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Blockchain with Multi Agent System: case of container stacking management

Extended Abstract (max. 500 words)

Port logistics chains occupy a very important position in global trade. Their complexity promotes the suggested use of applications that are drawn from distributed artificial intelligence, such as a multi agent systems and deep reinforcement learning for efficiency. Several technologies have been proven positively to work in logistics - individually, however the concept of combining converging technologies such as blockchain with deep reinforcement and multi agent systems is viewed as a novel approach to solving the complexity that is often associated with many facets of port logistical operations. In this paper a simulator is developed and tested.

One of the port logistical operations tested is the stacking of containers in a container yard. The simulation results indicate a more robust approach to currently used tools and methods is achieved. The port maximises throughput, while still maximising contract-price. In combining the port's objectives with the customers' objective functions into a Multiple Objective Optimization Problem (MOOP) system provides a Pareto set of solutions for the port with regards to a container picklist.

The scenario evaluated in the simulation model is that of a port with a container stack consisting of 400 containers arranged in a 10x10x5. In a typical day, the crane operating on this stack can move 100 containers – a single move is defined as either moving a container within the stack to another coordinate or removing a container from the stack and delivering it to the port's customers (via a 3rd party carrier, who has a truck at the port). Each container belongs to a specific carrier, and each carrier has their own set of delivery goals related to the number, type and importance of the containers they own. Various rules concerning the container stack have been included and are obtained from experts. Rules for the container stack includes: Each container resides within a specific x,y,z coordinate; The maximum x coordinate that containers can be placed in is 10, the maximum y coordinate is 10 and the maximum z coordinate is 5; In any given column, the container with the highest z coordinate is the only container that can be moved; Containers can't 'float' in the air, e.g. a container can only be placed on (5,2,5) if a container is already placed on (5,2,4).

Every container in the stack has been assigned a *contract price* between 1 and 50, reflecting the amount of money that the customer has contracted the port for delivery of this container. The port has a single objective function; maximize the total contract price of containers delivered in a day. The output from simulation considers the Pareto Front and provides a set

of moves that maximizes the total contract-price achieved by the port and the number of containers delivered, by splitting the allocation of extra moves across a number of customers.

Objective (max. 200 words)

In the context of port logistics systems, how can combining blockchain with crypto currency be used as a standard transactional mechanism is modeled in to Multi-Agent system for faster means of enabling transactions amongst interested actors. The simulation results of the modeled container stacking management yield a number of solutions that satisfies all actors. The blockchain smart contracts enable elements in the process, such as containers and trucks, or applications like the port scheduling system to swiftly define and execute secure transactions between each other.

Data/Methodology (max. 200 words)

The data used was obtained from a small terminal in west coast US and the methodology employed is known as simulation method. A prototype that was initially developed in NetLogo® is further developed and written in Python language so that it is supported by Ethereum® for the testing and evaluation on the concept of crypto-currency in coordination and control of container stacking operations. At this time, the incorporation of ML – Machine Learning algorithms is considered but not yet implemented for further development so as to build “deep learning” Multi Agent systems.

Results/Findings (max. 200 words)

The simulation model presents a means of evaluating various actor’s criteria and objectives by automating the decisions, based on auctions, for the picking process for the port, choosing when to rearrange stacked containers, and when to deliver them to transportation. The actors’ decisions on the optimal cryptocurrency price to set in order to achieve their goals and satisfy their constraints. In addition the simulation model shows how the multi agents continually adapts to the changing conditions, and dynamically determines the Pareto frontier, to give the highest benefits to each participant, even as the system is being disrupted or as participants alter their goals. Finally, it is suggested that multi-agent solution helps in efficient use of cryptocurrency in to minimize costs and maximize earnings for each participant, by automatically balancing conflicting priorities.

Implications for Research/Policy (max. 200 words)

The suggested solution proposes a multi-agent system approach that is specifically designed to optimize complex processes, such as the example of stacking containers, by using a deep reinforcement learning system to deliver a higher performance than current solutions. Due to its inherent characteristics, a multi-agent system is by it nature to be distributed, leading to synergies with blockchain, and utilization of cryptocurrency to provide a robust mechanism that is standardized for the exchange of value throughout a post logistics system. This allows the port logistics to run at an extremely high level of efficiency and gives each actor in the port logistics chain the ability to optimize their own function(s), yet still maintain a holistic balance. Multi-agents are programmed to run in a virtual, edge-based, or hybrid environment and are used to simplify deployment through a supply chain. By using cryptocurrency, such as Etherieum® it assists in establishing a standard transactional language across the port logistics chain, the suggested solution solves the multi-objective optimization problems, e.g. container stacking management by modeling a dynamic pareto frontier that maximizes value for each actor.

Keywords: *Blockchain, Multi Agent Simulation, Cyrptocurrency, Container Stacking Management*

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