# SOFT COMPUTING

## 1. KEY INDICATORS

CFU/ECTS: 6
Professor: Antonello Rizzi
Contact Professor: Tel. +39 0644585484, antonello.rizzi@uniroma1.it
Website Professor: http://infocom.uniroma1.it/~rizzi/

## 2. OBJECTIVES OF THE COURSE

The module deals with the basic principles of data driven modelling systems (classification, clustering, function approximation and prediction problems) based on soft computing techniques (neural networks, fuzzy logic, evolutionary algorithms).

## 3. ACQUIRED ABILITIES

Elementary notions of Geometry, Algebra, Differential Calculus, Signal Theory, Information Theory, Informatics

## 4. PROGRAM OF THE COURSE

Introduction to data driven modeling: Soft Computing, Computational Intelligence.
Basic data driven modelling problems: function approximation, classification, unsupervised modelling, prediction. Generalization capability. Deduction and induction.
Induction inference principle over normed spaces. Model and training algorithms. Distance measures and basic preprocessing procedures. Optimization problems.
Optimality conditions. Linear regression. LSE and RLSE algorithms. Numerical optimization algorithms: steepest descent and Newton's method. Fuzzy logic principles. Fuzzy induction inference principle.
Classification systems: performance and sensitivity measures. K-NN Classification rule.
The biological neuron and the central nervous system.
Perceptron. Feedforward networks: Multi layer perceptron. Error Back Propagation algorithm. Support Vector Machines. Hints on RBF networks.
Automatic modeling systems. Structural parameter sensitivity. Constructive and pruning algorithms.
Generalization capability optimization: cross-validation and Ockham's razor criterion based techniques.
Min-Max neurofuzzy classifiers; standard and regularized training algorithm. ARC, PARC; Principal Component Analysis; Generalized Min-Max neurofuzzy networks. GPARC.
Derivative free optimization algorithms: genetic algorithms. Automatic feature selection.
Particle Swarm Optimization, Ant Colony Optimization.
Fuzzy reasoning. Generalized modus ponens; FIS; fuzzyfication and e defuzzyfication. ANFIS. Basic and advanced training algorithms: clustering in the joint input-output space, hyperplane clustering.
Outline of prediction and cross-prediction problems: embedding based on genetic algorithms.
Applications and case studies: micro-gris energy flows modelling and control, classification and monitoring of TCP/IP traffic flows.

## 5. References


- Sergios Theodoridis, Konstantinos Koutroumbas, Pattern Recognition, Fourth Edition, Academic Press, ISBN: 597492728, September 2008.
- (lecture notes and didactic material available at http://infocom.uniroma1.it/rizzi/)


## 6. Website of the Course

http://infocom.uniroma1.it/rizzi/