



A multi-objective priority aware task scheduling in fog-cloud environment using improved meta-heuristic algorithm

Syed Mujibha Hussain^{1,2} · G. H. Begh¹

Received: 28 January 2024 / Revised: 10 July 2024 / Accepted: 25 October 2024

© The Author(s) under exclusive licence to The Society for Reliability Engineering, Quality and Operations Management (SREQOM), India and The Division of Operation and Maintenance, Luleå University of Technology, Sweden 2024

Abstract Internet of Things (IoT) tasks have a variety of quality of service (QoS) needs, wherein the fog-cloud computing has emerged as a promising platform for handling the tasks. As a result of its proximity to IoT devices, the fog environment offers minimal latency, but it also faces resource limitations, which is not present in cloud environment. So a basic problem of the fog-cloud environment is the execute tasks that are offloaded from IoT devices by effectively using the fog-cloud resources. Hence, this research introduces a novel task scheduling approach based on the improved meta-heuristic algorithm. An improved zebra algorithm (ImZP) is proposed for performing the priority aware task scheduling. The zebra algorithm is hybridized with the mutation operation of the differential evolution algorithm (DE) for enhancing the exploration criteria to accomplish the global best solution. Besides, the acquisition of non-dominant solutions while considering the multi-objective fitness function, pareto optimal front is considered. Here, the multi-objective function based on priority, cost and execution time are considered in scheduling the task optimally. The analysis of ImZP show superior performance over the existing algorithms in terms of the metrics like priority, availability, success, energy consumption, cost and success rate. The values obtained are respectively 0.9702%, 0.7436%, 0.00567 ms, 0.03066 k, 0.04171G\$ and 0.7438.

Keywords Priority aware task scheduling · Improved meta-heuristic algorithm · Pareto optimal front · Differential evolution · Fog broker · Multi-objective fitness · Resource management

1 Introduction

Cloud computing is widely used global data processing and data storage systems that serve both public and private organization (Meli et al. 2011).

Since the internet of things (IoT) based data flows continuously it is difficult to store those data based on location Yongrui et al. (2016). The cloud services are unaware of location and not highly flexible to allocate resource to the data (Yu et al. 2017). Hence task scheduling models are framed. However, the task scheduling in cloud highly depends on makespan, computation cost, reliability, availability, response time, energy consumption etc. (Sehshini and Kavitha 2011). To deal with the highly delay sensitive application of IoT by cloud, fog computing (Hussain et al. 2021) is integrated with the cloud. Moreover, the integration of edge computing with cloud would further increase latency (especially for mobile edge devices) (Cai et al. 2020) hence it is better to use fog with cloud.

Fog computing (Arthurs et al. 2021) is an extended form of cloud that could serve heterogeneous network systems such as IoT. The fog layer is located near the edge and smart devices thereby reducing the latency of transmission, storage and processing the IoT data. In Fog-cloud environment, the fog node would pre-process the data (Kashani et al. 2020) and post-processing and storage are done in cloud. Thus the amount of data transmitted to cloud is low and network bandwidth (Prajna et al. 2022) is highly reduced. The fog-computing structure is used in many applications such as

✉ Syed Mujibha Hussain
syed.mujibha@luleauniversity.se

¹ Advanced Communication Lab, Department of Electronics and Communication Engineering, National Institute of Technology Suragat, Sonapat, India

² Department of Computer Science and Engineering, Indian University of Science and Technology, Awaragat, Kachin 62122, India