Mathematics of deep learning

— **Context and objectives**
Deep-learning methods have a very significant impact and many applications [1]. Public libraries are easy to use and are applied widely. The mathematical properties of Neural Networks are however not well understood and many improvements are still achievable. The forthcoming developments within the group are related to **quantized neural networks** [2,3] and **robust neural networks** [4,5].
The successful candidate will have the possibility to choose the topic within a large range of subject going
— from **theoretical issues**.
— to **numerical and methodological issues**
— and **practical issues**, in close connection with industry

— **Salary :** Yes

— **PhD Thesis :** possible

— **Location :** Toulouse, within a group working on the mathematical aspects of deep learning, within the 3IA ANITI.

— **Supervisor :**
— François Malgouyres, Institut de Mathématiques de Toulouse, Université Paul Sabatier, ANITI
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— **Candidate profile and application :** Prospective applicants should have a MSc or engineering degree with a major in **applied mathematics, machine learning or optimization**.
Applicants should send, by email, a **CV** and **academic transcript** to François Malgouyres.
— **References :**
1. Y. LeCun, Y. Bengio, G. Hinton, "Deep learning". Nature, 521(7553), 436-444, 2015.
2. M. Courbariaux, Y. Bengio, J.-P. David. "Binaryconnect : Training deep neural networks with binary weights during propagations." In NeuRIPS, 2015.
3. Y. Ding, J. Liu, J. Xiong,Y. Shi. "On the universal approximability and complexity bounds of quantized relu neural networks." In ICLR, 2018.
4. C. Anil, J. Lucas, R. Grosse. "Sorting out lipschitz function approximation." In ICML, 2019.
5. Q. Li, Saminul Haque, C. Anil, J. Lucas, Roger B Grosse, J.-H. Jacobsen. "Preventing gradient attenuation in lipschitz constrained convolutional networks." In NeuRIPS, 2019.