Offer #2025-08717

PhD Position F/M on deep learning methods for mapping species interactions

Contract type : Fixed-term contract

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

Level of experience : Recently graduated

Context

This PhD thesis (with the possibility of starting with an internship/MSc thesis) is part of the PEPR Agroécologie & Numérique project (EcoControl), which is being developed by nine French institutions. EcoControl aims to improve our understanding of arthropod regulatory services and identify agroecological levers to enhance natural pest regulation in agriculture at both local and territorial levels, in continental France, Corsica and Guadeloupe. To achieve this goal, we will combine fieldwork with innovative conceptual and numerical approaches. We will address the following classical though not yet answered question: How do biotic and abiotic factors, whether phylogenetic, environmental, related to farming practices or to the introduction of alien species, influence the structure and dynamics of interaction networks between plants (cultivated or not), pests indigenous or introduced), and their natural enemies (predators /parasitoids)?

In this context where we need to jointly predict many species share responses to the environment, since they share a common niche, and have dependencies through biotic interactions, multi-species species distribution models (SMDs) can be relevant. In this project we will build upon recent work on deep learning-based SDMs (Ryckewaert et al., 2024), as they have they can automatically learn joint environmental features that predict well all the species.

Assignment

The objective of this thesis is to develop and deploy the necessary methods to map, at a scale ranging from region to country, the likelihood of ecological interactions relevant to the spread and regulation of agricultural pests.

This will require :

1) creating a large-scale dataset of environmental variables (e.g. OSO, Corine Land Cover, SAFRAN, Worldclim), as well as variables stemming from remote sensing (e.g. Landsat, Sentinel), that can be related to species responses (e.g. Picek et al., 2024) ;

2) training SDMs for the species of interest based these variables and species observations and/or surveys (starting from the work of Ryckewaert et al., 2024). To make the most out of the opportunistic and standardized data available, we aim at extending Integrated SDM principles (Isaac et al., 2020) to deep learning SDMs;

3) use information about ecological networks (from other partners in the EcoControl consortium) in order to understand which locations are compatible with several ecological interactions of interest, mostly related to plant pests;

4) a reflection based on explainable AI tools will be considered in order to help ecological modelers better understand complex model behavior at different scales. Special attention will also be paid to ensuring the developed methods allow for a probabilistic interpretation of the predictions to make them more useful for downstream tasks within the consortium.

Picek et al. "GeoPlant: Spatial Plant Species Prediction Dataset." NeurIPS Datasets and Benchmarks Track. (2024)

Ryckewaert et al. "Applying the maximum entropy principle to multi-species neural networks improves species distribution models." arXiv preprint arXiv:2412.19217 (2024).

Isaac, N. J., Jarzyna, M. A., Keil, P., Dambly, L. I., Boersch-Supan, P. H., Browning, E., ... & O'Hara, R. B. Data integration for large-scale models of species distributions. Trends in ecology & evolution, 35(1), 56-67. (2020)

Main activities

The selected PhD candidate is expected to:

- Become familiar with the state-of-the-art on species distribution modelling.

- Construct a dataset with the necessary input variables and reference data, including opportunistic species observations and systematic biodiversity surveys.
- Develop the necessary multi-modal deep learning methods to profit from the different modalities of input and reference data.
- Write papers describing this work aiming at top computer science and ecology venues.

Skills

We are seeking a candidate that is strongly motivated to improve our understanding of the interaction between biodiversity and agriculture.

Top candidates would also have a strong command of:

- Python programming
- Deep learning frameworks (preferably Pytorch)
- Use of Linux GPU severs via command line
- Written scientific English

It would be a plus to have familiarity with:

- GIS and remote sensing
- Point process models and/or SDMs

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 (after 6 months of employment) 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
- Social security coverage

Remuneration

Duration: 36 months
Location: Sophia Antipolis, France
Gross Salary:

1st year : 2200 € per month

2nd and 3rd year : 2300 €per month

General Information

- **Theme/Domain :** Earth, Environmental and Energy Sciences Information system (BAP E)
- **Town/city :** Montpellier
- **Inria Center :** Centre Inria d'Université Côte d'Azur
- **Starting date :** 2025-09-01
- **Duration of contract :** 3 years
- **Deadline to apply :** 2025-04-13

Contacts

- **Inria Team :** EVERGREEN
- **PhD Supervisor :**
  Marcos Gonzalez Diego / diego.marcos@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

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.