Course name: **Neural networks & machine learning**		
Field of study: **Computer science**	Type of study: **Full-time**	Sourse code: **CIDM2_01**
Course characteristics: **Mandatory within the additional content**	Level: **Second (M.Sc.)** **Computational Intelligence and Data Mining**	Year: **I** Semester: **II**
Type of classes: **lectures, exercises, project**	Hours per week: **2 lect, 1 ex, 2 proj**	ECTS points amount: **5 ECTS**

COURSE GUIDE

AIMS

A1. Introducing the students to the basic methods of neural networks and machine learning.

A2. Obtaining by the students the practical skills in solving various problems by making use of neural networks and machine learning.

PREREQUISITES

1. The knowledge in the field of the mathematics.
2. The basic knowledge in the field of the mathematical statistics.
3. The basic knowledge in the field of probability theory.
4. The basic knowledge and skills in computer programming.
5. The skills to use different sources of information and technical documentation.
6. The skills of working alone and in the group.
7. The skills of correct interpretation and presentation of his/her own activity.

LEARNING OUTCOMES

EE 1 – Students possess the basic theoretical knowledge in the field of modeling, simulation and classification by making use of machine learning and neural networks.

EE 2 – Students are able to solve various problems of pattern recognition, approximation and prediction.

EE 3 – Students are able to use the modem methods for modeling different types of systems.

EE 4 – Students are familiar with principles of computational intelligence.

CONTENT

Lectures		**Hours**
Lect. 1	Neuron and its models, structure and functioning of a single neuron, perceptron	**2**
Lect. 2	Adaline model, Sigmoidal neuron model, Hebb neuron model	**2**
Lect. 3	Backpropagation algorithm, Backpropagation algorithm with momentum term	**2**
Lect. 4	Variable-metric algorithm , Levenberg-Marquardt algorithm, Recursive least squares method	**2**
Lect. 5	Hopfield neural network , Hamming neural network	**2**
Lect. 6	BAM network , Self-organizing neural networks with competitive learning, WTA neural networks, WTM neural networks, ART neural networks	**2**

Lect. 7	Radial-basis function networks. Probabilistic neural networks 2	**2**
Lect. 8	Data clustering methods- HCM algorithm, FCM algorithm. PCM algorithm	**2**
Lect. 9	Gustafson-Kessel algorithm, FMLE algorithm. Clusteringvalidity measures	**2**
Lect. 10	Support vector machines for classification 2	**2**
Lect. 11	Support vector machines for regression 2	**2**
Lect. 12	Decision trees- ID3	**2**
Lect. 13	Decision trees- C4.5	**2**
Lect. 14	Fuzzy decision trees	**2**
Lect. 15	Principal Component Analysis	**2**
Exercises		**Hours**
Ex. 1	Neuron and its models, structure and functioning of a single neuron, perceptron	**1**
Ex. 2	Adaline model, Sigmoidal neuron model, Hebb neuron model	**1**
Ex. 3	Backpropagation algorithm, Backpropagation algorithm with momentum term	**1**
Ex. 4	Variable-metric algorithm, Levenberg-Marquardt algorithm, Recursive least squares method	**1**
Ex. 5	Hopfield neural network , Hamming neural network	**1**
Ex. 6	BAM network , Self-organizing neural networks with competitive learning, WTA neural networks, WTM neural networks, ART neural networks	**1**
Ex. 7	Radial-basis function networks, Probabilistic neural networks	**1**
Ex. 8	Data clustering methods- HCM algorithm, FCM algorithm. PCM algorithm	**1**
Ex. 9	Gustafson-Kessel algorithm, FMLE algorithm. Clustering validity measures	**1**
Ex. 10	Support vector machines for classification	**1**
Ex. 11	Support vector machines for regression	**1**
Ex. 12	Decision trees- ID3	**1**
Ex. 13	Decision trees- C4.5	**1**
Ex. 14	Fuzzy decision trees	**1**
Ex. 15	Principal Component Analysis	**1**
Project		**Hours**
Proj. 1	Designing multilayer neural network	**2**
Proj. 2	Designing Hopfield neural network	**2**
Proj. 3	Designing Hamming neural network	**2**
Proj. 4	Designing WTA neural network	**2**
Proj. 5	Designing radial- basis neural network	**2**
Proj. 6	Designing probabilistic neural network	**2**
Proj. 7	Designing decision trees ID3	**2**
Proj. 8	Designing decision trees C4.5	**2**
Proj. 9	Designing fuzzy decision trees	**2**
Proj. 10	Designing system for classification using support vector machines	**2**
Proj. 11	Designing system for regression using support vector machines	**2**
Proj. 12	Solving the problem of clustering using FCM algorithm	**2**
Proj. 13	Solving the problem of clustering using PCM algorithm	**2**
Proj. 14	Solving the problem of clustering using Gustafson-Kessel algorithm	**2**
Proj. 15	Solving the problem of dimension reduction	**2**

TEACHING TOOLS

1. – lectures using multimedia presentations
2. – exercises in the form of solving by students a problems posed in the time of the lectures
3. – project classes – presentation by students the progress in the tasks

LITERATURE

Leszek Rutkowski, Computational Intelligence, Springer, 2008
Shai Shalev-Shwartz , Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014
Ethem Alpaydin, Introduction to Machine Learning, M i T Press, 2014

TEACHERS

1. prof. Leszek Rutkowski

ADDITIONAL NOTES

Links to course unit teaching materials can be found on the http://iisi.pcz.pl/CIaDM/ website for current students.