

# Deep Learning of Recurrent Neural Networks

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Neural Networks (NNs) are one of the most useful and popular computational models in the areas of Machine Learning (ML) and Artificial Intelligence (AI). NNs are mathematical abstractions of the biological nervous system. There are two major types of network topologies: feedforward and recurrent ones. In this project we will focus in the recurrent case. A Recurrent Neural Network (RNN) is a dynamical system with good properties for modelling sequential data. RNNs have been used for solving engineering problems in areas as computer vision, natural language processing and forecasting time-series, etc. The architectural design of the network depends of the problem. Machine Learning is about finding a good network topology that makes the system exhibit to desired behavior, such as controlling a robot. The problem of defining an optimal RNN is very hard. Recently, a new approach for optimising the parameters of a RNN was introduced by the name of *Hessian-Free Optimization*. The method has been introduced by researchers of Google and outperforms other types of Neural Networks. In this project, a slight variation of HF will be implemented in order of improving its performance. In addition, the students will develop the HF method and will apply for forecasting time-series data. A series of lectures about Deep Learning techniques will be provided to the students in order to improve their theoretical background.

**Keywords:** Numerical Optimization, Neural Networks, Newton Methods, Machine Learning, Deep Learning.

**Students profile:** the students should have a good background in algebra and optimisation methods, and good knowledge in programming languages.

## References (not exhaustive list):

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- Hastie, T., Tibshirani, R., Friedman, J., *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*. Second Edition, Springer, February 2009.

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