GEOMETRY IN THE PLAYGROUND 2025

BOOK OF ABSTRACTS

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Decoupling actions of finite-dimensional Lie groups and of groups of diffeomorphisms in the large deformation framework

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In computational anatomy, the Large Deformation Diffeomorphic Metric Mapping (LDDMM) framework [Beg+05] has become a central tool for modeling smooth, invertible transformations between shapes such as curves or landmarks. In this work [MP25], we extend this framework by enriching diffeomorphic deformations with transformations induced by finite-dimensional Lie groups (e.g. isometries, scalings), and we develop a registration model that decouples the actions of these two types of deformation on the shape during the matching process. To achieve this, we consider semidirect products between finite-dimensional groups and groups of diffeomorphisms, endowed with a right-invariant sub-Riemannian structure that give rise to new variational problems for shape registration. By exploiting symmetries and reduction theory [MW74], we decouple the contributions of each group throughout the matching process. We further extend the framework to incoroporate anisotropic deformations that preferentially favor certain directions during registration. On the numerical side, we propose an algorithm based on a joint optimization over both deformation groups, in contrast to the standard two-stage approach that optimizes first over the finite-dimensional component and then over the diffeomorphic one. Experiments on curves and landmarks demonstrate that the proposed joint optimization improves registration accuracy and more effectively disentangles the contributions of the two deformation groups. This is a joint work with Thomas Pierron.

[Beg+05] Mirza F. Beg, Michael I. Miller, Alain Trouvé, and Laurent Younes. "Computing Large Deformation Metric Mappings via Geodesic Flows of Diffeomorphisms". In: *International Journal of Computer Vision* 61.2 (2005), pp. 139–157. DOI: 10.1023/B:VISI.0000043755.93987.aa.

[MP25] Rayane Mouhli and Thomas Pierron. *Decoupling actions of finite-dimensional Lie groups and of groups of diffeomorphisms in the large deformation framework*. 2025. arXiv: 2511.14151.

[MW74] Jerrold Marsden and Alan Weinstein. "Reduction of symplectic manifolds with symmetry". In: *Reports on Mathematical Physics* 5.1 (1974), pp. 121–130. ISSN: 0034-4877. DOI: https://doi.org/10.1016/0034-4877(74)90021-4. URL: https://www.sciencedirect.com/science/article/pii/0034487774900214.

Nonlinear Lebesgue spaces: Dense subspaces, completeness and separability

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L^p spaces of mappings taking values in arbitrary metric spaces, which we call nonlinear Lebesgue spaces, play an important role in several fields of mathematics. For instance, membership in these spaces is typically required for transport maps in optimal transport theory and for stochastic processes in probability theory. Nonlinear Lebesgue spaces also arise naturally in applications such as medical imaging, where the physical signals at play often exhibit little regularity and take their values in nonlinear spaces. Yet, these spaces remain little studied in the literature, likely due to their lack of differential structure outside the case where mappings are valued in a linear space. This work [ST25] is the first in a series by the authors devoted to the study of geometric and analytic properties of nonlinear Lebesgue spaces. The present article exposes a systematic treatment of their measure-theoretic properties, unifying and refining scattered results from the literature while also extending classical results from the linear setting to this broader nonlinear framework—including the characterizations of their completeness and their separability as well as the density of some of their subspaces: the spaces of simple, continuous and smooth mappings.

[ST25] Guillaume Sérieys and Alain Trouvé. *Nonlinear Lebesgue spaces: Dense subspaces, completeness and separability*. 2025. arXiv: 2512.19208.

Gradient flows in the space of probability measures

Théo Dumont (Université Gustave Eiffel)

TBD.

Lie–Poisson reduction on Banach half-Lie groups and applications to large deformation models

Thomas Pierron (ENS Paris-Saclay)

TBD.