**Method**

**Experimental Materials**

This study used a platform jumping game called 《Zool》, collecting player data for one month after its reset release. The game was released on the PC platform, and the data include 520 players and 6511 rows of game records. The game automatic records the player's performance, time, and other data every times when a player exits or completes a level.

**Data Cleaning Preparation**

The same ID names in the original data were changed to simple numbers, and the data format and names were modified for ease of analysis.

10 records with missing content were deleted.

2 records with particularly long playtime were set as NA (>2000s), but other data in those rows were retained. This was because there was no significant deviation in other variables, and the player eventually completed the level. The extended game time might be due to a temporary pause by the player.

One player was found to have replayed the same level 109 times (first world, first level), and apart from that, the most a player replayed a single level was 19 times. Thus, the data for that player was deleted.

After cleaning, the data included 519 players and 6390 rows of game records.

**Variable**

1. Warning

In this game, the warning setting indicates whether the player has enabled a reminder function. This function will cause the joystick to vibrate and illuminate when the player is left with their last life in a certain level. Players who have turned off this feature won't be affected.

2. Churn Rate

In the game, as it's a one-time purchase level-based game, we define churners as players who leave without completing all levels. 48 players (9.23%) completed all levels, and the rest left midway. In this data, we considered both natural and general churn. Natural churn refers to players who stop playing after completing all levels, while general churn refers to players quitting midway.

In the data, general churn is defined as the last row of gameplay data in the same player's final level, denoted as 1. Natural churn is defined as the last data entry for players who have completed the last level (degree 28), denoted as 2. The remaining data indicate that the player will continue to play the game, denoted as 0.

3. Degree

This game has 7 worlds, each with 4 levels, re-encoded as 28 different degrees.

4. Inputs

Total count of controller inputs the player produced during that level.

5. Deaths

The number of times the player has lost all their health and died within the level.

6. Dups\_count

The number of times the same player repeats the same level is marked in chronological order. For example, the first time player1 plays degree 1 is marked as 1; the second time he play degree 1 is marked as 2, and so on.

1. Dup\_flag

Indicates whether the player has replayed the level, with 1 for yes and 0 for no.

8. Times

Total time to complete the level (or game over) in seconds.

9. Total\_times

The total time spent by an individual player on all games.

10. Collecteds

The number of giant collectibles collected within each level. 0-3

11. Collectible Badge

Awarded for collecting over a target percentage of collectibles. Boolean; 0 for false or 1 for true.

12. Time Badge

Awarded for beating a target time. Boolean; 0 for false or 1 for true.

13. Game Over

Player dies without completing the level; 0 for completing the level or 1 for death.

**Hypothesis**

1. This study hypothesizes that warnings will have an effect on player behavior. In this research, we select the player's output count, death times, and clearance duration within a specific level to define a player's game performance. It is assumed that warnings will increase the input rate, reduce player death times, and clearance duration, influencing their clearance behavior and frequency. A linear regression model is used to verify this. Since clearance or not is a binary variable, logistic regression is chosen to validate the effect of activating this device on level clearance.

2. This study uses competing risks regression to explore the impact of various factors on player churn rate. In this research, 6 covariates are considered, with the hypothesis that Collectible Badge, Time Badge, gameover, warning, dup\_flag, and total\_time will all have an effect on the Churn Rate.