# Offer #2024-08305

# PhD Position F/M Online Learning with Limited Resources

**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 center at Université Côte d'Azur includes 42 research teams and 9 support services. The center’s staff (about 500 people) is made up of scientists of di?erent nationalities, engineers, technicians and administrative staff. The teams are mainly located on the university campuses of Sophia Antipolis and Nice as well as Montpellier, in close collaboration with research and higher education laboratories and establishments (Université Côte d'Azur, CNRS, INRAE, INSERM ...), but also with the regional economic players.

With a presence in the fields of computational neuroscience and biology, data science and modeling, software engineering and certification, as well as collaborative robotics, the Inria Centre at Université Côte d'Azur  is a major player in terms of scientific excellence through its results and collaborations at both European and international levels.

## Context

The position is part of a new Marie Curie Training Network called FINALITY, in which Inria joins forces with top universities and industries, including IMDEA, KTH, TU Delft, the University of Avignon (Project Leader), the Cyprus Institute, Nokia, Telefonica, Ericsson, Orange, and others. The PhD students will have opportunities for internships with other academic and industry partners and will be

able to participate in thematic summer schools and workshops organized by the project.

Only people who have spent less than one year in France in the last 3 years are eligible.

The candidate will receive a monthly living allowance of about €2,735, a mobility allowance of €414, and, if applicable, a family allowance of €458 (gross amounts).

## Assignment

Online learning algorithms [Hazan22,Shalev12] have shown substantial promise across various future networks' applications, including caching [Bhattacharjee20,Paschos19,SiSalem23], resource allocation in radio access networks [Kalntis24], and machine learning model placement [SiSalem24].

This thesis focuses on advancing online learning algorithms that offer theoretical guarantees against an adversary who selects the sequence of inputs with the goal to jeopardize system performance. Such adversarially robust algorithms are particularly beneficial for scenarios characterized by highly dynamic user demands and/or rapidly evolving network conditions.

A key metric in evaluating the robustness of these algorithms is regret, which measures the largest discrepancy between the algorithm's experienced cost and that of the optimal static policy in hindsight (i.e., one that has prior knowledge of the entire input sequence). The objective is to develop algorithms with sublinear regret growth relative to input sequence length, ensuring that their per-input-average cost asymptotically approaches that of the best static policy.

Online gradient descent, follow-the-perturbed-leader or follow-the-regularized-leader [Hazan22] exemplify algorithms that achieve sublinear regret in practical applications. However, their computational and memory requirements often exceed the capacities of edge devices and/or are incompatible with tight latency constraints, largely due to for large state storage and/or projection operations over the feasible state space.

This thesis aims to design online learning algorithms optimized for reduced memory and computational overhead, making them more suitable for resource-constrained and latency-sensitive environments. Initial strategies for complexity reduction include batch processing of inputs [Faticanti24, SiSalem23], input sampling [Mazziane23], and constraint relaxation [Carra24]. Building on these approaches, this work will explore novel methods to further streamline these algorithms while preserving robust performance.

References

[Bhattacharjee20] R Bhattacharjee, S Banerjee, and A Sinha, Fundamental Limits on the Regret of Online Network-Caching, 2020

[Carra24] D Carra, G Neglia, An Online Gradient-Based Caching Policy with Logarithmic Complexity and Regret Guarantees, arXiv preprint arXiv:2405.01263

[Faticanti24] F Faticanti, G Neglia, Optimistic online caching for batched requests, Elsevier Computer Networks 244, 2024

[Hazan22] E Hazan, Introduction to Online Convex Optimization, The MIT Press, 2022

[Kalntis24] M Kalntis, G Iosifidis and F A Kuipers, Adaptive Resource Allocation for Virtualized Base Stations in O-RAN with Online Learning, IEEE Transactions on Communications, 2024

[Mazziane23] Y B Mazziane, F Faticanti, G Neglia and S Alouf, No-Regret Caching with Noisy Request Estimates, 2023 IEEE Virtual Conference on Communications (VCC), 2023

[Paschos19] G S Paschos, A Destounis, L Vigneri, G Iosifidis, Learning to Cache With No Regrets, IEEE INFOCOM, 2019

[Shalev12] S Shalev-Shwartz, Online Learning and Online Convex Optimization, Foundations and Trends in Machine Learning, 2012

[SiSalem24] T Si Salem, G Castellano, G Neglia, F Pianese, A Araldo, Toward inference delivery networks: Distributing machine learning with optimality guarantees, IEEE/ACM Transactions on Networking, 2024

[SiSalem23] T Si Salem, G Neglia, and S Ioannidis, No-regret Caching via Online Mirror Descent. ACM Trans. Model. Perform. Eval. Comput. Syst. 8, 4, Article 11, 2023

## Main activities

Research

## Skills

The candidate should have a solid mathematical background (in particular on optimization) and in general be keen on using mathematics to model real problems and get insights. He should also be knowledgeable on machine learning and have good programming skills.

We expect the candidate to be fluent in English.

## 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 and flexible organization of working hours
- Social, cultural and sports events and activities
- Access to vocational training
- Contribution to mutual insurance (subject to conditions)

## Remuneration

The candidate will receive a monthly living allowance of about €2,735, a mobility allowance of €414, and, if applicable, a family allowance of €458 (gross amounts)

## General Information

- **Theme/Domain :** Optimization, machine learning and statistical methods System & Networks (BAP E)
- **Town/city :** Sophia Antipolis
- **Inria Center :** Centre Inria d'Université Côte d'Azur
- **Starting date :** 2025-03-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2025-05-31

## Contacts

- **Inria Team :** NEO
- **PhD Supervisor :**
  Neglia Giovanni / Giovanni.Neglia@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. Collecting applications 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.