An Intentional AI for Hanabi: Reproduction

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Introduction

In this reproduction, we consider the paper "*An intentional AI for hanabi*" (Eger, Martens, and Cordoba 2017) and propose the following research questions which reproduce and extend the findings of the prior paper:

- RQ1: Does an intentional AI agent perform better in a collaborative game with a human than a baseline AI agent? (as measured by score)
- RQ2: Is the player's perception of the AI agent (e.g. perceived skill and/or enjoyment of playing together) correlated with higher score, regardless of implementation?
- RQ3: Can we use Machine Learning to predict human responses to improve game-playing AI for more compatible cooperation?

Background and Motivation

Game-playing AI has proven to be a useful test-bed for exploring decision-making AI implementations, and has attracted a wide range of researchers and research interests (Yin et al. 2023; Hu et al. 2024). Similarly, AI within games offer a valuable opportunity to understand human perception of interacting, and collaborating, with AI (Laird 2002; Yannakakis 2005). As we rapidly approach a state where humans and AI interact and cooperate on a daily basis, it is becoming increasingly important to (1) develop AIs that meaningfully cooperate with humans, and (2) understand what aspects of human-AI interaction are enjoyable, challenging, or unpleasant for humans. With this paper, we aim to contribute to further understanding AI implementations and human-AI interaction through an analysis of an intentional AI for the game of hanabi.

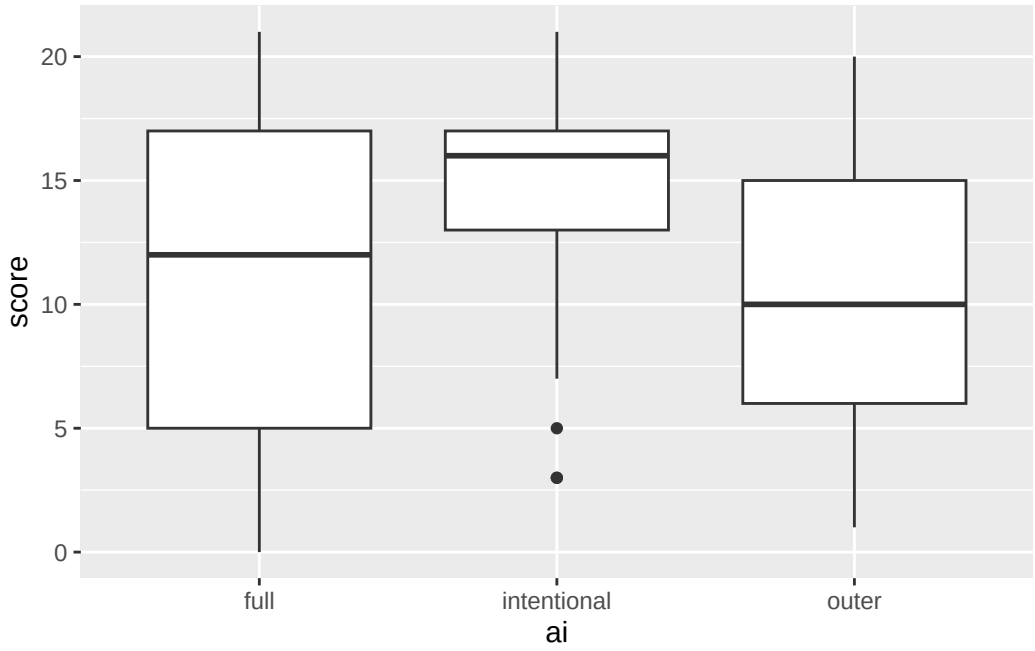
Dataset Description

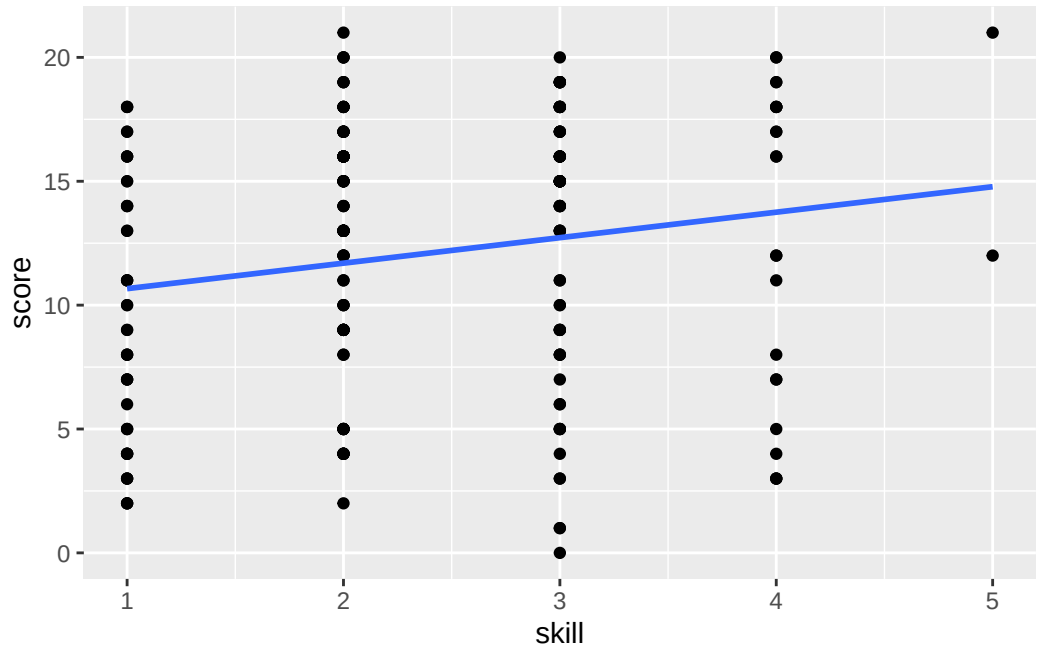
(source, size, key variables)

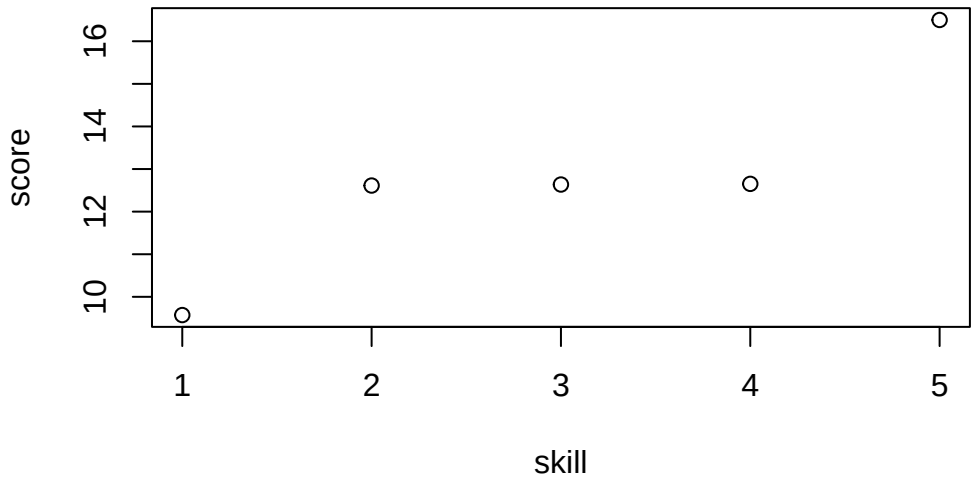
Study Objectives

Exploratory Data Analysis (1-1.5 pages)

- Summary statistics
- Data visualization (2-3 key plots)
- Data quality assessment (missing values, outliers, distributions)
- Preliminary insights that inform modeling choices







Track 1 (Paper Reproduction) should include:

- A combination of original EDA and useful pieces of the EDA presented in the paper. If you use/reproduce a plot from the original paper in your report, give credit to the

authors in the source.

5.1.3 3. Methods (1-1.5 pages)

Track 1 (Paper Reproduction) should include:

- Short explanation of the methods used in the original paper
- Proposed extension or alternative model (following the next section details)

Both tracks should include:

- **Statistical models used** with mathematical notation where appropriate
  - For regression: specify model equation, link function (if applicable), assumptions
  - For PCA: explain dimensionality reduction approach
  - For clustering: describe method and distance metric
  - For regularization: specify penalty type and selection procedure
- **Why these methods?** Connect to research questions and data structure
- Software and key R packages used (don't forget to cite the R packages)

Results (2-2.5 pages)

```
             Df Sum Sq Mean Sq F value   Pr(>F)
ai            2    589  294.66   11.19 2.42e-05 ***
Residuals   210   5531   26.34
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = score ~ ai, data = survey_complete)

$ai
                         diff       lwr       upr     p adj
intentional-full   3.1428571  1.064447  5.221268 0.0012846
outer-full        -0.7467532 -2.747293  1.253786 0.6528219
outer-intentional -3.8896104 -5.921657 -1.857564 0.0000309
```

Track 1 (Paper Reproduction) should include:

- Summary of reproduction success/challenges
- What did the original authors do well? What could be improved?
- Summary of results with proposed model following the next section details.

Both tracks should include:

- Model fitting and diagnostics
  - Assumption checking (residual plots, normality tests, etc.)
  - Model comparison (if applicable)
  - Goodness-of-fit measures
- Parameter interpretation with confidence intervals where appropriate
- Key findings presented with visualizations

Discussion & Conclusion (0.75-1 page)

Both tracks should include:

- Answers to research questions with supporting evidence
- Practical implications or insights
- Limitations and assumptions
- Future directions

Track 1 (Reproduction) should include:

- A summary of what could be improved in the original paper and how your new analysis does exactly that.

References

Eger, Markus, Chris Martens, and Marcela Alfaro Cordoba. 2017. "An Intentional AI for Hanabi." In *2017 IEEE Conference on Computational Intelligence and Games (CIG)*, 68–75. https://doi.org/10.1109/CIG.2017.8080417.

Hu, Chengpeng, Yunlong Zhao, Ziqi Wang, Haocheng Du, and Jialin Liu. 2024. "Games for Artificial Intelligence Research: A Review and Perspectives." *IEEE Transactions on Artificial Intelligence* 5 (12): 5949–68. https://doi.org/10.1109/TAI.2024.3410935.

Laird, John E. 2002. "Research in Human-Level AI Using Computer Games." *Commun. ACM* 45 (1): 32–35. https://doi.org/10.1145/502269.502290.

Yannakakis, Georgios N. 2005. "AI in Computer Games: Generating Interesting Interactive Opponents by the Use of Evolutionary Computation," December. https://era.ed.ac.uk/handle/1842/879.

Yin, Qi-Yue, Jun Yang, Kai-Qi Huang, Mei-Jing Zhao, Wan-Cheng Ni, Bin Liang, Yan Huang, Shu Wu, and Liang Wang. 2023. "AI in Human-Computer Gaming: Techniques, Challenges and Opportunities." *Machine Intelligence Research* 20 (3): 299–317. https://doi.org/10.1007/s11633-022-1384-6.