INSTITUT
DE RECHERCHE
EN INFORMATIQUE
FONDAMENTALE

PhD in cyber-physical systems, verification, learning at IRIF in Paris

WHAT:

A fully funded PhD position in Computer Science with the subject **"Cyber-physical systems with AI components: modeling, learning and verification"** opens in Paris, **starting in September or October 2022**. Excellent and motivated candidates are invited to apply.

WITH WHOM:

Prof. Eugene ASARIN, Dr. Mohammed FOUGHALI, Dr. Peter HABERMEHL

WHERE:

The PhD position will be hosted by IRIF (Institut de Recherche en Informatique Fondamentale), in the Modeling and verification team, in the framework of the Franco-Japanese research project CyPhAI.

IRIF is a research unit co-founded by CNRS and Université Paris Cité. The research conducted at IRIF is based on the study and understanding of the foundations of all computer science, in order to provide innovative solutions to the current and future challenges of digital sciences.
In particular, IRIF is renowned for its contributions to the design and analysis of algorithms, the study of computational and data representation models, the foundations of programming languages, software development, verification, and certification.

The **research activities of the Modeling and Verification team** address the development of algorithmic approaches to system verification, from theoretical foundations to innovative verification tools.

The **project CyPhAI is dedicated to modeling, identification, design and verification of cyber-physical systems** with artificial intelligence components. It involves researchers from Grenoble, Paris, Toulouse, Kyoto and Osaka.

The PhD student will be based in IRIF, Paris, and will have an opportunity (but not an obligation) to teach (in French or even in English). Research visits to other partners of CyPhAI project in France and in Japan will be possible.

WHAT WILL THE THESIS BE ABOUT:

Cyber-physical systems (CPS) are computer-based systems where the computer software and the physical world (of both the system and its environment) are tightly. CPS are omnipresent in everyday's life and their applications continue to proliferate – in robotics, industry, home appliances etc. Elegant and powerful mathematical models, such as hybrid and timed automata are used to represent CPS, design them and verify their properties.

In recent years, more and more CPS are equipped with components from the domain of artificial intelligence – AI (computer vision systems with neural networks, and even controllers based on reinforcement learning), it suffices to mention self-driving cars and other autonomous systems. The thesis will be centered on several aspects of modeling, learning and verification of such CPS-AI systems.

- **Defining mathematical models of CPS-AI**, based on hybrid, timed and/or probabilistic automata. Validating their relevance by modeling real-life systems. The challenge is to have several levels, from very precise models (suitable for simulation), to more abstract (e.g., for verification) to very abstract one (for human-understandable explanation)
- **Learning/identifying models of CPS from observational data**. Combining, in a pragmatic way, ideas from automata theory with model identification from control science, and with machine learning with neural networks. Using active and passive, black-box and white-box setting.
- **Formalizing and solving problems of quantitative verification of CPS**: to what extent the CPS satisfies a specification. In off-line (model-checking) and on-line (monitoring) setting.

For the three aspects we expect to follow the path from practical examples to clean mathematical definitions, theorems describing their properties, to algorithms, prototype tools, and experimental work on real-life benchmarks. Depending on the candidate profile, the focus will be on some of these aspects.

FOR WHOM:

The candidate should have a master's (or equivalent) degree in computer science or a closely related field, graduated or expected to graduate before October 2022.

The most important selection criterion is their motivation and capacity of doing creative research combining fundamental and applied aspects.

We require a solid background in theoretical computer science: automata, logic, algorithmics, complexity, as well as basic knowledge of mathematics (calculus, probability). Acquaintance with formal methods/verification, cyber-physical systems and their models (timed and hybrid automata), as well as machine learning (based on automata or on neural networks) will be appreciated but is not mandatory. Advanced programming skills are not required but highly appreciated.

HOW TO APPLY:

An application, in a free form, in English or French, should be sent by e-mail to the three addresses: asarin@irif.fr, foughali@irif.fr, haberm@irif.fr**.** It may contain some of the following: a CV, a motivation letter, references or recommendation letters, transcripts of grades for master's studies, links to publications or MSc thesis if relevant. Please send the application as soon as possible: the PhD should start in September or soon thereafter.

USEFUL LINKS:

The project: https://cyphai.io

The institute: https://www.irif.fr/en and its PhD page https://www.irif.fr/en/postes/these

The team: https://www.irif.fr/en/equipes/verif

The supervisors:

- Prof. Eugene Asarin https://www.irif.fr/~asarin/
- Dr. Mohammed Foughali https://mo-f.github.io/Mo-F/
- Dr. Peter Habermehl https://www.irif.fr/~haberm