

Essay Response on **the Desired Impact of My Research**

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My Ph.D. research aims to enhance the reliability of machine learning applications for visual analytics, focusing on dimensionality reduction algorithms. To this end, I create more precise ML algorithms, design reliable evaluation metrics, and tackle potential pitfalls that may emerge during user interaction with visual analytics systems involving machine learning. I further investigate efforts to democratize my research findings, enabling practitioners to more easily access and apply techniques that make visual analytics with machine learning more reliable.

My research considerably impacts the visualization and visual analytics community by underscoring the value of reliability. Visual analytics should be reliable, as unreliable analytics can lead to erroneous knowledge and decision-making. Despite this, limited research has concentrated on improving or preserving the reliability of visual analytics. For instance, many studies on big data visualization suggest "approximating" computations for faster rendering or data preprocessing, but only a handful focus on correcting errors caused by these approximations. My Ph.D. research emphasizes to the visualization community the importance of dedicating more effort to making visual analytics more reliable. This is achieved by illustrating that even one category of machine learning algorithm, namely dimensionality reduction, faces numerous reliability challenges

My research further informs practitioners not only in visual analytics but also in other disciplines to prioritize reliability when using ML algorithms. ML is now used anytime and anywhere, serving as a cornerstone in numerous research areas. Here, reliability is a crucial value that needs to be achieved in all ML algorithms and applications. For example, the reliability of ML algorithms in the medical domain is intrinsically tied to the safety of patients. I believe that my work to expose reliability problems in the visual analytics domain emphasizes the need for sanity checks in ML applications across various domains. My objective as a senior researcher, particularly as a professor, is to make more ML algorithms and application domains reliable.

Essay Response to **the Leadership Experience**

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I strongly believe that aiding and guiding junior researchers is my important duty. This is mainly because I was also supported by many people, including my advisor and collaborators. As a senior Ph.D. student in the lab, I make every effort to support junior graduate students and undergraduates in carrying out their initial research. This ranges from providing high-level feedback on their research to doing tedious low-level tasks, e.g., programming.

One notable experience that I would like to highlight is my dedication as a teaching assistant (TA). In 2020, I was a student in a graduate-level data visualization course that my advisor instructed. I noticed that many team projects, despite their innovative ideas worth publicizing, ended up solely as class outputs. Thus, when I served as a TA for the class in 2021 and 2023, **my goal was to guide students to solidify their team projects and publish them as papers.** My effort to achieve this goal was two-fold. First, I thoroughly redesigned the homework assignments, allowing students to develop practical skills that are useful for team projects. For instance, I designed assignments to confront students with programming challenges related to the web-based environment, which is now a common platform for developing data visualization applications. Second, I routinely reviewed projects and facilitated feedback sessions every few weeks. At these meetings, I suggested students devise a long-term plan to publicize their contributions as papers. For the students who made this decision, I provided support even after the semester concluded, guiding them in finishing their projects and submitting their manuscripts. My contributions resulted in the publication of three co-authored short papers in IEEE PacificVis 2022 and 2024, where one of them was honored as the best short paper of the year.

My commitment was inspired by the support from my advisors and collaborators. Similarly, I believe my dedication will encourage junior researchers to assist future juniors when they advance to senior positions. Ultimately, I aim to be a senior researcher who not only excels at groundbreaking research but also **cultivates a healthy research community by continuing to contribute to this positive cycle.**

Visual analytics is the science of analytical reasoning supported by interactive visual interfaces. As a scientific process, visual analytics must be reliable. It should enable analysts to make informed decisions and generate knowledge that accurately reflects the underlying data. However, visual analytics often becomes unreliable because of the underlying machine learning (ML) algorithms. The unreliability stems from a general overtrust towards ML. For example, while ML algorithms can yield incorrect results, practitioners frequently employ them without sufficient validation. Focusing on dimensionality reduction algorithms, I aim to remedy overtrust in ML to enhance the reliability of ML applications in the visual analytics field. I first found that practitioners use ML algorithms that mismatch with desired visual analytics tasks, which led me to design ML algorithms that better align with the tasks. I also identified and addressed erroneous assumptions that make ML evaluations or the interaction with visualizations unreliable. I also examine how we can democratize these findings so that practitioners can more reliably use ML for visual analytics. My research builds a solid foundation that can be applied to improve the reliability of more types of ML algorithms.