Human-centric Buildings: The Role of eXplainable AI in Cognitive Environments

Summary

Cognitive buildings represent a new era of structures that can react to surroundings and adapt to the needs of their occupants. This paradigm is steered by a mixture of enabling technologies such as AI, ML, IoT, data science, and a human-centric approach. The latter ensures that buildings augment the quality of life, highlighting a new era in the relationship between inhabitants and their physical environment. The amount and complexity of data in buildings makes them ideal candidates for sophisticated ML models. However, the frequent problem is the lack of interpretability of such models, meaning we do not understand how they make their decisions. Establishing trust between occupants and cognitive buildings becomes essential, as a trusted environment can lead to greater acceptance and appreciation of these advanced capabilities. eXplainable Artificial Intelligence (XAI) is a concept that tries to close this gap.

Research field:	Information and communication technology
Supervisors:	Martin Thalfeldt
	Prof. Dr. Juri Belikov
Availability:	This position is available.
Offered by:	School of Information Technologies
	Department of Software Science
Application deadline:	Applications are accepted between January 01, 2025 00:00 and January 24, 2025 23:59 (Europe/Zurich)

Description

We are seeking a prospective PhD candidate who will work on developing novel human-centric data-driven and XAI-based methods for cognitive buildings applications. The successful candidate will focus on exploring how AI, machine learning, and data science can be leveraged to create intelligent control systems that adapt building environments to the needs and preferences of occupants with the following general objectives:

- Develop data-driven algorithms that analyze data from sensors and user interactions to personalize various building parameters for improved comfort, productivity, and well-being as well as to more effectively utilize the energy flexibility available in buildings.
- Create interactive and responsive environments within cognitive buildings.
- Propose new evaluation metrics for the quality of explanations.
- Develop new standardization approaches and clear definitions suitable for different focus groups.

Main responsibilities of the prospective PhD candidate:

- Publish and present scientific articles top-tier journals and international conferences.
- Assist in relevant teaching activities and co-supervise students.
- Contribute to the goals of the Centre of Excellence in Energy Efficiency (ENER grant TK230) funded by the Estonian Ministry of Education and Research and to the project "Enabling smart-grid ready building through integrated solutions and digital technologies", funded by European Commission.

Requirements:

- M.Sc. degree or equivalent in Computer Science, Mathematics, or a related field.
- Clear interest in the research topic, demonstrated through a motivation letter, supported by the research plan.
- Proficiency in Python and MATLAB programming.
- Excellent English communication skills, both written and verbal.
- Strong analytical and research skills.
- Capacity to work independently and collaboratively in an international cross-disciplinary team.
- Optional: Experience in buildings' heating, ventilation and air-conditioning and/or building automation

- Optional: Experience with ML and AI, showcased through GitHub projects.

What do we offer:

- Competitive salary
- Working in the international environment
- Contribution to the top-level research projects
- Social benefits

References:

[1] L. Heistrene, R. Machlev, M. Perl, J. Belikov, D. Baimel, K. Levy, S. Mannor, Y. Levron. Explainability-based Trust Algorithm for electricity price forecasting models. *Energy and AI*, 14, p. 100259, 2023. DOI: 10.1016/j.egyai.2023.100259.

[2] R. Machlev, L. Heistrene, M. Perl, K. Y. Levy, J. Belikov, S. Mannor, and Y. Levron. Explainable Artificial Intelligence (XAI) techniques for energy and power systems: review, challenges and opportunities. *Energy and AI*, 9, p. 100169, 2022. DOI: 10.1016/j.egyai.2022.100169.

[3] R. Machlev, M. Perl, J. Belikov, K. Y. Levy, and Y. Levron. Measuring explainability and trustworthiness of power quality disturbances classifiers using XAI—Explainable Artificial Intelligence. *IEEE Transactions on Industrial Informatics*, 18(8), pp. 5127-5137, 2022. DOI: 10.1109/TII.2021.3126111.

[4] M. Meas, R. Machlev, A. Kose, A. Tepljakov, L. Loo, Y. Levron, E. Petlenkov, and J. Belikov. Explainability and transparency of classifiers for air-handling unit faults using explainable artificial intelligence (XAI). *Sensors*, 22(17), p. 6338, 2022. DOI: 10.3390/s22176338.

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