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2016

nature > scientific data > comment > article



SCIENTIFIC DATA

Comment | [OPEN](#) | Published: 15 March 2016

The FAIR Guiding Principles for scientific data management and stewardship

Mark D. Wilkinson, Michel Dumontier, IJsbrand Jan Aalbersberg, Gabrielle Appleton, Myles Axton, Arie Baak, Niklas Blomberg, Jan-Willem Boiten, Luiz Bonino da Silva Santos, Philip E. Bourne, Jildau Bouwman, Anthony J. Brookes, Tim Clark, Mercè Crosas, Ingrid Dillo, Olivier Dumon, Scott Edmunds, Chris T. Evelo, Richard Finkers, Alejandra Gonzalez-Beltran, Alasdair J.G. Gray, Paul Groth, Carole Goble, Jeffrey S. Grethe, Jaap Heringa, Peter A.C 't Hoen, Rob Hooft, Tobias Kuhn, Ruben Kok, Joost Kok, Scott J. Lusher, Maryann E. Martone, Albert Mons, Abel L. Packer, Bengt Persson, Philippe Rocca-Serra, Marco Roos, Rene van Schaik, Susanna-Assunta Sansone, Erik Schultes, Thierry Sengstag, Ted Slater, George Strawn, Morris A. Swertz, Mark Thompson, Johan van der Lei, Erik van Mulligen, Jan Velterop, Andra Waagmeester, Peter Wittenburg, Katherine Wolstencroft, Jun Zhao & Barend Mons - [Show fewer authors](#)

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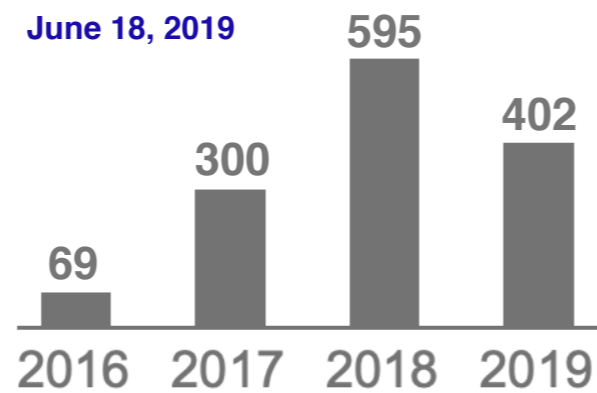
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Data and services that are **findable**, **accessible**, **interoperable**, **re-usable** both for machines and for people.

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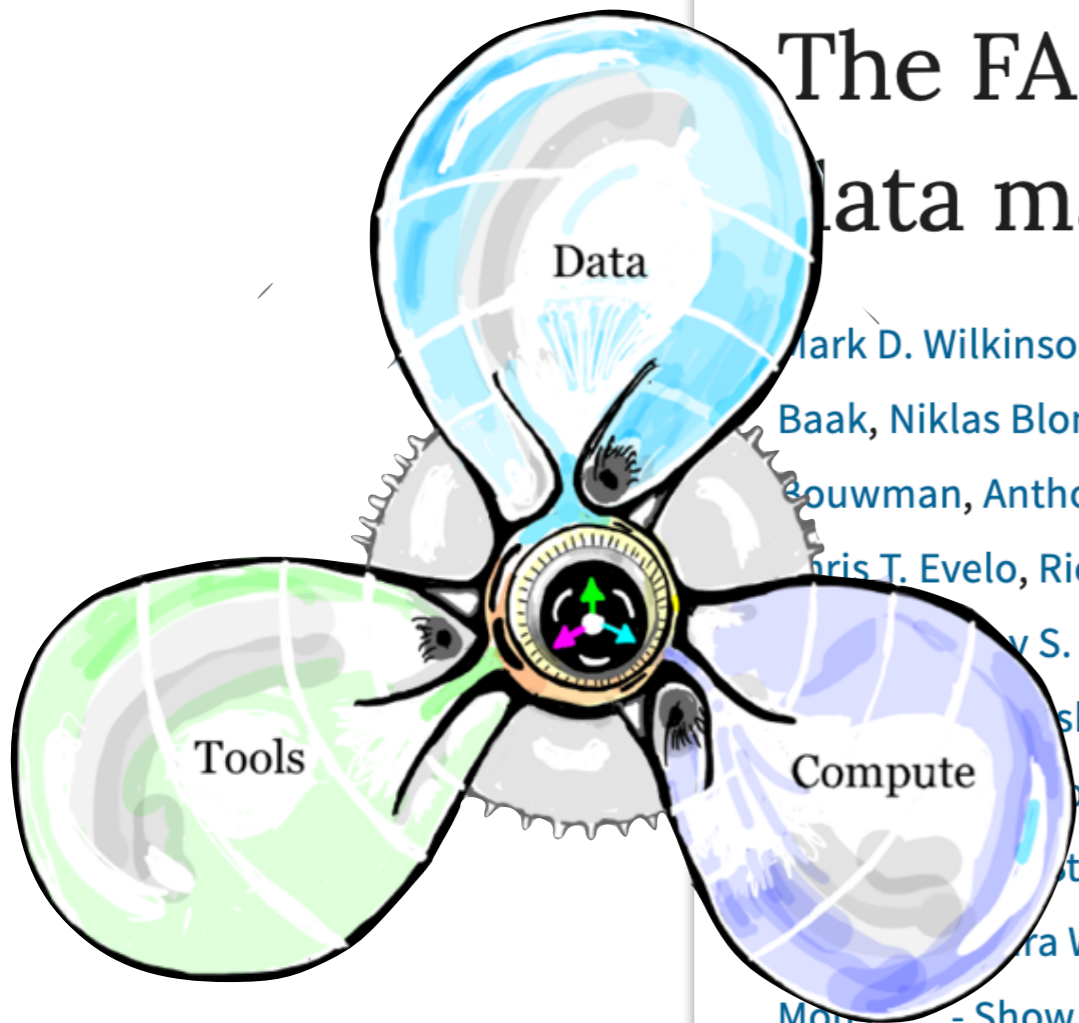
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Box 2 | The FAIR Guiding Principles

To be Findable:

- F1. (meta)data are assigned a globally unique and persistent identifier
- F2. data are described with rich metadata (defined by R1 below)
- F3. metadata clearly and explicitly include the identifier of the data it describes
- F4. (meta)data are registered or indexed in a searchable resource

To be 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

To be 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

To be 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
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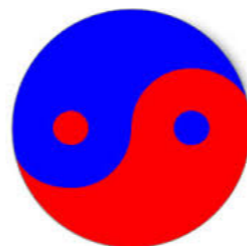
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Technology



Domain-relevant content

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2017

***FAIR
Principles***



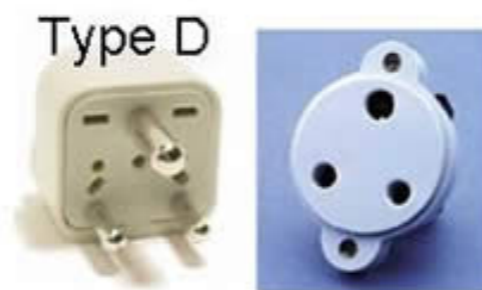
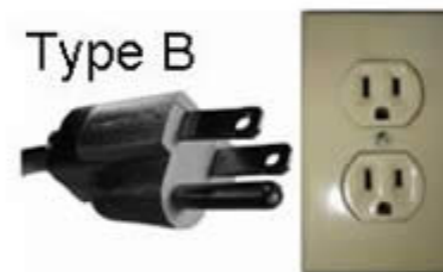
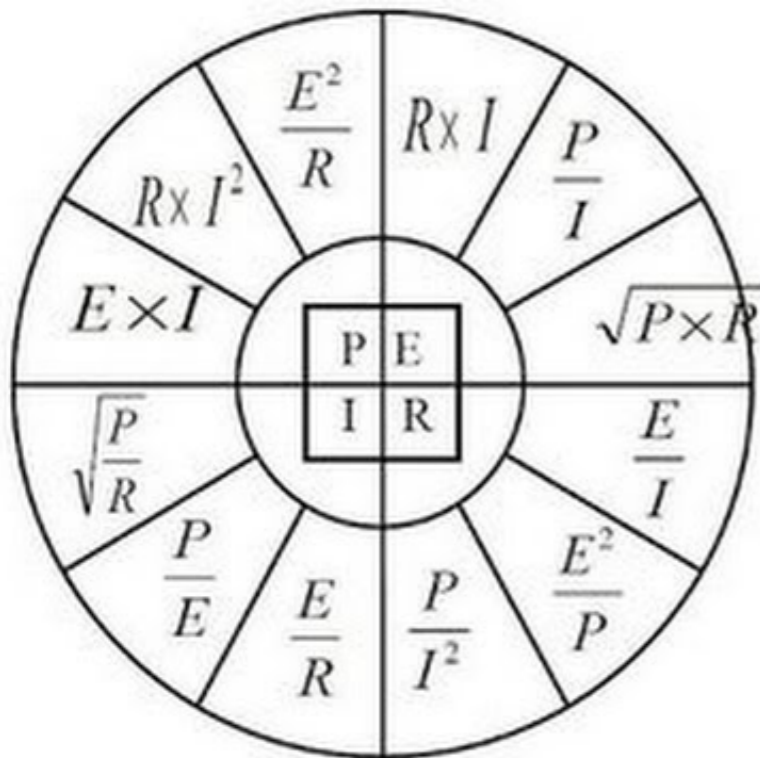
***FAIR
Implementations***

2017

FAIR *Principles*



FAIR *Implementations*



2017



International **Support** and **Coordination** Office



Leiden



Hamburg



Paris



Brazil



San Diego

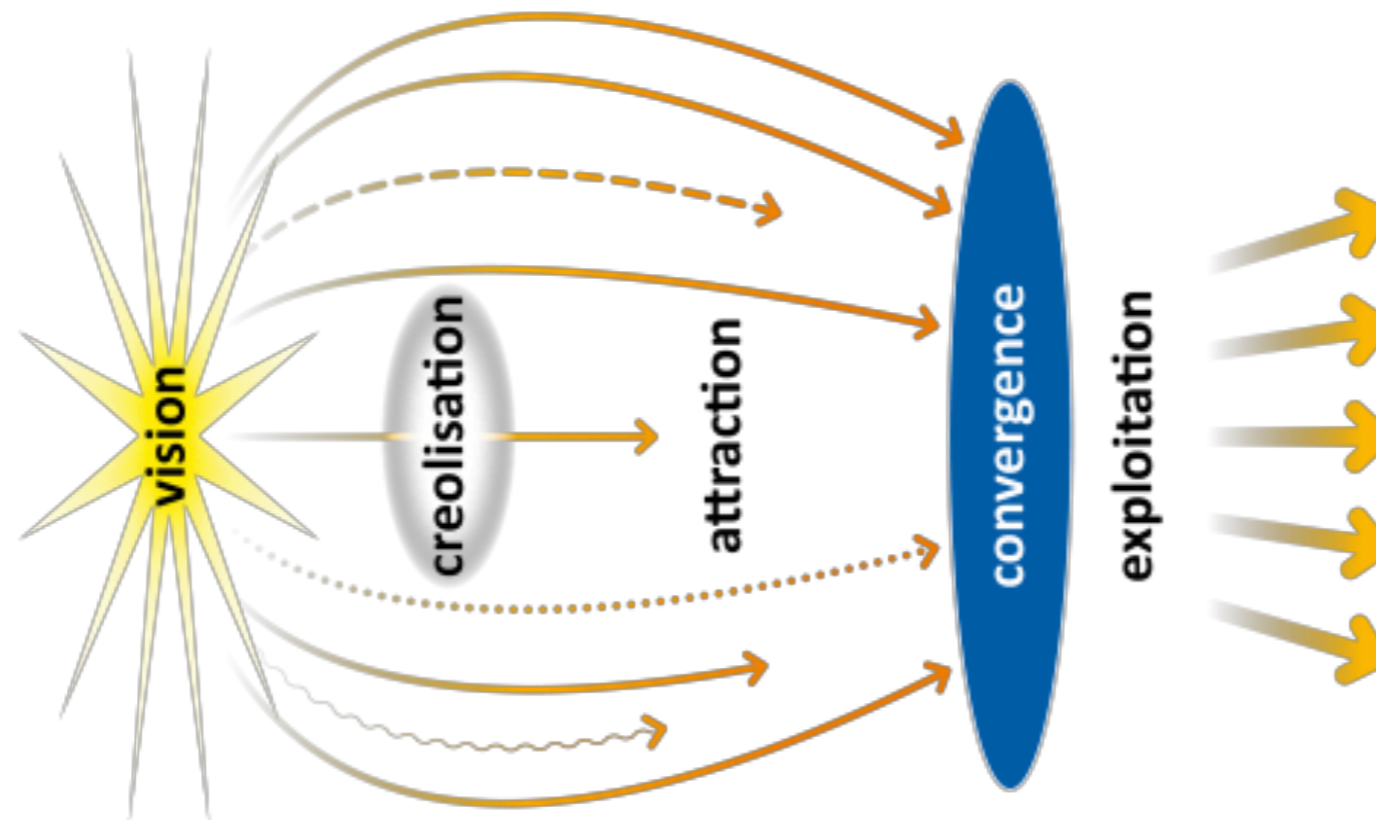
Common Patterns in Revolutionary Infrastructures and Data

Peter Wittenburg, Max Planck Computing and Data Facility

George Strawn, US National Academy of Sciences

February 2018

https://www.rd-alliance.org/sites/default/files/Common_Patterns_in_Revolutionising_Infrastructures-final.pdf



Catalyzing global decision-making on the efficient reuse of resources in the emerging Internet of FAIR data and services.

Creolization

Attractors

Convergence

IFDS

- LUMC
- UMC Utrecht
- UMCG
- WUR
- Maastricht University
- BioSemantics Group
- UCSD
- BioCom
- NDS
- ANDS
- NIH
- FAIRdICT
- DTL
- LERU
- CGIAR
- DANS
- RDA
- Metrics Group
- F1000
- Force 11
- Nerdalize
- ODEX
- Lorentz Center
- Personal Health Train
- ReproNIM
- EOSC
- EUDAT
- OpenAIRE
- FOSTER
- CODATA
- EDISON
- BioSB
- HRB
- ZonMW
- Elsevier
- Springer-Nature

GO CHANGE

GO TRAIN

GO BUILD

FAIR Funding
GO FAIR Brazil

CO-OPERAS

FAIR Funders

Neubias

Training Frameworks
Training Curriculum
Seasons Schools

AGU Enabling FAIR Data
System Terre
Sea Data Net

FAIR Pointer

Discovery IN
GERDI
OPEDAS
C2CAMP
Personal Health Train

Annotation

ASTRON

Metrology

Chemistry

Nano Research

NOMAD

FAIR Journalism (Fake News Monitoring)
Reproducibility and quality assurance of research data

Metabolomics

Vaccine IS

Rare disease

BiodiFAIRse

Agriculture & Food Systems

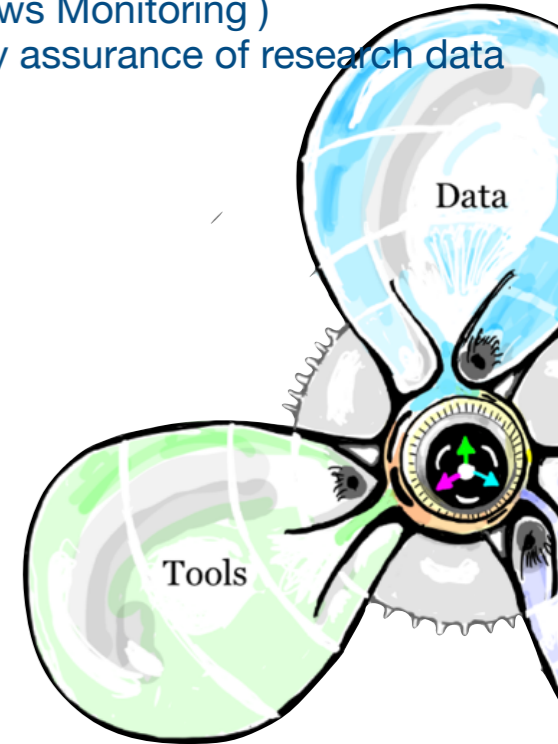
INOSIE

EcoSoc

PhenoMeNal

CBS (Economics)

Sustainability Research



2017

Q1

Q2

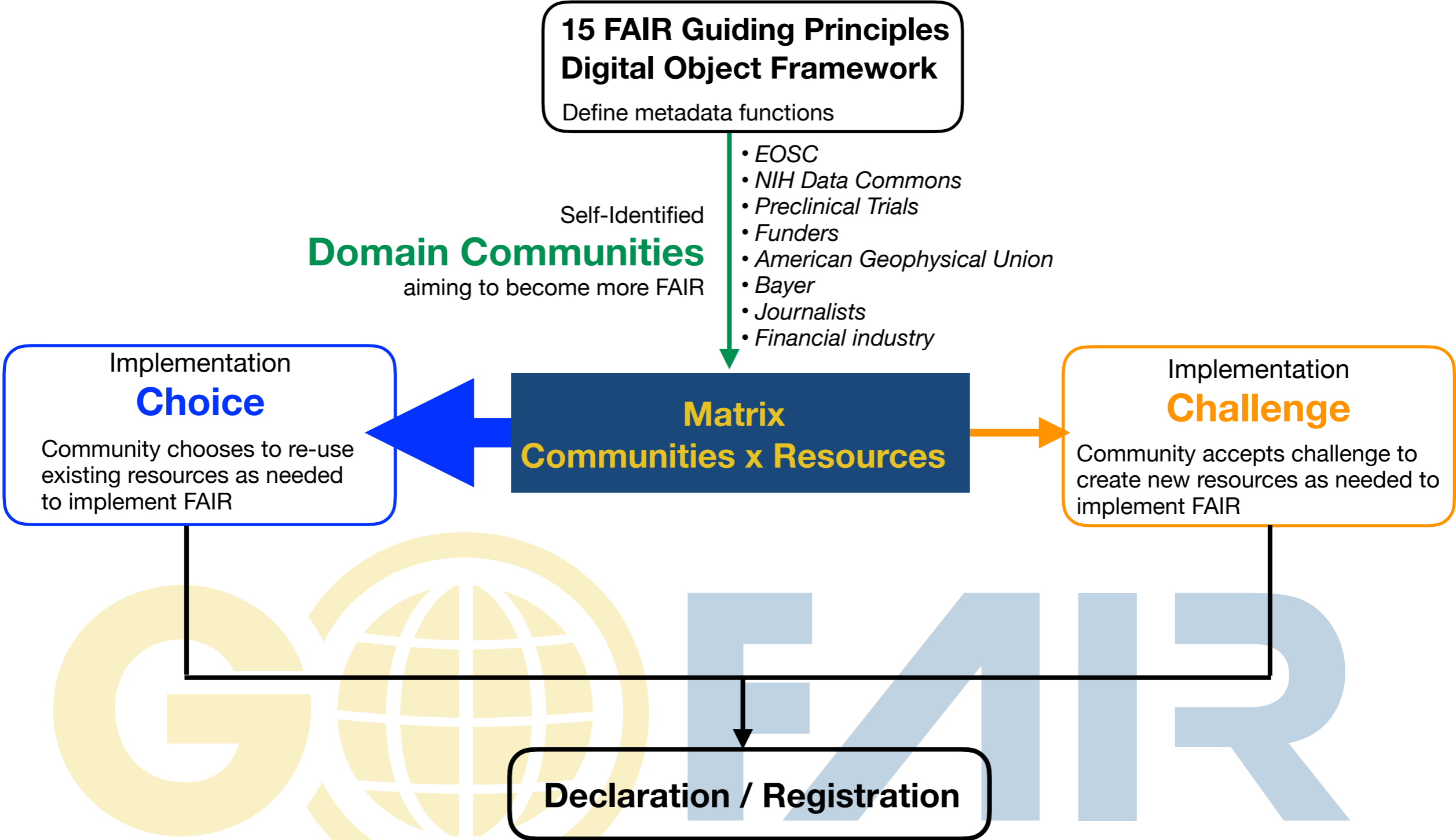
Q3

Q4

2019

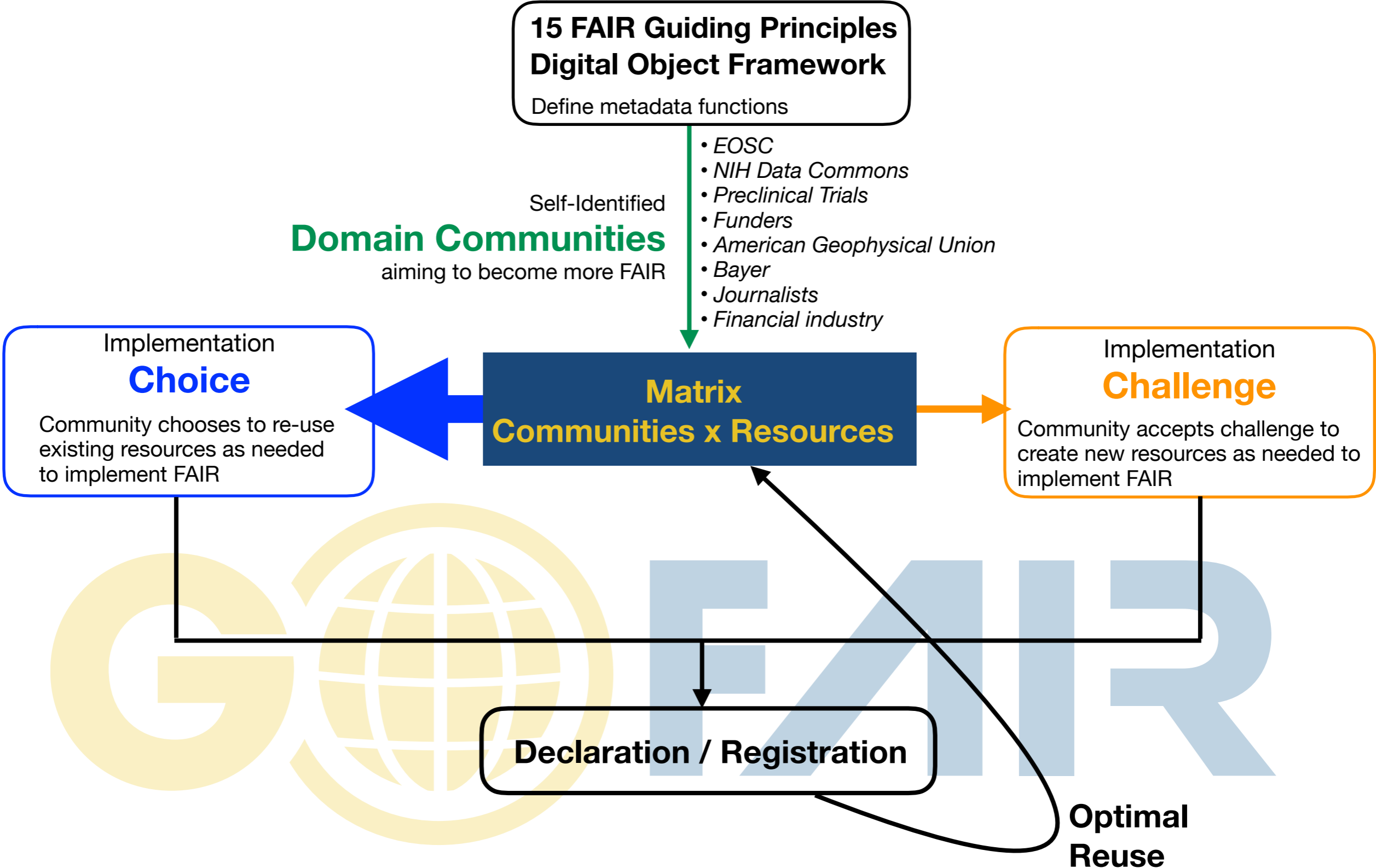
Community Implementation Choices & Challenges

<https://osf.io/4v9pm/>



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<https://osf.io/4v9pm/>



GO FAIR 'IN Profile' Survey

SEND

QUESTIONS RESPONSES 19

Section 1 of 14

Implementation Network (IN) Profile

We ask each IN Coordinator to complete this survey as a way for GO FAIR to begin profiling the FAIR-related resources found among more than 30 INs.

The survey contains 14 questions, and will take 30-45 minutes to complete. The entire form can be downloaded here as a PDF: <http://bit.ly/2BvxAH8>.

This survey serves two functions:

- (1) Cursory inventory of FAIR-related resources of the IN (this will enable GO FAIR to better search for and to exploit synergies maximising re-use of FAIR solutions).
- (2) A first step in helping INs to frame their own consortia and objectives in the context of the GO FAIR community.

Many of the questions below relate directly to the FAIR Principles (<https://www.go-fair.org/fair-principles/>) and are noted as such in the question. We hope this helps to guide the IN Coordinator to better understand the question.

1. Name of the Implementation Network *

Short answer text

2. IN Coordinator name *

SUBJECT	PREDICATE	OBJECT
name of IN (UPRI)	has-coordinator	ORCID
name of IN (UPRI)	has-participant	ORCID
name of IN (UPRI)	has-member-organisation	VIVO / CrossRef
name of IN (UPRI)	uses-repository	CTS?
name of IN (UPRI)	uses-registry-service	PW ?
name of IN (UPRI)	provides-registry-service	
name of IN (UPRI)	uses-data-format	format-PID
name of IN (UPRI)	provides-data-format	format-PID
name of IN (UPRI)	provides-access-protocol	format-PID
name of IN (UPRI)	uses-access-protocol	protocol-PID
name of IN (UPRI)	has-persistence-policy	policy
name of IN (UPRI)	is found by	Search engine
name of IN (UPRI)	uses-term-system	Term System-PID
name of IN (UPRI)	provides-term-system	Term System-PID
name of IN (UPRI)	uses-license	MR-license ID
name of IN (UPRI)	uses-metadata-format	format-PID
name of IN (UPRI)	provides-meta-data-format	Format-PID
name of IN (UPRI)	provides-training-material	Resource-ID
name of IN (UPRI)	uses-uses-training-material	Resource-ID
name of IN (UPRI)	provides-DS-tools	Resource-ID
name of IN (UPRI)	uses-DS-tools	Resource-ID
name of IN (UPRI)	uses-workspace-tool	Resource-ID
name of IN (UPRI)	Provides-workspace-tool	Resource-ID

F1
F1
F2
F2
A1
A1
F1 / A2
F4
I
I
R1.1
R1.2
R1.2

The questionnaire asks self-identified communities to inventory the FAIR-related resources they currently use.

To keep focus, the questions are based on the FAIR Principles, ensuring that the responses are relevant to “GOing FAIR”.

FAIR IN Profile Matrix

January 15-16, Leiden

Survey https://docs.google.com/forms/d/1Oug6GowuG1jNZNsjkIXOeEvPbUrhyuS_F-d185SOy6A/edit

Matrix <https://docs.google.com/spreadsheets/d/1MUZn7uh4x5YLPjqxi-V8XubsSEEonQWvx2jBlcyyNdU/edit#gid=0>



IN Profile Matrix

File Edit View Insert Format Data Tools Add-ons Help All changes saved in Drive

100% \$ % .0 .00 123 Helvetica ... 10 B I U A

FAIR Implementation Matrix

On the OSF <https://osf.io/n7uwp/>

Red indicates waist of hourglass

Blue is an Implementation Choice

Orange is Implementation Challenge

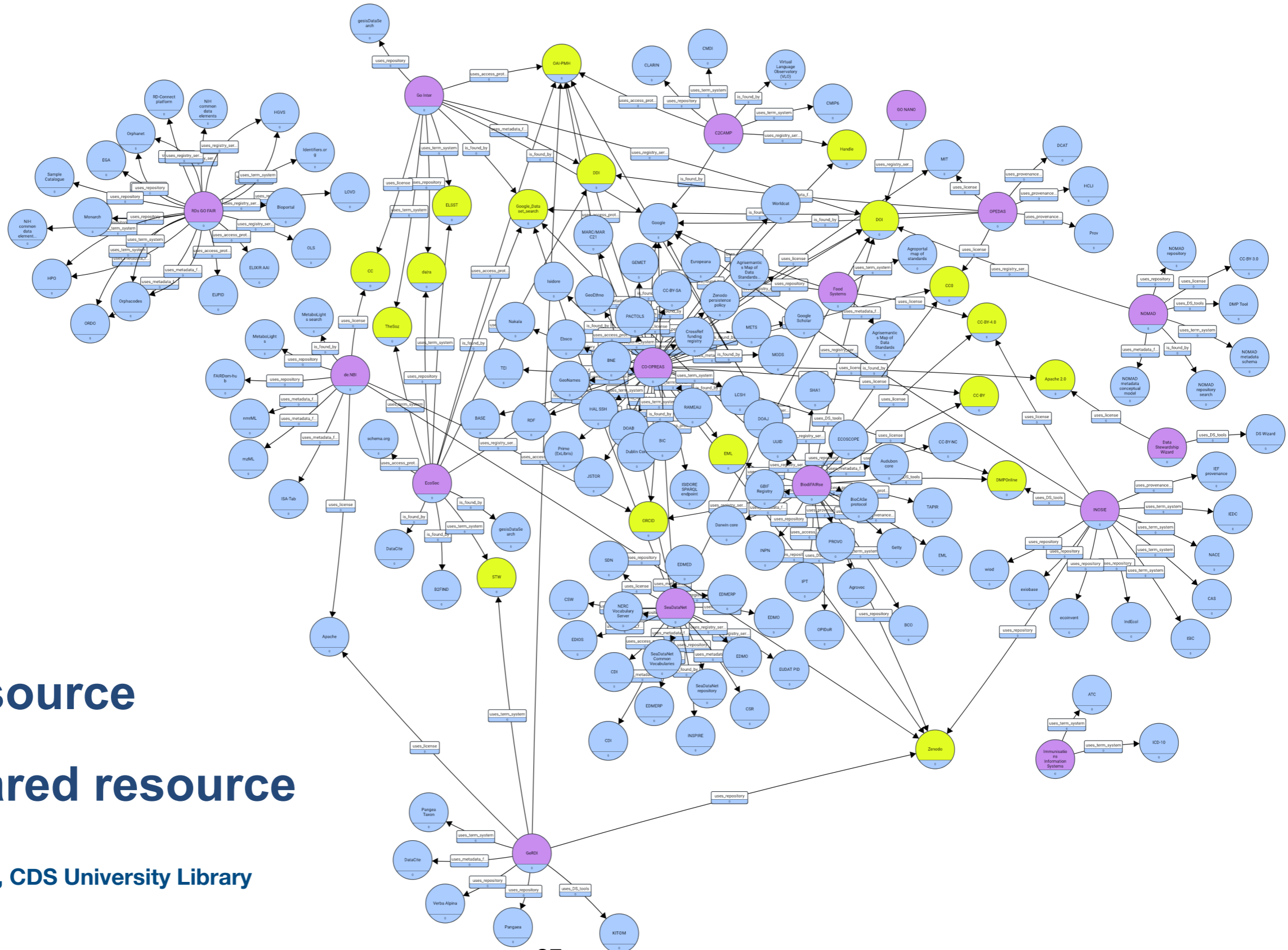
Green highlight indicates a service provided by the IN or spin-off

Blank cell is not relevant for IN

FAIR Principle	Services	Component	Most used	C2CAMP	OPEDAS	PHT	Rare-Diseases	GERI
	central to all	DOIP	DOIP	DOIP	DOIP	DOIP	DOIP	
	central to all	Metadata format	RDF		RDF	RDF	RDF	
	central to all	Metadata access protocol			LDP/FDP	LDP/FDP	LDP/FDP	
	central to all	Metadata core elements	TBD on M4M		TBD on M4M	TBD on M4M	TBD on M4M	
	Technology	Data Format			RDF for interop.	RDF for interop.	RDF for interop.	
	Technology	Data Access Protocols (MR/A)			LDP/FDP	PHT-standard	PHT-standard	
	Technology	Computer-actionable license description language			RDF	RDF	RDF	
	Tooling	Repository (Data/Metadata)		DONA	IFDS Data Station	IFDS Data Station	ERN?	GERI
	Tooling(Repository)	https://www.dataone.org						
	Tooling	Registry Service		DONA	IFDS Station Registry	IFDS Station Registry	ERN?	
	tooling	Metadata forms/creators			CEDAR/CASTOR			
	Tooling	Search capability		DOIP	IFDS Station Registry	IFDS Station Registry	IFDS Station Registry	
	Policy	Persistence Policy			TBD	TBD	TBD	
	Technology	Computer-actionable policy description language			RDF	RDF	RDF	
	Tooling	License protocols			TBD	TBD	TBD	
	Tooling	Training Materials			Training-IN	Training-IN	EJP	

Community Implementation Choices & Challenges

<https://osf.io/4v9pm/>



Kristina Hettne, CDS University Library

Matrix Development

<https://osf.io/n7uwp/>



Kristina Hettne

Peter Wittenburg



Tobias Kuhn



Pete McQuilton



Robert Pergl



Universiteit
Leiden



RESEARCH DATA ALLIANCE



MAX-PLANCK-GESELLSCHAFT



nanopublication

assertion

provenance

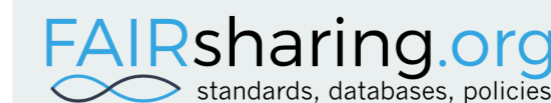
publication info



UNIVERSITY OF
OXFORD



CZECH
TECHNICAL
UNIVERSITY
IN
PRAGUE



FAIRsharing.org
standards, databases, policies



DSW
DATA STEWARDSHIP WIZARD

Item	Question	Open annotations	Open annotations	Open annotations	Comment/Action
1	Which registries do you use for data?	Use of an identifier or central registries are in use, often these are just local metadata.	F1: Metadata are registered or indexed in a searchable resource	right	This should be FA
2	Which repository software is being used?	In many cases specific repository software such as DSpace, Invenio, etc. are being used, these can also be home-made.	F1: Metadata are registered or indexed in a searchable resource	right	For some experts this already says that the registry uses objects and PIDs, so go further than FA
3	Which registries do you use for metadata?	Often people use relational databases or spreadsheets on a file or share program. Often registries start from existing metadata and add fields, but other systems may be in place or people use their own.	F1: Metadata are registered or indexed in a searchable resource	right	This should be FA
4	Do your registries use FAIR if to which PID pattern?	Often PIDs are assigned manually, but there are some where PIDs are assigned automatically.	F1: Metadata are assigned globally unique and persistent identifiers	right	
5	Do you assign PIDs manually or automatically?	Often people use DataCite for DOIs, and for general identifier local to office, services are being used.	F1: Metadata are assigned globally unique and persistent identifiers	right	When formally checking it is not sufficient to know that one uses FAI, one also needs to check the service provider
6	Which PID registration provider do you use?	Increasingly often registries use the PID service that the data is being used.	F1: Metadata are assigned globally unique and persistent identifiers	right	Why did you
7	Do you use the DOI service?		F1: Metadata are assigned globally unique and persistent identifiers	right	
8	Data level of metadata, what is your certification?		F1: Metadata are assigned globally unique and persistent identifiers	right	
9	What kinds of activity, or of its levels, section, etc.		F1: Metadata are assigned globally unique and persistent identifiers	right	
10	What is the metadata used for?		F1: Metadata are assigned globally unique and persistent identifiers	right	
11	What is the metadata used for?		F1: Metadata are assigned globally unique and persistent identifiers	right	
12	What is the metadata used for?		F1: Metadata are assigned globally unique and persistent identifiers	right	
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100	What is the metadata used for?		F1: Metadata are assigned globally unique and persistent identifiers	right	



Barbara Magagna

umweltbundesamt
ENVIRONMENT AGENCY AUSTRIA

ENVRI-FAIR KICK OFF MEETING

Hotel International Prague, Czech republic
January 14-16, 2019
Register at www.envri.eu



Kristina Hettne



Peter Wittenburg



FAIR principle	Class	Questions	Short explanations
F4: (Meta)data are registered or indexed in a searchable resource	Repository s	Which repositories do you use for data?	local as well domain or central repositories are in use, often these are just local servers with discs
F4: (Meta)data are registered or indexed in a searchable resource		Which repository software is being used?	in many cases specific repository software such as D-SPace, Fedora, etc are being used, these can also be home-made
F4: (Meta)data are registered or indexed in a searchable resource		Which repositories do you use for metadata?	often people use relational databases or spreadsheets on a disc for these purposes
F1: (Meta)data are assigned globally unique and persistent identifiers		Do your repositories use PIDs? If so which PID systems?	most often repositories start now using Handles and DOIs (which are Handles), but other systems may be in place or people just use URLs
F1: (Meta)data are assigned globally unique and persistent identifiers		Do you assign PIDs manually or automatically?	often DOIs are assigned manually, but more often PIDs are assigned automatically by scripts
F1: (Meta)data are assigned globally unique and persistent identifiers		Which PID registration provider do you use?	often people use DataCite for DOIs, and for general Handles local or ePIC services are being used
F2: Data are described with		DO you use the PID Record to store	increasingly often repositories use the PID record to store properties about the data and refer to other



Kristina Hettne



Peter Wittenburg



Barbara Magagna



FAIR principle	Class	Questions	Short explanations
F4: (Meta)data are registered or indexed in a searchable resource		Which repositories do you use for data?	local as well domain or central repositories are in use, often these are just local servers with discs
F4: (Meta)data are registered or indexed in a searchable resource		Which repository software is being used?	in many cases specific repository software such as D-SPACE, Fedora, etc are being used, these can also be home-made

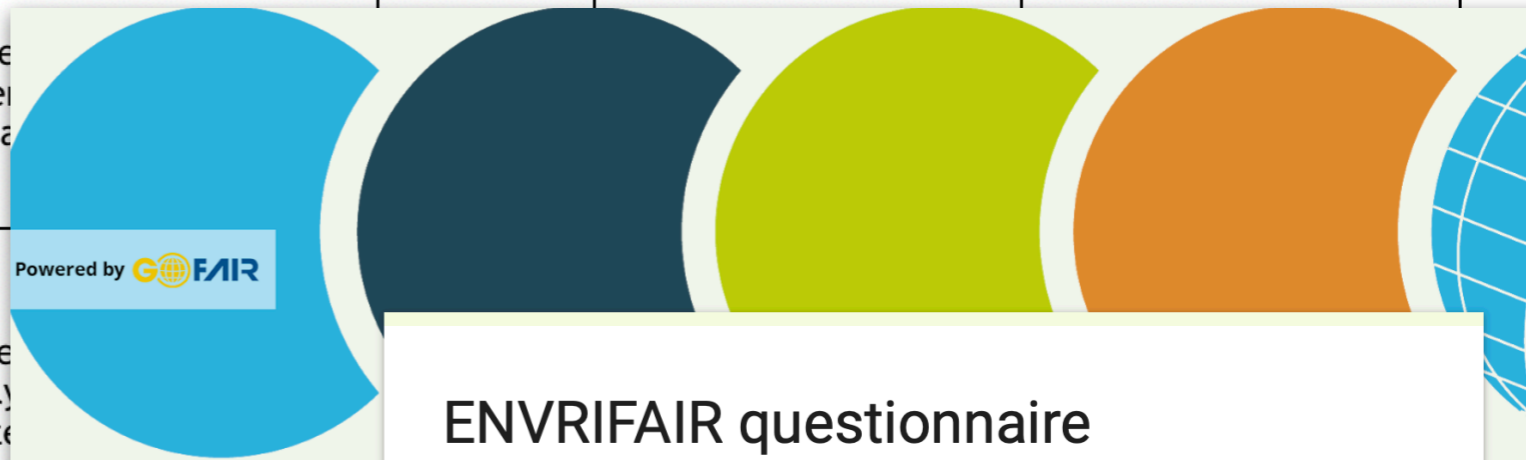
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F1: (Me
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F1: (Me
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F2: Dat



ENVRIFAIR questionnaire

Please provide information on the FAIRness of the data at your research infrastructure. Fill out this form for an example dataset of each different "data entity". As example: SeaDataNet offers the CDI metadata catalogue for observation data, and it offers a catalogue with metadata of dataproduct/data aggregations. These are two different entities, with a different metadata model and data access services.

More detailed information on the FAIR metrics that is used is available here:
<https://github.com/FAIRMetrics/Metrics/blob/master/ALL.pdf>

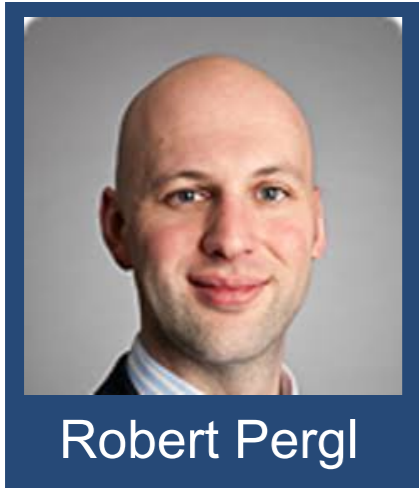
* Required

Contact name *

Your answer

Email *

Your answer



Robert Pergl



<https://fair-matrix.ds-wizard.org/>

The screenshot shows the GEDE Matrix Wizard interface. On the left is a navigation menu with 'Knowledge Models' selected. The main content area displays 'Knowledge Models' with a 'G' icon, 'GEDE-Matrix-V1 1.0.4', and 'dsw:GM1:1.0.4 · fourth version - 22.6.2019'.

- I. General Information about Survey ✓
- II. General Information about Participant ✓
- III. Repository Questions ✓**
- IV. Access Mechanisms ✓
- V. Data Questions ✓
- VI. Metadata Questions ✓
- VII. Semantic Questions ✓
- VIII. Data Management Plans ✓
- IX. Data Processing Methods ✓
- X. State of FAIRness ✓

1 Which repositories do you use for data?

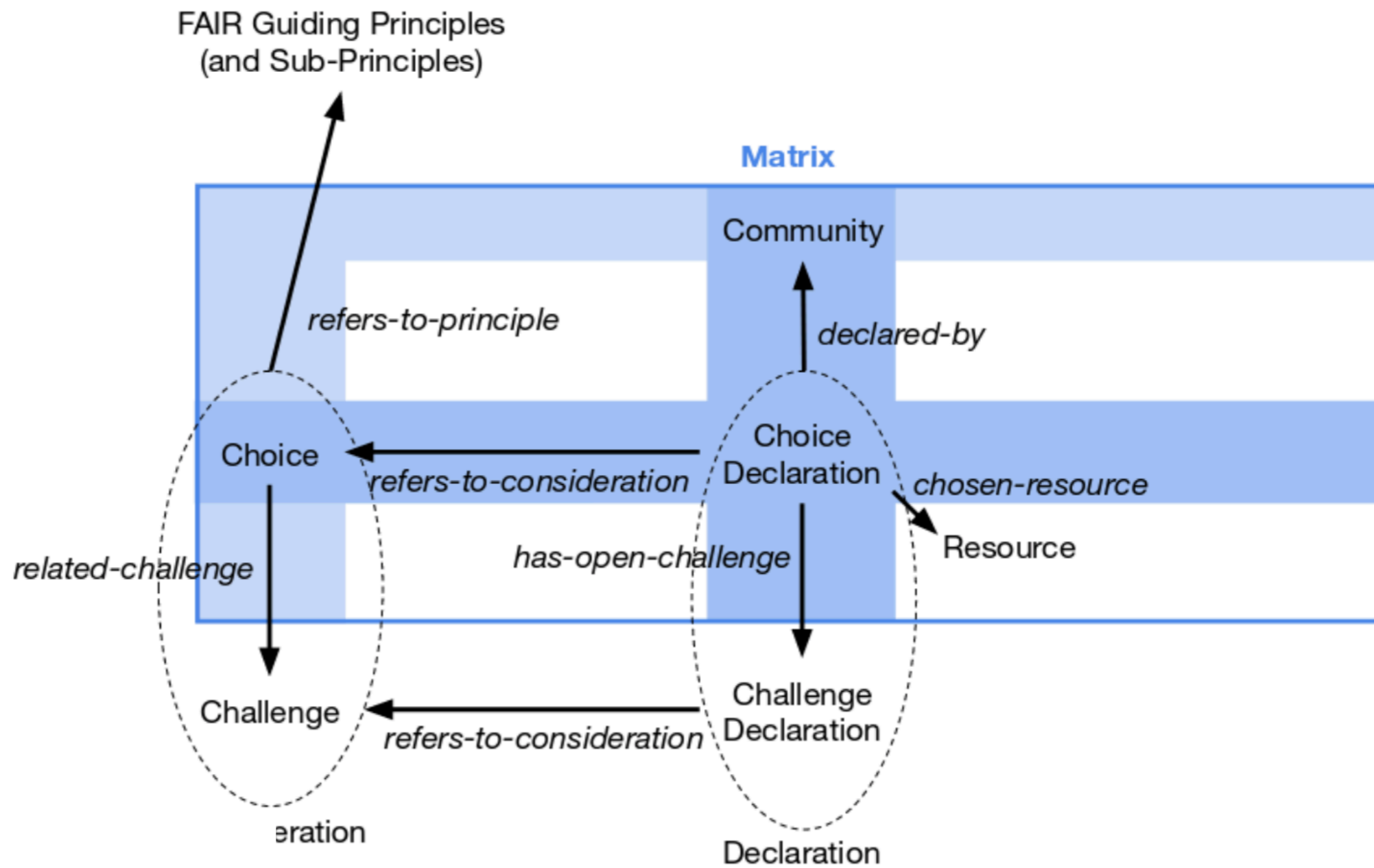
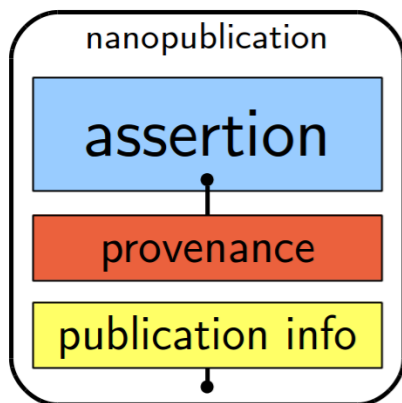
DOBES is part of The Language Archive (TLA), a central, domain-specific repository. The data is replicated to 2 offsite locations. Parts of the collection are also distributed in regional repositories in various countries.
https://archive.mpi.nl/islandora/object/lat:1839_00_0000_0000_0001_305B_C?asOfDateTime=2018-03-02T11:00:00.000Z

In the case that you are a researcher heavily creating data and depositing it in a repository, please, indicate the repositories you are using and which you will subsequently describe. If you are a repository manager describe your repository. Local as well domain or central repositories are in use, often these are just local servers with discs that are managed by a data manager. Please, also specify a PID that points to that repository.

- F4 applies: (Meta)data are registered or indexed in a searchable resource.
- Examples for repositories are: local (can be many), domain (can be many), generic (B2SAFE, B2SHARE, B2DROP, ZENODO, GITHUB, Dropbox, FIGSHARE, etc.)



Tobias Kuhn

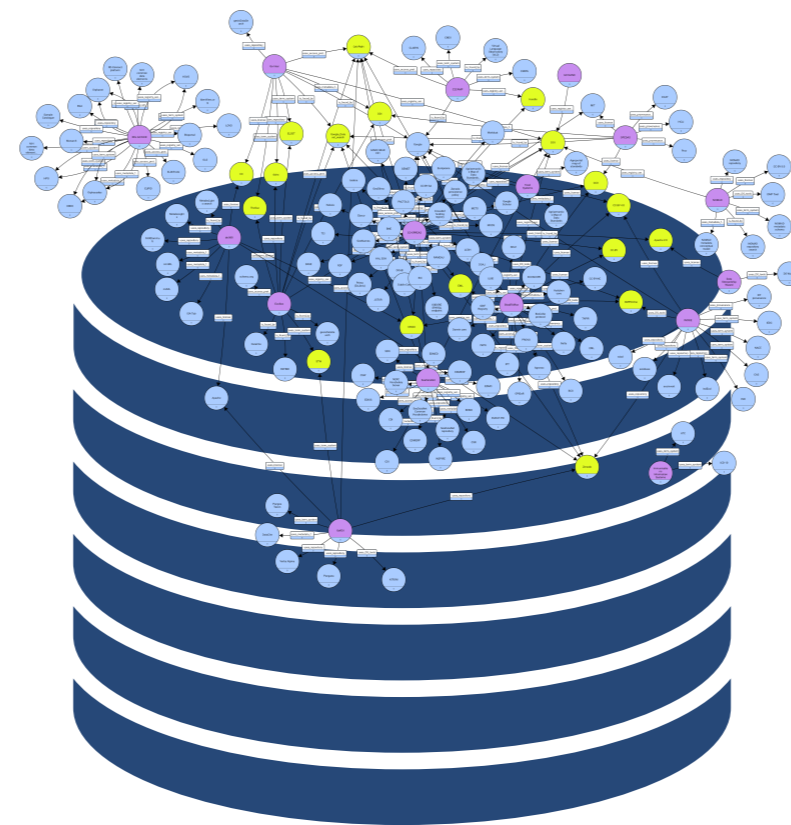


Communities need to decide on “all” implementation options to ensure interoperation and interdisciplinarity

- Chemistry should decide on chemical identifiers**
 - Chemistry should decide on geolocation schema**
 - Chemistry should decide on soil ontology**
 - Agriculture should decide on soil ontology**
 - Agriculture should decide on geolocation schema**
 - Agriculture should decide on chemical identifiers**
-
- Chemistry & Agriculture should decide on identifiers for people (e.g., ORCID)**

Community Implementation Choices & Challenges

<https://osf.io/4v9pm/>



Open FAIR Data Point
(hosted by trusted parties)

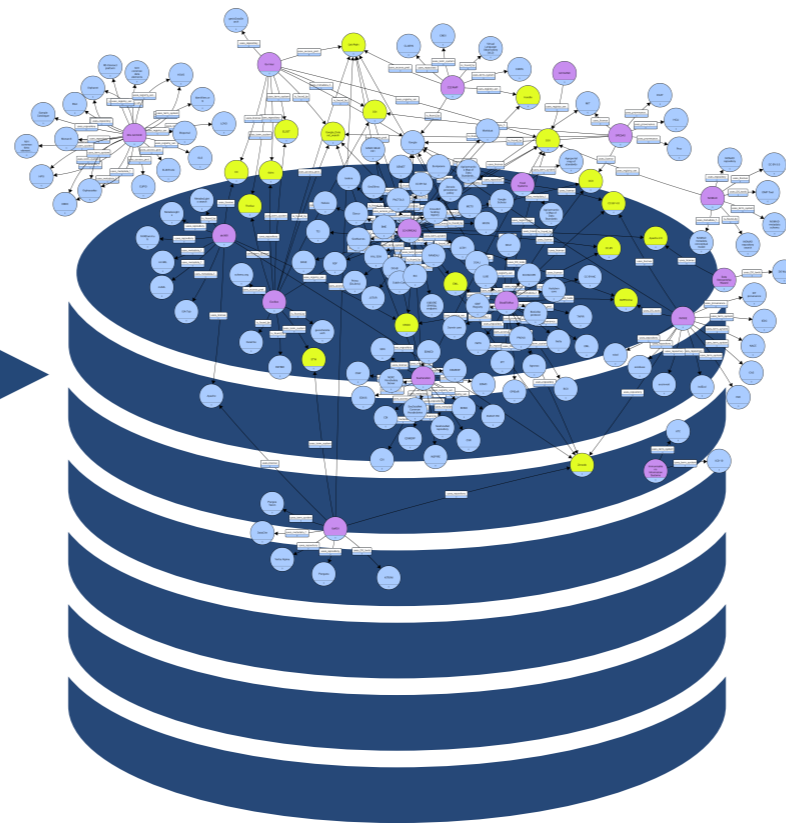
Community Implementation Choices & Challenges

<https://osf.io/4v9pm/>

Additional Community Profiles

(not necessarily GO FAIR INs)

- *ENVRIFAIR*
- *CS3*
- *FAIR Plus*
- *AGU Enabling FAIR Data*



Open FAIR Data Point
(hosted by trusted parties)

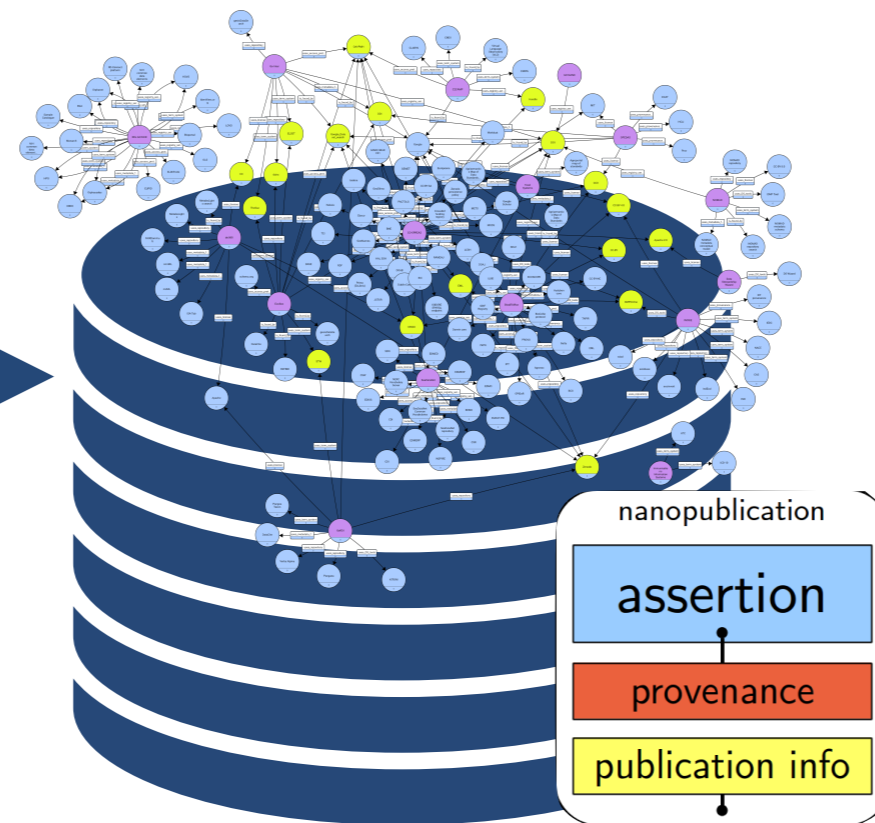
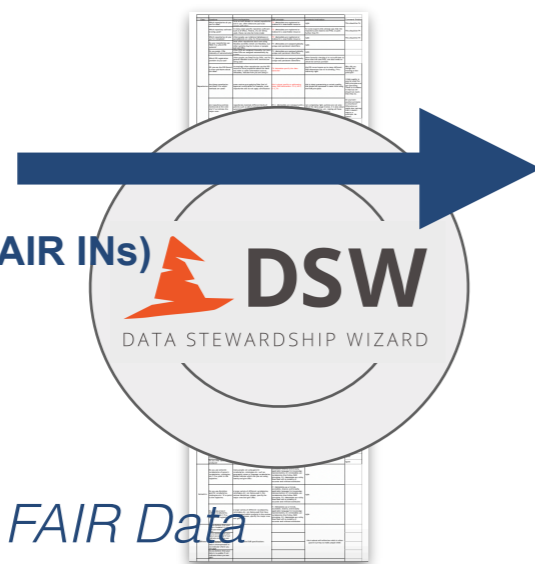
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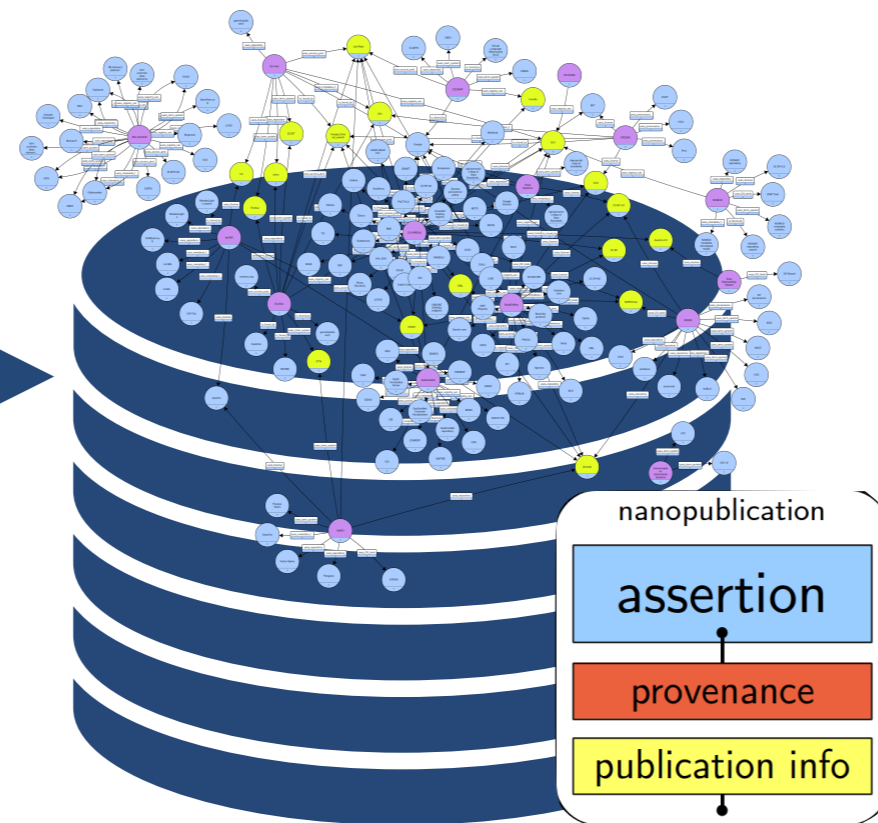
Community Implementation Choices & Challenges

<https://osf.io/4v9pm/>

Additional Community Profiles

(not necessarily GO FAIR INs)

- *ENVRIFAIR*
- *CS3*
- *FAIR Plus*
- *AGU Enabling FAIR Data*



Analytics

- **Common use**
- **Optimal reuse**

FAIRsharing.org
standards, databases, policies



**Open FAIR Data Point
(hosted by trusted parties)**

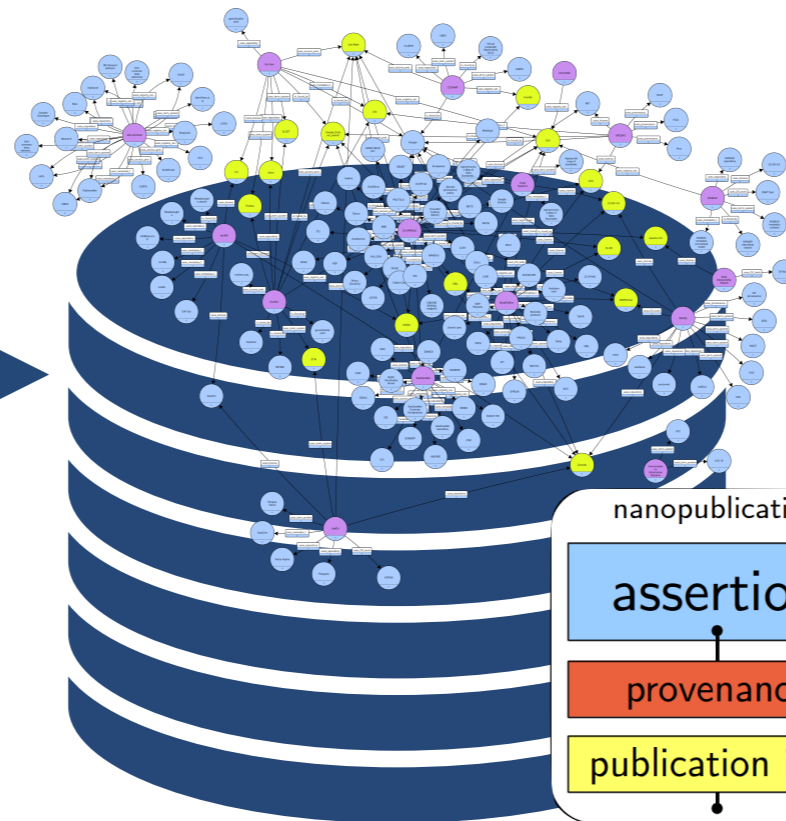
Community Implementation Choices & Challenges

<https://osf.io/4v9pm/>

Additional Community Profiles

(not necessarily GO FAIR INs)

- ENVRIFAIR
- CS3
- FAIR Plus
- AGU Enabling FAIR Data



CODATA



ZonMw

WILEY

Bottom-up
Best Practices



Analytics

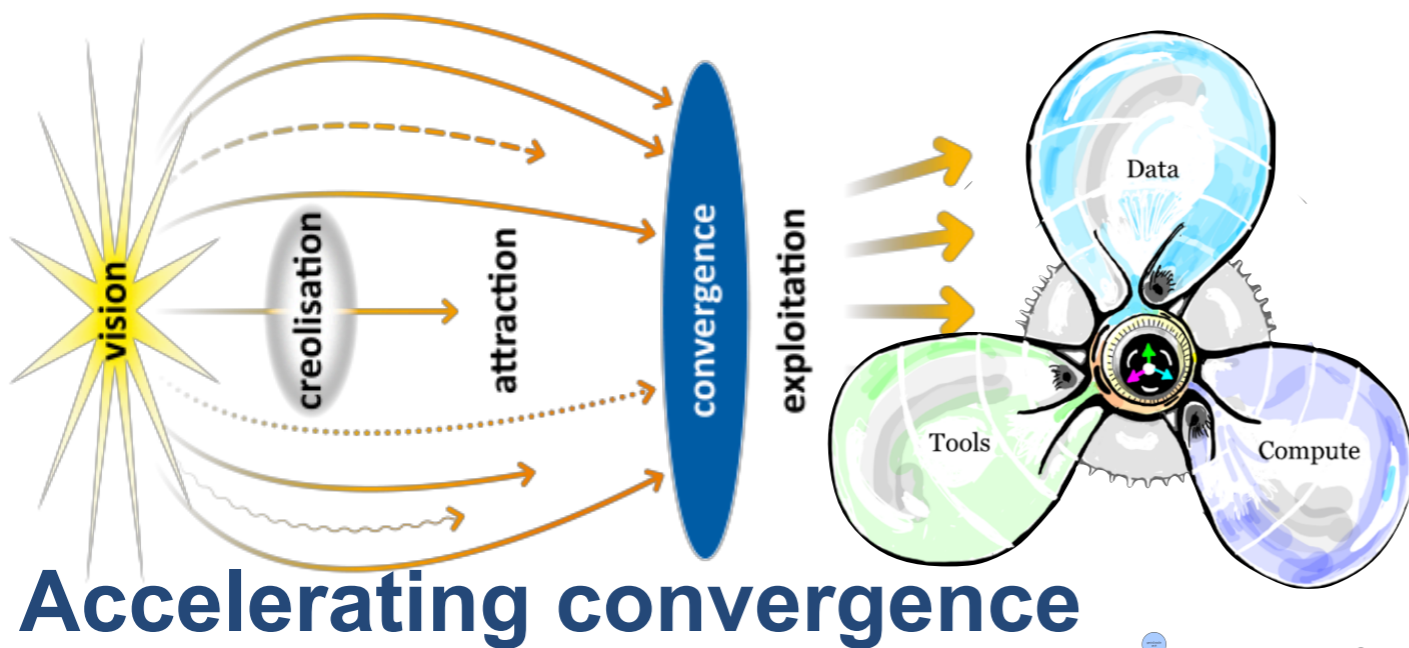
- Common use
- Optimal reuse



Open FAIR Data Point
(hosted by trusted parties)

Community Implementation Choices & Challenges

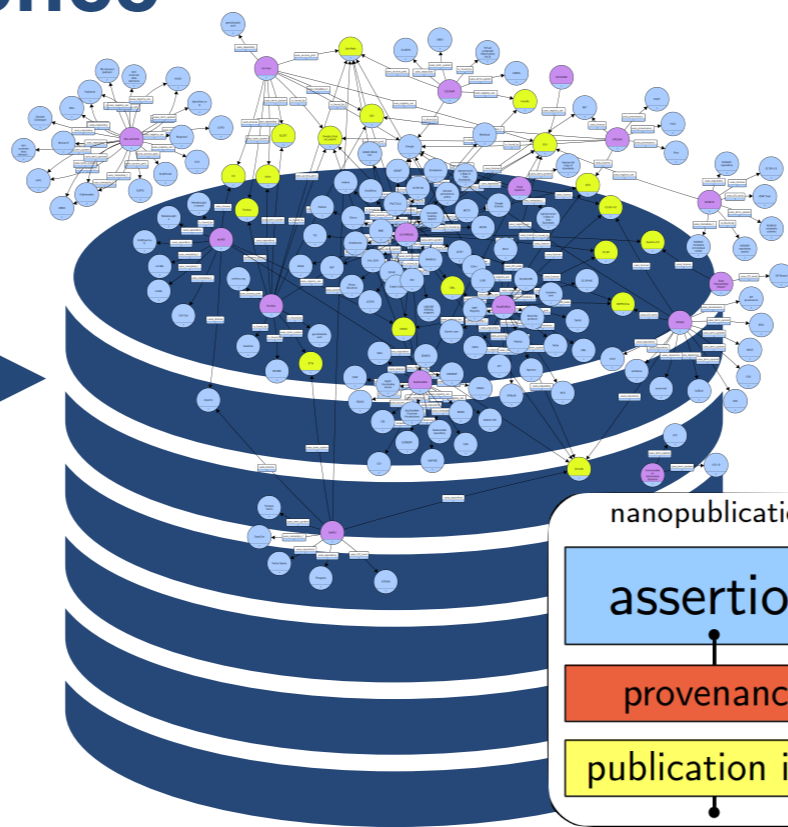
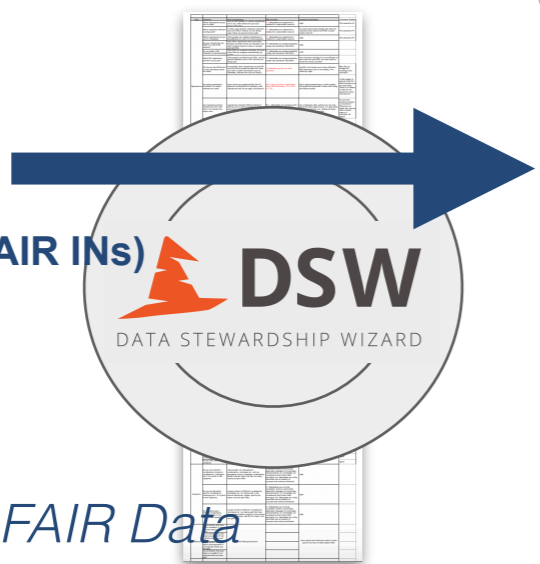
<https://osf.io/4v9pm/>



Additional Community Profiles

(not necessarily GO FAIR INs)

- ENVRIFAIR
- CS3
- FAIR Plus
- AGU Enabling FAIR Data



**Bottom-up
Best Practices**



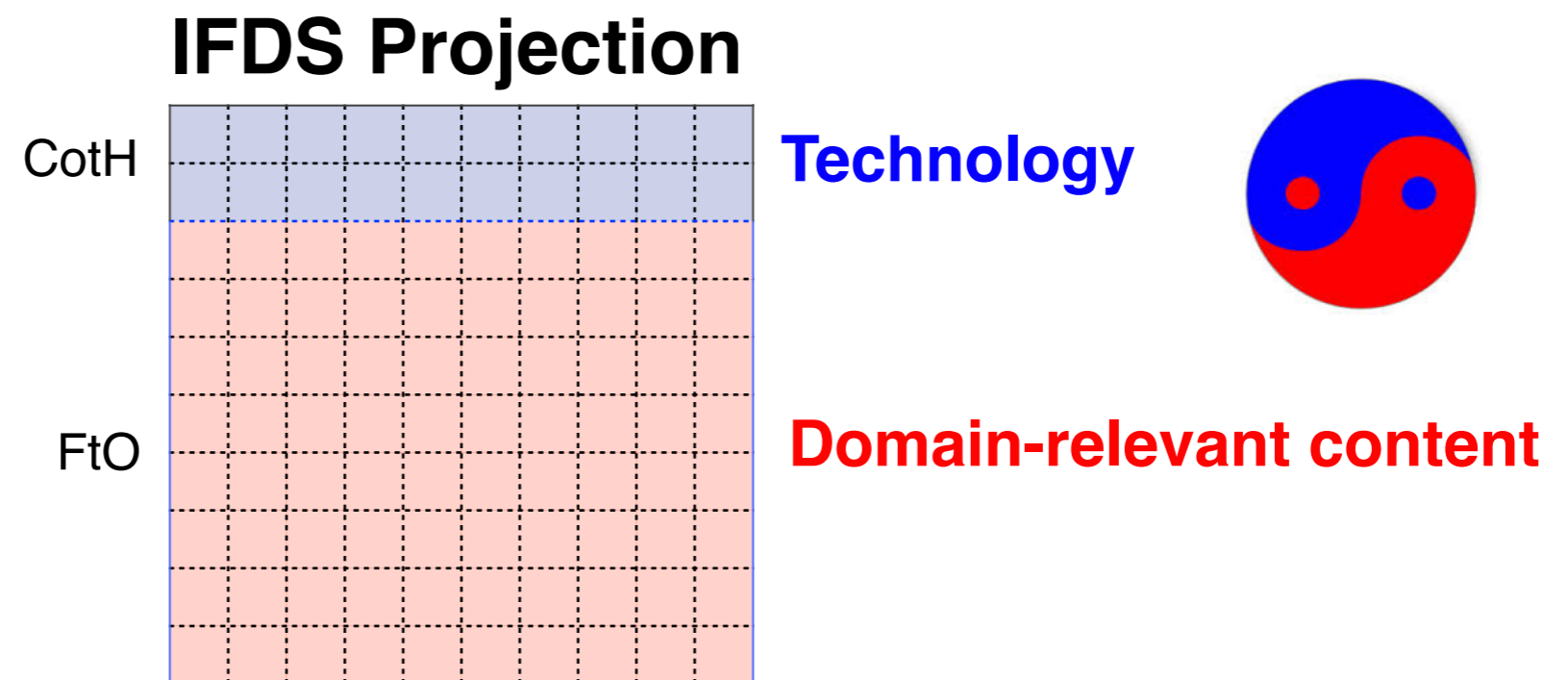
Analytics

- Common use
- Optimal reuse



**Open FAIR Data Point
(hosted by trusted parties)**

Matrix Projections: Same questions, different projections



[New Results](#)[Comment on this paper](#)

Evaluating FAIR Maturity Through a Scalable, Automated, Community-Governed Framework

 Mark D Wilkinson,  Michel Dumontier,  Susanna-Assunta Sansone,  Luiz Olavo Bonino da Silva Santos,  Mario Prieto,  Dominique Batista,  Peter McQuilton,  Tobias Kuhn,  Philippe Rocca-Serra,  Mercè Crosas,  Erik Schultes

doi: <https://doi.org/10.1101/649202>

This article is a preprint and has not been peer-reviewed [what does this mean?].

[Abstract](#)[Full Text](#)[Info/History](#)[Metrics](#)[Preview PDF](#)

Abstract

Transparent evaluations of FAIRness are increasingly required by a wide range of stakeholders, from scientists to publishers, funding agencies and policy makers. We propose a scalable, automatable framework to evaluate digital resources that encompasses measurable indicators,



FAIR Evaluation Services

Resources and guidelines to assess the FAIRness of digital resources.

Fork Star 52 Watch 30



Import Maturity Indicators

Import Maturity Indicators as YAML [smartAPI](#) interface annotation

Get started



Create collections

Assemble Maturity Indicators into community centered collections

Get started



Evaluate resources

Evaluate resources FAIRness against Maturity Indicator Collections

Get started

RDA / GEDE Webinar on Maturity Indicators for FAIRness and Certification of Repositories
22 March 2019

<https://www.rd-alliance.org/ge-de-webinar-maturity-indicators-fairness-and-certification-repositories>

Run evaluation

Globally Unique Identifier (GUID) to be Evaluated: *This is the GUID for the metadata (!) of your data record*

Hints: We currently recognize INCHI Keys, DOIs, Handles and URLs. Contact the developer to add new GUID types to this list - for example, we plan to support LSIDs soon, and others.

If you have a DOI for your data deposit, a DOI returns metadata to our system, so please use your DOI unless you have specifically created a better metadata record.

For DOIs, enter the DOI **without the 'doi:' prefix** (e.g. just '10.1002/abd.123')

For InCHI keys, enter the key **with no prefix** (e.g xxxxxxxxxxxxxxxx.xxxxxxxxxx.xxxxx)


Select a collection to evaluate the resource

Select a collection

GUID * **http://data.emso.eu/files/**

Title of this evaluation * **Test evaluation...**

Your ORCID * **0000-0001-8888-635X**

 *By submitting, you give us permission to associate your ORCID with this data, and to make this association publicly available. You may [contact the maintainers](#) at any time to have your ORCID deleted from this record*

RUN EVALUATION

CLEAR FIELDS



Please wait, your request is being processed.

This may take up to 3 minutes. If you do not receive a response, please contact Mark Wilkinson

(mark.wilkinson@upm.es)



This is a test evaluation for F and for EMSO data



Summary:

Description: FAIR Metrics Evaluation: This is a test evaluation for F and for EMSO data; Tested identifier: <http://data.emso.eu/files/>; generated by <https://orcid.org/0000-0001-8888-635X>

Resource: <http://data.emso.eu/files/>

Collection: 1

Observations: Ran 8 tests (1 succeeded, 7 failed).

Tests passing and failing



FAIR METRICS GEN2- UNIQUE IDENTIFIER



FAIR METRICS GEN2 - IDENTIFIER PERSISTENCE



FAIR METRICS GEN2 - DATA IDENTIFIER PERSISTENCE



FAIR METRICS GEN2 - STRUCTURED METADATA



FAIR METRICS GEN2 - GROUNDED METADATA



FAIR METRICS GEN2 - DATA IDENTIFIER EXPLICITLY IN METADATA



FAIR METRICS GEN2- METADATA IDENTIFIER EXPLICITLY IN METADATA



FAIR METRICS GEN2 - SEARCHABLE IN MAJOR SEARCH ENGINE



This is a test evaluation for F and for EMSO data



Summary:

Description: FAIR Metrics Evaluation: This is a test evaluation for F and for EMSO data; Tested identifier: <http://data.emso.eu/files/>; generated by <https://orcid.org/0000-0001-8888-635X>

Resource: <http://data.emso.eu/files/>

Collection: 1

Observations: Ran 8 tests (1 succeeded, 7 failed).

Tests passing and failing



● FAIR METRICS GEN2- UNIQUE IDENTIFIER +

● FAIR METRICS GEN2 - IDENTIFIER PERSISTENCE -

Status: Failure

Principle tested: F1

Description: Metric to test if the unique identifier of the metadata resource is likely to be persistent. Known schema are registered in FAIRSharing (https://fairsharing.org/standards/?q=&selected_facets=type_exact:identifier%20schema). For URLs that don't follow a schema in FAIRSharing we test known URL persistence schemas (purl, oclc, fdlp, purlz, w3id, ark).

Metric test created on: May 8, 2019 by [Mark D Wilkinson](#) (updated on May 8, 2019).

Test executed on: Jul 1, 2019

Test results

INFO: The metadata GUID appears to be a URL. Testing known URL persistence schemas (purl, oclc, fdlp, purlz, w3id, ark).

FAILURE: The metadata GUID does not conform with any known permanent-URL system.

● FAIR METRICS GEN2 - DATA IDENTIFIER PERSISTENCE +

