M2 internship $\rightsquigarrow$ Ph.D. position

Exploring computation/communication tradeoffs in distributed optimization for machine learning

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Key-words: optimization, distributed systems, asynchronous communications.

Topic: As the field of deep learning continues to advance, the need for scalable and efficient optimization algorithms becomes increasingly crucial. Asynchronous distributed optimization offers a promising avenue for enhancing the training of large-scale deep learning models by allowing for parallelization and efficient use of computational resources.

The primary goal of this internship is to investigate and develop novel asynchronous distributed optimization strategies tailored specifically for balancing the computations with the communications. The focus will be on improving convergence rates and tradeoffs by exploiting several recent advances in distributed optimization (eg [1,2]).

Typically, minimizing up to an ϵ-precision a n-sum of L-smooth and μ-strongly convex functions can be done in a centralized manner using $(n+\sqrt{n\frac{L}{\mu}})\log\frac{1}{\epsilon}$ **?**. The question to understand if this rate rate is reachable in the decentralized decentralized setting remains open and one of the goal of this internship will be to study lower bounds in multiple context where workers and/or communications are considered as independent.

As a long term perspective, this will be implemented for training large neural networks in a distributed computing environment, by balancing the rate of communications and computations and studying generalization, as in **?**. This research might help to improve training speed, training time and bandwidth use, which would overall benefit to a wide class of deep neural network models.

Practical information:

- Hosted at the Mathematics Institute of Toulouse
- Starting date: March/April 2024 $\rightsquigarrow$ Ph.D. position in October 2024 upon sucessful internship
- Strong background in mathematics required; proficiency in Python appreciated
- Contact and application: franck.iutzeler@math.univ-toulouse.fr

References:

[1] Nabli, A. and Oyallon, E. : *DADAO: Decoupled Accelerated Decentralized Asynchronous Optimization for Time-Varying Gossips*. ICML, 2023. [arXiv link]

[2] Hsieh, Y.G., Laguel, Y., Iutzeler, F. and Malick, J. : *Push-Pull with Device Sampling*. IEEE Transactions on Automatic Control, 2023. [arXiv link]