

Research topics	Distributed computation and communication tradeoffs over networks
Position (M/F)	Post-Doctoral / Research Engineer
Reference offer	CS/DM/ DCC/ PostDoc/022024
Research Department	Communication Systems (CS)
Publication date	09/02/2024
Start date	ASAP
Duration	Fixed Term Contract 18 months maximum

Description

EURECOM's Communication Systems Department, one of Europe's premier research labs in communications and networking, invites applications at PhD levels. The position is to be filled ASAP. The position is as part of the project "Computing Nonlinear Functions over Communication Networks (SENSIBILITÉ)" **supported by the European Research Council (ERC)** with a focus on **Distributed Computation and Communication Tradeoffs over Networks**. The position is intended for talented researchers with a strong mathematical background and the drive to push the knowledge frontiers in the area of advanced wireless networks, with a special emphasis on one (or more) of the following areas:

- Distributed computation and learning by exploiting the structures of data, functions, and networks
- Distributed matrix multiplication, distributed computation of other nonlinear functions
- Fundamental limits of distributed computation, joint design of placement and delivery
- Distributed coding for parallel systems for content access (in caches and at the edge), and efficient updates
- Learning algorithms for computing
- Distributed computation in sensor networks and over-the-air computing

Detailed Description of the ERC STARTING Project (SENSIBILITÉ)

In SENSIBILITÉ, we propose to create a unified framework for distributed nonlinear function computation in networks. Looking beyond the current research horizon, we envision a radically new approach to design our framework, which involves a careful balance between data, function, and network. We target the emerging frontier research field of distributed functional compression over networks, which capitalizes on finding the shortest length explanation of a function in the number of exchanged or communication bits over networks. To relieve the challenge, we will exploit the structural properties of sources via the notion of common information. We will marry this concept with a network information theory perspective to interpret the structural relations and realize efficient computation with protocol-free encodings.

A critical step towards realizing our goal is to analyze the tradeoff space for the computational versus communication complexities. To develop our theory, we will capture the structures of different tasks using the function decomposition theorem of Kolmogorov and Arnold. This representation theorem will allow us to get a handle on the low-complexity and feasible decompositions and the computational complexities of such representations. In our approach, the communication complexity for realizing minimal task representations is obtained using an information-theoretic concept called rate-distortion.

We identify six scientific objectives to achieve our goal and address the open problems. First is to devise a networked computation model. We will provide a novel network-driven perspective building on the theory of data and function-oriented compression approaches. Next is to exploit a decomposition paradigm for nonlinear computation to argue the possibility of a universal representation of continuous, multivariate, and nonlinear functions. Then, we focus on function-driven and protocol-independent codebooks. In other words, the encoding scheme does not require the knowledge of what the nodes should send, but only the rates that nodes need to send. We envision that, via a



coarse-grained lens on the representation of the common source structure, we can surmount the difficulty of designing joint source-channel codes. After, we contemplate a function-driven quantization framework for the succinct depiction of nonlinear functions. We then concentrate on network-driven functional compression and explore constructive mechanisms to prioritize different function classes to best use the network's processing. Last but not least, we evaluate nonlinear functions over communication networks.

Requirements

- Education Level / Degree : Graduate degree (PhD) in Electrical Engineering or in Mathematics
- Field / specialty: Communication Systems
- Technologies / Languages / systems: Matlab, Python
- Other skills / specialties: Strong Mathematical Background
- Other important elements: Strong Academic and Algorithmic Skills

Application

The application must include:

- Detailed curriculum,
- List of publications specifying the three most important publications,
- Motivation letter of two pages also presenting the perspectives of research and education,
- Name and address of three references..

Applications should be submitted by e-mail to secretariat@eurecom.fr with the reference :
CS/DM/ DCC/ PostDoc/022024

About EURECOM

EURECOM is a major Engineering School and a Research Center in digital sciences founded in 1991 as a consortium in the international technology park of Sophia Antipolis. The IMT is a founding member of the GIE. Teaching and research activities are organized around 3 promising fields: digital security, communication systems and Data Science.

EURECOM has a staff of 150 (researchers and support teams) and welcomes 400 international students on the Campus Sophia Tech, the largest information science and technology campus of the region. EURECOM enjoys a privileged geographical environment on the French Riviera (Côte d'Azur), between sea and mountains, at the heart of a dynamic and multidisciplinary ecosystem that promotes high-level scientific and technological innovation.

Social advantages

- Attractive salary - Corporate saving plans
- Private retirement plan (executive, employer participation of 100%)
- Employee profit sharing policy
- Company health insurance (mutuelle) with high levels of guarantees for the whole family (employer participation of 60%)
- Restaurant vouchers : value 10,50 euros (employer contribution of 60%)

EURECOM has a dynamic policy in terms of inclusion and quality of life at work, committed to diversity and gives the same consideration to all applications, without discrimination.

EURECOM has a "Mission Handicap" policy. All our positions are open to people with disabilities. A designated disability referent welcomes and provide support to employees and students suffering from a disability. He puts in place the necessary arrangements and makes positive commitments in favour of a personalized integration.

EURECOM, as part of its Annual Gender Equality Plan, practices inclusive recruitment without any kind of gender discrimination. The conditions of employment are identical for women and men. In order to promote the diversity in its teams, EURECOM encourages male applications for administrative positions, traditionally occupied by women, and female applications for teaching/research positions, traditionally occupied by men.

EURECOM carries out positive actions within the framework of its CSR policy. A CSR referent steers EURECOM's policy in terms of CSR and energy transition (electric charging stations, solar panels, selective sorting, etc.).