Sequence Recall: Chimp Test Adventure

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***Abstract*—To assess and enhance individuals' working memory capacity and monitor cognitive memorization abilities, programmers have developed a software application based on the Chimp Test. This test gained prominence due to the notion that monkeys outperform humans in this particular task. The software presents grids starting from 1x1, with a randomly generated sequence that players must accurately replicate by pressing the corresponding buttons in the predetermined order.**

***Keywords*—memory, cognitive function, cognitive skills, Chimp Test, monkey memorization game**

I. Introduction

There is a game that exists where a player or participant is presented with randomly generated integers displayed on a screen with random configurations (Inoue & Matsuzawa, 2007, as cited in Roberts & Quillinan, 2014). Using this concept, a professor from Kyoto University's Primate Research Institute named Tetsuro Matsuzawa, where he presented a video in his lecture, where it is shown that a chimpanzee is able to memorize and remember the locations of numbers from 1 - 9 in a rapid manner (Kasprak, 2016).

This Java-based program is looking to replicate this same game, where it will display grids that will increase in increments, where a random pattern will be generated, and the user will have to remember and click on the same pattern in order. This project looks to investigate and in turn, improve a person's cognitive skills, making it so that the user will be aware of how their memory is doing. This program will provide a user-friendly experience, where the UI will be easily understood. While providing a platform to assess and improve certain cognitive skills, The Chimp Test Game aims to give an interactive and engaging way to experience and use the program.

II. Objectives

This project aims to achieve the following objectives:

- Establish an interactive and easily navigable digital platform for evaluating cognitive skills.
- Create a tool that gradually tests users' short-term memory and attention span through escalating challenges.
- Integrate a timer and scoring mechanism to assess and monitor users' performance over time.
- Conventional approaches to evaluating cognitive skills can be time-consuming, require significant effort, and may not deliver immediate feedback. Moreover, existing digital assessment tools may lack user-friendly interfaces and fail to engage users effectively. The Chimp Test Game addresses these challenges by providing a lively, accessible, and enjoyable method for assessing and enhancing cognitive abilities.

The scope of this project will encompass:

- Designing the main game interface with clear instructions and level selection options.
- Introducing progressively challenging difficulty levels.
- Integrating a timer and scoring system to evaluate user performance.
- Implementing random sequence generation to enhance the testing process.
- Providing basic analytics for research and assessment purposes.

III. Methodology

The application flow begins with a title screen, including the game title and a "Play Game" button. Upon clicking the "Play Game" button, the startGame method is triggered. In the game initialization module, the program sets up the initial game grid with buttons, initializes various instance variables (such as buttons, sequence, currentIndex, gridSize, and startTime), and generates the initial button sequence with a shuffle effect.

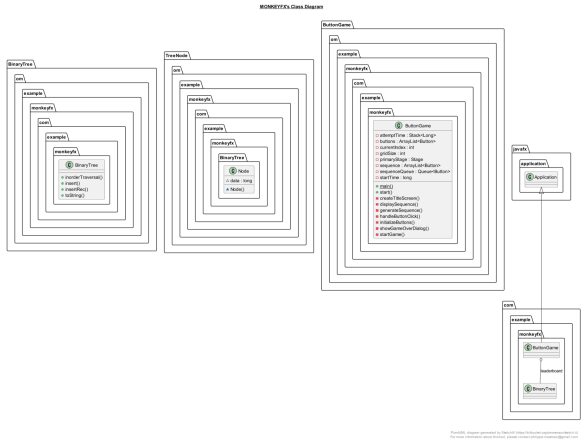
During gameplay, the handleButtonClick method manages button clicks. It checks if the clicked button is correct

in the sequence, updates the game state, increments the grid size, and generates a new sequence if the current one is completed. If the wrong button is clicked, the game ends, and a game-over dialog is displayed. This dialog shows the player's score, time taken, and the leaderboard, offering options to play again or exit the game.

The program utilizes a binary tree data structure implemented in the BinaryTree class to store leaderboard data. This class includes methods to insert completion times into the binary tree and generate a string representation of the leaderboard through an inorder traversal. Multithreading is employed for animation effects during the display of the button sequence.

The JavaFX UI components, including Stage, Scene, VBox, GridPane, Label, and Button, are used to create the user interface. It's worth noting that the provided program does not involve sorting or searching algorithms. Pseudocode for such algorithms or a UML diagram would typically be relevant for more complex applications that require these functionalities. If specific sorting or searching requirements are needed, additional details would be necessary to provide assistance.

UML Diagram:



Pseudocode for Bubble Sort:

```
procedure bubbleSort(arr: Array)
        n = length(arr)
        for i from 0 to n - 1
            for j from 0 to n - i - 1
                if arr[j] > arr[j+1]
                    swap(arr[j], arr[j+1])
```

Pseudocode for Binary Search:

```
function binarySearch(arr: SortedArray, target: Element)
    low = 0
    high = length(arr) - 1
    while low <= high
        mid = (low + high) / 2
        if arr[mid] == target
            return mid
        else if arr[mid] < target
            low = mid + 1
        else
            high = mid - 1
    return -1  // target not found
```

IV. Results and Discussion

This section will cover a trial run of the game, as well as its features.

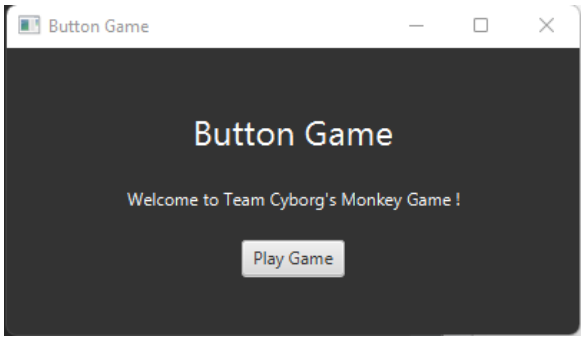


Fig. 1. Start Window

As seen in Fig. 1, The program starts with a window greeting the player. The window consists of the title of the game, “Button Game”, the greeting text, and a button that says “Play Game”, which is used to initiate the game.

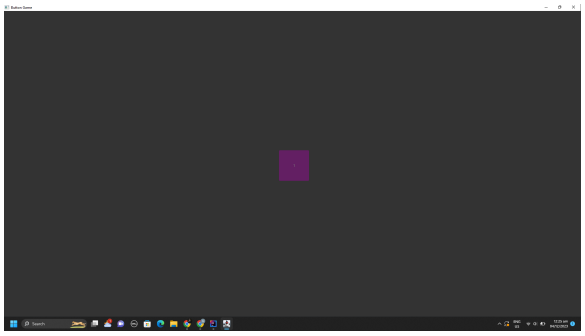


Fig. 2. Full Screen

Upon Pressing the “Play Game” Button, a new full-screen window appears, with the first round of the game starting immediately (See Fig. 2).

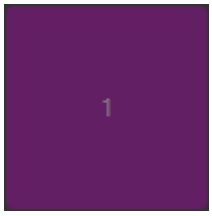


Fig. 3. Button With Number (Intangible)

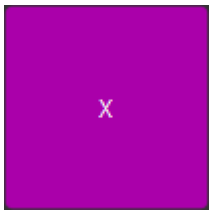


Fig. 4. Button With X (Tangible)

In the game, there are two types of buttons. There are tangible and intangible buttons. Initially, buttons are intangible (see Fig. 3). During each round players are given time to memorize the order to press each button. During this time, buttons are intangible but show their respective numbers based on the order of which they should be pressed in the sequence. Once the time for memorization is over, all of the numbers are replaced with an “X” and the buttons are made tangible (see Fig. 4). Note that the color of the button lightens to signify the change of intangibility to tangibility to the player.

Given that there is only 1 button during round 1, it is not possible for the player to lose. This, however, changes in the following rounds. As seen in Fig. 5, there are now 4 buttons in a 2 x 2 grid.

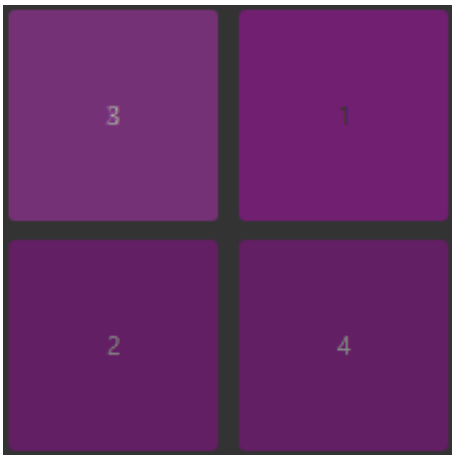


Fig. 5. 2 x 2 Grid

During round one, this feature is not as apparent, however, in the proceeding rounds, it could be observed that numbers are hidden in order. As seen in throughout Fig. 6A-6D, the numbers are not hidden all at once.

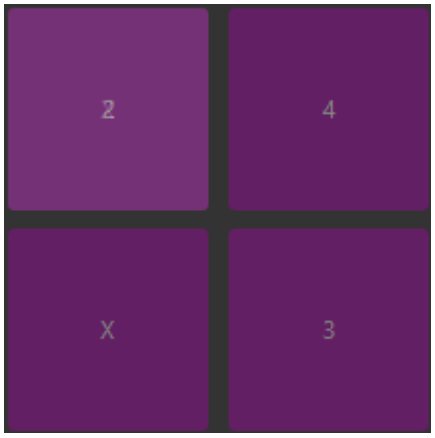


Fig. 6A. Sequential Hiding of Numbers

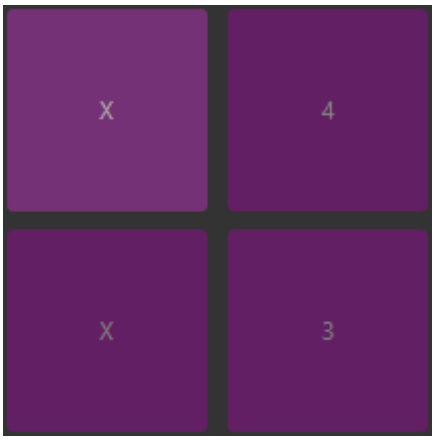


Fig. 6B. Sequential Hiding of Numbers

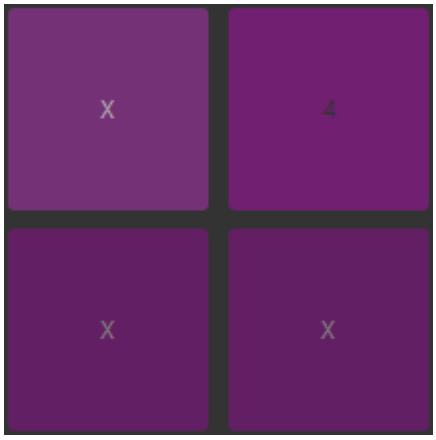


Fig. 6C. Sequential Hiding of Numbers

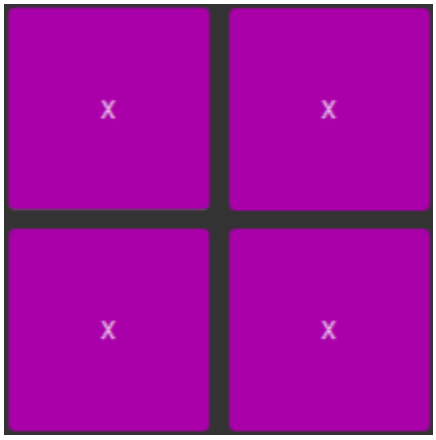


Fig. 6D. Sequential Hiding of Numbers

Another feature which is also not apparent during the first round is the changing of button color and tangibility once they are pressed.

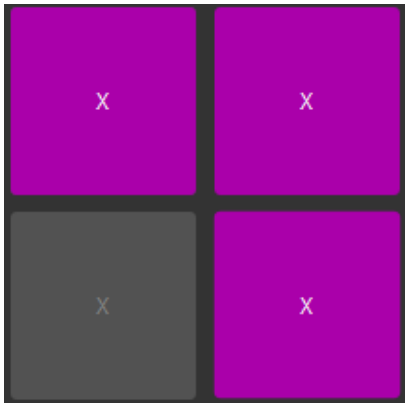


Fig. 7. Sequential Hiding of Numbers

As seen in Fig. 7 The first button was pressed, making it grey and intangible. This is to prevent the player from making repeated inputs.

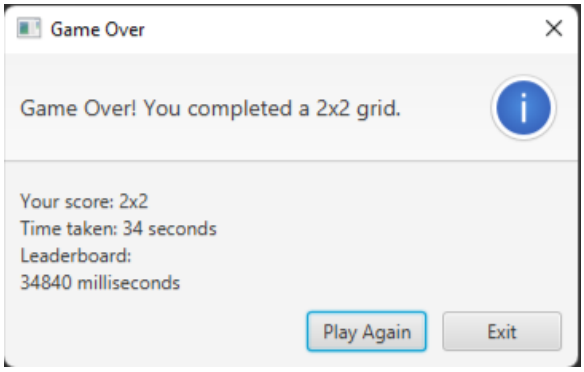


Fig. 8A. Game Over 1

The game ends when the player presses a button out of sequence. Upon doing so, the game displays a "Game Over" message, along with the level they were able to complete/score, time taken, and the leaderboard, which currently has 1 time (See Fig. 8A). It also comes with a "Play Again" button and "Exit" button. Pressing the "Exit" button would end the game. As for pressing the "Play Again" button, doing so would allow the player to start from round again and attempt to reach a new time.

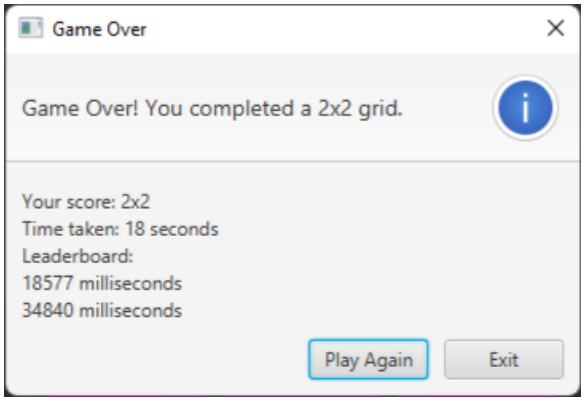


Fig. 8B. Game Over 2

After playing another game, the leaderboard ranks each number from slowest to fastest time. As seen in Fig 8B, a new fastest time (18577 milliseconds) was set and is placed over the previous time (34840 milliseconds)

Fig. 8C. Game Over 3

Fig. 8C shows the game over screen after a third game was played. As seen above, the new time added (25545 milliseconds), is neither faster than the previous game (18577 milliseconds), nor was it slower than the first game (34840 milliseconds). As such, it was placed in the middle of the two, ranking it second overall.

V. Conclusion

To effectively gauge and improve user engagement with the cognitive assessment game, it is advisable to adopt a comprehensive approach. Key performance metrics include monitoring the average session duration and the frequency of sessions per user, serving as indicators of sustained interest and involvement. Assessing the accuracy and recall rate of sequences helps evaluate cognitive performance. It is crucial to track the progression of difficulty levels to ensure users are appropriately challenged, reflecting the value derived from the game. Gathering user feedback through ratings and comments provides valuable insights into satisfaction levels and the game's effectiveness as an assessment tool. Additionally, the retention rate is pivotal in determining long-term user engagement, and if user accounts are in use, the completion rate becomes a significant metric, measuring user commitment to finishing the assessment. Integration of performance analytics offers valuable research insights in cognitive psychology. Ensuring accessibility across various devices and browsers and adhering to accessibility standards is vital for broad user reach. Addressing reported bugs and errors regularly maintains a seamless user experience. In cases involving user accounts. Privacy and data protection measures must align with regulatory standards to foster trust. Finally, optimizing load times and overall performance is crucial for an optimal user experience.

The Chimp Test Game has significantly contributed to the field of cognitive assessment by providing an interactive and engaging platform for evaluating users' short-term memory and attention span, drawing inspiration from a well-known psychology experiment. Having readily available and user-friendly tools for assessing cognitive abilities is crucial in fields such as education, psychology, and neuroscience. Traditional cognitive assessment methods are often time-consuming, labor-intensive, and lack immediate feedback. The Chimp Test Game addresses this gap by offering a digital solution that is intuitive, progressively challenging, and includes a timer and scoring system for accurate performance measurement. The incorporation of randomized sequences prevents pattern memorization, ensuring a fair and accurate assessment. Overall, this project serves as a valuable tool for evaluating cognitive skills in an engaging and accessible manner, making it pertinent and impactful in educational, clinical, and research settings.

VI. References

[1] Kasprak, A. (2016). Chimpanzee rapidly memorizes, locates numbers on a Screen. Snopes. https://www.snopes.com/fact-check/chimpanzee-rapidly-memorizes-locates-numbers-ona-screen/?fbclid=IwAR3Gw3nT9UV9YXK7kdYbI6J1fgKgqqdv6HTEQ424e-miw5D0GTmt f3CsZ

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