2025 EECMS Summer Internship Application Form

Main Supervisor	Dr. Redowan Mahmud
Other supervisors (if applicable)	
Project Title	Adaptive Hierarchical Federated Learning for Multi-Objective Optimization in Fog Computing Environments
Student location(s) for the project	Curtin University
Duration of project	Eight weeks
Project Description	**Background:** The rapid evolution of the Internet of Things (IoT) demands computational infrastructures that not only support real-time processing but also adapt to mobile user environments. Fog Computing (FC), proposed by Cisco, positions itself crucially by bringing computation closer to the edge of the network, thus enhancing performance and user experience by reducing latency. The unique challenges in FC include optimizing for multiple objectives such as execution time, energy consumption, and network bandwidth, all while managing heterogeneous resources spread across different network layers. **Project Aim:** The aim of this project is to develop a federated learning model capable of solving complex multi-objective optimization problems in Fog Computing. This model will employ a novel hierarchical approach to optimize resource allocation, task scheduling, and system scalability, addressing the nuanced needs of IoT applications. **Objectives:** Development of a Hierarchical Model: Design a hierarchical model that categorizes computational and networking constraints into different layers. This approach allows for modular adjustments and easier integration of diverse IoT applications. Implementation of Federated Learning: Utilize federated learning techniques to aggregate data from multiple FC nodes without compromising user privacy. This will enable the model to learn optimal configurations across a distributed network. Optimization of Multi-Objective Functions: Develop and implement algorithms that can efficiently find solutions to the formulated optimization problems, focusing on reducing makespan, energy consumption, and improving network efficiency. Validation and Testing: Simulate various IoT scenarios to validate the models and optimization strategies. This includes rigorous testing of the federated learning framework under different network conditions and scales.

	Methodology: ***Task 1: Modelling of FC System*** Develop comprehensive mathematical models for resources, applications, and constraints using a hierarchical structure. Model tasks, servers, and links using deterministic and stochastic representations to accurately predict system behaviors. ***Task 2: Federated Learning Implementation*** Develop federated learning algorithms tailored to the hierarchical models of FC, enabling decentralized optimization. Implement privacy-preserving mechanisms to ensure data security across federated nodes. ***Task 3: Multi-Objective Optimization Solutions*** Create scripts and tools to reformulate the hierarchical optimization problems for classical and metaheuristic solvers. Design heuristics and algorithms to find Pareto-efficient fronts for objectives like makespan, energy consumption, and network requirements. **Expected Outcomes:** A robust federated learning framework capable of handling multi-objective optimization problems in Fog Computing. Enhanced performance of IoT systems through optimized resource allocation and task scheduling. Contribution to the academic and industrial understanding of scalable and efficient FC architectures. **Impact:** The project will directly impact the efficiency of IoT systems, particularly in how they manage data and compute resources in real-time. The outcomes will benefit industries such as healthcare, smart cities, and manufacturing, where IoT devices play a crucial role. **Dissemination:** Results will be disseminated through peer-reviewed journal/conference/workshop publications. Additionally, prototypes and software tools developed will be made available to the academic and industrial communities.