Risky Business: Sweating the Small Stuff with Physiological Clues in the Iowa Gambling Task

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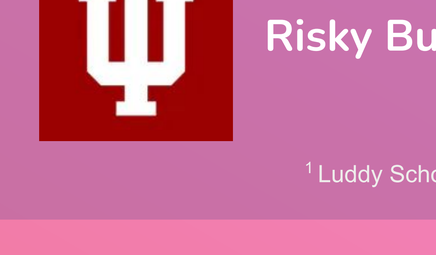
Abstract

Risk mitigation is a primary concern of many fields, from financial systems to warfare. Operator uncertainty can be a valuable indicator of confidence during risky decision making. However, quantification of this value is difficult.

We propose using multiple physiological signals as measures of the parasympathetic and sympathetic nervous systems in order to predict future risk taking taking behaviour.

Using Gradient Boosting Models, dimensionality reduction, and shapley values, we construct an interpretable model for predicting risk from autonomic nervous responses at above chance levels.

Introduction



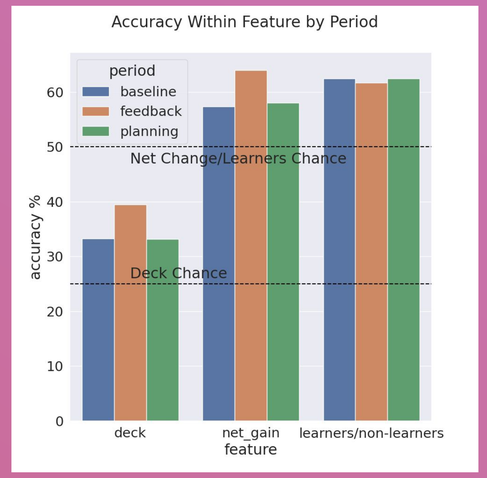
We simulate risky decision making using the Iowa Gambling Task (IGT), a card based game with the objective of score maximization.

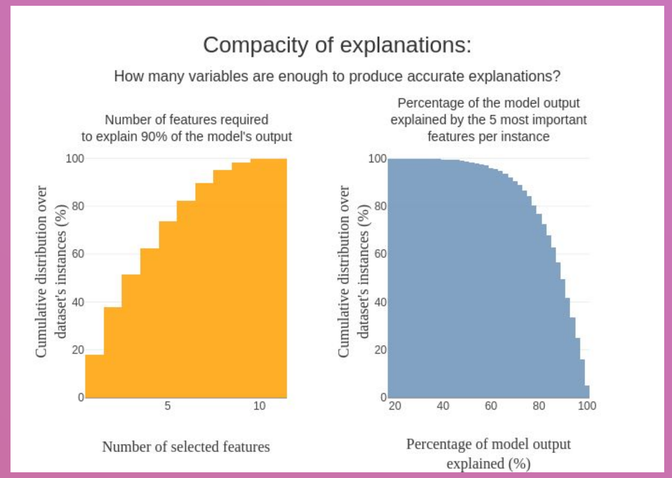
- Decks A&B (top row) lose money over time: Disadvantageous
- Decks C&D (bottom row) earn money over time: Advantageous

During this task, we collect multiple physiological signals from invasive and non-invasive sensors. In our analysis, we focus on four primary signals.

- Pupil diameter
- Respiratory sinus arrhythmia (RSA):
- Heart Rate
- Respiration Rate

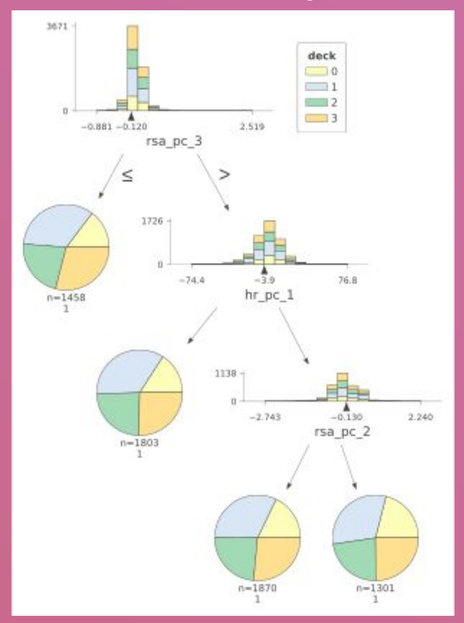
Results



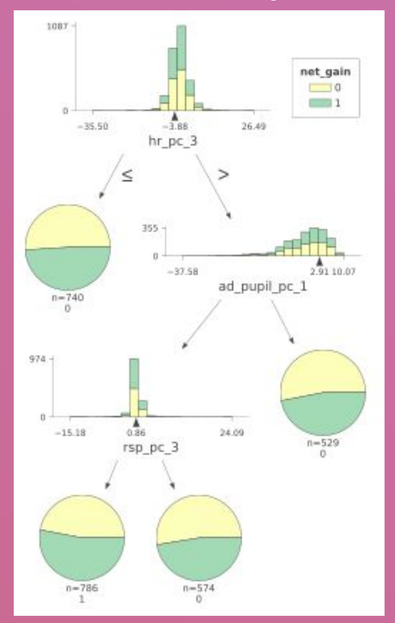


Sample Trees

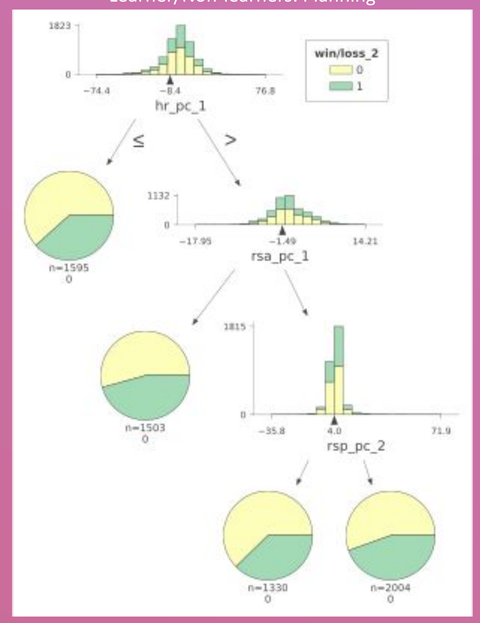
Deck Choice: Planning



Net Gain: Planning

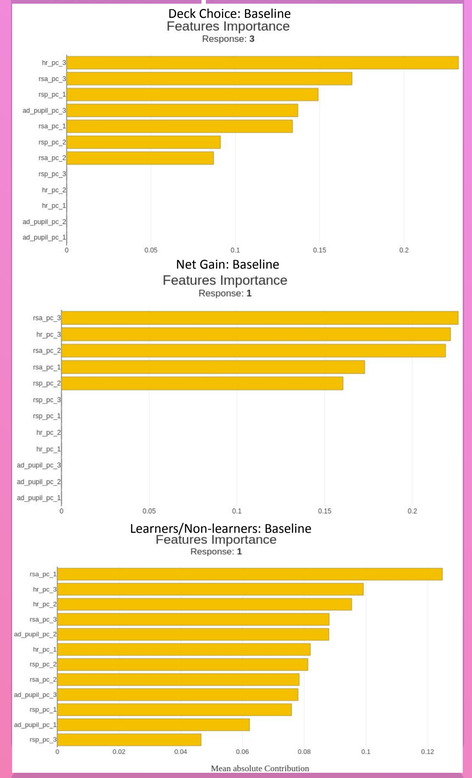


Learner/Non-learners: Planning



Classification of risky behaviour using three principal components from four blocked, physiological time series with LightGBT

Feature Importance



Conclusion

Using a combination of physiological response, we are able to predict at above chance levels a variety of outcomes involving risky decision making.
We hope to continue to refine the methods for predicting these behaviors using more advanced models and improved feature engineering.

References

Sources and code can be found at the provided link.
https://github.iu.edu/bci-fnir/trusting_ai

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