## Abstract of the Thesis

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Title of the Thesis: **Multicriteria Scheduling of Microservices in Container based Cloud Environment**

### Abstract

Containers provide lightweight and portable execution environments for microservice. The Container orchestration platforms such as Docker Swarm and Kubernetes offer automated deployment, scaling, and management of containerized microservices.Docker Swarm's default scheduling policies are based on static heuristics. They have lack of awareness of dynamic resource conditions and application-level performance. However, efficient container scheduling remains a significant challenge due to dynamic workload conditions, heterogeneous resource availability, Quality of Service (QoS) needs, and increasing energy consumption in cloud infrastructures. To address these limitations, this research proposes a Multi-Criteria Scheduling of Containerized Microservices using Reinforcement Learning (MCSCM-RL) framework for Docker Swarm environments. The proposed framework integrates multi-criteria decision-making and Deep Reinforcement Learning techniques to enable intelligent and adaptive container scheduling for microservices. The proposed scheduling approach integrates node-level metrics, such as CPU and memory utilization, and

container counts, with application-level QoS metrics, such as average startup time and average response time.

A multi-criteria node-ranking mechanism based on a relative closeness function is employed to evaluate the suitability of cluster nodes, while a DQN based reinforcement learning agent dynamically selects optimal deployment nodes based on real-time cluster conditions and learned scheduling mechanisms. The proposed scheduling framework was implemented and evaluated using a Docker Swarm cluster comprising one manager node and two worker nodes deployed on Ubuntu virtual machines. Experimental results exhibit that the proposed MCSCM-RL scheduler effectively improves workload distribution, resource utilization, startup time, response time, and energy efficiency compared with traditional container scheduling approaches. The integration of reinforcement learning enables adaptive scheduling behavior through continuous interaction with the environment, while the multi-criteria node-ranking mechanism enhances decision-making by considering multiple performance indicators simultaneously.

This PhD Thesis will help in; Multicriteria Scheduling of Microservices in Container based Cloud Environment

List of Publication(s):

(1) Anil Prajapati, Dr. Manish M Patel, Container Scheduling: A Taxonomy, Open Issues and Future Directions for Scheduling of Containerized Microservices in Cloud Environments, International Journal of INTELLIGENT SYSTEMS AND APPLICATIONS IN ENGINEERING, ISSN:2147-6799214, 2024, 12(22s), 1108–1122, DOI: 10.18201/ijisae.20240663439

(2) Anil A. Prajapati, Manish M. Patel, Multi-Criteria Deep Reinforcement Learning Energy-Aware and QoS-Driven Scheduling for Containerized Microservices in Docker Swarm Clusters, Journal of Advances in Engineering and Intelligence Systems e-ISSN:2821-0263 Volume 05, Issue 01, 2026, https://doi.org/10.22034/aeis.2026.568553.1405