I. PROJECT TITLE

"Kingdom of Eldoria: Simulating Kingdom Hierarchy through Binary Tree"

II. PROJECT DESCRIPTION

a) **Overview**

The Kingdom of Eldoria is a text-based simulation game where players manage a kingdom by recruiting knights, gaining resources, and making strategic decisions to expand and maintain their realm. The game is designed to provide an engaging and interactive experience with a rich narrative and a hierarchical structure of knights.

b) **Objective**

The objective is to lead the kingdom to glory by managing resources, recruiting knights, and making decisions that affect the kingdom's hierarchy and prosperity.

c) **Scope**

This project involves creating a dynamic and interactive command-line interface for the game. The game includes various features such as recruiting knights, viewing the kingdom's hierarchy, converting experience to gold, and more. The program is implemented in C and uses basic file I/O for data storage. The project is not designed to handle large or highly complex trees. Its scope is limited to educational purposes, providing a clear and understandable model of a kingdom's structure using binary trees. It does not involve complex game mechanics, such as combat or external interactions. There will be no advance features such as real-time updates.

III. FEATURES

a) **Recruit Knights:** Players can recruit new knights and assign them to leaders. Recruitment requires gold and increases the leader's experience.

b) **Inspect Knights:** Players can view detailed information about any knight in the kingdom, including their role, gold, experience, and subordinates.

c) **View Kingdom Hierarchy:** The entire hierarchy of the kingdom can be

displayed, showing the king and all subordinates in a tree structure.

d) **Exile Knights:** Players can remove knights and their subordinates from the kingdom.

e) **Convert Experience to Gold:** Knights' experience points can be converted into gold, allowing players to manage resources effectively.

f) **Save and Load Kingdom State:** The game's state can be saved to a file and loaded from it. This allows players to continue their progress at a later time.

g) **Display Help Guide:** A detailed help guide is available to assist players with understanding the game's features and commands.

IV. TECHNOLOGIES USED

a) Programming Language/s: C

b) Tools: VSCode, GitHub, Copilot AI

c) Databases: Notepad

V. PROJECT STRUCTURE

/DSA-Final-Project--Kingdom

/project

```
│   ├── main.c              # Main entry point of the program
│   ├── Design.c            # Handles program design/interface components
│   ├── Files.c             # Manages file-related operations
│   ├── GoldExp.c           # Handles gold/experience logic and validation
│   ├── Helper_Functions.c  # Utility/helper functions for the program
│   ├── Main_Features.c     # Core features of the program
│   └── tempCodeRunnerFile.c # Temporary file for testing (can be ignored)
│   └── Kingdom.h           # Contains declarations and macros for the program
│   └── KINGDOM.txt         # Stores kingdom-related data
│   └── README.md           # Project description
│   └── main.exe            # Compiled executable file
├── .gitattributes          # Git configuration for handling file attributes
├── .gitignore              # Git configuration to exclude files from version control
```

VI. USAGE

1. **Starting the Game:** Compile and run the main program file to start the game.

The game will load the kingdom's state from kingdom.txt if it exists.

2. **Main Menu:** Follow the on-screen prompts to navigate through the main menu and choose different actions like recruiting knights, inspecting status, viewing the hierarchy, etc.

```
+-----------------------------------------------------------------------------------------+
|                                                                                         |
|                                THE KINGDOM OF ELDORIA                                   |
|                                                                                         |
+-----------------------------------------------------------------------------------------+

What actions shall you take, my liege?

1. Recruit a new knight to our cause
2. Inspect a knight's status
3. View the entire kingdom's hierarchy
4. Exile a knight
5. Convert experience to gold
6. Save the kingdom's records and retire
7. Demolish kingdom
8. Program Guide

Your command:
```

a. **Choose option 1:**

```
+-----------------------------------------------------------------------------------------+
|                                                                                         |
|                                THE KINGDOM OF ELDORIA                                   |
|                                                                                         |
+-----------------------------------------------------------------------------------------+

Who shall lead this new recruit?
Enter leader's name: Art

And who is this brave soul seeking to join our ranks?
Enter recruit's name: A
```

```
In the grand halls of Art's command post...

+-----------------------------------------------------------------------------------------+

        A steadfast warrior steps forth, their armor gleaming faintly under the torchlight.
The hall falls silent as the warrior kneels, ledging their blade and loyalty to the realm.

        With a solemn nod, Art proclaims, 'By royal decree, I name thee, A, my sworn
left knight. Rise and serve with honor!'

        The kingdom grows ever mightier, its strength forged anew with the addition of such
valiant souls. Each knight who joins our cause brings honor to the realm and fortifies
the banners of our sovereignty.

+-----------------------------------------------------------------------------------------+

Press Enter to continue...
```

b. **Choose option 2:**

```
+-----------------------------------------------------------------------------------------------+
|                                                                                               |
|                                    THE KINGDOM OF ELDORIA                                     |
|                                                                                               |
+-----------------------------------------------------------------------------------------------+

Whose court shall we examine?
Enter knight's name: Art
```

```
+-----------------------------------------------------------------------------------------------+

== The Court of Art ==

Leader: Art (Elite Knight)
Personal Treasury: 200 gold
Knight Experience: 3000 exp
Kingdom Treasury: 200 gold

Direct Subordinates:
Left Knight: A (0 gold, 1000 exp)
Right Knight: B (0 gold, 1000 exp)

+-----------------------------------------------------------------------------------------------+


Press Enter to continue...
```

c. **Choose option 3:**

```
+-----------------------------------------------------------------------------------------------+
|                                                                                               |
|                                    THE KINGDOM OF ELDORIA                                     |
|                                                                                               |
+-----------------------------------------------------------------------------------------------+


Behold, the grand hierarchy of our kingdom!


+-----------------------------------------------------------------------------------------------+

Kingdom Treasury: 200 gold

Art (200 gold, 3000 exp, Elite Knight)
   A (0 gold, 1000 exp, Knight)
   B (0 gold, 1000 exp, Knight)

+-----------------------------------------------------------------------------------------------+


Press Enter to continue...
```

d. **Choose option 4:**

```
+-----------------------------------------------------------------------------------------------+
|                                                                                               |
|                                    THE KINGDOM OF ELDORIA                                     |
|                                                                                               |
+-----------------------------------------------------------------------------------------------+

Who shall be exiled from the kingdom?
Enter knight's name to be exiled: A


+-----------------------------------------------------------------------------------------------+

Warning: Exiling knight A will also remove all its subordinates.
Do you want to proceed? (yes/no): yes

Knight A and all its subordinates have been exiled.

+-----------------------------------------------------------------------------------------------+


Press Enter to continue...
```

e. **Choose option 5:**

```
+-----------------------------------------------------------------------------------------------+
|                                                                                               |
|                                    THE KINGDOM OF ELDORIA                                     |
|                                                                                               |
+-----------------------------------------------------------------------------------------------+

Who's experience shall we convert to gold?
Enter knight's name: B
```

```
+-----------------------------------------------------------------------------------------------+
|                                                                                               |
|                                    THE KINGDOM OF ELDORIA                                     |
|                                                                                               |
+-----------------------------------------------------------------------------------------------+

Current Status of B:
Experience Points: 1000
Gold: 0
Conversion Rate: 500 EXP = 100 Gold

How much experience would you like to convert to gold?
Enter amount (minimum of 500 exp): 500

Conversion successful!
Converted 500 EXP to 100 Gold

New Status:
Experience Points: 500
Gold: 100
+-----------------------------------------------------------------------------------------------+


Press Enter to continue...
```

f. **Choose option 6:**

```
+-------------------------------------------------------------------------------------------------+
|                                                                                                 |
|                                    THE KINGDOM OF ELDORIA                                       |
|                                                                                                 |
+-------------------------------------------------------------------------------------------------+

Preserving the kingdom's legacy for future generations...


===
The kingdom's records have been preserved for posterity.

+-------------------------------------------------------------------------------------------------+


Press enter to continue or 0 to exit...
```

g. **Choose option 7:**

- **If no:**

```
+-------------------------------------------------------------------------------------------------+
|                                                                                                 |
|                                    THE KINGDOM OF ELDORIA                                       |
|                                                                                                 |
+-------------------------------------------------------------------------------------------------+

My liege, art thou certain thou wouldst destroy the kingdom? This choice cannot be undone.
(yes/no): no


+-------------------------------------------------------------------------------------------------+

My liege, the kingdom hath been spared from destruction. Thy mercy shall be remembered by
all who dwell within these walls.

+-------------------------------------------------------------------------------------------------+


Press Enter to continue...
```

- **If yes:**

```
+-------------------------------------------------------------------------------------------------+
|                                                                                                 |
|                                    THE KINGDOM OF ELDORIA                                       |
|                                                                                                 |
+-------------------------------------------------------------------------------------------------+


As the sun sets on the horizon, the once-great kingdom of Eldoria crumbles into the annals
of history...

        The echoes of battles fought and victories won fade into silence, leaving behind
only remnants of a bygone era. The grand halls stand empty, and the banners that once flew
proudly now lie in tatters. The realm that was forged with courage and honor has met its
end, its glory diminished to mere whispers of the past. Yet, in its downfall, the kingdom's
stories will be told, legends of heroes and kings, of valor and sacrifice. Eldoria's spirit
will live on in the memories of those who once called it home, a testament to the rise and
fall of empires.

Press [ENTER] to acknowledge the end of an era...
```

```
+-------------------------------------------------------------------------------------------------+
|                                                                                                 |
|                                    May your reign be long remembered.                           |
|                                                                                                 |
+-------------------------------------------------------------------------------------------------+
PS C:\Users\user\Desktop\FINAL PROJECT>
```

h. **Choose option 8:**

```
================================ PROGRAM GUIDE ================================

                        Welcome to the Kingdom System Guide!

Features and System Explanation

1. Recruit a new knight to our cause
   Purpose: Recruit a new knight and assign them to a leader.

2. Inspect knight's status
   Purpose: View detailed information about a knight and their subordinates.
   The program will display the knight's role, gold, experience, and their
   subordinates.

3. View the entire kingdom's hierarchy
   Purpose: The program will display the kingdom's hierarchy starting from the
   king and including all subordinates.

4. Exile a knight
   Purpose: Remove a knight and all their subordinates from the kingdom.

5. Convert experience to gold
   Purpose: Convert the experience points of a knight into gold.
   Convertion Rate:
     500 exp is equivalent to 100 gold

6. Save the kingdom's records and retire
   Purpose: Save the current state of the kingdom to a file. You can choose to
   continue or exit the program.

7. Demolish kingdom
   Purpose: Permanently delete all records of the kingdom and end the game.
   Confirm if you want to demolish the kingdom. If confirmed, the kingdom will
   be deleted, and a farewell message will be displayed.

8. Program Guide
   Purpose: Display this guide for assistance.
```

VII. TESTING

1. **Compile the C code:** Before testing, compile the C program to generate the executable. Open terminal and type or paste:

   gcc main.c Design.c Files.c GoldExp.c Helper_Functions.c Kingdom.h Main_Features.c -o main

2. **Run the Program:** To start the program, execute the compiled binary:

   ./main

3. **Manual Testing:** Since C projects often don't have automated tests, manual testing is essential. Test various functionalities such as:
   - Recruiting knights and confirming they are added to the kingdom
   - Viewing the kingdom's current state
   - Ensuring that invalid inputs (e.g., entering letters instead of numbers) are handled properly

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Resources used throughout the project development:

- **GeeksforGeeks** – for its in-depth explanations and coding examples that guided me through complex concepts.
- **W3Schools** – for its accessible tutorials and references on various web technologies.
- **CopilotAI** – aid for improving code efficiency
- **Reddit** – for providing a community to discuss and find solutions to various technical challenges.
- **GitHub** – for hosting valuable open-source repositories that contributed to the development of specific parts of the project.

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"Documentation for *recruit* Function"

Purpose

The recruit function is designed to add a new knight to the kingdom's hierarchy under a specified leader. This function ensures that the knight is placed correctly in the binary tree structure of the kingdom, following specific rules for insertion.

Function Logic

1. **Input Validation**: Ensures the knight's name contains only alphabetic characters.
2. **Leader Validation**: Checks if the leader exists and has sufficient gold to recruit a new knight.
3. **Duplication Check**: Ensures there is no existing knight with the same name.
4. **Insertion**: Attempts to insert the new knight as the left or right subordinate of the leader, if those positions are available.
5. **Update and Save**: Updates the experience and role of the leader and its ancestors, and saves the kingdom state.

Insertion Logic

- If the left subordinate position of the leader is empty, the new knight is inserted there.
- If the left position is occupied but the right subordinate position is empty, the new knight is inserted there.
- If both positions are occupied, the recruitment fails.

Example Walk-Through

1. The program will prompt the user who will be the leader of the new recruit as well as the recruit's name.

```
Who shall lead this new recruit?
Enter leader's name: A

And who is this brave soul seeking to join our ranks?
Enter recruit's name: B
```

2. After pressing enter key the program will validate the user inputs and if validates it successful it will now take the user to the confirmation message.

```
In the grand halls of A's command post...

+-------------------------------------------------------------------------------------------+

        A steadfast warrior steps forth, their armor gleaming faintly under the torchlight.
The hall falls silent as the warrior kneels, ledging their blade and loyalty to the realm.

        With a solemn nod, A proclaims, 'By royal decree, I name thee, B, my sworn
left knight. Rise and serve with honor!'

        The kingdom grows ever mightier, its strength forged anew with the addition of such
valiant souls. Each knight who joins our cause brings honor to the realm and fortifies
the banners of our sovereignty.

+-------------------------------------------------------------------------------------------+

Press Enter to continue...
```

This process is also true for the second position of right subordinate.

```
In the grand halls of A's command post...

+-------------------------------------------------------------------------------------------+

        From the shadows of the hall, a determined warrior steps forward, their cloak
billowing with the draft of ancient stone walls. The gathered courtiers hold their breath
as the warrior kneels, swearing their unwavering allegiance to the crown.

        Raising a hand in declaration, A proclaims, 'By royal decree, I name thee, C,
my sworn right knight. Bear the crest of this kingdom with pride and valor!'

        The kingdom grows ever mightier, its strength forged anew with the addition of such
valiant souls. Each knight who joins our cause brings honor to the realm and fortifies
the banners of our sovereignty.

+-------------------------------------------------------------------------------------------+

Press Enter to continue...
```

3. The program may validate this information through the program's display hierarchy option (option 3), or through checking our text file (KINGDOM.txt).
    a. Display Hierarchy (option 3)

At first, after recruiting the first knight, displaying hierarchy will show:

```
+------------------------------------------------------------------------------------------+
|                                                                                          |
|                                THE KINGDOM OF ELDORIA                                    |
|                                                                                          |
+------------------------------------------------------------------------------------------+


Behold, the grand hierarchy of our kingdom!


+------------------------------------------------------------------------------------------+

Kingdom Treasury: 200 gold

King A (200 gold, 2000 exp, King)
   B (0 gold, 1000 exp, Knight)

+------------------------------------------------------------------------------------------+


Press Enter to continue...
```

After recruiting the second knight, the display option will now produce:

```
+------------------------------------------------------------------------------------------+
|                                                                                          |
|                                THE KINGDOM OF ELDORIA                                    |
|                                                                                          |
+------------------------------------------------------------------------------------------+


Behold, the grand hierarchy of our kingdom!


+------------------------------------------------------------------------------------------+

Kingdom Treasury: 400 gold

King A (400 gold, 3000 exp, King)
   B (0 gold, 1000 exp, Knight)
   C (0 gold, 1000 exp, Knight)

+------------------------------------------------------------------------------------------+


Press Enter to continue...
```

    b. Checking the text file KINGDOM.txt

At first, after recruiting our first knight, the text file will get something like this:

```
KINGDOM.txt
1  A 200 2000 King
2      B 0 1000 Knight
3
```

After recruiting the second knight, the text file will now produce:

KINGDOM.txt

```
1   A 400 3000 King
2       B 0 1000 Knight
3       C 0 1000 Knight
4
```

Limitation

The current implementation of the recruit function does not allow users to choose whether to add the new knight as the left or right subordinate. Instead, the function automatically assigns the new knight to the left position if it is available; otherwise, it assigns the knight to the right position. This limitation restricts the flexibility in placing new knights within the hierarchy.

"Documentation for *displayKingdom* Function"

Purpose

The displayKingdom function is designed to display the hierarchy of knights in the kingdom, starting from a specified target knight. It uses pre-order traversal to print the details of each knight in a structured and hierarchical manner.

Function Logic

1. **Null Check**: If the target knight is NULL, the function returns immediately.
2. **Indentation**: Prints appropriate indentation based on the level of the knight in the hierarchy.
3. **Print Details**: Prints the details of the current knight, labeling the root knight as "King" and others as regular knights.
4. **Recursive Traversal**: Recursively calls itself to display the left and right subordinates of the current knight.

Example Walk-Through

To verify the pre-order traversal happening in this function. This document will first show the current state of the kingdom through the contents of the text file, KINGDOM.txt.

KINGDOM.txt

```
1  A 400 4000 King
2     B 200 1500 Knight
3        D 0 1000 Knight
4     C 0 1000 Knight
5
```

According to this text file, the current kingdom have a King named A, which is found on line 1. Line 2 holds A's left knight, which is B. It is recognized as left knight of A because of its level (pertaining to the 3 spaces indentation). On line 3, it shows D as a left knight of B. Lastly C, as right knight of A, because again of its indentation.

If the user decides to check this hierarchy on the program's output, the user may therefore see:

```
+-------------------------------------------------------------------------------------------+
|                                                                                           |
|                                  THE KINGDOM OF ELDORIA                                   |
|                                                                                           |
+-------------------------------------------------------------------------------------------+


Behold, the grand hierarchy of our kingdom!


+-------------------------------------------------------------------------------------------+

Kingdom Treasury: 600 gold

King A (400 gold, 4000 exp, King)
   B (200 gold, 1500 exp, Knight)
      D (0 gold, 1000 exp, Knight)
   C (0 gold, 1000 exp, Knight)

+-------------------------------------------------------------------------------------------+


Press Enter to continue...
```

Proving Pre-order Traversal in displayKingdom Function

The displayKingdom function uses pre-order traversal to display the hierarchy of knights in the kingdom. Pre-order traversal visits nodes in the following order: Current node → Left subtree → Right subtree.

1. Visit the current node.
2. Visit the left sub tree.
3. Visit right subtree.

Consider the following state of the kingdom.

KINGDOM.txt

```
1  A 400 4000 King
2      B 200 1500 Knight
3          D 0 1000 Knight
4      C 0 1000 Knight
5
```

King A

Left Subordinate: B

Left Subordinate: D

Right Subordinate: C

Traversal Steps

1. Visit the Current Node (King A)
2. Recursively Visit the Left Subtree (Subordinate B)
    - Visit the Current Node (B)
    - Recursively Visit the Left Subtree (Subordinate D)
        - Visit the Current Node (D)
        - Left Subordinate of D is NULL (no further nodes to visit)
        - Right Subordinate of D is NULL (no further nodes to visit)
    - Right Subordinate of B is NULL (no further nodes to visit)
3. Recursively Visit the Right Subtree (Subordinate C)
    - Visit the Current Node (C)
    - Left Subordinate of C is NULL (no further nodes to visit)
    - Right Subordinate of C is NULL (no further nodes to visit)

Traversal Order

Following the pre-order traversal, the nodes will be visited in the following order:

1. King A
2. B
3. D
4. C

Confirming

To confirm, test the inputs on a normal pre traversal function.

```
// Function to perform pre-order traversal
void preOrderTraversal(Knight *root) {
    if (root == NULL) return;

    // Visit the current node
    printf("%s ", root->name);

    // Recursively visit the left subtree
    preOrderTraversal(root->leftSub);

    // Recursively visit the right subtree
    preOrderTraversal(root->rightSub);
}

int main() {
    // Create the hierarchy
    Knight *kingA = createKnight("A");
    kingA->leftSub = createKnight("B");
    kingA->rightSub = createKnight("C");
    kingA->leftSub->leftSub =
```

```
createKnight("D");

    // Perform pre-order traversal
    printf("Pre-order Traversal: ");
    preOrderTraversal(kingA);
    printf("\n");
```

Output: