School of Computing, Engineering, and the Built Environment
Edinburgh Napier University

PHD STUDENT PROJECT

Application instructions:
Detailed instructions are available at :
https://www.napier.ac.uk/research-and-innovation/doctoral-college/how-to-apply

Prospective candidates are encouraged to contact the Director of Studies (see details below) to discuss the project and their suitability for it.

Project details

Supervisory Team:

- DIRECTOR OF STUDY: Saima Rafi (Email: s.rafi@napier.ac.uk)
- 2ND SUPERVISOR: Dr Amjad Ullah

Subject Group: Computer Science

Research Areas: Computer Science

Project Title: Smart Grid Efficiency: Integrating AI and Automation

Project description:

Smart Grid is the emerging next-generation power grid concept that uses two-way flows of electricity and information to create a widely distributed automated energy delivery network. The key goal of SG is to transform the grid to greener and improve the delivery of power by shifting to sustainable technologies such as distributed generation and microgrids. More recently, SGs have rapidly evolved to incorporate sophisticated sensors, domestic power micro-generators, and IT infrastructures. However, traditional algorithms e.g., power flow algorithms, demand forecasting algorithms etc. used in SGs often struggle with the complexity and dynamism of modern energy networks. To address these challenges, DevOps practices can play a significant role in streamlining and automating the development and deployment processes, particularly in real-time data analysis, predictive maintenance, and adaptive energy management. In this context, this Ph.D. project will explore the integration of advanced automation techniques and machine learning (ML) algorithms into Smart Grid systems. The focus will be on developing ML-based algorithms to

optimise energy storage, improve micro-generator efficiency, and enhance communication between grid components. Additionally, DevOps practices to automate source-code management, software development, and IoT orchestration within SGs can be explored as well. By leveraging DevOps principles, the aim is to create a robust framework for continuous integration and deployment, ensuring that updates are seamlessly incorporated into the SG infrastructure, thus improving overall system efficiency and reliability.

The effectiveness of the proposed framework will be tested using simulation environments and real-world SG data. Experiments will be conducted to compare the performance of the new automation techniques against existing state-of-the-art methods, focusing on key metrics such as energy efficiency, fault tolerance, and system responsiveness. Prospective applicants are encouraged to contact the Supervisor to discuss their interest in this cutting-edge research at the intersection of Smart Grids, automation, and machine learning.

References:

1. Lévy, L.N., Bosom, J., Guerard, G., Amor, S.B., Bui, M. and Tran, H., 2022. DevOps model appproach for monitoring smart energy systems. Energies, 15(15), p.5516.
2. Fortuna, C., Yetgin, H. and Mohorčič, M., 2022. Smart infrastructures: Artificial intelligence-enabled lifecycle automation. IEEE Industrial Electronics Magazine, 17(2), pp.37-47.
3. Sun, Z., Li, Y. and Wen, L., 2022. DevOps and Neural Network Based Full Lifecycle Management Model for Power Information Systems. Procedia Computer Science, 208, pp.642-649.
4. Fortuna, C., Yetgin, H. and Mohorcic, M., 2022. AI-Enabled Life Cycle Automation of Smart Infrastructures. Industrial Electronics Magazine.
5. Pau, M., Mirz, M., Dinkelbach, J., Mckeever, P., Ponci, F. and Monti, A., 2022. A service oriented architecture for the digitalization and automation of distribution grids. IEEE Access, 10, pp.37050-37063.
6. Hernandez, L., Baladron, C., Aguiar, J.M., Carro, B., Sanchez-Esguevillas, A.J., Lloret, J. and Massana, J., 2014. A survey on electric power demand forecasting: future trends in smart grids, microgrids and smart buildings. IEEE Communications Surveys & Tutorials, 16(3), pp.1460-1495.

Candidate characteristics

Education:

A first-class honours degree, or a distinction at master level, or equivalent achievements in computer science

Subject knowledge:

Software engineering, ML, Computer programming

Essential attributes:

- Experience in fundamental software engineering
- Competent in one (or some) programming languages
- Knowledge of Smart Grid network and DevOps
- Good written and oral communication skills
- Strong motivation, with evidence of independent research skills relevant to the project
- Good time management