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DeCAIR

DeCAIR: Developing Curricula for Artificial Intelligence and Robotics

Report on Surveying Training Needs and Capabilities

Activity Information

Work Package	WP1 – Surveys and Needs Identification
Task	1.4 Identifying training needs for staff members in universities of Partner Countries
Activity Coordinator	UJ (Musa Alyaman)
Participating Partners	TTU, UJ, JUST, LU, BAU, UGR, UNIGE, UST, UNIPI
Objective(s)	• Identify AIR training needs of faculty members in universities of Partner Countries • Identify training capabilities of partners in Program Countries • Specify tentative topics for the training courses
Due Date	March 10th

Instructions

1. Activity coordinator is to communicate with the focal point of JUST, TTU, LU and BAU and request each of them to fill Table 1.4.4 about Preliminary List Courses Needed by universities of Partner Countries.
2. Activity coordinator is to communicate with EU partners and request each of them to fill Table 1.4.5 about Preliminary List of Suggested Courses to be delivered by universities in Program Countries to the DeCAIR Project.
3. This report is to be prepared through collaboration of different partners and submitted to the WP lead by the activity coordinator. Filled tables should be added to this report.

Summary and Recommendations

The training needs and capabilities in both program (Table 1.4.4) and partner universities (Tables 1.4.5) were collected and analyzed. Several training courses were considered as a step towards achieving the first work package (i.e. Surveys work package) in the DeCAIR project. The average number of targeted faculty members in Partner Countries is 20 for each university. The surveyed training courses are laid under three main training areas; AI, Data Science and Robotics.

AI

Generally, the needed AI related training courses focus on six areas ranging from basic to advanced levels. In Basic level, mainly two training courses were requested: "Introduction to AI and Machine Learning" and "Neural Network fundamentals". At the intermediate level, mostly two training courses were requested: "Deep Learning" and "Reinforcement Learning". Finally, in advanced level; essentially two training courses were reported: "Natural Language Processing" and "Computer Vision".

On the other hand, the partners from Program Countries offered several AI related training courses which focus on six areas range from basic to advanced levels. In Basic level; three training courses were reported: "Introduction to AI and Machine Learning", "Neural Network Fundamentals" and "Fuzzy Logic Fundamentals". At the intermediate level, one training course was reported: "Deep Learning". Finally, in advanced level; essentially two training courses were reported: "Natural Language Processing" and "Computer Vision". These courses are offered by University of Granada (UGR) and University of Genoa (UNIGE).

Table 1.4.1 summaries the needed training topics in AI listed from most to least wanted and the name of EU partner who offers these topics.

Table 1.4.1 List of Requested AI Topics

#	AI Topic	JU	JUST	TTU	LU	BAU	Offered by
1	Machine Learning	X	X	X	X	X	UGR
2	Deep Learning	X	X	X	X	X	UGR/UNIGE
3	Reinforcement Learning			X	X	X	
4	Introduction to AI	X	X	X			UNIGE
5	Computer Vision	X		X	X		UNIGE
6	Natural Language Processing	X		X			UNIGE
7	Neural Network	X		X			UNIGE
8	Fuzzy Logic			X			UNIGE
9	Intelligent Embedded Systems			X			
10	Pattern Recognition				X		
11	Federated Learning and Block chain					X	
12	Feature Engineering					X	
13	Generative Adversarial Networks					X	
14	AI in Security	X					
15	Knowledge Representation and Reasoning	X					

16	Multi-agent Systems and Game Theory	X					
17	AI in Games			X			
18	Machine learning techniques for Internet of Things				X		
19	Meta-heuristics and Natural Inspired Optimization						UGR

Data Science

Generally, the requested Data Science related training courses focused on three areas ranging from basic to advanced levels. In basic level; one training course was reported: "Introduction to Data Science". Additionally, in intermediate level, one training courses was reported: "Data Analysis and Visualization". Finally, in advanced level; one training courses was reported: "Big Data Analysis".

On the other hand, universities in Program Countries offered Data Science related training courses that focus on three areas ranging from basic to advance levels. In basic level; one training course was reported: "Introduction to Data Science". Additionally, in intermediate level, one training courses was reported: "Data Visualization". Finally, in advanced level; one training courses was reported: "Large scale Data Management" .These courses offered are offered by UGR and UNIGE.

Table 1.4.2 summaries the needed training topics in Data Science listed from most to least wanted and the name of EU partner who offers these topics.

Table 1.4.2 List of Requested Data Science Topics

#	Data Science Topic	JU	JUST	TTU	LU	BAU	Offered by
1	Data Science Fundamentals	X		X		X	UNIGE
2	Big Data Analytics Fundamental and tools	X				X	UNIGE
3	Statistical Data Science	X					
4	Data Mining				X		
5	Multi-Label classification				X		
6	Decision under uncertainties				X		
7	Python for AI and Data Science			X			UNIGE
8	Data pre-processing and visualization						UGR

Robotics

Generally, the requested Robotics related training courses focused on four areas ranging from basic to advanced levels. In basic level; mainly two training courses were reported: "Introduction to Robotics" and "Robot Control fundamentals". Additionally, in intermediate level, one training course was reported: "Robot Programming". Finally, in advanced level; one training course was reported: "Advanced Robotic Control".

On the other hand, universities from Program Countries offered Robotics related training courses that focus on six areas ranging from basic to advanced levels. In basic level; mainly

four training courses were reported: “Introduction to Robotics” and “Robot Control fundamentals”, “Introduction to Mobile and Distributed Robots” and “Building non-Expensive Robot”. Additionally, in intermediate level, two training courses were reported: “ROS Programming” and “Robot Modelling”. Finally, in advanced level; essentially two training courses were reported: “Controlling UAV” and “Distributed Control of Swarm Robots”. These courses offered by three universities; UNIPI, UST and UGR.

Table 1.4.3 summaries the needed training topics in Robotics listed from most to least wanted and the name of EU partner who offers these topics.

Table 1.4.3 List of Requested Robotics Topics

#	Robotics Topic	JU	JUST	TTU	LU	BAU	Offered by
1	Fundamental of robotics	X	X	X	X	X	UGR/ UNIPI(3)/ UST(3)
2	Advance robotics systems control	X	X	X	X		UNIPI/UST
3	Programming methods for Robotics	X			X	X	UNIPI
4	Ethical Standards in AI and Robotics	X	X				
5	Autonomy in Robotic Systems	X					
6	Human Robot Interaction	X					
7	Sensors and Actuators					X	UNIPI
8	AI and Mobile Robots			X			
9	Introduction to Automatic Control /Linear / Non-Linear						UNIPI(3)
10	Flexible One-Arm-Robot						UST
11	Regulation of a Spherical Pendulum						UST
12	Controller Design for a Model Railway						UST
13	Balanced Ball on Rim						UST
14	Control of a UAV						UST
15	External tracking of robots in a laboratory environment						UST
16	Distributed Control of a Swarm of Mobile Robots						UST

AIR Training Needs in Universities of Partner Countries

Note: *A total of 19 training courses are to be conducted in the project. Please list any topic you feel it is necessary to improve your expertise even if it is a fundamental course. List the topics in different categories from basic to advanced. Try to be specific in the topics you list. You can add rows as you need.*

Table 1.4.4 Preliminary List Courses Needed by University of Jordan

Partner Name	**University of Jordan**	
Targeted Program(s)	• B.Sc. in Computer Engineering (Existing) • B.Sc. in Mechatronics Engineering (Existing) • M.Sc. in Computer Engineering and Networks (Existing) • M.Sc. in AI and Robotics (to be established)	
Number of Targeted Faculty Members	20	
AI Topics to be Covered in Training		
Topic		**Priority (High, Medium, Low)**
Artificial Intelligence In Python (Basic)		High
Machine Learning (Basic)		High
Artificial Neural Networks Applications and Deep Learning (Intermediate)		High
Natural Language Processing (Intermediate)		High
AI in Security (Advanced)		Medium
Knowledge Representation and Reasoning (Advanced)		Low
Multi-Agent Systems and Game Theory (Advanced)		Low
Data Science Topics to be Covered in Training		
Topic		**Priority (High, Medium, Low)**
Data Science Fundamentals: Concepts, Importing, Cleaning, Manipulation, Visualization of Data		High
Statistical Data Science		High
Big Data Analytics Fundamentals and Tools (Hadoop, Spark, Tableau…)		High
Robotics Topics to be Covered in Training		
Topic		**Priority (High, Medium, Low)**
Fundamentals of Robotics		High

Partner Name	**University of Jordan**
Robotics Control	High
Artificial Intelligence and Machine Learning for Robotics	High
Programming Methods for Robotics	Low
Human-Robot Interaction	Medium
Machine Vision for Robotics	Medium
Autonomy in Robotic Systems	High
Ethical Standards in Artificial Intelligence and Robotics	High
Other Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Summary and Notes	

Table 1.4.4 Preliminary List Courses Needed by University of Science and Technology

Partner Name	**University of Science and Technology**
Targeted Program(s)	Master Program
Number of Targeted Faculty Members	10
AI Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Deep learning in Engineering Applications	High
Machine Learning impact on the fourth industrial revolution	Medium
Advanced training in using Microsoft Azure for AI	Medium
Python Programming for AI with Microsoft Azure	High
Data Science Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Robotics Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Advanced Robotics systems	Medium
Robots impact on the fourth industrial revolution	High
Warehouse Robots Design and Control	High
Other Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Summary and Notes	

Table 1.4.4 Preliminary List Courses Needed by Tafila Technical University

Partner Name	**Tafila Technical University**
Targeted Program(s)	Intelligent systems engineering
Number of Targeted Faculty Members	8
AI Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Introduction to AI	**Low**
Neural Networks	**High**
Deep Learning	**High**
Deep Reinforcement Learning	**High**
Fuzzy Logic	**Medium**
Machine Learning	**High**
Computer Vision	**High**
Natural Language Processing	**High**
Intelligent Embedded Systems	**High**
AI on edge	**High**
Data Science Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Data Exploration and Analytics	**High**
Artificial Intelligence in Games	**High**
Python for AI and Data Science	**High**
Robotics Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Robot Principles And Design	**High**
Robot Intelligent Control	**High**
Ai And Mobile Robots	**High**
Other Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Summary and Notes	
16 courses are needed as training topics in this project:	

Partner Name	Tafila Technical University
14 with high priority, 1 has a medium priority and 1 has a low priority.	

Table 1.4.4 Preliminary List Courses Needed by Lebanese University

Partner Name	**Lebanese University**
Targeted Program(s)	Master in Robotics and Intelligent Systems – Electrical Engineering – Mechanical Engineering
Number of Targeted Faculty Members	25
AI Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Machine Learning / Deep learning	High
Reinforcement learning	High
Pattern recognition	Medium
Data Science Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Data mining	High
Multi-label classification	High
Decisions under uncertainties	Medium
Robotics Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Computer vision	High
Serial, parallel and cable-driven robots	High
ROS-based development approaches	High
UAV dynamics and control	Medium
Other Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Machine learning techniques for the Internet of Things	High
Machine-to-Machine Communications	High
Summary and Notes	

Table 1.4.4 Preliminary List Courses Needed by Beirut Arab University

Partner Name	**Beirut Arab University**
Targeted Program(s)	Computer Engineering
Number of Targeted Faculty Members	10
AI Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
1. Applied Machine Learning, Basic Level	1. High
2. Reinforcement Learning, Advanced Level	2. Medium
3. Deep Learning, Advanced Level	3. High
4. Deep Reinforcement Learning, Advanced Level	4. High
5. Federated Learning, Advanced Level	5. High
6. Blockchain for Federated Learning, Advanced Level	6. Medium
7. Feature Engineering, Advanced Level	7. High
8. Generative Adversarial Networks, Advanced Level	8. High
Data Science Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
9. Data Science Fundamentals, Basic Level	9. High
10. Data Analysis with Python, Basic Level	10. Medium
11. Modern Software Tools for Data Science (R, Python, SAS, etc.), Basic Level	11. Medium
Robotics Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
12. Introduction to Robotics, Basic Level	12. Medium
13. Robotics Programming, Basic Level	13. Medium
14. Sensors and Actuators, Advanced Level	14. Medium
Other Topics to be Covered in Training	
Topic	**Priority (High, Medium, Low)**
Summary and Notes	

AIR Training Capabilities in Universities of Program Countries

Note: *A total of 19 5-day training courses are to be delivered by EU partners with the following distribution: six courses by UNIGE, five courses by UNIPI, five courses by UGR and three courses by UST. Please fill the table with the list of courses that you plan to deliver. You may list more than the required number of courses. List these courses from basic to advanced.*

Table 1.4.5 Preliminary List of Suggested Courses to be delivered by UNIGE to the DeCAIR Project

Partner Name	**UNIGE**		
Partner Main Expertise	■AI	☐ Data Science	☐ Robotics
AI Topics to be Covered in Training			
Topic			**Required Background and Resources**
Fuzzy Logic & Evolutionary Computation			basic
Neural Networks			basic
Deep Learning			advanced
Computer Vision			medium
Introduction to Artificial Intelligence			basic
Natural Language Processing			basic
Data Science Topics to be Covered in Training			
Topic			**Required Background and Resources**
Introduction to Data Science			basic
Large scale Data Management			advanced
Robotics Topics to be Covered in Training			
Topic			**Required Background and Resources**
Other Topics to be Covered in Training			
Topic			**Required Background and Resources**
Introduction to Python Language Programming			basic
Summary and Notes			
The proposed possible courses are more than six. The consortium will select the six more suitable			

Table 1.4.5 Preliminary List of Suggested Courses to be delivered by UGR to the DeCAIR Project

Partner Name	**University of Granada**		
Partner Main Expertise	☒ AI	☒ Data Science	☒ Robotics
AI Topics to be Covered in Training			
Topic			**Required Background and Resources**
Meta-heuristics and Nature-Inspired Optimization			None
Data Science Topics to be Covered in Training			
Topic			**Required Background and Resources**
Data Pre-processing and Visualization			None
Machine Learning Foundations			Basics on data management
Deep Learning and Advanced Machine Learning			Machine Learning basics
Robotics Topics to be Covered in Training			
Topic			**Required Background and Resources**
Fundamentals of Intelligent Robotics and Control			None
Other Topics to be Covered in Training			
Topic			**Required Background and Resources**
Summary and Notes			

Table 1.4.5 Preliminary List of Suggested Courses to be delivered by UNIPI to the DeCAIR Project

Partner Name	**University of Piza**		
Partner Main Expertise	☐ AI	☐ Data Science	☒ Robotics
AI Topics to be Covered in Training			
Topic			**Required Background and Resources**
Data Science Topics to be Covered in Training			
Topic			**Required Background and Resources**
Robotics Topics to be Covered in Training			
Topic			**Required Background and Resources**
Introduction to Automatic Control			Linear Algebra
Introduction to System Theory and Linear Control			Linear Algebra & Automatic Control
Introduction to Nonlinear Control			Previous courses
Introduction to Robotics			Previous courses
Introduction to Mobile Robotics (ground, aerial and underwater robotics)			
Introduction to Distributed Robotic Systems			
Introduction to ROS and Matlab Simulink			
Introduction to Sensors and Actuators for Robotics			
Introduction to Modelling and Simulation of Discrete Event Systems			Probability theory
Other Topics to be Covered in Training			
Topic			**Required Background and Resources**
Summary and Notes			

Table 1.4.5 Preliminary List of Suggested Courses to be delivered by UST to the DeCAIR Project

Partner Name	**University of Stuttgart**		
Partner Main Expertise	☐ AI	☐ Data Science	☒ Robotics
AI Topics to be Covered in Training			
Topic			**Required Background and Resources**
-			
Data Science Topics to be Covered in Training			
Topic			**Required Background and Resources**
-			
Robotics Topics to be Covered in Training			
Topic			**Required Background and Resources**
			Required Background: Basic understanding of mechatronic systems and their dynamics, modeling, the control of mechanic systems
Basic			
Building Non-expensive and Custom-Build Wheeled Mobile Robots			Required Background (R.-B.): kinematics of mobile robots, practical mechatronics experience (soldering, programming) Resources (R.): metal workshop, laser cutter, soldering station
Mobile Robot Motion Control			R.-B.: First knowledge in mobile robotics R.: multiple different wheeled mobile robots with different kinematics
Robot Kinematics (Articulated Robot)			R.-B.: theoretical knowledge of articulated robots R.: 6-DOF robot (Schunk)
Kinematics of Wheeled Mobile Robots			R.-B.: - R.: practical examples (omnidirectional and differentially driven)
Intermediate			
Flexible One-Arm-Robot			R.-B.: knowledge in flexible multi body systems R.: flexible one-arm robot in the ITM-lab

Partner Name	**University of Stuttgart**
Regulation of a Spherical Pendulum	R.-B.: general knowledge in applied dynamics and machine dynamics R.: 3D pendulum in the ITM-lab ("Expo-Pendulum")
Controller Design for a Model Railway	R.-B.: basic knowledge in control theory (PID controllers) R.: railway in the ITM-lab
Balanced Ball on Rim	R.-B.: basic knowledge in modeling mechanical systems and in control theory (LQR), basic knowledge of microprocessors R.: corresponding set-up in the ITM-lab
Advanced	
Control of a UAV	R.-B.: advanced knowledge in modeling and control R.: multiple quadcopters in the ITM-lab
External tracking of robots in a laboratory environment	R.-B.: basic knowledge in communication R.: external tracking system in the ITM-lab
Distributed Control of a Swarm of Mobile Robots	R.-B.: basic knowledge in modeling and advanced knowledge in (distributed) control R.: multiple mobile robots in the ITM-lab, tracking system
Other Topics to be Covered in Training	
Topic	**Required Background and Resources**
-	
Summary and Notes	
The Institute of Engineering and Computational Mechanics offers several practical trainings in WP 7 (summer 2023). These trainings will all be conducted in the laboratory of the institute at the University of Stuttgart using the given resources and facilities in Stuttgart. The focus is on providing practical knowledge and experience in the field of robotics. This includes, but is not limited to, programming of an articulated robot, analyzing the different kinematics of wheel-driven mobile robots, controlling mobile robots and UAVs, and designing and manufacturing custom mobile robots.	