MACHINA

O4-T2: Specifications for an EU-wide vocational qualification in Machine Learning for ICT work

Funded by the Erasmus+ Programme of the European Union

TABLE OF CONTENTS

1 ABOUT THIS DOCUMENT

This document contains the information that training providers need to offer the diploma "**Level 5 Certificate for Machine Learning for ICT professionals" ,** providing details and guidance on:

- Centre resource requirements
- Candidate entry requirements in the evaluation process
- Qualification standards and specifications
- Assessment requirements

2 VOCATIONAL QUALIFICATION ON MACHINE LEARNING

Name	Machine Learning skills for ICT professionals
Type	VET
EQF level	5
Delivery method	VOOC/ in classroom
Awarding body	VET institution/ training provider
Type of certification to be obtained	Professional Certificate in ML methods This certificate will act as an official testimonial of relevant skills acquisition, to be used as evidence in the labour market but also as part of a learner's process towards the completion of a VET qualification on Machine Learning
Prior knowledge	Python Language
Entry requirements	Secondary education completed, at least 16 years old
Credit points	30 (0.06 credits/hour) – to be modified according to the regulation of each implementing country
Duration	506 hours/ 2 semesters
Target group	ICT professionals
Assessment	• Written: 70% • Practical: 30%
Scoring/Passing thresholds	To pass a learning element (module), participants need to respond correctly to 66% of all element questions. In order to obtain the certificate, participants need to reach the passing threshold in all learning elements
Delivery language	English, Italian, Greek, Romanian, French, German

2.1 Qualification summary

Qualification demonstrates personal attributes, education, training and/or work experience. It is shown in the form of credentials (e.g. certificates or diplomas) or other evidence linked to the delivery and assessment of training received. Qualification is the outcome of specific training, education, work experience and shows a significant interdependency with the personal attributes of an individual. Qualification summarises knowledge, skills, and capabilities which are required by specific activities of a job or daily life. From an employer's point of view, the notion is associated with effectiveness gained by an individual in the production process. From an individual's point of view, qualification is a precondition for successful occupation and job fulfilment, because the status of development influences his/her market opportunities and thus his/her labour market value. The development of key qualifications is directly connected to compliance with specific occupational and academic requirements.

Machine Learning (ML) is a subset of Artificial Intelligence (AI) that has gained substantial prominence in diverse economic & social realities, having become the basis for a series of technological developments such as automated translation systems, medical image analysis, and virtual assistants. ML was born from pattern recognition but has evolved to refer to the use of data & learning algorithms to produce models, predict outcomes and make decisions with minimum human intervention.

MACHINA is an Erasmus+ KA2 project, which aims to tackle this ML skill deficit by increasing the relevance of Continuing & Initial VET provision in the sector, to assure that the existing & future ICT workforce will have the ML specific competences & transversal skills required to respond to modern workplace requirements and succeed in a competitive, fast-growing field. The project will also make available transnational educational materials in the form of OERs, to ensure wide adoption and support VET provision in a cost-effective, flexible way.

MACHINA developed a formal VET curriculum on Machine Learning for ICT professionals, to address current and emerging occupational needs, essentially improving the quality of sectoral formal and non-formal vocational training. The curriculum is referenced to the 5th EQF level and has a 2-semester duration. It comprises both theoretical & practical learning components, employing a modular structure to facilitate deployment in formal & informal C-VET environments.

Each learning unit was designed to consist of a unique set of learning outcomes, defined in terms of knowledge, skills and competences, which can be assessed and validated in a consistent and coherent approach. Each unit will be also assigned with ECVET credit points to serve as a point of reference for a future, accredited qualification on Machine Learning for ICT professionals.

2.2 Qualification structure

The MACHINA course, consisting of six learning units, is described in this section below. The learning units are:

- **LU1** ML essentials for ICT professionals,
- **LU2** Mathematical Foundations,
- **LU3** ML Algorithms, Programs and Protocols,
- **LU4** Deep Learning Advances,
- **LU5** Communicating the merits, challenges and implications of Machine Learning technology,
- **LU6** Legislation, Ethics, Project Management related to Machine Learning

Each learning unit is composed of several lessons and each lesson includes 2 or more learning outcomes.

Learning Units	Lessons	Duration
ML essentials for ICT professionals	Lesson 1: Introduction to ML	Total: 80 hours
	Lesson 2: Where to apply ML	
	Lesson 3: Machine Learning and Data processing	
	Lesson 4: Example ML applications	
Mathematical Foundations	Lesson 1: Set, Functions, Relations	Total: 80 hours
	Lesson 2: Linear Algebra	
	Lesson 3: Probability Theory	
	Lesson 4: Statistics	
	Lesson 5: Computation theory	

Learning Units	Lessons	Duration
ML Algorithms, Programs, and Protocols	Lesson 1: Machine Learning by linear models	Total: 100 hours
	Lesson 2: Supervised learning	
	Lesson 3: Unsupervised learning	
	Lesson 4: Semi-supervised learning	
	Lesson 5: Programming languages and frameworks for Machine Learning algorithms	
	Lesson 6: Best practices for ML	
Deep Learning (Advanced)	Lesson 1: Multilayer Perception (MLP)	Total: 80 hours
	Lesson 2: Convolutional Neural Networks (CNN)	
	Lesson 3: Recurrent Neural Networks (RNN)	
	Lesson 4: Autoencoders (AE), Restricted Boltzmann Machines (RBM)	
Communicating the merits, challenges, and implications of Machine Learning technology to customers and within own organization	Lesson 1: Introduction to communication and ML involvement	Total: 83 hours
	Lesson 2: Types, levels, components of effective communication and ways for using Machine Learning in Communications	
	Lesson 3: The future of communication in accordance with artificial intelligence	
	Lesson 4: The effects of artificial intelligence in communication	
Legislation, Ethics, Project Management related to ML	Lesson 1: EU guidelines on ethics in artificial intelligence	Total: 83 hours
	Lesson 2: Data Value/Costs Model	
	Lesson 3: Bias in Machine Learning	
	Lesson 4: Software engineering for AI applications	

3 CERTIFICATION

The qualification will be awarded to candidates who successfully complete the assessment threshold of 66%. The assessment and validation of learning outcomes given by the qualification is presented below:

MACHINA VALIDATION FRAMEWORK	
Examination Body	Third party certification organization (e.g., ECQA, OCNNI)
Examination duration	4-6 hours
Prerequisites for applicants	**Documentation (1)** • Certificate of completion of the MACHINA curriculum, as delivered in a classroom-based environment **or** • Certificate of completion of the MACHINA VOOC **or** • Certificate of completion of a course that includes at least 3 modules of the MACHINA curriculum **Documentation (2)** • Curriculum vitae **Documentation (3)** • Completed application form
Prior Knowledge	Python Language
Assessment method	• Written: 70% • Practical: 30%
Assessment tools	• Multiple Choice Questions • Observation (via videos) • Simulation • Evidence/results extracted from programming practical work
Modules	• Module 1: ML essentials for ICT professionals • Module 2: Mathematical Foundations

	• Module 3: ML Algorithms, Programs and Protocols • Module 4: Deep Learning • Module 5: Communicating the merits, challenges and implications of Machine Learning technology to customers and within own organisation • Module 6: Legislation, Ethics, Project Management related to ML
Main Learning Outcomes	• Know ML characteristics and different algorithms. • Understand the concept behind ML and how to detect patterns from data. • Identify different types of applications that use the ML algorithms. • Know the mathematical concepts required for writing programs and algorithms for ML and AI • Use programming languages for the implementation of machine learning algorithms. • Define foundational machine learning models • Select suitable ML model for a given problem • Develop/Implement ML models using programming languages. • Understand deep neural network architecture. • Assess the potential of deep learning in different applications such as natural language processing, computer vision, or recommendation systems. • Understand the EU law and regulations for AI and ML applications. • Identify different types of bias in AI and their consequences. • Know the project management requirements and the lifecycle for AI applications. • Adapt messages to the diverse needs of individuals, groups and contexts • Differentiate between various approaches of communicating issues

	• Select creative and appropriate modalities and technologies to accomplish communicative goals • Present messages in multiple communication modalities and contexts
Performance levels	• **Basic**: Basic knowledge of facts, principles, processes and general ML concepts • **Intermediate**: Factual and theoretical knowledge and a range of cognitive and practical skills required to generate ML enabled solutions to specific contexts • **Advanced**: Comprehensive, specialized, factual and theoretical knowledge and a comprehensive range of cognitive and practical skills required to develop creative ML enabled solutions to specific contexts and problems
Performance criteria	Description of the minimum level of performance (basic, intermediate or advanced) a participant must demonstrate for each learning outcome to be assessed as competent.
Scoring/Passing thresholds	To pass a learning element (module), participants need to respond correctly to 66% of all element questions. In order to obtain the certificate, participants need to reach the passing threshold in all learning elements
Type of certification to be obtained	Professional Certificate in ML methods This certificate will act as an official testimonial of relevant skills acquisition, to be used as evidence in the labour market but also as part of a learner's process towards the completion of a VET qualification on Machine Learning

4 REQUIREMENTS FOR TRAINING PROVIDERS

Accredited / Authorized education institutions can integrate the curricula into an existing course or a new course that can be offered at the undergraduate, postgraduate and graduate level. These education providers are required to demonstrate the relevance of their course by the description of the course, goals and objectives, the outline of the training course content and how the course relates to the Universal and related curricula.

Trainers must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- be occupationally competent or technically knowledgeable in the area[s] for which they are delivering training and/or have experience of providing training. This knowledge must be to the
- same level and/or at most a higher level that training being delivered
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

The training providers must ensure that learners have the potential and opportunity to gain the qualifications successfully and that they have the full engagement of the employers for the full programme.

5 QUALITY ASSURANCE

Quality assurance in education and competence assessment must be oriented towards the development of systems that can generate confidence in the process.

Quality standards are provided by independent standardization bodies and sector associations, supplied as normative documents. De facto standards are offered by public and/or private industry initiatives and are achieved through broad acceptance of stakeholders in a specific sector/field. Quality standards are distinguished according to the subjects covered, e.g. process, method and content.

In case of professional training, the reference is ISO 9001:2015 "Quality management systems — Requirements". The guidelines contained within ISO 9001:2015 do not add to, change the requirements for a training organization and provides guidance for a quality management system in educational organizations.

For competency certification, the reference is ISO/IEC 17024:2012: Conformity assessment — General requirements for bodies operating certification of persons.

The international standard ISO/IEC 17024 has been drawn up with the objective of achieving and promoting a globally accepted benchmark for organizations offering certification (ISO/IEC 17024, 2012).

Thus we can say that the process of professional training as well as the evaluation of competences must have a clear system and in accordance with international requirements. Thus, if an organization functions as a training provider and at the same time performs the certification of acquired skills, it can implement the requirements of the two standards mentioned above: ISO 9001:2015 "Quality management systems — Requirements" and ISO/IEC 17024:2012: Conformity assessment — General requirements for bodies operating certification of persons.

In an ideal case, applied quality standard(s) should be the basis for the certification bodies and their schemes, to promote acceptance at national and international level. One immediate approach to harmonising e-skills certifications is to assess underlying systems for developing and maintaining certification schemes. This is likely to establish the environment for mutual recognition and the global exchange of personnel. Quality management in further education and vocational training focuses, in particular, on organisation, learning infrastructure, training and teaching, and

the process of learning itself. Primarily, the certification body has to develop its own quality policy, implemented by means of quality models or concepts. In addition, certification bodies should derive a related mission statement to be followed by all persons involved (ISO/IEC 17024, 2012).

The organization must implement procedures to ensure the functionality of the system. Can implement procedures regarding document control, record control, corrective action, preventive action, non-compliant process control and internal audit. Also, for the training process, the organization must have operational procedures that describe how this process is carried out.

From the certification point of view, the organization must have a documented structure which safeguards impartiality, including provisions to assure the impartiality of the operations of the certification body. This structure shall enable the participation of all parties significantly concerned in developing policies and principles on the content and functioning of the certification system, without any particular interest predominating. In the case that organizations decide to subcontract work related to certification (e.g. examination, testing) to an external body or person, a properly documented agreement is recommended; this should include confidentiality and prevention of a conflict of interest. Decision on certification shall not be subcontracted under any circumstances. In general, the assessment of conformity of an object of interest with specific mandatory or voluntary standards is subject to further activity called accreditation.

Organizations are expected to support their staff in ensuring that their knowledge and/or practice remains current. This includes currency within the occupational area and of best practice in certification of competencies, delivery, mentoring, training, assessment and quality assurance. It should also take into account any national, international policy and legislative developments. All this is implemented in the context in which it is desired to develop an effective quality management system in education, professional training and certification of competences. Quality assurance includes, on the one hand, internal quality assurance, carried out by each organization, and external bodies are responsible for external quality assurance.

5.1 Internal quality assurance

Internal Quality Assurance (IQA) is the process of monitoring the teaching, learning, and assessment activities that a learner at a training provider will undertake. It refers to the Quality Assurance carried out in a training center, by an internal member of staff, called Quality manager.

Quality managers are the Supervisors or Managers within training centers. They are responsible for the staff, systems, and procedures. They are not trainers or assessors because this would cause a conflict of interest.

Internal quality assurance is key to ensuring that the training provider has an efficient training system and the competency certification process is independent of the training process.

Quality manager must have:

- experience in the technical field in which he carries out his activity
- experience in professional training
- experience in the assessment of professional skills
- proof of the fact that he participated in a quality manager training program

5.2 External quality assurance

External Quality Assurance (EQA) is the process of ensuring that the organization carries out all activities in a consistent, safe and fair manner.

External Quality Assurance is carried out by an external body. The external body can be an authority, an accreditation body.

The External Quality Assurance process guarantees that the service offered by the organization (professional training and competency certification) is of quality and complies with all related standards. The external body will monitor the training center's processes/practices. The external body will also monitor the competence of the organization's staff (trainers, competence evaluators). In the event that it identifies non-conformities in the evaluation process, the external body will make recommendations and monitor the implementation of the respective recommendations.

The external evaluation body collaborates with evaluators who have experience in the field of professional training and competency certification. They also have the necessary training to make external evaluations.

6 LEARNING UNITS SPECIFICATIONS

Learning Unit 1: ML essentials for ICT professionals				
Unit description	Defines the essential ML characteristics and addresses the fundamental features of ML applications.			
Learning objectives	- Get an overview of the ML characteristic and its different algorithms. - Understand the concept behind ML and how to detect patterns from data. - Identify different types of applications that use the ML algorithms.			
Lessons	1. Introduction to ML. 2. Where to apply ML. 3. Machine learning and Data processing. 4. Example ML applications.			
Learning outcomes	Lesson 1 - Understand the theoretical principles of Machine Learning - Get a general overview of the different machine learning algorithms.	Lesson 2 - Types of problems that Machine Learning algorithms can solve nowadays (ex. regression and classification) - How to solve the problems using various Machine Learning techniques.	Lesson 3 - Understand Data preprocessing and visualization methods.	Lesson 4 - Understand the elements of ML in applications. - Analyze some existing ML applications according to a given context.
EQF level	5			
ECVET credits	5			
Duration	83 hours			
Recommended background	Basic understanding of Linear Algebra, Background on computer science.			
Prerequisites	Basic knowledge of Python language			
Learning materials	• 21 pages with lecture notes • 4 presentation files with 66 slides in total • 10 Questions and Answers • 2 Case Studies			
Assessment materials	• 2 practical exercises on Juoyter IPython NoteBook with indicative solutions • 10 multiple choice questions			

Learning Unit 2: Mathematical Foundations					
Unit description	Defines the mathematical foundation required for writing programs and algorithms for ML and AI.				
Learning objectives	To break down the difficult mathematical concepts into easier one to understand concepts. To focus on mathematical concepts and algorithms to get full understanding of ML and AI techniques and methodologies.				
Lessons	1. Set, Functions, Relations 2. Linear Algebra 3. Probability Theory 4. Statistics 5. Computation theory				
Learning outcomes	Lesson 1 -To know the definition of sets and basic sets' operations -To know definition of function and basic functions' operations -To know definition of relation, equivalence relation, partition of a set -To know the concept of local minima and derivatives of a function -To be able to compute an approximation of	Lesson 2 -To know the definition of vector space and basic vector operations -To know the definition of metric -To know the difference between scalar, vector, tensor -To know how calculate the Hadamard product -To know the definition of the gradient of a function	Lesson 3 -To know the frequentist definition of probability of an event -To know the definition of probability as ratio between favorable outcomes on total outcomes -To be able to calculate easy probabilities base on basic combinatorics -To know the definition of join probability -To know the definition of independent events	Lesson 4 -To know the definition of population and sample -To know the meaning and to be able to compute mean, median, variance, standard deviation of a population -To know the meaning of covariance and correlation -To know the meaning of maximum likelihood estimator -To know the meaning of univariate and	Lesson 5 -To know the concept of algorithm -To be able to write a simple algorithm as a flow chart -To know the basics of procedural programming language (operations, conditions, if-else, while, for) -To be able write a simple algorithm in a programming language (Python) -To know the basic data structures (sets, lists, associative,

Learning Unit 2: Mathematical Foundations					
	derivative at a point using deltas		-to know the definition of conditional probability -To know the Bayes Theorem	multi variate linear regression and how to compute the parameters -To know the definition of correlation matrix -To know the meaning of logistic regression -To know the definition of precision, recall, confusion matrix	arrays) -To know the concept of classes, instances, methods
EQF level	5				
ECVET credits	4.8				
Duration	80 hours				
Recommended background	None				
Prerequisites (in terms of software)	Knowledge of a programming language				
Learning materials	• 26 pages with lecture notes • 1 presentation file with 15-20 slides • 15 Questions and Answers • 2 Case Studies				
Assessment materials	• 2 practical exercises • 15 multiple choice questions				

<table>
<tr><th colspan="7">Learning Unit 3: ML Algorithms, Programs and Protocols</th></tr>
<tr><td>Unit description</td><td colspan="6">Defines the foundational machine learning models and understands how to select the suitable ML model for a given problem and how to implement it in one of the available programming languages.</td></tr>
<tr><td>Learning objectives</td><td colspan="6">- Foundational understanding of machine learning models.
- Understand some of the essential machine learning algorithms and how to evaluate the performance of them.
- Identify different programming languages and frameworks that support the implementation of machine learning algorithms.</td></tr>
<tr><td>Lessons</td><td colspan="6">1. Machine learning by linear models
2. Supervised learning
3. Unsupervised learning
4. Semi supervised learning
5. Programming languages and frameworks for Machine learning algorithms
6. Best practices for ML</td></tr>
<tr><td>Learning outcomes</td><td>Lesson 1
- Get an overview of ML linear models.
- Identify the different ML linear models' algorithms and implementation.</td><td>Lesson 2
- Get an overview of supervised learning and its utility.
- Identify the different algorithms of supervised learning and implementation.</td><td>Lesson 3
- Get an overview of unsupervised learning and its utility.
- Identify the different algorithms of unsupervised learning and implementation.</td><td>Lesson 4
- Get an overview of semi-supervised learning and its utility.
- Identify the different algorithms of semi-supervised learning, and implementation.</td><td>Lesson 5
- Obtain an overview of the different programming languages and frameworks available for ML.</td><td>Lesson 6
- Understand best practices for building machine learning applications.
- Identify Hyperparameter Tuning methods.</td></tr>
<tr><td>EQF level</td><td colspan="6">5</td></tr>
<tr><td>ECVET credits</td><td colspan="6">6</td></tr>
<tr><td>Duration</td><td colspan="6">100 hours</td></tr>
<tr><td>Recommended background</td><td colspan="6">Basic understanding of Linear Algebra, and probability theory. Learning Unit 1 and 2</td></tr>
<tr><td>Prerequisites</td><td colspan="6">Basic knowledge of Python language</td></tr>
</table>

Learning Unit 3: ML Algorithms, Programs and Protocols	
Learning materials	• 18 pages with lecture notes • 6 presentation files with 112 slides in total • 15 Questions and Answers • 2 Case Studies
Assessment materials	• 3 practical exercises on Juoyter IPython NoteBook with indicative solutions • 15 multiple choice questions

Learning Unit 4: Deep Learning (Advanced)				
Unit description	The content of this unit is a general introduction to basic concepts relating with the most common neural networks models used in real life, i.e.: Multilayer Perceptron, Convolutional Networks, Recurrent Networks, Restricted Boltzmann Machines			
Learning objectives	To understand the important details about deep neural networks and get to know of different deep neural network architecture. To identify the potential of deep learning in different applications such as natural language processing, computer vision, or recommendation systems.			
Lessons	1. Multilayer Perceptron (MLP) 2. Convolutional Neural Networks (CNN) 3. Recurrent Neural Networks (RNN) 4. Autoencoders (AE), Restricted Boltzmann Machines (RBM)			
Learning outcomes	Lesson 1 -To know the definition of MLP -To know when to use MLP model -To know definition of different activation functions -To know basic cost functions' definition -To know common gradient descent techniques to minimize cost functions -To know general principles of back propagation algorithm -To know how to tune model fitting -To be able to implement, train, tuning	Lesson 2 -To know basic CNN filters -To know when to use CNN model -To know basic CNN architectures -To know basic concepts about transfer learning, end-to-end learning, multi-task learning -To be able to implement, train, tuning and validate a CNN model using Keras API -To be able to import a pre-trained CNN to solve specific problem	Lesson 3 -To know the definition of RNN -To know what a sequence model is -To know when to use RNN model -To know basic RNN architectures and modules (GRU, LSTM) -To be able to implement, train, tuning and validate a RNN model using Keras API	Lesson 4 -To know the definition of AE -To know the definition of RBM -To be able to implement, train, tuning and validate a AE model using Keras API -To be able to implement, train, tuning and validate a RBM model using Keras API

Learning Unit 4: Deep Learning (Advanced)				
	and validate a MLP model using Keras API			
EQF level	5			
ECVET credits	4.8			
Duration	80 hours			
Recommended background	Learning unit 1,2,3			
Prerequisites (in terms of software)	Knowledge of the basics of Python programming language			
Learning materials	• 23 pages with lecture notes • 4 presentation files with 66 slides in total • 18 Questions and Answers • 2 Case Studies			
Assessment materials	• 2 practical exercises • 18 multiple choice questions			

Learning Unit 5: Communication				
Unit description	Through this course, each participant builds on their communication strengths and learn new and interesting techniques to add to their skillset. This course will empower the participant to become an advanced communicator at workplace. Each participant will learn the elements of communication and be able to flex each one to meet objectives. The information and practice gained through this course will help bridge the gap in participants current verbal skills.			
Learning objectives	• Get familiar with basic communication principles and practices. • Understand the components of effective communication and ways for using Machine Learning in Communications. • Identify different types of application of ML in communication environments (eg. at the workplace).			
Lessons	1. Introduction to communication and ML involvement 2. Types, levels, components of effective communication and ways for using Machine Learning in Communications 3. The future of communication in accordance with artificial intelligence 4. The effects of artificial intelligence in communication			
Learning outcomes	Lesson 1 - Describe fundamental communication principles and practices - Select creative and appropriate modalities and technologies to accomplish communicative goals - To know the importance of communication in the 21st Century - To know the different methods of effective business	Lesson 2 - Differentiate between various approaches of communicating issues - To know the components of communication - Present messages in multiple communication - To understand how machine learning and artificial intelligence can help organizations and communications	Lesson 3 - To understand the positive communication - To understand the role of AI and Machine Learning in communication - To explain the relation between new media and communication	Lesson 4 - Identify contexts, situations and barriers that impede communication self-efficacy - Adapt messages to the diverse needs of individuals, groups and contexts - Differentiate between various approaches of communicating issues

Learning Unit 5: Communication				
	communication in brief - To know about the ML involvement in communication and organizations			
EQF level	5			
ECVET credits	5			
Duration	83 hours			
Recommended background	Learning Unit 1, 2, 3, 4			
Prerequisites (in terms of software)	Online conference tools (Zoom, Teams, Google Meets etc.)			
Learning materials	• 20 pages with lecture notes • 4 presentation files with 47 in total • 9 Questions and Answers • 2 Case Studies			
Assessment materials	• 2 practical exercises • 15 multiple choice questions			

Learning Unit 6: Legislation, Ethics, Project Management related to ML				
Unit description	Introduced the EU ethical and legal regulations for ML applications. Identify the life cycle, and project management requirement for an AI application.			
Learning objectives	- Understand the EU law and regulations for AI and ML applications. - Identify the different type of bias in AI and their consequences. - Know the project management requirement and lifecycle for AI applications.			
Lessons	1. EU guidelines on ethics in artificial intelligence. 2. Bias in Machine learning. 3. Software engineering for AI applications. 4. Project Management			
Learning outcomes	Lesson 1 - Get an overview of the EU ethics for AI and ML applications. - Identify the AI Regulation for AI applications.	Lesson 2 - Get a look about the bias in ML. - Identify the different types of machine learning bias.	Lesson 3 - Understand the project Lifecycle for an AI application. - Get an overview of the software architecture used for an AI application.	Lesson 4 - Get an overview of project management. - Define a data collection project.
EQF level	5			
ECVET credits	5			
Duration	83 hours			
Recommended background	Learning Unit 1			
Prerequisites (in terms of software)	n/a			
Learning materials	• 14 pages • 60 slides • 9 Questions and Answers • 2 Case Studies			
Assessment materials	• 2 practical exercises • 11 multiple choice questions			

7 COURSE DELIVERY PLANS

The curriculum is designed so that to cover horizontally the various aspects (scientific, technical, ethical, communicative) and topics of the machine learning field. This is coherent with course objectives; to give basic operative skills and general knowledge of machine learning theory and practice to workers not academically trained in the field. Consider the fact that if today basic information technology knowledge and skills for workers in the service industry are basically the use of the "office packet" (emailing, text processing, and calculus sheets) in the feature knowledge and basic use of ML algorithms will be probably necessary. The curriculum has been designed for a general audience, so that independently from the individual technical or scientifically entry level, everyone could choose learning units accordingly to personal or company interests or educational needs. The entry level is post-graduation in any course with basic mathematical courses. The duration of the course will last 3-4 months, considering 2 hours per day of learning activities. The targeting EQF level is 5.

7.1 LU1: ML essentials for ICT professionals

Lesson 1: Introduction to ML

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture: 4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "Who knows about ML" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like "What"s the future of ML" or "Is ML the solution for anything?". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analyzing and commenting the use case, each learner in a

	group writing his own ideas and sharing them. Initiate a debate around topics like "What"s the future of ML" or "Is ML the solution for anything?".
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.
Prerequisites	Basic knowledge of ICT and Linear Algebra

Lesson 2: Where to Apply ML

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Remind the group of learners of the definition of Machine Learning and what are the types of it by asking "What are the different types of ML?"
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like "? Do you know what types of problems the ML algorithms can solve?". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analysing and commenting the use case, each learner in a group writing his own ideas and sharing them. Initiate a debate around topics like "Do you know what types of problems the ML algorithms can solve? ".
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.
Prerequisites	Basic knowledge of ICT and Linear Algebra

Lesson 3: Machine learning and Data processing

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "Who knows about data pre-processing" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like "What"? What are the steps for processing the data of an ML project?". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analysing and commenting the use case, each learner in a group writing his own ideas and sharing them. Initiate a debate around topics like " Can you name the steps for processing the data of an ML project?
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.
Prerequisites	Basic knowledge of ICT and Linear Algebra

Lesson 4: Example ML Applications

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "Who can identify an application that uses ML" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to

	ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like What"s applications do you know from your everyday life uses ML? Classroom: Individual task: Create groups of 3 or 4 individuals, each group analyzing and commenting the use case, each learner in a group writing his own ideas and sharing them. Initiate a debate around topics like "What" are the different areas that can apply ML to facilitate its work?
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible, computer classroom for individual exercises.
Prerequisites	Basic knowledge of ICT and Linear Algebra

7.2 LU2: Mathematical foundations

Lesson 1: Set, Functions, Relations

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture: 6h Practice/Individual work: 4h Online : 6h Lecture: 3h Practice/Individual work: 3h
Lesson beginning	Assess the importance of set theory for a general formal approach to ML Checking the degree of classroom formal training and background
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes
Evaluate understanding/assessment	Checking the results of individual assignments provided in the learning materials
Closing activities	None
Resources	Paper, pencil, board.
Prerequisites	No knowledge or experience needed

Lesson 2: Linear Algebra

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture: 6h Practice/Individual work: 4h Online : 6h Lecture: 3h Practice/Individual work: 3h
Lesson beginning	Assess the importance of linear algebra to be operative in ML libraries active use
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes
Evaluate understanding/assessment	Checking the results of individual assignments provided in the learning materials
Closing activities	None

Resources	Paper, pencil, board.
Prerequisites	No knowledge or experience needed

Lesson 3: Probability Theory

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture: 6h Practice/Individual work: 4h Online: 6h Lecture: 3h Practice/Individual work: 3h
Lesson beginning	Assess the importance of probability theory to be aware its funding role of ML theory
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes
Evaluate understanding/assessment	Checking the results of individual assignments provided in the learning materials
Closing activities	None
Resources	Paper, pencil, board.
Prerequisites	No knowledge or experience needed

Lesson 4: Statistics

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture: 6h Practice/Individual work: 4h Online : 6h Lecture: 3h Practice/Individual work: 3h
Lesson beginning	Assess the importance of statistics in data analysis and the importance of linear regression theory as starting point and benchmark for general ML algorithms
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes
Evaluate understanding/assessment	Checking the results of individual assignments provided in the learning materials

Closing activities	None
Resources	Paper, pencil, board.
Prerequisites	No knowledge or experience needed

Lesson 5: Computation theory

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture: 6h Practice/Individual work: 4h Online : 6h Lecture: 3h Practice/Individual work: 3h
Lesson beginning	Introducing informally the python computational framework
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use a real computational framework as Ipython/Jupyter for concepts' exemplification.
Whole group instructions	Yes
Evaluate understanding/assessment	Checking the results of individual assignments provided in the learning materials
Closing activities	Developing together with the teacher some IPython notebooks to solve easy data analysis problem on its own pc
Resources	Paper, pencil, board, computational framework
Prerequisites	No knowledge or experience needed

7.3 LU3: ML Algorithms, Programs and Protocols

Lesson 1: Machine learning by linear models

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "Who knows about regression or classification analysis" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like ""What"s mathematical models do you know can be used to solve an ML problem?". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analysing and commenting the use case, each learner in a group writing his own ideas and sharing them. Initiate a debate around topics like " "How you can apply a linear model to solve one of the ML problems?".
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.
Prerequisites	LU1 and LU2, Basic understanding of Linear Algebra, and probability theory.

Lesson 2: Supervised learning

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "Who knows about Decision Trees" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like "What"s *Supervised Learning*?". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analyzing and commenting the use case, each learner in a group writing his own ideas and sharing them. Initiate a debate around topics like "What"s classification?".
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.
Prerequisites	LU1 and LU2, Basic understanding of Linear Algebra, and probability theory.

Lesson 3: Unsupervised learning

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "Who knows about K-means clustering" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are

	understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like "What"s Uns*upervised Learning*?". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analyzing and commenting the use case, each learner in a group writing his own ideas and sharing them. Initiate a debate around topics like like "What"s clustering?".
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.
Prerequisites	LU1 and LU2, Basic understanding of Linear Algebra, and probability theory.

Lesson 4: Semi supervised learning

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "Who knows about semi- supervised" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like "What"s semi-*Supervised Learning*?". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analyzing and commenting the use case, each learner in a group

	writing his own ideas and sharing them. Initiate a debate around topics like "What"s semi-*Supervised Learning*?".
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.
Prerequisites	LU1 and LU2, Basic understanding of Linear Algebra, and probability theory.

Lesson 5: Programming languages and frameworks for Machine learning algorithms

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "what programming languages do you know for ML" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like " What are the top programming languages used in ML projects?". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analyzing and commenting the use case, each learner in a group writing his own ideas and sharing them. Initiate a debate around topics like can you guess the top 3 programming languages used in ML projects?".
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.
Prerequisites	LU1 and LU2

Lesson 6: Best practices for ML

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "what programming languages do you know for ML" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like ""What's the best way to choose an ML algorithm parameter??". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analyzing and commenting the use case, each learner in a group writing his own ideas and sharing them. Initiate a debate around topics like ""What's the best way to choose an ML algorithm parameter?".
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.
Prerequisites	LU1 and LU2, LU3, L1,2,3,4,5.

7.4 LU4: Deep Learning (Advanced)

Lesson 1: Multilayer Perceptron (MLP)

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture: 6h Practice/Individual work: 4h Online : 6h Lecture: 3h Practice/Individual work: 3h
Lesson beginning	Introduce the single perceptron model by analogy with linear regression and logistic regression, stressing the same underlying input linear structure and different output nonlinear activation
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes
Evaluate understanding/assessment	Checking the results of individual assignments provided in the learning materials – Lab activity
Closing activities	None
Resources	Paper, pencil, board. Computational framework
Prerequisites	LU1, LU2, LU3

Lesson 2: Convolutional Neural Networks (CNN)

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture: 6h Practice/Individual work: 4h Online: 6h Lecture: 3h Practice/Individual work: 3h
Lesson beginning	Introduce the CNN with the problem of input dimensionality reduction
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes
Evaluate	Checking the results of individual assignments provided in the

understanding/assessment	learning materials – Lab activity
Closing activities	None
Resources	Paper, pencil, board. Computational framework
Prerequisites	LU1, LU2, LU3, LU4-lesson1

Lesson 3: Recurrent Neural Networks (RNN)

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture: 6h Practice/Individual work: 4h Online : 6h Lecture: 3h Practice/Individual work: 3h
Lesson beginning	Introduce the RNN with the problem of unknow input and output sequence length and the utility of having units with memory capacities
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes
Evaluate understanding/assessment	Checking the results of individual assignments provided in the learning materials – Lab activity
Closing activities	None
Resources	Paper, pencil, board. Computational framework
Prerequisites	LU1, LU2, LU3, LU4-lesson1

Lesson 4: Autoencoders (AE), Restricted Boltzmann Machines (RBM)

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture: 6h Practice/Individual work: 4h Online: 6h Lecture: 3h Practice/Individual work: 3h
Lesson beginning	Introduce the AE and RBM in the context of self-supervised and unsupervised learning using NN architectures
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.

Whole group instructions	Yes
Evaluate understanding/assessment	Checking the results of individual assignments provided in the learning materials – Lab activity
Closing activities	None
Resources	Paper, pencil, board. Computational framework
Prerequisites	LU1, LU2, LU3, LU4-lesson1

7.5 LU5: Communicating the merits, challenges and implications of ML technology to customers and within own organization

Lesson 1: Introduction to communication and ML involvement

Setting	Online or in classroom
Duration:	Classroom: 21h Lecture: 10h; practice/individual work 11h. Online: 21h Lecture: 8h; practice/individual work 13h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning, …) using "Who knows about…" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood. Online: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment and present on their findings for the class. Open a live online debate about topics like "What"s the future of ML" or "Is ML the solution for anything?". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analyzing and commenting the use case, each learner in a group writing his own ideas and sharing them.

Setting	Online or in classroom
	Initiate a debate around topics like "What"s the future of ML" or "Is ML the solution for anything?".
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises. More online resources and possible topics for discussion: • *The Role of Communication in Society* - https://www.youtube.com/watch?v=y15zc6meS4o • *Role and Importance of Communication* - https://www.youtube.com/watch?v=qNrwhyz-nzs • *Effective Communication: Why is it Important in Management?* - https://www.youtube.com/watch?v=nIQhHEWpdWs • *5 Ways To Develop Effective Business Communication* - https://www.youtube.com/watch?v=yfneUJ4W6Lo • *Characteristics of Effective Communication* - https://www.youtube.com/watch?v=LrjlW00kkws • *EFFECTIVE COMMUNICATION IN THE WORKPLACE* - https://www.youtube.com/watch?v=1-RuWoE_Mmw • *Methods of Communication in Business* - https://www.youtube.com/watch?v=w_oQ5JLSZGE • *The Advantages & Disadvantages of Technology* - https://www.youtube.com/watch?v=5r4NzvO9Cg4 • *What are Interpersonal Skills* - https://www.youtube.com/watch?v=VoUkP63O4Ik

Lesson 2: Types, levels, components of effective communication and ways for using Machine Learning in Communication

Setting	Online or in classroom
Duration:	Classroom: 25h Lecture: 12h; practice/individual work 13h. Online: 25h Lecture: 10h; practice/individual work 15h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning, …) using "Who knows about…" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.

Setting	Online or in classroom
	Use exercises like: **Design a machine learning system sketch to suggest a set of keywords for a long text that synthetizes the text content using a recurrent neural network model.**
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like "What"s the future of ML" or "Is ML the solution for anything?". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analyzing and commenting the use case, each learner in a group writing his own ideas and sharing them. *Study case – chat bot* https://towardsdatascience.com/how-to-create-a-chatbot-with-python-deep-learning-in-less-than-an-hour-56a063bdfc44 Initiate a debate around topics like "What"s the future of ML" or "Is ML the solution for anything?".
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises. • More resources for exercise https://stanford.edu/~shervine/teaching/cs-230/cheatsheet-recurrent-neural-networks • Verbal Vs Non-verbal Communication: Difference between them with examples & comparison chart - https://www.youtube.com/watch?v=akfatVK5h3Y • Process and Levels of Communication - https://www.youtube.com/watch?v=SYINeVtPn-c • Communication Skills For Workplace Success- https://www.youtube.com/watch?v=_ywNxbf4JyM • 10 Barriers to Effective Communication - https://www.youtube.com/watch?v=slq1nAhZuqE • How can Artificial Intelligence be used in businesses? - https://www.youtube.com/watch?v=hLSDcAxmPJg

Setting	Online or in classroom
	• What is Artificial Intelligence| How does it help in communication - https://www.youtube.com/watch?v=Z1eOPpTcyy0 • How Artificial Intelligence is Transforming Business - https://www.youtube.com/watch?v=mz4eyl0mC7A • Top 10 Artificial Intelligence Technologies In 2021 - https://www.youtube.com/watch?v=by-WC6gJ1yM

Lesson 3: The future of communication in accordance with artificial intelligence

Setting	Online or in classroom
Duration:	Classroom: 22h Lecture: 10h; practice/individual work 12h. Online: 22h Lecture: 6h; practice/individual work 16h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning, …) using "Who knows about…" questions.
Engage/motivation	Classroom: Make sure the fundamental elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood. Online: Make sure the fundamental elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes. Use exercises such as: **Using Python: design, implement and validate a machine learning system to classify if a sentence is polite/unpolite/neutral**
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the examples of ML application and comment on their findings. Start a new topic in a forum with open questions like "Is ML the solution for better communication?", "Are there any risks involved?". Classroom: Initiate a debate around topics like "Is ML the solution for better communication?", "Are there any risks involved?"
Closing activities	Summarize the main key elements learned and provide common

Setting	Online or in classroom
	feedback based on learner inputs; focusing on the essentials of MLin communication.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises. https://scikit-learn.org/stable/modules/feature_extraction.html#text-feature-extraction More online resources and possible topics for discussion • Prof Andrea Goldsmith: Can machine learning trump theory in communication system design? https://www.youtube.com/watch?v=7L4PHaYP6O4 • Configuring MIMO Communication Links with Machine Learning https://www.youtube.com/watch?v=98cQb1B2sks • Machine Learning for Wireless [Wireless Future Podcast] https://www.youtube.com/watch?v=Mx-z6KQPJJc • Introduction to New Media https://www.youtube.com/watch?v=XzCTAHM81hc • Artificial intelligence & interpersonal communication (Lecture 6 INTRO COURSE AI in COMMUNICATION) https://www.youtube.com/watch?v=t_fduq7SY7I • Artificial intelligence & the future of communication (Lecture 7 INTRO COURSE AI in COMMUNICATION) https://www.youtube.com/watch?v=3tIW6oO8dl8 • Artificial intelligence and the media (Lecture 4 INTRO COURSE on AI IN COMMUNICATION) https://www.youtube.com/watch?v=fRTaZz_EuzM • How does artificial intelligence influence communication? (Lecture 3 INTRO COURSE AI/COMMUNICATION) https://www.youtube.com/watch?v=ZoFnkcmYtvs • The Role of Deep Learning in Communication Systems - https://www.youtube.com/watch?v=vG2oyXECG-8

Lesson 4: The effects of artificial intelligence in communication

Setting	Online or in classroom
Duration:	Classroom: 15h Lecture: 6h; practice/individual work 9h. Online: 15h Lecture: 4h; practice/individual work 11h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning, …)

Setting	Online or in classroom
	using “Who knows about…” questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood. Online: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Start online debate on topics like “How does ML influence the workplace?” or “Is ML the solution for anything?”. Classroom: Initiate a debate around topics like “How does ML influence the workplace” or “Is ML the solution for anything?”.
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises. More online resources and possible discussion topics: • "Artificial Intelligence and the Future of Work" | Andy Chan | TEDxStLawrenceU https://www.youtube.com/watch?v=bScAMuegX7Y • AI & The Future of Work | Volker Hirsch | TEDxManchester https://www.youtube.com/watch?v=dRw4d2Si8LA • What Are The Negative Impacts Of Artificial Intelligence (AI)? - https://www.youtube.com/watch?v=P6vwNM_ecFk • The future of AI: risks and challenges - https://www.youtube.com/watch?v=peGV0aNaTfg

7.6 LU6: Legislation

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "What EU regulations do you know for AI applications" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like "What"s EU guidelines do you know about ML applications?". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analysing and commenting the use case, each learner in a group writing his own ideas and sharing them.
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.

Lesson 2: Bias in Machine learning

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "What you know about bias in ML" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online:

	Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like "What"s the bias in ML". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analysing and commenting the use case, each learner in a group writing his own ideas and sharing them. Initiate a debate around topics like "What"s the databias".
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.

Lesson 3: Software engineering for AI applications

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "What you know about bias in ML" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like "What"s the ML project lifecycle". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analysing and commenting the use case, each learner in a group writing his own ideas and sharing them. Initiate a debate around topics like "why it is important to have an ML project lifecycle?".
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML

	technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.

Lesson 4: Data Value and Cost Models / Project management

Setting	Online or in classroom
Duration:	Classroom: 10h Lecture:4h; practice/individual work 6h. Online: 10h.
Lesson beginning	Assess the awareness of the group of learners (Machine Learning) using "What do you consider while selecting a data source" / "What is a data pricing" questions.
Engage/motivation	Classroom: Make sure the fundamental technical elements are understood, use practical examples and ask open questions to ensure the basics and the vocabulary are understood.
Whole group instructions	Yes.
Evaluate understanding/assessment	Online: Individual task: Encourage learners to read the use cases and to comment on their findings. Start a new topic in a forum with open questions like "What kind of data source do you know, what are the associated costs / constraints". Classroom: Individual task: Create groups of 3 or 4 individuals, each group analysing and commenting the use case, each learner in a group writing his own ideas and sharing them.
Closing activities	Summarize the main key elements learned and provide common feedback based on learner inputs; focusing on the essentials of ML technology.
Resources	Paper, pencil, board. If possible computer classroom for individual exercises.
Prerequisites	LU6 lesson 1

8 CONCLUSIONS

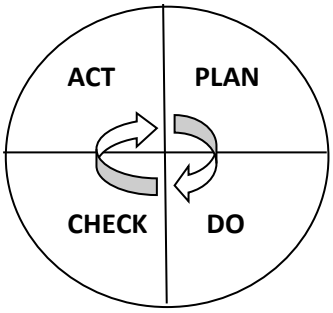
All activities described in the present document can be analyzed by the processes within an organization that carries out its activity in the field of training and evaluation of competences

Organization who functions as a training provider and at the same time performs the certification of acquired skills, it can implement the requirements of two standards: ISO 9001:2015 "Quality management systems — Requirements" and ISO/IEC 17024:2012: Conformity assessment — General requirements for bodies operating certification of persons.

Both standards have a process approach and can be applied by in a training provider and a certification center body.

In according with both standards, the quality management system for training and competency assessment providers is based on the PDCA cycle, which is a dynamic approach that can be carried out in each of the organization's processes as well as in the entire organization. Through the PDCA cycle, planning, implementation, control and continuous improvement of both the training and evaluation process are pursued. Continuous maintenance and improvement of process capability can be achieved by applying the PDCA concept at all levels of the organization.

Within a competence training and assessment organization, the process approach is structured as follows:



In the training process and in the certification of competentes proces the PDCA cycle has the following approach:

- "PLAN" -establishes the objectives and processes necessary to obtain results in accordance with the requirements of the beneficiaries of the training and competence assessment processes as well as with those of the organization

- "DO" -implements the processes of training and evaluation of competences;
- "CHECK"- monitors and measures the training processes and objectives as well as competence evaluation, analyzing the results obtained;
- "ACT"- applies actions for the continuous improvement of the performance of both the training and competence evaluation processes

Any process of training and evaluation of competences must be permanently improved in order to be efficient.