QUANTUM COMPUTING AND MACHINE LEARNING FOR EFFICIENCY OF MARITIME CONTAINER PORT OPERATIONS

CONSEQUENCES OF TECHNO-DETERMINIST NARRATIVES OF ARTIFICIAL INTELLIGENCE IN LOGISTICS

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SOCIOTECHNICAL SYNTHESIS

Recent global supply chain disruptions have harmed the wellbeing and economic integrity of America by slowing the import of silicon wafers, produce, and pharmaceuticals. In response, this technical project examines the applications of quantum computing and reinforcement learning to improving operational resiliency of maritime ports. Additionally, the proposed methods aim to reduce carbon emissions by reducing unnecessary container ship idling in berth. The coupled research paper uses practices of the Science, Technology, and Society (STS) field to examine the relationship between artificial intelligence (AI) and the greater logistics industry. The topics are interdependent, because the STS topic partially explains the current state of supply chain issues. Therefore, beneficial implementation of proposed technological solutions requires especially thoughtful consideration of their socio-technical context.

This technical project finds motivation in the goals of its partnered client, the Port of Virginia, of increased resilience and net zero emissions by 2040. At first, this effort took place within a greater multi-university research project of developing a quantum cyber-physical system to manage port operations. Since funding has not been acquired, focus shifted towards immediately available advanced computing technologies. By researching existing algorithms with potential for future quantum speedup, these results could benefit the larger project later.

After studying a variety of data driven and simulation technologies, Monte Carlo Tree Search (MCTS) based reinforcement learning was chosen for prototyping and recommendation. MCTS has strong potential for quantum speedup from parallelization of computation by superposition. A simulation of container movements using Python for MCTS demonstrated proof

of concept for port applications. The final recommendations include the modeling of high-risk scenarios to determine the best policies for returning normal conditions.

Research surrounding the latest machine learning and quantum technologies often predicts extreme improvement of any system imaginable. Such claims inspired the coupled research paper examining the impact of techno-determinist narratives of artificial intelligence on the logistics industry. The paper uses Law & Callon's Actor-Network Theory (ANT) to map out the relationships between individuals, technologies, legal entities, and semiotics within the socio-technical system examined. The process included researching public opinion polls, technology patents, and existing STS scholarship.

The current labor shortages in logistics, especially commercial truck driving, defy public expectations of AI which predict inevitable automation. Ironically, Amazon's use of AI automates middle management jobs instead of manual labor. Additionally, Amazon's patents prove they are continuing the same path. Every STS article cited similar trends but in different contexts and through different frameworks. Such misaligned perceptions are weaponized to negotiate against labor reform and discourage new employment in understaffed sectors. This analysis suggests that techno-determinism is performative in developing policies and cultural myths concerning AI that have directly harmed logistics workers and contributed to global supply chain issues.

The direct harm of supply chain disruption and impending climate change necessitate experimentation with new methods for prevention. However, purely technological solutions must be examined skeptically and removed from cultural myths suggesting inherent efficacy. Deconstructing the category of artificial intelligence would allow for realistic expectations and expand the agency of individuals in determining the applications of the technologies.

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