

Aditya Sharma  
2024sharmaaditya@gmail.com

There's a distinct joy in unraveling the unknown, in asking "why" and chasing the answer down every rabbit hole it leads to. Ever since I was a child, I've been fascinated with the process of discovery—whether it was taking apart my toys to understand their mechanics or spending hours reading about the way things work. The pursuit of knowledge has always excited me more than the end result. I enjoy problem-solving not just for the solution, but for the journey, from the moments of frustration to the eventual clarity that comes from deep understanding.

That curiosity led me to artificial intelligence and machine learning. I had used multiple large language models before, but I found myself wondering: How do they actually work? What allows them to generate human-like responses? Instead of just accepting them as black boxes, I decided to build a simple neural network from scratch using NumPy. Through this, I discovered loss functions, activation functions, and concepts I hadn't even known existed before diving in. Each new topic led me to another, and soon, I found myself captivated by the intricacies of AI.

Now, I am working with my professor Qingguang Guan, on building our own transformer model with reinforcement learning capabilities. Reading papers like Attention Is All You Need has been both fascinating and illuminating. I have also explored the latest breakthroughs in large language models, such as the advancements in DeepSeek's Mixture of Experts (MoE) approach. This research project has filled my mind with countless "whys," each one leading to another question and another discovery.

Furthermore, as a Research Assistant, I work on managing data from multiple NOAA missions, helping structure vast environmental datasets for improved accessibility. We are leveraging large language models (LLMs) and building AI-powered chatbots to assist researchers in navigating complex databases more efficiently. This experience has not only strengthened my technical skills in data science and AI applications but has also given me a firsthand look at the challenges of working with large-scale scientific datasets—a challenge that is central to this REU's focus on hydrologic forecasting and open-source cyberinfrastructure.

Beyond structured research, I have taken the initiative to explore AI and machine learning independently. I actively read research papers and challenge myself to implement different concepts to solidify my understanding. My love for mathematics and computer science naturally led me to an interest in data science, where I have completed multiple projects in computer vision and time series analysis. For my Data Analysis capstone project, I performed a time series analysis on a dataset of car sales records using an ARIMA model to forecast future sales, achieving an explained variance of 80% after addressing challenges related to seasonal fluctuations. In another project, I used computer vision techniques to analyze soccer match videos, extracting insights about gameplay and player movements.

One of the research directions that excites me most is the idea of converting time series outputs from large vectors into 2D representations, allowing models to "learn" hydrologic patterns in a manner similar to image recognition. The connection to

AI-driven bioacoustic analysis, such as Google's whale vocalization research, makes this even more fascinating. The possibility of training models to recognize the "whale songs" of hydrology is something I would love to explore.

What excites me most about this REU is the chance to work with researchers who are just as passionate about using AI for environmental challenges. I'm eager to learn from experts in hydrology while bringing in my own experience with AI and data science.

With my background in AI and my experience working with environmental datasets, I am eager to explore new applications of machine learning in hydrology. This program presents a unique opportunity for me to refine my technical skills while gaining a deeper understanding of hydrologic systems. More importantly, I am excited about the potential to contribute to projects that have a meaningful impact on water resource management.