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 the theory behind these algorithms is an emerging field of research. Typical questions aim at controlling the risk : What functions are well approximated using Neural Networks ? Why do simple algorithms often provide a good solution to the complicated (in particular non-convex) optimization problems [4,5] ? Are the features computed on the intermediate layer meaningful [2,3] ?
The successful candidate will have the possibility to choose the topic within a large range of subject going
— from **practical issues**, in close connection with industry
— to **theoretical issues**.

— **Salary :** Yes

— **PhD Thesis :** possible

— **Location :** Toulouse

— **Supervisor :**
— François Malgouyres, Institut de Mathématiques de Toulouse,
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— **Candidate profile and application :** Prospective applicants should have a MSc or engineering degree with a major in **machine learning, optimization or applied mathematics**.
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. F. Malgouyres, J. Landsberg, "On the identifiability and stable recovery of deep/multi-layer structured matrix factorization", proceedings of the Information Theory Workshop 2016.
3. F. Malgouyres, J. Landsberg, "Multi-linear compresses sensing and application to convolutional linear networks", hal-01494267, 2018.
4. Nguyen, Q. and Hein, M., "The loss surface of deep and wide neural networks", arXiv preprint arXiv :1704.08045, 2017.
5. Venturi, Bandeira, Bruna, "Neural Networks with Finite Intrinsic Dimension have no Spurious Valleys", ArXiv, February 2018.