Data Science Profession and Education

EDISON Data Science Framework (EDSF) as a foundation to establish Data Science profession

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University of Amsterdam
EUROCON 2017

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EDISON – Education for Data Intensive Science to Open New science frontiers

Grant 675419 (INFRASUPP-4-2015: CSA)
Outline

• Background: Reports, Studies, Initiatives
• Who is Data Scientist
• EDISON Data Science Framework (EDSF)
  – Defined Competences and skills – walk through
  – Data Science Professional Profiles Family
• Data Science Body of Knowledge and Model Curriculum
• Use of EDSF
  – Competence Benchmarking
  – Data Science Teams
  – Tailored Training Programs
• Discussion and Questions
Visionaries and Drivers: Seminal works, High level reports, Activities

The Fourth Paradigm: Data-Intensive Scientific Discovery.

Riding the wave: How Europe can gain from the rising tide of scientific data.

The Data Harvest: How sharing research data can yield knowledge, jobs and growth.
An RDA Europe Report. December 2014

HLEG report on European Open Science Cloud (October 2016)

Emergence of Cognitive Technologies (IBM Watson, Cortana and others)
The Fourth Paradigm of Scientific Research

1. Theory, hypothesis and logical reasoning
2. Observation or Experiment
   - E.g. Newton observed apples falling to design his theory of mechanics
   - But Gallileo Galilei made experiments with falling objects from the Pisa leaning tower
3. Simulation of theory or model
   - Digital simulation can prove theory or model
4. Data-driven Scientific Discovery (aka Data Science)
   - More data beat hypnotized theory
   - e-Science as computing and Information Technologies empowered science
5. Computer-human-driven science?
   - Machine discovers new patterns and formulates hypothesis in one or multiples knowledge spaces
   - Scientist validates and designs additional texts or experiments
Very high impact events and facts

- **US Election 2012** – Obama’s campaign and rise of Big Data analytics
  - Micro-targeting and Social Networks analysis
- **Brexit 2016**
  - “Data driven Brexit” – first serious ring for right use of Data Science technologies
- **US Election 2016**
  - Clinton’s campaign – “Data driven” but using only upper layer of Social Network (SN) web
  - Trump’s campaign – Targeting bottom SN web and “forgotten people not to be forgotten”
    - Matt Oczkowski, leader on Trump’s campaign: “If he was going to win this election, it was going to be because of a Brexit style mentality and a different demographic trend than other people were seeing.”
- **France election 2017**
  - Awakening
Data-Driven Brexit: A Wakeup Call for Analysts
By Barry Devlin, June 28, 2016

Article “In Data we trust” by T.Edsall in The New York Times
Multimillion-dollar contract for data management and collection services awarded May 1, 2013 to Liberty Work (for Republicans) to build advanced list of voters

There are significant lessons for believers in data-driven business to learn from how data was and wasn’t used for decision making before, during, and after the Brexit vote.

Human attitude -- including emotion, intuition, and social empathy -- and motivation are at the heart of decision making and the action that follows.

Information will only be accepted when it conforms to preconceived notions. Expertise is not sufficient and, in extremis, will be dismissed with ridicule.

Book: In Data We Trust: How Customer Data is Revolutionising Our Economy (Aug 2012)

• A strategy for tomorrow’s data world
Industry reports on Data Science Analytics and Data enabled skills demand

• Final Report on European Data Market Study by IDC (Feb 2017)
  – The EU data market in 2016 estimated EUR 60 Bln (growth 9.5% from EUR 54.3 Bln in 2015)
    • Estimated EUR 106 Bln in 2020
  – Number of data workers 6.1 mln (2016) - increase 2.6% from 2015
    • Estimated EUR 10.4 million in 2020
  – Average number of data workers per company 9.5 - increase 4.4%
  – Gap between demand and supply estimated 769,000 (2020) or 9.8%

• PwC and BHEF report “Investing in America’s data science and analytics talent: The case for action” (April 2017)
  – 2.35 mln postings, 23% Data Scientist, 67% DSA enabled jobs
  – DSA enabled jobs growing at higher rate than main Data Science jobs

• Burning Glass Technology, IBM, and BHEF report “The Quant Crunch: How the demand for Data Science Skills is disrupting the job Market” (April 2017)
  – DSA enabled jobs takes 45-58 days to fill: 5 days longer than average
  – Commonly required work experience 3-5 yrs
PwC&BHEF: Demand for DSA enabled jobs

Demand for business people with analytics skills, not just data scientists

- Of 2.35 million job postings in the US
  - 23% Data Scientist
  - 67% DSA enabled jobs

- Strong demand for managers and decision makers with Data Science (data analytics) skills/understanding
  - Challenge to deliver actionable knowledge and competences to CEO level managers
PwC&BHEF: Skills that are tough to find

To be mapped to Competences, Knowledge, Skills and Personal (soft) Skills

- Cybersecurity: 97%
- Data science and analytics: 95%
- Critical thinking and problem solving: 83%
- Design/systems thinking: 79%
- Global perspective: 79%
- Innovation and creativity: 78%
- Cognitive flexibility: 78%
- Cross-disciplinary ability: 74%

### PwC&BHEF: Data Science and Analytics skills, by 2021: The supply-demand challenge

<table>
<thead>
<tr>
<th>Student supply</th>
<th>Employer demand</th>
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- **23%** of educators say all graduates will have data science and analytics skills.
- **69%** of employers say they will prefer job candidates with these skills over ones without.
Challenge for Education: Sustainable ICT and Data Skills Development

• Educate vs Train
  – Training is a short term solution
  – Education is a basis for sustainable skills development

• Technology focus changes every 3-4 years
  – Study: 50% of academic curricula are outdated at the time of graduation

• Lack of necessary skills leads to underperforming projects and organisations and loose of competitiveness
  – Challenge: Policy and decision makers don’t have mind set to plan human factor (competences and skills) as a part of technology strategy

• Need to change the whole skills management paradigm
  – Dynamic (self-) re-skilling: Continuous professional development and shared responsibility between employer and employee
  – Skills and career management as a part of professional orientation
EDISON Products for Data Science Skills Management and Tailored Education

- **EDISON Data Science Framework (EDSF)**
  - Compliant with EU standards on competences and professional occupations e-CFv3.0, ESCO
  - Customisable courses design for targeted education and training

- **Skills development and career management for Core Data Experts and related data handling professions**

- **Capacity building and Data Science team design**

- **Academic programmes and professional training courses (self) assessment and design**

- **EU network of Champion universities pioneering Data Science academic programmes**

- **Engagement in relevant RDA activities and groups**

- **Cooperation with International professional organisations IEEE, ACM, BHEF, APEC (AP Economic Cooperation)**
EDISON Data Science Framework (EDSF)

EDISON Framework components
- CF-DS – Data Science Competence Framework
- DS-BoK – Data Science Body of Knowledge
- MC-DS – Data Science Model Curriculum
- DSP – Data Science Professional profiles
- Data Science Taxonomies and Scientific Disciplines Classification
- EOEE - EDISON Online Education Environment

Methodology
- ESDF development based on job market study, existing practices in academic, research and industry.
- Review and feedback from the ELG, expert community, domain experts.
- Input from the champion universities and community of practice.
Data Scientist definitions: From Math to Hacking

- Strongly depend on the background of the Data Scientist

Substantive Expertise

Data Science

Hacking Skills

Math & Statistics Knowledge

Machine Learning

Data Science

Danger Zone!

Traditional Research

Mathematics Expertise

Technology; Hacking Skills

Business/Strategy Acumen
• Good and practical advice how to learn Data Science, step by step

• Follow the route
Data Scientist definition

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

- **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
Data Science Competence Groups - Research

Data Science Competences include 5 groups
- Data Science Analytics
- Data Science Engineering
- Domain Knowledge and Expertise
- Data Management
- Scientific Methods or Business Process Management

Scientific Methods
- Design Experiment
- Collect Data
- Analyse Data
- Identify Patterns
- Hypothesis Explanation
- Test Hypothesis

Business Operations
- Operations Strategy
- Plan
- Design & Deploy
- Monitor & Control
- Improve & Re-design
Data Science Competences include 5 groups

- Data Science Analytics
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Scientific Methods

- Design Experiment
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- Hypothesise Explanation
- Test Hypothesis

Business Process Operations/Stages

- Design
- Model/Plan
- Deploy & Execute
- Monitor & Control
- Optimise & Re-design
<table>
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<tr>
<th>Identified Data Science Competence Groups</th>
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<tr>
<td><strong>Data Science Analytics (DSDA)</strong></td>
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<tr>
<td><strong>Data Management (DSDM)</strong></td>
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<tr>
<td><strong>Data Science Engineering (DSENG)</strong></td>
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<tr>
<td><strong>Research/Scientific Methods (DSRM)</strong></td>
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<tr>
<td><strong>Data Science Domain Knowledge, e.g. Business Processes (DSDK/DSBPM)</strong></td>
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<tr>
<td>0</td>
<td>Use appropriate statistical techniques and predictive analytics on available data to deliver insights and discover new relations</td>
<td>Develop and implement data management strategy for data collection, storage, preservation, and availability for further processing.</td>
<td>Use engineering principles to research, design, develop and implement new instruments and applications for data collection, analysis and management</td>
<td>Create new understandings and capabilities by using the scientific method (hypothesis, test/ artefact, evaluation) or similar engineering methods to discover new approaches to create new knowledge and achieve research or organisational goals</td>
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<tr>
<td>1</td>
<td><strong>DSDA01</strong> Use predictive analytics to analyse big data and discover new relations</td>
<td><strong>DSDM01</strong> Develop and implement data strategy, in particular, Data Management Plan (DMP)</td>
<td><strong>DSENG01</strong> Use engineering principles to design, prototype data analytics applications, or develop instruments, systems</td>
<td><strong>DSRM01</strong> Create new understandings and capabilities by using scientific/research methods or similar domain related development methods</td>
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<tr>
<td>2</td>
<td><strong>DSDA02</strong> Use statistical techniques to deliver insights</td>
<td><strong>DSDM02</strong> Develop data models including metadata</td>
<td><strong>DSENG02</strong> Develop and apply computational solutions</td>
<td><strong>DSRM02</strong> Direct systematic study toward a fuller knowledge or understanding of the observable facts</td>
</tr>
<tr>
<td>3</td>
<td><strong>DSDA03</strong> Develop specialized tools for data analysis</td>
<td><strong>DSDM03</strong> Collect integrate data</td>
<td><strong>DSENG03</strong> Develops specialized tools</td>
<td><strong>DSRM03</strong> Undertakes creative work</td>
</tr>
<tr>
<td>4</td>
<td><strong>DSDA04</strong> Analyze complex data</td>
<td><strong>DSDM04</strong> Maintain repository</td>
<td><strong>DSENG04</strong> Design, build, operate</td>
<td><strong>DSRM04</strong> Translate strategies into actions</td>
</tr>
<tr>
<td>5</td>
<td><strong>DSDA05</strong> Use different analytics</td>
<td><strong>DSDM05</strong> Visualise complex data</td>
<td><strong>DSENG05</strong> Secure and reliable data</td>
<td><strong>DSRM05</strong> Contribute to organizational goals</td>
</tr>
</tbody>
</table>
Key Data Science Analytics Competences by EDISON and DARE Project for APEC countries

• Data Science Analytics, Data Science Engineering, Data Management, Research Methods, Domain Knowledge
  – 3 levels of proficiency defined: Entry/Associate, Professional, Expert/Lead

• Foundational competences (starting from entry level to expert level)
  – Statistics, Probability theory, mathematics, calculus
  – Statistical programming languages, frameworks, tools
  – Computational methods and document processing tools (including Excel, Office visualization, or similar)
  – Data Visualisation and tools

• 21st Century Skills and Data Science Professional skills
Data Science Professional Skills: 
Thinking and Acting like Data Scientist

1. **Recognise value of data**, work with raw data, exercise good data intuition, use SN and open data
2. 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)
3. Good **sense of metrics**, understand importance of the results validation, never stop looking at individual examples
4. **Ask the right questions**
5. Respect domain/subject matter knowledge in the area of data science
6. **Data driven problem solver** and **impact-driven mindset**
7. **Be aware about power and limitations** of the main machine learning and data analytics algorithms and tools
8. 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 variables and factors
9. Recognise what things are **important** and what things are **not important** (in data modeling)
10. Working in **agile environment** and coordinate with other roles and team members
11. Work in **multi-disciplinary team**, ability to communicate with the domain and subject matter experts
12. Embrace **online learning**, continuously improve your knowledge, use **professional networks** and communities
13. **Story Telling**: Deliver actionable result of your analysis
14. **Attitude**: Creativity, curiosity (willingness to challenge status quo), commitment in finding new knowledge and progress to completion
15. **Ethics and responsible use** of data and insight delivered, awareness of dependability (data scientist is a feedback loop in data driven companies)
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21st Century Skills (DARE & BHEF & EDISON)

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

2. **Communication**: Understanding and communicating ideas

3. **Collaboration**: Working with others, appreciation of multicultural difference

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

5. **Planning & Organizing**: Planning and prioritizing work to manage time effectively and accomplish assigned tasks

6. **Business Fundamentals**: Having fundamental knowledge of the organization and the industry

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

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

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

10. **Professional networking**: Involvement and contribution to professional network activities

11. **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
Practical Application of the CF-DS

- Basis for the definition of the Data Science Body of Knowledge (DS-BoK) and Data Science Model Curriculum (MC-DS)
  - CF-DS => Learning Outcomes (MC-DS) => Knowledge Areas (DS-BoK)
  - CF-DS => Data Science taxonomy of scientific subjects and vocabulary
- Data Science professional profiles definition
  - Extend existing EU standards and occupations taxonomies: e-CFv3.0, ESCO, others
- Professional competence benchmarking
  - For customizable training and career development
  - Including CV or organisational profiles matching
- Professional certification
  - In combination with DS-BoK professional competences benchmarking
- Vacancy construction tool for job advertisement (for HR)
  - Using controlled vocabulary and Data Science Taxonomy
**Data Science Professions Family**

**Managers:** Chief Data Officer (CDO), Data Science (group/dept) manager, Data Science infrastructure manager, Research Infrastructure manager

**Professionals:** Data Scientist, Data Science Researcher, Data Science Architect, Data Science (applications) programmer/engineer, Data Analyst, Business Analyst, etc.

**Professional (database):** Large scale (cloud) database designers and administrators, scientific database designers and administrators

**Professional (data handling/management):** Data Stewards, Digital Data Curator, Digital Librarians, Data Archivists

**Technicians and associate professionals:** Big Data facilities operators, scientific database/infrastructure operators

**Support workers and data handling clerks:** User support workers, data entry clerks, data entry field workers

Icons used: Credit to [ref] https://www.datacamp.com/community/tutorials/data-science-industry-infographic
DSP Profiles mapping to ESCO Taxonomy
High Level Groups

- DSP Profiles mapping to corresponding CF-DS Competence Groups
  - Relevance level from 5 – maximum to 1 – minimum
EVSF for Education and Training

- **Foundation and methodological base**
  - Data Science Body of Knowledge (DS-BoK)
    - Taxonomy and classification of Data Science related scientific subjects
  - Data Science Model Curriculum (MC-DS)
    - Set Learning Units mapped to CF-DS Learning and DS-BoK Knowledge Areas/Units
  - Instructional methodologies and teaching models

- **Platforms and environment**
  - Virtual labs, datasets, developments platforms
  - Online education environment and courses management

- **Services**
  - Individual benchmarking and profiling tools (competence assessment)
  - Knowledge evaluation tools
  - Certifications and training for self-made Data Scientists practitioners
  - Education and training marketplace: Courses catalog and repository
DS-BoK Knowledge Area Groups (KAG)

• **KAG1-DSA**: Data Analytics group including Machine Learning, statistical methods, and Business Analytics

• **KAG2-DSE**: Data Science Engineering group including Software and infrastructure engineering

• **KAG3-DSDM**: *Data Management group including data curation, preservation and data infrastructure*

• **KAG4-DSRM**: *Research Methods and Project Management group*

• **KAG5-DSBA**: Business Analytics and Business Intelligence

• **KAG* - DSDK**: Data Science domain knowledge to be defined by related expert groups
Example DS-BoK Knowledge Areas definition and mapping to existing BoKs and CCS (2012)

<table>
<thead>
<tr>
<th>Knowledge Area Groups (KAG)</th>
<th>Knowledge Areas (KA)</th>
<th>Suggested Knowledge Units (KU)</th>
<th>Mapping to CCS2012 (including suggested Data Science extensions) and existing BoKs</th>
</tr>
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<tbody>
<tr>
<td>KAG1-DSDA: Data Analytics group (including Machine Learning, statistical methods)</td>
<td>Theory of computation</td>
<td>Design and Analysis of Algorithms</td>
<td>CCS2012: Theory of computation Design and analysis of algorithms Data structures design and...</td>
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<tr>
<td>KAG2-DSENG: Data Science Engineering group including Software and infrastructure engineering</td>
<td>Computer systems organisation for Big Data</td>
<td>Parallel and Distributed Computer Architecture</td>
<td>CCS2012: Computer systems organisation Architectures Parallel architectures</td>
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- Mapping suggested to CCS2012 and existing BoKs
Data Science Model Curriculum (MC-DS)

Data Science Model Curriculum includes

- Learning Outcomes (LO) definition based on CF-DS
  - LOs are defined for CF-DS competence groups and for all enumerated competences

- LOs mapping to Learning Units (LU)
  - LUs are based on CCS(2012) and universities best practices
  - Data Science university programmes and courses inventory (interactive)
    http://edison-project.eu/university-programs-list

- LU/course relevance: Mandatory Tier 1, Tier 2, Elective, Prerequisite

- Learning methods and learning models (in progress)
Example MC-DS Mapping Learning Units to DS-BoK and CCS (2012)

- Mapping suggested to ACM CCS2012, DS-BoK and other related BoKs
Outcome Based Educations and Training Model

From Competences and DSP Profiles to Learning Outcomes (LO) and Knowledge Units (KU) and Learning Units (LU)

- EDSF allow for customized educational courses and training modules design
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

- Data Science Applications Developer
- Data Steward
- Data Engineer, Database Developer
- Data Scientist
- Data Analyst/Business Analyst
- Data Science Researcher
- Business Analyst
- Data Science Applications Developer
- Data Steward
- Data Steward
- Data Steward
- Data Steward
- Data设施 Operator
- Data Source (Experiment, Data Driven Application)
- Data Collection
- Data Ingest
- Data Analysis
- Results, Actionable Data
- Data Visualisation, Reporting, Storage
- Data Science Group Manager, Data Science Architect
- Researcher (Scientific domain)
Data Science or Data Management Group/Department: Organisational structure and staffing - EXAMPLE

Data Science or Data Management Group/Department

- (Managing) Data Science Architect (1)
- Data Scientist (1), Data Analyst (1)
- Data Science Application programmer (2)
- Data Infrastructure/facilities administrator/operator: storage, cloud, computing (1)
- **Data stewards**, curators, archivists (3-5)

>> Reporting to CDO/CTO/CEO
- Providing cross-organizational services

Estimated: Group of 10-12 data specialists for research institution of 200-300 research staff.

Growing role and demand for Data Stewards and data stewardship
Data Stewards – A rising new role in Data Science ecosystem

- Data Stewards as a key bridging role between Data Scientists as (hard)core data experts and scientific domain researchers (HLEG EOSC report)
- Current definition of Data Steward (part of Data Science Professional profiles)
  - Data Steward is a data handling and management professional whose responsibilities include planning, implementing and managing (research) data input, storage, search, and presentation.
  - Data Steward creates data model for domain specific data, support and advice domain scientists/researchers during the whole research cycle and data management lifecycle.
Further developments and Next steps

- **EDSF Release 2 (mid July 2017)** will link competences to skills and knowledge
  - Data Science Body of Knowledge and Model Curriculum ready for direct use
- **Development of EDSF based tools**: Self assessment and Market monitoring
- **Certification Framework** for at least two levels of Data Science competences proficiency: Associates and Professionals
  - Data Science knowledge and competences for decision makers
- **Toward EDSF and Data Science profession standardisation**
  - ESCO (European Skills, Competences and Occupations) taxonomy
  - CEN TC428 (European std body) – Extending current eCFv3.0 and ICT profiles towards e-CF4 with Data Science related competences
  - Work with the IEEE and ACM curriculum workshop to define Data Science Curriculum and extend current CCS2012 (Classification Computer Science 2012)
- **Data Science Manifesto** – Primarily focused on Professional and Ethical issues in Data Science, new type of professional
Summary: Services and References

- EDISON Website: http://edison-project.eu/
- Directory of University programs: http://edison-project.eu/university-programs-list
- Community Portal: http://datasciencepro.eu/

- Survey Data Science Competences: Invitation to participate: https://www.surveymonkey.com/r/EDISON_project_-_Defining_Data_science_profession

- Competences benchmarking and tailored training for practitioners
- Data Science Curriculum advice and design for universities
- Data Science team building and organizational roles profiling
Links to EDISON Resources

• EDISON project website http://edison-project.eu/

• EDISON Data Science Framework Release 1 (EDSF) http://edison-project.eu/edison-data-science-framework-edsf
  – Data Science Body of Knowledge http://edison-project.eu/data-science-body-knowledge-ds-bok

• Survey Data Science Competences: Invitation to participate https://www.surveymonkey.com/r/EDISON_project - Defining_Data_science_profession
Other related links

• Amsterdam School of Data Science
  – https://www.schoolofdatascience.amsterdam/
  – https://www.schoolofdatascience.amsterdam/education/

• Research Data Alliance interest Group on Education and Training on Handling of Research Data (IG-ETHRD)
  – https://www.rd-alliance.org/groups/education-and-training-handling-research-data.html

• Final Report on European Data Market Study by IDC (Feb 2017)

• PwC and BHEF report “Investing in America’s data science and analytics talent: The case for action” (April 2017)

• Burning Glass Technology, IBM, and BHEF report “The Quant Crunch: How the demand for Data Science Skills is disrupting the job Market” (April 2017)
OECD

• Demand for new type of “dynamic self-re-skilling workforce”
• Continuous learning and professional development to become a shared responsibility of workers and organisations

[ref] SKILLS FOR A DIGITAL WORLD, OECD, 25-May-2016

UN

• Data Revolution Report "A WORLD THAT COUNTS" Presented to Secretary-General (2014)
  http://www.undatarevolution.org/report/
• Data Literacy is defined as key for digital revolution
• Data literacy = critically analyse data collected and data visualised
EDSF Recognition, Endorsement and Implementation

- **DARE (Data Analytics Rising Employment)** project by APEC (Asia Pacific Economic Cooperation)
  - DARE project Advisory Council meeting 4-5 May 2017, Singapore
- **PcW and BHEF Report** “Investing in America’s data science and analytics talent” April 2017
  - Quotes EDSF and Amsterdam School of Data Science
- **Dutch Ministry of Education recommended EDSF** as a basis for university curricula on Data Science
  - Workshop “Be Prepared for Big Data in the Cloud: Dutch Initiatives for personalized medicine and health research & toward a national action programme for data science training”, Amsterdam 28 June 2016
  - Currently working with Dutch Gov on re-skilling IT/data workers for DSA competences
- **European Champion Universities network**
  - 1st Conference (13-14 July, UK), 2nd Conference (14-15 March, Madrid, Spain)
  - 3rd Conference 19-20 June 2017, Warsaw

- The need for **new multidisciplinary and digital skills in particular Data Scientist**
  - Expected rapidly growing demand will lead to more than 800 000 unfilled vacancies by 2020


- Launch **Digital Skills and Jobs Coalition** (1st December 2016, Brussels) to develop comprehensive national digital skills strategies by mid-2017


- **European Open Science Cloud (EOSC)** and European digital research and data infrastructure
  - To offer 1.7 million European researchers and 70 million professionals in science and technology open and seamless services for **storage, management, analysis and re-use** of research data

**HLEG report on European Open Science Cloud** (October 2016) identified need for data experts and data stewards

- Estimation: More than 80,000 data stewards (1 per every 20 scientists)
- **Core Data Experts** need to be trained and their career perspective improved
What challenges related to skills management the EDSF can help to address?

1. Guide researchers in using right methods and tools, latest Data Analytics technologies to extracting value from scientific data
2. Educate and train RI engineers dev to build modern data intensive research infrastructure and understand trends and project for future
3. Develop new data analytics tools and ensure continuous improvement (agile model, DevOps)
4. Correctly organise and manage data, make them accessible (adhering FAIR principles), education new profession of Data Stewards
5. Help managers to facilitate career dev for researchers and organise effective teams
6. Ensure skills and expertise sustain in organisation
7. Help research institutions to sustain in competition with industry and business in data science talent hunting