Application for NBER Digital Economics and AI Tutorial

Applicant: Divyanshu Jain

Email: djain@ucdavis.edu — Phone: (+1) 408-497-2291

I am applying to the NBER Digital Economics and AI Tutorial because my research lies squarely at the intersection of artificial intelligence, machine learning, and digital market behavior. As a PhD candidate in Economics at the University of California, Davis, my dissertation explores how autonomous AI agents—including large language models and reinforcement learning systems—behave in complex market environments such as wholesale electricity markets and sequential price-setting games. These rapidly evolving areas of digital economics raise profound questions about strategic learning, emergent coordination, and the design of market rules in the presence of algorithmic decision-makers. The tutorial offers a unique opportunity to deepen my conceptual foundation in these subjects while engaging with leading researchers who are shaping the future of AI-driven economic analysis.

In my recent work, I am studying how large language models can engage in dynamic pricing behavior that resembles classic Edgeworth cycles. In a series of computational experiments, I place LLM agents in a repeated price-competition environment and study how their natural-language reasoning drives decisions that produce non-trivial cycles and patterns consistent with tacit collusion. This project has shown me how quickly text-based systems can internalize strategic insights, raising important implications for algorithmic pricing and digital platform competition.

Complementing this line of inquiry, I am developing a multi-agent reinforcement learning simulation to study bidding behavior in wholesale power markets. The goal is to understand whether reinforcement learning agents can learn collusive supply-function equilibria and, if so, how specific market-design choices influence or prevent such behavior. Because electricity markets are high-frequency, data-rich, and increasingly automated, they offer an ideal environment for studying strategic interactions among AI-powered agents and for testing how alternative rules shape equilibrium outcomes in digital markets.

Beyond simulations, I also work extensively with large-scale empirical data. Using CAISO's wholesale electricity market data, I apply clustering algorithms, high-frequency panel estimators, and causal machine learning to study how the rapid expansion of battery energy storage systems has reshaped price formation. I find that increases in solar generation exert consistent price-depressing effects—on the order of about \$0.4/MWh for each additional gigawatt of solar output—while battery systems flatten the evening peak that once characterized California's "duck curve." These findings illustrate how modern machine-learning tools can uncover evolving market structures and reveal how digital and physical infrastructure jointly influence equilibrium outcomes.

I also serve as a research assistant on a statewide randomized controlled trial involving household EV charging behavior under dynamic electricity pricing. In this role, I construct high-dimensional telemetry and smart-meter datasets, link them to treatment assignments, and estimate behavioral responses using Difference-in-Differences, Instrumental Variables, and modern causal machine learning approaches. This experience has strengthened my ability to work with massive digital datasets,

to implement rigorous empirical strategies, and to translate statistical results into policy-relevant insights about consumer behavior in digitally mediated markets.

Participating in the NBER Digital Economics and AI Tutorial would significantly elevate the rigor and scope of my dissertation work. I hope to refine my understanding of algorithmic competition, learn new approaches to modeling interactions between autonomous agents, and engage deeply with recent advances in digital market design. The tutorial's focus on cutting-edge AI methods and applied economic questions aligns perfectly with my ambition to produce academically rigorous and policy-relevant research on how AI is transforming markets. I am eager to learn from and contribute to this community as I continue to develop my dissertation and prepare for an academic career at the frontier of digital economics.

Sincerely,

Divyanshu Jain