Reclaiming AI as a Theoretical Tool for Cognitive Science

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Abstract

This project describes how AI can be used in cognitive science to understand how thinking works. The paper has two parts. In the first part, the authors present an experiment in which a fictive AI engineer, Dr. Ingenia, tries to construct an AGI under ideal conditions. They support this idea with a proof that shows the limitations of today's AI methods. In the second part, they talk about how AI was originally used to study thinking, point out some mistakes that were made, and suggest ways to use AI to better understand how the mind works.

1 Introduction

- Artificial Intelligence (AI) originally served as a tool for cognitive science, providing computational models and frameworks, but now the path has changed and the goal now is to create systems that mimic human cognition. The authors argue that true human-like AI is unfeasible, current approaches misrepresent cognition, and AI should (re)focus as a conceptual tool.

- 1. Andrei Alexandru has made the summary essay and this LaTeX report.
  2. Razvan Mircea has made the demonstration of Perfect-vs-Chance theorem.
  3. Serban Baesu has made the demonstration of AI-by-Learning theorem.

- We read the paper and highlighted the most important aspects and then began to write the demonstrations of the two theorems mentioned above.
- All of us are passionate about AI and we thought that this project would be a great opportunity to do more research on the chosen topic and to understand the opinions of other people.
- Other research has been done by a Special Interest Group in Information Theory.
- https://link.springer.com/article/10.1007/s42113-024-00217-5

  https://uxmag.com/articles/how-cognitive-science-and-artificial-intelligence-are-intertwined

  The group mentioned above focused on understanding how the human mind works by trying to develop artificial minds, which sparked the cognitive revolution and led to the birth of cognitive science as a multidisciplinary field.
- The approach used in Theorem 2 was difficult to fully grasp, as the demonstration felt overly theoretical and abstract. More concrete examples or practical illustrations would have helped in clarifying the concepts and their application.

  1. Andrei: "I did not know that AI research was connected to cognitive science and that the current focus is much less on psychology. I would like to learn how the big companies see this topic and what is their future vision (and budget)."
  2. : Razvan: "I have learned that AI has many more useful applications beyond LLMs and ML. I have also learned more about complexity theory, a subject I would like to explore further in the future"
  3. : Serban: "I have learned that getting an AI to behave exactly as a human being is an unrealistic goal and that we should redirect our focus to using it as a tool for cognitive science. I would like to learn more about cognitive science, as it sounds interesting and combines different disciplines. "

2 Approach

1. **Link:** https://github.com/1AlexandruAndrei/AI-for-Cognitive-Science
2. **Software Tools Used:**

- **Python Libraries:**
  - `random`: Used for generating random numbers.
  - `numpy`: Utilized for matrix operations and data generation.
  - `scikit-learn`:
    * `LogisticRegression`: The logistic regression model was trained to classify data.
    * `accuracy_score`: For evaluating model performance.
    * `train_test_split`: To split the dataset into training and testing subsets.

3. **Training/Processing Time:**

   - **Training Time:**
     - The training of the logistic regression model is computationally inexpensive.
     - On a modern machine, each model (Perfect and Chance cases) typically trains in milliseconds to a few seconds due to the simplicity of the logistic regression algorithm and the moderate dataset size (10,000 samples, 20 features).

4. **Architecture:** This is not a deep learning architecture. Logistic regression is a linear classifier, which works well for linearly separable data, as is the case with the Perfect dataset.

5. **Tricks:**No tricks were tried.

6. **Evaluation Metrics:** The evaluation is based on accuracy, which measures the proportion of correct predictions.

   Results: Perfect Case: The model achieves a high accuracy (typically over 90%). This validates that the model learns well when data is linearly separable. Chance Case: Accuracy hovers around 50%, showing that the model performs as well as random guessing, as expected for data with no pattern.

7. **Images:**We have this image generated in Python.

3 Limitations

There may be a scalability issue for large problem sizes and a resource problem to handle very large scale 3SAT graphs. Edge case limitations, like contradictory clauses or repeated literals can impact the output of the algorithm.

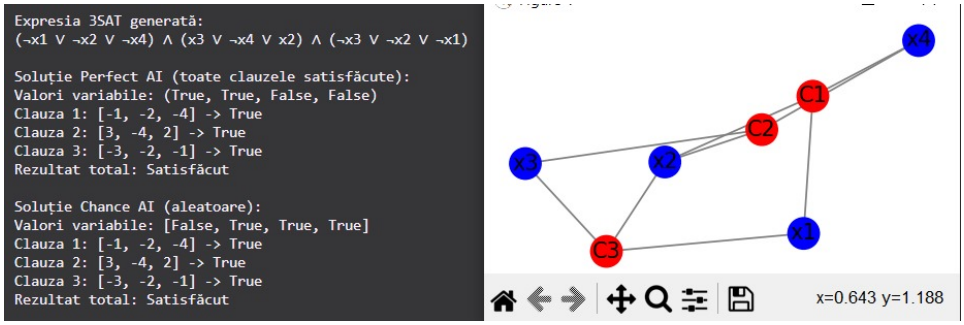

Figure 1: Perfect vs Chance Visualization

4 Conclusions and Future Work

- We believe that we did our best at this and, at this moment, we do not see how we could have done things differently.
- Definitely! There is always room for improvement, and for this project there can be added more visuals and a more complex code.
- We enjoyed working on this project and we believe it was a good exercise.
- Surely! None of us was aware that the link between AI and cognitive is so deep, and this is why we chose this project. It was something different.
- Maybe add a NLP project in the list next year.
- Adding more visuals in the research paper would probably help.

References

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