Laboratoire d'Informatique
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Équipe Reconnaissance des
Formes et Analyse d'Images

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Postdoctoral position

Machine learning for time series prediction in environmental sciences

Profile: PhD in machine learning (computer sciences or applied mathematics)
Duration: 18 months, starting from September 2023; another 18 months postdoc is planned on similar subject after the first one
Affiliation: Computer Science Lab of Université de Tours (LIFAT), Pattern Recognition and Image Analysis Group (RFAI)
Salary: around 2600€/month
Supervisor: Nicolas RAGOT (LIFAT-Tours)
Skills:
- a strong experience in data analysis and machine learning (theory and practice of deep learning in python) is required
- experiences/knowledge in time series prediction and environmental science is welcome
- curiosity and ability to communicate (in English at least) and work in collaboration with scientists from other fields
- ability to propose and validate new solutions and to publish the results
- autonomy and good organization skills

How to candidate:
Send the following documents by e-mail to **nicolas.ragot [at] univ-tours.fr** before September 15th: a CV, a motivation letter, a short description of your thesis and experiences in machine/deep learning (including projects you were involved in), references from researchers you worked with.

Context:
The JUNON project, driven by the BRGM, is granted from the Centre-Val de Loire region through ARD program (« Ambition Recherche Développement ») which goal is to develop a research & innovation pole around environmental resources (agriculture, forest, waters…). The main goal of JUNON is to elaborate digital services through large scale digital twins in order to improve the monitoring, understanding and prediction of environmental resources evolution and phenomena, for a better management of natural resources. Digital twins will allow to virtually reproduce natural processes and phenomena using combination of AI and environmental tools.
JUNON will focus on the elaboration of digital twins concerning quality and quantity of ground waters, as well as emissions of greenhouse gases and pollutants with health effects, at the scale of geographical area corresponding to the North part of the Centre-Val-de-Loire region.

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These digital twins will rely on geological and meteorological knowledge and data (time series), as well as physic-based models.
The project actors are: BRGM, Université d'Orléans, Université de Tours, CNRS, INRAE, and ATOS and ANTEA companies. There are 5 work packages (WP):

1. User's needs and geological knowledge for ground water
2. User's needs and biological/chemical knowledge about pollutants and greenhouse gases
3. Data management and data mining
4. Time series prediction
5. Aggregation and realization of digital twins themselves

The postdoctoral position will be in the WP 4, focused on the prediction of quantity of ground waters. There will be strong interactions with WP 1 and 3 (BRGM) through postdocs and engineers. The work will be supervised by the LIFAT - RFAI and you will have to interact with one PhD student in JUNON as well. Interaction with the RFAI group and other PhDs working on similar subjects will also be done.

Goals:
While the BRGM (a postdoc to be recruited) will have in charge to collect and arrange data (ground waters levels at different locations) and to benchmark predictions with mechanistic models as well as with classical prediction AI tools, the goal of the postdoc will be to build new prediction models able to integrate several sources of information like:
- meteorological data
- spatial information, i.e. geolocalization of sensors and locations of predictions to be made; topological information such as altitude
- integration of knowledge from mechanistic models as well as from expert knowledge (impact of attributes and variables used)
- etc.

The scientific locks are clearly related to:
- multivariate time series
- short-term to long term predictions (horizon)
- going from local predictors to 'connected predictors', i.e. how to use information coming from sensors spread over the area of study

And if possible:
- considering heterogenous data (time series, climatic data, topological information, combination with other models…)
- having an idea of how continuous learning (work of a PhD) could be done on such models.

Studying *transformers* and *Spatio-Temporal Graph Neural Networks* will be particularly investigated.
Of course, models will have to be implemented, learnt and compared with classical models on benchmarks.

NB: another 18 months postdoc is planned in JUNON WP4 nearly at the end of the first one, to work on XAI for time series prediction models. The candidate could apply on it to perform in the end a 3 years postdoc.

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Hosting group:
The RFAI group (Pattern Recognition and Image Analysis) is part of the LIFAT (EA 6300) computer science lab. The group is composed of 5 Professors, 3 HDR (associate professors habilitated), 10 associate professors, 9 PhDs plus 4 co-supervised PhDs in other universities. The group is working mainly on pattern recognition and machine learning for image/video analysis and temporal data with application domains mainly in health, environment and humanities. The group has access to several computing resources and especially to Leto computer (CPU nodes + 4 gpu nodes with 4 Nvidia Tesla v100 each).

Bibliography:
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- G. Zerveas, S. Jayaraman, D. Patel, A. Bhamidipaty, C. Eickhoff. *A Transformer-based Framework for Multivariate Time Series Representation Learning*. arXiv:2010.02803
- J. Ma, Zheng Shou, Alireza Zareian, Hassan Mansour, A. Vetro, and S. Chang. Cdsa: Cross-dimensional self-attention for multivariate, geo-tagged time series imputation. ArXiv, abs/1905.09904, 2019
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