Number System Tool

1. Introduction

Number System Tool is a Java executable calculator which can do basic arithmetic within and between different number systems. It will use binary, decimal, hexadecimal and octal. It will also include simple games to help learn and easily read some number systems. This tool is meant to be used by novice programmers or people who wish to learn the different number systems by allowing them to convert and play educational games and a quiz to test the users knowledge of numbering systems.

1.1 Purpose

This document is meant to outline features and requirements for the Number System Tool to work.

1.2 Scope

The document will outline many of the potential uses of the calculator tool but we will focus on basic arithmetic, and three games; snake, 2048, and a quiz.

1.3 Definitions

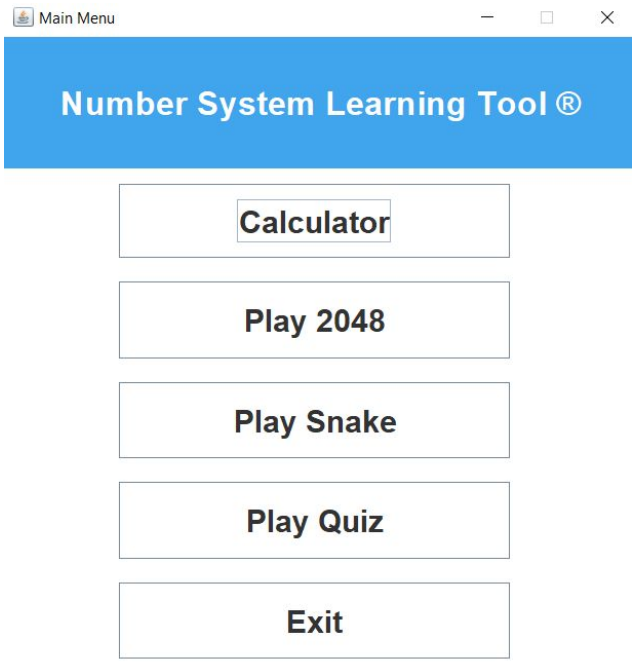
Snake - A simple game where you control a small 2D snake and collect dots to get longer
2048 - A game of blocks with numbers in a 4x4 grid where blocks with the same number combine to have the sum value and blocks appear on an empty space after every move. The goal is to get the biggest value block
32- Bit IEEE - A way to display numbers that represent a floating point or decimal number in base 10.
Binary (0b, BIN) - Number system in base 2 thats uses 1's and 0's
Hexadecimal (0x, HEX) - Number system in base 16 that uses, 1,2,3,4,5,6,7,8,9,A,B,C,D,E,F.
Octal (0o, OCT) - Number system in base 8 that uses 1-8.
1's , 2's Complement - Methods of displaying and doing arithmetic with integer decimal numbers in binary

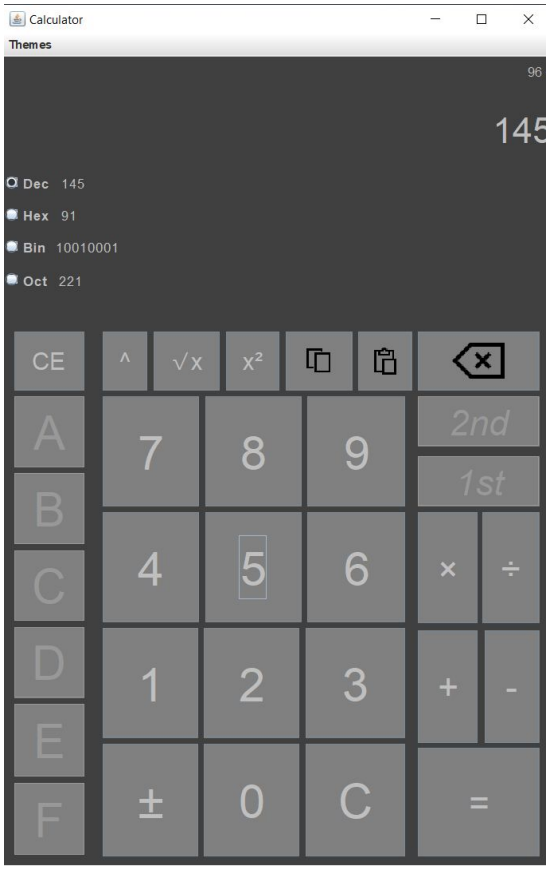
2. Overall Description

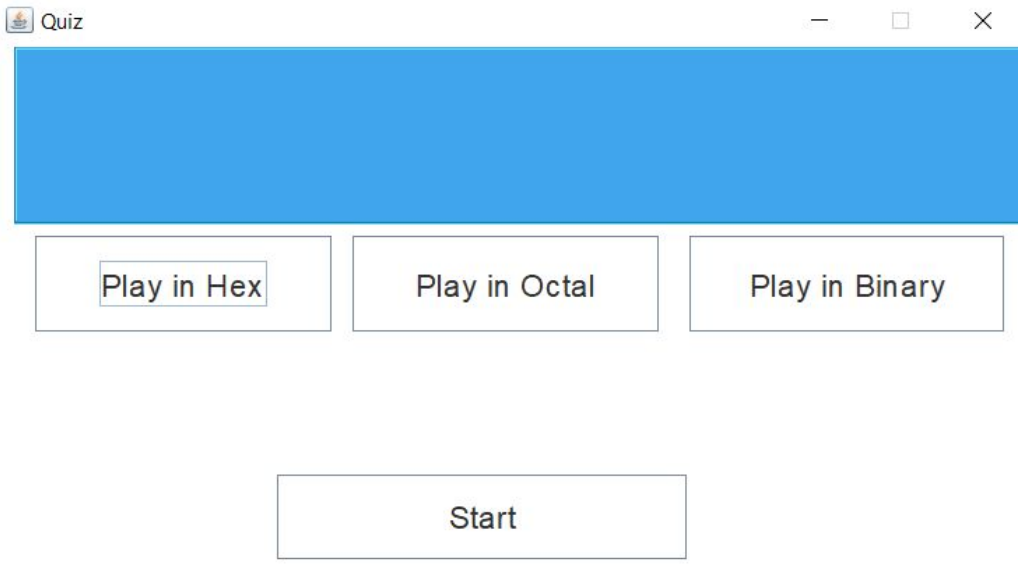
2.1 Product Perspective

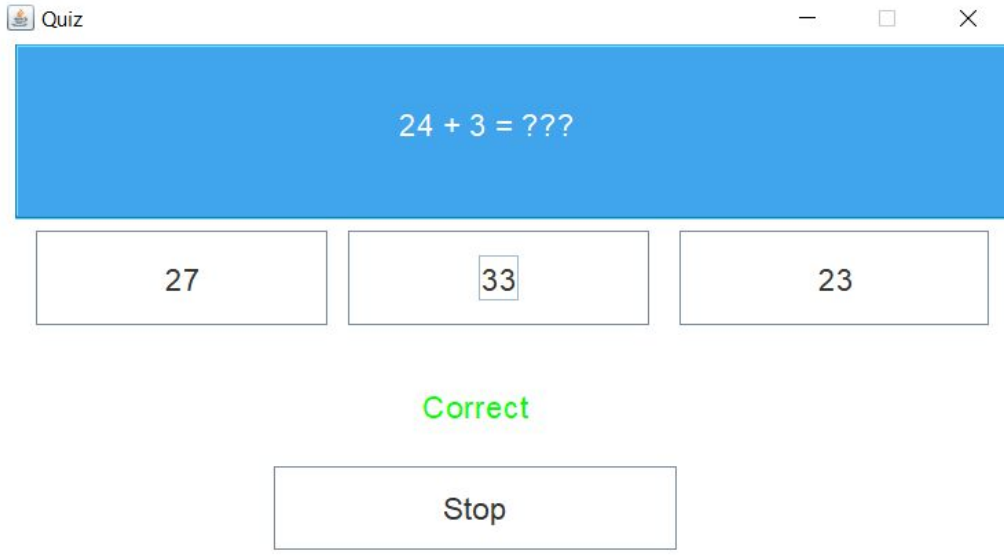
Our Numbering System Tool is a Java-based application that helps users have a better understanding of each numbering system and helps develop fundamental skills used while working with each.

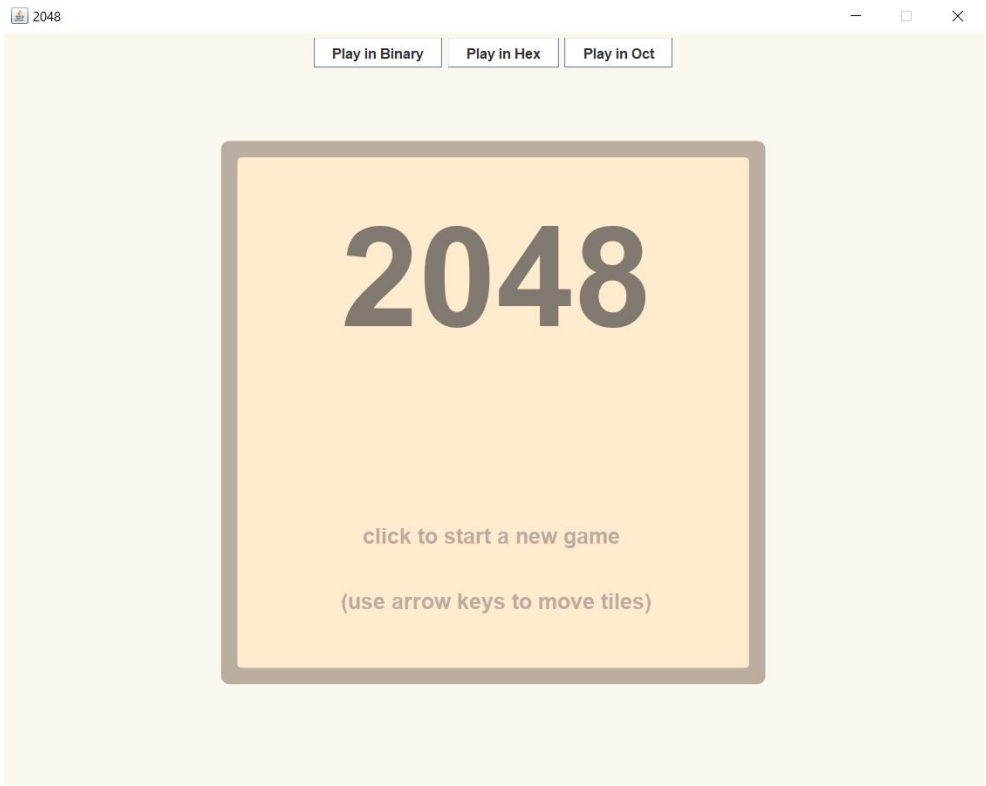
2.1.1 Sample GUI

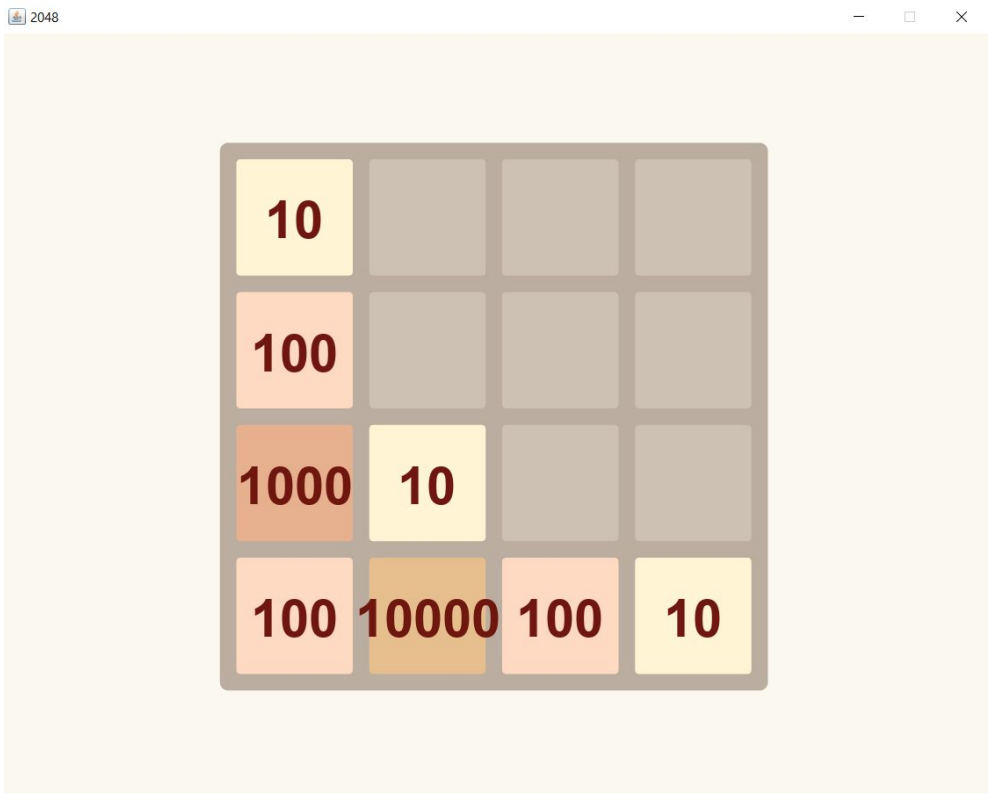


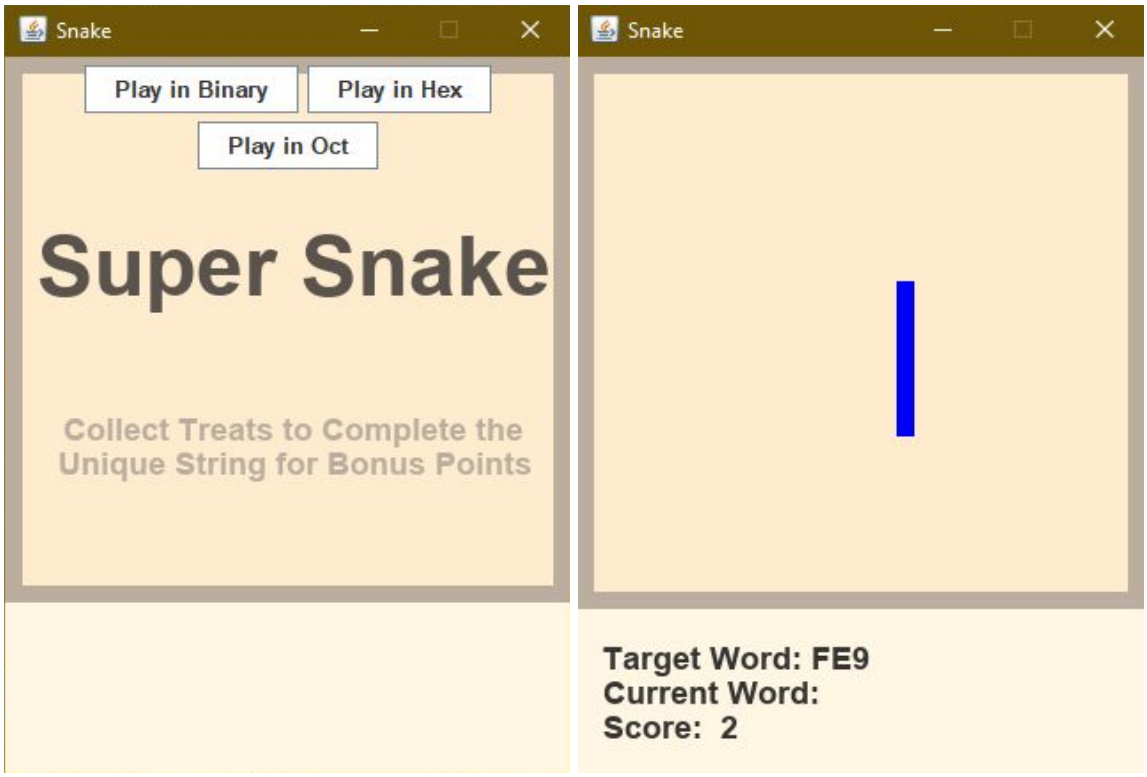



Quiz
Play in Hex
Play in Octal
Play in Binary
Start


Quiz
24 + 3 = ???
27
33
23
Correct
Stop


2048
Play in Binary
Play in Hex
Play in Oct
2048
click to start a new game
(use arrow keys to move tiles)


2048
10
100
1000
10
100
10000
100
10



2.2 Product Functions

When users first open up the Number System Tool, they are first introduced to the calculator. In the calculator, the user can use a wide variety of functions and algorithms based on many numbering systems. The Number System Tool also has other features to help the user learn mathematics. One example of this is our *2048 Game*. *2048* helps the users to learn addition or multiplication within multiple numbering systems by sliding the same numbers together it multiplies and displays the result. The user wins once they hit *2048* in either Hex, Decimal, Octal or Binary. *Snake Game* helps the user to have a better understanding of numbering systems. In the game the user controls a "snake" which collects numbers in order to match the target number, can be played in either Hex, Octal or Binary. Finally the Number System Tool also has a Quiz. This quiz is designed to test the user on numbering systems by displaying an addition problem in either Hex, Octal or Binary and three options with only one having the correct answer.

2.3 User Characteristics

Users would be any persons which has enough knowledge of number systems to understand the digits and symbols. This would typically be students, particularly those interested in computer science or math. Users could also be individuals who have a casual interest in the subject or those who simply wish to expand their knowledge of different numbering systems. It could also be used by people who are computer science experts but wish to do large calculations within the numbering systems quickly.

2.4 Constraints

- Numbers and results that are too big to be computed or displayed
- Syntax errors
- Mathematical impossibilities like division by 0

2.5 Assumptions and Dependencies

It is assumed that the user has a remedial knowledge of the number systems and basic arithmetic. The user also needs to know how to operate a basic game on the computer.

3. Requirements Specification

3.1 External Interface Requirements

- When the user changes numbering systems, the buttons corresponding to certain systems will be disable to insure that they input values of the current system
- The user can either press the buttons corresponding to the intended value or manually type it in on the keyboard

3.2 Functional Requirements

3.2.1 Open Calculator

Use Case	Enter Calculator
Trigger	User wishes to enter the Calculator Interface from the home menu
Precondition	User is on the Home Interface
Basic Path	From the Home Interface, user presses the Calculator Button
Alternative Path	
Postcondition	The Calculator Interface is opened
Exception Paths	
Other	

- The Calculator Interface is accessible from the Home Menu

3.2.2 Entering Numbers

Use Case	Enter a number into the Calculator
Trigger	User enters number to convert into calculator interface for conversion or arithmetic
Precondition	User is on the Calculator interface
Basic Path	From the Calculator Interface, user presses Number Interface buttons
Alternative Path	
Postcondition	Users number is displayed in the Current textbox.
Exception Paths	Number typed is of an incorrect format will result in no conversions being displayed.
Other	Conversions are displayed in the relevant display textboxes as a side effect of entering a number.

- When the user clicks on a different numbering system, it will display the numbering system on the big display label
- The calculator will automatically convert all inputs into all numbering systems

3.2.3 Choosing Primary Number System

Use Case	Clicking one of the 4 radio buttons
Trigger	User clicks on a radio button that represents a certain number system
Precondition	User is on the Calculator interface
Basic Path	From the Calculator Interface, user presses one of four radio buttons
Alternative Path	
Postcondition	Users chosen numbering system is displayed in the Current textbox and they can now access all the buttons and functions specific to that number system
Exception Paths	
Other	Conversions are displayed in the relevant display textboxes as a side effect of entering a number.

- Can only click

3.2.4 Clearing User Field

Use Case	Clear
Trigger	User wishes to clear all stored values and start again
Precondition	User is on the Calculator Interface
Basic Path	User presses the Clear button
Alternative Path	
Postcondition	Numbers are cleared from every number label on the Calculator Interface
Exception Paths	
Other	

- The clear button clears all labels that display numbers and temporary memory

3.2.5 Clear Entry (CE)

Use Case	Clear Entry Field
Trigger	User wishes to clear the current value.
Precondition	User is on the Calculator Interface
Basic Path	User presses the Clear button
Alternative Path	
Postcondition	Numbers are cleared from every number label on the Calculator Interface
Exception Paths	
Other	

- The ce button clears all labels that display numbers but keeps inputs that are stored in the temporary memory unlike clear which clears everything

3.2.6 Copy User Field

Use Case	Copying current value
Trigger	User wishes to clear all stored values and start again
Precondition	User is on the Calculator Interface
Basic Path	User presses the Copy button
Alternative Path	
Postcondition	Numbers that were in the display field are copied and stored for later use
Exception Paths	
Other	

- The copy button copies the value that is the current displayfield

3.2.7 Paste

Use Case	Pasting copied value
Trigger	User wishes to paste the value they have copied
Precondition	User is on the Calculator Interface, has to have something already copied
Basic Path	User presses the paste button
Alternative Path	
Postcondition	Numbers that were copied are now pasted onto current display field and is converted for all numbering systems
Exception Paths	
Other	

- The paste button paste the value that was previously copied into the display field

3.2.8 Adding Numbers

Use Case	Adding Two Numbers
Trigger	User wishes to Add two numbers and display the sum
Precondition	User is on the Calculator Interface
Basic Path	User enters a number, presses the Add button, then enters a second number
Alternative Path	
Postcondition	First number, the add function, and the second number are stored in memory
Exception Paths	The equals button or another arithmetic function must be pressed to complete the arithmetic.
Other	

- When the add button is clicked, it will add the current value and the next inputted value together for all numbering systems

3.2.9 Subtracting Numbers

Use Case	Subtracting Two Numbers
Trigger	User wishes to Subtract two numbers and display the difference
Precondition	User is on the Calculator Interface
Basic Path	User enters a number, presses the Subtract button, then enters a second number
Alternative Path	
Postcondition	First number, the subtract function, and the second number are stored in memory
Exception Paths	
Other	The equals button or another arithmetic function must be pressed to complete the arithmetic.

- When the subtract button is clicked, it will subtract the current value and the next inputted value together for all numbering systems

3.2.10 Multiplying Numbers

Use Case	Multiplying Two Numbers
Trigger	User wishes to Multiply two numbers

Precondition	User is on the Calculator Interface
Basic Path	User enters a number, presses the Multiply button, then enters a second number
Alternative Path	
Postcondition	First number, the multiply function, and the second number are stored in memory
Exception Paths	
Other	The equals button or another arithmetic function must be pressed to complete the arithmetic.

- When the multiplication button is clicked, it will multiply the current value and the next inputted value together for all numbering systems

3.2.11 Dividing Numbers

Use Case	Dividing Two Numbers
Trigger	User wishes to Divide two numbers
Precondition	User is on the Calculator Interface
Basic Path	User enters a number, presses the Divide button, then enters a second number
Alternative Path	
Postcondition	First number, the divide function, and the second number are stored in memory
Exception Paths	
Other	The equals button or another arithmetic function must be pressed to complete the arithmetic.

- When the divide button is clicked, it will divide the current value and the next inputted value together for all numbering systems

3.2.12 Exponents

Use Case	Multiplying a number a certain amount of times
Trigger	User wishes to multiple the base (first inputted value) by itself x (the second value) amount of times

Precondition	User is on the Calculator Interface
Basic Path	User enters a number, presses the exponent button, then enters a second number
Alternative Path	
Postcondition	First number is multiplied a certain amount of times and is displayed
Exception Paths	
Other	The equals button or another arithmetic function must be pressed to complete the arithmetic.

- When the exponent button is clicked, it will take the first inputted value and multiple it by itself x amount of times where x is the second value

3.2.13 Square Rooting

Use Case	Taking a Square Root
Trigger	User wishes to take the Square Root of a number
Precondition	User is on the Calculator Interface
Basic Path	User enters a number and presses the Square Root button
Alternative Path	
Postcondition	The Square Root of the inputted number is displayed in the Current label
Exception Paths	The Square Root function will not work with negative numbers
Other	

- When the square root button is pressed, it will square root the current value

3.2.14 Squaring

Use Case	Squaring a number
Trigger	User wishes to multiply a number by itself twice
Precondition	User is on the Calculator Interface
Basic Path	User enters a number, presses the square button
Alternative Path	

Postcondition	First number, is squared and displayed
Exception Paths	
Other	The equals button or another arithmetic function must be pressed to complete the arithmetic.

- When the square button is clicked, it will multiply the current value in display by itself twice

3.2.15 Negative Numbers

Use Case	Making a negative number
Trigger	User wishes to make the current value negative
Precondition	User is on the Calculator Interface
Basic Path	User enters a number, presses the negative
Alternative Path	
Postcondition	The negative version of that number is displayed in the current label
Exception Paths	
Other	The equals button or another arithmetic function must be pressed to complete the arithmetic.

- When the negative button is clicked, it will make the current number negative in all number systems

3.2.16 1's Complement

Use Case	Finding the 1's Complement of a Binary Number
Trigger	User wishes to take the 1's Complement of a Binary Number
Precondition	User is on the Calculator Interface
Basic Path	User enters a Binary number and presses the 1's Complement button
Alternative Path	
Postcondition	The 1's Complement of the inputted number is displayed in the Current label
Exception Paths	The 1's Complement function will not work with non-binary numbers
Other	

- When the 1’s Complement button is pressed, it will the 1’s Complement of the current binary number

3.2.17 2’s Complement

Use Case	Finding the 2’s Complement of a Binary Number
Trigger	User wishes to take the 2’s Complement of a Binary Number
Precondition	User is on the Calculator Interface
Basic Path	User enters a Binary number and presses the 2’s Complement button
Alternative Path	
Postcondition	The 2’s Complement of the inputted number is displayed in the Current label
Exception Paths	The 2’s Complement function will not work with non-binary numbers
Other	

- When the 2’s Complement button is pressed, it will the 2’s Complement of the current binary number

3.2.18 Deleting

Use Case	Deleting
Trigger	User wishes to Delete the most recent input
Precondition	User is on the Calculator Interface
Basic Path	User presses the delete button
Alternative Path	
Postcondition	The most recent inputted number is deleted
Exception Paths	
Other	The equals button or another arithmetic function must be pressed to complete the arithmetic.

- When the divide button is clicked, it will delete the most recent value that was added

3.2.19 Executing Calculation

Use Case	Equals
Trigger	User wishes to complete the arithmetic and display the result.
Precondition	User is on the Calculator Interface, with two numbers and a function stored in memory
Basic Path	User presses the Equals button
Alternative Path	
Postcondition	The result of the two numbers and arithmetic function is displayed in the Current textbox, and the result is stored as the first number in memory.
Exception Paths	
Other	Trying to Equals while less than two numbers and an arithmetic function are stored in memory will display an error

- The equals button displays the result on the arithmetic and displays it in all displays

3.2.20 Themes

Use Case	Changing themes
Trigger	User wishes to change the color of calculators interface
Precondition	User is on the Calculator Interface
Basic Path	User clicks on themes and chooses either light or dark theme
Alternative Path	
Postcondition	The color of the ui and buttons are changed based on user preference
Exception Paths	
Other	

- When the themes menu bar is clicked, a drop down menu appears giving the user the option of either dark mode or light mode. When either is pressed, it changes the background to match the option selected

3.2.21 Exit Interface

Use Case	Exit Interface
Trigger	User wishes to exit the current Interface and access the Home Interface
Precondition	User is on any Interface except the Home Interface
Basic Path	User presses the Exit button
Alternative Path	
Postcondition	The current Interface is closed and the user is returned to the Home Interface
Exception Paths	User is already on the Home Interface
Other	

- The exit button is present on every interface except the Home Interface and allows the user to return to the home menu

3.2.22 Snake Game

Use Case	Enter Snake game
Trigger	User wishes to enter the Snake Interface from the home menu
Precondition	User is on the Home Interface
Basic Path	From the Home Interface, user presses the Snake button
Alternative Path	
Postcondition	The Snake Interface is opened
Exception Paths	
Other	

- The Snake game is accessible from the main menu through the Snake button

3.2.23 2048 Game

Use Case	Enter 2048 game
Trigger	User wishes to enter the 2048 Interface from the home menu

Precondition	User is on the Home Interface
Basic Path	From the Home Interface, user presses the 2048 button
Alternative Path	
Postcondition	The 2048 Interface is opened
Exception Paths	
Other	

- The 2048 game is accessible from the main menu through the 2048 button

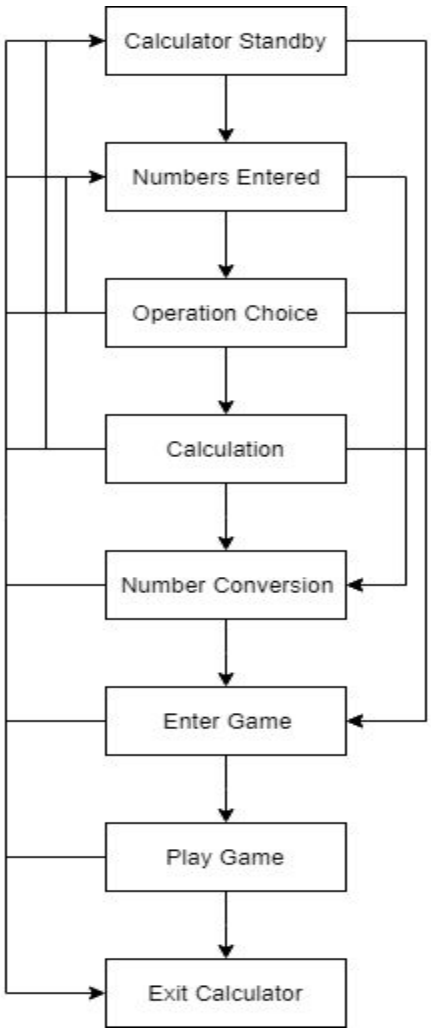
3.2.24 Quiz

Use Case	Enter Math Game game
Trigger	User wishes to enter the Math Game Interface from the home menu
Precondition	User is on the Home Interface
Basic Path	From the Home Interface, user presses the Play Quiz button
Alternative Path	
Postcondition	The Quiz Interface is opened
Exception Paths	
Other	

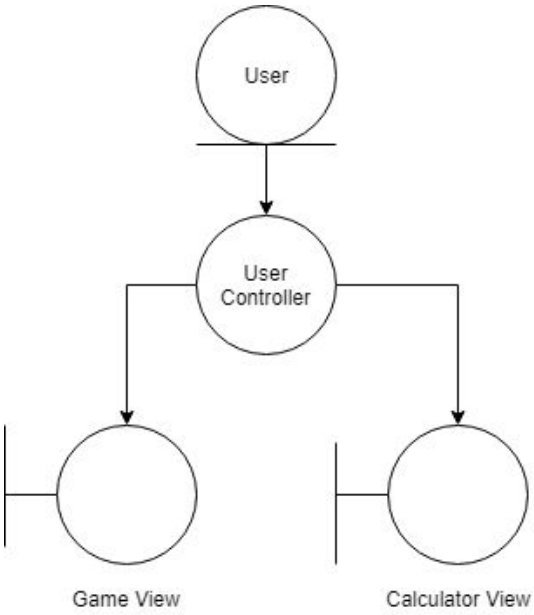
- The quiz is accessible from the main menu through the Quiz button

4. Diagrams

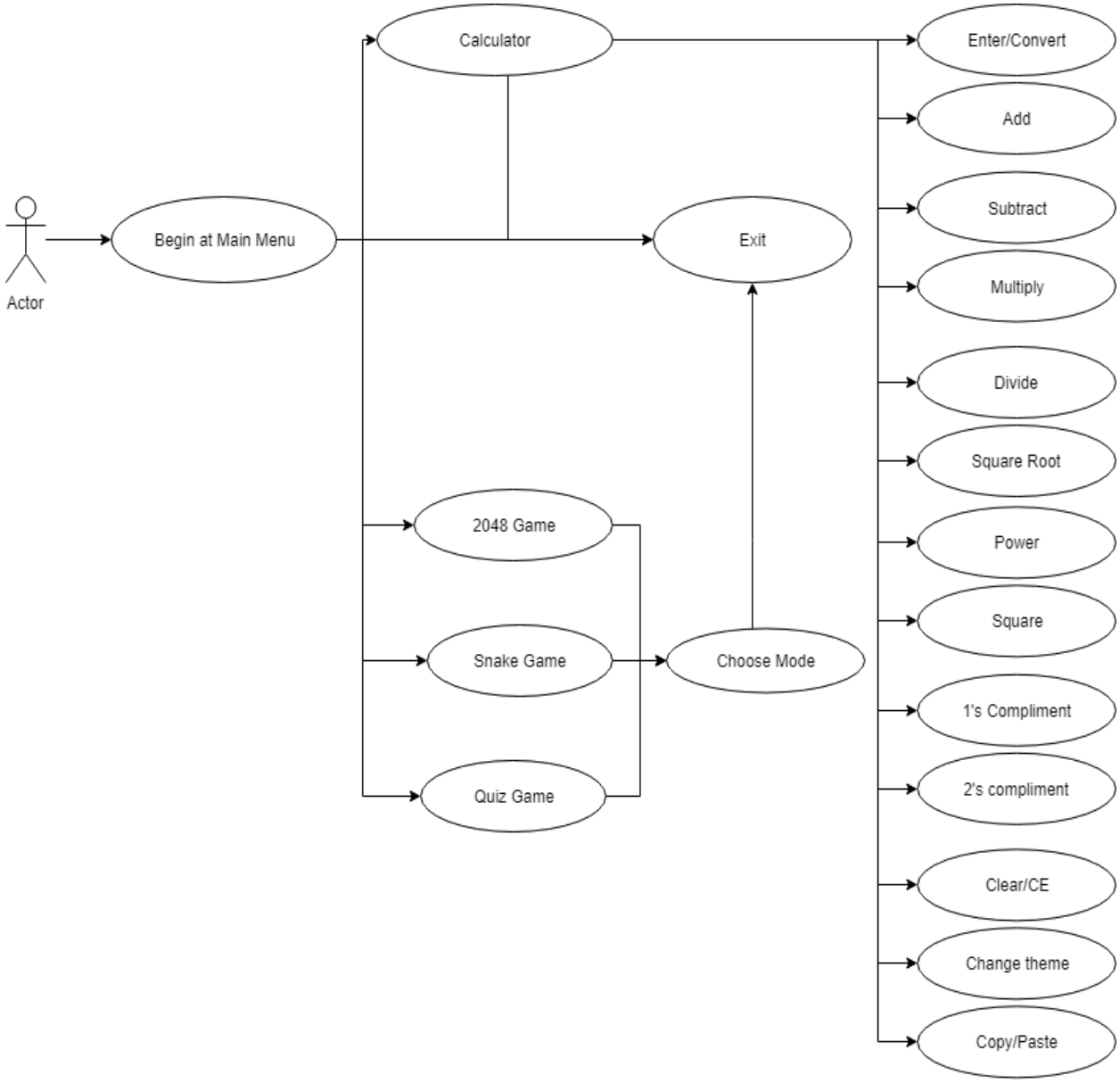
4.1 Analysis Diagram



4.2 Object Diagram



4.3 User Diagram



5. Versions

- Version 0.1 06/12/2019 Document outline created
- Version 0.2 07/04/2019 Further information added
- Version 0.3 07/10/2019 Updated use case diagram
- Version 0.4 07/15/2019 Added more functions
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6. Authored by:

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