Offer #2023-06913

Internship - Reinforcement Learning for Stochastic Resource Allocation in 6G Networks

Contract type: Internship
Level of qualifications required: Graduate degree or equivalent
Fonction: Internship Research

About the research center 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

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MARACAS (Models and Algorithms for Reliable Communication Systems) team is joint team with Inria Lyon and INSA Lyon, active in wireless communications, information theory and statistical signal processing. MARACAS investigates on recent results from learning and artificial intelligence and their adaptation to multi-user communication systems. The team is hosted in the CITI laboratory of the Telecommunication Department of INSA Lyon.

We propose an internship at the crossroad of machine learning and telecommunications, seeking to apply reinforcement learning techniques to resource allocation problems.

The internship will by supervised by PhD student Alix Jeannerot and Pr. Jean-Marie Gorce, head of MARACAS team.

Assignment

Context:

Internet of things (IoT) networks as well as 6G networks are expected to support a much higher number of devices compared to current networks. A key challenge of the deployment of such network is to avoid as much as possible collision between packets of the different devices. To this end, it is crucial to make a better utilization of the available resources (frequency band, time slots, power level...) that can be used for transmissions.

Currently, in wireless network, before transmitting data, devices need to ask for a grant (an exclusive allocation of resources) to the base station, and once they have this authorization, they can transmit data on the resources. This scheme is well suited is the device has lots of data to send or receive (for example, performing a video call). However in the context of Internet of Things, the transmission of the request of a grant can be longer than the actual data the device wants to send (for example, a smart sensor sending a temperature), making this scheme inefficient. A protocol, better suited for IoT networks, called grant free random access (GFRA) has been proposed and shows improvement in the energy efficiency of the devices. This protocol relies on the widely used assumption that devices in the network are equally likely to transmit and are statistically independent of each other. But this assumption is not holding in most of practical cases.

Assignment:

The objective of this internship, is, in line with some previous work done in our team, to investigate the possibility of modifying the GFRA protocol in order to exploit the different probability of transmissions or the possible correlation between devices. To this end, we wish to use reinforcement learning.
techniques to learn which resources should be assigned to which devices.

**Objective:**

The first step of the internship will be to formalize a reinforcement learning problem, where the environment, actions, rewards and states are clearly defined. Based on that, different algorithms (policy gradient, Q learning... for solving RL problems will be tested and evaluated. Comparisons with the commonly used methods for resource allocation will also be carried. If time permits and depending on the wishes of the intern, either a mathematical regret analysis of the algorithms or an implementation of the proposed algorithms on the experiment platform of the lab (Cortex Lab) can be considered.

**Main activities**

Main activities:

- Survey of state of the art and identification of possible solutions.
- Formalization of optimization problems
- Implementation of different algorithms

Additional activities (3 maximum):

- Write report

**Skills**

We are looking for a Master's student (engineering school or university) pursuing a degree in computer science, telecommunications or electrical engineering for a duration of 4-6 month. Starting date and end date are flexible.

Technical skills:

- Programming in Python
- Knowledge in Machine Learning and/or Telecommunications (knowledge of both fields is not mandatory)

Languages:

- English and/or French

**Benefits package**

- Subsidized meals
- Partial reimbursement of public transport costs
- Professional equipment available (videoconferencing, loan of computer equipment, etc.)
- Social, cultural and sports events and activities

**Remuneration**

Minimum legal gratification

**General Information**

- **Theme/Domain**: Networks and Telecommunications
  
  System & Networks (BAP E)
- **Town/city**: Villeurbanne
- **Inria Center**: Centre Inria de Lyon
- **Starting date**: 2023-03-01
- **Duration of contract**: 6 months
- **Deadline to apply**: 2024-02-11

**Contacts**

- Inria Team: MARACAS
- Recruiter: Jeannerot Alix / alix.jeannerot@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.
**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.

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**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.