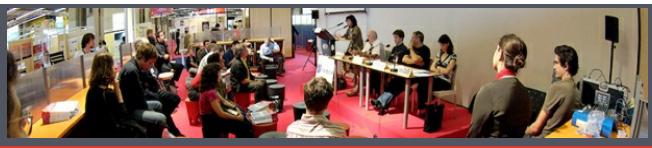
INTERNATIONAL RELATIONS



INTERNSHIP SUBJECT

2888 - Optimal transport and applications to variational problems or deep

Context

We are seeking a Master 2 level intern to work on one of the scientific axes of the ECOS Sud Project OPTIMA (submitted), within the **Inria Team MOKAPLAN**.

MOKAPLAN is an Inria research group specialized in optimal transport and the numerical resolution of nonlinear variational problems.

The ECOS Sud Project OPTIMA (OPtimal Transport Innovations for Multidisciplinary Applications) is a collaborative research initiative between France and Chile, aiming to advance the theory and applications of Optimal Transport (OT). The project (submitted) aims at bringing together leading researchers in mathematics, optimization, physics, and data science, and offers a stimulating international research environment. The acceptance of the ECOS project OPTIMA does not condition the existence of this internship.

Internship Topic

We are looking for candidates interested in one of the three axes of the project, but **preferably on Axes 1 (Multi-marginal OT) and 2 (Quantization).**

The full description of the project is attached to the internship proposal. Following is a brief description of each Axis.

Axis 1: Multi-marginal Optimal Transport and Particle Interactions

Multi-marginal optimal transport extends the classical OT problem to settings involving more than two distributions, a framework that arises naturally in physics and chemistry, particularly in Density Functional Theory (DFT) for modeling electron distributions, and in systems of interacting particles. This axis focuses on the mathematical analysis of multi-marginal problems with repulsive costs, variational problems involving kinetic and interaction energies, and the asymptotic behavior of such systems as the number of particles grows.

Possible research directions include:

- Selection principle for Coulomb interacting particles.
- Asymptotic analysis of interaction energies as the number of particles increases.
- Asymptotics of short-range interaction functionals and finite-range decomposition.

Axis 2: Quantization of Measures

Quantization of measures aims to optimally approximate a continuous probability distribution by a discrete one, a problem at the crossroads of optimal transport, signal processing, and numerical analysis. This axis addresses both the theoretical aspects—such as the study of the asymptotic arrangement and crystallization of quantizers, entropic regularization, and branched transport settings—as well as numerical methods for constructing quantizers.

Possible research topics include:

- Analysis of the structure and asymptotic behavior (e.g., crystallization) of optimal quantizers.
- Study of entropic regularization in quantization problems.
- Exploration of branched optimal transport and fractal structures in quantization.

Axis 3: Optimal Transport for Generative Models in Deep Learning

Required Skills

Profile Sought

- Master 2 (second-year MSc) student in mathematics, applied mathematics, or related fields.
- Strong background in analysis is highly recommended ; required to work on axes 1 and 2 of the project.
- Interest in calculus of variations, optimization, mathematical physics, or machine learning.
- Some familiarity with optimal transport, variational methods, or numerical analysis is a plus.
- We are particularly seeking students who intend to pursue with a PhD after the internship (in France or Chile).

General Information

- **Research Theme :** Numerical schemes and simulations
- **Locality :** Paris
- **Level :** Master
- **Period :** 12th January 2026 -> 10th April 2026 (3 months)

  These are approximative dates. Please contact the training supervisor to know the precise period.

- **Deadline to apply :** 1st July 2025 (midnight)

Contacts

- **Training Supervisor :** Paul Pegon / paul.pegon@inria.fr
- **Team Manager :** Vincent Duval / vincent.duval@inria.fr

More information

- **Inria Team :** MOKAPLAN
- **Inria Center :** Centre Inria de Paris

Recent advances in deep learning have leveraged optimal transport theory to significantly improve generative models, especially in settings like flow-matching and diffusion models. This axis explores both the development of scalable OT-based distances (such as Sliced Wasserstein) for training generative models and the connection between vector-valued OT and models generating categorical or structured data, with potential applications in computational chemistry and biology.

Possible research topics include:

- Development and analysis of computationally efficient OT distances (e.g., Sliced Wasserstein).
- Use of optimal transport in flow-matching and diffusion-based generative models.
- Bridging vector-valued optimal transport with categorical data and generative tasks (such as molecule or sequence generation).

Supervision and environment

The intern will be based at Inria Paris, within the MOKAPLAN team. He will be supervised by members of the MOKAPLAN team (main supervisor: Paul Pegon) and some members of the ECOS project OPTIMA, depending on the precise direction chosen by the candidate and the team, and of their presence in the Paris area during the internship period. Potential co-supervisors from the OPTIMA project are M. Petrache from PUC Chile, R. Mahadevan from Universidad de Conception Chile, L. Nenna from Univ. Paris-Saclay France, K. Nadjahi from ENS Paris France.

Period of the internship

3 months period between January 2026 and June 2026.