

Compiler Technologies for Approximate Computing

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-specific project is described 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: Politecnico di Milano (POLIMI), Italy

ESR 8 Objectives:

- Understand the state of the art in compiler-based tools for approximate computing;
- Devise tools for supporting approximate computing at the compiler level, balancing the need to minimize user intervention with the ability to understand the trade-offs involved;
- Implement the proposed tools as plugins for the LLVM compiler framework, targeting select hardware platforms;
- Support the trade-off evaluation on selected error-tolerant applications.

ESR Expected Results:

A set of compiler transformations, implemented within the industry grade LLVM compiler framework, able to support approximate computing trading off results precision for energy savings and performance; completion of the PhD at the hosting unit withing 36 months.

Planned secondment(s): IBT Systems, supervisor Dr. Simone Libutti, M24, 6 months industrial training and integration of developed technologies in an IBT Systems application scenario, assessing the impact of automated precision tuning against manually optimized code.

Supervisory team:

- Prof. William Fornaciari (POLIMI), main supervisor
- Prof. Giovanni Agosta (POLIMI), academic co- supervisor
- Dr. Simone Libutti (IBTS), industrial co- supervisor

Enrolment in Doctoral degree: Politecnico di Milano, Italy

Target degree: Doctoral Studies (PhD Programme) in Information Technology (IT)

Degree details: <https://dottoratoit.deib.polimi.it/>

Expected start date: June 2021 (M8 from the beginning of the project)

Approximate gross salary: about 3200 EUR/month for researchers without family (and about 3600 EUR/month for researchers with family); Note: for different positions within the same APROPOS network, the salary is country- and unit-dependent.

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: n/a

Working and living conditions in the country: Italy is, according to OECD data, one of the safest countries in Europe, with excellent and inexpensive healthcare. With its rich, millennia-long, history, Italy is one of the main tourist destinations world-wide, and offers a wealth of monuments and a vibrant cultural and social life, as well as an almost-inexhaustible variety of regional cuisines. **Milan** is the economic heart of Italy, as well as a global metropolis, as well as one of the world's fashion capitals. As an academic center, Milan features no less than seven universities, which attract more than 10% of the national total students. The post-graduate student community is estimated to be as large as 5000, the largest in Italy, contributing to the city cosmopolitan outlook.

Unit details: Politecnico di Milano (Milan, Italy) is the largest Technical University in Italy with more than 40000 students. POLIMI is a vital institution capable of promoting education, fundamental and applied research, and technology transfer to companies. POLIMI is a member of the CINECA consortium, one of the largest HPC centres in Europe. The involved department, DEIB, is one of the largest ICT departments in Europe.

The POLIMI group, based in the HEAP laboratory, is a well-established team of 20 researchers, including 7 faculty members, with a broad range of competences from compiler technology to runtime systems, across domains including both high performance and embedded systems, and covering extra-functional properties from performance to energy efficiency and security. More information on the group can be found at: <http://heaplab.deib.polimi.it/>

Seconding Unit description: IBT Solutions is a supplier of state of the art hardware and software embedded solutions for several application fields, including industrial, automotive, wellness and e-health. IBTS is covering the entire design stack, from the requirements analysis up to the design of the computing platform and of the application, from the edge to the cloud. Given his dynamic nature and the strong link with the academia, it had also a technology scouting role in the development of leading edge solutions in cooperation with big market players. <https://www.ibtsolutions.it/>

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: computer engineering, electrical engineering, communications 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.