IPParis HPDA/PDS Master projects 2023-2024
**Advancing AI-Driven IoT: Enabling Proactive Adaptation
of IoT Systems with Multi-Agent Reinforcement Learning**
September 15, 2023

Project Description

Context. The Internet of Things (IoT) has revolutionized the way we interact with our environment. Today's IoT environments consist of a complex infrastructure comprising IoT devices and sensors that sense physical phenomena and generate data. This data is further processed by virtual sensors to create enriched high-level observations, and various applications offer services to different stakeholders within these smart environments. However, ensuring the quality of these services, known as Quality-of-Service (QoS), is a critical challenge. QoS requirements, such as maximum latency, data accuracy, and location constraints, must be met to guarantee the correct behavior of IoT applications. For instance, a smart museum may deploy intrusion detection applications for security and audioguide applications for visitors, each with its unique QoS requirements.

The Challenge. IoT systems are dynamic by nature and changes may occur to the infrastructure deployed at runtime, leading to applications experiencing degraded QoS performance. For instance, some IoT devices may become unavailable because of low energy levels, or some applications might experience higher latency because of network link congestion or failure. To address these challenges, several approaches have beed developed to propose adaptation strategies in response to possible changes. However, most of these approaches are reactive, meaning they respond to problems *after* they occur and QoS degrades. The primary challenge we address in this project is how to proactively adapt IoT systems to predict and limit potential QoS degradation *before* it impacts users.

Project Objectives

This project aims to propose an AI-driven proactive adaptation solution for IoT systems. In particular, the primary objectives of the project are to develop:

– A **performance prediction** system that analyzes and predicts the performance of the IoT system while continuously monitoring its status. This prediction system will identify possible QoS violations before they happen. To achieve this, we will rely on machine learning models to accurately predict performance trends.

– **Adaptation mechanisms** that will be triggered when the performance prediction system detects potential QoS violations. These mechanisms will execute adaptation plans to address the identified issues. These plans will be created by intelligent agents that leverage multi-agent reinforcement learning approaches and work alongside various components of the IoT system.

Skills & qualities

– Fluent in English
– Experience in developing machine learning models for accurate prediction.
– Knowledge of control models (e.g., MAPE-K) for autonomic and self-adaptive systems is a plus.
– Experience with reinforcement learning techniques (e.g., Q-learning, SARSA) is a plus.

Supervisors

Georgios Bouloukakis, `georgios.bouloukakis AT telecom-sudparis.eu`
Houssam Hajj Hassan, `houssam.hajj_hassan AT telecom-sudparis.eu`