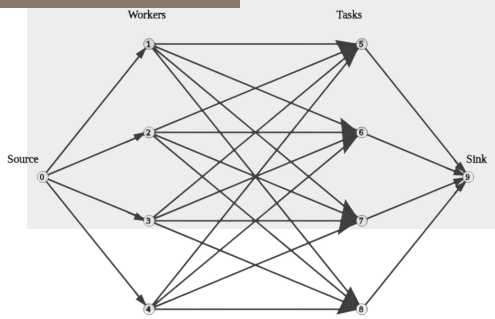
NEWSLETTER

MARCH 15, 2024 | *QUARTERLY*

> *How computer science affects supply chain systems*

BASIC RESEARCH

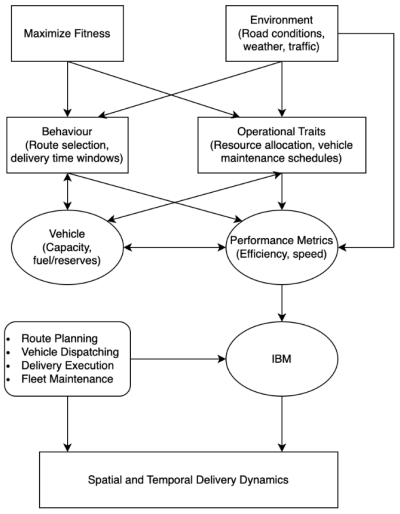
MATRIXELLENT INC. is a Delaware charitable nonstock corporation that is primarily engaged in basic research. Basic research is general research to gain more comprehensive knowledge or understanding of the subject under study, without specific applications in mind. Basic research is also research that advances scientific knowledge, but does not have specific immediate commercial objectives although it may be in fields of present or potential commercial interest. It may include research and investigation in the sciences, social sciences, or humanities. (8 CFR 214.2(h)(19)(iii)(C)).



WORK PRODUCT BY HAODONG HU (INDUSTRIAL ENGINEERING VOLUNTEER) AT MATRIXELLENT INC.

SCIENTIFIC KNOWLEDGE OF MINIMUM COST FLOW SOLVER

Haodong Hu's current research is about conducting fundamental research on the methodology of minimum cost flow solvers and analyzing the functions implemented in Python, Java, and C++. Then, perform a comparative analysis of these implementations.
The scientific knowledge involves constructing a network of nodes and edges, which includes a notional source node, a set of worker nodes (warehouses), a set of task nodes (orders), and a notional sink node. The minimum cost flow (min cost flow) solver often returns a solution more quickly than either the Mixed Integer Programming (MIP) or Constraint Programming (CP-SAT) solvers.



WORK PRODUCT BY YAN LI (INDUSTRIAL ENGINEERING VOLUNTEER) AT MATRIXELLENT INC.

COMPREHENSIVE UNDERSTANDING OF SDP PROCESS

SDP model provides a robust framework for addressing the SVRP by allowing decisions to be made at multiple stages, each considering the stochastic nature of future events. Such knowledge effectively captures the evolving state of the system and enables the optimization of routing decisions under uncertainty.

SDP MODEL IMPACT

When utilizing SDP to model SVRP to take stochastic factors into consideration, the state space encompasses the vehicle's location, remaining capacity, and time, while the decision space includes the possible routes. This scientific approach allows for a dynamic and probabilistic assessment of routing options, accommodating the inherent uncertainties in customer demand and travel times.

BASIC RESEARCH ON SDP CHALLENGES AND PROBLEMS

Current SDP models encounter significant challenges due to their computational intensity and difficulties in handling large-scale problems. These limitations result in prolonged processing times and reduced efficiency, making it difficult to apply SDP effectively in solving complex SVRP scenarios. The inability to scale efficiently with increasing problem size hampers their practicality in real-world logistics and transportation applications, where rapid and accurate solutions are crucial.

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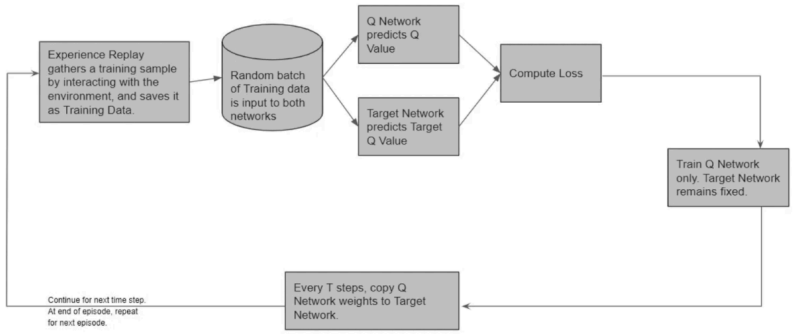
FUNDAMENTAL RESEARCH ON MACHINE LEARNING

MATRIXELLENT INC. is primarily engaged in basic research to advance more comprehensive understanding and scientific knowledge about machine learning (Computer Science) methodologies and algorithms and their impact on supply chain systems in general. Our focus is on two reinforcement learning algorithms: Deep Q-Network (DQN) and Deep Deterministic Policy Gradient (DDPG). We examine their fundamental concepts and processes for generating outcomes, as well as identify how these scientific methodologies have been integrated into supply chain systems for fundamental research.



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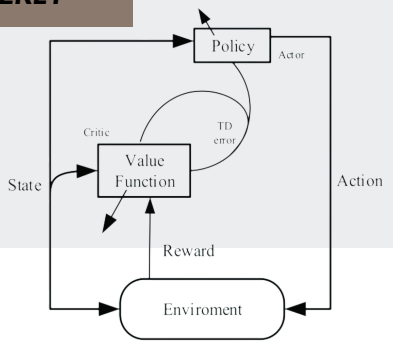

WORK PRODUCT BY HAODONG HU (INDUSTRIAL ENGINEERING VOLUNTEER) AT MATRIXELLENT INC.

COMPREHENSIVE UNDERSTANDING: RL ALGORITHM - DDPG

Haodong Hu is mainly responsible for conducting basic research on the theoretical process of DDPG. The Deep Deterministic Policy Gradient (DDPG) algorithm is a powerful reinforcement learning technique designed to handle continuous action spaces. It combines the advantages of both value-based and policy-based methods to learn optimal policies for decision-making.

SCIENTIFIC KNOWLEDGE of RL ALGORITHM-DQN

The workflow of a Deep Q-Network (DQN) algorithm involves several key stages, each contributing to its robust decision-making capabilities. The DQN algorithm operates within the framework of reinforcement learning, where an agent interacts with an environment to maximize cumulative reward.

SCIENTIFIC CONCEPT AND IMPACT OF DQN

Target Network predicts Target Q-value: The Q-network estimates the Q-values for each action. The target Q-value is calculated using the Bellman equation, incorporating the reward received and the maximum Q-value for the next state. The network's weights are updated to minimize the difference between the predicted and target Q-values. In logistics, DQN can optimize delivery routes by considering factors such as traffic conditions, delivery time windows, and vehicle capacities.

SCIENTIFIC CONCEPT AND IMPACT OF DDPG

Action Selection: The actor network selects actions based on the current state, introducing noise to encourage exploration. This noise, often modeled as Ornstein-Uhlenbeck process, ensures that the agent explores the action space effectively. From the perspective of basic research, DDPG can optimize warehouse operations by determining the best storage locations for products, optimizing picking routes, and scheduling tasks efficiently.