Dynamic Data-dependent Precision Scaling for Energy-Scalable Neural-Network and Security Applications

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: Institute of Electronics, Communications and Information Technology (ECIT), Queen's University Belfast, United Kingdom (QUB)

ESR 15 Objectives:
- Develop a scheme through circuit architecture co-design for enabling dynamic precision scaling.
- Combine with voltage and/or frequency over-scaling for enabling dynamic trade-offs between power-consumption, performance and output quality.
- Analyse the properties of neural-network and security applications to exploit data-aware dynamic adaptation of operating settings.
- Implement precision-scalable accelerators for popular neural-networks and security algorithms.

ESR Expected Results:
Proof-of-concept implementation of precision-scalable accelerator for neural network and/or security applications, completion of the PhD at the hosting unit withing 36 months.

Planned secondment(s): XILINX Research, supervisor Dr. Michaela Blott, M18, 6 months industrial training and matching the research results on a XILINX platform and industrial application.

Supervisory team:
- Prof. Georgios Karakonstantis (QUB), main supervisor
- Prof. Maire O'Neill (QUB), academic co- advisor
- Prof. Roger Woods (QUB), academic co-advisor
- Dr. Michaela Blott (XILINX), industrial co-advisor

Enrolment in Doctoral degree: Queen's University Belfast, United Kingdom

Target degree: PhD in Computer Science or Electrical Engineering

Degree details: https://www.qub.ac.uk/schools/eeecs/Study/PostgraduateResearch/

Expected start date: March 2021 (M5 from the beginning of the project)

Approximate gross salary: The approximate annual basic gross salary is
Basic Salary with special pension: £30,830.96
Basic Salary w/o special pension contributions: £35,707.56

with £410 mobility and £338 family allowance (preliminary data to be discussed during the interview). 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

Probation period: 6 months

Working and living conditions in the country: The **United Kingdom of Great Britain and Northern Ireland**, commonly known as the **United Kingdom (UK)** is among the safest and most advanced countries globally, forming the fifth largest economy in the world and the second largest in Europe. **Belfast** is the modern capital city of Northern Ireland, rated as the safest region and most affordable city in the United Kingdom.

Today Belfast is one of the UK's fastest growing economies, leading advances in technology and innovation. It is ranked in the top 10 cities in the UK to develop a digital career and is in the world's top 10 Digital Economies of the Future - the only UK city outside London to be listed in the recent Financial Times' fDi Intelligence report. There are almost 900 international companies located in Northern Ireland, making Belfast the second most successful city in the UK (after London) for attracting US trade. Belfast is one of Europe's most connected cities, with two international airports and one more at Dublin close by, with a rich cultural heritage and a buzzling social and cultural scene. Northern Ireland's spectacular scenery offers stunning outdoor pursuits and hosts the filming locations of popular shows like HBO' Game of Thrones.

Read more about Belfast and the region:

- https://www.qub.ac.uk/about/Living-in-Northern-Ireland/Life-in-Belfast/belfast-smart-city/
- https://www.qub.ac.uk/about/Living-in-Northern-Ireland/Life-in-Belfast/
- https://www.qub.ac.uk/about/Living-in-Northern-Ireland/
- https://visitbelfast.com/

Host Unit details: Queen's University Belfast (QUB), established in 1845, is the 9th oldest University in the UK and a member of the Russell Group which consists of the top 24 research-driven universities in the UK. Queen's is ranked in the Top 1% of Universities in the World (QS World Rankings). The School of Electronics, Electrical Engineering and Computer Science

(EEECS) is ranked 5th in the UK in terms of research excellence in Electrical and Electronic Engineering, and is among the top 100 in the world (QS World Rankings). QUB was awarded the European Commission HR Excellence in Research Award based on a UK-wide process incorporating the Concordat to Support the Career Development of Researchers. QUB is one of the top five UK universities for revenue generated from research commercialisation and is the number one in the UK for Knowledge Transfer Partnerships (KTP) with industry.

APROPOS' ESR15 will be hosted in the Institute on Electronics, Communications and Information Technology (ECIT) of EEECS. ECIT is a flagship Global Research Institute of QUB, aiming at becoming a world leading research and innovation hub for Secure Connected Intelligence that is recognised by a Queen's Anniversary Prize in 2015. ECIT hosts 250 researchers, engineers and PhD students, who are supported with annual training courses for technical and career development. PhD students will benefit from ECIT's research & innovation model, which has led to 12 spin-out companies and over £600 million investment. ECIT hosts the UK Research Institute in Secure Hardware and Embedded Systems (RISE).

The ESR will join a prolific group of researchers working on the design and modelling of energy efficient and dependable computing systems with over 45 to tier publications in the past 4 years and several awards including the Best Paper award at the renowned IEEE DATE conference on 2020 and the Best Paper nomination at the prestigious IEEE/ACM MICRO conference on 2020.

Read more about Queen's University and its Global Research Institute of ECIT:
- https://www.qub.ac.uk/about/
- https://www.qub.ac.uk/ecit/
- https://www.qub.ac.uk/schools/eeecs/

Seconding Unit description: Xilinx, founded in 1984, is the world's leading provider of ACPAs, FPGAs, SoCs, MPSoCs and 3D ICs, enabling the next generation of smarter, connected, and differentiated systems and networks. Driven by the industry-wide shifts towards Cloud Computing, Machine Learning, SDN/NFV, Video Everywhere, Embedded Vision, Industrial IoT, and 5G Wireless, Xilinx innovations enable these applications that are both, software defined, yet hardware optimized. Xilinx's portfolio of software defined and hardware optimized solutions include proven C and IP based design tools that support the development of 'software defined hardware', and a new family of software development environments that supports the development of 'software defined systems'. With this unique combination, Xilinx is addressing the rapidly growing demands for programmability and intelligence with software, while enabling >10X the bandwidth, 1/10th the latency and power, and flexible any-to-any connectivity with optimized hardware. Xilinx has overall 3500 employees with 300 based in the European headquarters at Dublin, Ireland. Xilinx owns almost half of the FPGA market that is set to touch $7.9 Billion by 2020.

Read more about XILINX: www.xilinx.com

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.

In relation to ESR15, the country of the host organization is **United Kingdom,** of which Northern Ireland is a part.

Early-Stage Researchers (ESRs)/fresh MSc graduates: ESR's must be, at the time of recruitment, in the first four years (full-time equivalent) of their research careers and must not have been awarded a doctoral degree. This is measured from the date when the researcher obtained the degree entitling him or her to embark on a doctorate, either in the country in which the degree was obtained or in the country in which the researcher is recruited, even if a doctorate was never started or envisaged.

Background requirements: Applicants should have a 1st or 2.1 honours degree (or equivalent) in a relevant subject. Relevant subjects include Electrical and Electronics Engineering, Computer Science, Computer Engineering or a closely related discipline. Students who have a 2.2 honours degree and a Master's degree may also be considered. The applicant should have not been awarded any doctoral degree at the date of the employment.

English language requirements: Evidence of an IELTS* score of 6.0, with not less than 5.5 in any component, or equivalent qualification acceptable to the University is required

https://www.qub.ac.uk/International/International-students/Applying/English-language-requirements/

Additional information:
You may contact Georgios Karakonstantis (g.karakonstantis@qub.ac.uk) for more information about the project and the position.