CS 516: Responsible Data Science and Algorithmic Fairness
Project Proposal for Mitigating Gender Bias in Search Engines

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1. Motivation and Novelty:

What is the problem that you will investigate? Why is it interesting?

This project is inspired by the critical recognition of the internet as a fundamental human right, essential for accessing information and expressing oneself. As search engines play a pivotal role in shaping access to information, it is imperative to scrutinize the fairness of search results. The motivation extends beyond the technical realm, delving into the societal fabric that search engines influence. By examining biases across multiple search engines and cultures, this research seeks to uncover the complex interplay between algorithms, search engine optimization practices, and societal norms. The novelty of this project lies in its comprehensive approach, aiming to identify and mitigate gender biases in search engine results, particularly focusing on the global variation and impact.

2. Technical Challenges:

What are the challenges of this project?

The primary challenges include developing a robust methodology for detecting gender bias across different search engines, which involves overcoming the technical limitations of API usage, language barriers, and the subjective nature of bias itself. Another significant challenge is the design of bias mitigation strategies that can adapt to the diverse algorithms used by different search engines without compromising the relevance of search results.

3. Vision of Technical Contribution:

How will you solve the problem? What method, algorithm or methodology are you proposing?

The project proposes a tool for collecting and analyzing search results from multiple search engines. This tool, combined with a mixed-method approach for gender detection (utilizing both AI APIs and human judgment), sets the stage for an innovative exploration of algorithmic fairness. The development of re-ranking algorithms, specifically tailored to address identified biases, represents a forward-thinking approach to algorithmic fairness, aiming to balance bias mitigation with search result quality.

4. Literature:

What reading will you examine to provide context and background? If relevant, what papers do you refer to?

The literature review will delve into foundational and cutting-edge research on gender bias within AI, algorithmic fairness, and digital media representation. It will critically examine seminal papers such as

"**Propagation of Societal Gender Inequality by Internet Search Algorithms**," which explores how search algorithms can perpetuate gender disparities. Studies like "**Are Gender-Neutral Queries Really Gender-Neutral? Mitigating Gender Bias in Image Search**" and "**Balanced Datasets Are Not Enough: Estimating and Mitigating Gender Bias in Deep Image Representations**" will be instrumental in understanding the nuances of gender bias in image searches and the limitations of current mitigation strategies. These works underscore the complex nature of bias in AI systems and highlight innovative approaches to addressing these challenges, providing a comprehensive backdrop for our project's aims in advancing algorithmic fairness.

5. Data:

What dataset are you using? How do you plan to collect it?

The dataset for this project will include image search results from search engines like Google and other search engines using gender-neutral queries. To enrich the analysis, we will incorporate widely recognized datasets such as MS-COCO and Flickr30K. These datasets, known for their extensive collection of labeled images, will serve as benchmarks for evaluating gender representation and bias in image recognition models. Utilizing these datasets alongside our search result collections will facilitate a comprehensive examination of gender bias and the effectiveness of our mitigation strategies.

6. Evaluation:

How will you evaluate your results? Qualitatively, what kind of results do you expect (e.g. plots or figures)? Quantitatively, what kind of analysis will you use to evaluate and/or compare your results (e.g. what performance metrics or statistical tests)?

Our evaluation strategy combines qualitative case studies with quantitative analysis to assess the impact of our bias mitigation strategies on search engine results.

Qualitative Analysis:

- **Case Studies:** We will showcase specific instances where our solution has effectively reduced gender bias. Through before-and-after visual comparisons for identical queries, we'll illustrate the improvements in gender representation, highlighting the practical benefits of our approach.

Quantitative Analysis:

- **Disparity Reduction:** We'll measure the change in gender representation in search results before and after applying our re-ranking algorithms, aiming for a significant reduction in disparity.
- **Diversity Index:** Utilizing a diversity index, we'll quantify the variety of genders presented in the search results, striving for a more balanced representation.

This streamlined approach allows us to vividly demonstrate the effectiveness of our re-ranking algorithms in producing fairer and more diverse search results, thereby addressing gender bias in image search engines.