Professional and 21st Century Skills for Data Driven Digital Economy

Yuri Demchenko
EDISON Community Initiative
University of Amsterdam

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Outline

- Background: Data driven research, data driven industry and demand for new skills
  - European Programs and initiatives
  - Agile data driven companies
- EDISON Data Science Framework (EDSF)
  - Data Science competences and skills
  - Essential Data Scientist Professional Skills: Thinking and doing like Data Scientist
- 21st Century Skills and demand for new skills for Industry 4.0
- Discussion: Managers – Experts - Generalists
- References and additional materials

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Share – Define the problem – Discuss: Solicit contribution

European Programs and initiatives

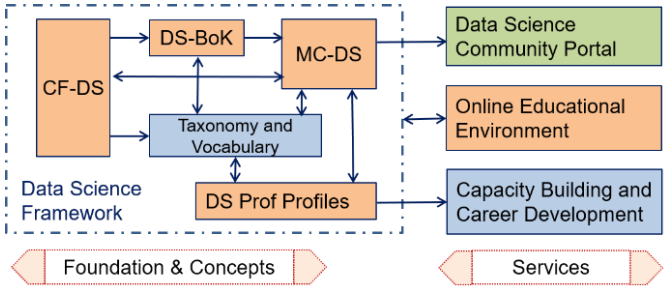
- 2023 European Year of Skills is announced in “2022 State of the Union Address by President von der Leyen”
  - “goal 80% of worker have sufficient digital skills” (less 65% now), and “there should be 20 million employed ICT specialists in the EU”
- Previous initiatives
  - European Skills Agenda (since 2020) and Pact for Skills (started in 2021)
  - Erasmus+ sectoral Skill Agendas: Maritime, Offshore Energy, Textiles, Tourism, others
- European e-Competence Framework (e-CF) developed and maintained by the IT Professionalism Europe (ITPE)
  - Currently European standards CEN EN 16234-1: 2019 and CEN EN 17748-2:2022
- European Skills, Competences, Qualifications and Occupations (ESCO) classification and framework
- European Qualifications Framework (EQF)
  - 8 EQF levels defined in terms of (i) Knowledge; (ii) Skills cognitive; (iii) Responsibility and Autonomy

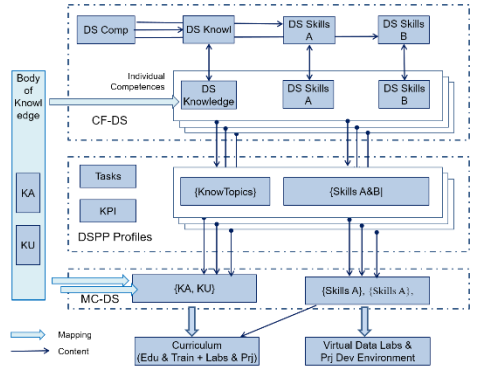
Agile Data Driven Companies and Data Skills

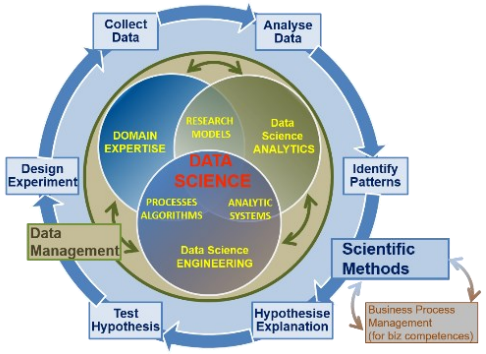
1. **Data-driven leadership:**
   - Leaders define the culture of their organization. A data-driven leader supports a culture of data by demonstrating data-driven decision making and involving the team members. A data-driven leader sees data as a strategic asset and makes "think and act data" a key strategic priority.
   - Being data-driven requires a bit of a researcher's mindset and understanding of how data can be used for the business.
2. **Data-driven decision-making processes:**
   - Establish a structured process of forward-looking decision making and backward-looking reviews of decisions.
   - Build experience in aligning data analytics, insight and data-driven decision-making processes.
3. **Data management maturity:**
   - Formalisation and automation of data management workloads, including data quality assurance. A core criterion for a data-driven organization is how much data analytics tools are automated and integrated into the organisational decision making process.
4. **Data literacy:**
   - An organization's ability to succeed in the digital era is heavily dependent on its employees' data literacy: the ability to read, work, analyze, and argue with data. Data literacy is an important bridge from the abstract Data Science domain to the domain decision makers.
5. **A data-driven culture adoption:**
   - Becoming data-driven involves more than technology and tools. It also requires a shift in the enterprise mindset and culture.
   - Data driven culture becomes a reality when for example, the company’s business analysts start understanding the benefits of blending their traditional business data with other data sources such as social media and environment data.

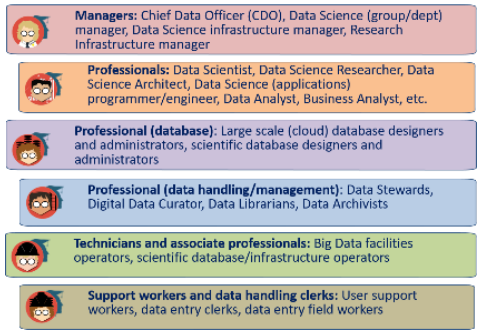
EDISON Products for Data Science Skills Management and Curriculum Design

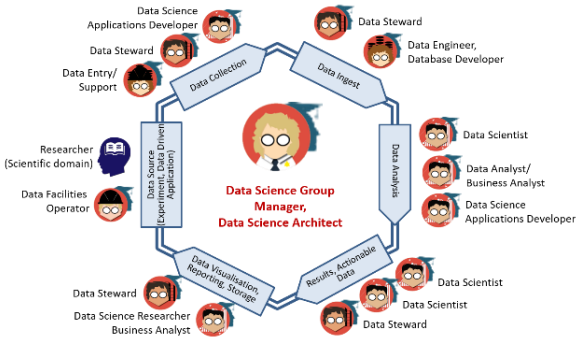
- EDISON Data Science Framework (EDSF)
  - Release 4 (2022) components CF-DS, DS-BoK, MC-DS, DSPP, and EDSF-UCA (Use Cases and Applications)
  - Compliant with EU stds on competences and professional occupations e-CFv3.0, ESCO
- Skills development and career management for core Data Experts and related data handling professions
- Academic programmes and professional training courses (self) assessment and design
- Individual competences benchmarking and Data Science team design
- Cooperation with International professional organisations IEEE, ACM, BHEF, APEC (AP Economic Cooperation)

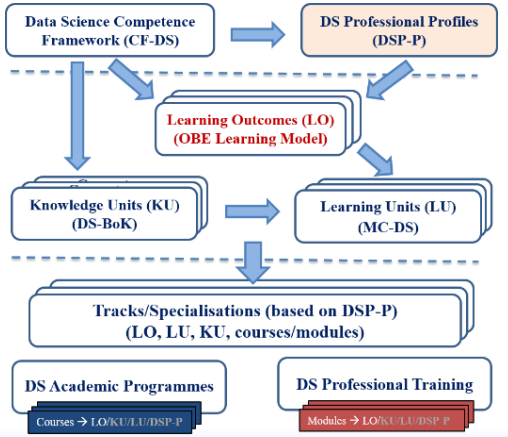




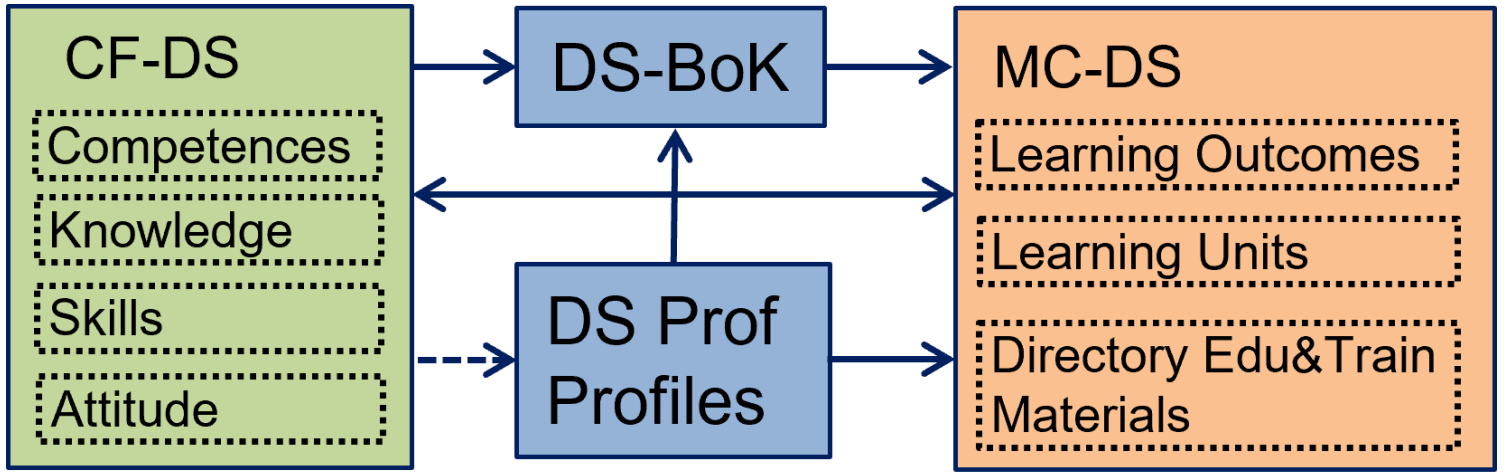






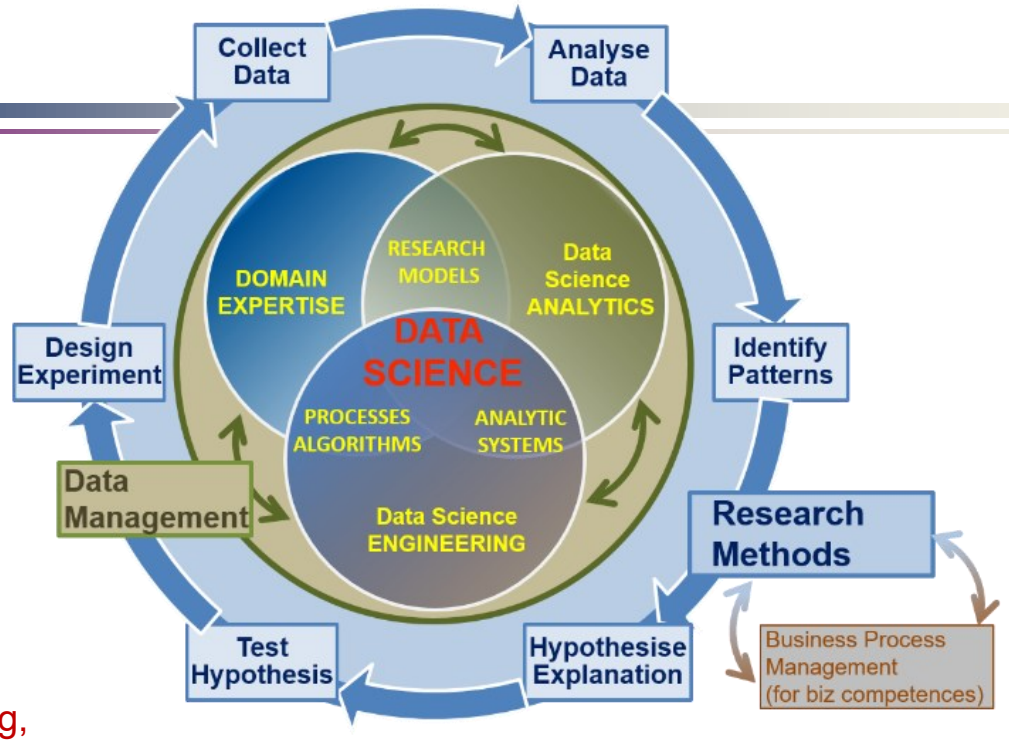


EDISON Data Science Framework (EDSF release 4) – Core components and community maintained services



- **CF-DS** – Data Science Competence Framework (Part 1) –
  - Competences, Knowledge, Skills, Attitude
- **DS-BoK** – Data Science Body of Knowledge (Part 2)
  - Knowledge Area Groups (KAG), Knowledge Areas (KA), Knowledge Unites (KU) - Enumerated
- **MC-DS** – Data Science Model Curriculum (Part 3)
  - Learning Outcomes (LO), Learning Units (LU), Directory of Education and Training materials, Customised Semantic Curriculum Design
- **DSPP** – Data Science Professional profiles (Part 4)
  - Managers, Professionals, Professional (Databases), Professionals (Data Handling and Management), Technicians and associated professionals, Support workers – Based on ESCO
- **EDSF-UCA** – EDSF Use Cases and Applications

Data Scientist definition



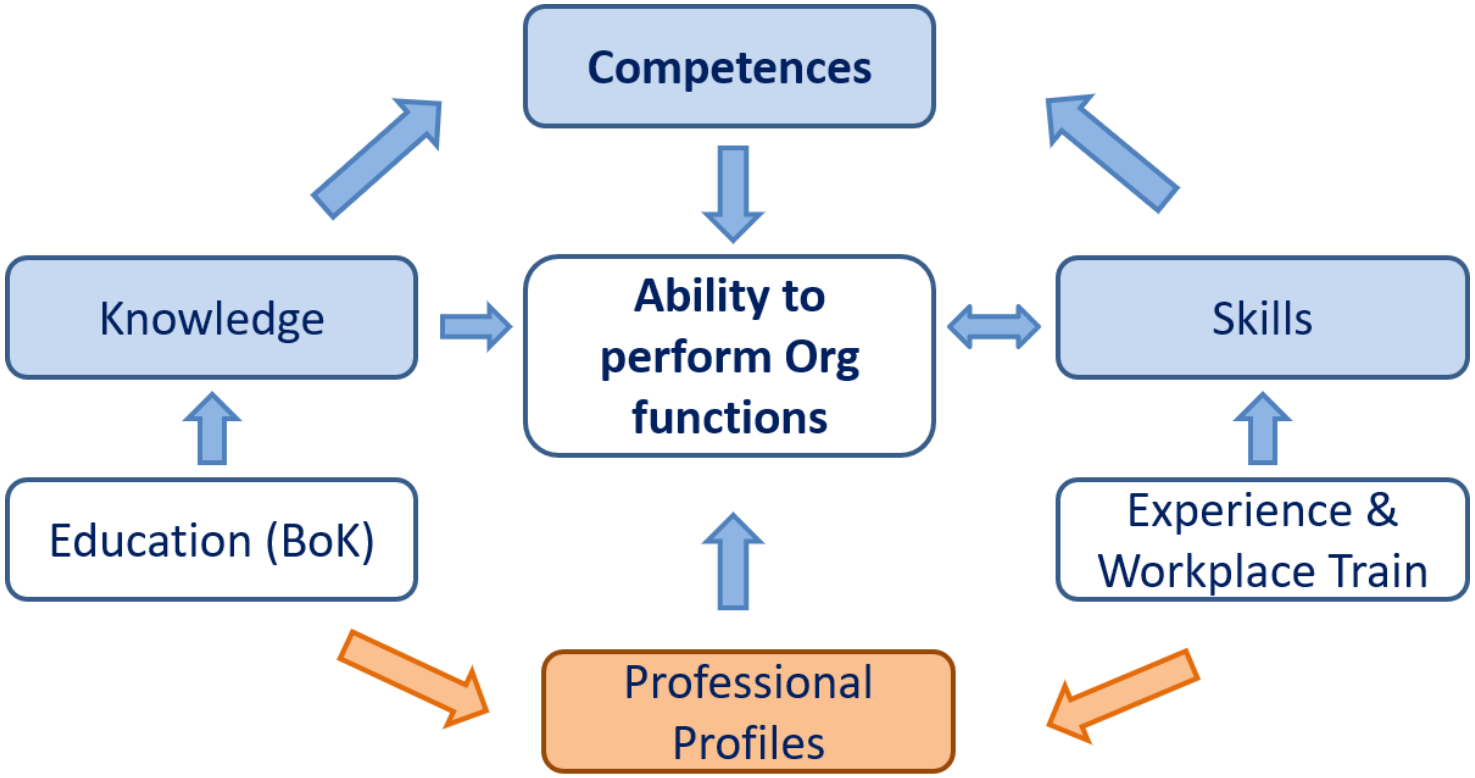
Based on the definitions by NIST SP1500 – 2015, extended by EDISON (2017)

- *A **Data Scientist** is a practitioner who has sufficient knowledge in the overlapping regimes of expertise in **business needs, domain knowledge, analytical skills, and programming and systems engineering expertise** to manage the end-to-end scientific method process through each stage in the **big data lifecycle** till the delivery of an **expected scientific and business value** to organisation or project.*

  - Core Data Science competences and skills groups
    - **Data Science Analytics** (including Statistical Analysis, Machine Learning, Business Analytics)
    - **Data Science Engineering** (including Software and Applications Engineering, Data Warehousing, Big Data Infrastructure and Tools)
    - **Domain Knowledge and Expertise** (Subject/Scientific domain related)
  - EDISON identified 2 additional competence groups demanded by organisations
    - **Data Management, Data Governance, Stewardship, Curation, Preservation**
    - **Research Methods and/vs Business Processes/Operations**
  - **Data Science professional skills**: Thinking and acting like Data Scientist – required to successfully develop as a Data Scientist and work in Data Science teams

Competences Map to Knowledge and Skills

- **Competence** is a demonstrated ability to apply knowledge, skills and attitudes for achieving observable results



Identified Data Science *Skills/Experience* Groups

Skills Type A – Based on knowledge acquired

- **Group 1: Skills/experience related to competences**
  - Data Analytics and Machine Learning
  - Data Management/Curation (including both general data management and scientific data management)
  - Data Science Engineering (hardware and software) skills
  - **Research Methods or Business Process Management**
  - Application/subject domain related (research or business)
- **Group 2: Mathematics and statistics**
  - Mathematics and Statistics and others

Skills Type B – Base on practical or workplace experience

- **Group 3: Big Data (Data Science) platforms and tools**
  - Big Data Analytics Technologies and ***Cloud based platforms and tools***
  - Data Management and Curation platform
  - Databases (SQL and NoSQL)
  - Mathematics & Statistics applications & tools
- **Group 4: Data analytics programming languages and IDE**
  - General and specialized development platforms for data analysis and statistics
- **Group 5: Soft skills and Workplace skills**
  - Data Science professional skills: Thinking and Acting like Data Scientist
  - 21st Century Skills: Personal, inter-personal communication, team work, professional network

Data Science Professional Skills: Thinking and Acting like Data Scientist

DSPS01: Recognise value of data, work with raw data, exercise good data intuition, use SN and open data
DSPS02: Accept (be ready for) **iterative development**, know when to stop, comfortable with failure, accept the symmetry of outcome (both positive and negative results are valuable)
DSPS03: Good **sense of metrics**, understand importance of the results validation, never stop looking at individual examples
DSPS04: Ask the right questions
DSPS05: Respect domain/subject matter knowledge in the area of data science
DSPS06: Data driven problem solver and **impact-driven mindset**
DSPS07: Be aware about power and limitations of the main machine learning and data analytics algorithms and tools
DSPS08: Understand that most of **data analytics algorithms are statistics and probability based**, so any answer or solution has some degree of probability and represent an optimal solution for a number of variables and factors
DSPS09: Recognise what things are **important** and what things are **not important** (in data modeling)
DSPS10: Working in **agile environment** and coordinate with other roles and team members
DSPS11: Work in **multi-disciplinary team**, ability to communicate with the domain and subject matter experts
DSPS12: Embrace **online learning**, continuously improve your knowledge, use **professional netw**orks and communities
DSPS13: Story Telling: Deliver actionable result of your analysis
DSPS14: Attitude: Creativity, curiosity (willingness to challenge status quo), commitment in finding new knowledge and progress to completion
DSPS15: Ethics and responsible use of data and insight delivered, awareness of dependability (data scientist is a feedback loop in data driven companies)

21st Century Skills (after DARE & BHEF & EDISON)

SK21C01: Critical Thinking: Demonstrating the ability to apply critical thinking skills to solve problems and make effective decisions

SK21C02: Communication: Understanding and communicating ideas

SK21C03: Collaboration: Working with other, appreciation of multicultural difference

SK21C04: Creativity and Attitude: Deliver high quality work and focus on final result, initiative, intellectual risk

SK21C05: Design Thinking: Structural problem solving and implementation aware solutions

SK21C06: Planning & Organizing: Planning and prioritizing work to manage time effectively and accomplish assigned tasks

SK21C07: Business Fundamentals: Having fundamental knowledge of the organization and the industry

SK21C08: Customer Focus: Actively look for ways to identify market demands and meet customer or client needs

SK21C09: Working with Tools & Technology: Selecting, using, and maintaining tools and technology to facilitate work activity

SK21C10: Dynamic (self-) re-skilling: Continuously monitor individual knowledge and skills as shared responsibility between employer and employee, ability to adopt to changes

SK21C11: Professional networking: Involvement and contribution to professional network activities

SK21C12: Ethics: Adhere to high ethical and professional norms, responsible use of power data driven technologies, avoid and disregard un-ethical use of technologies and biased data collection and presentation

Managers vs Experts vs Generalists

- Knowledge workers and managers are commonly understood organisational roles
  - Are organized in complex and typically hierarchical relations in an organisational structure
- Experts or expert groups are typically cross- or inter- organisational
  - Experts possess a critical body of knowledge, typically multi-domain or multi-discipline, with a proven record of contribution to the expert domain and the ability to cross-pollinate between domains.
  - Experts can be positioned at EQF levels 7 or 8.
  - Experts often act as think tanks or policy defining boards
- The generalist may be an important category or profile, but it can presumably perform effectively at a specific level of professional development
  - Generalist concept as contrasting to/or complementing a manager or an expert concept
- When introducing the generalist concept the following properties to be considered
  - (1) category of possessed knowledge: single-/multi-/cross- domain; vertical or horizontal span;
  - (2) role in organization: managerial, advisory or research/development; - Or extra organisational?
  - (3) qualification level: how deep knowledge and skills are required.
- Practical experience
  - To have a strong background in one or more domains, generalist must posses/acquire sufficient practical experience in those domains, multidisciplinary knowledge and experience would provide a benefit.

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Questions and Discussion

- Who are generalists?
- Do we need to define them formally?
- Do you know any?

Additional materials

- Design and System thinking
- Customised curriculum design methodology – Semantic based
- Competence based Data Science team composition
- References and links

Assessing Expertise and Capacity in Research Groups Strategy Development

Expertise by Levels			
	Expertise Level	Points	Papers +0.5
1	General knowledge	1	
2	Rsch&Develop 1-2 yrs	2	
3	Teaching 2+ yrs	3	
4	Rsch&Develop 3-5 yrs, Std Dev Org	4	1-2 papers
5	Rsch&Develop 5+ yrs, Prj Mgnt/WPL/PI	5	3-4 papers
6	Rsch&Develop 5+ yrs, RschGroup, PhD DA	6	5+ papers

Research and Teaching by domains/subjects			
	Rsch/Edu activity	Points	Papers +0.5
1	Course prepararion now, TA	1	
2	Following topic, group discussion	2	
3	Teaching on topic now, Tutorials, Workshops	3	1-2 papers
4	> 3 yrs past 5-10 yrs ago, Std Dev Org	4	1-2 papers
5	< 3 yrs past 5-10 yrs ago, Prj Mgnt/WPL/PI	5	3-4 papers
6	starting now and next 3 yrs	6	1-2 papers
7	< 3 yrs last 5 yrs, Prj Mgnt/WPL/PI	7	2-3 papers
8	now and next 3+ yrs, RschGroup, PhD DA	8	1-2 papers

EQF Levels: Knowledge, Skills, Responsibilities

EQF Levels	EQF Levels description
8	**Knowledge at the most advanced frontier, the most advanced and specialised skills and techniques to solve critical problems** in research and/or innovation, demonstrating substantial authority, innovation, autonomy, scholarly or professional integrity.
7	**Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study**, as the basis for original thinking, critical awareness of knowledge issues in a field and at the interface between different fields, specialised problem-solving skills in research and/or innovation to develop new knowledge and procedures and to integrate knowledge from different fields, managing and transforming work or study contexts that are complex, unpredictable and require new strategic approaches, taking responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams.
6	**Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles**, advanced skills, demonstrating mastery and innovation in solving complex and unpredictable problems in a specialised field of work or study, management of complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts, for continuing personal and group professional development.
5	**Comprehensive, specialised, factual and theoretical knowledge** within a field of work or study and an awareness of the boundaries of that knowledge, expertise in a comprehensive range of cognitive and practical skills in developing creative solutions to abstract problems, management and supervision in contexts where there is unpredictable change, reviewing and developing performance of self and others.
4	**Factual and theoretical knowledge in broad contexts** within a field of work or study, expertise in a range of cognitive and practical skills in generating solutions to specific problems in a field of work or study, self-management within the guidelines of work or study contexts that are usually predictable, but are subject to change, supervising the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities.
3	**Knowledge of facts, principles, processes and general concepts**, in a field of work or study, a range of cognitive and practical skills in accomplishing tasks. Problem solving with basic methods, tools, materials and information, responsibility for completion of tasks in work or study, adapting own behaviour to circumstances in solving problems.

Master Level

Design Thinking

The Design Thinking mindset includes the following aspects:

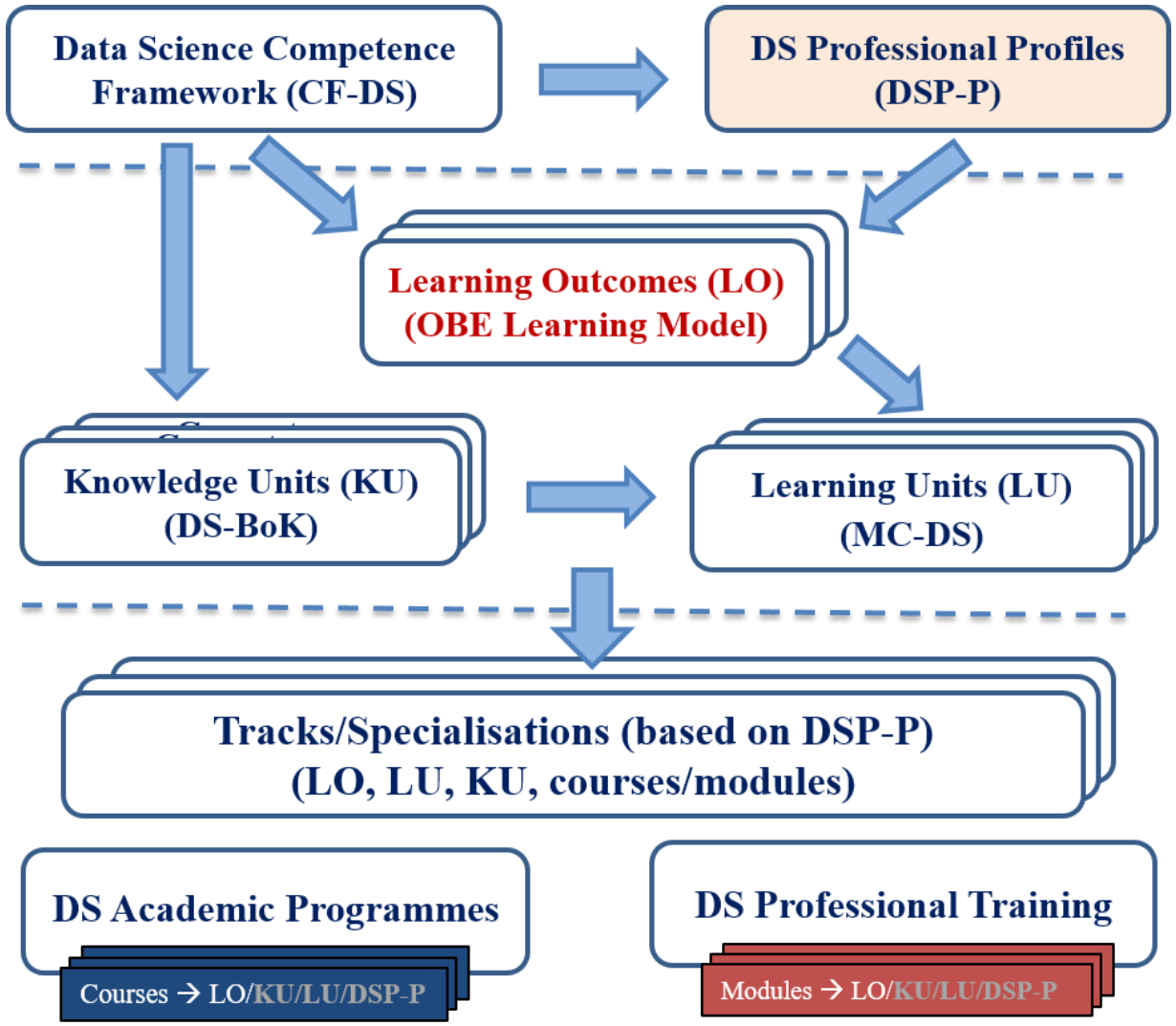
- Driven by the problem solving curiosity
- Focused on people as a target for products or services
- Accept complexity
- Develop process awareness and the whole lifecycle
- Visualise and show relations
- Prototype, experiment and iterate
- Co-create, grow, and scale with varying perspectives and frameworks
- Collaborate in networks
- Reflect on actions

System thinking

The mindset of the system thinker, should:

- Always look at the big picture
- Think positively about system improvement, and don’t complain if the system doesn’t work
- Check the results and improve results with each iteration
- Reflect on the way of thinking because it affects what will happen
- Take time to penetrate even complex interconnections
- Search for the key to the system
- Consider facts from different perspectives
- Accept the change takes place gradually and interconnections also trigger changes
- Identify an effect that was triggered by an action

Outcome Based Educations and Training Model: Addressing target competences for the profession



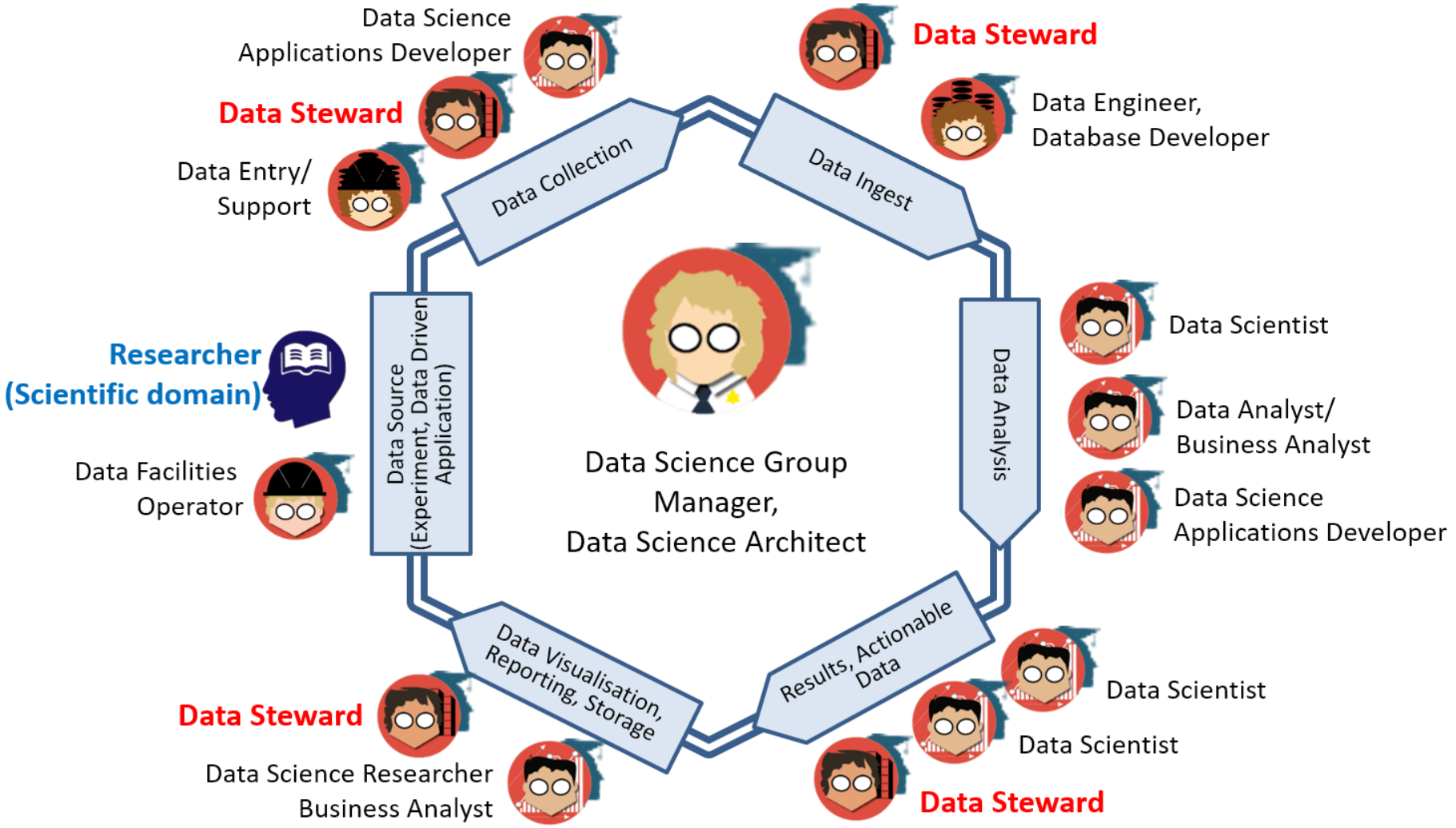
From Competences and DSP Profiles

to Learning Outcomes (LO) and

to Knowledge Unites (KU) and Learning Units (LU)

- EDSF allow for customized educational courses and training modules design

Building a Data Science Team



EQF Levels and Corresponding Professional Knowledge and Activities

- EQF levels 1-3 correspond to starter positions up to a master degree requiring sufficient knowledge in a field of work or study.
- EQF levels 4-6 correspond to advanced knowledge in one professional domain with the ability to manage complex activities and projects involving people and groups.
- Higher EQF levels 7 and 8 require wide cross-domain knowledge and the ability to lead and transform work context, develop new ideas and contribute to professional knowledge and research.

Links to EDISON Resources

EDISON Data Science Framework Release 4 (EDSF2022)
https://github.com/EDISONcommunity/EDSF

Component EDSF documents

CF-DS – Data Science Competence Framework
https://github.com/EDISONcommunity/EDSF/blob/master/EDISON01_CF-DS-release4-v11.pdf

DS-BoK – Data Science Body of Knowledge
https://github.com/EDISONcommunity/EDSF/blob/master/EDISON02_DS-BoK-release4-v07.pdf

MC-DS – Data Science Model Curriculum
https://github.com/EDISONcommunity/EDSF/blob/master/EDISON03_MC-DS-release4-v07.pdf

DSPP – Data Science Professional profiles
https://github.com/EDISONcommunity/EDSF/blob/master/EDISON04_DSPP-release4-v08.pdf