

Neural Computation

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An important branch of the Artificial Intelligence (AI) is the Neural Computation (NC) area, which is an interdisciplinary field enriched by several sciences such as: mathematics, computer science, physics, engineering and neuroscience. The field is very vast and it plays an important role in many applications ranging from medical engineering, telecommunications, cognitive sciences, and several applications in computer science. One of the most popular model in NC is named Neural Network (NN). The research on NN started in the 40s, and it has been producing a rich literature with a strong concentration since the the 80s and 90s. NN tools are used in the most global important leaders in analysing of data such as: Facebook and Google. We can see a NN as a function with many parameters, which are intelligent adjusted for solving a specific problems. At the beginning of the 2000s, a new paradigm in the NN area was introduced. The approach consisted in optimising only a subset of the global parameters of a NN. Two big families of NN models that follow this approach are: Extreme Learning Machines (ELM) and Reservoir Computing (RC). In this project the students will apply evolutionary techniques (such as: Genetic Algorithms, Swarm Intelligence, Simulating Annealing, etc) for selecting the global parameters of the model, in order of improving the RC and ELM techniques. A part of the project consists of developing a toolbox of the developed models. Besides, the performance of the models will be evaluated on real world problems. The first part of the project consists in studying the NN models, a second part consists in programming, testing and solving real world problems.

Keywords: Neural Computation, Soft-Computing, Extreme Learning Machines, Echo State Networks, Reservoir Computing

Students profile: the students should have good knowledge in programming languages and basic notions in statistics and numerical optimisation methods.

References (not exhaustive list):

- Bishop, C., Neural Networks for Pattern Recognition, Oxford University Press, 1996.
- Hastie, T., Tibshirani, R., Friedman, J., The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Second Edition, Springer, February 2009.
- Huang, G.B., Zhu, Q.Y., Siew, C.K, Extreme Learning Machine: Theory and Applications, *Neurocomputing* 70(1), 489-501 (2006).
- Lukoševičius, M., Jaeger, H., Reservoir Computing Approaches to Recurrent Neural Network Training, *Computer Science Review* 3(3), 127-149, 2009.

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