3iA Côte d'Azur
Interdisciplinary Institute for Artificial Intelligence

Ph.D. research topic

- Title of the proposed topic: Ensembles of deep generative models
- Research axis of the 3IA: 1
- **Supervisor (name, affiliation, email): Pierre-Alexandre Mattei, Inria, pierre-alexandre.mattei@inria.fr**
- Potential co-supervisor (name, affiliation): Frédéric Precioso (UniCA, Inria), Rémy Sun (Inria)
- The laboratory and/or research group: Inria, Maasai team

Apply by sending an email directly to the supervisor.
The application will include:

- Letter of recommendation of the supervisor indicated above
- Curriculum vitæ.
- Motivation Letter.
- Academic transcripts of a master's degree(s) or equivalent.
- At least, one letter of recommendation.
- Internship report, if possible.

- Description of the topic:

Ensemble methods have been increasingly popular in recent years, notably through deep ensembles [Lakshminarayanan et al., 2017, Fort et al., 2019] and their extensions [Ramé et al., 2021]. Deep ensembles aggregate the outputs of several classifiers trained on the same dataset but with different initialisations. Empirically and theoretically, these ensembles perform much better than their individual members [Mattei and Garreau, 2024].

Deep ensembles are mostly applied to supervised learning problems, and this PhD is about extending them to generative models. Ensembling generative models is not as straightforward as ensembling standard supervised predictors, because of the lack of functional identifiability of most deep generative models.

The goal will be to study (both in theory and practice) various ways of ensembling deep generative models. The deep generative models will will mostly focus on will be score-based diffusion models [Song et al., 2021], variational autoencoders and flow matching [Lipman et al., 2023]. It will also be interesting to study more classical statistical models like Gaussian mixtures.

A potential application would be to use these models for missing data imputation. Another application would be to use them for medical image segmentation, building on works that uses variational autoencoders to this end. This application could be done in collaboration with 3IA chair Olivier Humbert.

References

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B. Lakshminarayanan, A. Pritzel, and C. Blundell. Simple and scalable predictive uncertainty estimation using deep ensembles. NeurIPS, 2017.

Y. Lipman et al., Flow Matching for Generative Modeling, ICLR, 2023

P.-A. Mattei and D. Garreau. Are ensembles getting better all the time? arXiv preprint arXiv:2311.17885, 2023.

S. A. A. Kohl et al., A Probabilistic U-Net for Segmentation of Ambiguous Images, NeurIPS, 2019

A. Ramé, R. Sun, and M. Cord, MixMo: Mixing Multiple Inputs for Multiple Outputs via Deep Subnetworks, ICCV, 2021

Y. Song et al., Score-Based Generative Modeling through Stochastic Differential Equations, ICLR, 2021