Offer #2024-07742

PhD Position F/M Learning with personalization : application to system parameters optimization in cellular networks

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

About the research centre or Inria department

The Inria research centre in Lyon is the 9th Inria research centre, formally created in January 2022. It brings together approximately 300 people in 17 research teams and research support services.

Its staff are distributed in Villeurbanne, Lyon Gerland, and Saint-Etienne.

The Lyon centre is active in the fields of software, distributed and high-performance computing, embedded systems, quantum computing and privacy in the digital world, but also in digital health and computational biology.

Context

This PhD is funded by a joint project between Inria and Nokia Bell Labs. The project LearnNet holds at the intersection of learning and networking. The objective is to study how networking and learning are entangled and have to be co-designed.
One research direction in this project is to explore the use of distributed learning to improve wireless network management. Typically, we consider a set of agents (devices or base stations), that observe some data from which they have to decide an action, individually. Because the data are sparse, the agents want to collaboratively learn from these data, but they belong to hidden classes of agents.
The objective of the internship is to study personalization learning to cope with such kind of scenario, and to propose generic solutions adapted to specific scenarios coming from wireless networks.

The PhD will be co-advised by 3 researchers from Inria Lyon (Jean-Marie Gorce, MARACAS) and Inria Grenoble (Florence Forbes, STATIFY and Hadrien Hendrikx, TOTH) with complementary skills in wireless networks and machine learning. This work will be also supervised by a researcher from Nokia Bell Labs, as a partner of the project. The recruited PhD student will be hosted either in Lyon or Grenoble, and will visit the other center regularly (all travelling costs will be covered).

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Assignment

The work in this PhD will focus on personalized learning techniques such as the approach proposed in Even et al. [2022]. In this method, a model is learned and the personalization is taken into account through a topology matrix. The objective of the internship is to elaborate a strategy to learn this topology from the observations during the learning process.

In addition, to guide the study, this method will be adapted and applied to a very important problem in wireless networks: channel state information (CSI) estimation in a cellular system with multiple antennas Liu et al. [2020], Wen et al. [2018], Utschick et al. [2022]. We consider large system with one multiple antennas transmitter (Base station) and multiple receivers (mobile). A symbol X transmitted by the BS is received at a device through a linear transformation such as $Y_i = H_i \cdot X + N$. To optimize the joint transmission, the base station needs to know the kernel H_i associated to each device which may be a matrix of a tensor, and can be observed only at the receiver. Thus, the receiver has to encode and compress this information, before sending it to the BS. Because this a complex problem, a DNN based auto-encoder may be learned. We will consider the case where different classes of devices are present and the parameters of the auto-encoder have to be

learned. The personalization may help to reduce the amount of parameters and the quality of the distributed channel estimation.

While the PhD will start with the study of channel estimation, methodological contributions beyond the scope of this specific problem are expected.

El Mahdi Chayti, Sai Praneeth Karimireddy, Sebastian U Stich, Nicolas Flammarion, and Martin Jaggi. Linear speedup in personalized collaborative learning. arXiv preprint arXiv:2111.05968, 2021.

Mathieu Even, Laurent Massoulié, and Kevin Scaman. On sample optimality in personalized collab- orative and federated learning. Advances in Neural Information Processing Systems, 35:212–225, 2022.

Zhenyu Liu, Lin Zhang, and Zhi Ding. An efficient deep learning framework for low rate massive MIMO CSI reporting. IEEE Transactions on Communications, 68(8):4761–4772, 2020.

Wolfgang Utschick, Valentina Rizzello, Michael Joham, Zhengxiang Ma, and Leonard Piazzi. Learning the CSI recovery in FDD systems. IEEE Transactions on Wireless Communications, 21(8):6495–6507, 2022.

Chao-Kai Wen, Wan-Ting Shih, and Shi Jin. Deep learning for massive MIMO CSI feedback. IEEE Wireless Communications Letters, 7(5):748–751, 2018.

Main activities

- Main activities :

– Read papers and state of the art.

– Write problem formulation, proofs of convergence.

– Adapt the formulation to the target scenario.

– Propose a new dedicated algorithm.

– Program, run and analyse simulation results.

- Complementary activities

– Participate to the teams activities : scientific meetings, seminars, scientific presentations.

Skills

- Hard skills
  - Applied mathematics, probabilty theory.
  - Data analytics, learning.
  - Programming (Python or equivalent).
  - Fluent in English (preferably) or in French.
- Soft skills
  - Strong communication skills.
  - Rigor in problem analysis, and formulation.
  - Autonomy, enthousiasm.
  - Curiosity, ability to propose ideas.

Benefits package

- Subsidized meals
- Partial reimbursement of public transport costs
- Leave: 7 weeks of annual leave + 10 extra days off due to RTT (statutory reduction in working hours) + possibility of exceptional leave (sick children, moving home, etc.)
- Possibility of teleworking (90 days / year) and flexible organization of working hours
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities
- Access to vocational training
- Complementary health insurance under conditions

Remuneration

1st and 2nd year: 2 100 euros gross salary /month

3rd year: 2 190 euros gross salary / month

General Information

- **Theme/Domain :** Optimization, machine learning and statistical methods
  System & Networks (BAP E)
- **Town/city :** Villeurbanne
- **Inria Center :** Centre Inria de Lyon
- **Starting date :** 2024-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2024-06-30

Contacts

- **Inria Team :** MARACAS
- **PhD Supervisor :**
  Gorce Jean-marie / jean-marie.gorce@inria.fr

About Inria

Inria is the French national research institute dedicated to digital science and technology. It employs 2,600 people. Its 200 agile project teams, generally run jointly with academic partners, include more than 3,500 scientists and engineers working to meet the challenges of digital technology, often at the interface with other disciplines. The Institute also employs numerous talents in over forty different professions. 900 research support staff contribute to the preparation and development of scientific and entrepreneurial projects that have a worldwide impact.

The keys to success

The topic requires a strong background in optimization and machine learning.

A background in signal processing and mathematics is also necessary : linear systems, Fourier transform, random signals, convolution, ...

A basic knowledge of wireless protocols may be a plus, but is not mandatory.

Warning : you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.

Instruction to apply

Applications must be submitted online on the Inria website.

Processing of applications sent by other channels is not guaranteed.

Defence Security :
This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST).Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy :
As part of its diversity policy, all Inria positions are accessible to people with disabilities.