DeCAIR Course Syllabus Form

Author(s)	Ahmad Aljaafreh		
Author Organization Name(s)	Tafila Technical University		
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
Submission Date	6/11/2021	**Project Month**	M7

Revision History

Version	Date	Author	Description	Action *	Page(s)
1	6/11/2021	Ahmad Aljaafreh	Original (base) document	C	1-6
2	16/01/2022	Ahmad Aljaafreh	Revised based on a peer review	U	1-6
3	2/2/2022	Ahmad Aljaafreh	Revised based on an expert review	U	1-6
4					

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

Disclaimer

This project has been co-funded by the Erasmus+ Programme of the European Union.

Email: DeCAIR@ju.edu.jo

Project Website: http://DeCAIR.ju.edu.jo/

Course title	Reinforcement Learning and Game Development
Course number	0112535
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	Artificial Neural Network and Deep Learning (0112564)
Prerequisites by topic (other than the formal prerequisites above)	-Proficiency in Python -College Calculus, Linear Algebra. -Basic Probability and Statistics. -Foundations of Machine Learning
Level and type (compulsory, elective)	Bachelor' Elective Course
Year of study and semester	Fifth year, first semester
Catalogue description	This course provides a solid introduction to the field of reinforcement learning. Students learn about the core challenges and approaches, including generalization and exploration. Through a combination of lectures, and written and coding assignments, students will become well versed in key ideas and techniques for Reinforcement Learning (RL). Assignments will include the basics of reinforcement learning as well as deep reinforcement learning, an extremely promising new area that combines deep learning techniques with reinforcement learning.
Objectives	1- Learn how to define RL tasks and the core principals behind the RL, including policies, value functions, 2- Implement in code common algorithms following code standards and libraries used in RL 3- Understand and work with tabular methods to solve classical control problems 4- Understand and work with approximate solutions (deep Q network based algorithms) 5- Learn the policy gradient methods from vanilla to more complex cases 6- Explore imitation learning tasks and solutions 7- Recognize current advanced techniques and applications in RL
Intended learning outcomes	Upon successful completion of this course, students will be able to:

No	Intended learning Outcome (ILO)	Program learning outcome (PLO)*
1	Define the key features of reinforcement learning that distinguishes it from AI and non-interactive machine.	1,6,7
2	Given an application problem (e.g. from computer vision, robotics, etc), decide if it should be formulated	1,6,7

		as a RL problem; if yes be able to define it formally (in terms of the state space, action space, dynamics and reward model), state what algorithm (from class) is best suited for addressing it and justify your answer .	
	3	Implement in code common RL algorithms.	1,6,7
	4	Describe (list and define) multiple criteria for analyzing RL algorithms and evaluate algorithms on these metrics: e.g. regret, sample complexity, computational complexity, empirical performance, convergence, etc.	1,6,7
	5	Describe the exploration vs exploitation challenge and compare and contrast at least two approaches for addressing this challenge (in terms of performance, scalability, complexity of implementation, and theoretical guarantees)	1,6,7
	(*) The PLOs are listed in the appendix		
Teaching and learning methods	Development of ILOs is promoted through the following teaching and learning methods: • Lectures will be delivered through Microsoft Teams and will be recorded for later access. • 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 in deep learning. • The student carries out a term project for solving a problem using deep learning techniques. • The student develops a professional report for the term report. • The student presents the term project in class.		
Learning material type	Class handouts, some instructor keynotes, selected YouTube videos, and access to a personal computer and the internet and a number of the supporting readings.		
Resources and references	There is no official textbook for the class but a number of the supporting readings will come from: 1- Reinforcement Learning: An Introduction, Sutton and Barto, 2nd Edition. This is available for free here and references will refer to the final pdf version available. Some other additional references that may be useful are listed below: 2- Deep Learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville, 2016. 3- Reinforcement Learning: State-of-the-Art, Marco Wiering and Martijn van		

<table>
<tr><td></td><td>Otterlo, Eds, 2012.
4- Introduction to Reinforcement Learning with David Silver, https://deepmind.com/learning-resources/-introduction-reinforcement-learning-david-silver</td></tr>
<tr><td>Topic outline and schedule</td><td>
<table>
<tr><th>Week</th><th>Topic</th><th>ILO</th><th>Resources</th></tr>
<tr><td>1</td><td>Introduction to Reinforcement Learning</td><td>1</td><td>1, 2</td></tr>
<tr><td>2,3</td><td>Tabular MDP Planning</td><td>4</td><td>4</td></tr>
<tr><td>3,4</td><td>Tabular RL Policy Evaluation</td><td>1, 2, 4</td><td>1</td></tr>
<tr><td>4,5</td><td>Q-Learning</td><td>1, 2, 4</td><td>1</td></tr>
<tr><td>6</td><td>Policy optimization</td><td>1, 2, 4</td><td>1</td></tr>
<tr><td>7,8</td><td>Model based RL</td><td>1, 2, 4</td><td>1</td></tr>
<tr><td>9,10</td><td>RL with function approximation</td><td>1, 2</td><td>1</td></tr>
<tr><td>11,12</td><td>Deep RL</td><td>1</td><td>1</td></tr>
<tr><td>13</td><td>Policy Search</td><td>1, 2</td><td>1</td></tr>
<tr><td>14</td><td>Applications in Gaming</td><td>1, 2</td><td>1</td></tr>
<tr><td>15</td><td>Term Project Presentations</td><td>1, 2,5</td><td>1</td></tr>
</table>
</td></tr>
<tr><td>Evaluation tools</td><td>Opportunities to demonstrate achievement of the ILOs are provided through the following assessment tools:
<table>
<tr><th>Assessment tool</th><th>Mark</th><th>Topic(s)</th><th>Time</th></tr>
<tr><td>Homework assignments</td><td>10%</td><td>Programming aspects</td><td>W2-W14</td></tr>
<tr><td>Midterm exam</td><td>30%</td><td>Introduction through classical techniques</td><td>W8</td></tr>
<tr><td>Term project report and presentation</td><td>20%</td><td>Practical and presentation aspects</td><td>W15</td></tr>
<tr><td>Final exam</td><td>40%</td><td>All material</td><td>W16</td></tr>
<tr><td>Total</td><td>100%</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Student requirements</td><td>The student should have a computer and internet connection.</td></tr>
<tr><td>Course policies</td><td>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</td></tr>
</table>

	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 B.S. IN INTELLIGENT SYSTEMS ENGINEERING

Students who successfully complete the B.S. IN INTELLIGENT SYSTEMS ENGINEERING will have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.