Utilizing Eye Gaze Data: Sudoku Game Decision Modelling of Experts/Novices

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Data Science Capstone Project
with AI Research, J.P. Morgan

Motivation

- Tasks with sequential decisions ($$$)
  - Traders -> screens
  - Chess players -> game boards
- Advent of eye-gaze technology
  - Precise eye-tracking
  - Reasonable costs

- Generalize users' on-screen behavior
- Hope to extend findings to the financial applications at J.P. Morgan

Problem Statement

- Expert vs. Novice of Sudoku Games
  - Analysis - Data visualization & Gaze pattern extraction
  - Prediction - Feature Engineering & Deploy ML to predict expert/novice

Game Design

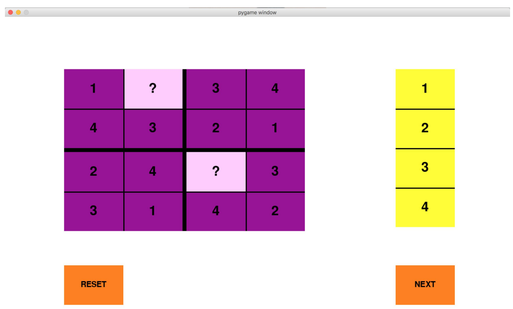

Figure 1. Sudoku Game Interface

- 4 by 4 sudoku puzzle
  - Smaller data volume
  - Reduce eye-gaze data errors
- Colored zones
  - Game area & selection area
  - Easier for players to focus
- 3 levels of difficulties
  - 2/8/12 blanks

Data Collection & Exploration

- Conducted two rounds of experiments to collect data
  - Invited a single student to solve the game and observe the initial pattern
  - Extended the experiments to 20 students to verify the ideas
- Designed a questionnaire to distinguish experts and novice

Figure 2. Gazepoint eye tracking device

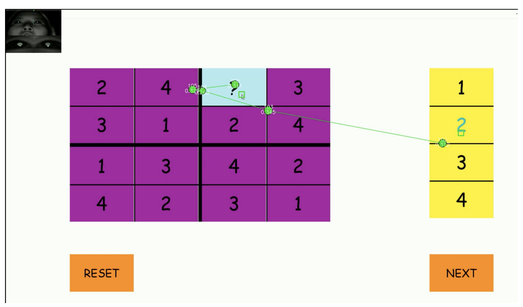

Figure 3. Data demo with eye gaze paths

Feature Selection & Feature importance

- Our team built a pipeline to create four intuitive and meaningful features to feed into our interpretable models including
  - the correctness of input
  - difficulty levels
  - time-spent in the decision making process
  - the transition matrix

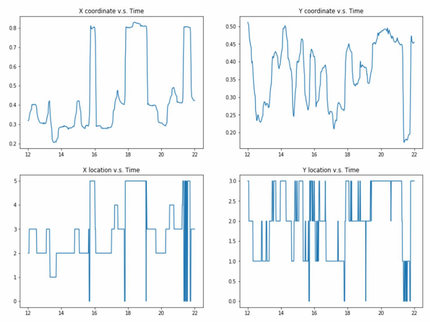

Figure 4. Processed gaze location

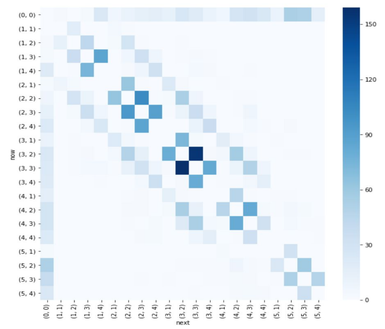

Figure 5. Transition matrix

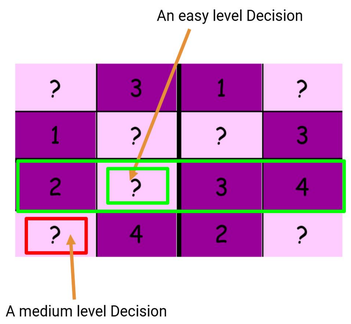

Figure 6. Difficulty level interpretation

- Our team visualized feature importance for each cell of the game board.

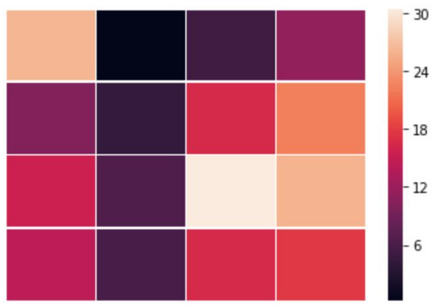

Figure 7. Feature importance of each cell

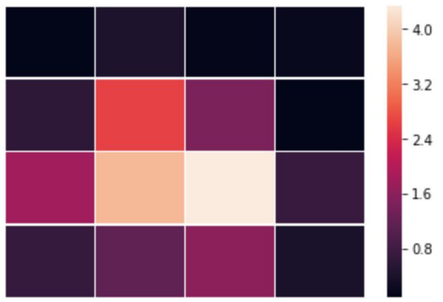

Figure 8. Feature importance of hard question 10

Models & Prediction Results

Logistic regression	70.34%
Random forest	73.25%
Light GBM	80.23%

- Cluster player self-evaluation and performance in the whole game to label data.
- Make prediction whether the player is expert or novice based on first several decisions the player made.

Conclusions and Acknowledgements

Our team has predicted whether the player is an expert or novice with a relatively high accuracy using the Sudoku software designed by our own and aimed to generalize to other fields like financial industry. We would like to thank Dr. Cohen and his team for giving us the opportunity and careful guidance to work on this project.

References

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