SYLLABUS

1. Information regarding the programme

1.1 Higher education institution	**Babeş Bolyai University**
1.2 Faculty	**Faculty of Biology and Geology**
1.3 Department	**Department of Molecular Biology and Biotechnology**
1.4 Field of study	**Biology**
1.5 Study cycle	**Master**
1.6 Study programme / Qualification	**Bioinformatics applied in life sciences**

2. Information regarding the discipline

2.1 Name of the discipline (en) (ro)			**Machine Learning in Bioinformatics** **Invatare automata in Bioinformatica**				
2.2 Course coordinator			**Assoc. Prof. Dr. Bocicor Maria Iuliana**				
2.3 Seminar coordinator			**Assoc. Prof. Dr. Bocicor Maria Iuliana**				
2.4. Year of study	**2**	2.5 Semester	**3**	2.6. Type of evaluation	**E**	2.7 Type of discipline	**Compulsory**
2.8 Code of the discipline		**MMX9902**					

3. Total estimated time (hours/semester of didactic activities)

3.1 Hours per week	3	Of which: 3.2 course	2	3.3 seminar/laboratory	1
3.4 Total hours in the curriculum	42	Of which: 3.5 course	28	3.6 seminar/laboratory	14

Time allotment:	hours
Learning using manual, course support, bibliography, course notes	43
Additional documentation (in libraries, on electronic platforms, field documentation)	40
Preparation for seminars/labs, homework, papers, portfolios and essays	50
Tutorship	4
Evaluations	3
Other activities:	-

3.7 Total individual study hours	140
3.8 Total hours per semester	182
3.9 Number of ECTS credits	7

4. Prerequisites (if necessary)

4.1. curriculum	• Algorithms, data structures
4.2. competencies	• Average software development skills in Python, general knowledge about machine learning

5. Conditions (if necessary)

5.1. for the course	• Projector
5.2. for the seminar /lab activities	• Laboratory with computers /laptop; internet access.

6. Specific competencies acquired

Professional competencies	CE1.3 Use of Machine Learning methods, techniques and algorithms to model solutions to classes of problems CE1.4 Identification and explanation of Machine Learning techniques and algorithms and their use for solving specific problems CE1.5 Using models and solutions from Machine Learning in dedicated applications
Transversal competencies	CT1. Application of efficient work rules and responsible attitudes towards the scientific domain, for the creative exploitation of one's own potential according to the principles and rules of professional ethics CT2. Efficient conduct of activities organized in an interdisciplinary group and development of empathic capacity of interpersonal communication, networking and collaboration with diverse groups

7. Objectives of the discipline (outcome of the acquired competencies)

7.1 General objective of the discipline	• To introduce various concepts, as well as complex problems in Bioinformatics and illustrate a series of approaches for these problems using Machine Learning models.
7.2 Specific objective of the discipline	• Identification of real, relevant problems in the context of Bioinformatics. • Modelling the problems from a Machine Learning perspective. • Proposal of theoretical and practical Machine Learning based solutions for complex problems in Bioinformatics. • Application and evaluation of the proposed solutions using real biological or medical data.

8. Content

8.1 Course	Teaching methods	Remarks
1. Introduction in Bioinformatics. Basic concepts in molecular biology.	• Interactive exposure • Explanation • Conversation • Examples • Didactical demonstration	
2. Genomics, proteomics, networks and systems biology, evolution.		
3. Encoding of biological data. DNA and protein databases. Public Bioinformatics tools.		
4. Machine learning. Classification. Clustering. Optimisation.		
5. Gene finding, gene function prediction.		
6. Protein-protein interactions.		
7. Disease diagnosis based on biological data.		
8. Text mining in Bioinformatics.		
9. Protein folding.		
10. Sequence alignment.		
11. Clustering in Bioinformatics.		
12. Presentation of research papers.		
13. Presentation of research papers.		
14. Presentation of research papers.		

Bibliography

1. Goodfellow, I., Bengio, Y., Courville, A., & Bengio, Y. (2016). Deep learning (Vol. 1, No. 2). Cambridge: MIT press.
2. Larranaga, P., Calvo, B., Santana, R., Bielza, C., Galdiano, J., Inza, I., ... & Robles, V. (2006). Machine learning in bioinformatics. Briefings in bioinformatics, 7(1), 86-112.

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<tr><td colspan="3">3. A.E. Hassanien, M.G. Milanova, Smolinski T.G., and Abraham A. Computational Intelligence in Solving Bioinformatics Problems: Reviews, Perspectives, and Challenges. Computational Intelligence in Biomedicine and Bioinformatics Studies in Computational Intelligence, 151:3-47, 2008.
4. N.M. Luscombe, D. Greenbaum, and M. Gerstein. What is bioinformatics? An introduction and overview. Yearbook of Medical Informatics, pages 83-100, 2001.</td></tr>
<tr><td>8.2 Seminar / laboratory</td><td>Teaching methods</td><td>Remarks</td></tr>
<tr><td>1. Study and discussion regarding the topic for the research paper and software application.</td><td rowspan="8">• Explanation
• Conversation</td><td rowspan="8">The laboratory is structured as 2 hour classes every two weeks.</td></tr>
<tr><td>2. Selection of topic for the research paper and software application.</td></tr>
<tr><td>3. Problem statement and relevance in Bioinformatics.</td></tr>
<tr><td>4. Methodology and Machine Learning approach for the chosen problem – iteration 1.</td></tr>
<tr><td>5. Methodology and Machine Learning approach for the chosen problem – iteration 2.</td></tr>
<tr><td>6. Experimental evaluation of the approach using public/acquired data sets.</td></tr>
<tr><td>7. Presentation of the final software application.</td></tr>
<tr><td colspan="3">Bibliography
1. Goodfellow, I., Bengio, Y., Courville, A., & Bengio, Y. (2016). Deep learning (Vol. 1, No. 2). Cambridge: MIT press.
2. Larranaga, P., Calvo, B., Santana, R., Bielza, C., Galdiano, J., Inza, I., ... & Robles, V. (2006). Machine learning in bioinformatics. Briefings in bioinformatics, 7(1), 86-112.
3. A.E. Hassanien, M.G. Milanova, Smolinski T.G., and Abraham A. Computational Intelligence in Solving Bioinformatics Problems: Reviews, Perspectives, and Challenges. Computational Intelligence in Biomedicine and Bioinformatics Studies in Computational Intelligence, 151:3-47, 2008.
4. N.M. Luscombe, D. Greenbaum, and M. Gerstein. What is bioinformatics? An introduction and overview. Yearbook of Medical Informatics, pages 83-100, 2001.</td></tr>
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9. Corroborating the content of the discipline with the expectations of the epistemic community, professional associations and representative employers within the field of the program

- The course exists in the studying program of major universities abroad;

10. Evaluation

Type of activity	10.1 Evaluation criteria	10.2 Evaluation methods	10.3 Share in the grade (%)
10.4 Course	• Writing and presentation of a paper. The topic must be a Bioinformatics problem approached via Machine Learning techniques. • The paper must be similar to a research article, in topic and structure (approximately 10 pages).	Written exam / Evaluation of the research paper	50%
10.5 Seminar/lab activities	• Development of a software application related to the research paper.	Testing of the application.	40%

	• Correctness and punctuality of delivered laboratory assignments.		
	• Lecture and laboratory activity.	Continuous observation of the student during lectures and laboratories.	10%

10.6 Minimum performance standards

- Each student has to prove that they acquired an acceptable level of knowledge and understanding of the core concepts taught in the class, that they are capable of using knowledge in a coherent form, that they have the ability to establish certain connections and to use the knowledge in solving different Bioinformatics problems.
- Successfully passing of the examination is conditioned by a minimum grade of 5 for each of the following: written exam/lecture paper, laboratory software application.

Date	Signature of course coordinator	Signature of seminar coordinator
19.06.2024	Conf. dr. Maria Iuliana Bocicor	Conf. dr. Maria Iuliana Bocicor

Date of approval	Signature of the head of department
19.06.2024	Conf. dr. Adrian Sterca