Research engineer position

Host research team and general purpose of the position

Networks are omnipresent and increasingly complex, and require an efficient management of their operations. The ERMINE team designs and analyzes procedures and policies for efficiently managing network operations, but also works on the required measurement and monitoring of performance metrics. A cross-cutting research axe for both management and measuring is artificial intelligence. Our activity is a trade-off between methodological/mathematical developments and practical implementations.

We are searching for a research engineer that would like to have fun with us while working seriously on ongoing activities/projects in our team. The main tasks to be carried out are described below.

Task 1 - IoT4Pest project: an IoT-based system for early pest detection

Keywords: IoT (Internet of Things), LoRaWAN, NB-IoT, WSN, Satellite, LEO, Unmanned Aerial Vehicles (UAV)

Context:

A collaborative project between our ERMINE research team at Centre Inria de l'Université de Rennes and the University of Abomey-Calavi in Cotonou, Benin, in sub-Saharan Africa, has just been launched. This project focuses on the development of a digital method of pest detection based on an intelligent crop monitoring network system. Such a detection method would contribute to the establishment of an effective control protocol against fall armyworms as soon as it is detected in the vicinity of crops. This would reduce the use of plant protection products, pesticides, and the uses of GMOs (Genetically Modified Organisms), or considerably reduce the quantities usually used.

The proposed approach is based on smart wireless sensors by combining a set of usual agricultural parameter measurement sensors (temperature, humidity) and electronic nose type sensors for the measurement of volatile substances in the environment of the caterpillar using an electronic system to design in order to detect early caterpillars. The data provided by such sensors will be collected in a way that reduces the energy consumption of the sensors as they could be in place for several month periods. Unmanned Aerial Vehicles (drones) will be used to fly upon crops to gather sensor data. As crop fields are often located in isolated areas with no communications infrastructure, satellite data collection will also be considered. In particular, two important technologies have emerged in this context: LoRaWAN (Long Range Wide Area Network) and NB-IoT (Narrowband Internet of Things).

The latter go beyond the limits of traditional wireless sensor networks (WSNs) in terms of range, scalability and energy efficiency.

Objectives and missions: The research engineer will:

1. exploring the adaptation of Low-Power Wide-Area Network (LPWAN) technologies to operate in satellite networks
2. identifying, deploying and, if necessary, developing the tools/technologies required to advance the IoT4Pest project
3. coordinate the project as a whole, interacting with the researchers, PhD students and trainees involved in the project within the ERMINE team in Rennes, France, but also in partnership with our colleagues at the University of Abomey-Calavi in Benin.

Task 2 - On Deep-learning based environment detection of mobile network users

Keywords: Beyond 5G, Machine Learning, Neural networks, Mobile networks, LSTM, Transformers

Context: In today's fast-paced digital landscape, mobile networks have become the backbone of modern communication, enabling seamless connectivity and accessibility for millions of users worldwide. There is a proliferation of smartphones and an increasing demand for high-quality services. This has led to the exponential growth of mobile network data, presenting a unique opportunity to extract valuable insights and optimize network performance. One critical aspect of mobile network optimization is accurately detecting and classifying user environments, such as distinguishing between indoor and outdoor settings. Understanding the user's environment is paramount for operators to make informed choices regarding resource allocation, coverage enhancement, user positioning or localization and quality of service/experience improvements.

Supervised learning has been the conventional approach for environment detection, requiring manually labeled data. This process is, however, laborious specially when annotated manually by a group of annotators and impractical for large-scale or real-time applications.

To tackle this problem, we would like to study approaches for semi-supervised learning as well as techniques to artificially generate data using AI.

Objectives and missions: We have already studied some semi-supervised approaches such as the approaches based on clustering, co-training, LSTM-AE, transfer learning, etc. The research engineer will build upon the existing work to improve them and explore new approaches.
Within our project, he/she will:

- Study Deep learning based Semi-Supervised learning techniques, such as LSTM or Transformer based Auto-encoders for environment detection using radio signal metrics defined in 3GPP such as RSRP, etc. The goal will be to use reduced amount of labeled data.
- Study generative AI approach for generating artificial data containing metrics such radio signal metrics.

Task 3 - Mobility-based service placement in the Edge-Cloud Continuum

Keywords: Beyond 5G, NFV, Network Slicing, mobility, service placement, machine learning

Context: 5G and Beyond 5G networks are expected to cope with a wide range of services with stringent and sometimes conflicting requirements (delays, energy consumption, throughput, etc.). To address and efficiently manage such constrained service, one solution is bringing the computation and networking resources to the edge of the network, as near as possible to end-users. However, leveraging edge resources leads to more heterogeneity and thus more complexity in resource management.

Network Slicing [1], enabled by Software-Defined Networking (SDN) [2] and Network Function Virtualization (NFV) [3,4] paradigms, is a key feature that allows Infrastructure providers to share their physical networks among multiple tenants through the instantiation of fully-isolated logical networks. The latter are managed based on the tenants' specific service requirements. Network slicing calls then for efficient solutions to tackle the issue of resources management towards provisioning end-users with satisfying experience.
To be efficient, a resource management solution should then consider:

- the end-user context and environment and specifically in case of mobility that can severely affect the perceived quality by end-users;
- different conflicting objective functions (e.g., completion time, energy consumption, cost, reliability, availability, accessibility, etc.);
- the resource heterogeneity particularly at the edge which is known to be limited.

Thus, the integration of intelligent functions within the network becomes a strong requirement to efficiently control and manage the network resources and dynamically react to changes on both the resources and the user environment.

Objectives and missions: For this work, the research engineer will participate to the design of solutions that: (i) will study the users' trajectories using ML tools and technologies and predict the future locations of users (ii) and based on this inferred information automate the service placement in the continuum and ensure seamless service continuity when end-users are mobile in an efficient costless manner.

[1] NGMN Alliance, "Description of Network Slicing Concept", Tech. rep., Version 1.0, 2016.
[2] KIRIHA, Yoshiaki, and Motoo NISHIHARA. "Software-Defined Networking: The new norm for networks Software-Defined Networking: The new norm for networks, 2012." IEICE transactions on communications 96.3 (2013): 713-721.
[3] NFV White paper: "Network Functions Virtualisation, An Introduction, Benefits, Enablers, Challenges & Call for Action, Issue 1", Oct. 2012.
[4] ETSI GS NFV 002: "Network Functions Virtualisation (NFV); Architectural Framework", Version 1.2.1, Dec. 2014.

Information for application

- Job type: Full-time (CDD)
- Duration: 1 year renewable
- Expected starting date: as soon as possible
- Location: IRISA, Campus de Beaulieu, 35042 Rennes cedex, France
- Salary: Depending on the profile from a minimum of 2446,62 euros/month gross

Expected Candidate Profile

- Desired level of education: Preferably young graduate PhD, but Master/Engineer degree with good skills can also be considered
- Software engineering design and development skills (git, Linux, Python, C++, etc.)
- You know how to annotate your code and generate its documentation to allow its reuse.
- Machine learning methods and tools
- You are autonomous, versatile, proactive and you are interested in continuous learning
- Proficiency in the English language for speaking, writing and reading are necessary.
- French language skills are not a prerequisite. Depending on the candidate native language, French or English will be the working language.

Advantages

- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Social security coverage

To apply:

Candidates should send the following:

- A covering letter expressing clearly the order of preference/skills for the 3 main tasks indicated in the position profile
- A CV
- All documents attesting the required skills and knowledge
- 2 selected publications if applicable
- Contact information of 2 professors who can provide recommendation on the candidate, if applicable

The applications should be sent to cesar.viho@irisa.fr. Please put in the subject of your email: Ing-Rech-App
Application deadline: 06/09/2024