Approximate Computing Techniques for Energy-Efficient and Fault-Tolerant Embedded Systems

Basic information:

Applications are invited for 15 full-time PhD student positions (called Early Stage Researchers or ESR) for PhD degrees for 36 months. The positions are offered within the Approximate Computing for Power and Energy Optimisation (APROPOS) International Training Network action of the highly appreciated EU-funded Marie Skłodowska Curie grants. The positions are fully funded for a 36-month period. You can choose your position in one of 14 top-level universities and companies in Europe and complement your experience within periods from 3 to 9 months of cross-sector secondments by working with the highly committed industrial partners of the action. You are encouraged to apply for up to three positions within APROPOS network if you believe your profile is suitable for multiple topics. A separate application is needed for each position in case you apply for multiple positions.

APROPOS is an international, multidisciplinary and multi-sectorial training network programme on approximate computing. APROPOS is funded by the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska Curie grant agreement No. 956090.

The ESR project is listed below. Please read the description carefully before applying. We recommend you choose the position you apply for based on your technical profile and desired technical expertise, rather than based on the hosting location, as all positions involve high-level research mobility.

Project information:

APROPOS will train 15 Early Stage Researchers to tackle the challenges of future embedded and high-performance computing by using disruptive methodologies. Following the current trend, by 2040 computers will need more electricity than the world energy resources can generate. On the communications side, energy consumption in mobile broadband networks is comparable to datacentres. To make things worse, Internet-of-Things will soon connect 20 to 50 billion devices through wireless networks to the cloud.

APROPOS aims at decreasing energy consumption in both distributed computing and communications for cloud-based cyber-physical systems. We propose adaptive Approximate Computing to optimize energy-accuracy trade-offs. Luckily, in many parts of the global data acquisition, transfer, computation, and storage systems there exists the possibility to trade off accuracy to either less power or less time consumed – or both. As examples, numerous sensors are measuring noisy or inexact inputs; the algorithms processing the acquired signals can be stochastic; the applications using the data may be satisfied with an "acceptable" accuracy instead of exact and absolutely correct results; the system may be resilient against occasional errors; and a coarse classification or finding the most probable matches may be enough for a data mining system. By introducing a new dimension, accuracy, to the design optimization, the energy efficiency can even be improved by a factor of 10x-50x.

APROPOS will train the spearheads of the future generation to cope with the technologies, methodologies, and tools for successfully applying Approximate Computing to power and energy saving. The training, in this first ever ITN addressing approximate computing, is to a large extent done by researching energy-accuracy trade-offs on circuit, architecture, software, and system-level solutions, bringing together world leading experts from European organizations. In addition, we will provide network-wide and local trainings on the substance and on the complementary skills needed in both industrial and academic work life.

ESR Host Unit: University of Amsterdam (UvA), The Netherlands

ESR 2 Objectives:
- Study the symbiotic combination of two seemingly incompatible concepts: fault tolerance and approximate computing;
- Investigate how approximate computing techniques can be deployed at the system level to improve fault tolerance of embedded systems, while trying to meet their performance and power/energy consumption constraints. In particular, study and evaluate techniques for achieving fault tolerance by means of
  - runtime mapping strategies that exploit a variety in precision of cores (i.e. approximating cores), and
  - task replication and fuzzy voting strategies utilizing lower-precision replicas;
- Design and develop a software framework for system-level simulation and design space exploration (DSE) to study and evaluate the developed techniques.

ESR Expected Results:
Proof-of-concept implementation of a software framework for system-level simulation and DSE for achieving fault tolerance by means of i) runtime mapping strategies that exploit a variety in precision of cores (i.e. approximating cores), and ii) task replication and fuzzy voting strategies utilizing lower-precision replicas. In addition, the completion of the PhD at the hosting unit within 48 months.

Planned secondment(s): Thales Netherlands (THN), supervisor Dr. Hans Schurer, M18, 3-6 months, for understanding fault tolerance in an industrial setting.

Supervisory team:
- Prof. dr. Andy Pimentel (UvA), main supervisor
- Dr. Clemens Grelck (UvA), academic co-supervisor
- Dr. Anuj Pathania (UvA), academic co- supervisor
- Dr. Sobhan Niknam (UvA), academic co-supervisor
- Dr. Hans Schurer (THN), industrial co- supervisor

Enrolment in Doctoral degree: University of Amsterdam, The Netherlands

Target degree: PhD in Computer Science

Degree details: https://www.uva.nl/en/research/phd/phd.html

Expected start date: May 2021 (M7 from the beginning of the project)

Approximate gross salary: The approximate salary will be on average €3.173 (scale P) gross per month, based on a full-time contract of 38 hours a week. Please note that the salary will not be flat rate, but starts lower and ends higher than the aforementioned amount. Moreover, an ESR with family is eligible for an additional monthly Family Allowance of approx. €400 (gross) for the duration of the project.

Duration: 36 months

Researcher Profile: First Stage Researcher (R1)

Research Field: Engineering; Computer science; Technology

Type of contract: Temporary

Job Status: Full-time

Hours per week: 40

Trial period: 18 months

Working and living conditions in the country: The Netherlands is among the most stable, free, and safest countries in the world, based on prominent ratings by various agencies. It is also ranked as one of the top countries as far as social progress is concerned. **Amsterdam** is one of the greatest small cities in the world. It is considered to be a major academic hub in Europe, offers a dynamic living environment and has an extremely rich cultural scene. The city is the financial and cultural capital of the Netherlands. Many large Dutch institutions have their headquarters there, and a range of the world's top 500 companies, including Philips and ING, are based in the city. In the 2019 Quality of Living ranking from multinational HR consultants Mercer, Amsterdam was ranked as the world's 11th best city.

Read more about working and living in Amsterdam:
- https://www.uva.nl/en/education/bachelor-s/practical-matters/living-in-amsterdam/living-in-amsterdam.html
- https://www.uva.nl/en/about-the-uva/working-at-the-uva/practical-information/practical-information.html

Unit details: The University of Amsterdam (UvA) is an intellectual hub with almost 40,000 students, 3,000 PhD researchers, 6,000 staff and 100 different nationalities. UvA's mission is to educate tomorrow's leaders, conduct cutting-edge research and translate our research results into applications that can benefit society. Within APROPOS, the Parallel Computing Systems (PCS) group from UvA's Faculty of Science will be involved in the training network. The PCS group performs research on the design, programming and run-time management of multi-core and multi-processor computer systems. The modeling, analysis and optimization of the extra-functional aspects of these systems, such as performance, power/energy

consumption, and reliability but also the degree of productivity to design and program these systems, play a pivotal role in our work. See the following links for more information:

- [PCS research group](#)
- [Informatics Institute](#)
- [University of Amsterdam](#) and its [Faculty of Science](#)

Seconding Unit description: Thales NL (THN) is a leading, globally operating company in the areas of surveillance, weapon control, command control and communications for naval applications. Thales ranks first in the field of defense electronics within Europe and among the leading companies in the world, and has been involved in the development of surveillance systems since the early days of radar technology.

Read more about THN at: https://www.thalesgroup.com/en/countries/europe/netherlands

Eligibility criteria: please check carefully that you are eligible; all conditions below are compulsory

Transnational mobility: The researcher must not have resided or carried out their main activity (work, studies, etc.) in the country of the host organization for more than 12 months in the 3 years immediately prior to the start date. Note: the mobility rule applies to the (main) beneficiary where the researcher is recruited, and not to partners to which the researcher is sent or seconded. It is also only determined at one point in time: at the time when the ESR starts working for APROPOS.

Early-Stage Researchers (ESRs)/fresh MSc graduates: All researchers recruited in APROPOS must have less than 4 years since the completion of their first MSc degree and have not been awarded any doctoral degree at the date of the employment.

Background requirements: The applicant must be in possession of Master of Science (MSc) diploma in a relevant field, such as: electrical engineering, communications engineering, computer engineering, software engineering/computer science, signal processing, radio communications, mathematics, physics, aerospace engineering, mechanical engineering, biomedical engineering, etc.

English language requirements: The candidate must be in possession of an English certificate with good level according to the regulations of the university to which the student will be enrolled for the PhD degree – check the degree requirements of the corresponding doctoral program for details.