Institut de Recherche en Informatique de Toulouse
CNRS - Toulouse INP - UT3 - UT Capitole - UT2

M2/Engineering Internship Offer in Numerical Optimization and Deep Learning

Subject : Scalable Optimization Algorithms for Meta-learning

Context and objectives:

The Toulouse Institute of Computer Science Research (IRIT), one of the largest Joint Research Units (UMR 5505) at the national level, is a major pillar of research in the Occitanie region, with approximately 600 members and around one hundred external collaborators. Owing to its multi-institutional governance (CNRS and the universities of Toulouse), its scientific impact, and its interactions with other disciplines, the laboratory represents a key structural force in the field of computer science and its applications in the digital domain, both at the regional and national levels.

This project focuses on the development of scalable optimization methods to enhance existing meta-learning frameworks, with applications to medical imaging. In particular, the proposed algorithms will exploit the structure of global multi-task objectives that decompose naturally into task-specific subproblems. This setting enables the design of domain-decomposition-inspired strategies, in which tasks are optimized locally and subsequently integrated into a coherent global solution.

Principal missions :

This internship will be carried out in the following stages:

- Acquire a solid theoretical and practical understanding of the MAML framework and the Domain-Decomposition AdaGrad (DD-ADA) algorithm [1].
- Reformulate the global multi-task optimization problem underlying MAML to explicitly reveal its decomposition into task-specific subproblems. Identify additional components of the MAML framework that might admit DD-inspired reformulations.
- Design and implement a DD-ADA algorithm within the MAML framework.
- Conduct extensive numerical experiments to assess the proposed method in terms of convergence behavior, stability, computational efficiency, and generalization performance. Analyze sensitivity to hyperparameters and compare the results against standard MAML baselines.

Desired profile:

The ideal candidate is an M2-level student with a solid background in applied mathematics, numerical optimization, computer science, and a strong interest in deep learning, and medical imaging applications.

Institut de Recherche en Informatique de Toulouse
CNRS - Toulouse INP - UT3 - UT Capitole - UT2

Required skills

- Solid background in iterative methods and numerical optimization
- Strong interest in numerical mathematics and large-scale training algorithms
- Basic knowledge of deep learning; familiarity with meta-learning is a plus
- Proficiency in Python and PyTorch; experience with scientific computing is appreciated
- Working proficiency in English

Duration: 5 to 6 months
Location: IRIT–ENSEEIHT
Compensation: €4.50 per hour

Application:
Please send your CV and academic transcripts to : alena.kopanicakova@toulouse-inp.fr and amel.aissaoui@irit.fr

References:

[1] Gratton, S., Kopaničáková, A., & Toint, P. (2025). Recursive bound-constrained AdaGrad with applications to multilevel and domain decomposition minimization. *arXiv preprint arXiv:2507.11513*.