DeCAIR Course Syllabus Form

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Work Package Number & Title	Work Package 2: Development of new MSc and BSc programs in AIR		
Activity Number & Title	Activity 2.2: Designing and developing syllabi and content for the agreed upon courses in the new programs		
Work Package Leader	Francesco Masulli, University of Genoa		
Due Date of Delivery	1/2/2022	**Project Month**	M14
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Revision History

Version	Date	Author	Description	Action *	Page(s)
1	20/11/2021	Mohammad Abdel-majeed	Original (base) document	C	1-5
2	9/12/2021	Mohammad Abdel-majeed	Updated based on the feedback from the 27-11-2021 meeting	U	1-5
3					
4					

(*) Action: C = Creation, I = Insert, U = Update, R = Replace, D = Delete

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Course title	Unsupervised Learning
Course number	0907754
Credit hours (lecture and lab)	3 (3 + 0)
ECTS (weekly contact and self-study load)	6 (3 + 3)
Prerequisites/co-requisites by course number and name	Applied Machine Learning (0907743)
Prerequisites by topic (other than the formal prerequisites above)	Students are assumed to have good background in machine learning and Python programming skills.
Level and type (compulsory, elective)	Masters' Elective course
Year of study and semester	First year, second semester or Second year, first semester
Catalogue description	Unsupervised learning algorithms are methods for finding structure and patterns in datasets on an unlabeled dataset. Students will learn about different clustering and dimensionality reduction techniques to achieve this goal. For each technique, the student will learn how to apply the appropriate technique, interpret results and refine and tune unsupervised machine learning models to solve problems on real-world datasets. The course has practical assignment and term project.
Objectives	1. Correctly apply different clustering algorithms like k-means, agglomerative clustering, hierarchal clustering and DBSCAN on unlabeled dataset. 2. Learn how to use t-SNE and multi-dimensional scaling models to extract high-dimensional information into a lower dimension for better visualization. 3. Understand the tradeoffs and assumptions inherent in different clustering techniques. 4. Use auto-encoders to solve unsupervised learning tasks. 5. Apply ~~U~~unsupervised learning techniques for anomaly detection and association rule learning. 6. Apply topic modeling techniques like Latent Dirichlet Allocation and Non-Negative Matrix Factorization. 7. Enable the students to gain practical skills in solving wide range of problems using unsupervised learning techniques.
Intended learning outcomes	Upon successful completion of this course, students will be able to:

No	Intended learning Outcome (ILO)	Program learning outcome (PLO)*
1	Demonstrate a sound understanding of the main unsupervised learning techniques and algorithms.	1
2	Solve unsupervised learning problems by developing	3

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<tr><td></td><td>an appropriate ML system.</td><td></td></tr>
<tr><td>3</td><td>Communicate the development of unsupervised learning models through a detailed technical report and a short presentation.</td><td>4</td></tr>
<tr><td>4</td><td>Use Python and its specialized libraries to develop programs for solving ML problems.</td><td>3</td></tr>
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(*) The PLOs are listed in the appendix
</td></tr>
<tr><td>Teaching and learning methods</td><td>Development of ILOs is promoted through the following teaching and learning methods:
• The AI lab is open for the students to practice the practical aspects and solve the programming homework assignments.
• The student attends the class presentations and participates in the discussions.
• The student joins the related online team/group and participates in its discussions.
• The student studies the reference material, including books and videos.
• The student solves the programming assignments.
• The student carries out a term project for solving a problem using unsupervised learning techniques.
• The student develops a professional report for the term report.
• The student presents the term project in class.</td></tr>
<tr><td>Learning material type</td><td>Textbook, class handouts, some instructor keynotes, selected YouTube videos, and access to a personal computer and the internet.</td></tr>
<tr><td>Resources and references</td><td>A- Required book(s), assigned reading and audio-visuals:
1. Aaron Jones, Christopher Kruger, and Benjamin Johnston, The Unsupervised learning Workshop, Packt Publishing, 2020.
2. Andreas C. Müller and Sarah Guido, Introduction to Machine Learning with Python, O'Reilly Media, 2018.
3. Trevor Hastie, Robert Tibshirani, Jerome FriedmanThe Elements of Statistical Learning, Data Mining, Inference, and Prediction, Springer Series in Statistics, 2017
4. Ankur A. Patel, Hands-On Unsupervised Learning Using Python: How to Build Applied Machine Learning Solutions from Unlabeled Data, O’Reilly, 2019

B- Recommended book(s), material and media:
5. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow: Concepts: Tools, and Techniques to Build Intelligent Systems, 2nd Edition, O’Reilly Media, Oct 2019.</td></tr>
<tr><td>Topic outline and schedule</td><td></td></tr>
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Week	Topic	ILO	Resources
1	Introduction to Unsupervised Learning	1	1, 2,4
2-4	Clustering Techniques (K-means, Hierarchical Cluster Analysis (HCA), and DBSCAN)	1, 2, 4	1, 2
5	Gaussian Mixture Models (GMM)	1, 2, 4	3
6-7	Visualization and Dimensionality Reduction (PCA, Kernel PCA, and t-SNE)	1, 2, 4	1, 2, 3
8-9	Auto-encoders	1, 2, 4	1, 2
10	Anomaly Detection	1, 2, 4	4
11-12	Association Rule Learning (Apriori and Eclat)	1, 2, 4	1, 2
13-14	Topic Modeling techniques (LSA, LDE, etc.)	1, 2, 4	1, 2
15	Term Project Presentations	3, 4	1, 2

Evaluation tools

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment tools:

Assessment tool	Mark	Topic(s)	Time
Homework assignments	10%	Programming aspects	W2-W14
Midterm exam	30%	Introduction through visualization	W8
Term project report and presentation	20%	Practical and presentation aspects	W15
Final exam	40%	All material	W16
Total	**100%**		

Student requirements

The student should have a computer and internet connection.

Course policies

A- Attendance policies:

- Attendance is required. Class attendance will be taken every class and the university polices will be enforced in this regard.

B- Absences from exams and not submitting assignments on time:

- A makeup exam can be arranged for students with acceptable absence causes.
- Assignments submitted late, but before announcing or discussing the solution can be accepted with 25% penalty.
- The project report must be handed in in time.

C- Health and safety procedures:

- All health and safety procedures of the university and the school should be followed.

D- Honesty policy regarding cheating, plagiarism, misbehavior:

- Open-book exams
- All submitted work must be of the submitting student.
- Other text or code must be properly quoted with clear source specification.

	• Cheating will not be tolerated. E- Available university services that support achievement in the course: • Microsoft Teams team and Moodle course page • AI Lab for practicing the practical aspects and solving the programming assignments. • Program announcements Facebook group
Additional information	None

Appendix

Learning Outcomes for the MSc in Artificial Intelligence and Robotics

Students who successfully complete the MSc in Artificial Intelligence and Robotics (AIR) will be able to:

1. Demonstrate a sound understanding of the main areas of AIR including artificial neural networks, machine learning, data science, industrial and service robots, and intelligent and autonomous robots.

2. Apply a critical understanding of essential concepts, principles and practices of AIR, and critically evaluate tools, techniques and results using structured arguments based on subject knowledge.

3. Apply the methods and techniques of the AIR fields in the design, analysis and deployment of AIR solutions and solving practical problems.

4. Demonstrate the ability to produce a substantial piece of research work from problem inception to implementation, documentation and presentation.

5. Demonstrate life-long learning, independent self-learning and continuous professional development skills in the AIR fields.

6. Demonstrate a sound understanding of the ethical, safety and social impact issues of AIR solutions and products.