ERC-funded post-doc position

Morphogenetic reverse-engineering: learning collective cell behaviors in embryos and tissues

Job application portal: https://emploi.cnrs.fr/Offres/CDD/UMR7241-HERTUR-011/Default.aspx

Deadline: January 15th 2024

Place: Collège de France
Center for Interdisciplinary Research in Biology
11, place Marcelin Berthelot, 75005 Paris

Team: *Multiscale Physics of Morphogenesis* www.turlierlab.com

Supervision: Hervé Turlier, team leader herve.turlier@college-de-france.fr

Duration: 24 months, from Mar 2024 - possibility to extend to 36 months after evaluation

Salary: between € 2,992 and € 4,204 gross monthly depending on experience

Activities: The project focuses on developing inverse morphogenetic approaches to collective cellular behaviors, with a particular emphasis on early embryos and small tissues. The work will consist of exploring multicellular morphogenetic principles from a computational perspective coupling realistic physical models with machine learning approaches. The work will rely on powerful in-house models of multicellular mechanics and cell-cell signaling in 3D. The postdoctoral fellow will explore how growth, division, patterning, and cell cycle dynamics can sculpt embryos and tissues, and how these morphogenetic pathways and self-organisation principles can be learned from data or engineered in reverse. The research activities are part of the ERC DeepEmbryo project led by Hervé Turlier, whose goal is to reverse-engineer the development of embryos by combining biophysical and machine learning methods.

Missions: The successful candidate will build an optimization framework that couples internal 3D models of multicellular mechanics and cell-cell signaling with neural networks and train such a framework coupling classical optimizers and reinforcement learning approaches. She/he will implement this framework in Python and C++ and deploy it on the team's internal GPU/CPU cluster. He/she will explore morphogenetic pathways and shape emergence principles in silico with forward and inverse modeling approaches. She/he will have to work in collaboration with biologists and with the team's software engineers. She/he will have to present her/his results at scientific conferences, write scientific articles and actively participate in the scientific and social life of the team and of the host Institute.

Expected profile: The candidate must hold a PhD in applied mathematics, theoretical physics or computer science, demonstrate excellent computer science skills (python, C++) and have strong prior experience with deep learning methods. Experience or expertise in reinforcement learning will be an important asset and prior experience working with a high-performance computing cluster will be useful. The candidate must have already demonstrated the ability to publish in international peer-reviewed scientific journals or conferences. No prior knowledge of biology is expected, but a genuine interest in biological systems and morphogenesis is necessary. Prior experience of collaboration with biologists or biophysicists will be however considered very positively. Genuine work autonomy, initiative and scientific curiosity are key assets for this position. Fluency in English, good communication skills and motivation for research are naturally expected.

Working environment: The successful candidate will be welcomed into the interdisciplinary team "Multiscale physics of morphogenesis" led by Hervé Turlier and composed of ~10 researchers. We are committed to establishing a welcoming place for all and fostering inclusion and diversity. The team is located at the Collège de France, in the heart of the Latin Quarter in Paris. Integrated within the PSL University, and close to other major institutions such as the Ecole Normale Supérieure and the Institut Curie, the Collège de France constitutes an exceptional scientific environment unique in the world. The successful candidate will have access at an individual workstation in renovated premises, to a powerful laptop and to a high performance computing cluster fully dedicated to the team (12 GPUs, 396CPUs). The position does not pose any particular constraints or risks and 1 day of teleworking is possible per week.

To apply, please submit CV and letter of motivation **through the CNRS application portal** and prepare at least **two letters of recommendation** to be sent directly upon request after a first screening**.**

For enquiries please contact Dr. Hervé Turlier - herve.turlier@college-de-france.fr

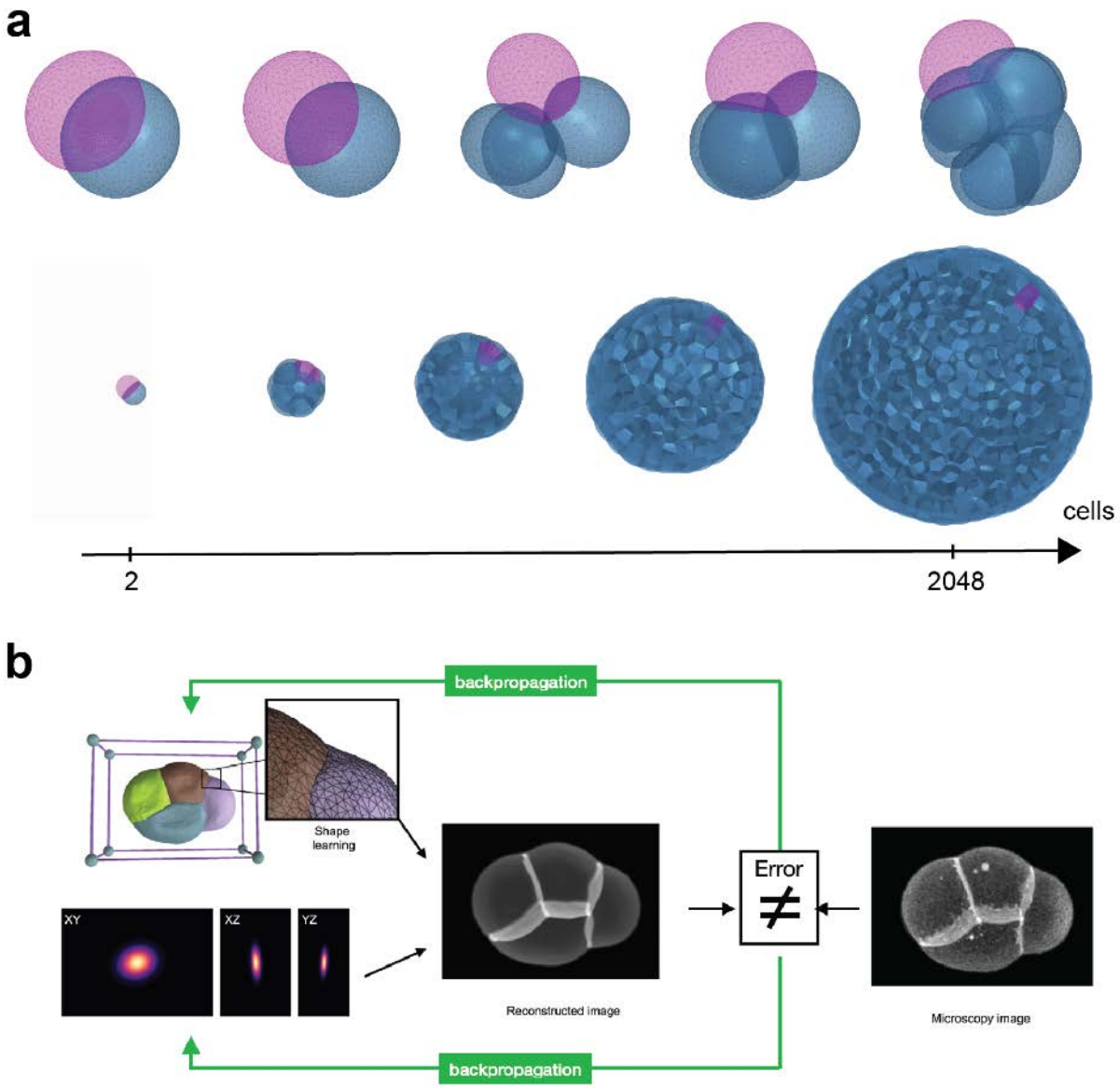

Figure 1: **a)** Foam-like mechanical simulations of multicellular systems, including viscous dissipation and cel divisions. The simulations run in C++ with Python bindings allowing each parameter to be easily adjusted and optimized and to couple our simulations with other frameworks, including artificial neural networks. **b)** A differentiable implementation of artificial fluorescence imaging allows simulation results to be directly compared to fluorescence images to optimize model and microscope parameters via backpropagation or gradient-free optimization techniques. **c)** Mechanical simulations can be coupled with simple models of cell signaling to study multicellular self-organization and optimise mechanochemical feedbacks to achieve specific target patterns.