



Doctoral Vacancy Announcement form

Research Topic Title:

Multi-modal Uncertainty Quantification and Management of AI

No. of Openings: 1

Description

This PhD project aims at developing techniques for effective and reliable uncertainty quantification of AI components used in robotic applications. Concretely, by investigating approaches for managing the uncertainty associated with AI components, the project will ultimately enable effective and efficient risk-informed decision making.

The role is funded by the Marie-Sklodowska-Curie Doctoral Training Network CAVECORE (Continuous, Automated Validation, and Evaluation of Cognitive Robots in Open-Ended Environments) within the Horizon Europe Programme of the European Commission. CAVECORE is a consortium of high-profile universities, research institutions and companies located in Germany, UK, France, Denmark, Spain, and the UK.

In addition to your individual project, you will pursue further continuing education, including a variety of training modules as well as transferable skills courses and active participation in workshops and conferences. You will have regular contact with the other 14 researchers in the CAVECORE DTN and their supervisors.

The post is tenable for 3 years, and the starting date is September 2026.

Research Aims

The overarching goal of this project is to develop monitoring and self-adaptation capabilities that treat uncertainty as a first-class concern in the design and operation of autonomous systems. Specifically, the PhD researcher will:

- Conduct research on rigorous and mathematically based techniques for empowering monitoring and self-adaptation in autonomous systems, explicitly accounting for uncertainty.



- Develop learning-enabled monitors that can be revised and refined based on runtime data, improving the fidelity of system models and enabling robust self-adaptation.
- Design and implement techniques for effective and efficient uncertainty-based decision making that enable reasoning about epistemic and/or aleatoric uncertainty.
- Investigate techniques for uncertainty analysis and quantification based on the operating context and data.

Potential Research Themes

This project offers scope for research across several interrelated areas, including but not limited to:

- Formal and probabilistic verification for autonomous and adaptive systems under uncertainty.
- Stochastic and hybrid modeling techniques incorporating partial observability and non-determinism.
- Learning-based refinement of monitors and models from runtime and operational data.
- Uncertainty quantification for AI components in robotic and cyber-physical systems.
- Uncertainty-aware decision-making frameworks enabling reasoning about epistemic and aleatoric uncertainty.
- Development of software toolsets for uncertainty analysis, risk evaluation, and adaptive control in real-world CPS applications.

Expected Results

By the completion of the PhD, the candidate is expected to deliver:

- Novel techniques for monitoring and decision-making under uncertainty, integrating heterogeneous stochastic models that handle partial observability and non-determinism.
- Methods for learning and refinement of monitors that improve structural and behavioural representations based on operational data.
- A toolset for uncertainty analysis and quantification, adaptable to various operating contexts.
- Uncertainty-based decision-making techniques enabling principled reasoning about different forms of uncertainty.

Required Qualifications

- A Bachelor's and Master's degree in Computer Science, Electrical/Computer Engineering, Mathematics, or related fields.
- Strong background in Artificial Intelligence, Machine Learning, or Applied Mathematics.
- Experience with Deep Learning frameworks (e.g., PyTorch, TensorFlow) or formal verification tools is highly desirable.



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- Demonstrated interest in autonomous systems, reliability, and safety-critical AI.
- Excellent communication skills in English (written and spoken).
- High degree of self-motivation, ability to work independently and collaboratively, and a commitment to high-quality research.

Funding

This PhD project is fully-funded under the CAVECORE Marie Curie Doctoral Network.

Research Advisor

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Position: Assistant Professor

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