**Analyzing Search and Recommendation Systems**

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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**Analyzing Search and Recommendation Systems**

This is a capstone project for the Department of Computer Science with Dr. Hongning Wang as the technical advisor. Project collaborators include Mitchell Campbell and mentors such as Nolen Wang, Aobo Yang, and Kaiying Shan. The technical research consisted of two loosely related applications - a Chrome extension that reranks search results and a website used to study algorithms used for recommendation systems. Both were focused on understanding how users and common algorithms interact and change with each other.

Search engines aim to provide results that are timely, relevant, and applicable for any user query. Specialized search engines, such as JSTOR and Web of Science, are built for specific audiences and have filtering features tailored toward professionals. General search engines like Google and Bing need to make their interface intuitive for a wider audience and rely heavily on ranking algorithms to provide relevant results. On Google, which has the most advanced ranking algorithm, 28.5% of people click on the first search result and up to 92% of users only view results on the first page (Southern, 2020; Shelton, 2021). The top five results contain relevant information 68% of the time, so users often do not look at links further down the page (Shelton, 2021).

The project goal is to develop a Chrome extension to analyze the effectiveness of user-personalized search across popular search engines, such as Google and Bing. The extension would intercept user queries from Google and Bing and send the query to a remote server. The server would then query Google or Bing to retrieve a list of the most common search results without associated user data. A constraint of this approach is that Google limits the requests to their search engine so we are unable to make too many queries at once. A machine learning model, built on top of the existing BERT (Bidirectional encoder representations from transformers) model, would analyze and rank the search results. These rankings would then be

sent back to the browser, where the Chrome extension would overwrite the search results area on Google and Bing with the custom results. The results that a user clicks on would be sent back to the server to improve the machine learning model and for analysis. After data collection, we can evaluate how effective our relevance modeling is compared to other general search engines and assess if a model tailored to a specific user provides any additional benefits compared to anonymous searching. The conclusions will help improve personalized search results for users across all search engines.

The second project was a web application built to analyze various recommendation algorithms through games related to the multi-armed bandit problem. The multi-armed bandit game asks the user to reach the highest score by sampling a set of "arms", without knowing the underlying random distributions behind them. While the base game was focused on human decision-making, the multi-armed cooperative bandit and BAIR games focused on testing recommendation systems. In both games, the website would suggest an "arm" to sample from and the user would either agree or disagree with the decision. The decision the user made would influence the algorithm to decide which "arm" had the best distribution. In the multi-armed cooperative bandit game, the score from the decision would also be taken into account by the underlying algorithm. These games mimicked user behavior toward recommendations on shopping websites like Amazon and entertainment platforms such as YouTube and would help test the effectiveness of algorithms behind these suggestions.

## References

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