Bridging Disciplines: How AI and NLP are Transforming Materials Science and Beyond

While writing this blog, where I was interested in connecting the current trends of Artificial Intelligence (AI) and machine learning to materials science and engineering, I attended a seminar as part of our BADM 261 class, where Dr. Mark Moran was a guest speaker. The session stood out not only for its focus on advanced AI applications but also for how it explored unconventional applications of NLP in research. It reinforced the idea that AI is not confined to technical or engineering domains but can extend to redefine how we analyze and interpret qualitative data.

Dr. Moran's research focuses on analyzing over thousands of CEO letters to shareholders from S&P 500 companies, spanning 2005 to 2019. Using AI, text-mining, and NLP, he has developed innovative methods to measure how CEOs represent different stakeholder groups over time. By establishing a set of terms for each stakeholder group, his work reveals trends in corporate social performance, CEO demographics, and even shifts in tone, quantity, and content, a phenomena he referred to as "context collapse." This research highlights how text-based AI tools can provide practical insights into corporate strategies and stakeholder communication. It was fascinating to see how his findings not only inform academic discourse but also have the potential to influence business strategies and stakeholder engagement practices.

Hearing about Dr. Moran's research sparked a thought: Could similar approaches and technologies transform materials science? While numerical and structural datasets are the norm in materials research, there are vast amounts of text-based data, scientific publications, patents, and experimental records, which remain untouched. Leveraging NLP to mine these sources could unlock previously unconventional or hidden relationships between material properties, synthesis methods, and performance metrics. The application of text-based AI could complement traditional data analysis in materials science, bridging the gap between experimental data and theoretical insights.

These methods can lead to exciting tools and methods. Tools like an AI-powered text analysis tools capable of identifying overlooked synthesis techniques from decades of published studies or clustering algorithms that reveal innovation trends in areas like renewable energy or advanced alloys. By combining NLP with numerical analysis, researchers could create a more holistic approach to materials discovery, accelerating breakthroughs in sustainable and high-performance materials. Such interdisciplinary approaches could even democratize access to cutting-edge materials research by making vast repositories of scientific knowledge more accessible and actionable.

Another exciting application of NLP in materials science lies in semantic similarity analysis. This involves using specialized NLP models to evaluate the relationships between scientific concepts, materials, and methodologies as described in research texts. For example, NLP

algorithms can identify similar materials with close properties or synthesis based on how they are discussed in the literature. This capability not only helps in narrowing down potential candidates for experimental testing but also supports the discovery of novel materials by drawing connections that may not be immediately apparent through traditional methods.

Dr. Moran's work reminded me of the importance of interdisciplinary thinking. His use of AI to extract insights from corporate texts shows that even established fields like stakeholder communication can heavily benefit from innovative applications of technology. Similarly, materials science stands to gain much by integrating text-based AI methods alongside traditional computational approaches. It is a reminder that the boundaries of innovation are often unclear or gray when ideas from disparate fields come together to address complex challenges.

As students of various engineering and business fields, this seminar was a valuable reminder that breakthroughs often lie at the intersection of disciplines. Whether analyzing CEO letters or mining scientific papers, the ability to draw connections across fields is essential for driving progress. This resonates with my own experiences as a student, where exposure to diverse ideas has often sparked some of the most meaningful insights and growth.