SYLLABUS

MACHINE LEARNING

1. **Information on academic programme**

1.1. University	**„1 Decembrie 1918" of Alba Iulia**
1.2. Faculty	**Faculty of Informatics and Engineering**
1.3. Department	**Informatics, Mathematics and Electronics Department**
1.4. Field of Study	**Computer Science**
1.5. Cycle of Study	**Undergraduate**
1.6. Academic programme / Qualification	**Computer Science/ ESCO-08: 2511/ Systems Analyst, 2512/ Software developers** **Analyst 251201** **Computer System Programmer 251204** **Computer System Engineer 251203**

2. **Information of Course Matter**

2.1. **Course**			*Machine Learning*			2.2. **Code**		CSE 304	
2.3. **Course Leader**			Lect.univ.dr. Muntean Maria-Viorela						
2.4. **Seminar Tutor**			Asist.univ.drd. Cristea Daniela						
2.5. Academic Year	**III**	2.6. Semester	**I**	2.7. Type of Evaluation (E – final exam/ CE - colloquy examination / CA -continuous assessment)	**CE**	2.8. Type of course (**C**– Compulsory, **Op** – optional, **F -** Facultative)			**Op**

3. Course Structure (Weekly number of hours)

3.1. Weekly number of hours	*6*	3.2. course	*2*	3.3. seminar, laboratory	*4*
3.4. Total number of hours in the curriculum	**84**	3.5. course	*28*	3.6. seminar, laboratory	*56*

Allocation of time:	Hours
Individual study of readers	*20*
Documentation (library)	*20*
Home assignments, Essays, Portfolios	*14*
Tutorials	*-*
Assessment (examinations)	*12*
Other activities…….	*-*

3.7 Total number of hours for individual study	**66**
3.8 Total number of hours in the curriculum	**84**
3.9 Total number of hours per semester	**150**
3.10Number of ECTS	**6**

4. Prerequisites (*where applicable*)

4.1. curriculum-based	*1. Artificial intelligence*
4.2. competence-based	*C2.1 The identification of appropriate methodologies for software systems development.* *C2.2 The identification and explanation of appropriate mechanisms for software systems specification.* *C2.3 The use of methodologies, specification mechanisms and development environments for the development of computer applications.* *C2.4. The use of appropriate criteria and methods for the evaluation of computer applications.* *C2.5. The development of dedicated computer projects.* *C3.1. The description of concepts, theories and models used in the application field.* *C3.2 The identification and explanation of base computer models that is suitable for the application domain.* *C3.3. The use of computer and mathematical models and tools to solve specific problems in the application field.* *C3.4. Data and model analysis.* *C3.5. The development of software components of interdisciplinary projects.* *C4.1 The definition of base concepts and principles of computer science and mathematics as well as of the mathematical theories and models.* *C4.2 The interpretation of mathematical and computer science (formal) models.* *C4.3 The identification of appropriate models and methods for solving real-life problems.* *C4.4 The use of simulation in the study of the behavior of developed models and evaluation of results.* *C4.5 The embedding of formal models in specific applications in various domains.*

5. **Requisites** (*where applicable*)

5.1. course-related	Room equipped with video projector and board
5.2. seminar/laboratory-based	*Laboratory – computers, Software: Matlab minimum 6.5, Python minimum 2.7, Internet access.*

6. **Specific competences to be acquired (chosen by the course leader from the programme general competences grid)**

| Professional competences | *C1. Programming in high-level languages*
C1.1 The appropriate description of programming paradigms and of specific language mechanisms, as well as the identification of differences between semantic and syntactic aspects.
C1.2 The explaining of existing software applications using different abstraction layers (architecture, packages, classes, methods), correctly using base knowledge.
C1.3 The development of correct source codes and the testing of various components in a known programming language, given a set of design specifications.
C1.4 The testing of various applications given specific testing plans
C1.5 Developing program units and their documentation.
C2. Development and maintenance of computer applications
C2.1 The identification of appropriate methodologies for software systems development.
C2.2 The identification and explanation of appropriate mechanisms for software systems specification.
C2.3 The use of methodologies, specification mechanisms and development environments for the development of computer applications.
C2.4. The use of appropriate criteria and methods for the evaluation of computer applications.
C2.5. The development of dedicated computer projects.
C3. The use of computer tools in an interdisciplinary context |

	C3.1. The description of concepts, theories and models used in the application field.
	C3.2 The identification and explanation of base computer models that are suitable for the application domain.
	C3.3. The use of computer and mathematical models and tools to solve specific problems in the application field.
	C3.4. Data and model analysis.
	C3.5. The development of software components of interdisciplinary projects.
Transversal competences	-

7. Course objectives (as per the programme specific competences grid)

7.1 General objectives of the course	*The course provides an introduction to the theory and practice of Machine Learning as part of Artificial Intelligence.*
	The course presents the main learning concepts: decision trees, neural networks, instance-based learning, analytical learning, Bayesian learning, Support Vector Machines. It also introduces the main approaches and developments in pattern recognition (statistical approach, neural approach, syntactic approach).
7.2 Specific objectives of the course	

8. Course contents

8.1 Course (learning units)	**Teaching methods**	**Remarks**
1. Introduction to Machine Learning. Concept learning.	*Lecture, conversation, exemplification*	2h
2. Decision Trees	*Lecture, conversation, exemplification*	2h
3. Artificial Neural Networks	*Lecture, conversation, exemplification*	2h
4. Assumptions evaluation and Bayesian learning.	*Lecture, conversation, exemplification*	2h
5. Instance-based learning. Analytical learning	*Lecture, conversation, exemplification*	2h
6. Machine Learning and Data Mining	*Lecture, conversation, exemplification*	2h
7. Support Vector Machines	*Lecture, conversation, exemplification*	2h
8. Approaches to pattern recognition. Classification methods.	*Lecture, conversation, exemplification*	2h
9. Statistical approaches to pattern recognition. Feature selection.	*Lecture, conversation, exemplification*	2h
10. Syntactic elements in pattern recognitions	*Lecture, conversation, exemplification*	2h
11. Clustering methods. K-means algorithm.	*Lecture, conversation, exemplification*	4h
12. Image Analysis Techniques.	*Lecture, conversation, exemplification*	4h
Seminars-laboratories	**Teaching methods**	
1. Supervised and unsupervised learning. Applications in Matlab and R language.	*Laboratory activities*	4h

2. Bayesian learning. Matlab implementations	*Project-work, computer-based activities, laboratory activities*	4h
3. Instance-based learning. Analytical learning. Matlab and R language implementations	*Project-work, computer-based activities, laboratory activities*	4h
4. Decision trees. Implementation and examples.	*Project-work, computer-based activities, laboratory activities*	4h
5. Classification techniques using the k-nearest neighbor. Implementation in one programming language of choice (Matlab, R, C++, Python)	*Project-work, computer-based activities, laboratory activities*	4h
6. Support Vector Machines. Matlab implementation.	*Project-work, computer-based activities, laboratory activities*	4h
7. Neural networks. Applications and examples.	*Project-work, computer-based activities, laboratory activities*	4h
8. Unsupervised K-means algorithm. Applications and examples.	*Project-work, computer-based activities, laboratory activities*	4h
9. Approaches to pattern recognition. Feature selection. Syntactic elements in pattern recognitions. Matlab implementations.	*Project-work, computer-based activities, laboratory activities*	4h
10. Image Analysis Techniques. Examples.	*Project-work, computer-based activities, laboratory activities*	10h
11. Practical evaluation.	*Project-work, computer-based activities, laboratory activities*	10h

References

1. Bishop, Christopher M., *Pattern Recognition and Machine Learning*, 1st ed. 2006 Springer-Verlag New York, Inc. Secaucus, NJ, USA, ISBN 978-0-387-31073-2.
2. Stephen Marsland, *Machine Learning: An Algorithmic Perspective*, Chapman & Hall/CRC Machine Learning & Pattern Recognition, 2009, ISBN-10: 1420067184, ISBN-13: 978-1420067187.
3. Mitchell, T., *Machine Learning*, The McGraw-Hill Companies, Inc., 1997, pp. 52-78.
4. Morariu, D. I., *Text Mining Methods based on Support Vector Machines*, ed. MATRIX ROM, Bucureşti, 2008.
5. Kaelbling, L. P., *Learning in Embedded Systems*, MIT Press, 1993.
6. Cristianini, N., and Shawe-Taylor, J., *An Introduction to Support Vector Machines and Other Kernel-based Learning Methods*, Cambridge University Press, 2000, ISBN: 0521780195.
7. Haykin, S., *Neural Networks: A Comprehensive Foundation*, Prentice Hall, 1999.
8. Abe, S., *Support Vector Machines for Pattern Classification*, Second Edition, Springer New York Dordrecht Heidelberg London, 2010, ISBN: 978-1-84996-097-7, DOI: 10.1007/ 978-1-84996-098-4.
9. Lampert, C., *Kernel Methods in Computer Vision*, Foundations and Trends in Computer Graphics and Vision: Vol. 4: No 3, 2009.
10. Han, J., Kamber, M., *Data Mining: Concepts and Techniques*, Second Edition, Morgan Kaufmann Press, Elsevier Inc, San Francisco, ISBN 13: 978-1-55860-901-3, ISBN 10: 1-55860-901-6, 2006.
11. Bramer, M., *Principles of Data Mining*, Springer-Verlag, London, ISBN-10: 1-84628-765-0, ISBN-13: 978-1-84628-765-7, 2007.
12. Witten, I., H., Frank, E., *Data Mining. Practical Machine Learning Tools and Techniques*, Second Edition, Kaufmann Press, Elsevier Inc, San Francisco, ISBN: 0-12-088407-0, 2005.
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14. RUSSELL, Stuart J., NORVIG, Peter, *Artificial Intelligence: a modern approach*, 3rd ed., Upper Saddle River, NJ: Pearson Education, 2010, ISBN 978-0-13-207148-2.

15. PYTHON MACHINE LEARNING: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2, Sebastian RASCHKA; Vahid MIRJALILI (2019), Autori: RASCHKA, Sebastian; MIRJALILI, Vahid, Ediție: Editia a treia, Third Edition - Includes TensorFlow 2, GANs, and Reinforcement Learning, ISBN: 9781789955750
16. HANDS-ON MACHINE LEARNING WITH SCIKIT-LEARN, KERAS / Aurelien GERON (2019), Autori: GERON, Aurelien, Ediție: Editia a doua, ISBN: 9781492032649
17. http://www.cs.uiuc.edu/class/fa06/cs446/
18. *IEEE Transactions on Machine Learning and Pattern Recognition*

9. Corroboration of course contents with the expectations of the epistemic community's significant representatives, professional associations and employers in the field of the academic programme

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10. Assessment

Activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Percentage of final grade
10.4 Course	*Final evaluation*	*Tests, control papers*	50%
10.5 Seminar/laboratory	*Continuous assessment*	*Laboratory activities/projects portfolio*	50%
10.6 Minimum performance standard: minimum 5 at written evaluation and minimum 5 at practical evaluation			

Submission date   Course leader signature   Seminar tutor signature

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Date of approval by Department members   Department director signature

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