



Offer #2024-07249

PhD Position F/M [campagne doc mi-nf-lys-2024] Fundamental limits of multi-user transmissions in the non-asymptotic regime

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Other valued qualifications : Master, Engineer in computer sciences, mathematics or signal processing

Fonction : PhD Position

Level of experience : Recently graduated

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 16 research teams and research support services.

Its staff are distributed at this stage on 2 campuses: in Villeurbanne La Doua (Centre / INSA Lyon / UCBL) on the one hand, and Lyon Gerland (ENS de Lyon) on the other.

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

The development of machine-to-machine applications that require effective communications for the control of robots, vehicles, drones, machines in an Industry4.0 context is a key problem for future machines.

The challenge is to be able to develop radio communication protocols with guarantees of very high delays and reliability (latency $< 1\text{ms}$, error probability $< 10^{-8}$). This in the context of very small amounts of data. A central solution is to develop joint coding techniques (considering groups of packets, rather than individual packets), but the necessary theoretical framework is not yet complete. The aim of the thesis is to develop this thesis is therefore positioned in the field of multi-user information theory, both from the angle of calculating performance bounds and from the determination of new short codes. Determining new multiple transmission and coding techniques is one of the challenges of 6G design, particularly to cope with the increasing complexity of cellular systems (multi-antennas, cell-free, etc.).

Assignment

The context of machine-to-machine communications and vehicular or drone communications requires the development of new control-oriented transmission schemes, that is to say: small packets, very short delays. The aim of this doctoral contract is to work on upstream methods and demonstrate their performance as well as develop and establish the optimal performances achievable in the sense of Shannon.

Scientific challenges:

Challenge 1: determine theoretical limits (throughput, error probability, latency) for multi-user communications in short codes.

Challenge 2: establish a theoretical framework for the definition of new codes built on an LDPC basis, but in a multi-user context.

Challenge 3: as these code designs are complex, we will consider relying on deep learning-based encoders or decoders for implementation.

Main activities

Main activities:

- Establishment of a state of the art.
- Mathematical formalization of the problem.
- Establishment of theorems on fundamental limits, with proofs.
- Simulations, numerical calculation and validation
- Development of coding schemes approaching fundamental limits.

Complementary activities:

- Presentation at conferences.
- Participation in team meetings.
- Report writing.
- Supervision of interns.

Skills

Technical skills and level required:

- mathematics (probability theory, statistics),
- information theory (Shannon capacity, entropy, error exponent law),
- programming in matlab or python,
- use of tools such as numerical integration.

Languages: English required, French optional.

Relational skills: ability to work in a group, to convince, to present your work.

Additional skills appreciated: Interest in rigorous academic work, in establishing evidence, but also interest for exploiting the results for codes or protocols design

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: 2 082 euros gross salary / month

3rd year: 2 190 euros gross salary / month

General Information

- **Theme/Domain :** Networks and Telecommunications
- Scientific computing (BAP E)
- **Town/city :** Villeurbanne
- **Inria Center :** [Centre Inria de Lyon](#)
- **Starting date :** 2024-10-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2024-05-05

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

You are a young master or engineer, with a background in mathematics or information theory. You want to apply your skills in the field of telecommunications and networking.

You are interested by random processes, law of large numbers, you want to establish theorems at the root of information theory to sustain networking applications in the field of machine-to-machine communications ? This job is for you.

You want to play with mathematics, signal processing, coding theory, and you want to contribute to develop a new paradigm for machine to machine wireless communications ? please consider to apply.

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.