



Member States Working Group on ESCO

State of play of the work on skills clustering: The process of building the skills clusters hierarchy

18 March 2024

Overview

Introduction

- Scope of the project
- Project workflow

Developing a new skills and knowledge structure

- External ontologies and classification systems
- Design principles
- ICT demo
- Health demo
- Agriculture and veterinary demo

Skill-skill co-occurrence links

- Identifying and visualising co-occurrence relations between skills

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Introduction

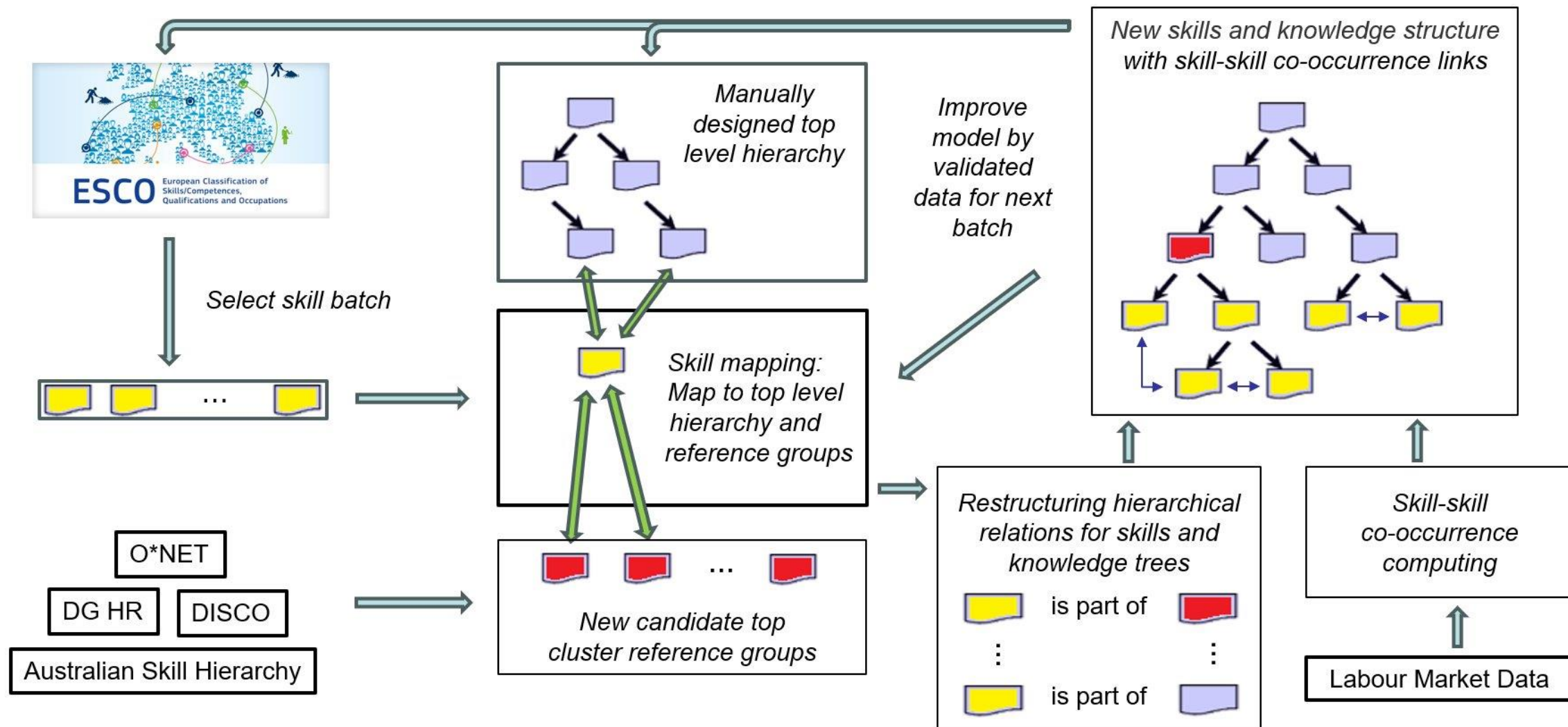
Why skills clustering?

- **Improve classification browsing** by applying an intuitive grouping of skills.
- **Support the use case of matching and skills suggestion** through logical grouping and co-occurrence data.

Scope of the exercise

- Short term improvement of two use cases. Aim is to create a specific view on top of ESCO.
- In parallel, the skills clustering allows for **exploration of strategic improvements** to ESCO.

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External classification systems that contributed to skills clusters

- Dewey Decimal Classification
- Library of Congress Classification
- Universal decimal classification
- ISCED-F
- NACE
- Australian skills classification
- Industrial Ontology Foundry
- Common Core Ontologies
- Relations Ontology
- The Food Ontology
- SNOMED
- FIBO
- The Environment Ontology
- Agrovoc
- GEMET

Design principles (heuristics)

- Consistency
- Economy / minimalism
- Completeness / comprehensiveness
- Rules around usage of polyhierarchy
- Meaningful hierarchical relations
- Ontological realism
- Mutual exclusivity
- Being data driven

Top layer architecture

Current ESCO visualisation



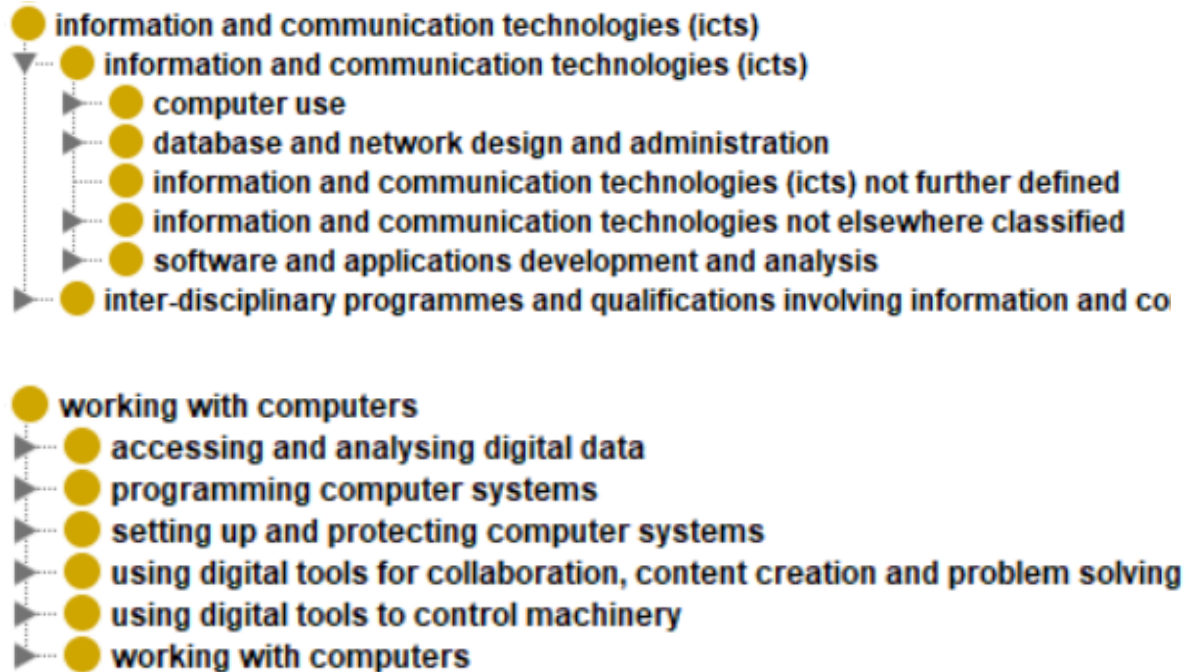
- Not structured around industries / sectors
- Skills concepts and knowledge concepts in 2 different trees

Skills clusters visualisation



- Structured around industries / sectors
- Skills concepts and knowledge concepts all together

Current ESCO visualisation



- Repetition
- Miscellaneous categories
- Access to little information
- Mutually exclusivity /comprehensiveness
- Not user friendly

Skills clusters visualisation



- Mutually exclusive / comprehensiveness
- Access to a lot of information
- User friendly
- Ontological realism

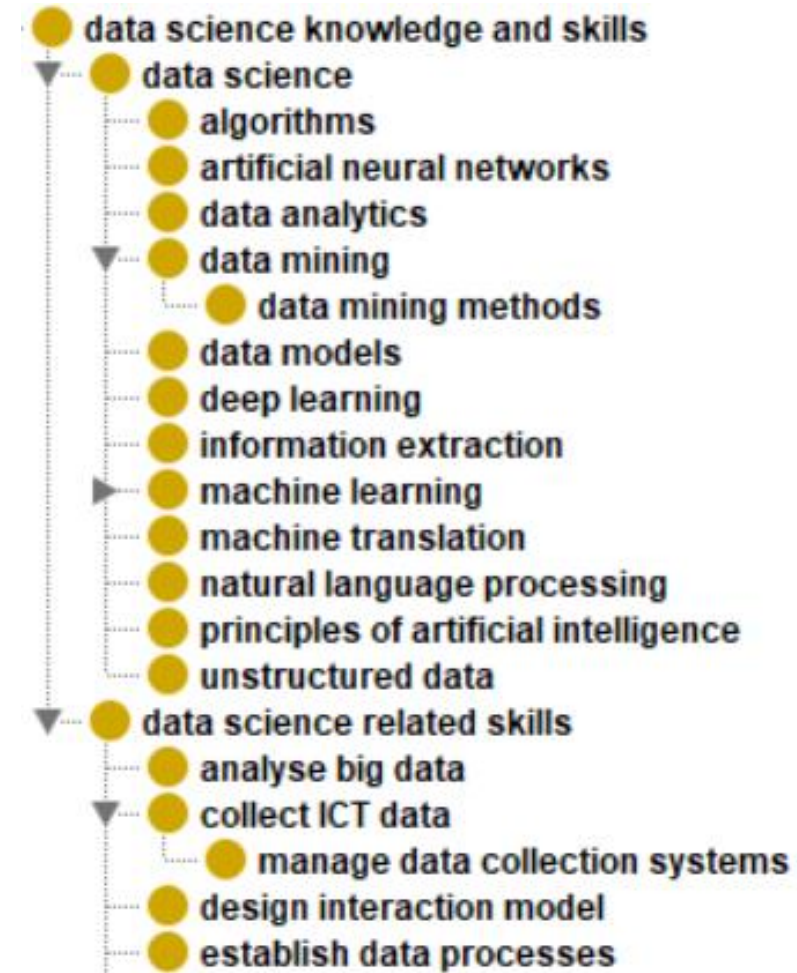
Data Science

Current ESCO visualisation



- **Ontological realism**
- **Meaningful hierarchical relations**
- **Long lists of granular concepts**

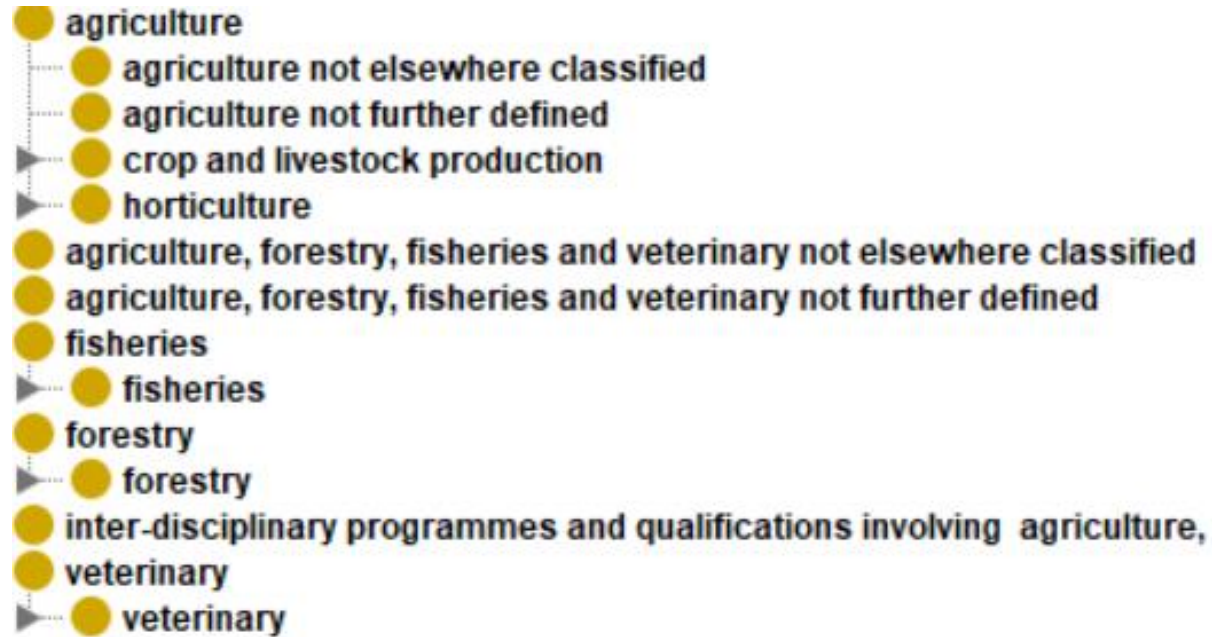
Skills clusters visualisation



- **User friendly**
- **Consistency**

Agriculture

Current ESCO visualisation



Skills clusters visualisation



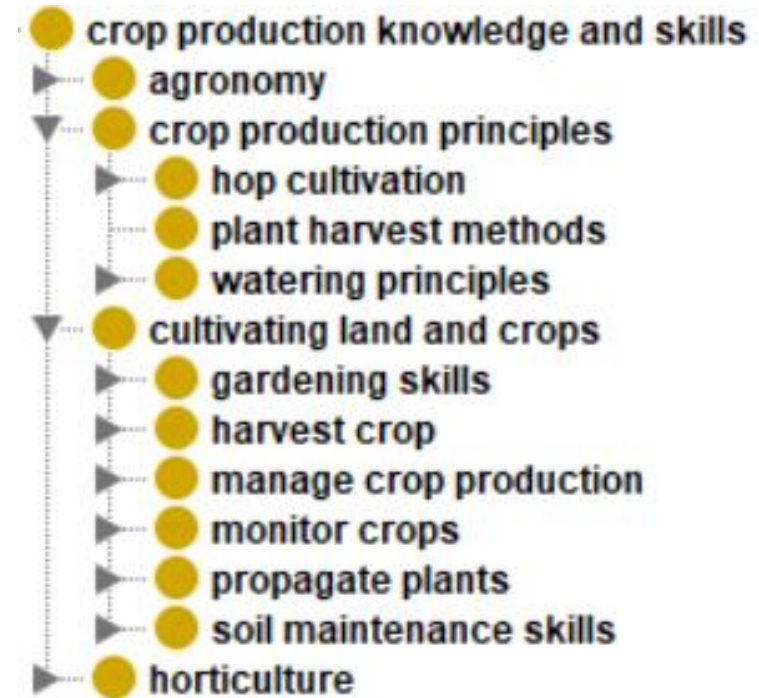
- **Miscellaneous categories**
- **Correctness of hierarchical relations**
- **Comprehensiveness**

Agriculture

Current ESCO visualisation



Skills clusters visualisation



- **Ontological realism**
- **Meaningful hierarchical relations**
- **Long lists of granular concepts**

Health

Current ESCO visualisation



- **Ontological realism**
- **Meaningful hierarchical relations**
- **Long lists of granular concepts**

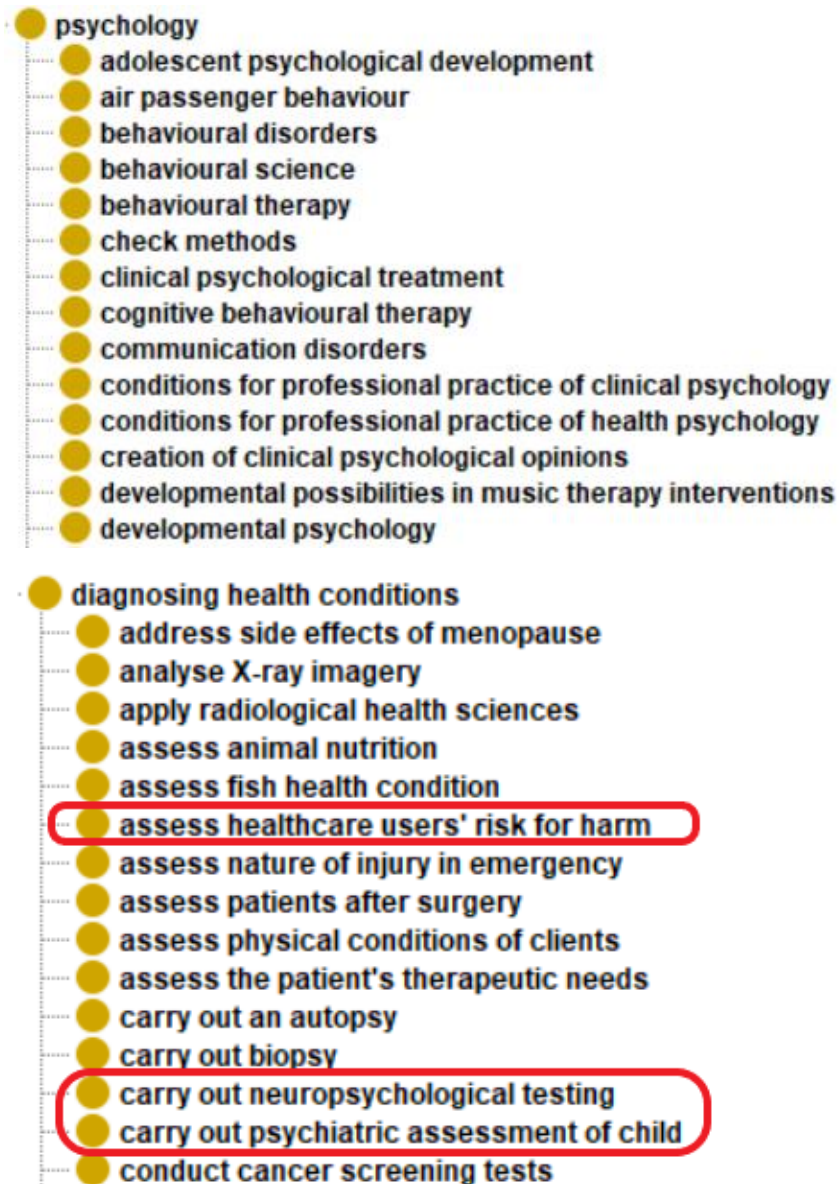
Skills clusters visualisation



- **Comprehensiveness**
- **Consistency**
- **User friendly**

Mental health

Current ESCO visualisation



Skills clusters visualisation



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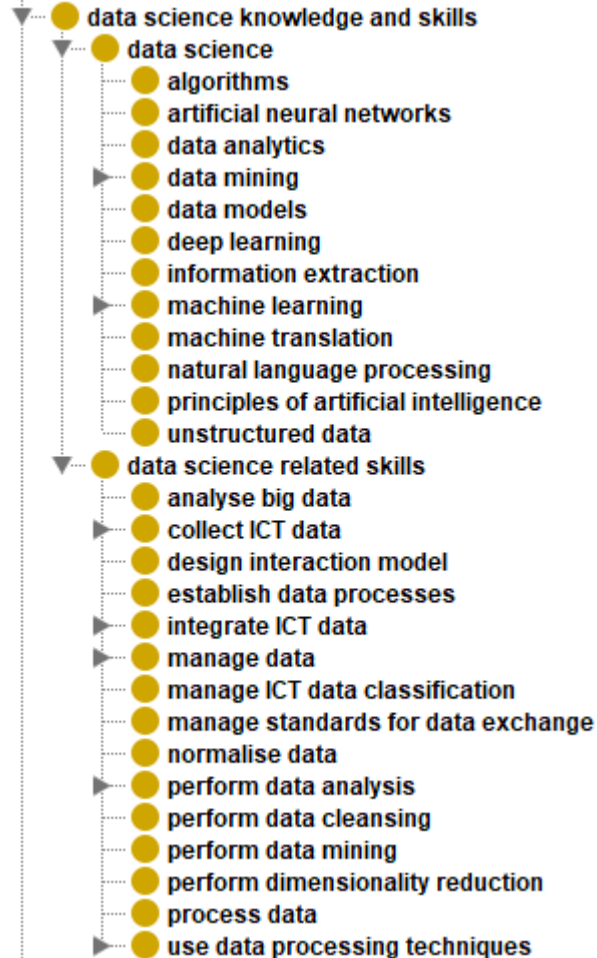
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Skill-skill co-occurrence links

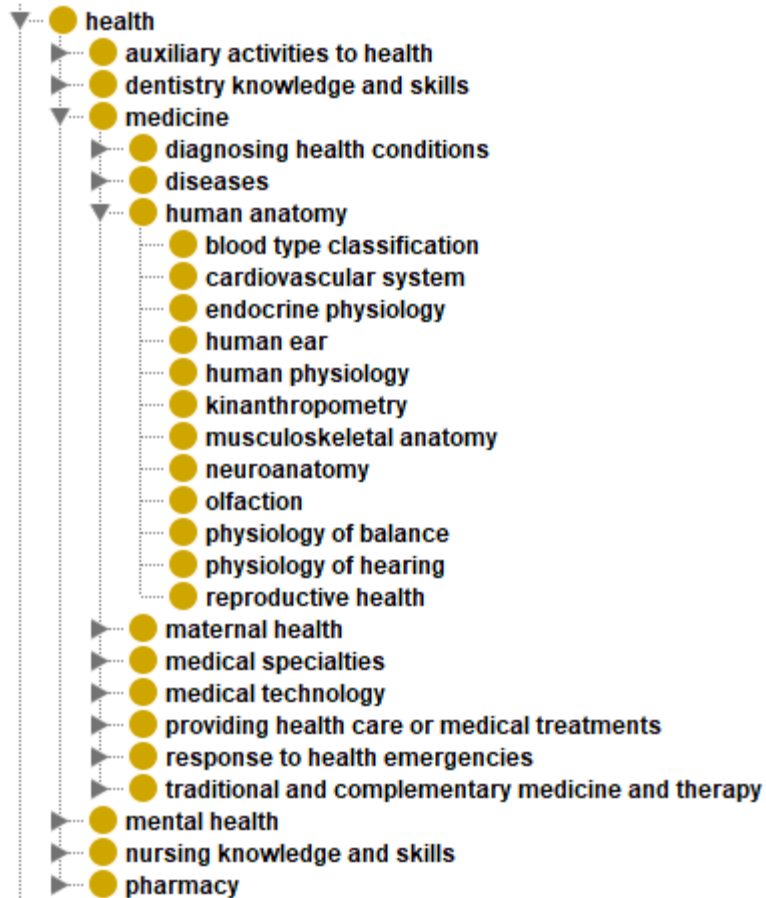
- Identifying and visualising co-occurrence relations between skills

Skill-skill Co-occurrence Links: Why?



- New structure provides a more meaningful grouping of concepts

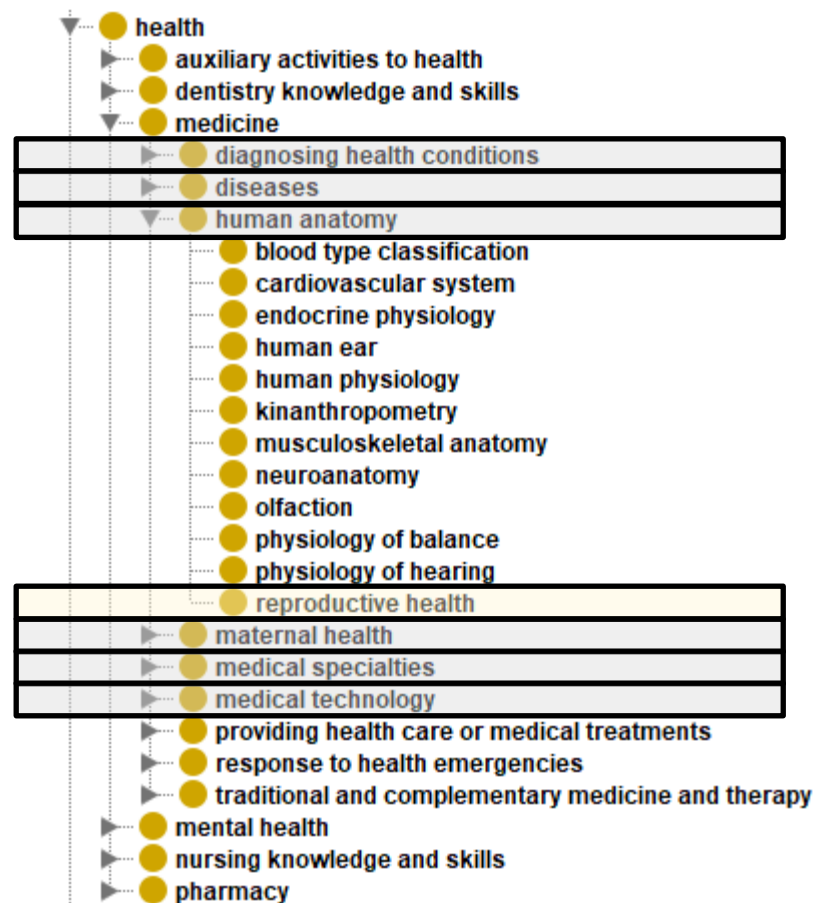
Skill-skill Co-occurrence Links: Why?



- New structure provides a more meaningful grouping of concepts
- However, for applications such as:
 - Skill suggestions to complete profile (Europass)
 - Job recommendation (EURES)
 - Skills intelligence

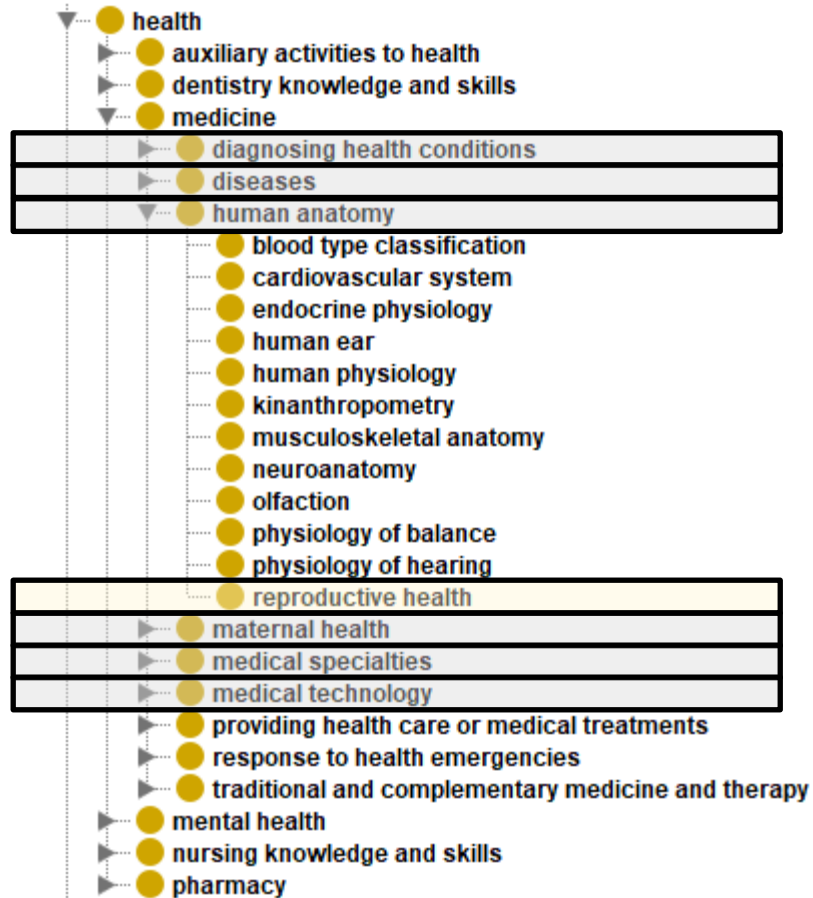
complementary skill-skill relations are relevant

Skill-skill Co-occurrence Links: Why?



ESCO concept	Cluster
obstetrics and gynaecology	medical specialties
female reproductive system pathology	diseases
diagnose gynaecological disorders	diseases
reproductive health	human anatomy
childbirth	maternal health
perform gynecological examination	diagnosing health conditions
obstetric ultrasonography	medical technology
urogynaecology	medical specialties

Skill-skill Co-occurrence Links: Why?



Complement new hierarchy with information on how employers and workers request/use combinations of skills

ESCO concept	Cluster	Co-occurrence ratio
obstetrics and gynaecology	medical specialties	1.00
female reproductive system pathology	diseases	0.29
diagnose gynaecological disorders	diseases	0.24
reproductive health	human anatomy	0.16
childbirth	maternal health	0.14
perform gynecological examination	diagnosing health conditions	0.14
obstetric ultrasonography	medical technology	0.13
urogynaecology	medical specialties	0.11

Skill-skill Co-occurrence Links: Why?

Why additional links instead of integrated in clustering?

- Not feasible to cluster all ESCO skills in non-overlapping groups without rules/guidelines:
 - CAD software
 - CAD for footwear
 - footwear industry
- Relations between concepts are non-symmetric:
 - environmental impact of tourism \Rightarrow applying environmental skills and competences
 - applying environmental skills and competences \nRightarrow environmental impact of tourism
- Co-occurrence links can later be made more explicit using specific ontology relations, e.g.: software for skill, knowledge for skill, etc.

Skill-skill Co-occurrence Links: Metric Development

How to compute co-occurrences?

- Count in how many vacancies / user profiles skills appear together
- Tested on small sample of 4 million vacancies
- Co-occurrence ratio for skill X, skill Y:

$$\text{confidence (skill X, skill Y)} = \frac{\# \text{ vacancies with skill X and skill Y}}{\# \text{ vacancies with skill X}}$$

- Extend to +100 million vacancies and Europass profiles

Skill-skill Co-occurrence Links: Example

ESCO skill: **hearing disability**

ESCO PT	Co-occurrence ratio
hearing loss	0.61
support people with hearing impairment	0.52
communication related to hearing impairment	0.33
physiology of hearing	0.22
adapt hearing tests	0.22
hearing aids	0.18
diagnose hearing impairment	0.18
audiology	0.13
recommend hearing aids	0.13
adjust hearing aids	0.13

Skill-skill Co-occurrence Links: Example

ESCO skill: **control compliance of railway vehicles regulations**

ESCO PT	Co-occurrence ratio
ensure compliance with railway regulation	0.68
railway law	0.64
enforce railway safety regulations	0.60
railway framework legislation	0.54
comply with railway safety standards	0.52
oversee operational safety on trains	0.46
perform maintenance work on rail tracks	0.26
perform rail track inspections	0.21
operate switching locomotives	0.11

Skill-skill Co-occurrence Links: Example

ESCO skill: **plan digital marketing**

ESCO PT	Co-occurrence ratio
digital marketing techniques	0.79
plan marketing campaigns	0.34
plan social media marketing campaigns	0.30
develop campaigns	0.26
online ads campaign techniques	0.22
content marketing strategy	0.21
search engine optimisation	0.19
web analytics	0.17
conduct search engine optimisation	0.16
manage online content	0.15

ESCO Portal Visualisation: Example – Digital Marketing Techniques

digital marketing techniques

Relationships

Broader concepts

marketing and advertising

Essential for

eBusiness manager digital marketing manager publications coordinator

Optional for

fortune teller photographer book publisher print studio supervisor
search engine optimisation expert business and marketing vocational teacher
medical sales representative art director marketing consultant

Co-occurring with

plan digital marketing plan social media marketing campaigns
social media marketing techniques plan marketing campaigns

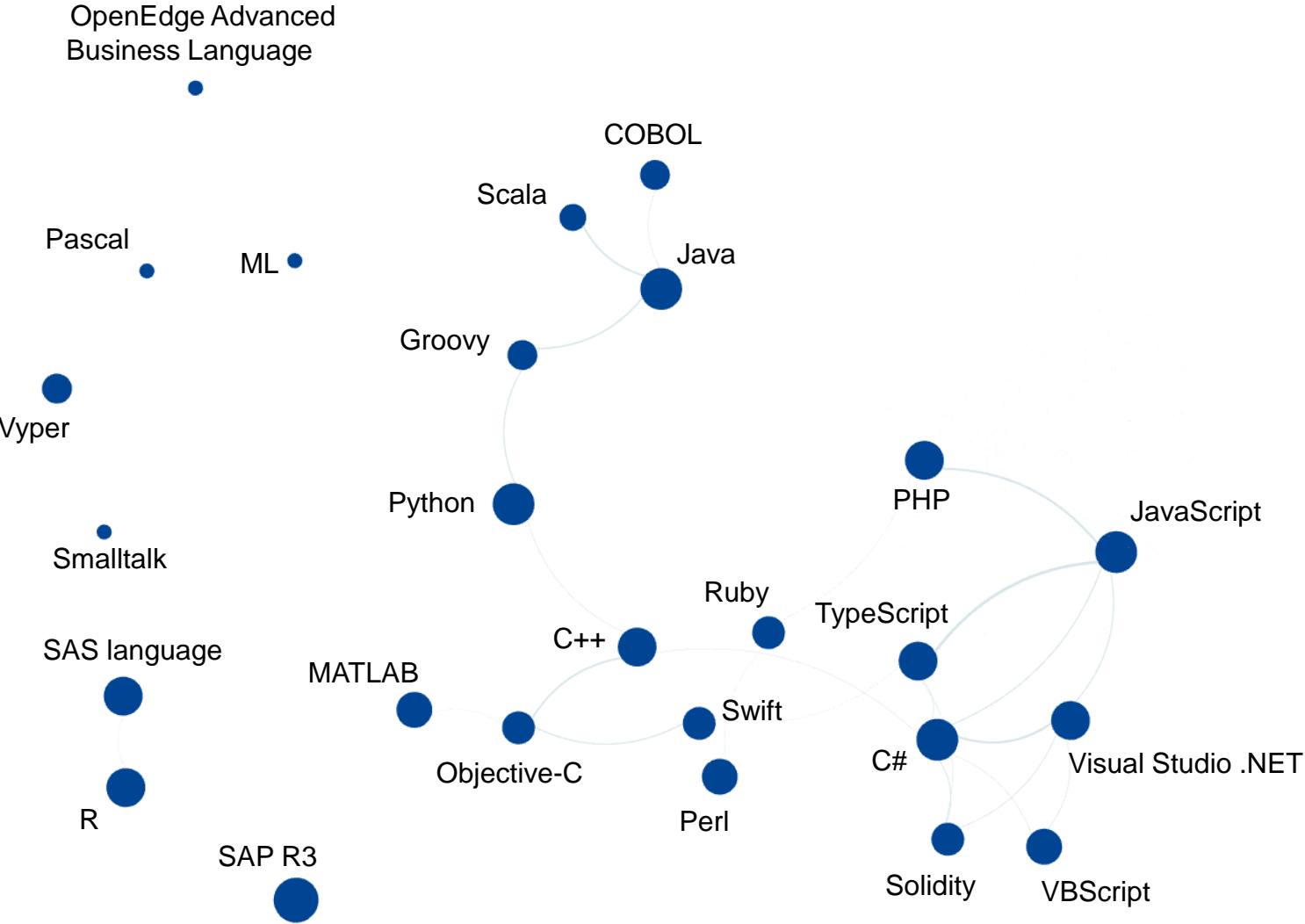
Concept URI

Concept Uri

<http://data.europa.eu/esco/skill/43dfbe7f-9e10-4871-b171-e5076737b4cf>

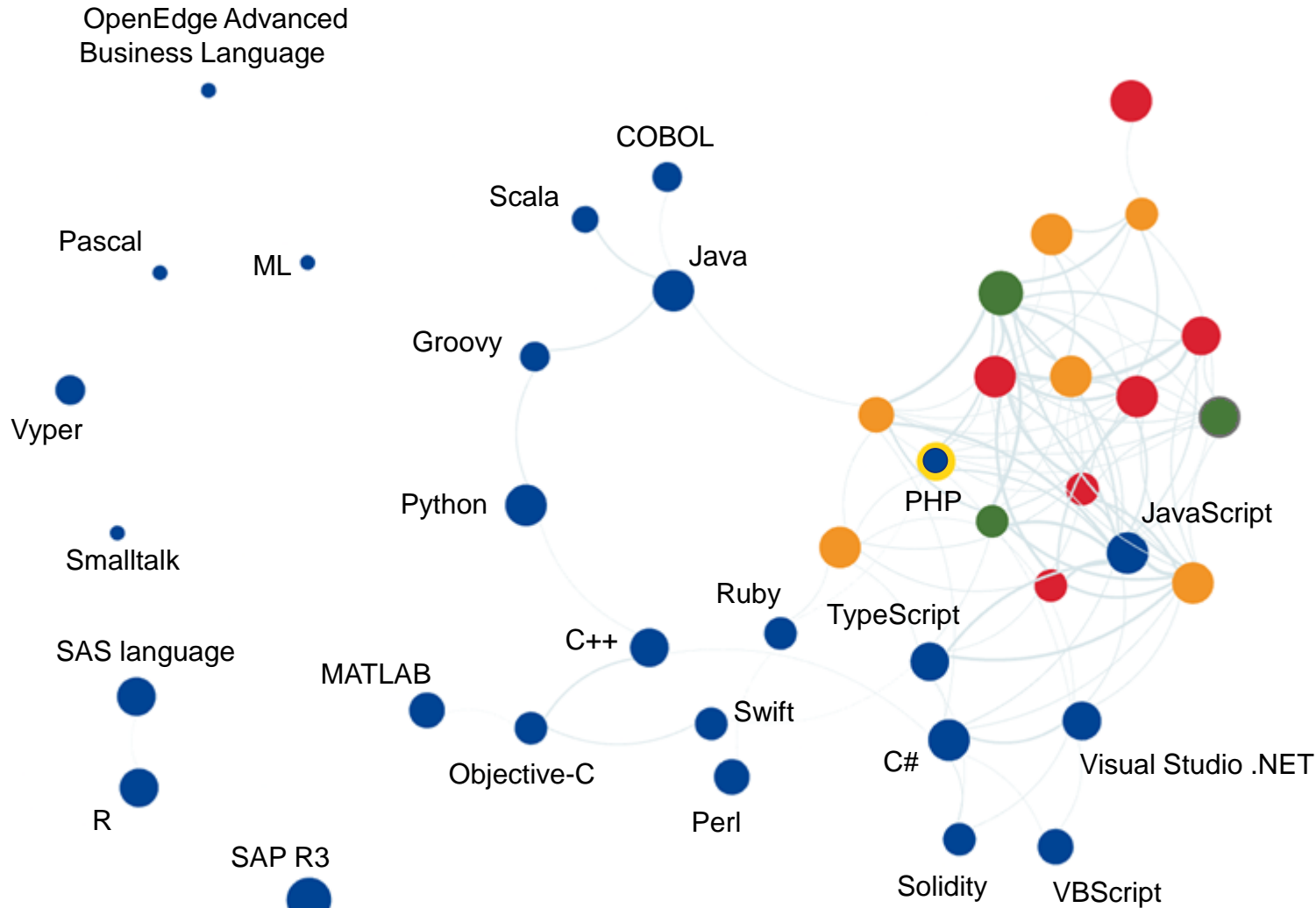
- Include co-occurrence information under *Relationships* on ESCO portal
- Display sorted list of co-occurring concepts
- Provide downloadable files

Graphical Visualisation: Example – Programming Languages

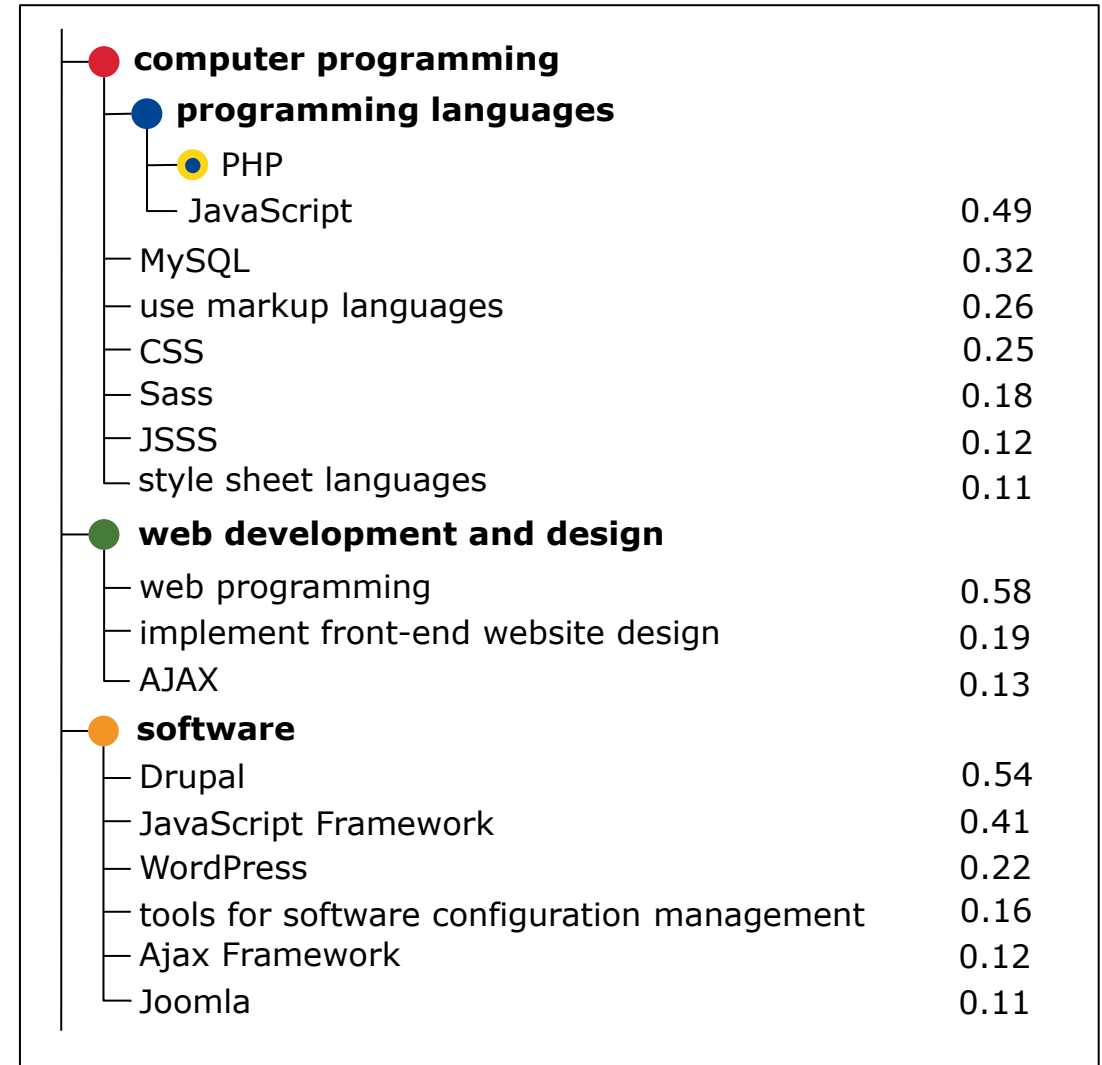
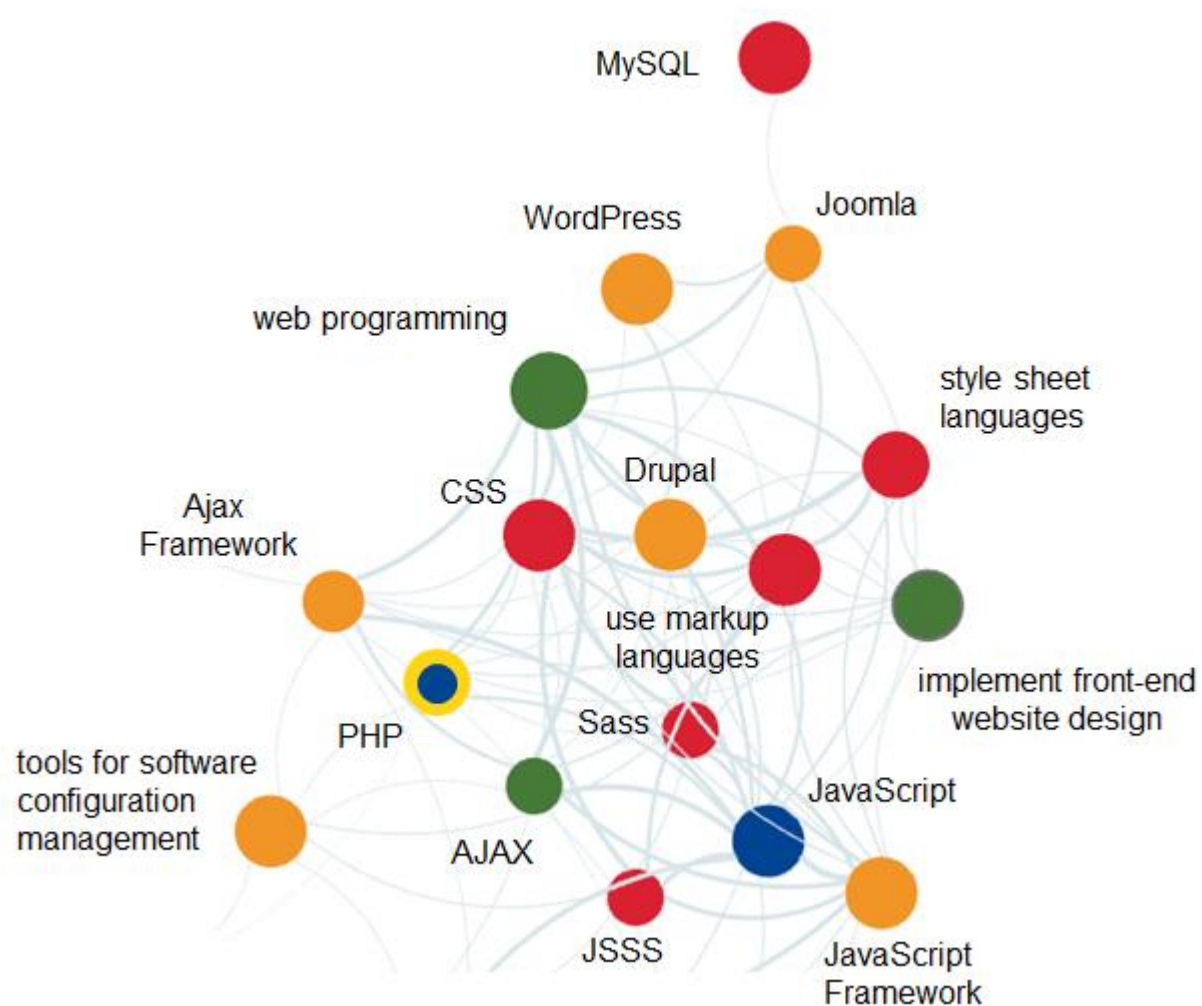


● programming languages

Graphical Visualisation: Example – PHP Co-occurring Clusters



Graphical Visualisation: Example – PHP Co-occurring Skills



Summary

- Developed methodology for creating alternative skills hierarchy
- Designed top level hierarchy and restructured hierarchical relations for 5,000 skill concepts based on established taxonomic guidelines
- Test with co-occurrence links provided additional relations between skills from the same and different clusters
- Apply methodology to all ESCO skill concepts
- Extend co-occurrence test to full scale analysis on 100+ million records

Thank you!

The ESCO Secretariat is always available to support implementers.

May you have any question, please contact us via email at EMPL-ESCO-SECRETARIAT@ec.europa.eu, use our hashtag #ESCO_EU.