Title: Comparative Analysis of Radial and Linear Menus

Name/NSID: Leo Liu / wni817

CMPT481 Project Final Report

• Interaction problem

Users often interact with software interfaces to menus. The coordination problem lies in constructing the most efficient menu structure in terms of Fitts law and target time. Fitts' law determines how long it will take to reach the target depending on the size and distance of the target. Aiming to investigate how menu layouts affect user performance and whether these effects vary across experiences would be the main topic of this report.

• Interaction technique

Two main interaction techniques were implemented to be compared for the reasons to discover which technique would be a better option for pop-up menus, and the probability predicting that switching to a radial menu from a linear menu for most of the systems would be a good idea.

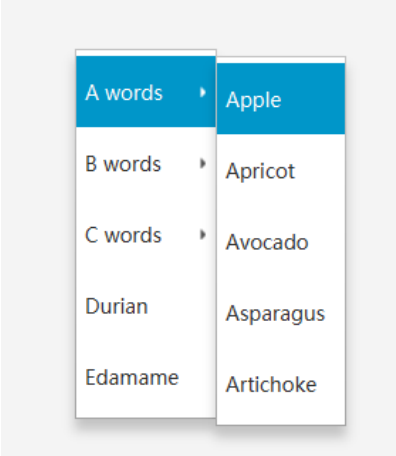
Linear Menu:

The linear menu offers a straightforward, horizontally oriented design that expands smoothly from its primary menu item upon user interaction. Sized to match its radial counterpart for visual consistency, the linear menu's submenus elegantly reveal themselves to the right of the primary menu items. Users can navigate through options by moving their cursor horizontally, with each item visibly highlighted for clarity. Clicking on a submenu item selects the item inside. Closing the menu is simple, clicking on an item from both the primary or submenu would do so.

Radial Menu:

The radial menu offers a visually captivating circular arrangement of submenu options gracefully encircling central primary items. The submenu items fan out in a visually appealing display, forming a symmetrical array around the primary items. Users can navigate this interface by circling their cursor around the circular items, with each item visually highlighted upon selection. Clicking on a submenu item will select the corresponding item. Closing the menu is also simple, the same as a linear menu, clicking on a primary or submenu item would close the menu.

Screenshots below show the example of a linear menu(left) and a radial menu(right):



• Technical overview

Model Composition:

The implementation of the linear and radial menus within the testing experiment is primarily built using JavaFX, a robust framework for creating rich user interfaces in Java. JavaFX provides a comprehensive set of APIs for developing desktop and mobile applications with a focus on GUI (Graphical User Interface) functionality.

Software Approach:

Stages for Instructions and Sessions:

Stages are utilized for organizing the testing experiment into clear instruction and session stages. Instructions are presented in dedicated stages, guiding users on how to interact with and navigate the menus. Sessions are then presented in separate stages, where users can engage with the menus and perform tasks or tests.

Libraries Used:

JavaFX:

JavaFX provides the foundation for creating the graphical elements of the menus, including layouts, data structures and event handling. The menus themselves are designed as custom JavaFX components, each packaging the logic and visual representation of the menu items and their interactions.

Open-Source Code Used:

Open-Source External Radial Menu:

Source: https://github.com/ammarchebbi/RadialMenu

A pre-existing radial menu component sourced from GitHub is incorporated into the project. Modifications are made to adjust its size and possibly customize its appearance to fit the design and functionality requirements of the experiment.

Modification Details:

The open-source radial menu from GitHub is modified to ensure its size matches that of the linear menu. This adjustment ensures fairness and consistency in user interaction and visual presentation between the two menu types. Changes include adjusting dimensions, scaling options, and layout configurations within the radial menu component.

• Evaluation

The goal of the Evaluation:

The evaluation aims to determine the time efficiency of the linear and radial menus, using Fitts' law principles. Specifically, it seeks to identify which menu type, between the linear and radial designs, allows users to navigate to primary and submenu items more quickly. The goal is to assess the potential for the radial menu to replace the commonly used linear menu.

Methods:

Participants: A diverse set of participants familiar with menu-based interfaces.

Tasks: Participants perform navigation tasks with both linear and radial menus.

Data Collection: Empirical time measurements in milliseconds for tasks in 20 datasets.

Time Measurement: Records time for selecting primary and submenu items.

Analysis: The average time for primary and secondary menus in both linear and radial menus will be calculated to compare menu performances.

Fitts' Law Application: Examines the relationship between menu size, distance, and task completion time.

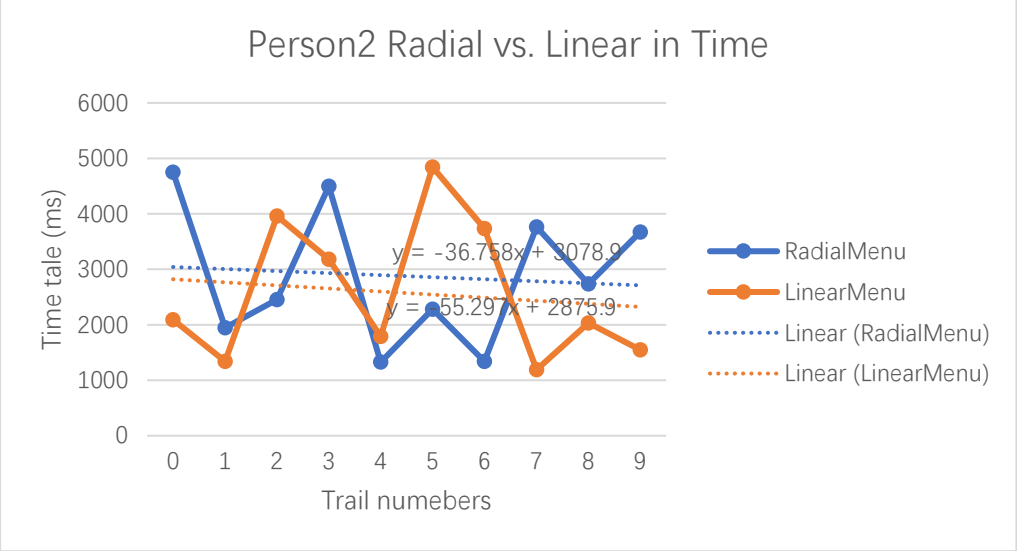
The evaluation provides insights into menu navigation efficiency, focusing on the speed and effectiveness of linear versus radial menu designs, note that targets in primary items are considered as closer targets whereas submenu items are considered as further targets in distance.

Report on results:

In this evaluation involving 20 participants, a consistent trend emerged in the time taken for navigation across both linear and radial menus. Since the dataset from Person 2 makes the most sense compared to other ones, it will be used for the analysis. When utilizing the linear menu, Person 2 initially spent an average of 2088 milliseconds to navigate through the menu options. There was a marginal decrease in the average time taken, suggesting that Person 2 was becoming increasingly adept and efficient with the linear menu layout. In the radial menu data, Person 2 shows an initial average time of 4749 milliseconds. Similar to the linear menu, there was a slight decrease in the average time taken with each trial, indicating a learning effect as Person 2

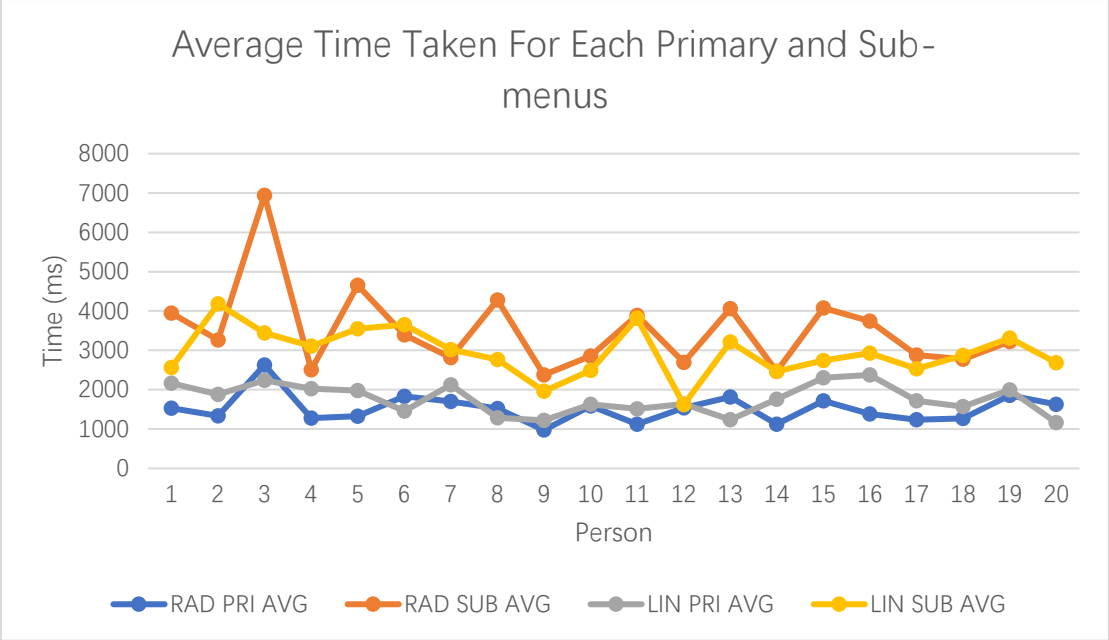
gained familiarity with the radial menu.

Comparing the linear and radial menus based on the dataset of Person 2, it is discerned that the radial menu displayed a slightly higher average time compared to the linear menu. Both menu types showcased a consistent decrease in the average time taken over trials. This declining trend underscores the notion that users, including Person 2, were improving in their efficiency and speed with both menu designs. This aligns well with the concept of the Power Law of Practice, which indicates that users tend to become more skilled and efficient with practice, leading to quicker navigation times. The observed decrease in time taken with practice indicates a learning effect as users familiarize themselves with the intricacies of both menu layouts.



As shown in the "Average Time Taken For Each Primary and Submenus" chart, the data reveals evidence of the efficiency of linear and radial menus. Both the Radial Primary Menu average and Linear Primary Menu average show lower time spent compared to their respective submenus. In comparing the two primary menu types, Linear Primary appears to have a slightly lower average time than Radial Primary menus. This trend shows when examining the submenu comparisons, with Linear Submenus displaying a slightly lower average time than their Radial Submenus.

Applying Fitts' law to the study, the study was controlled for item size to be similar across both menu types, and the distance was categorized into two ranges: Primary/Close and Submenu/Far. The results gleaned from this analysis show that the linear menu beats the radial menu in terms of time efficiency overall. With the slight advantage of Linear Primary menus over Radial Primary menus, the consistent trend of lower average times for Linear Submenus compared to Radial Submenus underscores the efficiency of the linear menu layout.



• Conclusion

Based on these findings, it appears that the linear menu is more time-efficient than the radial menu. The controlled conditions using the Fitts' law principles, and consistent data trends indicate that the linear menu offers advantages in navigation speed and efficiency. The testing results predict that the linear menu cannot be easily replaced by the radial menu in terms of time efficiency. This conclusion provides valuable insights for interface designers and developers, highlighting the strengths of the linear menu layout in optimizing user-interaction speed and effectiveness. Further studies and refinements in menu design could continue to explore the detailed differences between these menu types and their impact on user experience.