FAIR4HE – FAIR for Higher Education

Data Stewardship Professional Competence Framework (CF-DSP) and Body of Knowledge (DSP-BoK)

Yuri Demchenko
University of Amsterdam

FAIRsFAIR Final WP7 Workshop
15 February 2022

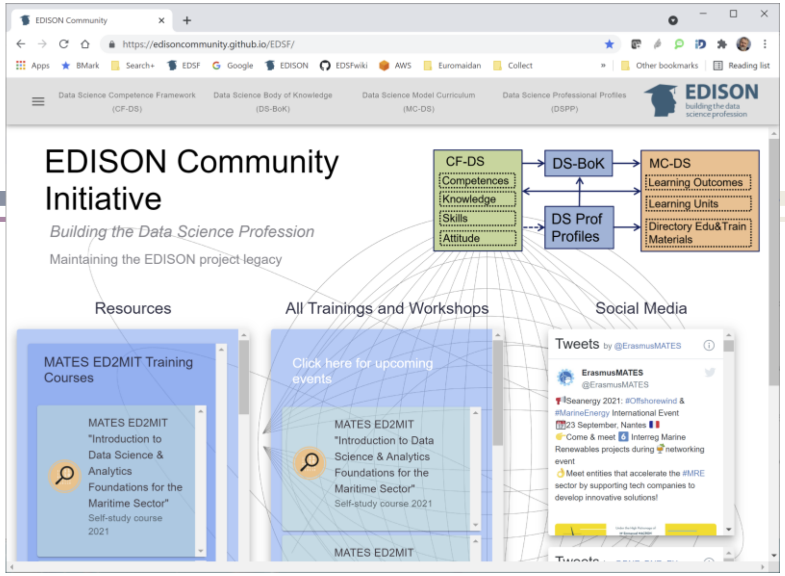
FAIRSFAIR
Fostering Fair Data Practices in Europe

EDISON
building the data science profession

Outline

- FAIRsFAIR WP7 and Data Stewardship Professional Competence Framework (Deliverable D7.3)
- Job market analysis for Data Stewardship and related professions
  - Data collection and analysis outcome
- Proposed Data Stewardship Professional Competence Framework (CF-DSP)
  - Essential competence groups
- DSP Body of Knowledge: Advice for curriculum design and practical teaching
- Reference dataset for Data Stewardship competences assessment
- Discussion

Methodology: How to put all together?



EDISON Community
https://edisoncommunity.github.io/EDSF/
Apps
BMark
Search+
EDSF
Google
EDISON
EDSFwiki
AWS
Euromaidan
Collect
Other bookmarks
Reading list
Data Science Competence Framework (CF-DS)
Data Science Body of Knowledge (DS-BoK)
Data Science Model Curriculum (MC-DS)
Data Science Professional Profiles (DSPP)
EDISON
building the data science profession
CF-DS
Competences
Knowledge
Skills
Attitude
DS-BoK
DS Prof Profiles
MC-DS
Learning Outcomes
Learning Units
Directory Edu&Train Materials

EDISON Community Initiative

Building the Data Science Profession

Maintaining the EDISON project legacy

Resources

All Trainings and Workshops

Social Media

MATES ED2MIT Training Courses

MATES ED2MIT "Introduction to Data Science & Analytics Foundations for the Maritime Sector"
Self-study course 2021

Click here for upcoming events

MATES ED2MIT "Introduction to Data Science & Analytics Foundations for the Maritime Sector"
Self-study course 2021

MATES ED2MIT

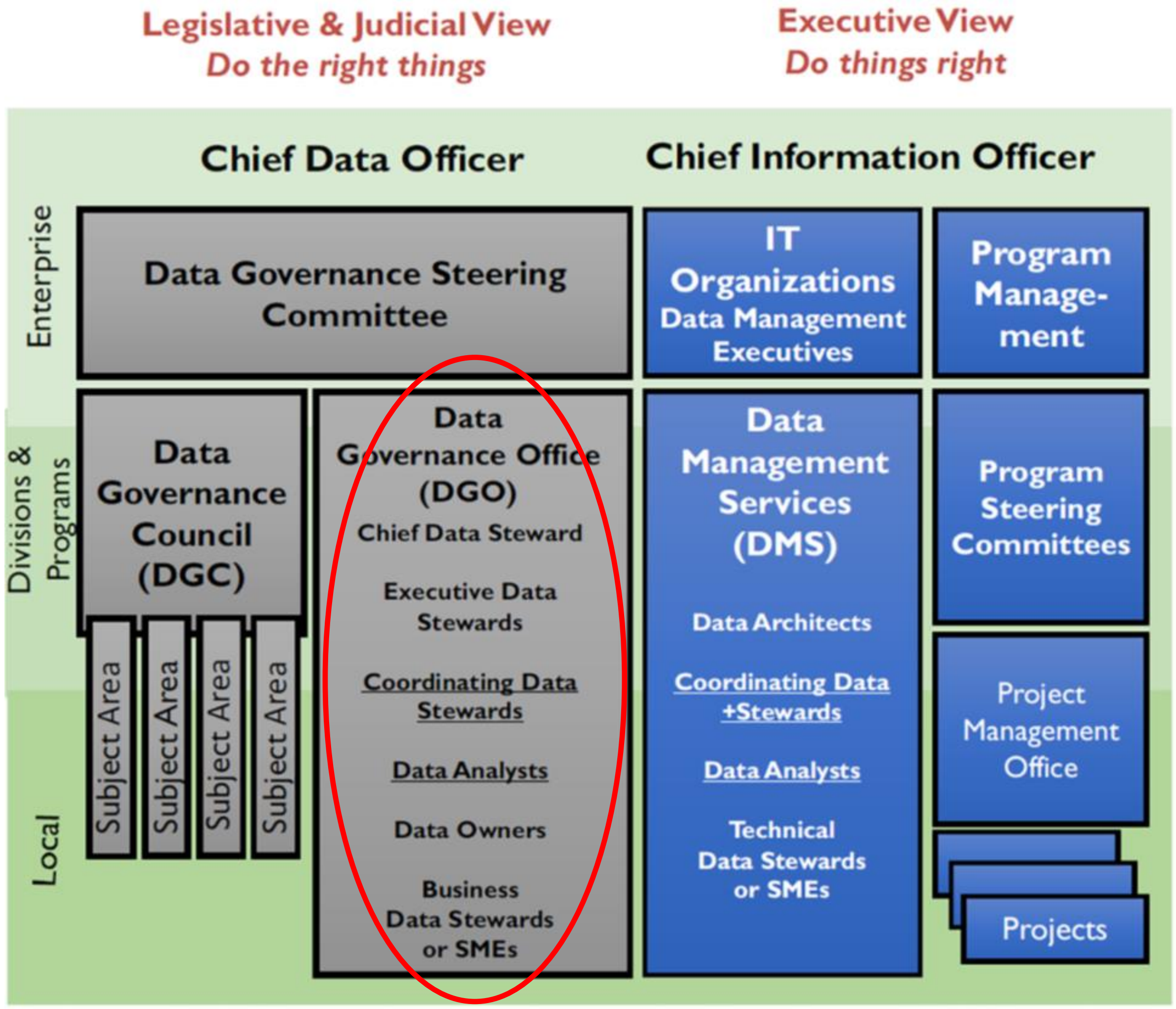
Tweets by @ErasmusMATES

ErasmusMATES
@ErasmusMATES

Seanergy 2021: #Offshorewind & #MarineEnergy International Event
23 September, Nantes
Come & meet Interreg Marine Renewables projects during networking event
Meet entities that accelerate the #MRE sector by supporting tech companies to develop innovative solutions!

- EDISON Data Science Framework (EDSF) as a base methodology https://edisoncommunity.github.io/EDSF/
  - CF-DS: Data Science Competence groups: DSDA, **DSENG, DSDM,** DSRMP, DSDK structure and mapping
  - EDSF Data Management Body of Knowledge (DS-BoK, includes KAG-DSDM)
- DAMA Body of Knowledge (DAMA BoK)
- Job market Analysis: Evidence based and market driven
- Existing Frameworks for Data Stewardship and Research Data Management (RDM)

DMBOK Framework: Data Governance Organisation Parts



Legislative & Judicial View
Do the right things

Executive View
Do things right

Chief Data Officer

Chief Information Officer

Enterprise

Divisions & Programs

Local

Data Governance Steering Committee

IT Organizations
Data Management Executives

Program Manage-ment

Data Governance Council (DGC)

Subject Area

Subject Area

Subject Area

Subject Area

Data Governance Office (DGO)
Chief Data Steward
Executive Data Stewards
Coordinating Data Stewards
Data Analysts
Data Owners
Business Data Stewards or SMEs

Data Management Services (DMS)
Data Architects
Coordinating Data +Stewards
Data Analysts
Technical Data Stewards or SMEs

Program Steering Committees

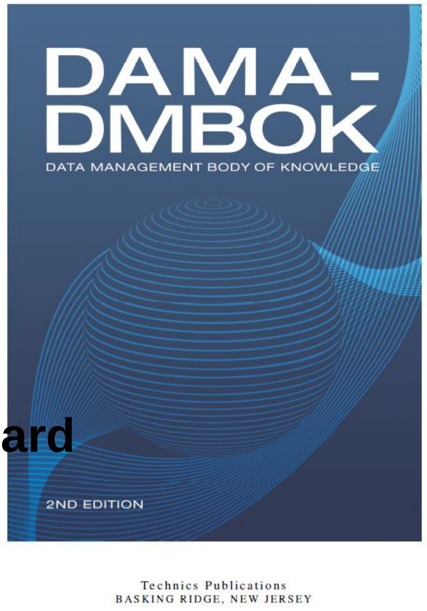
Project Management Office

Projects

- Separation of governance responsibilities
- Multi-layer
- CDO
- CIO
- Councils

Data Governance Office (DGO)

- Chief **Data Steward**
- Executive **Data Steward**
- Business **Data Steward** or SME



DAMA-DMBOK
DATA MANAGEMENT BODY OF KNOWLEDGE
2ND EDITION
Technics Publications
BASKING RIDGE, NEW JERSEY

Data Steward functions

- Creating and managing core Metadata
- Documenting rules and standards
- Managing data quality issues
- Executing operational data governance activities

“Best Data Steward is not made but found” DMBOK1 (2009)

Data Stewardship Job Market Analysis (Snapshot Sept 2020)

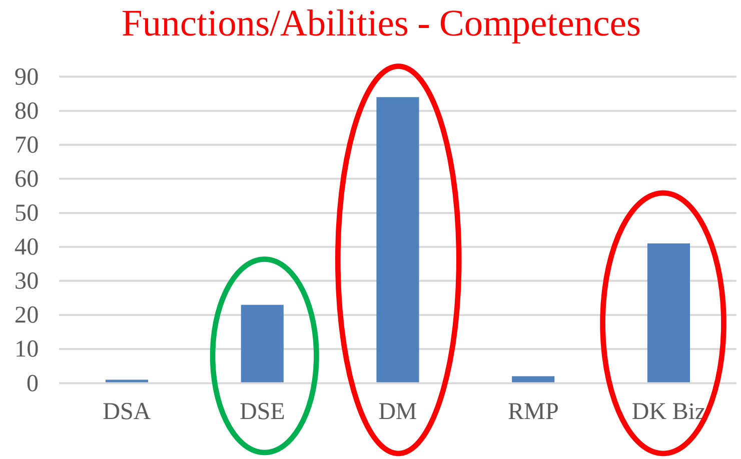
- First stage: Exploratory – manual collection

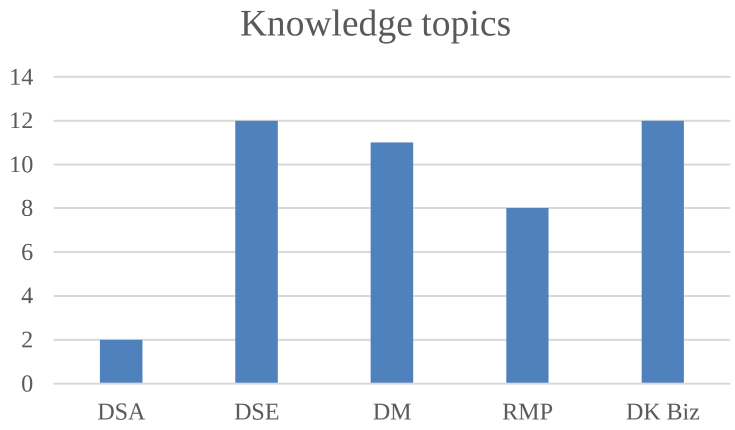
- Period data collected: 30 August – 1 September 2020
- Sites: Indeed.com – NL, UK, DE, USA (large number of vacancies); monsterboard.nl, IEEE Jobs – NL (single vacancies)
- Days vacancy open: >50% more than 30 days
- Data Steward and related vacancies discovered: NL – 51, UK – 30+, DE ~20, US – 300+
- Information collected/downloaded:
- Key skills snapshot: – for all or first 200 for USA
- Full vacancy texts analysed: – approx. 40 in total
- Detailed analysis of sample vacancies
- Number of companies and organisations posted Data Steward related jobs: – more than 50

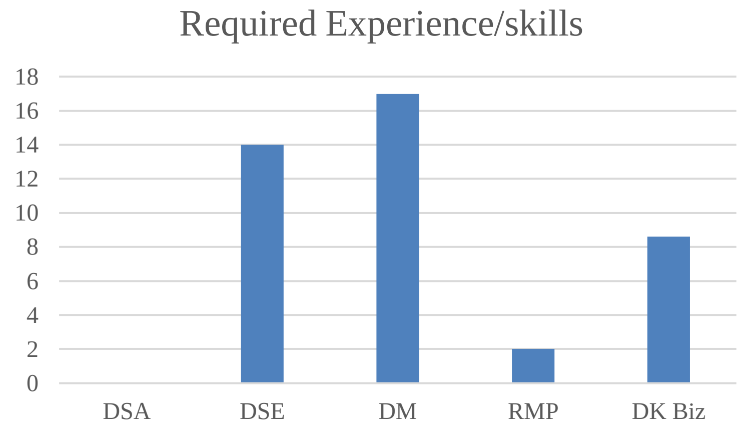
- New job market analysis (massive data collection): Preliminary May 2021, Advanced – Sept 2021
  - Datasets and trained data analytics model has been published

Vacancies profile – By Data Science Competence Groups

Wide range of Competences: Responsibility, Functions, activities, however focus om Data Management and Business/Domain specific competences


Functions/Abilities - Competences


Knowledge topics


Required Experience/skills

DSA – Data Science and Analytics
DSE – Data Science Engineering
DM – Data Management and Governance
RMP – Research Methods and Project Management
DK Biz – Domain Knowledge, particular Business domain

Important Knowledge Items extracted from Job vacancies (indeed.com – NL, DE, UK, US, Sept 2020)

- Data Management techniques
- FAIR data principles
- Data Management and Data Governance principles
- Data integrity
- Metadata, PID and linked data
- Ontology and Semantics
- FAIR metrics and Maturity framework, FAIR certification
- Data compliance regulations and standards
- Data privacy law
- GDPR
- Ethics
- Business process management
- Marketing
- Banking financial services and data management
- Multilevel Bill of Materials
- Data Warehouses

- Version control system
- Master Data Management (MDM) and Reference Data
- Research methods
- Project management
- Data analysis and visualisation tools
- Data lifecycle, lineage, provenance
- Visual Basic for Applications (VBA) and interface design
- WebAPI use for data access, collection and publishing
- DevOps, Agile, Scrum methods and technologies
- Data formats, standards
- Data modeling (SQL and EDBMS, NoSQL)
- Modern data infrastructure: Data registries, Data Factories, Semantic storage, SQL/NoSQL

Proposed CF-DSP Competences DSDM01-DSDM04 as extension to CF-DS general Data Management Competences (1)

EDSF Competences	Proposed DSP Competence
Data Management (DSDM)	**Relevance and proposed changes and extensions** (posted as revised text and bulleted extensions)
DSDM Develop and implement data management strategy for data collection, storage, preservation, and availability for further processing.	DSDM Develop and implement data management strategy for data collection, storage, preservation, and availability for further processing, • ensure compliance with FAIR data principles.
DSDM01 Develop and implement data strategy, in particular, in a form of data management policy and Data Management Plan (DMP)	DSDM01 Develop and implement data management and governance strategy, in particular, in a form of Data Governance Policy and Data Management Plan (DMP) • Ensure **compliance with standards and best practices in Data Governance and Data Management**
DSDM02 Develop and implement relevant data models, define metadata using common standards and practices, for different data sources in variety of scientific and industry domains	DSDM02 Develop and implement relevant data models, define metadata using common standards and practices, for different data sources in variety of scientific and industry domains. • **Ensure metadata compliance with FAIR requirements** • Be familiar with the metadata management tools
DSDM03 Integrate heterogeneous data from multiple sources and provide them for further analysis and use	DSDM03 Integrate heterogeneous data from multiple sources and provide them for further analysis and use • Perform data preparation and cleaning • Match/transfer data model
DSDM04 Maintain historical information on data handling, including reference to published data and corresponding data sources (data provenance)	DSDM04 Maintain historical information on data handling, including reference to published data and corresponding data sources • **Publish data, metadata and related metrics** • Perform and maintain data archiving • **Develop necessary archiving policy, comply with Open Science and Open Access policies** if applicable • Ensure data provenance continuity through the whole data lifecycle

Proposed CF-DSP Competences DSDM01-DSDM04 as extension to CF-DS general Data Management Competences (2)

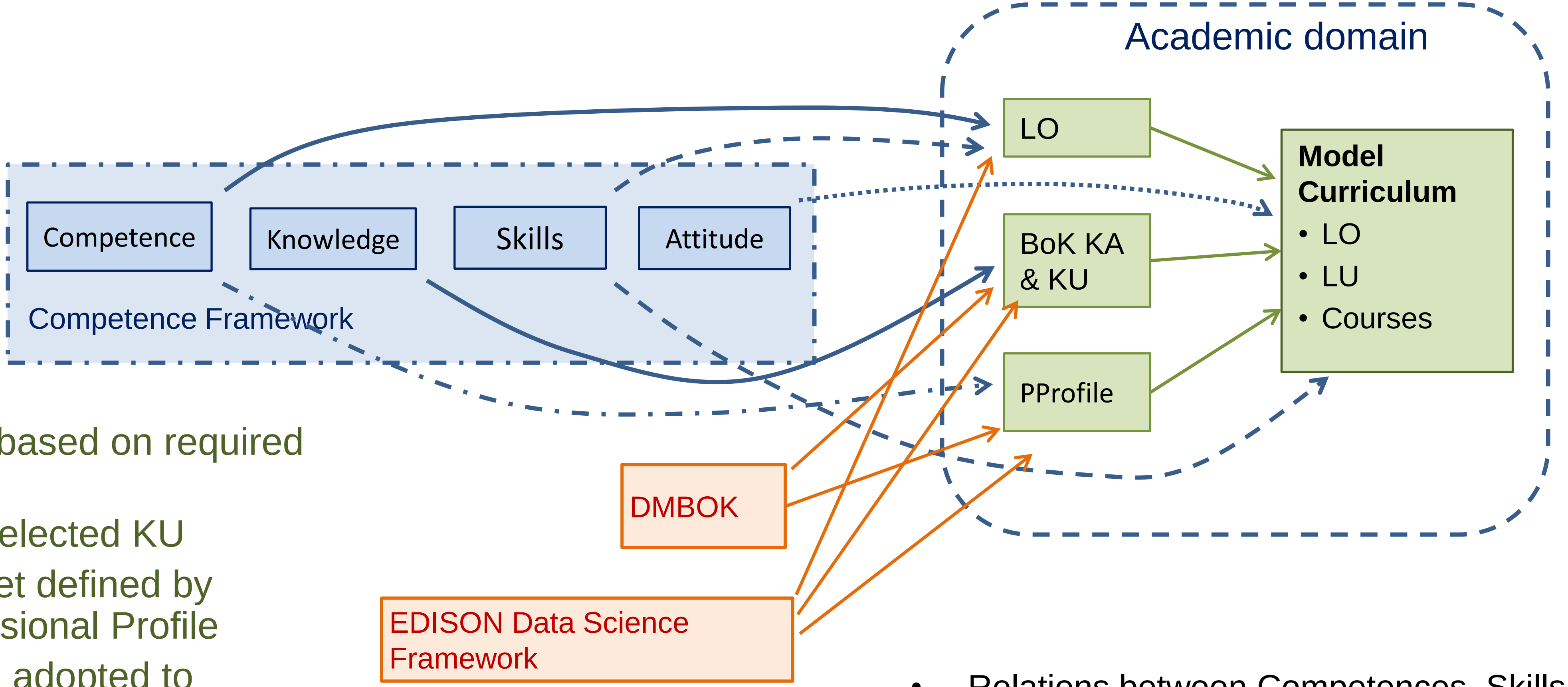
EDSF Competences	Proposed DSP Competence
DSDM05 Ensure data quality, accessibility, interoperability, compliance to standards, and publication (data curation)	DSDM05 Develop policy and metrics for data quality management (e.g. Altmetrix), maintain data quality and compliance to standards, perform data curation • Interact/Collaborate with data providers and data owners to ensure data quality
DSDM06 Develop and manage/supervise policies on data protection, privacy, IPR and ethical issues in data management	DSDM06 Develop and manage/supervise policies on data protection, privacy, IPR and ethical issues in data management, address legal issues if necessary. • Ensure GDPR compliance in data management and access • Develop data access policies and coordinate their implementation and monitoring, including security breaches handling
None	DSDM07* (new) **Manage Data Management/Data Stewards team**, coordinate related activity between organisational departments, external stakeholder to fulfil Data Governance policy requirements, provide advice and training to staff. Define domain/organisation specific data management requirements, communicate to all departments and supervise/coordinate their implementation. Coordinate/supervise data acquisition.
None	DSDM08* (new) **Develop organisational policy and coordinate activities for sustainable implementation of the FAIR data principles** and Open Science, define corresponding requirements to data infrastructure and tools, ensure organisational awareness.
None	DSDM09* (new) **Specify requirements to and supervise the organisational infrastructure for data management** and (and archiving), maintain the park for data management tools, provide support to staff (researchers or business developers), coordinate solving problems.

Necessary Data Stewardship Competences in Data Engineering and Data Infrastructure (DSENG)

Data Steward must work with the IT services and coordinate/supervise implementation of necessary organization specific tools and services

- Coordinate development of new tools and applications for data management, ensure support of the data FAIRness requirements by existing and new tools and applications
- Implement requirements for data storage facilities to comply with the data management policies and FAIR data principles in particular.
- Define and implement (coordinate) data access policies for different stakeholders and organisational roles
- Define, implement and maintain data model, reference data, master data definitions, implement consistent metadata

How to use CF-DSP and DSP-BoK for curriculum Design



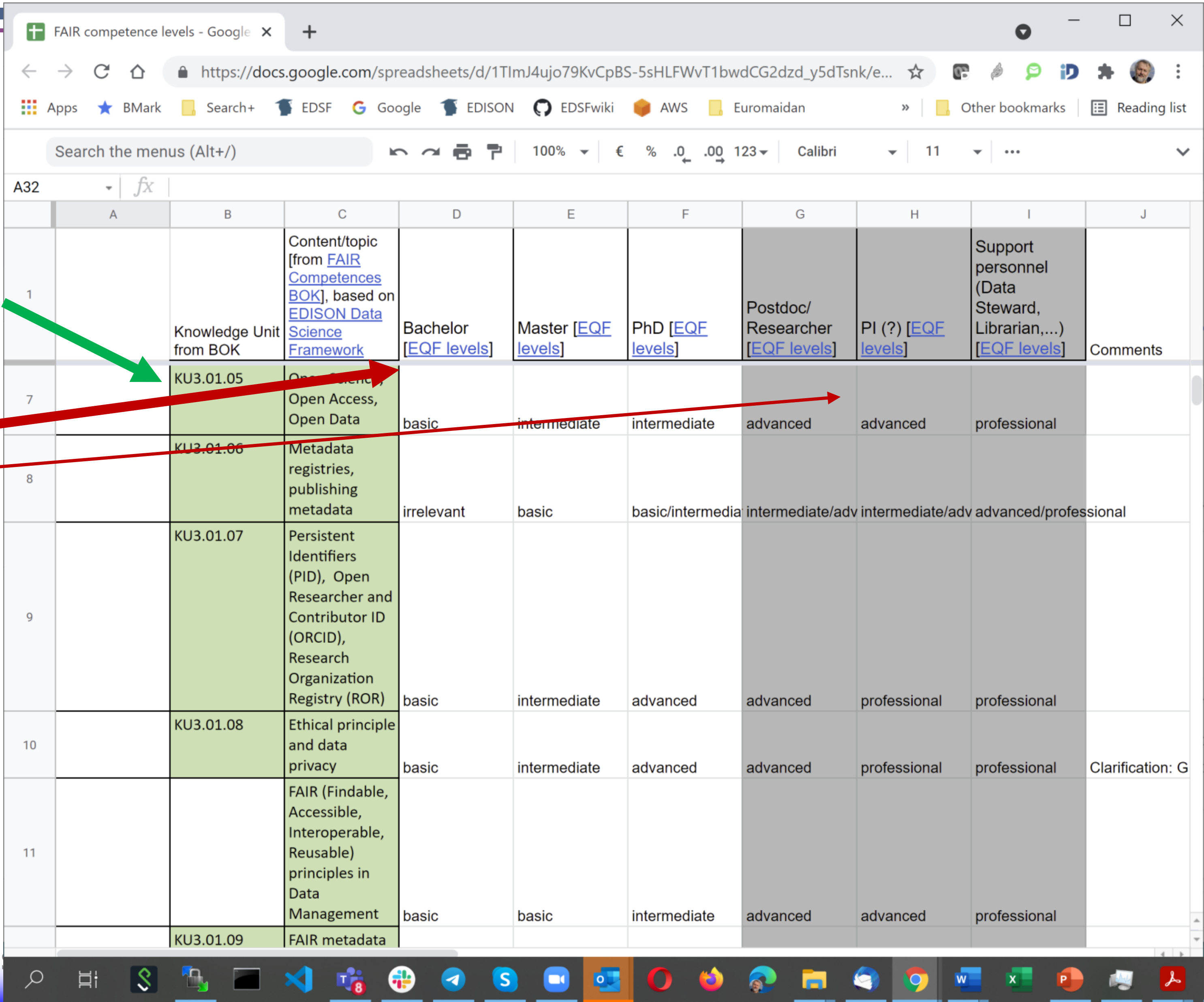
- LO are defined based on required competences
- LU defined by selected KU
- Curriculum target defined by intended Professional Profile
- Final curriculum adopted to available resources
- Look *Adoption Handbook* for suggested courses

- Relations between Competences, Skills, Knowledge/BoK, Professional Profiles
- Mapping between Competence elements and Academic domain elements

Data Stewardship Professional Body of Knowledge

https://docs.google.com/spreadsheets/d/1TImJ4ujo79KvCpBS-5sHLFWvT1bwdCG2dzd_y5dTsnk/online/edit#gid=0

- Defined as a profile/subset and extension to the Data Science Body of Knowledge
  - Working document after FAIR Adoption Handbook sprint
  - Defined set of Knowledge Units (KU) Data Management Knowledge Area Group (KAG-DSDM)
- Competence level defined for Bachelor, Master, PhD, Postdoc, Professional
  - Mapped to EQF
- Valuable contribution from community as part of the FAIR Adoption Handbook Sprint in summer 2021
- To be published as a separate document: Zenodo, FAIRsFAIR, part of EDSF at the EDSF website

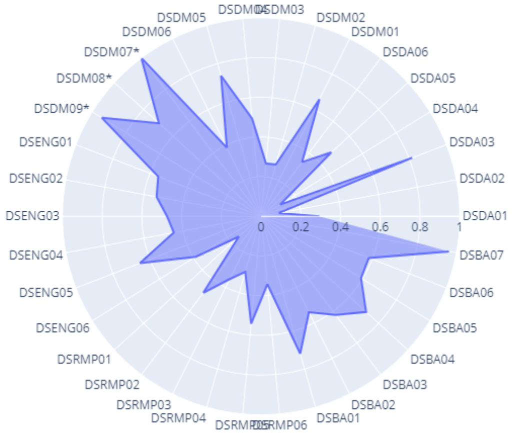


	A	B	C	D	E	F	G	H	I	J
1		Knowledge Unit from BOK	Content/topic [from FAIR Competences BOK], based on EDISON Data Science Framework	Bachelor [EQF levels]	Master [EQF levels]	PhD [EQF levels]	Postdoc/ Researcher [EQF levels]	PI (?) [EQF levels]	Support personnel (Data Steward, Librarian,...) [EQF levels]	Comments
7		KU3.01.05	Open Science, Open Access, Open Data	basic	intermediate	intermediate	advanced	advanced	professional	
8		KU3.01.06	Metadata registries, publishing metadata	irrelevant	basic	basic/intermedia	intermediate/adv	intermediate/adv	advanced/professional	
9		KU3.01.07	Persistent Identifiers (PID), Open Researcher and Contributor ID (ORCID), Research Organization Registry (ROR)	basic	intermediate	advanced	advanced	professional	professional	
10		KU3.01.08	Ethical principle and data privacy	basic	intermediate	advanced	advanced	professional	professional	Clarification: G
11			FAIR (Findable, Accessible, Interoperable, Reusable) principles in Data Management	basic	basic	intermediate	advanced	advanced	professional	
		KU3.01.09	FAIR metadata							

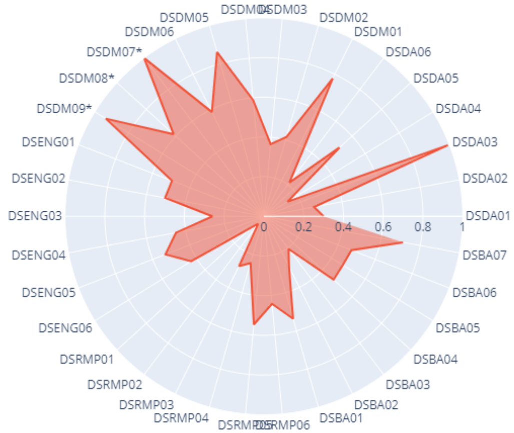
Reference dataset: Data Stewardship vacancies collection (2021)

- Published o Zenodo https://zenodo.org/record/6008122
  - Data Steward Professional: Reference dataset of Data Steward related job vacancies for competences assessment
- Structure:
  - README
  - 32 vacancies from indeed.com (2021): Primarily business oriented (well described)
  - Metadata
  - Application code
- Data Steward related roles
  - Data curators, Data archivists
  - Data Architect, Data Managers
  - Data Quality Managers
- TODO: Extended dataset with research oriented vacancies worldwide

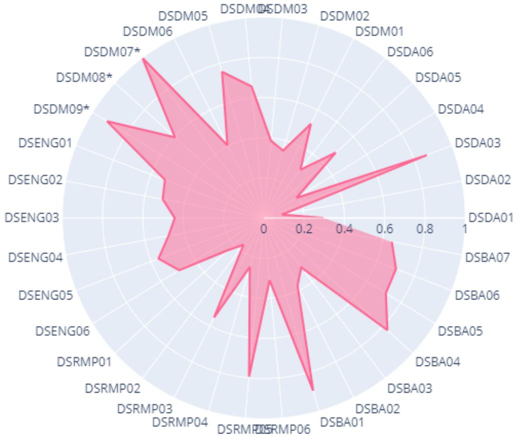
Example Data Steward Competences structure



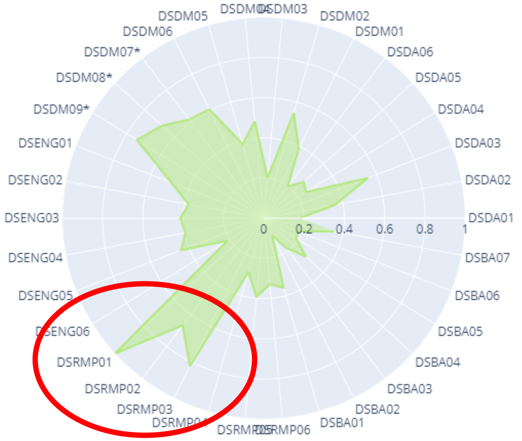
Business Consultant - Organisation Structure Data - ABN AMRO Bank



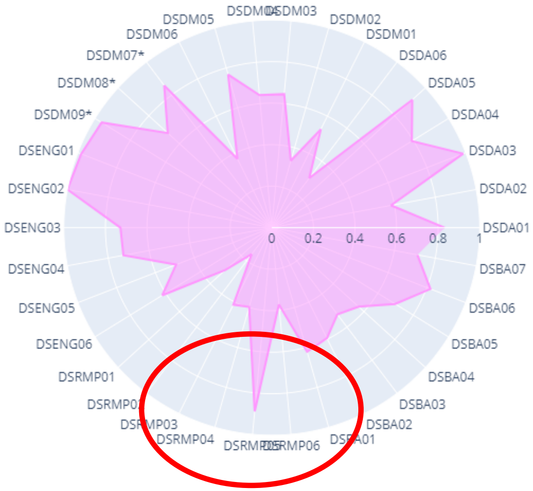
Business Developer II - ABN AMRO Bank



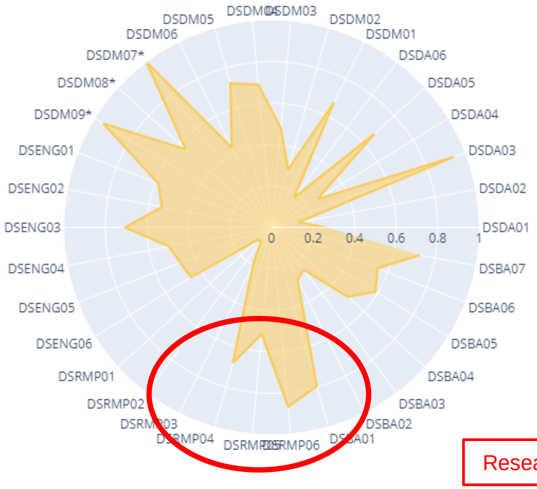
Regulatory Reporting & Data Steward - Robert Walters



Research Data Officer - Vrije Universiteit Amsterdam

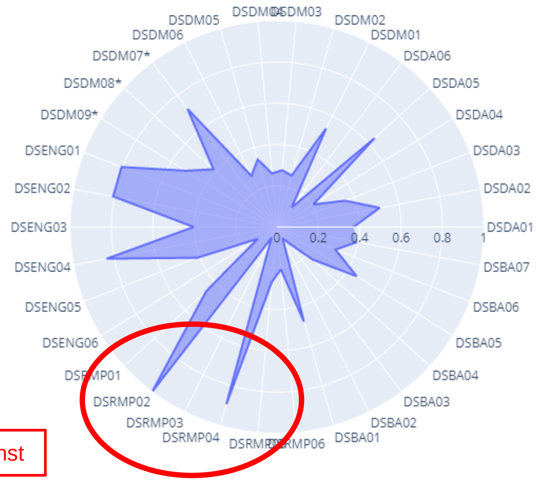


Principal Data Architect - Arcadis

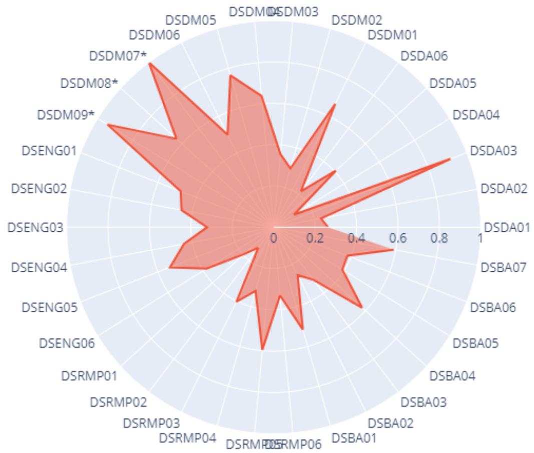


Informatiemanager Groen & Water - BlueTrail

Research focus/elemenst



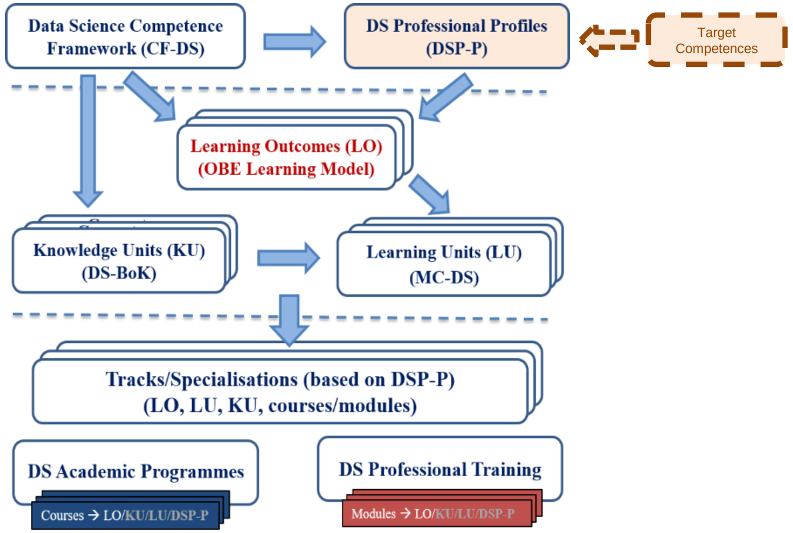
Finance Traineeship - Calco



Specialist Data Management - DAS

How to use CF-DSP and DSP-BoK

- Customised Curriculum Design
- Competences – Vacancies assessment
- Data Science/Data Steward Team building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DS Professional Profiles (DSP-P)
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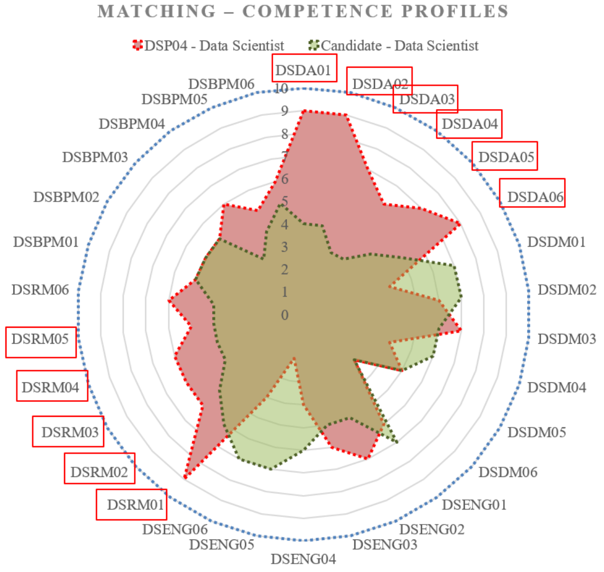
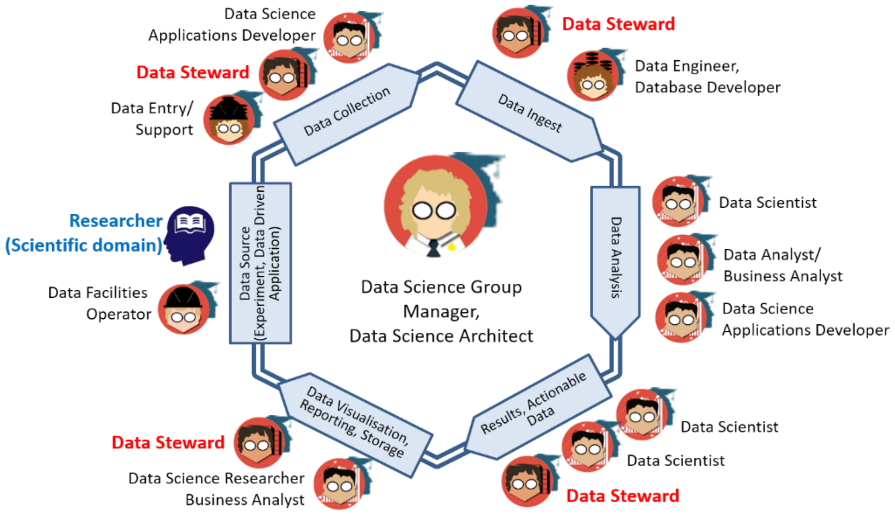
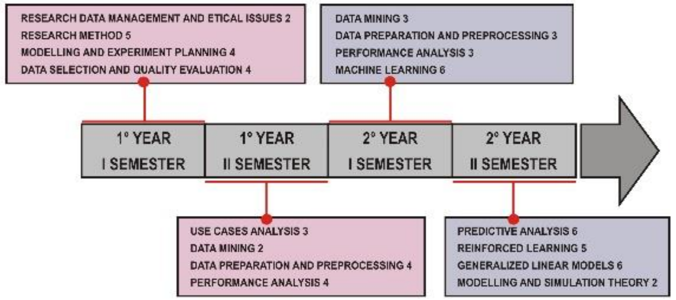
Learning Outcomes (LO) (OBE Learning Model)
Knowledge Units (KU) (DS-BoK)
Learning Units (LU) (MC-DS)
Tracks/Specialisations (based on DSP-P) (LO, LU, KU, courses/modules)
DS Academic Programmes
Courses → LO/KU/LU/DSP-P
DS Professional Training
Modules → LO/KU/LU/DSP-P




Data Science Applications Developer
Data Steward
Data Entry/ Support
Researcher (Scientific domain)
Data Facilities Operator
Data Steward
Data Science Researcher Business Analyst
Data Steward
Data Engineer, Database Developer
Data Scientist
Data Analyst/ Business Analyst
Data Science Applications Developer
Data Scientist
Data Scientist
Data Steward
Data Collection
Data Ingest
Data Analysis
Results, Actionable Data
Data Visualisation, Reporting, Storage
Data Source (Experiment, Data Driven Application)
Data Science Group Manager, Data Science Architect


RESEARCH DATA MANAGEMENT AND ETICAL ISSUES 2
RESEARCH METHOD 5
MODELLING AND EXPERIMENT PLANNING 4
DATA SELECTION AND QUALITY EVALUATION 4
DATA MINING 3
DATA PREPARATION AND PREPROCESSING 3
PERFORMANCE ANALYSIS 3
MACHINE LEARNING 6
1° YEAR I SEMESTER
1° YEAR II SEMESTER
2° YEAR I SEMESTER
2° YEAR II SEMESTER
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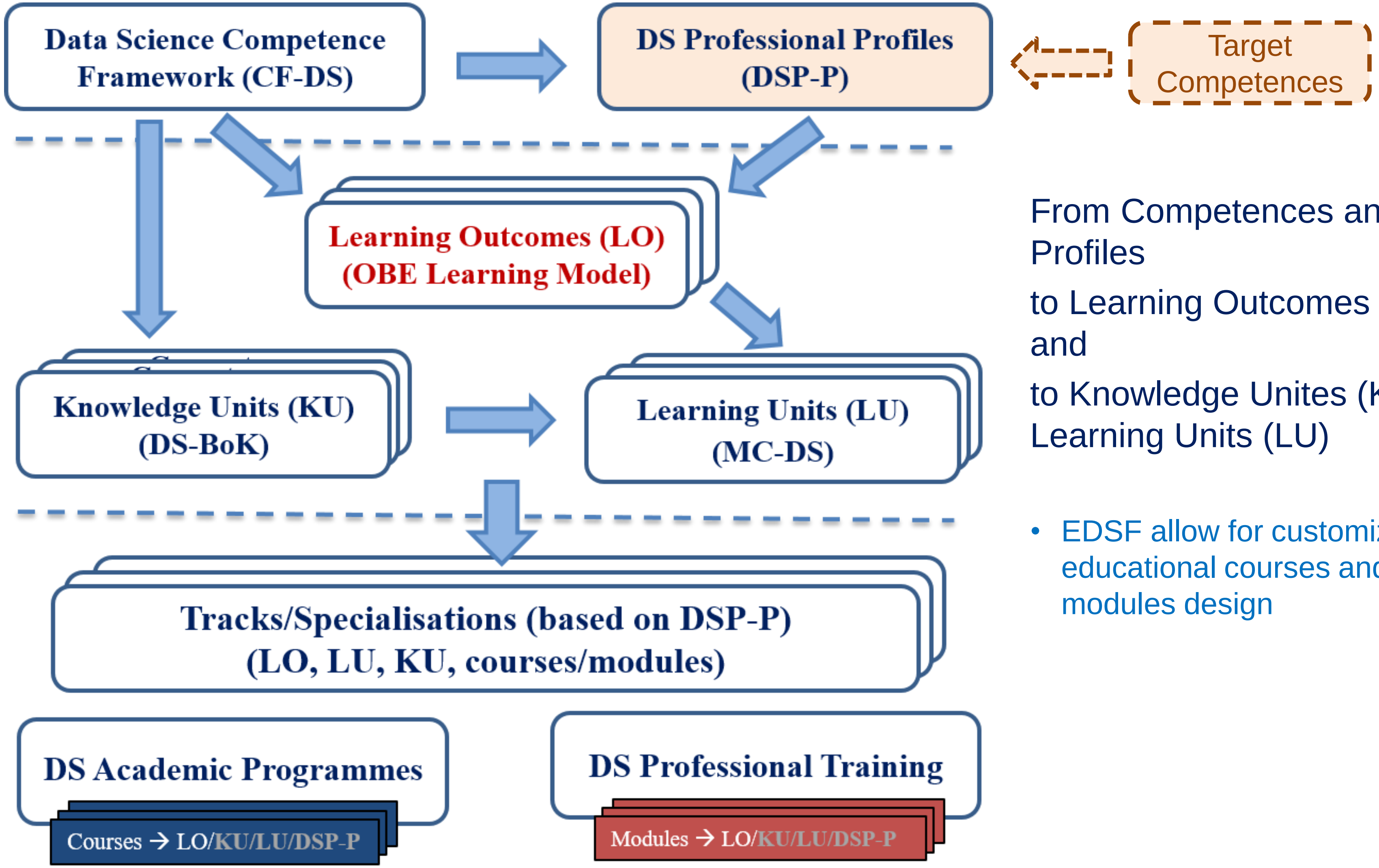
PERFORMANCE ANALYSIS 4
PREDICTIVE ANALYSIS 6
REINFORCED LEARNING 5
GENERALIZED LINEAR MODELS 6
MODELLING AND SIMULATION THEORY 2

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



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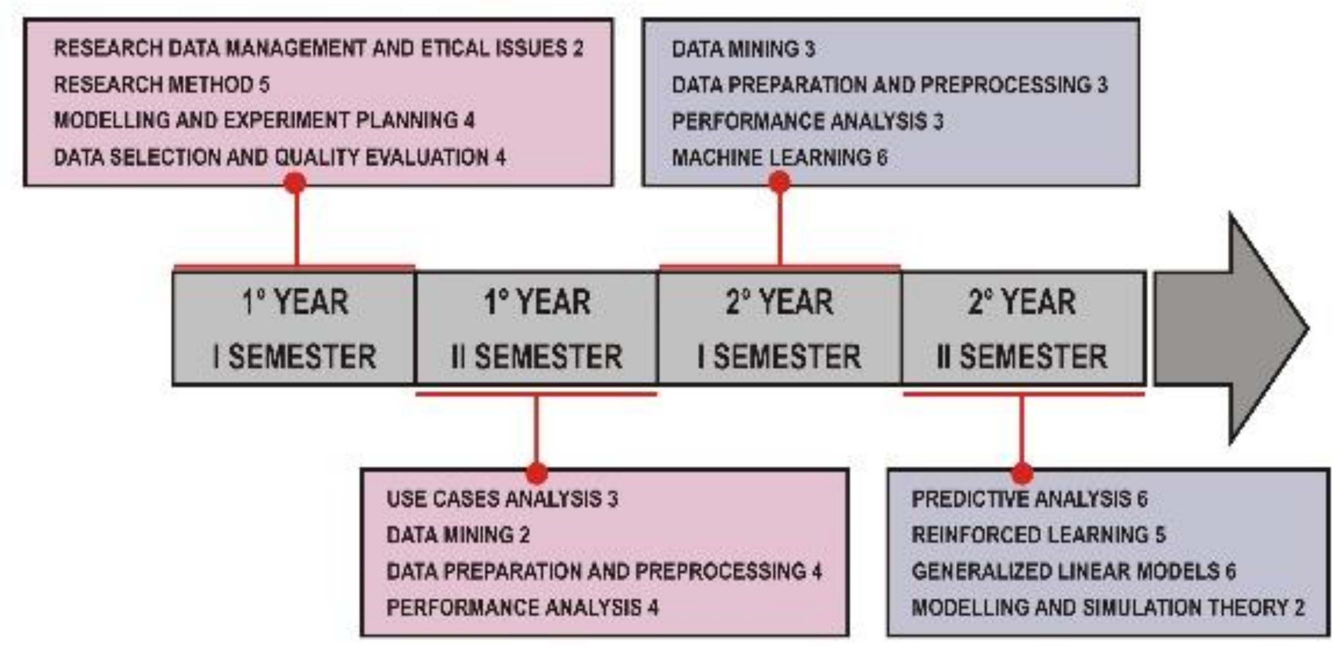
From Competences and DSP Profiles

to Learning Outcomes (LO) and

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

- EDSF allow for customized educational courses and training modules design

Example curriculum planning: Based on implied courses duration and DSPP profile proficiency levels



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MACHINE LEARNING 6

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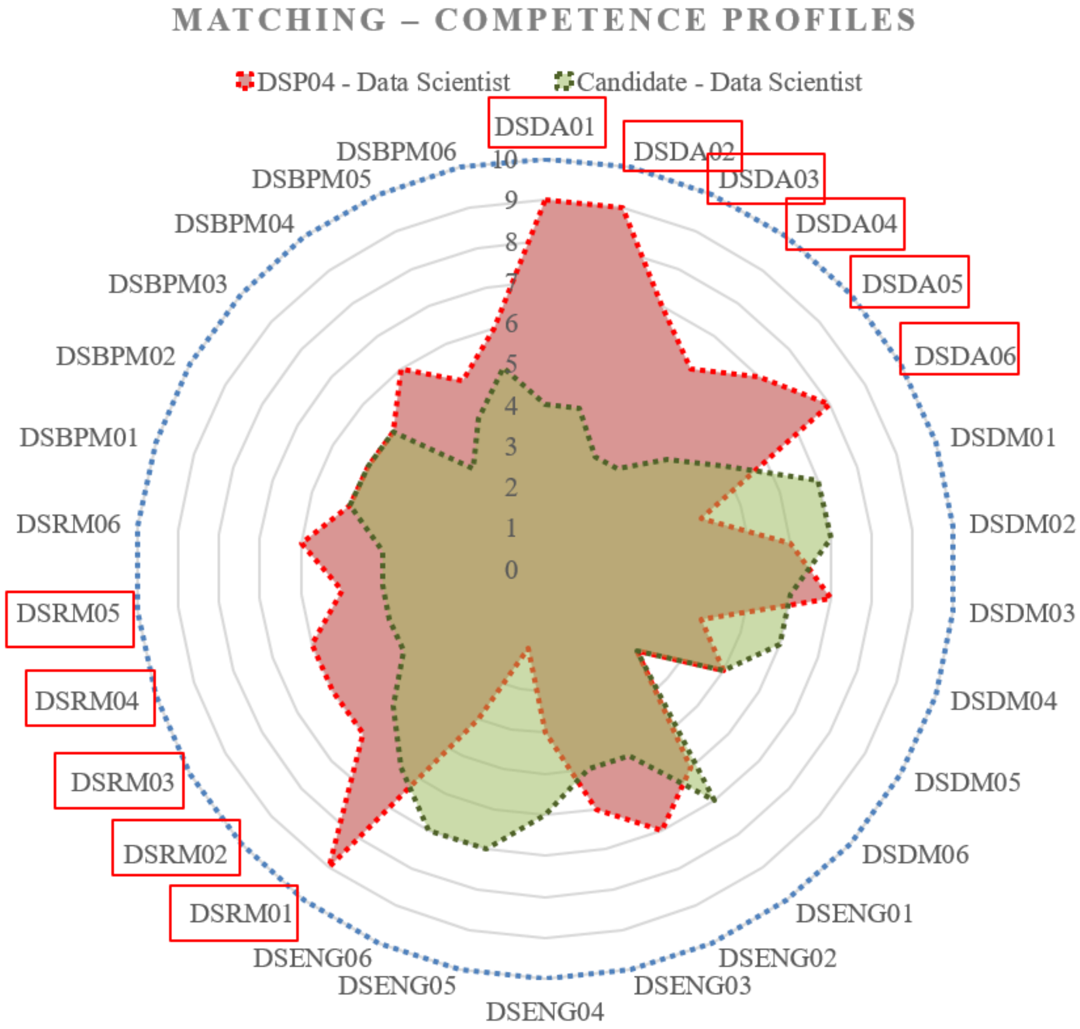
PERFORMANCE ANALYSIS 4

PREDICTIVE ANALYSIS 6
REINFORCED LEARNING 5
GENERALIZED LINEAR MODELS 6
MODELLING AND SIMULATION THEORY 2

- Planning on sequence and duration of courses for maximum learning outcome
- Importance of splitting core courses over 2 semesters
- Theory and practice oriented courses
- Importance of pre-requisite knowledge:
  - Statistics for Data Scientists
  - Organisational management for Data Stewards

Individual Competences Benchmarking

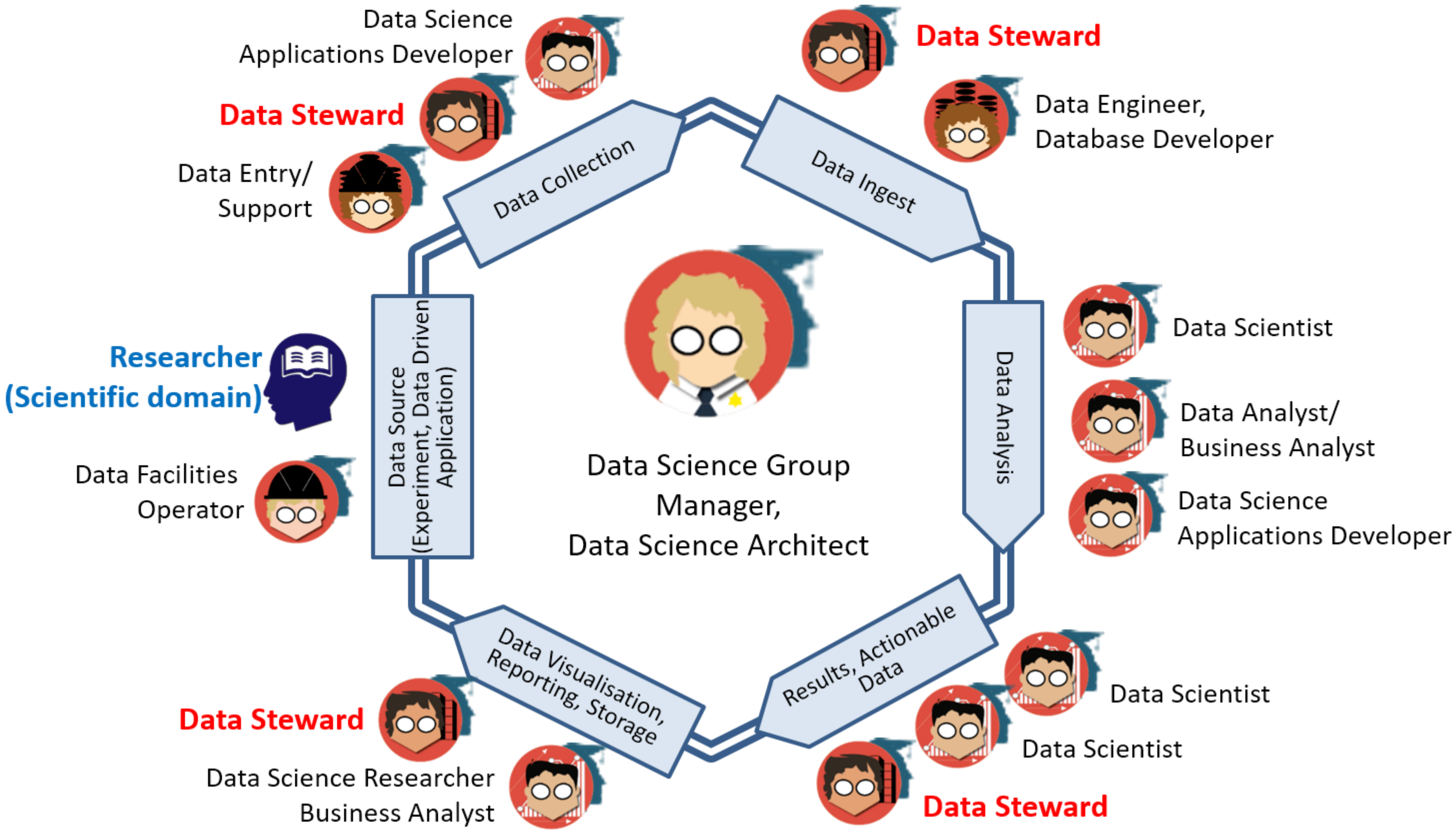


Individual Education/Training Path based on Competence benchmarking

- Red polygon indicates the chosen professional profile: Data Scientist (general)
- Green polygon indicates the candidate or practitioner competences/skills profile
- Insufficient competences (gaps) are highlighted in *red*
  - *DSDA01 – DSDA06 Data Science Analytics*
  - *DSRM01 – DSRM05 Data Science Research Methods*
- Can be use for team skills match marking and organisational skills management

[ref] For DSP Profiles definition and for enumerated competences refer to EDSF documents CF-DS and DSP Profiles.

Building a Data Science Team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Data Analyst/ Business Analyst
Data Science Applications Developer
Data Scientist
Data Scientist
Data Steward
Data Collection
Data Ingest
Data Analysis
Results, Actionable Data
Data Visualisation, Reporting, Storage
Data Source (Experiment, Data Driven Application)
Data Science Group Manager, Data Science Architect

Discussion

- How to use the Data Stewardship Professional Competence Framework (CF-DSP) and Body of Knowledge (DSP-BoK) for teaching and organizational staff/HR management

- How to implement FAIR and Data Stewardship in university curriculum and teaching: Challenges, opportunities and experience

- How to contribute to CF-DSP and DSP-BoK update and maintenance

References

- FAIR Competence Framework for Higher Education (Data Stewardship Professional Competence Framework), FAIRsFAIR Project Deliverable D7.3
  - https://zenodo.org/record/4562089#.YIBZeegzZPZ
- D7.2 Briefing on FAIR Competences and Synergies
  - https://zenodo.org/record/4009007#.YL86SfkzaF4
- Data Stewardship Curricula in Denmark
  - https://www.deic.dk/sites/default/files/Data%20Steward%20Education%20in%20Denmark_0.pdf
- ZonMw & ELIXIR-NL funded project “Towards FAIR Data Steward as profession for the Life Sciences”
  - Final report (Oct 3, 2019): https://doi.org/10.5281/zenodo.3471707
- Yuri Demchenko, Lennart Stoy, Research Data Management and Data Stewardship Competences in University Curriculum, In Proc. Data Science Education (DSE), Special Session, EDUCON2021 – IEEE Global Engineering Education Conference, 21-23 April 2021, Vienna, Austria
  - http://www.uazone.org/demch/papers/educon2021-data-stewardship-competence-fw-v02.pdf
- EDISON Data Science Framework (EDSF)
  - https://edisoncommunity.github.io/EDSF/
- FAIRsFAIR FAIR Adoption Handbook: D7.4 How to be FAIR with your data. A teaching and training handbook for higher education institutions:
  - https://zenodo.org/record/5905866
- Data Steward Professional: Reference dataset of Data Steward related job vacancies for competences assessment
  - https://zenodo.org/record/6008122

Additional information

- ESDF development and EDSF Release 4
- FAIR data principles, technical context and organisational roles

EDISON Project (2015-2017) and EDISON Data Science Framework (EDSF)

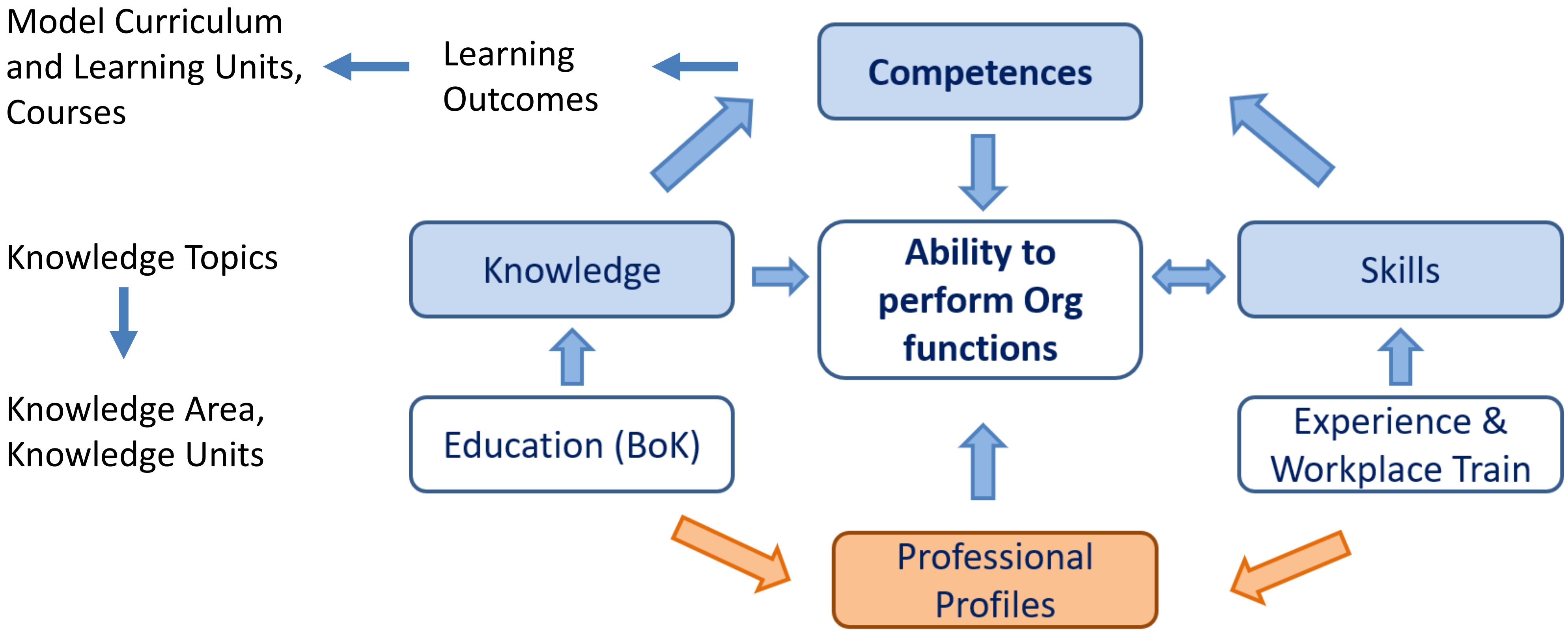
- EDISON project website - http://edison-project.net/

- EDISON Data Science Framework (EDSF) – main outcome of the project
- Currently maintained by EDISON Community Initiative, coordinated by UvA

- EDSF Release 3 published in 2018 – Currently active
- EDSF Release 4 (EDSF2021) to be published by the end of 2021 (initially planned end 2020)
  - Reviewed at EDSF Release 4 Design Workshop – 20 Nov 2019, UvA

Competences Map to Knowledge and Skills

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



Model Curriculum and Learning Units, Courses

Learning Outcomes

Competences

Knowledge Topics

Knowledge Area, Knowledge Units

Knowledge

Ability to perform Org functions

Skills

Education (BoK)

Experience & Workplace Train

Professional Profiles

Competence
vs
Competency

Learning Outcomes
vs
Learning Objectives

FAIR Data Principles: Metadata Management (GO FAIR recommendations)

Findable:

- F1 (meta)data are assigned a globally unique and persistent identifier;
- F2 data are described with rich metadata;
- F3 metadata clearly and explicitly include the identifier of the data it describes;
- F4 (meta)data are registered or indexed in a searchable resource;

Interoperable:

- I1. (meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.
- I2. (meta)data use vocabularies that follow FAIR principles;
- I3. (meta)data include qualified references to other (meta)data;

Accessible:

- A1 (meta)data are retrievable by their identifier using a standardized communications protocol;
  - A1.1 the protocol is open, free, and universally implementable;
  - A1.2 the protocol allows for an authentication and authorization procedure, where necessary;
- A2 metadata are accessible, even when the data are no longer available;

Reusable:

- R1 meta(data) are richly described with a plurality of accurate and relevant attributes;
- R1.1 (meta)data are released with a clear and accessible data usage license;
- R1.2 (meta)data are associated with detailed provenance;
- R1.3 (meta)data meet domain-relevant community standards;

FAIR adoption and Ecosystem Sustainability Elements

- FAIR must be accepted by all roles in organisational data management and governance process
  - FAIR must be endorsed by top management C-level
  - Roles and responsibilities to be defined and staffed
  - Inter-role functions as factor for modern agile organisations
- FAIR must be adopted for the whole Research/industrial Data lifecycle
- FAIR must be practiced by all participants along data lifecycle and specifically started from the data producers i.e. researchers or facility operators or sale agents
- FAIR must be supported by infrastructure and tools
- FAIR must be embedded into applications development
- Organisational capability and capacity management
- Education and training – To enable them all
  - Basic academic and professional education + continuous education

FAIR from the technical point of view

- Findable
  - Metadata and PDI – infrastructure and tools
  - Registries and handles resolution, API
  - Policies and SLA
- Accessible
  - Repositories and data storage: infrastructure and management
  - Policy and access control: infrastructure and API management
  - Data access protocols
  - Usage Policy and Sovereignty
  - Data protection, compliance, privacy and GDPR
- Interoperable
  - Standard data formats
  - Metadata and API
  - FAIR maturity level and certification
- Reusable
  - Data provenance and lineage
  - Preservation
  - Metadata, PID and API – linked or embedded into datasets

This motivates Data Stewards' interaction with both **Data Analytics and Applications developers** roles and **Data Infrastructure** roles

- Consequently related competences from Data Stewards are needed

FAIR Data Management and Organisational Roles

FAIR data principles to be adopted cross organisation for the whole data lifecycle

- Data collection
  - Researchers, Data Engineers, data entry workers
- Data preservation and curation
  - Data curators, Data Custodians/Archivists
- Data Analysis
  - Data Scientists, Data Architects, Application developers
- Data publication, sharing access
  - Data Stewards, Data Curators
- Data Governance and Data management
  - Data Stewards and CDO
    - Data policy and data delivery agreements
- Data Infrastructure and tools for data storage and handling
  - Storage, database engineers/managers
    - Metadata and PID services, Master data and Reference data