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# ARIS

## O4-T3: Position paper to support the integration of AI skills requirements into the European e-Competence Framework

LIKS



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ARIS PROJECT

AI SKILLS FOR ICT PROFESSIONALS

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## Abbreviations and Acronyms

Definitions	
<b>AI</b>	Artificial Intelligence
<b>e-CF</b>	European e-Competence Framework
<b>EQF</b>	European Qualification Framework
<b>EU</b>	European Union
<b>ICT</b>	Information Computer Technology
<b>OER</b>	Open Educational Resource
<b>VET</b>	Vocational Education & Training
<b>VOOC</b>	Vocational Open Online Course

ARIS Consortium	
<b>BT</b>	BUSINESS TRAINING SA
<b>CNR-ISTC</b>	CONSIGLIO NAZIONALE DELLE RICERCHE
<b>EXELIA</b>	EXELIA E.E.
<b>LIKS</b>	LIETUVOS KOMPIUTERININKU SAJUNGA
<b>UPC</b>	UNIVERSITAT POLITÈCNICA DE CATALUNYA

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## 1 Introduction

Artificial Intelligence (AI) revolutionizes the economy and society by automating tasks and business processes; managing workflows and critical data more effectively. The fast-paced development of AI technologies in diverse economic and social realities exponentially increases the demand for ICT professionals with the right combination of AI and transversal skills. The global artificial intelligence market was valued at USD 62.35 billion in 2020 and is expected to expand at a compound annual growth rate (CAGR) of 40.2% from 2021 to 2028. Software solutions led the artificial intelligence market and accounted for more than 38.0% of the global revenue in 2020 [1]. LinkedIn's annual 2020 Emerging Jobs Report [2] showed that the top 3 emerging jobs are **Artificial Intelligence Specialist**, **Robotics Engineer**, and **Data Scientist**. Hiring growth for AI specialists has grown 74% in the past 4 years. Machine learning Engineer job openings grew 344% between 2015 to 2018 [3].

Massive and stable growth in demand for AI specialists forces employers to struggle to find suitable candidates from the existing workforce. Further to demand, the gap is amplified by the shortage and inadequacy of relevant skills expected via VET provision. AI is currently a subject of ICT specialization mostly offered at the highest level of tertiary education. The upgrading of initial and continuous VET provision in the field is essential so that existing and future ICT professionals can acquire and develop the AI skills and competencies required to respond to modern workplace requirements and succeed in a competitive labor market.

ARIS is an Erasmus+ KA2 project that aims to strengthen the key digital competencies in VET provision for ICT professionals by offering an up-to-date curriculum and Open Educational Resources (OERs) in AI to address the existing occupational skills needs and mismatches.

The main ARIS project activities have been:

- Analysis of current and future skills and knowledge needs leading to the development of learning outcomes.
- Development of the structure of a curriculum on AI technologies and practical applications.
- Creation of corresponding pedagogical materials to be offered as Open Education Resources.
- Development, testing, and delivery of Vocational Open Online Course (VOOC) infrastructures on AI applications, promoting the uptake of innovative and flexible practices in VET.

- Involvement of key policy-makers and stakeholders for the recognition of ARIS learning outcomes as well for supporting the integration of AI skills into occupational standards.

## 1.1 ARIS objectives

ARIS objectives are as follows:

1. 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.
2. 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 & methods to integrate into their training offerings.
3. To facilitate the integration of AI skills requirements into the EU certification and standardization schemes.

## 1.2 ARIS target groups

ARIS addresses the following targets:

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

## 1.3 ARIS results

The ARIS partners within the Erasmus+ program aims to improve the skills and competencies of ICT professionals:

1. Based on an investigation of the current gap between the requests of companies and the current training of IT professionals in the AI domain, the essential IT professionals' skills were

identified.

2. To overcome existing professional mismatches and to meet the labor market's demands the educational resources and materials were developed.
3. A course “Artificial Intelligence skills for ICT professionals” has been developed on Artificial Intelligence skills needs that will support the large-scale open access and participation in training activities for ICT professionals. The [ARIS VOOC](#) is an online course designed to help ICT professionals to learn the theoretical concepts of AI technology and its practical applications. It is organized into four learning units:
  1. Foundations of Artificial Intelligence
  2. Machine Learning
  3. Neural Networks and Deep Learning
  4. Deep Learning for Natural Language Processing and Big Data Analysis

## 1.4 Aim of this paper

This paper aims to foster the integration of AI skills requirements into the European e-Competence Framework (e-CF) and addresses bodies and stakeholders active in the ICT sector that participate in policy-making or consult the policy-makers. The e-CF is the European standard for ICT professionals (officially recognized by the EU), outlining the sum of knowledge, skills, and competencies required at the ICT-related workplace.

Its objectives are to:

- Promote the collaboration between VET centers and ICT companies and influence policy-making towards initiatives that aim to increase VET provision's supply, quality, and attractiveness by better aligning training content with actual workplace requirements.
- Impact on policy-making for education and training.
- Promote the incorporation of AI skills requirements into occupational standards for ICT professionals.
- Influence decision-making towards enhancing practical components in VET provision, empowering cooperation between VET providers and employers, and promoting the establishment of skill development policies and strategies.

## 2 ARIS research results and implications

The growing penetration of AI technology across the major sectors of the EU economy is increasing the need of up-skilling ICT professionals so that they are able to understand and work on AI applications. Therefore, the first intellectual output of the ARIS project comprises tasks that work towards defining the specifications (i.e., learning outcomes) for the ARIS course curriculum.

### 2.1 Data analysis of the online questionnaire

An online questionnaire was addressed to ICT employers, experienced ICT professionals and academics to determine the most valued and needed digital skills for ICT professionals as regards AI technology. The questionnaire was open online for a month and a half, between 01/10/2019 and 31/12/2019.

Here is an indicative, not exhaustive, list of survey respondents the consortium tried to target the following:

- Executives from ICT companies (e.g. Coin Market Cap, Smith + Crown, e-Estonia)
- VET providers, career-related stakeholders and other educational and training entities
- Trainers on ICT and business related issues
- Social partners and sector representatives (e.g. professional associations)
- Representatives from VET national and EU authorities
- ICT professionals employed in companies building and offering AI-related products and services
- ICT freelancers (e.g. programmers, architects), entrepreneurs
- Academics, researchers and consultants

According to 187 the questionnaire [4] respondents, the five most needed field knowledge for working on artificial intelligence and related services are, in decreasing order (Figure 1):

- *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 %)

With less than 10% of the answers we find *Foundations of Cognitive Science* (9.08 %), *Project Management Principles* (5.90 %) and *Elements of Social Cognition (Norms, Reputation, Emotions, Socio-Cognitive architecture)* (3.78 %). Finally, with the least number of answers, we find *AI applications in Banking, Finance and Public Services* (3.33 %).

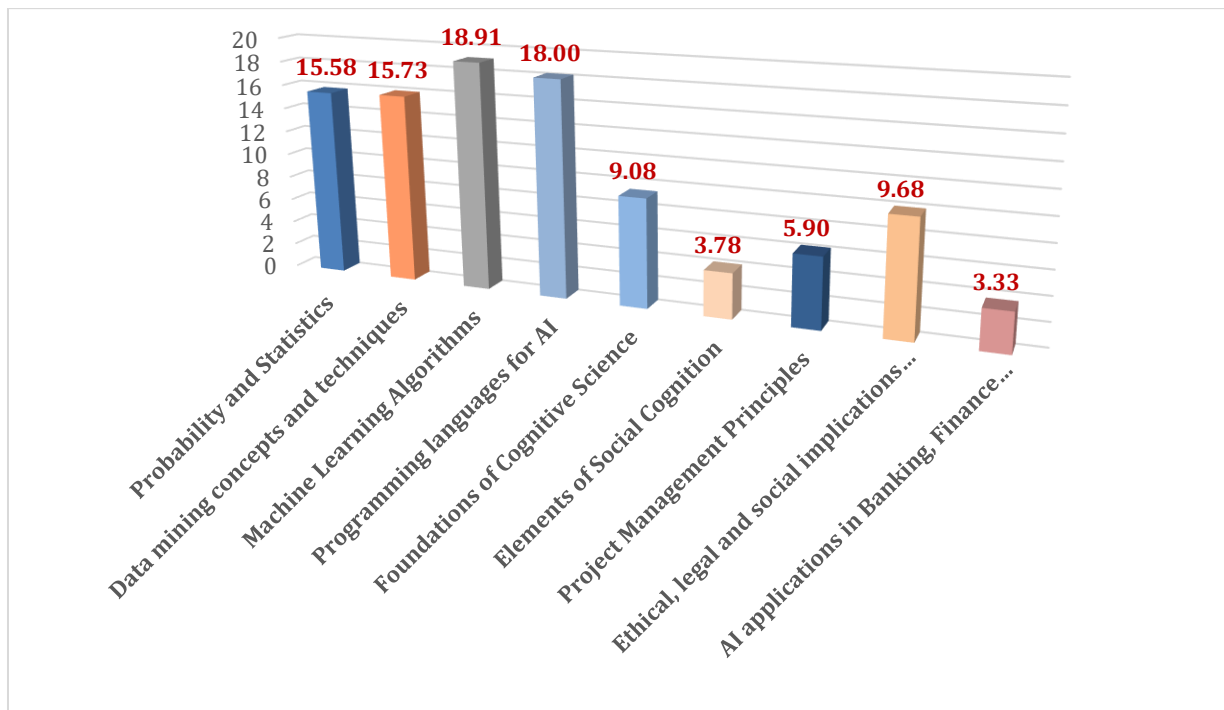


Figure 1. Most needed field knowledge for working on AI applications and related services (%).

Regarding the four most essential skills to work as AI professional, the respondents valued the most, 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 %)

With less than 10% of the answers we find *Develop proof of concepts for envisioned AI applications* (9.89 %), *Develop tailor made AI solutions for businesses* (9.27 %), *Assess implications and possibilities of AI application in a business context* (8.50 %), *Communicate the merits of AI technologies to potential customers* (6.49 %) and *Lead organisational changes to support the integration of AI in a business*

context (5.56 %) (see Figure 2). Finally, with the least number of answers, we find *Communicate insights from data to business stakeholders* (5.41 %).

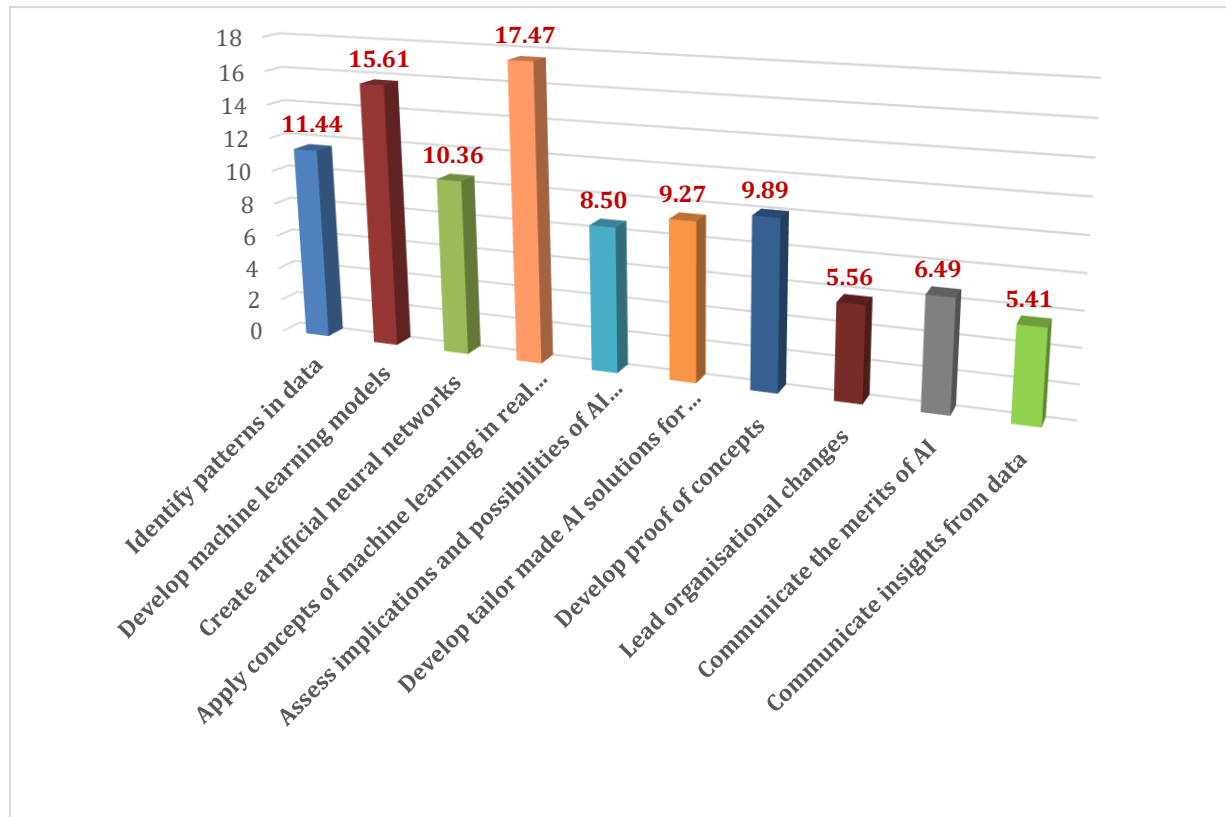


Figure 2. Most important skills to work as AI professional

Analysis of evidence has shown that curricula offered at specialized master's degrees are usually restricted in access, resulting in a few educated individuals. On the other hand, most existing AI training programs are paid, so it is expensive to follow entire learning paths. In addition, the offer in terms of training dealing with AI and related subjects is not that varied.

This research has also shown that tech firms in EU that are focusing on AI are struggling to find suitable candidates from the current workforce. Further to demand, the gap is amplified by the shortage and inadequacy of relevant skills expected via VET provision.

The upgrading of initial and continuous VET provision in the field is therefore essential so that existing and future ICT professionals can acquire and develop the AI skills and competences required to respond to modern workplace requirements and succeed in a competitive employment market.

## 2.2 Definition of ARIS learning outcomes

The definition of the ARIS learning outcomes is based on the European Qualification Framework (EQF)

[5], as the latter acts as a translation device to make national qualifications more readable and comparable across Europe, aiming to promote workers' and learners' mobility between countries and facilitate their lifelong learning. According to the 2017 CEDEFOP handbook [6], learning outcomes are “statements of what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and competences”. And finally, the The European e-Competence Framework (e-CF) [7] is used as guidance in the formulation of the ARIS learning outcomes [4].

The ARIS project aims to strengthen the key competences of ICT professionals (namely initiative, entrepreneurship and communication skills), rather than focus on the technical and coding skills associated with AI technology, which risk being outdated by the time the project will make available its results to its target groups. The content of AI curricula is based on the training needs analysis and organized in learning units as follows [4]:

1. **Learning unit 1:** Foundations of Artificial Intelligence.
  - a. Scope of AI
  - b. Problem Solving
  - c. Knowledge Representation
  - d. Machine Learning
  - e. Applications
  - f. Ethical Implications
2. **Learning unit 2:** Machine Learning (ML).
  - a. Introduction to ML
  - b. Languages and Resources
  - c. Data Transformation and Visualization
  - d. Supervised Linear ML
  - e. Supervised Non-Linear ML
  - f. Unsupervised ML
3. **Learning unit 3:** Neural Networks and Deep Learning.
  - a. Brain origin and element of neural networks.
  - b. Simple perceptrons and supervised learning.
  - c. Multilayer perceptrons and Keras.
  - d. Deep learning for image classification: Convolutional neural networks.
  - e. Different CNNs for image classification.



- f. Real-time object localization with YOLO models.
- 4. **Learning unit 4:** AI for solving real-life problems or Deep Learning for Natural Language Processing and Big Data Analysis.
  - a. Word Embeddings and Text Classification
  - b. Neural networks for NLP and libraries
  - c. New approaches, applications, open problems
  - d. Big data: problems, core techniques, and introduction to Hadoop
  - e. Big data: Hadoop and Spark for data processing
  - f. Big data: main analytics, visualization, and applications

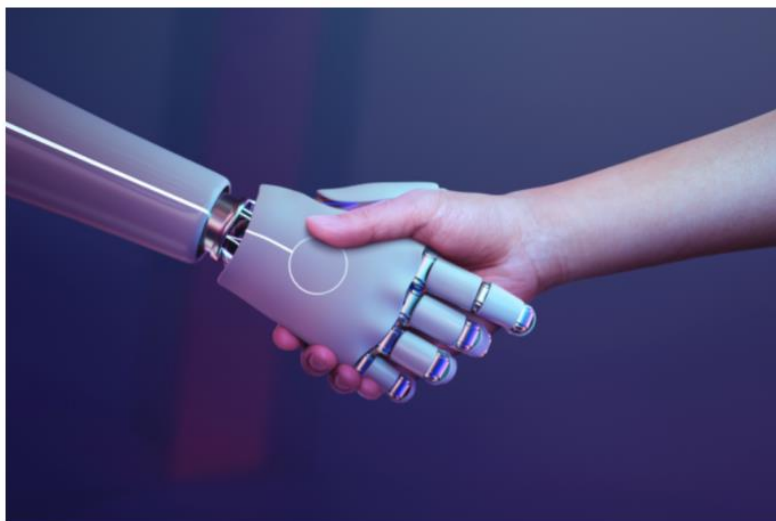



Figure 3 Learning units on OpenLearning.com platform


### 3 The ARIS OERs and VOOC


ARIS consortium has developed Open Educational Resources that have been used to produce a VOOC (Vocational Open Online Course) (see Figure 3). It has been tested during the pilot run at the project time. The VOOC is freely available in English and could be accessed following the link <https://www.openlearning.com/courses/artificial-intelligence-ai-skills-for-ict-professionals>


## Artificial Intelligence (AI) skills for ICT professionals




 **Credential type**  
Certificate of completion

 **Start date**  
Start any time

 **Duration**  
Flexible

 **Cost**  
Free

 **Community**  
186 Learners

**JOIN NOW**

Figure 4. ARIS VOOC landing page on OpenLearning.com platform

The course can be followed by individual users but is designed in particular to be used by teachers with their students. The course duration is about 160 hours and each learning unit consist of (e. g. Figure 5):

- Introduction of the learning unit.
- 6 lectures (presentation slides and lecture notes).
- Use cases.
- Practical exercises.
- Question and answers section
- A questionnaire with automatic correction.



▼ L1.1: Scope of Artificial Intelligence

Completed: 5 of 5



THEORETICAL CONTENT



QUESTIONS AND ANSWERS

📍 Last visited page



USE CASES



PRACTICAL EXERCISES



QUESTIONNAIRE

QUESTIONS AND ANSWERS (Q&A)

This section provides a series of theory questions and answers to help learners develop a deeper conceptual understanding of the different aspects discussed in the first lesson, before proceeding to use cases, practical exercises, and assessment.



1. What are the goals of Artificial Intelligence?

The goal of Artificial Intelligence is to develop programs able to solve complex tasks that we consider that need intelligence to be solved including tasks that need cognitive abilities or perception.

L1: Foundations of Artificial Intelligence > L1.2: Problem Solving with Search Algorithms  
QUESTIONNAIRE

MULTIPLE CHOICE QUESTIONNAIRE

Please select the correct answers. Be careful, you can submit your answers to the questionnaire only twice. After you use all of your allowed submissions, you can't change your answers and complete the questionnaire again.



1. In order to solve a problem we have to define it in terms of the following characteristics:

- ☐ A goal, a set of actions, a set of constraints for the solution
- ☐ A starting point, a goal an exploration graph and a search strategy
- ☒ A starting point, a goal, a set of actions, constraints about the solution and relevant information about the domain of the problem

Figure 5. An example of the learning unit lecture content, questions and answers section, and questionnaire



## 4 European e-Competence Framework (e-CF) and Artificial Intelligence (AI)

### 4.1 The European e-Competence framework

The European Norm (EN) 16234-1 European e-Competence Framework (e-CF) [8] provides a reference of 41 competences as applied at the Information and Communication Technology (ICT) workplace, using a common language for competences, skills, knowledge and proficiency levels that can be understood across Europe. The e-CF is the result of more 10 years of continuous effort and commitment by the European ICT sector. As the first sector-specific and workplace-oriented implementation of the European Qualifications Framework (EQF), the e-CF supports the definition of jobs, training courses, qualifications, career paths, formal and non-formal learning paths, certifications etc. In this way, ICT service in public and private organizations, ICT professionals, managers and HR departments, vocational education, higher education and other training, assessment and accreditation bodies, social partners, professional associations, market analysts, and policymakers have access to a shared reference [9]. The e-CF is organized in four dimensions [8]:

<b>Dimension 1</b> (5 e-Competence areas)	Derived from the IT macro processes PLAN –BUILD –RUN – ENABLE – MANAGE. They provide the entry point to the e-Competences and reflect a process perspective based upon the waterfall approach. However, the e-CF is equally relevant to the steps applied in agile process structures such as Agile/ DevOps lifecycles.
<b>Dimension 2</b> (41 e-Competences)	41 e-Competences in total provide the European standard references of IT Professional competence as required and performed in IT work context. Each dimension 2 description contains a competence title and a generic competence description, defined from an organisational perspective.
<b>Dimension 3</b> (5 e-CF proficiency levels)	5 e-Competence proficiency levels characterised by increasing levels of context complexity, autonomy, influence and typical behaviour. To each e-Competence, specifically relevant proficiency levels are assigned. The dimension 3 level descriptors provide the individual perspective of competence performance.
<b>Dimension 4</b> (knowledge and skills examples)	Examples of knowledge and skills relate to the e-Competences generic descriptions in Dimension 2. These examples are provided to add value to the competence descriptor and are not intended to be exhaustive. They offer inspiration and orientation for the identification of further specific knowledge and skills assignment according to contextual needs.

The European e-Competence Framework has proven in practice to be a successful ICT workforce planning and development tool. Many companies and associations, including National Public Authorities in Europe and abroad currently use the e-CF.

Consequently, the e-CF is a primary reference used in the European ICT Professional Role Profiles description.

An example of e-Competences for a data scientist are presented in Figure 6.

DATA SCIENTIST			Create PDF				
Dimension 1	Dimension 2	Dimension 3					
		e-1	e-2	e-3	e-4	e-5	
Plan	A.7. Technology Trend Monitoring						
	A.9. Innovating						
Enable	D.10. Information and Knowledge Management						
	D.11. Needs Identification						
Manage	E.1. Forecast Development						

Figure 6 E-competences for Data Scientist according European e-CF 3.0 [10]

## 4.2 e-CF and AI

Artificial intelligence could be applied in many domains and the growing penetration of AI technology across the major sectors of the EU economy is increasing the need of up-skilling ICT professionals so that they are able to understand and work on AI applications. In Figure 7, we have highlighted the principal e-Competence that should require knowledge and skills related to Artificial Intelligence.

Dimension 1	Dimension 2	Dimension 3					Dimension 1	Dimension 2	Dimension 3				
		e-1	e-2	e-3	e-4	e-5			e-1	e-2	e-3	e-4	e-5
Plan	A.1. IS and Business Strategy Alignment						Enable	D.1. Information Security Strategy Development					
	A.2. Service Level Management							D.2. ICT Quality Strategy Development					
	A.3. Business Plan Development							D.3. Education and Training Provision					
	⇒ A.4. Product / Service Planning							D.4. Purchasing					
	A.5. Architecture Design							D.5. Sales Development					
	A.6. Application Design							D.6. Digital Marketing					
	⇒ A.7. Technology Trend Monitoring							⇒ D.7. Data Science and Analytics					
	A.8. Sustainability Management							D.8. Contract Management					
	⇒ A.9. Innovating							D.9. Personnel Development					
	A.10. User Experience							D.10. Information and Knowledge Management					
Build	⇒ B.1. Application Development						Manage	⇒ D.11. Needs Identification					
	⇒ B.2. Component Integration							E.1. Forecast Development					
	⇒ B.3. Testing							E.2. Project and Portfolio Management					
	⇒ B.4. Solution Deployment							⇒ E.3. Risk Management					
	⇒ B.5. Documentation Production							E.4. Relationship Management					
	⇒ B.6. ICT Systems Engineering							E.5. Process Improvement					
Run	C.1. User Support							E.6. ICT Quality Management					
	⇒ C.2. Change Support							E.7. Business Change Management					
	C.3. Service Delivery							E.8. Information Security Management					
	⇒ C.4. Problem Management							E.9. Information Systems Governance					
	C.5. Systems Management												

Figure 7 e-Competences that requires knowledge and skills related to AI



### 4.3 European ICT professionals' role profiles

The e-CF, from version 1.0 onwards, has been developed within CEN. In the same context it was also developed the European ICT Professional Role Profile (now version 2 - 2016) [9]. The prime objective of the presented 30 European ICT Professional Profiles is to increase transparency and to continue the convergence of the European ICT Skills landscape, as initiated in the origins of the European e-Competence Framework (e-CF).

As a response to the vast number of ICT Profiles Frameworks and Profiles descriptions used today in European ICT Business and Qualification practice, it was decided to create a reasonable number of representative ICT Profiles which cover the whole ICT Business process reflected by e-CF Dimension 1 and which can be used for reference or further development by stakeholders Europe-wide. Structured in seven main ICT Profile families (process improvement, business, technical, design, development, service&operation, and support), the philosophy behind these reference Profiles is to reflect the top of a European ICT Profiles family tree ( Figure 8).

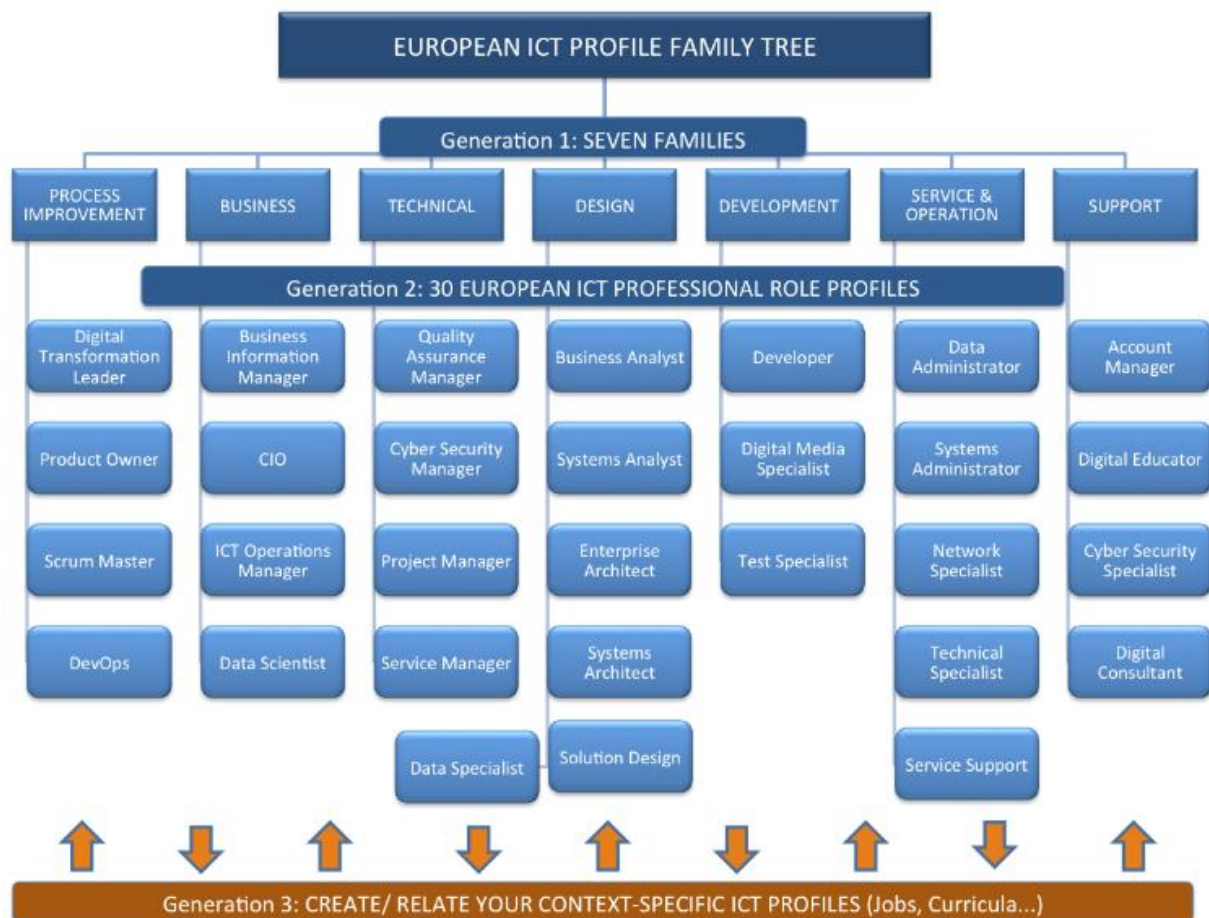


Figure 8 30 European ICT Professional Role Profiles (generation 2) in seven families (generation 1) at the top of the European ICT Profile Family Tree [9]



## 4.4 AI and the ICT professionals' role profiles

One of the 30 ICT profiles (second generation) is "Developer". This is certainly a profile that must be articulated in the third generation. Regardless of what they develop, they have some common competencies and require different knowledge and skills based on the particular technology they develop for. In this articulation many companies should define a profile of an Artificial intelligence specialist. But many other profiles could be affected by Artificial Intelligence. Figure 9 shows the principal ones.

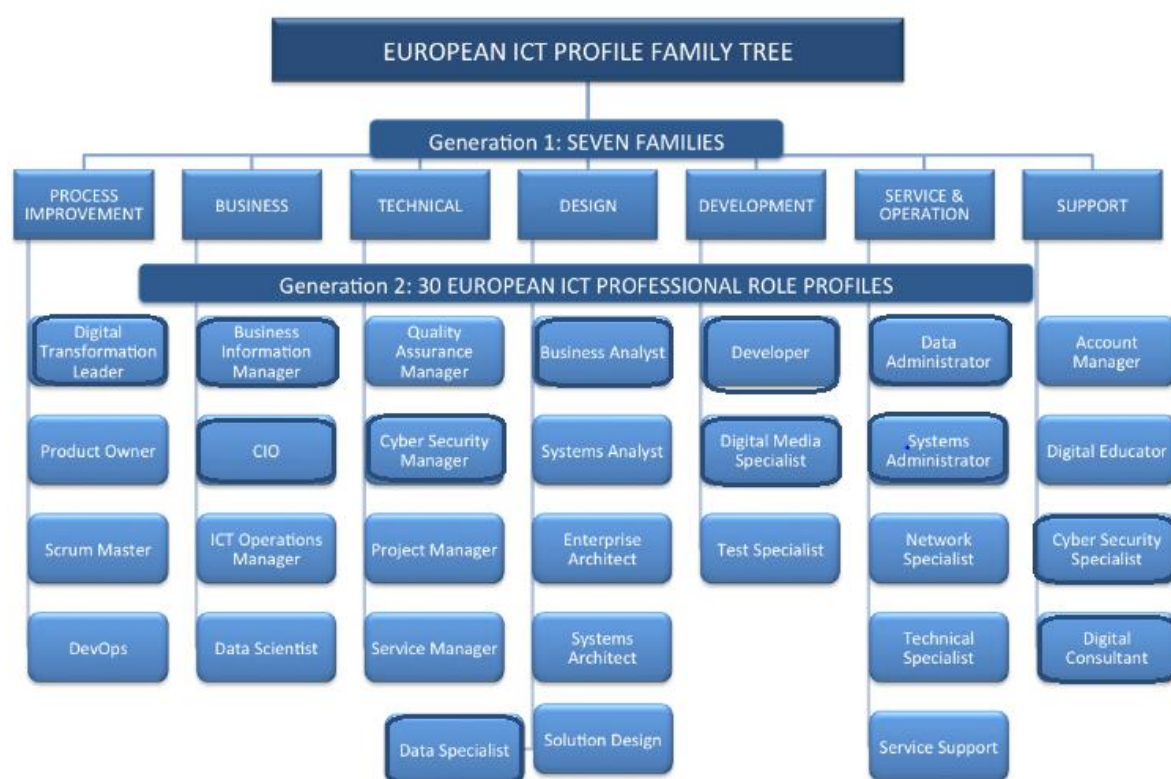


Figure 9 Role profiles affected by Artificial Intelligence

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