UNIVERSITÀ DI PISA
DOTTORATO DI RICERCA IN INGEGNERIA INDUSTRIALE

Doctoral Course

Fundamentals of artificial neural networks and genetic algorithms

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Course contents

Part 1: Introduction to artificial neural networks (2 hr)

- Main characteristics of neural networks: neuron model, activation functions, types of neural networks
- Supervised learning.
- Delta rule
- Learning rate
- Momentum

Part 2: Multilayer networks (2 hr)

- Perceptron
- Multilayer perceptron
- Backpropagation algorithm
- Creation of the training set
- Overtraining
- Train, test and validation sets

Part 3: RBF, SOM (2 hr)

- RBF networks
- Unsupervised learning
- Competitive networks
- Self-organizing maps

Part 4: Introduction to deep learning (2 hr)

- Convolutional neural networks

Part 5: Introduction to genetic algorithms (2 hr)

- Crossover and mutation
- Fitness function
- Selection for recombination
- Selection for replacement and survival
- Binary encoding
- Real-valued encoding

Course schedule

The course will be articulated in three days, comprising 3, 3 and 4 hours of class lectures, respectively.

1. Introduction to artificial neural networks. Main characteristics of neural networks. Artificial neuron model. Activation functions. Types of neural networks. Supervised learning. Delta rule. Convergence of the delta rule. Learning rate. Local minima. Batch and online learning. Momentum. Perceptron. Perceptron learning rule. The XOR problem. Hidden layers. Multilayer networks. Multilayer perceptron. Error backpropagation. The backpropagation algorithm. (3h)
2. Creation of the training set: analysis of the data, selection of variables, data preprocessing, outliers, missing data, non-numeric data, data normalization. Stopping conditions of neural network training. Overtraining. Early stopping. Train, test and validation sets. Network's size. Unbalanced data sets. Examples of applications. Radial functions. Introduction to RBF networks. Learning strategies for RBF networks. Comparison of RBF networks and Multilayer Perceptrons. Unsupervised learning. Competitive networks. Self-organizing maps. Examples of applications. (3h)
3. Introduction to deep learning. Convolutional neural networks. (2h)
4. Introduction to Genetic Algorithms. Crossover and mutation. Fitness function. Selection for recombination. Selection for replacement and survival. Binary encoding. Real-valued encoding. Examples of applications. (2h)

Total # of hours: 10

Timetable

Date	Time	Lecture number	Teacher
June 26 , 2018	14:30-17:30	1	Lazzerini
June 27, 2018	14:30-17:30	2	Lazzerini
June 28, 2018	11-13	3	Lazzerini
June 28, 2018	15-17	4	Lazzerini

Room: *Aula DIA della sede di Ingegneria Aerospaziale*, *Via G. Caruso 8, Pisa*