energy2 -= 50
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=550, y=95)
            top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top2.place(x=700, y=35)
            pOrange = Label(self.canvas, text = "Orange Cat",
bg='#FF746C', fg='white', font=('Modern 20 bold'))
            pOrange.place(x=712, y=95)
```

```
            damage2 = 70
            if selection1 == 1:
                distance = math.sqrt((self.orange.getLeft() -
self.orange2.getRight()) ** 2 + (self.orange.getTop() -
self.orange2.getTop()) ** 2)
                if distance <= 300:
                    Orange.takeDamage(self, damage2)
            elif selection1 == 2:
                distance = math.sqrt((self.white.getLeft() -
self.orange2.getRight()) ** 2 + (self.white.getTop() -
self.orange2.getTop()) ** 2)
                if distance <= 300:
                    White.takeDamage(self, damage2)
            elif selection1 == 3:
                distance = math.sqrt((self.black.getLeft() -
self.orange2.getRight()) ** 2 + (self.black.getTop() -
self.orange2.getTop()) ** 2)
                if distance <= 300:
                    Black.takeDamage(self, damage2)

    def ultAtk(self):
        if self.energy2 >= 100:
            self.energy2 -= 100
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=550, y=95)
            top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top2.place(x=700, y=35)
            pOrange = Label(self.canvas, text = "Orange Cat",
bg='#FF746C', fg='white', font=('Modern 20 bold'))
            pOrange.place(x=712, y=95)
            damage2 = 135
            if selection1 == 1:
                distance = math.sqrt((self.orange.getLeft() -
self.orange2.getRight()) ** 2 + (self.orange.getTop() -
self.orange2.getTop()) ** 2)
                if distance <= 215:
                    Orange.takeDamage(self, damage2)
            elif selection1 == 2:
                distance = math.sqrt((self.white.getLeft() -
self.orange2.getRight()) ** 2 + (self.white.getTop() -
self.orange2.getTop()) ** 2)
                if distance <= 215:
                    White.takeDamage(self, damage2)
            elif selection1 == 3:
```

```
                distance = math.sqrt((self.black.getLeft() -
self.orange2.getRight()) ** 2 + (self.black.getTop() -
self.orange2.getTop()) ** 2)
                if distance <= 215:
                    Black.takeDamage(self, damage2)

    def takeDamage(self, damage1):
        if guarding2 == False:
            if self.health2 >= damage1:
                self.health2 -= damage1
                lHealth = Label(self.canvas, text = ('Health:',
self.health2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
                lHealth.place(x=540, y=42)
                top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
                top2.place(x=700, y=35)
                pOrange = Label(self.canvas, text = "Orange Cat",
bg='#FF746C', fg='white', font=('Modern 20 bold'))
                pOrange.place(x=712, y=95)
            else:
                self.health2 = 0
                lHealth = Label(self.canvas, text = ('Health:',
self.health2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
                lHealth.place(x=540, y=42)
                top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
                top2.place(x=700, y=35)
                pOrange = Label(self.canvas, text = "Orange Cat",
bg='#FF746C', fg='white', font=('Modern 20 bold'))
                pOrange.place(x=712, y=95)
                self.winners.append("Player 1")
                lose = Label(self.canvas, text=self.winners,
font=('Modern 12'), bg='#FF6D9E', fg='white')
                lose.place(x=320, y=180)
                self.start_new_round()

class White:
    def __init__(self, canvas, x, y, imagePath):
        global damage1
        global guarding1
        guarding1 = False
        self.canvas = canvas
        self.image = PhotoImage(file=imagePath)
        self.imageID = self.canvas.create_image(200, 380,
image=self.image)
        self.imageWidth = self.image.width()
```

```
        self.imageHeight = self.image.height()

    def move_left(self, event):
        if self.getLeft() > 0:
            self.canvas.move(self.imageID, -10, 0)

    def move_right(self, event):
        if self.getRight() < self.canvas.winfo_width():
            self.canvas.move(self.imageID, 10, 0)

    def getLeft(self):
        return self.canvas.coords(self.imageID)[0]

    def getTop(self):
        return self.canvas.coords(self.imageID)[1]

    def getRight(self):
        return self.canvas.coords(self.imageID)[0] +
self.imageWidth

    def getBottom(self):
        return self.canvas.coords(self.imageID)[1] +
self.imageHeight

    def jump(self, event):
        current_y = self.canvas.coords(self.imageID)[1]
        jumpDistance = 50
        self.canvas.move(self.imageID, 0, -jumpDistance)
        self.canvas.after(500, lambda:
self.canvas.move(self.imageID, 0, jumpDistance))

    def guard(self, event):
        global guarding1
        guarding1 = True

    def unguard(self, event):
        global guarding1
        guarding1 = False

    def calcEnergy(self):
        if self.energy1 != 500:
            self.energy1 += 10
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=200, y=95)
        else:
            self.energy1 == 500
```

```
    def normalAtk(self):
        damage1 = 35
        if selection2 == 1:
            distance = math.sqrt((self.white.getLeft() -
self.orange2.getRight()) ** 2 + (self.white.getTop() -
self.orange2.getTop()) ** 2)
            if distance <= 400:
                Orange2.takeDamage(self, damage1)
        elif selection2 == 2:
            distance = math.sqrt((self.white.getLeft() -
self.white2.getRight()) ** 2 + (self.white.getTop() -
self.white2.getTop()) ** 2)
            if distance <= 400:
                White2.takeDamage(self, damage1)
        elif selection2 == 3:
            distance = math.sqrt((self.white.getLeft() -
self.black2.getRight()) ** 2 + (self.white.getTop() -
self.black2.getTop()) ** 2)
            if distance <= 400:
                Black2.takeDamage(self, damage1)

    def specialAtk(self):
        if self.energy1 >= 50:
            self.energy1 -= 50
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=200, y=95)
            damage1 = 60
            if selection2 == 1:
                distance = math.sqrt((self.white.getLeft() -
self.orange2.getRight()) ** 2 + (self.white.getTop() -
self.orange2.getTop()) ** 2)
                if distance <= 310:
                    Orange2.takeDamage(self, damage1)
            elif selection2 == 2:
                distance = math.sqrt((self.white.getLeft() -
self.white2.getRight()) ** 2 + (self.white.getTop() -
self.white2.getTop()) ** 2)
                if distance <= 310:
                    White2.takeDamage(self, damage1)
            elif selection2 == 3:
                distance = math.sqrt((self.white.getLeft() -
self.black2.getRight()) ** 2 + (self.white.getTop() -
self.black2.getTop()) ** 2)
                if distance <= 310:
                    Black2.takeDamage(self, damage1)
```

```
    def ultAtk(self):
        if self.energy1 >= 100:
            self.energy1 -= 100
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=200, y=95)
            damage1 = 130
            if selection2 == 1:
                distance = math.sqrt((self.white.getLeft() -
self.orange2.getRight()) ** 2 + (self.white.getTop() -
self.orange2.getTop()) ** 2)
                if distance <= 230:
                    Orange2.takeDamage(self, damage1)
            elif selection2 == 2:
                distance = math.sqrt((self.white.getLeft() -
self.white2.getRight()) ** 2 + (self.white.getTop() -
self.white2.getTop()) ** 2)
                if distance <= 230:
                    White2.takeDamage(self, damage1)
            elif selection2 == 3:
                distance = math.sqrt((self.white.getLeft() -
self.black2.getRight()) ** 2 + (self.white.getTop() -
self.black2.getTop()) ** 2)
                if distance <= 230:
                    Black2.takeDamage(self, damage1)

    def takeDamage(self, damage2):
        if guarding1 == False:
            if self.health1 >= damage2:
                self.health1 -= damage2
                lHealth = Label(self.canvas, text = ('Health:',
self.health1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
                lHealth.place(x=200, y=42)
            else:
                self.health1 = 0
                lHealth = Label(self.canvas, text = ('Health:',
self.health1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
                lHealth.place(x=200, y=42)
                self.winners.append("Player 2")
                lose = Label(self.canvas, text=self.winners,
font=('Modern 12'), bg='#FF6D9E', fg='white')
                lose.place(x=320, y=180)
                self.start_new_round()
```

```
class White2:
    def __init__(self, canvas, x, y, imagePath):
        global damage2
        global guarding2
        guarding2 = False
        self.canvas = canvas
        self.image = PhotoImage(file=imagePath)
        self.imageID = self.canvas.create_image(675, 380,
image=self.image)
        self.imageWidth = self.image.width()
        self.imageHeight = self.image.height()

    def move_left(self, event):
        if self.getLeft() > 0:
            self.canvas.move(self.imageID, -10, 0)

    def move_right(self, event):
        if self.getRight() < self.canvas.winfo_width():
            self.canvas.move(self.imageID, 10, 0)

    def getLeft(self):
        return self.canvas.coords(self.imageID)[0]

    def getTop(self):
        return self.canvas.coords(self.imageID)[1]

    def getRight(self):
        return self.canvas.coords(self.imageID)[0] +
self.imageWidth

    def getBottom(self):
        return self.canvas.coords(self.imageID)[1] +
self.imageHeight

    def jump(self, event):
        current_y = self.canvas.coords(self.imageID)[1]
        jumpDistance = 50
        self.canvas.move(self.imageID, 0, -jumpDistance)
        self.canvas.after(500, lambda:
self.canvas.move(self.imageID, 0, jumpDistance))

    def guard(self, event):
        global guarding2
        guarding2 = True

    def unguard(self, event):
        global guarding2
        guarding2 = False
```

```
    def calcEnergy(self):
        if self.energy2 != 500:
            self.energy2 += 10
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=550, y=95)
            top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top2.place(x=700, y=35)
            pWhite = Label(self.canvas, text = "White Cat",
bg='#F7E0FE', fg='white', font=('Modern 20 bold'))
            pWhite.place(x=729, y=95)
        else:
            self.energy2 == 500

    def normalAtk(self):
        damage2 = 35
        if selection1 == 1:
            distance = math.sqrt((self.orange.getLeft() -
self.white2.getRight()) ** 2 + (self.orange.getTop() -
self.white2.getTop()) ** 2)
            if distance <= 400:
                Orange.takeDamage(self, damage2)
        elif selection1 == 2:
            distance = math.sqrt((self.white.getLeft() -
self.white2.getRight()) ** 2 + (self.white.getTop() -
self.white2.getTop()) ** 2)
            if distance <= 400:
                White.takeDamage(self, damage2)
        elif selection1 == 3:
            distance = math.sqrt((self.black.getLeft() -
self.white2.getRight()) ** 2 + (self.black.getTop() -
self.white2.getTop()) ** 2)
            if distance <= 400:
                Black.takeDamage(self, damage2)

    def specialAtk(self):
        if self.energy2 >= 50:
            self.energy2 -= 50
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=550, y=95)
            top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top2.place(x=700, y=35)
```

```
            pWhite = Label(self.canvas, text = "White Cat",
bg='#F7E0FE', fg='white', font=('Modern 20 bold'))
            pWhite.place(x=729, y=95)
            damage2 = 60
            if selection1 == 1:
                distance = math.sqrt((self.orange.getLeft() -
self.white2.getRight()) ** 2 + (self.orange.getTop() -
self.white2.getTop()) ** 2)
                if distance <= 310:
                    Orange.takeDamage(self, damage2)
            elif selection1 == 2:
                distance = math.sqrt((self.white.getLeft() -
self.white2.getRight()) ** 2 + (self.white.getTop() -
self.white2.getTop()) ** 2)
                if distance <= 310:
                    White.takeDamage(self, damage2)
            elif selection1 == 3:
                distance = math.sqrt((self.black.getLeft() -
self.white2.getRight()) ** 2 + (self.black.getTop() -
self.white2.getTop()) ** 2)
                if distance <= 310:
                    Black.takeDamage(self, damage2)

    def ultAtk(self):
        if self.energy2 >= 100:
            self.energy2 -= 100
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=550, y=95)
            top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top2.place(x=700, y=35)
            pWhite = Label(self.canvas, text = "White Cat",
bg='#F7E0FE', fg='white', font=('Modern 20 bold'))
            pWhite.place(x=729, y=95)
            damage2 = 130
            if selection1 == 1:
                distance = math.sqrt((self.orange.getLeft() -
self.white2.getRight()) ** 2 + (self.orange.getTop() -
self.white2.getTop()) ** 2)
                if distance <= 230:
                    Orange.takeDamage(self, damage2)
            elif selection1 == 2:
                distance = math.sqrt((self.white.getLeft() -
self.white2.getRight()) ** 2 + (self.white.getTop() -
self.white2.getTop()) ** 2)
                if distance <= 230:
```

```
                    White.takeDamage(self, damage2)
            elif selection1 == 3:
                distance = math.sqrt((self.black.getLeft() -
self.white2.getRight()) ** 2 + (self.black.getTop() -
self.white2.getTop()) ** 2)
                if distance <= 230:
                    Black.takeDamage(self, damage2)

    def takeDamage(self, damage1):
        if guarding2 == False:
            if self.health2 >= damage1:
                self.health2 -= damage1
                lHealth = Label(self.canvas, text = ('Health:',
self.health2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
                lHealth.place(x=540, y=42)
                top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
                top2.place(x=700, y=35)
                pWhite = Label(self.canvas, text = "White Cat",
bg='#F7E0FE', fg='white', font=('Modern 20 bold'))
                pWhite.place(x=729, y=95)
            else:
                self.health2 = 0
                lHealth = Label(self.canvas, text = ('Health:',
self.health2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
                lHealth.place(x=540, y=42)
                top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
                top2.place(x=700, y=35)
                pWhite = Label(self.canvas, text = "White Cat",
bg='#F7E0FE', fg='white', font=('Modern 20 bold'))
                pWhite.place(x=729, y=95)
                self.winners.append("Player 1")
                lose = Label(self.canvas, text=self.winners,
font=('Modern 12'), bg='#FF6D9E', fg='white')
                lose.place(x=320, y=180)
                self.start_new_round()

class Black:
    def __init__(self, canvas, x, y, imagePath):
        global damage1
        global guarding1
        guarding1 = False
        self.canvas = canvas
        self.image = PhotoImage(file=imagePath)
```

```
        self.imageID = self.canvas.create_image(200, 380,
image=self.image)
        self.imageWidth = self.image.width()
        self.imageHeight = self.image.height()

    def move_left(self, event):
        if self.getLeft() > 0:
            self.canvas.move(self.imageID, -10, 0)

    def move_right(self, event):
        if self.getRight() < self.canvas.winfo_width():
            self.canvas.move(self.imageID, 10, 0)

    def getLeft(self):
        return self.canvas.coords(self.imageID)[0]

    def getTop(self):
        return self.canvas.coords(self.imageID)[1]

    def getRight(self):
        return self.canvas.coords(self.imageID)[0] +
self.imageWidth

    def getBottom(self):
        return self.canvas.coords(self.imageID)[1] +
self.imageHeight

    def jump(self, event):
        current_y = self.canvas.coords(self.imageID)[1]
        jumpDistance = 50
        self.canvas.move(self.imageID, 0, -jumpDistance)
        self.canvas.after(500, lambda:
self.canvas.move(self.imageID, 0, jumpDistance))

    def guard(self, event):
        global guarding1
        guarding1 = True

    def unguard(self, event):
        global guarding1
        guarding1 = False

    def calcEnergy(self):
        if self.energy1 != 500:
            self.energy1 += 10
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
```

```
            lEnergy.place(x=200, y=95)
        else:
            self.energy1 == 500

    def normalAtk(self):
        damage1 = 25
        if selection2 == 1:
            distance = math.sqrt((self.black.getLeft() -
self.orange2.getRight()) ** 2 + (self.black.getTop() -
self.orange2.getTop()) ** 2)
            if distance <= 410:
                Orange2.takeDamage(self, damage1)
        elif selection2 == 2:
            distance = math.sqrt((self.black.getLeft() -
self.white2.getRight()) ** 2 + (self.black.getTop() -
self.white2.getTop()) ** 2)
            if distance <= 410:
                White2.takeDamage(self, damage1)
        elif selection2 == 3:
            distance = math.sqrt((self.black.getLeft() -
self.black2.getRight()) ** 2 + (self.black.getTop() -
self.black2.getTop()) ** 2)
            if distance <= 410:
                Black2.takeDamage(self, damage1)

    def specialAtk(self):
        if self.energy1 >= 50:
            self.energy1 -= 50
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=200, y=95)
            damage1 = 50
            if selection2 == 1:
                distance = math.sqrt((self.black.getLeft() -
self.orange2.getRight()) ** 2 + (self.black.getTop() -
self.orange2.getTop()) ** 2)
                if distance <= 330:
                    Orange2.takeDamage(self, damage1)
            elif selection2 == 2:
                distance = math.sqrt((self.black.getLeft() -
self.white2.getRight()) ** 2 + (self.black.getTop() -
self.white2.getTop()) ** 2)
                if distance <= 330:
                    White2.takeDamage(self, damage1)
            elif selection2 == 3:
```

```
                distance = math.sqrt((self.black.getLeft() -
self.black2.getRight()) ** 2 + (self.black.getTop() -
self.black2.getTop()) ** 2)
                if distance <= 330:
                    Black2.takeDamage(self, damage1)

    def ultAtk(self):
        if self.energy1 >= 100:
            self.energy1 -= 100
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=200, y=95)
            damage1 = 150
            if selection2 == 1:
                distance = math.sqrt((self.black.getLeft() -
self.orange2.getRight()) ** 2 + (self.black.getTop() -
self.orange2.getTop()) ** 2)
                if distance <= 200:
                    Orange2.takeDamage(self, damage1)
            elif selection2 == 2:
                distance = math.sqrt((self.black.getLeft() -
self.white2.getRight()) ** 2 + (self.black.getTop() -
self.white2.getTop()) ** 2)
                if distance <= 200:
                    White2.takeDamage(self, damage1)
            elif selection2 == 3:
                distance = math.sqrt((self.black.getLeft() -
self.black2.getRight()) ** 2 + (self.black.getTop() -
self.black2.getTop()) ** 2)
                if distance <= 200:
                    Black2.takeDamage(self, damage1)

    def takeDamage(self, damage2):
        if guarding1 == False:
            if self.health1 >= damage2:
                self.health1 -= damage2
                lHealth = Label(self.canvas, text = ('Health:',
self.health1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
                lHealth.place(x=200, y=42)
            else:
                self.health1 = 0
                lHealth = Label(self.canvas, text = ('Health:',
self.health1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
                lHealth.place(x=200, y=42)
                self.winners.append("Player 2")
```

```
                lose = Label(self.canvas, text=self.winners,
font=('Modern 12'), bg='#FF6D9E', fg='white')
                lose.place(x=320, y=180)
                self.start_new_round()

class Black2:
    def __init__(self, canvas, x, y, imagePath):
        global damage2
        global guarding2
        guarding2 = False
        self.canvas = canvas
        self.image = PhotoImage(file=imagePath)
        self.imageID = self.canvas.create_image(675, 380,
image=self.image)
        self.imageWidth = self.image.width()
        self.imageHeight = self.image.height()

    def move_left(self, event):
        if self.getLeft() > 0:
            self.canvas.move(self.imageID, -10, 0)

    def move_right(self, event):
        if self.getRight() < self.canvas.winfo_width():
            self.canvas.move(self.imageID, 10, 0)

    def getLeft(self):
        return self.canvas.coords(self.imageID)[0]

    def getTop(self):
        return self.canvas.coords(self.imageID)[1]

    def getRight(self):
        return self.canvas.coords(self.imageID)[0] +
self.imageWidth

    def getBottom(self):
        return self.canvas.coords(self.imageID)[1] +
self.imageHeight

    def jump(self, event):
        current_y = self.canvas.coords(self.imageID)[1]
        jumpDistance = 50
        self.canvas.move(self.imageID, 0, -jumpDistance)
        self.canvas.after(500, lambda:
self.canvas.move(self.imageID, 0, jumpDistance))

    def guard(self, event):
        global guarding2
```

```
        guarding2 = True

    def unguard(self, event):
        global guarding2
        guarding2 = False

    def calcEnergy(self):
        if self.energy2 != 500:
            self.energy2 += 10
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=550, y=95)
            top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top2.place(x=700, y=35)
            pBlack = Label(self.canvas, text = "Black Cat",
bg='#0D111D', fg='white', font=('Modern 20 bold'))
            pBlack.place(x=729, y=95)
        else:
            self.energy2 == 500

    def normalAtk(self):
        damage2 = 25
        if selection1 == 1:
            distance = math.sqrt((self.orange.getLeft() -
self.black2.getRight()) ** 2 + (self.orange.getTop() -
self.black2.getTop()) ** 2)
            if distance <= 400:
                Orange.takeDamage(self, damage2)
        elif selection1 == 2:
            distance = math.sqrt((self.white.getLeft() -
self.black2.getRight()) ** 2 + (self.white.getTop() -
self.black2.getTop()) ** 2)
            if distance <= 400:
                White.takeDamage(self, damage2)
        elif selection1 == 3:
            distance = math.sqrt((self.black.getLeft() -
self.black2.getRight()) ** 2 + (self.black.getTop() -
self.black2.getTop()) ** 2)
            if distance <= 400:
                Black.takeDamage(self, damage2)

    def specialAtk(self):
        if self.energy2 >= 50:
            self.energy2 -= 50
```

```
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=550, y=95)
            top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top2.place(x=700, y=35)
            pBlack = Label(self.canvas, text = "Black Cat",
bg='#0D111D', fg='white', font=('Modern 20 bold'))
            pBlack.place(x=729, y=95)
            damage2 = 50
            if selection1 == 1:
                distance = math.sqrt((self.orange.getLeft() -
self.black2.getRight()) ** 2 + (self.orange.getTop() -
self.black2.getTop()) ** 2)
                if distance <= 300:
                    Orange.takeDamage(self, damage2)
            elif selection1 == 2:
                distance = math.sqrt((self.white.getLeft() -
self.black2.getRight()) ** 2 + (self.white.getTop() -
self.black2.getTop()) ** 2)
                if distance <= 300:
                    White.takeDamage(self, damage2)
            elif selection1 == 3:
                distance = math.sqrt((self.black.getLeft() -
self.black2.getRight()) ** 2 + (self.black.getTop() -
self.black2.getTop()) ** 2)
                if distance <= 300:
                    Black.takeDamage(self, damage2)

    def ultAtk(self):
        if self.energy2 >= 100:
            self.energy2 -= 100
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=550, y=95)
            top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top2.place(x=700, y=35)
            pBlack = Label(self.canvas, text = "Black Cat",
bg='#0D111D', fg='white', font=('Modern 20 bold'))
            pBlack.place(x=729, y=95)
            damage2 = 150
            if selection1 == 1:
                distance = math.sqrt((self.orange.getLeft() -
self.black2.getRight()) ** 2 + (self.orange.getTop() -
self.black2.getTop()) ** 2)
```

```
                if distance <= 200:
                    Orange.takeDamage(self, damage2)
            elif selection1 == 2:
                distance = math.sqrt((self.white.getLeft() -
self.black2.getRight()) ** 2 + (self.white.getTop() -
self.black2.getTop()) ** 2)
                if distance <= 200:
                    White.takeDamage(self, damage2)
            elif selection1 == 3:
                distance = math.sqrt((self.black.getLeft() -
self.black2.getRight()) ** 2 + (self.black.getTop() -
self.black2.getTop()) ** 2)
                if distance <= 200:
                    Black.takeDamage(self, damage2)

    def takeDamage(self, damage1):
        if guarding2 == False:
            if self.health2 >= damage1:
                self.health2 -= damage1
                lHealth = Label(self.canvas, text = ('Health:',
self.health2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
                lHealth.place(x=540, y=42)
                top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
                top2.place(x=700, y=35)
                pBlack = Label(self.canvas, text = "Black Cat",
bg='#0D111D', fg='white', font=('Modern 20 bold'))
                pBlack.place(x=729, y=95)
            else:
                self.health2 = 0
                lHealth = Label(self.canvas, text = ('Health:',
self.health2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
                lHealth.place(x=540, y=42)
                top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
                top2.place(x=700, y=35)
                pBlack = Label(self.canvas, text = "Black Cat",
bg='#0D111D', fg='white', font=('Modern 20 bold'))
                pBlack.place(x=729, y=95)
                self.winners.append("Player 1")
                lose = Label(self.canvas, text=self.winners,
font=('Modern 12'), bg='#FF6D9E', fg='white')
                lose.place(x=320, y=180)
                self.start_new_round()
```

```
class Game(Frame):
    def __init__(self, master):
        super().__init__(master)
        self.master = master
        self.master.title("Cat Fight")
        self.master.geometry("863x600")

        self.bg = PhotoImage(file="starting.png")  #Keep a
reference to the PhotoImage object
        label1 = Label(self.master, image=self.bg) #Display the
image as the background of the window
        label1.place(x=0, y=0)

        global timeLimit #Public attributes to be used in other
methods
        global rounds
        timeLimit = 90 #Make 90 the default value
        rounds = 3 #Make 3 the default value

        global selection1
        global selection2
        selection1 = 0 #Make 0 the default value
        selection2 = 0

        self.winners = [] #List to store the winner of each round
        self.actualWinner = None #Attribute to store the end
winner

        settings = Button(self.master, text='Settings',
fg='#DA6BFF', bg='#6BFFA9', bd=1, font=('Modern 17 bold'),
                          command=self.options, height=2, width=8)
        settings.place(x=25, y=25)

        instructions = Button(self.master, text='How to play',
fg='#DA6BFF', bg='#6BFFA9', bd=1, font=('Modern 17 bold'),
                              command=self.howToPlay, height=1,
width=15)
        instructions.place(x=140, y=40)

        start = Button(self.master, text='Start', fg='#FF746C',
bg='#6BFFA9', bd=5, font=('Modern 35 bold'),
                       command=self.charaSelect1, height=1,
width=8)
        start.place(x=350, y=470)

    def howToPlay(self):
        inst = Frame(root, bg='#6D97FF')
        inst.pack(fill="both", expand="yes")
```

```
        top = Label(inst, text = "How to play", bg='#FF6D9E',
fg='white', font=('Modern 30 bold'))
        top.pack(pady=20)

        left = Label(inst, text="Player 1", bg='#FF6D9E',
fg='white', font=('Modern 25 bold'))
        left.place(x=100, y=105)

        right = Label(inst, text="Player 2", bg='#FF6D9E',
fg='white', font=('Modern 25 bold'))
        right.place(x=450, y=105)

        p1Move = Label(inst, text="Move", bg='#FF6D9E',
fg='white', font=('Modern 20'))
        p1Move.place(x=100, y=180)

        p2Move = Label(inst, text="Move", bg='#FF6D9E',
fg='white', font=('Modern 20'))
        p2Move.place(x=450, y=180)

        p1Guard = Label(inst, text="Guard", bg='#FF6D9E',
fg='white', font=('Modern 12'))
        p1Guard.place(x=330, y=170)

        p2Guard = Label(inst, text="Guard", bg='#FF6D9E',
fg='white', font=('Modern 12'))
        p2Guard.place(x=680, y=170)

        p1Normal = Label(inst, text="Normal attack", bg='#FF6D9E',
fg='white', font=('Modern 20'))
        p1Normal.place(x=100, y=270)

        p2Normal = Label(inst, text="Normal attack", bg='#FF6D9E',
fg='white', font=('Modern 20'))
        p2Normal.place(x=450, y=270)

        p1Special = Label(inst, text="Special attack",
bg='#FF6D9E', fg='white', font=('Modern 20'))
        p1Special.place(x=100, y=350)

        p2Special = Label(inst, text="Special attack",
bg='#FF6D9E', fg='white', font=('Modern 20'))
        p2Special.place(x=450, y=350)

        p1Ult = Label(inst, text="Ultimate attack", bg='#FF6D9E',
fg='white', font=('Modern 20'))
        p1Ult.place(x=100, y=430)
```

```
        p2Ult = Label(inst, text="Ultimate attack", bg='#FF6D9E',
fg='white', font=('Modern 20'))
        p2Ult.place(x=450, y=430)

        p1Charge = Label(inst, text="Charge energy", bg='#FF6D9E',
fg='white', font=('Modern 20'))
        p1Charge.place(x=100, y=510)

        p2Charge = Label(inst, text="Charge energy", bg='#FF6D9E',
fg='white', font=('Modern 20'))
        p2Charge.place(x=450, y=510)

        close = Button(inst, text='X', fg='white', bg='#FF746C',
bd=1, font=('Modern 20 bold'), #Close the frame when the button is
clicked
                       command = inst.pack_forget, height=1,
width=4)
        close.place(x=750, y=20)

        wasd = PhotoImage(file="wasd.png")
        wasd.image = wasd
        wasd_label = Label(inst, image=wasd, bd=0)
        wasd_label.place(x=200, y=160)

        arrows = PhotoImage(file="arrows.png")
        arrows.image = arrows
        arrows_label = Label(inst, image=arrows, bd=0)
        arrows_label.place(x=550, y=160)

        s = PhotoImage(file="s.png")
        s.image = s
        s_label = Label(inst, image=s, bg='#6D97FF', bd=0)
        s_label.place(x=335, y=205)

        down = PhotoImage(file="down.png")
        down.image = down
        down_label = Label(inst, image=down, bg='#6D97FF', bd=0)
        down_label.place(x=685, y=205)

        e = PhotoImage(file="e.png")
        e.image = e
        e_label = Label(inst, image=e, bd=0)
        e_label.place(x=265, y=240)

        b = PhotoImage(file="b.png")
        b.image = b
        b_label = Label(inst, image=b, bd=0)
```

```
        b_label.place(x=615, y=240)

        r = PhotoImage(file="r.png")
        r.image = r
        r_label = Label(inst, image=r, bd=0)
        r_label.place(x=265, y=320)

        n = PhotoImage(file="n.png")
        n.image = n
        n_label = Label(inst, image=n, bd=0)
        n_label.place(x=615, y=320)

        t = PhotoImage(file="t.png")
        t.image = t
        t_label = Label(inst, image=t, bd=0)
        t_label.place(x=265, y=400)

        m = PhotoImage(file="m.png")
        m.image = m
        m_label = Label(inst, image=m, bd=0)
        m_label.place(x=615, y=400)

        q = PhotoImage(file="q.png")
        q.image = q
        q_label = Label(inst, image=q, bd=0)
        q_label.place(x=265, y=480)

        l = PhotoImage(file="l.png")
        l.image = l
        l_label = Label(inst, image=l, bd=0)
        l_label.place(x=615, y=480)

    def options(self):
        sett = Frame(root, bg='#6D97FF')
        sett.pack(fill="both", expand="yes")
        top = Label(sett, text = "Settings", bg='#FF6D9E',
fg='white', font=('Modern 30 bold'))
        top.pack(pady=20)

        roundsTitle = Label(sett, text="Rounds", bg='#FF6D9E',
fg='white', font=('Modern 25 bold'))
        roundsTitle.pack(pady=45)
        rounds1 = Button(sett, text='1', fg='white', bg='#FF6D9E',
bd=1, font=('Modern 15 bold'),
                         command = self.oneRound, height=2, width=8)
        rounds1.place(x=170,y=220)
        rounds3 = Button(sett, text='3', fg='white', bg='#FF6D9E',
bd=1, font=('Modern 15 bold'),
```

```
                        command = self.threeRound, height=2,
width=8)
        rounds3.place(x=390, y=220)
        rounds5 = Button(sett, text='5', fg='white', bg='#FF6D9E',
bd=1, font=('Modern 15 bold'),
                        command = self.fiveRound, height=2, width=8)
        rounds5.place(x=600,y=220)

        timeLimit = Label(sett, text="Time limit", bg='#FF6D9E',
fg='white', font=('Modern 25 bold'))
        timeLimit.pack(pady=120)
        time60 = Button(sett, text='60s', fg='white',
bg='#FF6D9E', bd=1, font=('Modern 15 bold'),
                        command = self.sixty, height=2, width=8)
        time60.place(x=160,y=440)
        time90 = Button(sett, text='90s', fg='white',
bg='#FF6D9E', bd=1, font=('Modern 15 bold'),
                        command = self.ninety, height=2, width=8)
        time90.place(x=310,y=440)
        time120 = Button(sett, text='120s', fg='white',
bg='#FF6D9E', bd=1, font=('Modern 15 bold'),
                        command = self.one20, height=2, width=8)
        time120.place(x=460,y=440)
        timeInf = Button(sett, text='∞', fg='white', bg='#FF6D9E',
bd=1, font=('Modern 15 bold'),
                        command = self.infinite, height=2, width=8)
        timeInf.place(x=610,y=440)
        close = Button(sett, text='X', fg='white', bg='#FF746C',
bd=1, font=('Modern 20 bold'), #Close the frame with the button is
clicked
                        command = sett.pack_forget, height=1,
width=4)
        close.place(x=750, y=20)

    def oneRound(self):
        global rounds #Public attribute to be used in other
methods
        rounds = 1 #Store player's choice of rounds clicked in
buttons in options method

    def threeRound(self):
        global rounds
        rounds = 3

    def fiveRound(self):
        global rounds
        rounds = 5
```

```
    def sixty(self):
        global timeLimit #Public attribute to be used in other
methods
        timeLimit = 60 #Store player's choice of time limit
clicked in buttons in options method

    def ninety(self):
        global timeLimit
        timeLimit = 90

    def one20(self):
        global timeLimit
        timeLimit = 120

    def infinite(self):
        global timeLimit
        timeLimit = 'infinite'

    def charaSelect1(self):
        global start
        start = Frame(root, bg='#68ffa9')
        start.pack(fill="both", expand="yes")

        wCat = PhotoImage(file="white2.png")
        wCat.image = wCat #Store reference to image
        wCat_label = Label(start, image=wCat, bd=0) #Create label
to display image
        white = Button(start, image=wCat, bg='#f9e8ff', bd=1,
font=('Modern 17 bold'),
                       command = self.wChar1, height=170,
width=170)
        white.place(x=350,y=385)

        oCat = PhotoImage(file="orange2.png")
        oCat.image = oCat
        oCat_label = Label(start, image=oCat, bd=0)
        orange = Button(start, image=oCat, bg='#f9e8ff', bd=1,
font=('Modern 17 bold'),
                       command = self.oChar1, height=170,
width=170)
        orange.place(x=100,y=385)

        bCat = PhotoImage(file="black2.png")
        bCat.image = bCat
        bCat_label = Label(start, image=bCat, bd=0)
        black = Button(start, image=bCat, bg='#f9e8ff', bd=1,
font=('Modern 17 bold'),
```

```
                    command = self.bChar1, height=170,
width=170)
        black.place(x=595,y=385)

        rectangle = Canvas(start, width=863, height=320,
bg='#FF6D9E', bd=0)
        rectangle.place(x=0, y=0)
        info = Canvas(start, width=220, height=260, bg='#68ffa9',
bd=0)
        info.place(x=590, y=35)
        top = Label(start, text = "Player 1", bg='#68ffa9',
fg='#DA6BFF', font=('Modern 35 bold'))
        top.place(x=40, y=35)

        back = Button(start, text='Back', fg='#DA6BFF',
bg='#68ffa9', bd=1, font=('Modern 17 bold'),
                    command = start.destroy, height=1, width=8)
        back.place(x=40,y=160)

        toP2 = Button(start, text='Next', fg='#DA6BFF',
bg='#68ffa9', bd=1, font=('Modern 17 bold'),
                    command = self.charaSelect2, height=2,
width=8)
        toP2.place(x=40,y=230)

    def charaSelect2(self):
        if selection1 == 0:
            messagebox.showwarning("Alert", "Must choose a
character") #Make sure player cannot progress if a character
hasn't been chosen
        else:
            global player2
            player2 = Frame(start, bg='#68ffa9')
            player2.pack(fill="both", expand="yes")

            wCat = PhotoImage(file="white2.png")
            wCat.image = wCat
            wCat_label = Label(player2, image=wCat, bd=0)
            white = Button(player2, image=wCat, bg='#f9e8ff',
bd=1, font=('Modern 17 bold'),
                           command = self.wChar2, height=170,
width=170)
            white.place(x=350,y=385)

            oCat = PhotoImage(file="orange2.png")
            oCat.image = oCat
            oCat_label = Label(player2, image=oCat, bd=0)
```

```
            orange = Button(player2, image=oCat, bg='#f9e8ff',
bd=1, font=('Modern 17 bold'),
                            command = self.oChar2, height=170,
width=170)
            orange.place(x=100,y=385)

            bCat = PhotoImage(file="black2.png")
            bCat.image = bCat
            bCat_label = Label(player2, image=bCat, bd=0)
            black = Button(player2, image=bCat, bg='#f9e8ff',
bd=1, font=('Modern 17 bold'),
                            command = self.bChar2, height=170,
width=170)
            black.place(x=595,y=385)

            r = Canvas(player2, width=863, height=320,
bg='#FF6D9E', bd=0)
            r.place(x=0,y=0)
            info = Canvas(player2, width=220, height=260,
bg='#68ffa9', bd=0)
            info.place(x=590, y=35)
            top = Label(player2, text = "Player 2", bg='#68ffa9',
fg='#DA6BFF', font=('Modern 35 bold'))
            top.place(x=40, y=35)

            back = Button(player2, text='Back', fg='#DA6BFF',
bg='#68ffa9', bd=1, font=('Modern 17 bold'),
                            command = player2.destroy, height=1,
width=8)
            back.place(x=40,y=160)

            toGame = Button(player2, text='Start game',
fg='#DA6BFF', bg='#68ffa9', bd=1, font=('Modern 17 bold'),
                            command = self.battle, height=2,
width=12)
            toGame.place(x=40,y=230)

    def oChar1(self):
        global selection1 #Public attribute to be used in other
methods to check which character has been chosen
        selection1 = 1

        photo = PhotoImage(file="oCS2.png")
        photo.image = photo
        photo_label = Label(start, image=photo, bg='#FF6D9E',bd=0)
#Display the chosen character on screen
        photo_label.place(x=260, y=30)
```

```
        details = Label(start, text = "Details", bg='#68ffa9',
fg='#DA6BFF', font=('Modern 20 bold')) #Display the character's
details on screen
        details.place(x=600, y=45)
        nAtk = Label(start, text = "Normal Attack      20",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        nAtk.place(x=600, y=110)
        sAtk = Label(start, text = "Special Attack      70",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        sAtk.place(x=600, y=180)
        uAtk = Label(start, text = "Ultimate Attack    135",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        uAtk.place(x=600, y=250)

    def oChar2(self):
        global selection2
        selection2 = 1

        photo = PhotoImage(file="oCS2.png")
        photo.image = photo
        photo_label = Label(player2, image=photo,
bg='#FF6D9E',bd=0)
        photo_label.place(x=260, y=30)

        details = Label(player2, text = "Details", bg='#68ffa9',
fg='#DA6BFF', font=('Modern 20 bold'))
        details.place(x=600, y=45)
        nAtk = Label(player2, text = "Normal Attack      20",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        nAtk.place(x=600, y=110)
        sAtk = Label(player2, text = "Special Attack      70",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        sAtk.place(x=600, y=180)
        uAtk = Label(player2, text = "Ultimate Attack    135",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        uAtk.place(x=600, y=250)

    def wChar1(self):
        global selection1
        selection1 = 2

        photo = PhotoImage(file="wCS2.png")
        photo.image = photo
        photo_label = Label(start, image=photo, bg='#FF6D9E',bd=0)
        photo_label.place(x=260, y=30)

        details = Label(start, text = "Details", bg='#68ffa9',
fg='#DA6BFF', font=('Modern 20 bold'))
```

```
        details.place(x=600, y=45)
        nAtk = Label(start, text = "Normal Attack      35",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        nAtk.place(x=600, y=110)
        sAtk = Label(start, text = "Special Attack      60",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        sAtk.place(x=600, y=180)
        uAtk = Label(start, text = "Ultimate Attack    130",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        uAtk.place(x=600, y=250)

    def wChar2(self):
        global selection2
        selection2 = 2

        photo = PhotoImage(file="wCS2.png")
        photo.image = photo
        photo_label = Label(player2, image=photo,
bg='#FF6D9E',bd=0)
        photo_label.place(x=260, y=30)

        details = Label(player2, text = "Details", bg='#68ffa9',
fg='#DA6BFF', font=('Modern 20 bold'))
        details.place(x=600, y=45)
        nAtk = Label(player2, text = "Normal Attack      35",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        nAtk.place(x=600, y=110)
        sAtk = Label(player2, text = "Special Attack      60",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        sAtk.place(x=600, y=180)
        uAtk = Label(player2, text = "Ultimate Attack    130",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        uAtk.place(x=600, y=250)

    def bChar1(self):
        global selection1
        selection1 = 3

        photo = PhotoImage(file="bCS2.png")
        photo.image = photo
        photo_label = Label(start, image=photo, bg='#FF6D9E',bd=0)
        photo_label.place(x=260, y=30)

        details = Label(start, text = "Details", bg='#68ffa9',
fg='#DA6BFF', font=('Modern 20 bold'))
        details.place(x=600, y=45)
        nAtk = Label(start, text = "Normal Attack      25",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
```

```
        nAtk.place(x=600, y=110)
        sAtk = Label(start, text = "Special Attack      50",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        sAtk.place(x=600, y=180)
        uAtk = Label(start, text = "Ultimate Attack    150",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        uAtk.place(x=600, y=250)

    def bChar2(self):
        global selection2
        selection2 = 3

        photo = PhotoImage(file="bCS2.png")
        photo.image = photo
        photo_label = Label(player2, image=photo,
bg='#FF6D9E',bd=0)
        photo_label.place(x=260, y=30)

        details = Label(player2, text = "Details", bg='#68ffa9',
fg='#DA6BFF', font=('Modern 20 bold'))
        details.place(x=600, y=45)
        nAtk = Label(player2, text = "Normal Attack      25",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        nAtk.place(x=600, y=110)
        sAtk = Label(player2, text = "Special Attack      50",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        sAtk.place(x=600, y=180)
        uAtk = Label(player2, text = "Ultimate Attack    150",
bg='#68ffa9', fg='#DA6BFF', font=('Modern 17'))
        uAtk.place(x=600, y=250)

    def battle(self):
        if selection2 == 0:
            messagebox.showwarning("Alert", "Must choose a
character") #Make sure player cannot progress if a character
hasn't been chosen
        else:
            self.canvas = Canvas(player2, bg='#6D97FF', width=863,
height=600)
            self.canvas.pack()

            rectangle = Canvas(self.canvas, width=863, height=402,
bg='#FF6D9E', bd=0)
            rectangle.place(x=0, y=439)

            global check #Public attribute to be used in other
methods
```

```
            check = 1 #Stores 1 to keep track which screen is
currently displayed on screen

            top1 = Label(self.canvas, text = "Player 1",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top1.place(x=40, y=35)

            self.start_label = Label(self.canvas, text="Start!",
font=('Modern 70 bold'), bg='#FF6D9E', fg='white')
            self.start_label.place(x=350, y=200)
            self.start_label.after(2000,
self.start_label.place_forget) #Remove label after 2 seconds

            self.round_no = 1 #Store current round

            self.round_label = Label(self.canvas, text=f"Round
{self.round_no}", font=('Modern 20 bold'), bg='#FF6D9E',
fg='white') #Display current round on screen
            self.round_label.place(x=405, y=140)

            self.health1 = 1000
            self.energy1 = 500
            lHealth = Label(self.canvas, text = ('Health:',
self.health1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold')) #Display current health on screen for player 1
            lHealth.place(x=200, y=42)
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold')) #Display current energy on screen for player 1
            lEnergy.place(x=200, y=95)

            self.health2 = 1000
            self.energy2 = 500
            lHealth = Label(self.canvas, text = ('Health:',
self.health2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold')) #Display current health on screen for player 2
            lHealth.place(x=540, y=42)
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold')) #Display current energy on screen for player 2
            lEnergy.place(x=550, y=95)

            self.paused = False #Make sure game isn't paused when
the battle starts

            if selection1 == 1: #Check which character has been
chosen
```

```
                pOrange = Label(self.canvas, text = "Orange Cat",
bg='#FF746C', fg='white', font=('Modern 20 bold'))
                pOrange.place(x=40, y=95)

                self.orange = Orange(self.canvas, 200, 380,
"oFight.png") #Display character image on screen
                self.master.bind("<w>", self.orange.jump) #Bind
the keys to the character class methods
                self.master.bind("<a>", self.orange.move_left)
                self.master.bind("<d>", self.orange.move_right)
                self.master.bind("<KeyPress-s>",
self.orange.guard)
                self.master.bind("<KeyRelease-s>",
self.orange.unguard)

                self.master.bind('<q>',
                                 lambda _:
Orange.calcEnergy(self))
                self.master.bind('<e>',
                                 lambda _: Orange.normalAtk(self))
                self.master.bind('<r>',
                                 lambda _:
Orange.specialAtk(self))
                self.master.bind('<t>',
                                 lambda _: Orange.ultAtk(self))

            elif selection1 == 2:
                pWhite = Label(self.canvas, text = "White Cat",
bg='#F7E0FE', fg='white', font=('Modern 20 bold'))
                pWhite.place(x=40, y=95)

                self.white = White(self.canvas, 200, 380,
"wFight.png")
                self.master.bind("<w>", self.white.jump)
                self.master.bind("<a>", self.white.move_left)
                self.master.bind("<d>", self.white.move_right)
                self.master.bind("<KeyPress-s>", self.white.guard)
                self.master.bind("<KeyRelease-s>",
self.white.unguard)

                self.master.bind('<q>',
                                 lambda _: White.calcEnergy(self))
                self.master.bind('<e>',
                                 lambda _: White.normalAtk(self))
                self.master.bind('<r>',
                                 lambda _: White.specialAtk(self))
                self.master.bind('<t>',
                                 lambda _: White.ultAtk(self))
```

```
            elif selection1 == 3:
                pBlack = Label(self.canvas, text = "Black Cat",
bg='#0D111D', fg='white', font=('Modern 20 bold'))
                pBlack.place(x=40, y=95)

                self.black = Black(self.canvas, 200, 380,
"bFight.png")
                self.master.bind("<w>", self.black.jump)
                self.master.bind("<a>", self.black.move_left)
                self.master.bind("<d>", self.black.move_right)
                self.master.bind("<KeyPress-s>", self.black.guard)
                self.master.bind("<KeyRelease-s>",
self.black.unguard)

                self.master.bind('<q>',
                                 lambda _: Black.calcEnergy(self))
                self.master.bind('<e>',
                                 lambda _: Black.normalAtk(self))
                self.master.bind('<r>',
                                 lambda _: Black.specialAtk(self))
                self.master.bind('<t>',
                                 lambda _: Black.ultAtk(self))

            if selection2 == 1:
                top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
                top2.place(x=700, y=35)
                pOrange = Label(self.canvas, text = "Orange Cat",
bg='#FF746C', fg='white', font=('Modern 20 bold'))
                pOrange.place(x=712, y=95)

                self.orange2 = Orange2(self.canvas, 675, 380,
"oFight2.png")
                self.master.bind("<Up>", self.orange2.jump)
                self.master.bind("<Left>", self.orange2.move_left)
                self.master.bind("<Right>",
self.orange2.move_right)
                self.master.bind("<KeyPress-Down>",
self.orange2.guard)
                self.master.bind("<KeyRelease-Down>",
self.orange2.unguard)

                self.master.bind('<l>',
                                 lambda _:
Orange2.calcEnergy(self))
                self.master.bind('<b>',
```

```
                                lambda _:
Orange2.normalAtk(self))
                self.master.bind('<n>',
                                lambda _:
Orange2.specialAtk(self))
                self.master.bind('<m>',
                                lambda _: Orange2.ultAtk(self))

            elif selection2 == 2:
                top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
                top2.place(x=700, y=35)
                pWhite = Label(self.canvas, text = "White Cat",
bg='#F7E0FE', fg='white', font=('Modern 20 bold'))
                pWhite.place(x=729, y=95)

                self.white2 = White2(self.canvas, 675, 380,
"wFight2.png")
                self.master.bind("<Up>", self.white2.jump)
                self.master.bind("<Left>", self.white2.move_left)
                self.master.bind("<Right>",
self.white2.move_right)
                self.master.bind("<KeyPress-Down>",
self.white2.guard)
                self.master.bind("<KeyRelease-Down>",
self.white2.unguard)

                self.master.bind('<l>',
                                lambda _:
White2.calcEnergy(self))
                self.master.bind('<b>',
                                lambda _: White2.normalAtk(self))
                self.master.bind('<n>',
                                lambda _:
White2.specialAtk(self))
                self.master.bind('<m>',
                                lambda _: White2.ultAtk(self))

            elif selection2 == 3:
                top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
                top2.place(x=700, y=35)
                pBlack = Label(self.canvas, text = "Black Cat",
bg='#0D111D', fg='white', font=('Modern 20 bold'))
                pBlack.place(x=729, y=95)

                self.black2 = Black2(self.canvas, 675, 380,
"bFight2.png")
```

```
                self.master.bind("<Up>", self.black2.jump)
                self.master.bind("<Left>", self.black2.move_left)
                self.master.bind("<Right>",
self.black2.move_right)
                self.master.bind("<KeyPress-Down>",
self.black2.guard)
                self.master.bind("<KeyRelease-Down>",
self.black2.unguard)

                self.master.bind('<l>',
                                 lambda _:
Black2.calcEnergy(self))
                self.master.bind('<b>',
                                 lambda _: Black2.normalAtk(self))
                self.master.bind('<n>',
                                 lambda _:
Black2.specialAtk(self))
                self.master.bind('<m>',
                                 lambda _: Black2.ultAtk(self))

            if timeLimit != 'infinite': #Check player's time limit
selection
                self.time_limit = timeLimit #Set time limit to
player's choice or default
                self.start_time = None
                self.remaining_time = self.time_limit
                self.start_timer()

                self.timer_label = Label(self.canvas, text="",
font=('Modern 60 bold'), bg='#FF6D9E', fg='white') #Display time
on screen
                self.timer_label.place(x=410, y=40)
                self.update_timer()
            else:
                self.timer_label = Label(self.canvas, text="∞",
font=('Modern 60 bold'), bg='#FF6D9E', fg='white') #Otherwise do
not start a timer and display infinity symbol on screen
                self.timer_label.place(x=410, y=40)

            self.pause = Button(self.canvas, text='Pause',
bg='#6D97FF', fg='white', bd=1, font=('Modern 15 bold'), #Display
pause button screen
                        command = self.pause_game, height=2,
width=6)
            self.pause.place(x=410,y=490)

    def start_timer(self):
        self.start_time = time.time()
```

```
    def update_timer(self):
        if not self.paused: #Check if game isn't paused
            self.timer_label.config(text=str(self.remaining_time))
#Update timer on screen
            self.remaining_time -= 1
            if self.remaining_time < 0: #Check if the time has run
out
                self.remaining_time = 0 #Make sure the time
doesn't go below 0 on screen
                if self.health1 > self.health2: #Check which
player has the most health
                    self.winners.append("Player 1") #Add player
with the most health into the winners list
                elif self.health2 > self.health1:
                    self.winners.append("Player 2")
                else:
                    self.winners.append("Draw") #Otherwise add
'Draw' to the list
                lose = Label(self.canvas, text=self.winners,
font=('Modern 12'), bg='#FF6D9E', fg='white')
                lose.place(x=320, y=180)
                self.start_new_round()
        self.canvas.after(1000, self.update_timer) #Update the
timer after every seconds

    def pause_game(self):
        if not self.paused: #Check if the game isn't already
paused
            self.paused = True #Pause the game
            self.show_pause_frame()
            self.pause_characters()
            self.pause_timer()

    def resume_game(self):
        if self.paused: #Check if the game is paused
            self.paused = False #Unpause the game
            self.hide_pause_frame()
            self.resume_characters()
            self.resume_timer()

    def show_pause_frame(self):
        self.pause_frame = Frame(self.canvas, bg="#DA6BFF",
bd=100)
        self.pause_frame.place(relx=0.5, rely=0.5,
anchor="center")
```

```
        pause = Label(self.pause_frame, text="Pause",
bg='#6D97FF', fg='white', font=('Modern 25 bold'))
        pause.pack(pady=20)

        resume_button = Button(self.pause_frame, text="Resume",
fg='white', bg='#FF746C', bd=1, font=('Modern 17 bold'),
                               command=self.resume_game)
        resume_button.pack(pady=20)

        retry_button = Button(self.pause_frame, text="Retry",
fg='white', bg='#FF746C', bd=1, font=('Modern 17 bold'),
                               command=self.retry)
        retry_button.pack(pady=20)

        inst_button = Button(self.pause_frame, text="How to play",
fg='white', bg='#FF746C', bd=1, font=('Modern 17 bold'),
                               command=self.instructions)
        inst_button.pack(pady=20)

        chara_button = Button(self.pause_frame, text="Back to
character selection", fg='white', bg='#FF746C', bd=1,
font=('Modern 17 bold'),
                               command=self.battle_chara)
        chara_button.pack(pady=20)

        start_button = Button(self.pause_frame, text="Back to
starting page", fg='white', bg='#FF746C', bd=1, font=('Modern 17
bold'),
                               command=self.battle_back)
        start_button.pack(pady=20)

    def instructions(self):
        howToPlay = Frame(self.canvas, bg="#6D97FF", bd=100)
        howToPlay.place(relx=0.5, rely=0.5, anchor="center")

        top = Label(howToPlay, text = "How to play", bg='#FF6D9E',
fg='white', font=('Modern 20 bold'))
        top.pack(pady=10)

        left = Label(howToPlay, text="Player 1", bg='#FF6D9E',
fg='white', font=('Modern 15 bold'))
        left.pack(pady=10)

        wasd2 = PhotoImage(file="wasd2.png")
        wasd2.image = wasd2
        wasd2_label = Label(howToPlay, image=wasd2, bg="#6D97FF",
bd=0)
        wasd2_label.pack(pady=10)
```

```
        p1Atks = PhotoImage(file="p1Atks.png")
        p1Atks.image = p1Atks
        p1Atks_label = Label(howToPlay, image=p1Atks,
bg="#6D97FF", bd=0)
        p1Atks_label.pack(pady=10)

        right = Label(howToPlay, text="Player 2", bg='#FF6D9E',
fg='white', font=('Modern 15 bold'))
        right.pack(pady=10)

        arrows2 = PhotoImage(file="arrows2.png")
        arrows2.image = arrows2
        arrows2_label = Label(howToPlay, image=arrows2,
bg="#6D97FF", bd=0)
        arrows2_label.pack(pady=10)

        p2Atks = PhotoImage(file="p2Atks.png")
        p2Atks.image = p2Atks
        p2Atks_label = Label(howToPlay, image=p2Atks,
bg="#6D97FF", bd=0)
        p2Atks_label.pack(pady=10)

        close = Button(howToPlay, text='Close', fg='white',
bg='#FF746C', bd=1, font=('Modern 20 bold'),
                       command = howToPlay.place_forget, height=1,
width=4)
        close.pack(pady=10)

    def hide_pause_frame(self):
        self.pause_frame.place_forget() #Remove the pause frame
from the screen

    def pause_timer(self):
        self.paused = True

    def resume_timer(self):
        self.paused = False

    def pause_characters(self):
        self.master.unbind("<w>") #Unbind the keys of the
characters so that they can't be used
        self.master.unbind("<a>")
        self.master.unbind("<d>")
        self.master.unbind("<e>")
        self.master.unbind("<r>")
        self.master.unbind("<t>")
        self.master.unbind("<q>")
```

```
        self.master.unbind("<Left>")
        self.master.unbind("<Right>")
        self.master.unbind("<Up>")
        self.master.unbind("<b>")
        self.master.unbind("<n>")
        self.master.unbind("<m>")
        self.master.unbind("<l>")
        self.master.unbind("<s>")
        self.master.unbind("<Down>")

    def resume_characters(self):
        if selection1 == 1:
            self.master.bind("<w>", self.orange.jump) #Bind the
keys to the characters so that they can be used again
            self.master.bind("<a>", self.orange.move_left)
            self.master.bind("<d>", self.orange.move_right)
            self.master.bind("<KeyPress-s>", self.orange.guard)
            self.master.bind("<KeyRelease-s>",
self.orange.unguard)

            self.master.bind('<q>',
                             lambda _: Orange.calcEnergy(self))
            self.master.bind('<e>',
                             lambda _: Orange.normalAtk(self))
            self.master.bind('<r>',
                             lambda _: Orange.specialAtk(self))
            self.master.bind('<t>',
                             lambda _: Orange.ultAtk(self))

        elif selection1 == 2:
            self.master.bind("<w>", self.white.jump)
            self.master.bind("<a>", self.white.move_left)
            self.master.bind("<d>", self.white.move_right)
            self.master.bind("<KeyPress-s>", self.white.guard)
            self.master.bind("<KeyRelease-s>", self.white.unguard)

            self.master.bind('<q>',
                             lambda _: White.calcEnergy(self))
            self.master.bind('<e>',
                             lambda _: White.normalAtk(self))
            self.master.bind('<r>',
                             lambda _: White.specialAtk(self))
            self.master.bind('<t>',
                             lambda _: White.ultAtk(self))

        elif selection1 == 3:
            self.master.bind("<w>", self.black.jump)
            self.master.bind("<a>", self.black.move_left)
```

```
            self.master.bind("<d>", self.black.move_right)
            self.master.bind("<KeyPress-s>", self.black.guard)
            self.master.bind("<KeyRelease-s>", self.black.unguard)

            self.master.bind('<q>',
                             lambda _: Black.calcEnergy(self))
            self.master.bind('<e>',
                             lambda _: Black.normalAtk(self))
            self.master.bind('<r>',
                             lambda _: Black.specialAtk(self))
            self.master.bind('<t>',
                             lambda _: Black.ultAtk(self))

        if selection2 == 1:
            self.master.bind("<Up>", self.orange2.jump)
            self.master.bind("<Left>", self.orange2.move_left)
            self.master.bind("<Right>", self.orange2.move_right)
            self.master.bind("<KeyPress-Down>",
self.orange2.guard)
            self.master.bind("<KeyRelease-Down>",
self.orange2.unguard)

            self.master.bind('<l>',
                             lambda _: Orange2.calcEnergy(self))
            self.master.bind('<b>',
                             lambda _: Orange2.normalAtk(self))
            self.master.bind('<n>',
                             lambda _: Orange2.specialAtk(self))
            self.master.bind('<m>',
                             lambda _: Orange2.ultAtk(self))

        elif selection2 == 2:
            self.master.bind("<Up>", self.white2.jump)
            self.master.bind("<Left>", self.white2.move_left)
            self.master.bind("<Right>", self.white2.move_right)
            self.master.bind("<KeyPress-Down>", self.white2.guard)
            self.master.bind("<KeyRelease-Down>",
self.white2.unguard)

            self.master.bind('<l>',
                             lambda _: White2.calcEnergy(self))
            self.master.bind('<b>',
                             lambda _: White2.normalAtk(self))
            self.master.bind('<n>',
                             lambda _: White2.specialAtk(self))
            self.master.bind('<m>',
                             lambda _: White2.ultAtk(self))
```

```
        elif selection2 == 3:
            self.master.bind("<Up>", self.black2.jump)
            self.master.bind("<Left>", self.black2.move_left)
            self.master.bind("<Right>", self.black2.move_right)
            self.master.bind("<KeyPress-Down>", self.black2.guard)
            self.master.bind("<KeyRelease-Down>",
self.black2.unguard)

            self.master.bind('<l>',
                             lambda _: Black2.calcEnergy(self))
            self.master.bind('<b>',
                             lambda _: Black2.normalAtk(self))
            self.master.bind('<n>',
                             lambda _: Black2.specialAtk(self))
            self.master.bind('<m>',
                             lambda _: Black2.ultAtk(self))

    def retry(self):
        self.resume_game() #Resume game after it was paused

        lose = Label(self.canvas, text='
', font=('Modern 12'), bg='#6D97FF', fg='white')
        lose.place(x=320, y=180)

        self.winners = [] #Reset the winners list
        self.actualWinner = None #Reset the overall winner

        lose = Label(self.canvas, text=self.winners, font=('Modern
12'), bg='#FF6D9E', fg='white') #Reset winners on screen
        lose.place(x=320, y=180)

        self.health1 = 1000 #Reset the attributes
        self.energy1 = 500
        self.health2 = 1000
        self.energy2 = 500
        lHealth = Label(self.canvas, text = ('Health:',
self.health1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold')) #Display values in attributes on screen
        lHealth.place(x=200, y=42)
        lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
        lEnergy.place(x=200, y=95)
        lHealth = Label(self.canvas, text = ('Health:',
self.health2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
        lHealth.place(x=540, y=42)
```

```
        lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
        lEnergy.place(x=550, y=95)

        self.start_label = Label(self.canvas, text="Start!",
font=('Modern 70 bold'), bg='#FF6D9E', fg='white')
        self.start_label.place(x=350, y=200)
        self.start_label.after(2000,
self.start_label.place_forget)

        self.round_no = 1 #Reset the round number

        self.round_label = Label(self.canvas, text=f"Round
{self.round_no}", font=('Modern 20 bold'), bg='#FF6D9E',
fg='white') #Display the round number on screen
        self.round_label.place(x=405, y=140)

        if timeLimit != 'infinite':
            if self.start_time is not None:
                self.canvas.after_cancel(self.canvas.after(1000,
self.update_timer)) #Stop the current timer if it's running
            self.start_time = None
            self.remaining_time = self.time_limit #Reset the timer
            self.start_timer() #Start the timer again

        if selection1 == 1: #Check which character has been chosen
            self.orange.canvas.delete(self.orange.imageID) #Remove
the current character object from the screen

            self.orange = Orange(self.canvas, 200, 380,
"oFight.png") #Display character image on screen at the reset
position
            self.master.bind("<w>", self.orange.jump) #Bind the
keys to the character class methods
            self.master.bind("<a>", self.orange.move_left)
            self.master.bind("<d>", self.orange.move_right)
            self.master.bind("<KeyPress-s>", self.orange.guard)
            self.master.bind("<KeyRelease-s>",
self.orange.unguard)

            self.master.bind('<q>',
                             lambda _: Orange.calcEnergy(self))
            self.master.bind('<e>',
                             lambda _: Orange.normalAtk(self))
            self.master.bind('<r>',
                             lambda _: Orange.specialAtk(self))
            self.master.bind('<t>',
```

```
                                lambda _: Orange.ultAtk(self))

        elif selection1 == 2:
            self.white.canvas.delete(self.white.imageID)

            self.white = White(self.canvas, 200, 380,
"wFight.png")
            self.master.bind("<w>", self.white.jump)
            self.master.bind("<a>", self.white.move_left)
            self.master.bind("<d>", self.white.move_right)
            self.master.bind("<KeyPress-s>", self.white.guard)
            self.master.bind("<KeyRelease-s>", self.white.unguard)

            self.master.bind('<q>',
                             lambda _: White.calcEnergy(self))
            self.master.bind('<e>',
                             lambda _: White.normalAtk(self))
            self.master.bind('<r>',
                             lambda _: White.specialAtk(self))
            self.master.bind('<t>',
                             lambda _: White.ultAtk(self))

        elif selection1 == 3:
            self.black.canvas.delete(self.black.imageID)

            self.black = Black(self.canvas, 200, 380,
"bFight.png")
            self.master.bind("<w>", self.black.jump)
            self.master.bind("<a>", self.black.move_left)
            self.master.bind("<d>", self.black.move_right)
            self.master.bind("<KeyPress-s>", self.black.guard)
            self.master.bind("<KeyRelease-s>", self.black.unguard)

            self.master.bind('<q>',
                             lambda _: Black.calcEnergy(self))
            self.master.bind('<e>',
                             lambda _: Black.normalAtk(self))
            self.master.bind('<r>',
                             lambda _: Black.specialAtk(self))
            self.master.bind('<t>',
                             lambda _: Black.ultAtk(self))

        if selection2 == 1:
            self.orange2.canvas.delete(self.orange2.imageID)

            self.orange2 = Orange2(self.canvas, 675, 380,
"oFight2.png")
            self.master.bind("<Up>", self.orange2.jump)
```

```
            self.master.bind("<Left>", self.orange2.move_left)
            self.master.bind("<Right>", self.orange2.move_right)
            self.master.bind("<KeyPress-Down>",
self.orange2.guard)
            self.master.bind("<KeyRelease-Down>",
self.orange2.unguard)

            self.master.bind('<l>',
                             lambda _: Orange2.calcEnergy(self))
            self.master.bind('<b>',
                             lambda _: Orange2.normalAtk(self))
            self.master.bind('<n>',
                             lambda _: Orange2.specialAtk(self))
            self.master.bind('<m>',
                             lambda _: Orange2.ultAtk(self))

        elif selection2 == 2:
            self.white2.canvas.delete(self.white2.imageID)

            self.white2 = White2(self.canvas, 675, 380,
"wFight2.png")
            self.master.bind("<Up>", self.white2.jump)
            self.master.bind("<Left>", self.white2.move_left)
            self.master.bind("<Right>", self.white2.move_right)
            self.master.bind("<KeyPress-Down>", self.white2.guard)
            self.master.bind("<KeyRelease-Down>",
self.white2.unguard)

            self.master.bind('<l>',
                             lambda _: White2.calcEnergy(self))
            self.master.bind('<b>',
                             lambda _: White2.normalAtk(self))
            self.master.bind('<n>',
                             lambda _: White2.specialAtk(self))
            self.master.bind('<m>',
                             lambda _: White2.ultAtk(self))

        elif selection2 == 3:
            self.black2.canvas.delete(self.black2.imageID)

            self.black2 = Black2(self.canvas, 675, 380,
"bFight2.png")
            self.master.bind("<Up>", self.black2.jump)
            self.master.bind("<Left>", self.black2.move_left)
            self.master.bind("<Right>", self.black2.move_right)
            self.master.bind("<KeyPress-Down>", self.black2.guard)
            self.master.bind("<KeyRelease-Down>",
self.black2.unguard)
```

```
            self.master.bind('<l>',
                             lambda _: Black2.calcEnergy(self))
            self.master.bind('<b>',
                             lambda _: Black2.normalAtk(self))
            self.master.bind('<n>',
                             lambda _: Black2.specialAtk(self))
            self.master.bind('<m>',
                             lambda _: Black2.ultAtk(self))

    def start_new_round(self):
        if self.round_no == rounds: #Check if the round number has
reached the amount chosen by the player
            self.end_battle()
        else:
            self.health1 = 1000 #Reset the attributes
            self.energy1 = 500
            self.health2 = 1000
            self.energy2 = 500
            lHealth = Label(self.canvas, text = ('Health:',
self.health1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lHealth.place(x=200, y=42)
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=200, y=95)
            lHealth = Label(self.canvas, text = ('Health:',
self.health2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lHealth.place(x=540, y=42)
            lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
            lEnergy.place(x=550, y=95)

            self.round_no += 1 #Increment the round number by one
for the next round
            self.round_label.config(text=f"Round {self.round_no}")
#Display the new round number on screen

            self.start_label = Label(self.canvas, text="",
font=('Modern 70 bold'), bg='#FF6D9E', fg='white')
            self.start_label.place(x=260, y=200)
            self.start_label.config(text=f"Round {self.round_no}
!")
            self.start_label.after(2000,
self.start_label.place_forget)
```

```
            if timeLimit != 'infinite':
                if self.start_time is not None:

self.canvas.after_cancel(self.canvas.after(1000,
self.update_timer)) #Stop the current timer if it's running
                self.start_time = None
                self.remaining_time = self.time_limit #Reset the
timer
                self.start_timer() #Start the timer again

            if selection1 == 1: #Check which character has been
chosen
                self.orange.canvas.delete(self.orange.imageID)
#Remove the current character object from the screen

                self.orange = Orange(self.canvas, 200, 380,
"oFight.png") #Display character image on screen at the reset
position
                self.master.bind("<w>", self.orange.jump) #Bind
the keys to the character class methods
                self.master.bind("<a>", self.orange.move_left)
                self.master.bind("<d>", self.orange.move_right)
                self.master.bind("<KeyPress-s>",
self.orange.guard)
                self.master.bind("<KeyRelease-s>",
self.orange.unguard)

                self.master.bind('<q>',
                                 lambda _:
Orange.calcEnergy(self))
                self.master.bind('<e>',
                                 lambda _: Orange.normalAtk(self))
                self.master.bind('<r>',
                                 lambda _:
Orange.specialAtk(self))
                self.master.bind('<t>',
                                 lambda _: Orange.ultAtk(self))

            elif selection1 == 2:
                self.white.canvas.delete(self.white.imageID)

                self.white = White(self.canvas, 200, 380,
"wFight.png")
                self.master.bind("<w>", self.white.jump)
                self.master.bind("<a>", self.white.move_left)
                self.master.bind("<d>", self.white.move_right)
                self.master.bind("<KeyPress-s>", self.white.guard)
```

```
                self.master.bind("<KeyRelease-s>",
self.white.unguard)

                self.master.bind('<q>',
                                 lambda _: White.calcEnergy(self))
                self.master.bind('<e>',
                                 lambda _: White.normalAtk(self))
                self.master.bind('<r>',
                                 lambda _: White.specialAtk(self))
                self.master.bind('<t>',
                                 lambda _: White.ultAtk(self))

            elif selection1 == 3:
                self.black.canvas.delete(self.black.imageID)

                self.black = Black(self.canvas, 200, 380,
"bFight.png")
                self.master.bind("<w>", self.black.jump)
                self.master.bind("<a>", self.black.move_left)
                self.master.bind("<d>", self.black.move_right)
                self.master.bind("<KeyPress-s>", self.black.guard)
                self.master.bind("<KeyRelease-s>",
self.black.unguard)

                self.master.bind('<q>',
                                 lambda _: Black.calcEnergy(self))
                self.master.bind('<e>',
                                 lambda _: Black.normalAtk(self))
                self.master.bind('<r>',
                                 lambda _: Black.specialAtk(self))
                self.master.bind('<t>',
                                 lambda _: Black.ultAtk(self))

            if selection2 == 1:
                self.orange2.canvas.delete(self.orange2.imageID)

                self.orange2 = Orange2(self.canvas, 675, 380,
"oFight2.png")
                self.master.bind("<Up>", self.orange2.jump)
                self.master.bind("<Left>", self.orange2.move_left)
                self.master.bind("<Right>",
self.orange2.move_right)
                self.master.bind("<KeyPress-Down>",
self.orange2.guard)
                self.master.bind("<KeyRelease-Down>",
self.orange2.unguard)

                self.master.bind('<l>',
```

```
                                lambda _:
Orange2.calcEnergy(self))
                self.master.bind('<b>',
                                lambda _:
Orange2.normalAtk(self))
                self.master.bind('<n>',
                                lambda _:
Orange2.specialAtk(self))
                self.master.bind('<m>',
                                lambda _: Orange2.ultAtk(self))

            elif selection2 == 2:
                self.white2.canvas.delete(self.white2.imageID)

                self.white2 = White2(self.canvas, 675, 380,
"wFight2.png")
                self.master.bind("<Up>", self.white2.jump)
                self.master.bind("<Left>", self.white2.move_left)
                self.master.bind("<Right>",
self.white2.move_right)
                self.master.bind("<KeyPress-Down>",
self.white2.guard)
                self.master.bind("<KeyRelease-Down>",
self.white2.unguard)

                self.master.bind('<l>',
                                lambda _:
White2.calcEnergy(self))
                self.master.bind('<b>',
                                lambda _: White2.normalAtk(self))
                self.master.bind('<n>',
                                lambda _:
White2.specialAtk(self))
                self.master.bind('<m>',
                                lambda _: White2.ultAtk(self))

            elif selection2 == 3:
                self.black2.canvas.delete(self.black2.imageID)

                self.black2 = Black2(self.canvas, 675, 380,
"bFight2.png")
                self.master.bind("<Up>", self.black2.jump)
                self.master.bind("<Left>", self.black2.move_left)
                self.master.bind("<Right>",
self.black2.move_right)
                self.master.bind("<KeyPress-Down>",
self.black2.guard)
```

```
                self.master.bind("<KeyRelease-Down>",
self.black2.unguard)

                self.master.bind('<l>',
                                 lambda _:
Black2.calcEnergy(self))
                self.master.bind('<b>',
                                 lambda _: Black2.normalAtk(self))
                self.master.bind('<n>',
                                 lambda _:
Black2.specialAtk(self))
                self.master.bind('<m>',
                                 lambda _: Black2.ultAtk(self))

    def end_battle(self):
        self.pause_timer()
        self.pause_characters()

        self.end = Frame(self.canvas, bg='#FF746C')
        self.end.pack(fill="both", expand=True)

        if check == 1: #Check if the end battle screen is opening
from the battle canvas
            self.end_screen = Frame(player2, bg='#FF746C')
            self.end_screen.pack(fill="both", expand=True)
        elif check == 2: #Check if the battle screen is opening
from a battle that has been retried
            self.end_screen = Frame(self.end_screen, bg='#FF746C')
            self.end_screen.pack(fill="both", expand=True)

        player1_wins = self.winners.count("Player 1") #Store how
many times Player 1 has won stored in the winners list
        player2_wins = self.winners.count("Player 2") #Store how
many times Player 2 has won stored in the winners list
        if player1_wins > player2_wins:
            self.actualWinner = "Player 1"
            winner_label = Label(self.end_screen, text="Player 1
wins!", font=('Modern 50 bold'), bg='#DA6BFF', fg='white')
#Declare Player 1 as the overall winner is they have more wins
than Player 2
            winner_label.place(x=20, y=20)
        elif player1_wins < player2_wins:
            self.actualWinner = "Player 2"
            winner_label = Label(self.end_screen, text="Player 2
wins!", font=('Modern 50 bold'), bg='#DA6BFF', fg='white')
#Declare Player 2 as the overall winner is they have more wins
than Player 1
            winner_label.place(x=20, y=20)
```

```
        else:
            self.actualWinner = "Draw"
            winner_label = Label(self.end_screen, text="Draw!",
font=('Modern 50 bold'), bg='#DA6BFF', fg='white') #Declare a draw
otherwise
            winner_label.place(x=20, y=20)

        if self.actualWinner == "Player 1":
            if selection1 == 1:
                winner = PhotoImage(file="oWin.png") #Display
winning image of Orange Cat if Player 1 won and is Orange Cat
                winner.image = winner
                winner_label = Label(self.end_screen,
image=winner, bg='#FF746C',bd=0)
                winner_label.place(x=10, y=130)
                if selection2 == 1:
                    loser = PhotoImage(file="oLose.png") #Display
losing image of Orange Cat if Player 2 lost and is Orange Cat
                elif selection2 == 2:
                    loser = PhotoImage(file="wLose.png")
                elif selection2 == 3:
                    loser = PhotoImage(file="bLose.png")
                loser.image = loser
                loser_label = Label(self.end_screen, image=loser,
bg='#FF746C',bd=0)
                loser_label.place(x=300, y=200)
            elif selection1 == 2:
                winner = PhotoImage(file="wWin.png")
                winner.image = winner
                winner_label = Label(self.end_screen,
image=winner, bg='#FF746C',bd=0)
                winner_label.place(x=10, y=130)
                if selection2 == 1:
                    loser = PhotoImage(file="oLose.png")
                elif selection2 == 2:
                    loser = PhotoImage(file="wLose.png")
                elif selection2 == 3:
                    loser = PhotoImage(file="bLose.png")
                loser.image = loser
                loser_label = Label(self.end_screen, image=loser,
bg='#FF746C',bd=0)
                loser_label.place(x=300, y=200)
            elif selection1 == 3:
                winner = PhotoImage(file="bWin.png")
                winner.image = winner
                winner_label = Label(self.end_screen,
image=winner, bg='#FF746C',bd=0)
                winner_label.place(x=10, y=130)
```

```
                if selection2 == 1:
                    loser = PhotoImage(file="oLose.png")
                elif selection2 == 2:
                    loser = PhotoImage(file="wLose.png")
                elif selection2 == 3:
                    loser = PhotoImage(file="bLose.png")
                loser.image = loser
                loser_label = Label(self.end_screen, image=loser,
bg='#FF746C',bd=0)
                loser_label.place(x=300, y=200)
        elif self.actualWinner == "Player 2":
            if selection2 == 1:
                winner = PhotoImage(file="oWin.png")
                winner.image = winner
                winner_label = Label(self.end_screen,
image=winner, bg='#FF746C',bd=0) #Display winning image of Orange
Cat if Player 2 won and is Orange Cat
                winner_label.place(x=10, y=130)
                if selection1 == 1:
                    loser = PhotoImage(file="oLose.png")
                elif selection1 == 2:
                    loser = PhotoImage(file="wLose.png")
                elif selection1 == 3:
                    loser = PhotoImage(file="bLose.png")
                loser.image = loser
                loser_label = Label(self.end_screen, image=loser,
bg='#FF746C',bd=0)
                loser_label.place(x=300, y=200)
            elif selection2 == 2:
                winner = PhotoImage(file="wWin.png")
                winner.image = winner
                winner_label = Label(self.end_screen,
image=winner, bg='#FF746C',bd=0)
                winner_label.place(x=10, y=130)
                if selection1 == 1:
                    loser = PhotoImage(file="oLose.png")
                elif selection1 == 2:
                    loser = PhotoImage(file="wLose.png")
                elif selection1 == 3:
                    loser = PhotoImage(file="bLose.png")
                loser.image = loser
                loser_label = Label(self.end_screen, image=loser,
bg='#FF746C',bd=0)
                loser_label.place(x=300, y=200)
            elif selection2 == 3:
                winner = PhotoImage(file="bWin.png")
                winner.image = winner
```

```
                winner_label = Label(self.end_screen,
image=winner, bg='#FF746C',bd=0)
                winner_label.place(x=10, y=130)
                if selection1 == 1:
                    loser = PhotoImage(file="oLose.png")
                elif selection1 == 2:
                    loser = PhotoImage(file="wLose.png")
                elif selection1 == 3:
                    loser = PhotoImage(file="bLose.png")
                loser.image = loser
                loser_label = Label(self.end_screen, image=loser,
bg='#FF746C',bd=0)
                loser_label.place(x=300, y=200)
        else: #Otherwise if a draw display losing images for both
players
            if selection1 == 1:
                draw1 = PhotoImage(file="oLose.png")
            elif selection1 == 2:
                draw1 = PhotoImage(file="wLose.png")
            elif selection1 == 3:
                draw1 = PhotoImage(file="bLose.png")
            draw1.image = draw1
            draw1_label = Label(self.end_screen, image=draw1,
bg='#FF746C',bd=0)
            draw1_label.place(x=40, y=200)

            if selection2 == 1:
                draw2 = PhotoImage(file="oLose.png")
            elif selection2 == 2:
                draw2 = PhotoImage(file="wLose.png")
            elif selection2 == 3:
                draw2 = PhotoImage(file="bLose.png")
            draw2.image = draw2
            draw2_label = Label(self.end_screen, image=draw2,
bg='#FF746C',bd=0)
            draw2_label.place(x=270, y=200)

        self.winners = [] #Reset winners list
        self.actualWinner = None #Reset the overall winner

        select = Canvas(self.end_screen, width=300, height=350,
bg='#6D97FF', bd=0)
        select.place(x=510, y=120)

        retry_button = Button(select, text="Retry", fg='white',
bg='#DA6BFF', bd=1, font=('Modern 17 bold'),
                              command=self.end_retry)
        retry_button.place(x=130, y=50)
```

```
        chara_button = Button(select, text="Back to character
selection", fg='white', bg='#DA6BFF', bd=1, font=('Modern 17
bold'),
                              command=self.end_chara)
        chara_button.place(x=30, y=145)

        start_button = Button(select, text="Back to starting
page", fg='white', bg='#DA6BFF', bd=1, font=('Modern 17 bold'),
                              command=self.end_back )
        start_button.place(x=60, y=240)

    def end_retry(self):
        self.canvas = Canvas(self.end_screen, bg='#6D97FF',
width=863, height=600)
        self.canvas.pack()

        rectangle = Canvas(self.canvas, width=863, height=402,
bg='#FF6D9E', bd=0)
        rectangle.place(x=0, y=439)

        global check
        check = 2 #Store 2 to keep track which screen is currently
displayed on screen

        self.winners = [] #Reset winners list
        self.actualWinner = None #Reset the overall winner

        top1 = Label(self.canvas, text = "Player 1", bg='#FF6D9E',
fg='white', font=('Modern 30 bold'))
        top1.place(x=40, y=35)

        self.start_label = Label(self.canvas, text="Start!",
font=('Modern 70 bold'), bg='#FF6D9E', fg='white')
        self.start_label.place(x=350, y=200)
        self.start_label.after(2000,
self.start_label.place_forget)

        self.round_no = 1 #Reset round number

        self.round_label = Label(self.canvas, text=f"Round
{self.round_no}", font=('Modern 20 bold'), bg='#FF6D9E',
fg='white')
        self.round_label.place(x=405, y=140)

        self.health1 = 1000 #Reset character attributes
        self.energy1 = 500
```

```
        lHealth = Label(self.canvas, text = ('Health:',
self.health1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
        lHealth.place(x=200, y=42)
        lEnergy = Label(self.canvas, text = ('Energy:',
self.energy1, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
        lEnergy.place(x=200, y=95)

        self.health2 = 1000
        self.energy2 = 500
        lHealth = Label(self.canvas, text = ('Health:',
self.health2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
        lHealth.place(x=540, y=42)
        lEnergy = Label(self.canvas, text = ('Energy:',
self.energy2, '   '), bg='#6D97FF', fg='white', font=('Modern 20
bold'))
        lEnergy.place(x=550, y=95)

        self.paused = False #Make sure game isn't paused

        if selection1 == 1:
            pOrange = Label(self.canvas, text = "Orange Cat",
bg='#FF746C', fg='white', font=('Modern 20 bold'))
            pOrange.place(x=40, y=95)

            self.orange = Orange(self.canvas, 200, 380,
"oFight.png") #Display character images on screen
            self.master.bind("<w>", self.orange.jump) #Bind keys
to character's class method
            self.master.bind("<a>", self.orange.move_left)
            self.master.bind("<d>", self.orange.move_right)
            self.master.bind("<KeyPress-s>", self.orange.guard)
            self.master.bind("<KeyRelease-s>",
self.orange.unguard)

            self.master.bind('<q>',
                             lambda _: Orange.calcEnergy(self))
            self.master.bind('<e>',
                             lambda _: Orange.normalAtk(self))
            self.master.bind('<r>',
                             lambda _: Orange.specialAtk(self))
            self.master.bind('<t>',
                             lambda _: Orange.ultAtk(self))

        elif selection1 == 2:
```

```
            pWhite = Label(self.canvas, text = "White Cat",
bg='#F7E0FE', fg='white', font=('Modern 20 bold'))
            pWhite.place(x=40, y=95)

            self.white = White(self.canvas, 200, 380,
"wFight.png")
            self.master.bind("<w>", self.white.jump)
            self.master.bind("<a>", self.white.move_left)
            self.master.bind("<d>", self.white.move_right)
            self.master.bind("<KeyPress-s>", self.white.guard)
            self.master.bind("<KeyRelease-s>", self.white.unguard)

            self.master.bind('<q>',
                             lambda _: White.calcEnergy(self))
            self.master.bind('<e>',
                             lambda _: White.normalAtk(self))
            self.master.bind('<r>',
                             lambda _: White.specialAtk(self))
            self.master.bind('<t>',
                             lambda _: White.ultAtk(self))

        elif selection1 == 3:
            pBlack = Label(self.canvas, text = "Black Cat",
bg='#0D111D', fg='white', font=('Modern 20 bold'))
            pBlack.place(x=40, y=95)

            self.black = Black(self.canvas, 200, 380,
"bFight.png")
            self.master.bind("<w>", self.black.jump)
            self.master.bind("<a>", self.black.move_left)
            self.master.bind("<d>", self.black.move_right)
            self.master.bind("<KeyPress-s>", self.black.guard)
            self.master.bind("<KeyRelease-s>", self.black.unguard)

            self.master.bind('<q>',
                             lambda _: Black.calcEnergy(self))
            self.master.bind('<e>',
                             lambda _: Black.normalAtk(self))
            self.master.bind('<r>',
                             lambda _: Black.specialAtk(self))
            self.master.bind('<t>',
                             lambda _: Black.ultAtk(self))

        if selection2 == 1:
            top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top2.place(x=700, y=35)
```

```
            pOrange = Label(self.canvas, text = "Orange Cat",
bg='#FF746C', fg='white', font=('Modern 20 bold'))
            pOrange.place(x=712, y=95)

            self.orange2 = Orange2(self.canvas, 675, 380,
"oFight2.png")
            self.master.bind("<Up>", self.orange2.jump)
            self.master.bind("<Left>", self.orange2.move_left)
            self.master.bind("<Right>", self.orange2.move_right)
            self.master.bind("<KeyPress-Down>",
self.orange2.guard)
            self.master.bind("<KeyRelease-Down>",
self.orange2.unguard)

            self.master.bind('<l>',
                             lambda _: Orange2.calcEnergy(self))
            self.master.bind('<b>',
                             lambda _: Orange2.normalAtk(self))
            self.master.bind('<n>',
                             lambda _: Orange2.specialAtk(self))
            self.master.bind('<m>',
                             lambda _: Orange2.ultAtk(self))

        elif selection2 == 2:
            top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top2.place(x=700, y=35)
            pWhite = Label(self.canvas, text = "White Cat",
bg='#F7E0FE', fg='white', font=('Modern 20 bold'))
            pWhite.place(x=729, y=95)

            self.white2 = White2(self.canvas, 675, 380,
"wFight2.png")
            self.master.bind("<Up>", self.white2.jump)
            self.master.bind("<Left>", self.white2.move_left)
            self.master.bind("<Right>", self.white2.move_right)
            self.master.bind("<KeyPress-Down>", self.white2.guard)
            self.master.bind("<KeyRelease-Down>",
self.white2.unguard)

            self.master.bind('<l>',
                             lambda _: White2.calcEnergy(self))
            self.master.bind('<b>',
                             lambda _: White2.normalAtk(self))
            self.master.bind('<n>',
                             lambda _: White2.specialAtk(self))
            self.master.bind('<m>',
                             lambda _: White2.ultAtk(self))
```

```
        elif selection2 == 3:
            top2 = Label(self.canvas, text = "Player 2",
bg='#FF6D9E', fg='white', font=('Modern 30 bold'))
            top2.place(x=700, y=35)
            pBlack = Label(self.canvas, text = "Black Cat",
bg='#0D111D', fg='white', font=('Modern 20 bold'))
            pBlack.place(x=729, y=95)

            self.black2 = Black2(self.canvas, 675, 380,
"bFight2.png")
            self.master.bind("<Up>", self.black2.jump)
            self.master.bind("<Left>", self.black2.move_left)
            self.master.bind("<Right>", self.black2.move_right)
            self.master.bind("<KeyPress-Down>", self.black2.guard)
            self.master.bind("<KeyRelease-Down>",
self.black2.unguard)

            self.master.bind('<l>',
                             lambda _: Black2.calcEnergy(self))
            self.master.bind('<b>',
                             lambda _: Black2.normalAtk(self))
            self.master.bind('<n>',
                             lambda _: Black2.specialAtk(self))
            self.master.bind('<m>',
                             lambda _: Black2.ultAtk(self))

        if timeLimit != 'infinite': #Check player's time limit
choice
            self.start_time = None
            self.remaining_time = self.time_limit #Reset timer
            self.start_timer() #Start timer again
            self.timer_label = Label(self.canvas, text="",
font=('Modern 60 bold'), bg='#FF6D9E', fg='white') #Display timer
on screen
            self.timer_label.place(x=410, y=40)
        else:
            self.timer_label = Label(self.canvas, text="∞",
font=('Modern 60 bold'), bg='#FF6D9E', fg='white') #Otherwise
display infinity symbol in place of timer
            self.timer_label.place(x=410, y=40)

        self.pause = Button(self.canvas, text='Pause',
bg='#6D97FF', fg='white', bd=1, font=('Modern 15 bold'),
                  command = self.pause_game, height=2, width=6)
        self.pause.place(x=410,y=490)

    def end_chara(self):
```

```
        global selection1
        global selection2
        selection1 = 0 #Reset selections
        selection2 = 0
        self.end_screen.destroy() #Go back to character selection
frame from end battle frame
        self.canvas.destroy()
        player2.destroy()
        start.destroy()
        self.charaSelect1()

    def end_back(self):
        global selection1
        global selection2
        selection1 = 0 #Reset selections
        selection2 = 0
        self.end_screen.destroy() #Go back to starting screen from
end battle frame
        self.canvas.destroy()
        player2.destroy()
        start.destroy()

    def battle_chara(self):
        global selection1
        global selection2
        selection1 = 0 #Reset selections
        selection2 = 0
        self.canvas.destroy() #Go back to character selection
frame from battle
        player2.destroy()
        start.destroy()
        self.charaSelect1()

    def battle_back(self):
        global selection1
        global selection2
        selection1 = 0 #Reset selections
        selection2 = 0
        self.canvas.destroy() #Go back to starting screen from
battle
        player2.destroy()
        start.destroy()

if __name__ == '__main__':
    root = Tk()
    game = Game(root)
    game.mainloop()
```