Offer #2021-04057

PhD Position F/M Dimensioning multi-criticality embedded systems for efficient execution of artificial intelligence algorithms

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

Level of experience : Recently graduated

Context

The PhD thesis is funded by the Paris region PhD 2021 program (see more details at https://www.iledefrance.fr/paris-region-phd-2021) and it is hosted by the Kopernic team in Paris (see more details at https://team.inria.fr/kopernic/)

Supervised by Liliana Cucu-Grosjean (https://who.rocq.inria.fr/Liliana.Cucu/Welcome.html) and Yasmina Abdeddaïm (https://perso.esiee.fr/~abdedday/), the student interactes with Kopernic members as well as with StatInf members, a Kopernic spin-off (https://statinf.fr). The thesis is expected to start as soon as possible and no later than January 1st, 2022.

Travelling is expected in France and abroad, the associated costs being covered following the current public laws. Inria offers an equal opportunity and friendly working environnement, while covering partially the transport and meal costs. AGOS (its commité d'entreprise) provides financial support for holidays or jobbies.

Assignment

With the introduction of artificial intelligence methods in the embedded systems sector, more and more embedded applications require complex computations that require a lot of computing power, for example in the case of autonomous vehicles. These applications, which are often critical, must respect strict time constraints in order to ensure a high level of safety. For example, in an autonomous vehicle, braking induced by the automatic recognition of a pedestrian can have dangerous consequences if it takes longer than expected.

In order to perform these complex calculations in the given time, designers are using the latest generation of embedded processors integrating multiple cores with a tendency to integrate hybrid architectures such as CPU-GPU or CPU-FPGA to decrease response times, but also energy consumption. Although hybrid architectures increase computing power, the time validation of the execution of programs running on these architectures is an open problem, especially when the programs do not share the same criticalities.

The worst-case execution time (WCET) and the worst-case response time are important parameters in the time validation of real-time critical systems because they allow to verify if a program, combined with other programs, can be implemented on a processor while respecting strict time constraints. The WCET can be estimated either by static analysis methods, or by measurement-based methods, or by a combination of both approaches [1]. Depending on this estimation, the response time calculation methods can be analytical or measurement-based. The response time are associated to the scheduling algorithms. The objective of the thesis is to evolve existing scheduling algorithms towards hybrid architectures, to compare their energy performances, while respecting the time constraints.

The following non-exhaustive list of papers may help understanding the background associated to this thesis:

[1] Reinhard Wilhelm et al., The Worst- case Execution-time Problem: Overview of Methods and Survey of Tools, ACM Trans. Embed. Comput. Syst., 7(3), May 2008.
[2] Robert Davis and Liliana Cucu-Grosjean, Survey of Probabilistic Schedulability Analysis Techniques for Real-Time Systems. Leibniz Trans. Embed. Syst. 6(1): 04:1-04:53 (2019)
[3] Slim Ben-Amor, Liliana Cucu-Grosjean, Mehdi Mezouak, Yves Sorel:Probabilistic Schedulability Analysis for Precedence Constrained Tasks on Partitioned Multi-core. ETFA 2020: 345-352
[4] Dorin Maxim, Robert I. Davis, Liliana Cucu-Grosjean, Arvind Easwaran : Probabilistic analysis for mixed criticality systems using fixed priority preemptive scheduling. RTNS 2017: 237-246
[5] Liliana Cucu-Grosjean et al.: Measurement-Based ProbabilisticTiming Analysis for Multi-path Programs. ECRTS 2012: 91-101
[6] Cristian Maxim, Adriana Gogonel, Irina Mariuca Asavoae, Mihail Asavoae, Liliana Cucu-Grosjean:

Reproducibility and representativity: mandatory properties for the compositionality of measurement-based WCET estimation approaches. SIGBED Review 14(3): 24-31 (2017)

Main activities

The thesis is expected to cover the following mean activitivies :

1. Adaptation of existing scheduling and placement algorithms to hybrid architectures. Choice of the studied architecture.
   2. Evolution of the scheduling and placement algorithms to take into account programs with dependencies and to make a comparison of the energy performances.
   3. Proposal of versions of the algorithms that reduce energy consumption.
   4. Validation of the results on a case study proposed by StatInf, and open source benchmarks.

All results are expected to be published within real-time conferences and journals.

Skills

Technical skills and level required : background on real-time systems is an avantage, but not necessary. Python is the main programming language, but C/C++ also.

Languages : English

Benefits package

- Subsidized meals
- 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 (after 6 months of employment) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Social security coverage

General Information

- **Theme/Domain :** Embedded and Real-time Systems
  System & Networks (BAP E)
- **Town/city :** Paris
- **Inria Center :** Centre Inria de Paris
- **Starting date :** 2021-12-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2021-11-15

Contacts

- **Inria Team :** KOPERNIC
- **PhD Supervisor :**
  Cucu Liliana / liliana.cucu@inria.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

The keys to success

Clearly the student should enjoy working in a team, but also be sufficientlly autonomous. Enthusiastic about research and embedded systems, the student will interact with teams from avionics, space and automotive, thus the curiosity is a plus.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is

not guaranteed.

Instruction to apply

Defence Security :
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :
As part of its diversity policy, all Inria positions are accessible to people with disabilities.