

## STATEMENT OF PURPOSE

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Master of Information Management and Systems applicant

My research interests lie in uncovering the mathematics that drives Machine Learning and deep learning and their theoretical nature. What are the theoretical foundations explaining the success of deep networks in approximating complex functions, and are there inherent limits to their expressiveness? What insights can we gain into the dynamics of training deep networks? What are the potential applications of learned representations in various domains, such as computer vision, natural language processing, and speech recognition? How do we address the challenges of interpretability and explainability in learned representations? I aim to explore these problems and develop an understanding of the fundamental theoretical limits of Machine Learning. I am particularly interested in leveraging this knowledge and effectively applying these algorithms to build intelligent systems to solve problems in scientific domains and expedite research efforts in AI for science.

My undergraduate research endeavors have been in applying deep learning techniques to astronomy and astrophysics, which are undergoing significant transformations brought about by exponential growth in data collection. This influx of data usually needs to be extensively processed to extract useful information. I attempted to solve this problem using deep learning algorithms and along with my colleagues, worked on a project to apply CNNs for Galaxy Morphology Classification, which subsequently turned into my first authored research paper. We sought to create a 7-class system encompassing most galaxy morphologies. I set up the entire training pipeline and the model architectures, enabling robust training of 7 EfficientNet models. Our results were better than those at the second position on the Kaggle Public Leaderboard, effectively making it the second-best submission. This study has been cited multiple times since This project made me realize the potential impact intelligent systems can have on our society.

I kept exploring more applications of such systems to astronomy. I started working with Dr. Snehal Kamalapur in the Intelligent Systems Lab and looked into developing an efficient process to colorize and up-scale unprocessed astronomical images that lie dormant and unseen in extensive space archives. I was fortunate enough to present this study under the title “*Astronomical Image Colorization and Up-scaling with Conditional Generative Adversarial Networks*” at the Informatik 2022 conference’s Astro ML workshop in Hamburg. The paper was published in the *Lecture Notes in Informatics (LNI)*, *Gesellschaft für Informatik, Bonn 2022*, and was my second publication as a primary author. The project helped improve my research skills, critical thinking, and decision-making. I was more mindful of designing the training pipeline because of the limits on resource utilization.

These projects shaped my thinking and my research started gravitating toward developing systems for scientific problems. Inspired by this, I started contributing to an open-source project called EinsteinPy. EinsteinPy is an open-source pure Python package dedicated to the study of problems arising in General Relativity and gravitational physics. Using EinsteinPy, it is possible to approach problems symbolically as well as numerically. Working on problems motivated by the challenges in science and engineering requires understanding other fields like numerical methods, computational geometry, etc. I am particularly interested in pursuing this area of research at the Berkeley AI Research Lab. Prof. Dr. Krishnapriyan’s interests in the development of physics-inspired machine learning methods seem to align perfectly with mine and I would like to explore more such research at the BAIR Lab.

After graduation, I started working as a Machine Learning Engineer and later as a Machine

Learning Consultant at a start-up called Relfor Labs. During my time there, I mainly worked on applications of deep learning to audio data analysis and classification. I set up the ML pipelines and developed novel architectures that were designed specifically for the use case. While working on various ML projects or projects involving large amounts of data, I have often run into the problem of managing and understanding it. I have experienced the problems of automating an end-to-end ML pipeline which can be sustainable in the long term. There are various problems like data quality and consistency, model drift, version control, debugging, etc. My experience in developing ML models and designing ML pipelines and the problems that I have faced have also motivated me to address these problems by building tools for simplifying datasets and ML processes. I have followed the work of Prof. Dr. Parameswaran, and his student Miss. Shankar and I want to contribute to their efforts of simplifying data science and building tools to effectively manage ML pipelines.

For the past two years, I have been working as a full-time Software Developer at a type-design studio in London called Dalton Maag. Soon after I started working at Dalton Maag, I became part of a project to design a proof-of-concept system for the automatic generation of CJK glyphs using genetic algorithms. Witnessing how data can be harnessed to develop intelligent systems across a wide spectrum of disciplines is remarkable. My exposure to the industry has significantly influenced my interests. I have developed a strong passion for crafting comprehensive systems that address the specific requirements of businesses, particularly those that rely on the effective utilization of data and information. One notable example of such a system is Pricebot, which serves as a means to translate the intricate nuances of glyphs within a typeface into a coherent pricing model. Pricebot is adept at generating quotes based on a range of criteria, including the number of font weights, axes, and supported scripts. This tool is invaluable in delivering consistent and precise results, preventing project overruns and unforeseen expenses. Additionally, it liberates designers from the challenging and error-prone task of manual quote creation, saving both time and resources.

The potential for innovation and problem-solving appears boundless when we consider the transformative impact of harnessing data to create smarter, more efficient solutions. This continuous journey of exploration and discovery in the realm of intelligent systems captivates me and holds the promise of shaping a brighter and more interconnected future.

The interdisciplinary nature of the MIMS program aligns perfectly with my diverse interests. My goal is to leverage the mathematical foundations of machine learning to apply AI to scientific applications, developing tools that streamline data management and systems for automating business processes through information systems. My determination to pursue a career in research is unwavering, and I aspire to work in an academic setting and eventually pursue a Ph.D.