Approximation at the Edge for Automated Driving

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: Delft University of Technology (TU Delft), Netherlands

ESR 4 Objectives:
> • Design and develop an approximate edge computing platform for next generation autonomous driving services, to achieve low latency, resiliency, and better quality of experience for end users
> • Evaluate the feasibility, practicality and scalability by deploying approximate computing at edge layer through real world experiment and measurements (e.g., in operational networks), in collaboration with industrial partners

ESR Expected Results:
Develop proof-of-concept software and hardware implementations for an approximate "data-to-knowledge" pipeline to accelerate the transferring process of raw measurement data from car and road infrastructure into productive knowledge; completion of the PhD at the hosting unit withing 48 months.

Planned secondment(s): Telefónica R&D, supervisor Dr. Diego Perino, M12, 3-6 months industrial training and matching the research results with Telefónica. The doctoral student will be supervised by a senior research member of the research team of Telefónica Innovation and will be provided with the appropriate facilities to successfully carry out his secondment activities. The topic will include Edge Computing and latency-demanding services such as autonomous driving and distributed ML, which are the key topics within our team.

Supervisory team:
- Asst Prof. Aaron Ding (TU Delft), main supervisor
- Prof. Marijn Janssen (TU Delft), academic co-supervisor
- Prof. Jari Nurmi (TAU), academic co-supervisor
- Dr. Diego Perino (Telefónica), industrial co-supervisor

Enrolment in Doctoral degree: Delft University of Technology, Netherlands

Target degree: PhD in Delft University of Technology

Degree details: https://www.tudelft.nl/en/education/programmes/phd/

Expected start date: April 2021 (M6 from the beginning of the project)

Approximate gross salary: about 2500 EUR/month estimated for researchers without family (and about 2900 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 (unified for APROPOS to be used in EURAXESS – might be less in reality)

Trial period: 6 months

Working and living conditions in the country: Netherlands is among the most stable, free, and safest countries in the world, based on prominent ratings by various agencies. **Delft** is the hosting city for one of the top engineering schools globally and offers a pleasant living environment.

Unit details: TU Delft is the oldest, largest, and most comprehensive university of technology in the Netherlands. TU Delft aims to discover research problems in society, usually with a technical or engineering component. In recent years, TU Delft has been active in Internet of Things (IoT), edge computing, smart transportation and AI research.

Seconding Unit description: Telefónica I+D (TID) is the innovation company of the Telefónica Group. Founded in 1988. It contributes to the Group's competitiveness and modernity through technological innovation.
The Research team of Telefónica Innovation will be involved in hosting the Early Stage Researchers (ESRs) for secondment at no cost. The doctoral student will be supervised by a senior research member of the research team of Telefónica Innovation and will be provided with the appropriate facilities to successfully carry out his secondment activities. The topic will include Edge Computing and latency-demanding services such as autonomous driving and distributed ML, which are the key topics within our team.

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 English proficiency 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.