Junior Professorship Chair

Lead institution/organization: Inria Research Center of University of Rennes
Name of the head of institution/organization : Patrick Gros
Site concerned: Rennes
Academic region: Brittany

Partner institutions/organizations envisaged: University of Rennes 1, ENS of Rennes

Project name: Modeling, numerical simulation and coupling of models in Earth and environmental sciences
Acronym: Modèliterre

Scientific theme: Applied mathematics

Keywords: modeling and numerical simulation, model coupling, data assimilation, Earth and assimilation, Earth and environmental sciences, digital twins

Target duration: 3 to 6 years

Scientific theme: Applied mathematics

Financial environment: 200 k€ for the duration of the project
The project will also be supported by the incentive resources of Inria and the University of Rennes 1, as well as by those of the local authorities: Scientific installation allowance from Rennes métropole, the ARED doctoral grant programme and the Bienvenüe post-doctoral grant programme of the Brittany Region, in addition to the resources that the person will find elsewhere. This will ensure at least one thesis supervision or co-supervision for the first 6 years.

Corresponding CNU/CoNRS/CSS section(s): CNU 26/27, CoNRS 7/41 (no section at Inria)

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Institutional strategy

This project is part of three major operations on the site.
1- The IRIS-E project proposed by the site in response to the ExcellenES call for proposals focuses on strengthening multidisciplinary approaches in research, but also in training, in the study of the environmental transition. This project complements the joint Environmental Intelligence Program, which was awarded the France Universities Prize for Research (2022).
2- In September 2022, ENS Rennes will open a new Department of Environmental Sciences and propose a new "PhD Track" for students interested in a quantitative disciplinary and interdisciplinary training on the environmental transition. The person recruited will join the department's teaching team to develop the digital aspects of the training.
3- In January 2022, Inria and the University of Rennes 1 signed a framework agreement to strengthen their collaboration in order to create interdisciplinary project teams. This recruitment is part of this framework with the objective of creating a project-team between digital and Earth sciences within the UMR (= lab) Geosciences Rennes.

Strategy of the host laboratory

For the Inria center: digital ecology has been listed as one of the center's 4 priorities in the contract signed between Inria and its supervisory ministries in February 2020. The center is creating a project-team with IFREMER on numerical modeling of the oceans, in connection with the ERC Synergy Grant STUOD obtained by E. Mémin, and also wishes to develop numerical methods for the study of continental environments. The present recruitment aims at creating a project-team on the subject with the UMR Geosciences on the latter subject.

For Geosciences lab: following several emblematic projects (ERC, ITNs, IF MSCA...), the lab has resolutely oriented part of its research on the study of couplings between Earth sciences, physics, chemistry or microbiology. The present Chair would reinforce this dynamic on the coupling of processes in the field of numerical modeling. The ability to develop numerical twins at different scales of time and space would allow essential progress in this field. As modeling and learning methods are evolving very rapidly, it is essential for our unit to strengthen collaborations in the field of numerical modeling on the site.

The person recruited will have strong links with IRMAR and potentially IRISA. IRMAR wishes to consolidate its disciplinary base in order to maintain its level of excellence and influence and, through this recruitment, to become involved in the themes developed at Géosciences Rennes. Beyond these specific themes, IRMAR expects above all that the winner of this junior professorship will strengthen its scientific dynamism while developing research directions that are complementary, but related, to the existing ones. The creation of new links with Geoscience is an important development axis for IRMAR.

Scientific project

The current studies in water sciences for the study of fractured and porous media for storage, extraction of liquids, or for the realization of numerical twins of watersheds in order to understand and predict the diffusion of pollutants require to take into account various phenomena: The simultaneous numerical modelling of these phenomena is the subject of intense research, for example on the management of the appearance or disappearance of gaseous or mineral phases, taking into account the vast range of spatial scales or the choice of

discretization schemes for each phenomenon. Coupling models and data is another challenge. It is necessary to quantify the uncertainties thanks to stochastic approaches, to exploit the masses of data available on the surface with deep learning, while taking into account the limited information on the structure of the underground environment, and often to resort to model reduction techniques to manage the diversity of the spatiotemporal scales and to address the creation of digital twins of the environment on which to predict and scenario the future evolution of water resources.

Teaching project

The person recruited will participate in the constitution of the Environmental Sciences Department. The training is initiated by the creation of a PhD Track (Master + Doctorate) which will rely on quantitative approaches and a triptych data-model-society to address environmental issues in a systemic way by mobilizing exact, experimental, human and social sciences. The person will integrate the teaching team, develop the digital aspects of the training and contribute to the emergence of new synergies between the digital and environmental transitions in the image of what can be found in smart cities and, by extension, in an intelligence of the environment that would be based on and go beyond an intelligibility of the environment. The department's project is rooted in knowledge of the state of the environment through some of its key processes (see research profile). It is positioned on the evolution of the environment in an approach where digital technology is an asset to perceive, represent and share future evolution scenarios with the various actors as a common reference based on solid scientific knowledge, as is done in the case of climate change.

Scientific dissemination: specify the expected results in terms of scientific dissemination (publications, communications, etc.)

The scientific dissemination will be done in the CMWR (Computational Methods in Water Resources) and SAIM Geosciences conferences, and in journals such as Advances in Water Re-sources,
Computational Geosciences or SIAM journals in general.

Open Science: Is the project part of an open science approach? If so, describe its implementation.

The project is part of the open and participatory science approach as proposed in the IRIS-E project submitted in response to the ExcellencES call for projects and the project prepared in view of the Sciences with and for Society call for projects. These two projects are led by the University of Rennes 1 for the institutions on the Rennes site.
The participatory approach of these projects is centered on the creation of a "Participatory Science Hub", a third place located in the center of Rennes and intended for activities and training seminars bringing together academic and non-academic actors to invent and disseminate participatory methods and skills.

Science and society: does the project envisage communication with the general public? If yes: specify how and when

In addition to the participatory science aspect mentioned above, the project will rely on the tools we have for communication with the general public: articles, podcasts or videos in the online magazine Interstices, collaboration with the Espace des Sciences (which is the CCSTI of Rennes and the leader of scientific popularization in Brittany), participation in the science festival.
Particular importance will be given to contacts with schools, especially with girls, to show that digital technology is not just for geeks who play video games! The "Chiche! 1 class, 1 scientist" or "J'peux pas, j'ai informatique" could be used for this purpose.

Indicators
The two major objectives of this project are

- the creation of a joint project-team between Inria and the university within the UMR Geosciences over a 4-year period. Various tools could be mobilized to reinforce the collaborations: delegations of research professors of the UMR Geosciences, co-supervision of theses, follow-up by Inria's permanent engineers of software development projects in the UMR, support of the transfer service of the Inria center for the diffusion of these softwares...
- the development of the digital aspect in the PhD-Track of the ENS of Rennes which should result in co-supervision of Master's courses and theses between specialists in Earth or Environmental sciences and specialists in digital technology. The objective in 5 years is that a quarter of the department's thesis students be in this case (it should be noted that many other disciplinary interfaces are targeted and that not all disciplines will be able to be found in all theses).