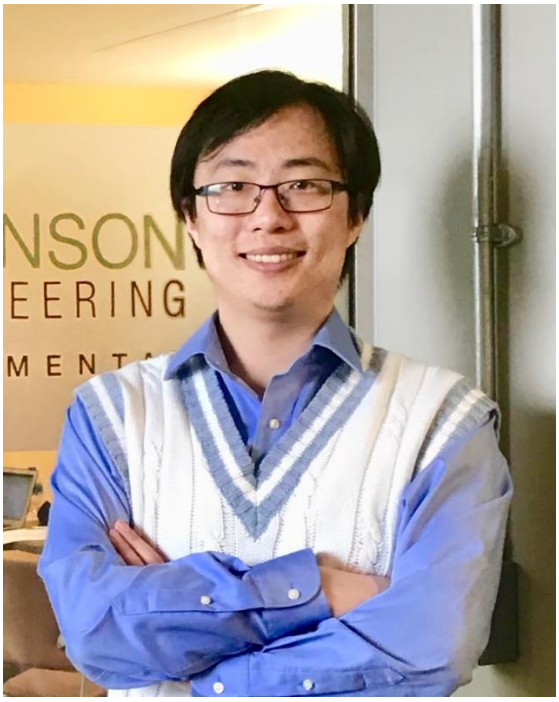
Title

Assessing Oil Spill Impacts Using an AI-Driven Approach with Fine-Tuned Large Language Models and Data Augmentation: A Case Study from the Gulf of Mexico

Abstract

Hydrocarbons, a cornerstone of global energy supply, have been extensively extracted over the past few decades, leading to the drilling of numerous wells worldwide. These wells can be classified into three categories: active, abandoned, and orphaned. Without effective planning and control, hydrocarbon leaks can occur in any of these categories, posing a serious risk of environmental pollution. However, hydrocarbon leakage is not limited to the extraction process alone; it also occurs during transportation, storage, and consumption, exacerbating environmental pollution to a considerable extent. The relative contributions of each of these aspects of hydrocarbon production have not previously been quantified nor placed in the context of the contributions of other sectors to accidental hydrocarbon release. This presentation leverages publicly available oil spill databases from the National Oceanic and Atmospheric Administration (NOAA), spanning 1970 to 2025, to conduct an AI-driven analysis. By employing advanced methodologies, including fine-tuning large language models and data augmentation techniques, this study addresses the prevalent challenge of data scarcity in geo-energy systems. The analysis focuses on elucidating the causes of oil spills, quantifying leakage volumes by well category, and characterizing their temporal and spatial patterns, thereby informing strategies for mitigating environmental impacts.

Biography



Yunxing Lu, Ph.D., is a postdoctoral researcher at the University of Pittsburgh, where he earned his doctorate in 2022. He also holds an M.S. from Texas A&M University (2017). His research focuses on advancing geo-energy systems and sustainability by developing more efficient and safer renewable energy solutions, innovating resilient geomaterials for extreme conditions, and harnessing the power of geodata science through advanced AI. Through these efforts, his work is committed to promoting smarter, more efficient, and sustainable geo-engineering practices.