

ERASMUS+ ARIS PROJECT AI SKILLS FOR ICT PROFESSIONALS

Objectives, activities and outcomes



Co-funded by the
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PROJECT OBJECTIVES

- **To design** a comprehensive and up-to-date training course in AI technologies and practical applications, to empower ICT professionals with initiative, entrepreneurship & updated digital skills required in the workplace.
- **To introduce** modern training delivery methods and innovative open-access pedagogical resources, enabling learners to acquire and self-assess AI related skills, including VET providers resources & techniques to integrate into their training offerings.
- **To facilitate** the integration of AI skills requirements into the EU certification and standardization schemes.



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TARGET GROUPS

- ICT professionals in need of CVET
- Students in need of IVET
- VET providers and employers
- Sectoral stakeholders
- Policy-makers
- Other European learners



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PROJECT DETAILS

Project acronym	ARIS
Project name	Artificial Intelligence Skills For ICT Professionals
Project code	2019-1-BE01-KA202-050425
Start date	01-09-2019
End date	28-02-2022
Budget	€374,710



ARIS PROJECT PARTNERS



- **BUSINESS TRAINING SA** (Lead partner, Belgium)

- www.businesstraining.be



- **Lietuvos kompiuterininkų sąjunga** (Dissemination Leader, Lithuania)

- www.liks.lt



- **UNIVERSITAT POLITÈCNICA DE CATALUNYA** (Spain)

- www.upc.edu



- **CONSIGLIO NAZIONALE DELLE RICERCHE** (Italy)

- www.cnr.it



- **EXELIA E.E.** (Greece)

- www.exelia.gr



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MAIN PROJECT OUTCOMES

Learning outcomes for training provision in the different AI technologies & practical applications for ICT professionals.

Learning units (curriculum structure), trainers' toolkit, and VET integration guidelines.

Open Educational Resources for AI technologies and applications.

ARIS Vocational Open Online Course infrastructures & content on AI technology applications for ICT professionals.

• AI Skills Certificate Supplement for the integration of AI skills into certification schemes.

Position paper to support decision-making and promote the incorporation of AI skills requirements into the European e-Competence Framework.

5 national information days (one in each partnership country) to promote ARIS project.



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2nd SEMESTER TASKS

- 2nd project meeting in Rome (virtually due to COVID-19)
- Preparation of project website content in all partnership languages
- Preparation of printable materials (brochure, poster) in all partnership languages
- Website and social media updates
- 1st digital presentation
- 1st email campaign
- Preparation and submission of the 1st interim report
- 1st quality assurance report

Start date: 01-03-2020

End date: 30-09-2020



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2nd SEMESTER MAIN OUTPUTS & ACTIVITIES

- Analysis of evidence (desk research)
- Define learning units: curriculum outline
- Define learning materials
- Identify MOOC platforms to host the ARIS VOOC
- Decide on MOOC platform



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SURVEY ON AI SKILLS REQUIREMENTS

- The online survey was open for one month and a half, between 01/10/2019 and 31/12/2019.
- 194 individuals with experience in AI technology and computing innovations filled in the online questionnaire.

Country	Obtained number	%
Austria	1	0,52
Belgium	33	17,01
Denmark	1	0,52
Germany	1	0,52
Greece	21	10,82
Italy	51	26,29
Lithuania	38	19,59
Portugal	1	0,52
Slovak Republic	1	0,52
Spain	45	23,20
United Kingdom	1	0,52
TOTAL	194	100



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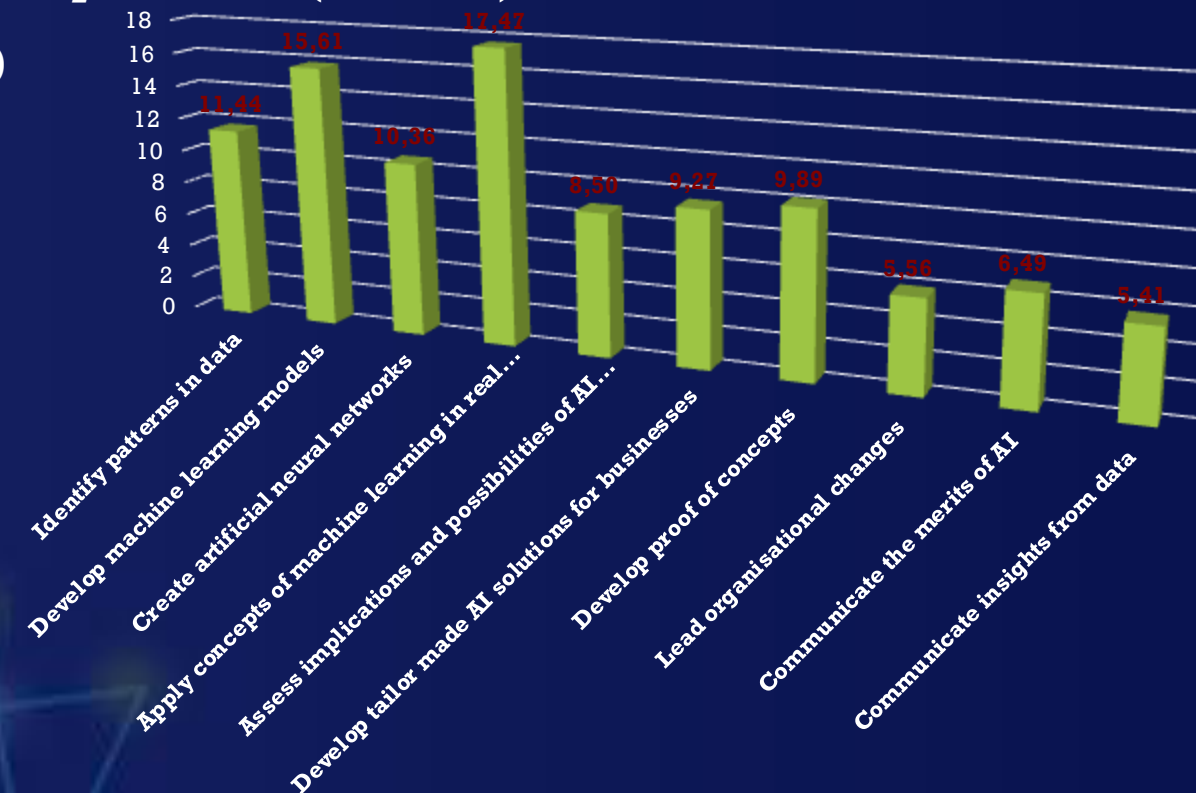
MOST NEEDED FIELD KNOWLEDGE

- According to the respondents, the five most needed field knowledge for working on artificial intelligence and related services are, in decreasing order:
 - ***Machine Learning Algorithms*** (*supervised, unsupervised, semi-supervised, reinforcement learning*) (18.91 %),
 - ***Programming languages for Artificial Intelligence*** (*e.g., Python, Java, LISP, C++, Prolog*) (18 %),
 - ***Data mining concepts and techniques*** (15.73 %),
 - ***Probability and Statistics*** (15.58 %),
 - ***Ethical, legal and social implications of Artificial Intelligence*** (10 %).



MOST IMPORTANT SKILLS TO WORK AS AI PROFESSIONAL

- According the survey, the four most important skills to work as AI professional, according to participants' responses, were in decreasing order:
 - ***Apply concepts of machine learning in real life problems*** (17.47 %)
 - ***Develop machine learning models*** (15.61 %)
 - ***Identify patterns in data*** (11.41 %)
 - ***Create artificial neural networks*** (10.36 %)



ANALYSIS OF EVIDENCE - AI SKILLS REQUIREMENTS FROM JOB VACANCIES

- The skills requirements for AI as drawn from a set of current job vacancy announcements in Belgium, Greece, Italy, and Spain.
- The results have shown that the following skills are shared by the majority of employers:
 - Machine learning
 - Deep learning
 - Data Science
 - Natural language processing
 - Artificial vision systems
 - Neural networks
 - Emotion recognition
 - Cognitive engines
 - Computer vision and 2D image analysis
 - Robotics
 - Business intelligence analytics



ANALYSIS OF EVIDENCE - TOOLS AND THE IMPLEMENTATION TECHNOLOGIES

- The following tools and the implementation technologies are the most cited by the majority of employers:
 - Python
 - Tensorflow
 - PyTorch
 - Cloud computing tools
 - C/C++
 - Big Data tools
 - IBM Watson
 - Apache Spark





ANALYSIS OF EVIDENCE - AI PRACTICAL APPLICATIONS IN DIFFERENT INDUSTRIES SETTINGS

- AI skills requirements, as evidenced by AI practical applications in Belgium, Italy, Spain, the United States of America, and Japan.
- The common required skills are as follow:
 - Deep learning
 - Machine learning
 - Automated reasoning
 - Data analysis
 - Natural language processing
 - Image processing
 - Robotics
 - High-performance computing
 - Programming in Python and in C/C++
 - Cloud computing
 - CI/CD and DevOps practices



ANALYSIS OF EVIDENCE - EXISTING AI ACADEMIC AND TRAINING PROGRAMS

- Existing academic, e-learning, and training programs offer the vast majority of AI curriculums.
- The shortlist of the knowledge and the skills provided by these courses:
 - Problem-solving techniques
 - Machine Learning: deep learning, unsupervised, reinforcement
 - Logic for AI
 - Linear algebra
 - Multi-agent systems
 - Probabilistic graphical models
 - Computational vision
 - Multi-agent systems
 - Natural language processing
 - Speech and audio processing
 - AI for robotics



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FROM FINDINGS TO LEARNING OUTCOMES

The most needed knowledge for AI

- Machine learning algorithms
- ❑ Programming languages for AI
- ❖ Data mining concepts and techniques
- ❑ Probability and statistics
- ❑ Ethical, legal and social implications of Artificial Intelligence



❑ **1. Foundations of Artificial Intelligence**

➤ **2. Machine Learning**

❖ **3. Neural Networks and Deep Learning**

The most needed skills for AI

- Apply concepts of machine learning to real-life problems
- Develop machine learning models
- ❖ Identify patterns in data
- ❖ Create artificial neural networks
- ✓ Develop the proof of concepts for envisioned AI applications



✓ **4. AI for solving real-life problems**



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FROM FINDINGS TO LEARNING OUTCOMES

The most needed skills from job vacancies

- Machine learning
- ❖ Deep learning
- Data science
- ❑ Natural language processing
- ✓ Artificial vision systems
- ❖ Neural networks
- ❖ Emotion recognition
- ❑ Cognitive engines
- ✓ Computer vision and 2D image analysis
- ✓ Robotics
- ✓ Business intelligence analytics

The most needed skills from AI actual use cases

- ❖ Deep learning
- Machine learning
- ❑ Automated reasoning
- Data analysis
- ❑ Natural language processing
- ✓ Image processing
- ✓ Robotics
- ✓ High performance computing
- ❑ Programming in Python and in C/C++
- ✓ Cloud computing
- ❑ CI/CD and DevOps practices

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- ❑ **Foundations of Artificial Intelligence**
 - **2. Machine Learning**
 - ❖ **Neural Networks and Deep Learning**
 - ✓ **AI for solving real-life problems**



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ARIS LEARNING UNITS

- ✓ Unit 1: Foundations of Artificial Intelligence
 - Defines the essential AI characteristics.
 - Addresses the fundamental features of AI applications.
- ✓ Unit 2: Machine Learning
 - Defines the foundations for Machine Learning.
 - Teaches how to select the right ML model and to implement it in a given domain.
- ✓ Unit 3: Artificial neural networks (ANNs) and deep learning for vision
 - Provides the knowledge, skills, and competence to apply big data analysis to large datasets and deep learning to vision.
- ✓ Unit 4: Deep learning for natural language processing and big data analysis
 - Provides the knowledge, skills, and competence to apply deep learning to Natural Language Problems and Big Data analysis to large datasets.



UNIT 1: FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

Title	Unit 1: Foundations of Artificial Intelligence		
EQF Level	EQF Level 4		
Abstract	<p>Defines the essential AI characteristics. Addresses the fundamental features of AI applications.</p>		
Learning Outcomes	<ul style="list-style-type: none"> • Give an account of the main methods used in AI solutions and the main areas where AI has been successful • Autonomously explain the benefits and risks of AI solutions in terms of performance, accuracy • Examine a suitable real-world problem and abstract its elements to suit one of the AI paradigms 		
Skills developed	<ul style="list-style-type: none"> • Explain the scope of AI differentiating applications from methods and techniques • Identify a potential application of AI and critically chose the AI sub-field that may be applied 	<ul style="list-style-type: none"> • Provide examples of problems that must be addressed with deterministic or probabilistic AI methods • Differentiate the knowledge representation, learning, and reasoning components in a given AI system. 	<ul style="list-style-type: none"> • Explain the ethical implications of an AI deployment and anticipate the ethical dilemmas that may have to be addressed





UNIT 1: FOUNDATIONS OF ARTIFICIAL INTELLIGENCE – LESSON TOPICS

- General overview of all the areas of AI.
- An introduction to three of the main topics in AI and their techniques.
- Main areas of application of artificial intelligent areas n industry.
- Ethical implications of the use of AI.

Lesson No.	Topic
1.	Scope of AI
2.	Problem Solving
3.	Knowledge Representation
4.	Machine Learning
5.	Applications
6.	Ethical Implications



UNIT 2: MACHINE LEARNING

Title	Unit 2: Machine Learning		
EQF Level	EQF Level 4		
Abstract	<p>Defines the foundations for Machine Learning. Teaches how to select the right ML model and to implement it in a given domain.</p>		
Learning Outcomes	<ul style="list-style-type: none"> • Evaluate the feasibility of implementing a suitable ML algorithm in a novel domain • Provide expertise on a detailed plan to gather the right data, develop the right algorithm taking advantage of existing resources, and conducting a suitable validation • Examine a given problem, identify the component that may be formalized as an ML task, and recognize the appropriate typology that is more suitable 		
Skills developed	<ul style="list-style-type: none"> • Provide examples of the different ML types of problems • Identify the ML component in a software system • Communicate the potential of ML methods critically telling advantages and disadvantages concerning more traditional approaches 	<ul style="list-style-type: none"> • For a given problem, formalize requirements of an ML solution, collect the set of methods that may be applied, and critically design a plan to test and evaluate the different alternatives • Identify languages and other resources for specific ML applications 	<ul style="list-style-type: none"> • Recognize the relevant data by choosing the right visualizations and the right transformation from raw noisy data. • Design a plan for testing an ML solution, evaluate its performance, and validate its accuracy.



UNIT 2: MACHINE LEARNING - LESSON TOPICS

- Introduction to the main topics of Machine learning (ML).
- Main lessons covering data transformation, supervised ML, and unsupervised ML methods.
- Practical approach using python numerical calculus and ML libraries.

Lesson No.	Topic
1.	Introduction to ML
2.	Languages and Resources
3.	Data Transformation and Visualization
4.	Supervised Linear ML
5.	Supervised Non-Linear ML
6.	Unsupervised ML



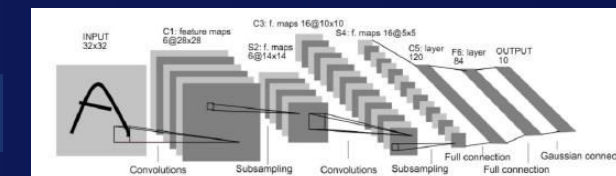
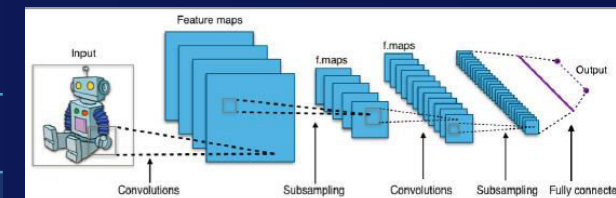
UNIT 3: NEURAL NETWORKS AND DEEP LEARNING FOR VISION

Title	Unit 3: Neural Networks and Deep Learning for Vision		
EQF Level	EQF Level 4		
Abstract	Provides the knowledge, skills, and competence to apply big data analysis to large datasets and deep learning to vision.		
Learning Outcomes	<ul style="list-style-type: none"> • Classify different types of problems where different types of NN and DL are applicable. • Plan the features of the chosen models to solve a specific problem with NN/DL. • Select and prepare data to face a particular problem with NN and DL. • Use suitable resources to implement specific NN and DN solutions for a given problem. • Improve models iteratively (meta-parameters, overfitting/bias, performance), and make decisions on data, to face a given problem. 		
Skills developed	<ul style="list-style-type: none"> • Code a neuron activation, sigmoid/ReLU, and NN spreading • Code and train a perceptron from scratch to solve a basic classification problem (AND/OR) 	<ul style="list-style-type: none"> • Implement a deep NN with Keras • Implement a convolutional NN with Keras • Solve problems of object recognition with a NN and Keras 	<ul style="list-style-type: none"> • Solve problems of object localization with NN and Keras



UNIT 3: NEURAL NETWORKS AND DEEP LEARNING FOR VISION- LESSON TOPICS

- ANNs and deep neural networks (DNNs) able to solve regression and classification problems (Python and Keras).
- Convolutional neural networks (CNNs) to classify images and locate objects within them.



Lesson No.	Topic
1.	Brain origin and element of neural networks.
2.	Simple perceptrons and supervised learning.
3.	Multilayer perceptrons and Keras.
4.	Deep learning for image classification: Convolutional neural networks.
5.	Different CNNs for image classification.
6.	Real-time object localization with YOLO models.

UNIT 4: DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING AND BIG DATA ANALYSIS

Title	Unit 4: Deep Learning for Natural Language Processing and Big Data Analysis		
EQF Level	EQF Level 4		
Abstract	Provides the knowledge, skills, and competence to apply deep learning to Natural Language Problems and Big Data analysis to large datasets		
Learning Outcomes	<ul style="list-style-type: none"> • Frame and solve problems that can be solved with NLP techniques • Apply suitable methodologies and libraries for NLP applications of different types • Apply sentiment analysis to real problems • Frame and solve problems that can be solved with big-data techniques • Apply suitable methodologies and libraries for big data analysis to large databases of different types 		
Skills developed	<ul style="list-style-type: none"> • Implement methods and techniques for text embedding • Develop and test NN for Natural Language Processing 	<ul style="list-style-type: none"> • Develop and test NN for sentiment analysis • Recognize different big data problems and choose the techniques for their solution 	<ul style="list-style-type: none"> • Perform analytics of large datasets with Hadoop and Spark • Collect, clean, store, manipulate, analyze and visualize large datasets





UNIT 4: DEEP LEARNING FOR NATURAL LANGUAGE PROCESSING AND BIG DATA ANALYSIS - LESSON TOPICS

- Deep learning for natural language processing and its evolution during time.
- Big data: Hadoop, Spark, and data analytics.

Lesson No.	Topic
1.	Word Embeddings and Text Classification
2.	Neural networks for NLP and libraries
3.	New approaches, applications, open problems
4.	Big data: problems, core techniques, and introduction to Hadoop
5.	Big data: Hadoop and Spark for data processing
6.	Big data: main analytics, visualization, and applications



LEARNING MATERIALS

- 365 presentation slides and 215+ pages of lecture notes
- 36-48 case studies
- Average duration for reading the lecture notes, slide presentations, and case studies: 36h
- Learner personal work: 12h
- All learning materials will be available in English and the partnership languages (FR, NL, IT, ES, GR, LT).



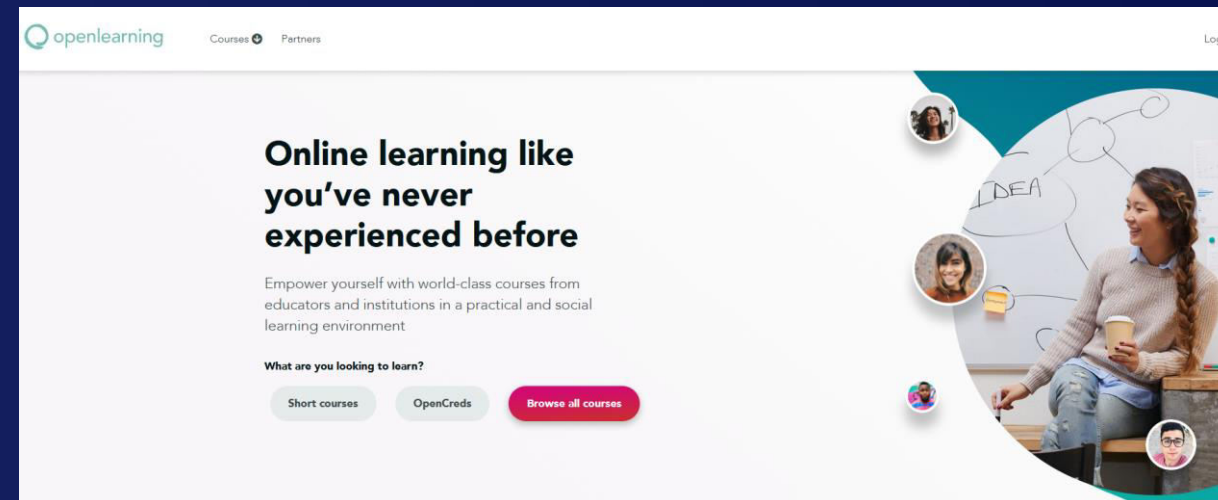
ASSESSMENT MATERIALS

- 180-240 multiple choice questions
- 60-120 question answers
- 60 short response questions
- 12-24 practical exercises
- 12 case studies and application scenarios analysis



TO BE HOSTED ON OPENLEARNING

- ARIS AI course and all materials will be available on www.openlearning.com
- Openlearning platform provides these functionalities:
 - No restriction on language to use
 - Content under an open license
 - Access to course materials through mobile devices
 - Aesthetically appealing
 - Increased interactivity (e.g. social media)
 - Automated & peer assessment



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