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Métricas FAIR. Principios FAIR y su aplicación en ASIO

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Temas a tratar

- **FAIR Data**
  - Principios
  - FAIR vs Open Data
  - Impementing FAIR & FAIRmetrics
  - FAIRness de ASIO-HERCULES

- Research Objects
  - Definición
  - Estándar RO-CRATE
  - Ejemplos de uso

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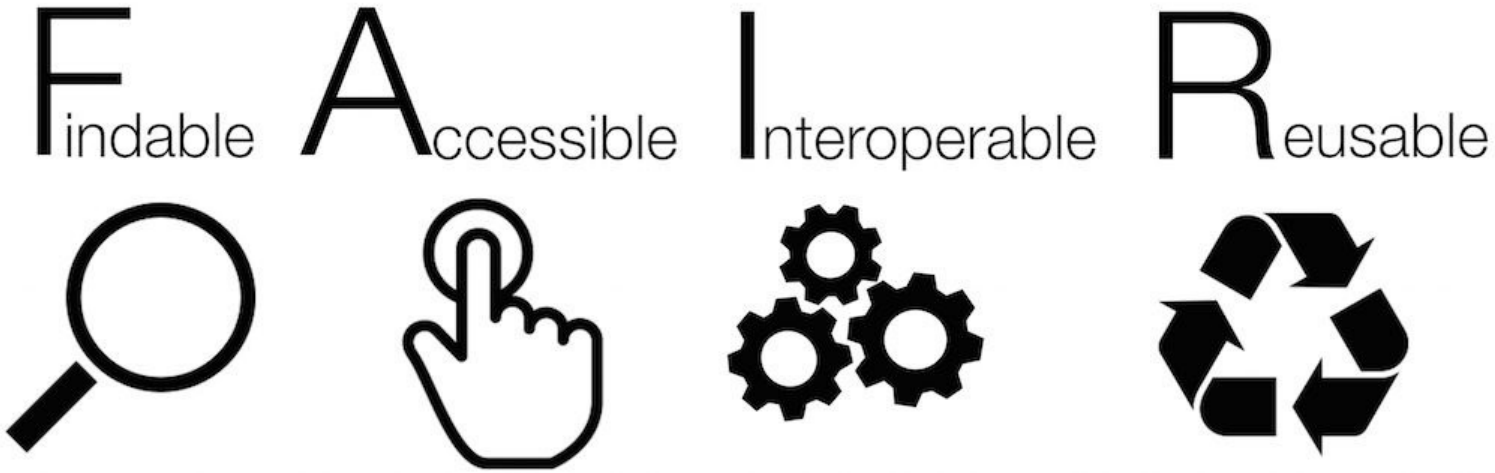
What is FAIR data?

- A set of principles to ensure that data are shared in a way that enables & enhances reuse, by humans and machines



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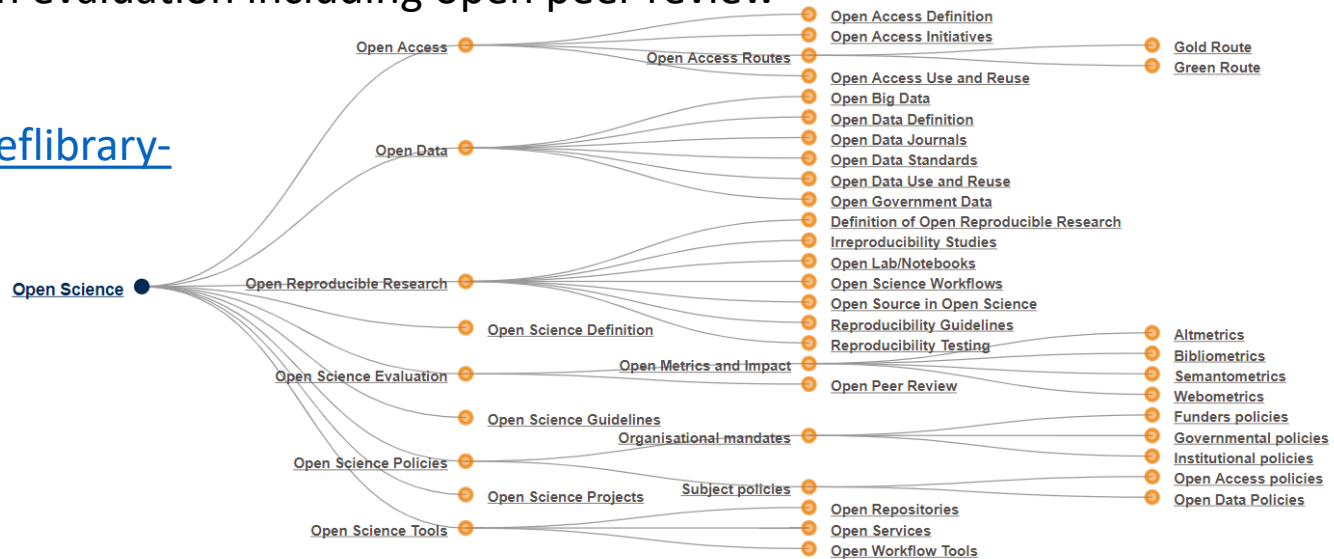
Origins of FAIR Data

- Emerged from a workshop held in Leiden in 2014
- Come from life sciences but intended for all data
  - Issued by FORCE11 community
- Echo previous principles on Open Research Data
  - Data underpinning scientific research results that has no restrictions on its access, enabling anyone to access it.
  - **Open Science** encompasses a variety of practices, usually including areas like open access to publications, open research data, open source software/tools, open workflows, citizen science, open educational resources, and alternative methods for research evaluation including open peer review

Beyond Open Access to publication: https://blogs.uef.fi/ueflibrary-bors/different-ways-to-make-your-research-more-open/



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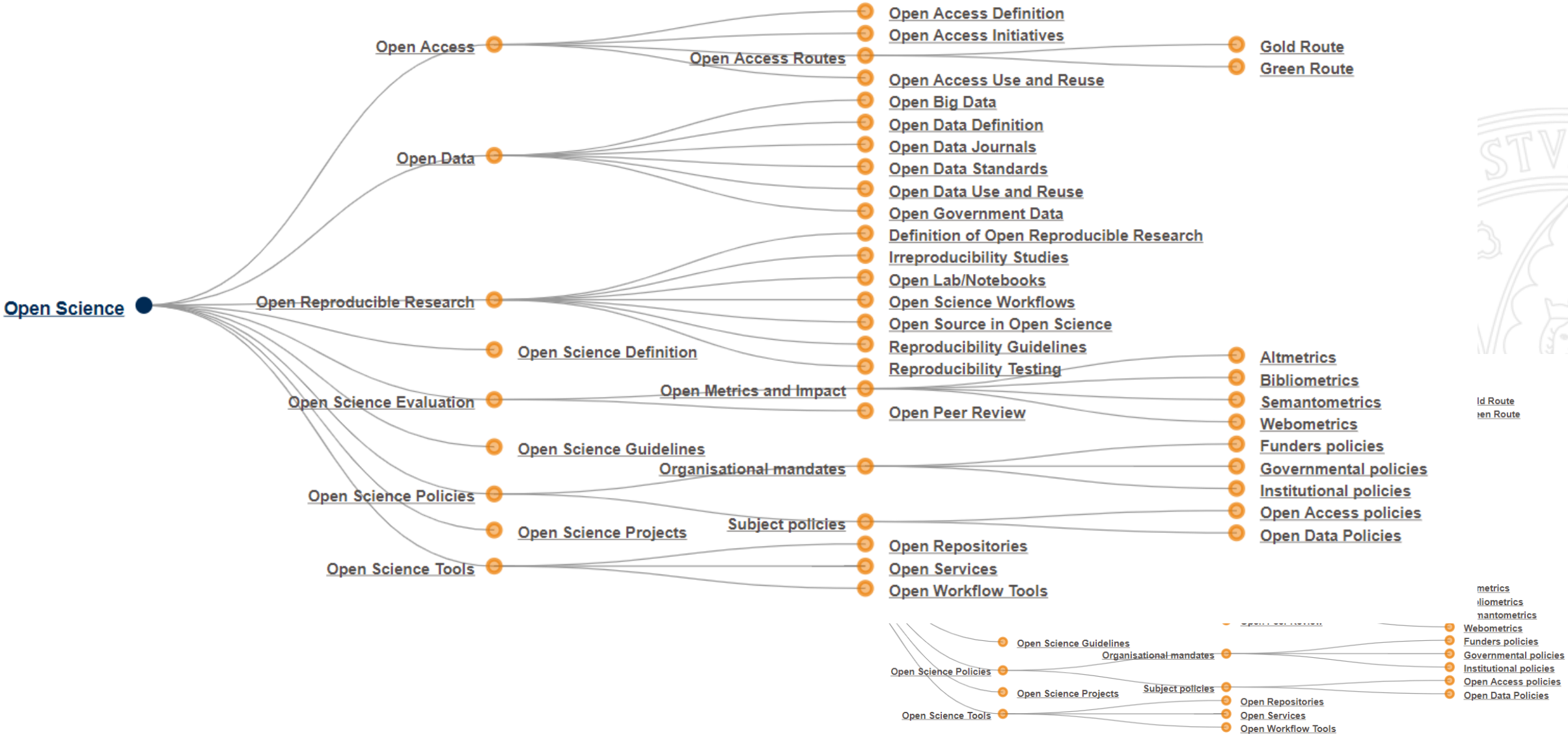

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What FAIR means?

Findable

F1. (meta)data are assigned a globally unique and eternally persistent identifier.
F2. data are described with rich metadata.
F3. (meta)data are registered or indexed in a searchable resource.
F4. metadata specify the data identifier.

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.

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.

Reusable

R1. meta(data) have 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 their provenance.
R1.3. (meta)data meet domain-relevant community standards.

FAIR Data Checklist

- ❑ **Findable**
  - Persistent ID
  - Metadata online
- ❑ **Accessible**
  - Data online
  - Restrictions where needed
- ❑ **Interoperable**
  - Use standards, controlled vocabs
  - Common (open) formats
- ❑ **Reusable**
  - Rich documentation
  - Clear usage licence

How FAIR are your data?

Findable

It should be possible for others to discover your data. Rich metadata should be available online in a searchable resource, and the data should be assigned a persistent identifier.

- ☐ A persistent identifier is assigned to your data
- ☐ There are rich metadata, describing your data
- ☐ The metadata are online in a searchable resource e.g. a catalogue or data repository
- ☐ The metadata record specifies the persistent identifier

Accessible

It should be possible for humans and machines to gain access to your data, under specific conditions or restrictions where appropriate. FAIR does not mean that data need to be open! There should be metadata, even if the data aren't accessible.

- ☐ Following the persistent ID will take you to the data or associated metadata
- ☐ The protocol by which data can be retrieved follows recognised standards e.g. http
- ☐ The access procedure includes authentication and authorisation steps, if necessary
- ☐ Metadata are accessible, wherever possible, even if the data aren't

Interoperable

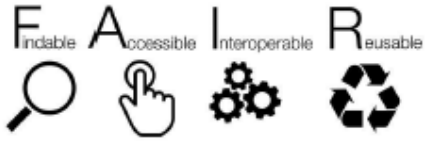
Data and metadata should conform to recognised formats and standards to allow them to be combined and exchanged.

- ☐ Data is provided in commonly understood and preferably open formats
- ☐ The metadata provided follows relevant standards
- ☐ Controlled vocabularies, keywords, thesauri or ontologies are used where possible
- ☐ Qualified references and links are provided to other related data

Reusable

Lots of documentation is needed to support data interpretation and reuse. The data should conform to community norms and be clearly licensed so others know what kinds of reuse are permitted.

- ☐ The data are accurate and well described with many relevant attributes
- ☐ The data have a clear and accessible data usage license
- ☐ It is clear how, why and by whom the data have been created and processed
- ☐ The data and metadata meet relevant domain standards



'How FAIR are your data?' checklist, CC-BY by Sarah Jones & Marjan Grootveld, EUDAT. Image CC-BY-SA by SangyaPundir

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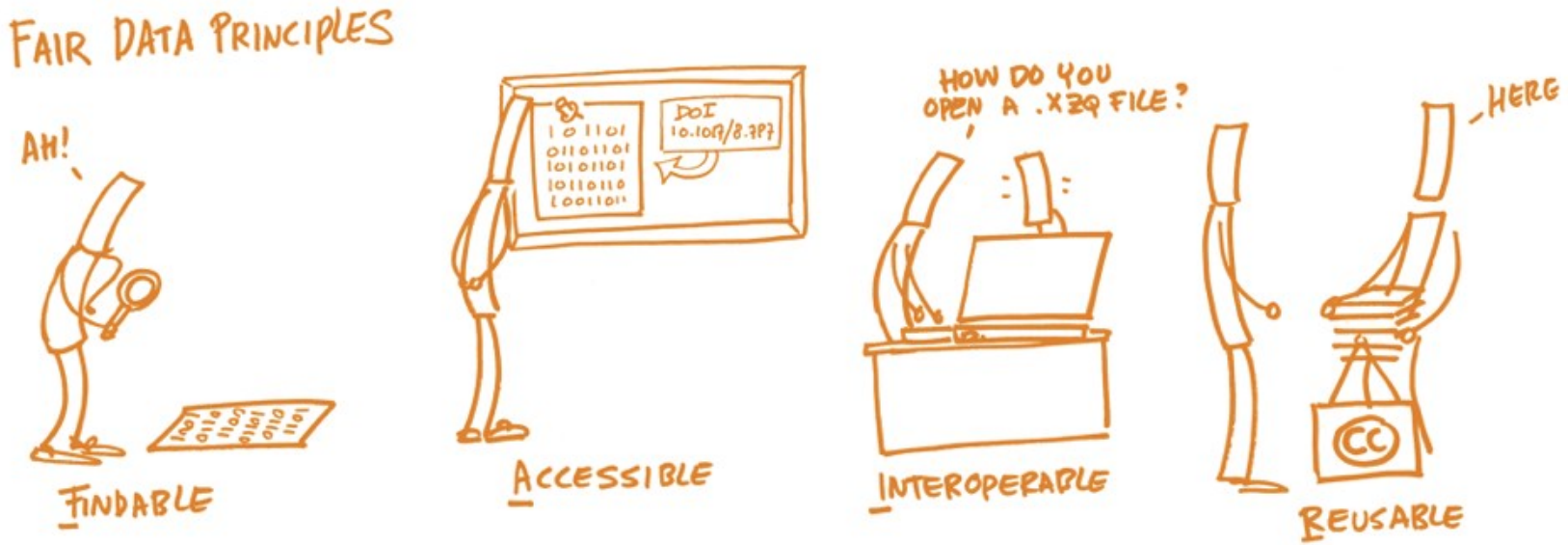
FAIR vs. Open Data

- FAIR data does not have to be open
- Data can be shared under restrictions & still be FAIR
- Making data FAIR ensures it can be found, understood and reused
- Open data is a subset of all the data shared

Implementing FAIR

- The principles do not specify particular technologies or implementations e.g. semantic web
- FAIR is not a standard to be followed or strict criteria – it's a spectrum / continuum
- Supporting FAIR will require investment in infrastructure, coordination across initiatives and engagement with research communities



Implementing FAIR: FAIRsharing

- **FAIRsharing** is a web-based, searchable portal of three interlinked registries, containing both in-house and crowdsourced manually curated descriptions of standards, databases and data policies, combined with an integrated view across all three types of resource.
  - By registering your resource on FAIRsharing, you not only gain credit for your work, but you increase its visibility outside of your direct domain, so reducing the potential for unnecessary reinvention and proliferation of standards and databases.

https://fairsharing.org/educational/

Researchers in academia, industry, government
Use FAIRsharing to identify and cite the standards, databases or repositories that exist for your discipline when creating a data management plan, releasing data or submitting a manuscript to a journal.

Developers and curators of resources
Make your standard, database or repository discoverable, by adding or claiming it in FAIRsharing; increase exposure and credit outside of your immediate community and promote adoption.

Journal publishers or organizations with data policy
Create in FAIRsharing your interrelated list of citable databases, repositories and relevant standards to recommend to your authors, users or their community; maintain and revise your recommendation over time.

Research data facilitators, librarians, trainers
Use FAIRsharing to provide a foundation on which to create or enrich educational lectures, training and teaching material; and to plug into data management planning tools and other FAIR-supporting resources.

Learned societies, unions and associations
Collaborate with FAIRsharing to raise awareness of standards, databases, repositories and data policies; mobilize your community to take action to promote registration, use and citation of key resources.

Funders and data policy makers
Recommend FAIRsharing to your awardees or community, to inform the development of their data management plan; and select the appropriate resources to recommend in your data policy.

Implementing FAIR: FAIR metrics

- Implement the FAIR principles into a **data assessment tool** so that every dataset which is deposited or reused from any digital repository can be assessed in terms of a score on the principles Findable, Accessible, Interoperable, and Reusable, using a **'FAIRness' scale from 1 to 5 stars**.
- Documentation: https://www.slideshare.net/OSFair/osfair2017-workshop-outcomes-fair-metrics-starring-your-data-sets
- "A design framework and exemplar metrics for FAIRness", https://dx.doi.org/10.1038%2Fsdata.2018.118

Comprobación del nivel FAIR en ASIO

- Sistema de comprobación automatizado del nivel FAIR cumplido por los recursos publicados durante el desarrollo del proyecto, que devuelve el nivel FAIR alcanzado, asociado a la versión del proyecto y la fecha en la que se ejecutó la comprobación.

- La red de ontologías ROH es FAIR significa que:
  1. Ofrece datos que sean Findable (Encontrables) a través de un identificador persistente e incluyendo metadatos
  2. Accessible (Accesible) a través del protocolo universal HTTP
  3. Interoperable usando vocabularios ampliamente adoptados y
  4. Reusable, se publican usando licencias de uso que promocionen la reusabilidad, como por ejemplo Creative Commons 4.0 BY-SA.

- La mejor manera de publicar datos FAIR es hacerlo mediante Linked Data, teniendo especial cuidado de generar datos y metadatos de alta calidad, mejorando así la reusabilidad de los datos para máquinas (y, como consecuencia y en última instancia, para humanos).

Sistema de Comprobación FAIRness Automatizado en HERCULES-ASIO

- La definición precisa de las métricas se ha realizado en base a las métricas definidas en el proyecto FAIR Metrics
- 14 métricas formuladas por FAIRmetrics
  - https://github.com/FAIRMetrics
- Front-end (interfaz de usuario) que facilite el lanzamiento del test suite y la generación de reportes que informen sobre el grado de cumplimiento de las métricas FAIR
  - http://herc-as-front-desa.atica.um.es/collections/15/evaluate/template
- Tales reportes son archivados (históricos) para poder analizar el compromiso a lo largo del tiempo de ROH con los principios FAIR.

Estrategia de implementación de métricas FAIR

1. **Evaluación del estado de cumplimiento actual de las propiedades FAIR del prototipo ROH**:
   - Servicio de ejecución de evaluación de servicios FAIR: https://fairsharing.github.io/FAIR-Evaluator-FrontEnd/#!/collections/new/evaluate
   - Resultado: https://fairsharing.github.io/FAIR-Evaluator-FrontEnd/#!/evaluations/4065

2. **Análisis de la implementación disponible de las métricas en Ruby**
   - Cambios introducidos en los últimos meses lo que implica que el proyecto sigue activo: https://github.com/FAIRMetrics/Metrics/tree/master/MetricsEvaluatorCode/Ruby/metrictests
   - Despliegue del back-end de métricas FAIR en máquina local para uso dentro del proyecto:
     - GNOSS ha realizado despliegue en el servidor de desarrollo
     - Se ha contactado con autores, concretamente mark.wilkinson@upm.es
       - Su recomendación ha sido que hagamos uso de la API disponible en https://ejp-evaluator.appspot.com/FAIR_Evaluator//
         - Sin embargo, es necesario tener nuestro propio despliegue para evitar dependencias de terceros

Estrategia de implementación de métricas FAIR

3. **Diálogo con autores de FAIRsharing (Mark Wilkinson):**
   - Es razonable contribuir al proyecto existente en vez de reinventar la rueda
   - Se ha contrastado que las métricas FAIRsharing funcionan. Análisis realizado con:
     - Simple recurso apuntando a un DOI (`10.1016/j.future.2019.09.033`): https://fairsharing.github.io/FAIR-Evaluator-FrontEnd/#!/evaluations/3236
     - Tal como se ha mencionado ejecutado también contra la definición de la red de ontologías ROH: https://fairsharing.github.io/FAIR-Evaluator-FrontEnd/#!/evaluations/4065
   - Es posible crear nuevas métricas específicas al dominio de gestión de datos de la investigación a través de la compleción de FAIR Maturity Indicator template. A partir de esta plantilla:
     - Equipo de FAIRsharing se ofrece a implementarlo
     - Se pueden realizar extensiones a través de la provisión de un endpoint para tales nuevas métricas usando SmartAPI (https://smart-api.info/), extensión de OpenAPI

Estrategia de implementación de métricas FAIR

4. Decisión de estrategia de implementación de métricas FAIR

- Creación de un proxy API usando OpenAPI, que será utilizada desde back-end HERCULES-ASIO para realizar validación de recursos (resources) y de la red de ontologías como tal
  - Tal API se comunico en primera instancia con API pública ya desplegada por FAIRsharing: https://ejp-evaluator.appspot.com/FAIR_Evaluator// y ofrece interfaz web Swagger
  - Incluye interfaz gráfica para introducir, basada en https://github.com/FAIRsharing/FAIR-Evaluator-FrontEnd:
    - Recurso a validar
    - Conjunto de métricas a ejecutar
    - Visualización amigable del grado de cumplimiento de las políticas FAIR
- Publicación de issues y pull requests con modificaciones a las métricas ya implementadas en el caso de encontrarse bugs o realizarse extensiones a las existentes
- Clonar API pública de FAIRsharing para asegurar no dependencia con recurso externo
- Generación de nuevas métricas específicas al ámbito ASIO a través de smartAPI y/o entrega de plantillas para FAIRsharing

Estrategia de implementación de métricas FAIR

5. **Solución desarrollada**
   - Se ha creado un proxy API (bridge) usando OpenAPI, que será utilizada desde HERCULES-ASIO para realizar validación de recursos (resources) y de la red de ontologías como tal
     - Incluye interfaz Swagger con 4 operaciones:
       - Recuperar colecciones de métricas (baterías de test disponibles)
       - Ejecución de colección de métricas seleccionada sobre recurso indicado
       - Recuperación de evaluaciones realizadas desde un ORCID
       - Recuperación de resultados de evaluación de ejecución de colección de métricas
6. **Trabajo futuro**
   - Generación de recomendaciones para hacer ROH y recursos asociados (y por ende otras ontologías y recursos) compatible con políticas FAIR: https://github.com/FAIRMetrics/Your_Path_To_FAIRness/tree/master/MI_Test_Tutorials
   - Ejecución de políticas FAIR sobre test suite de recursos ROH y la red de ontologías
     - Adaptación de ROH para su cumplimiento integro de políticas FAIR

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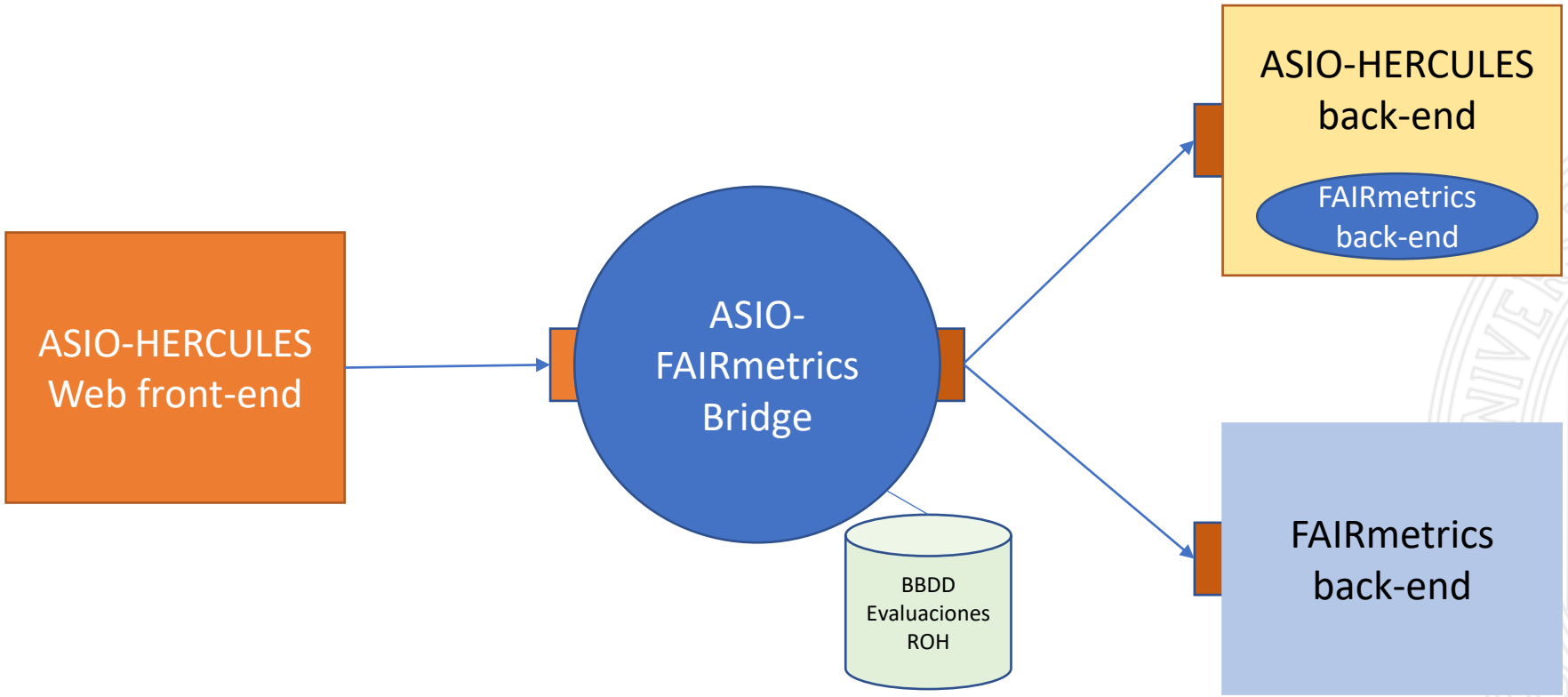
Arquitectura puente entre ASIO y FAIRmetrics



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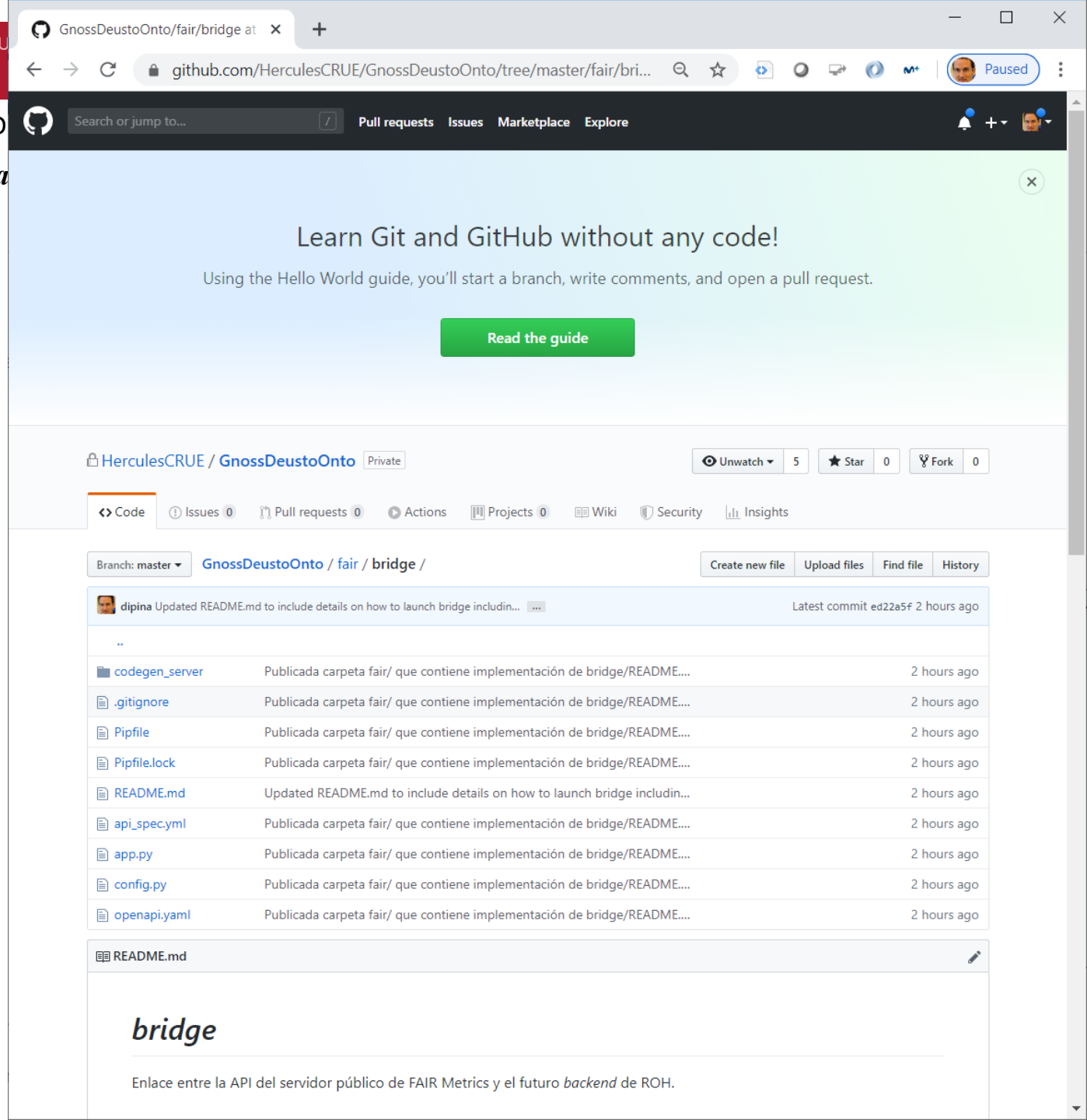
Bridge ASIO-FAIR Metrics código fuente

https://github.com/HerculesCRUE/GnossDeustoBackend/tree/master/src/fair/bridge

http://herc-as-front-desa.atica.um.es/bridgeswagger/v1/ui



Pasos para la ejecución de FAIRness de recursos

1. **Identificar y seleccionar batería de tests a realizar**
   - Se puede usar una de las baterías existentes: https://fairsharing.github.io/FAIR-Evaluator-FrontEnd/#!/collections
   - O definirse una nueva a través de interfaz: https://fairsharing.github.io/FAIR-Evaluator-FrontEnd/#!/collection/new

2. **Instalación y lanzamiento del puente ASIO-FAIRmetrics**
   - Configuración para selección endpoint FAIRmetrics con el que conectarse
   - Acceso al front-end Swagger

3. **Ejecución de operaciones sobre API bridge ASIO-FAIRmetrics**
   - Ejecución de los métodos del API con recursos externos, ej. 10.1109/ACCESS.2019.2952321
   - O con la propia red de ontologías de Hércules: http://purl.org/roh

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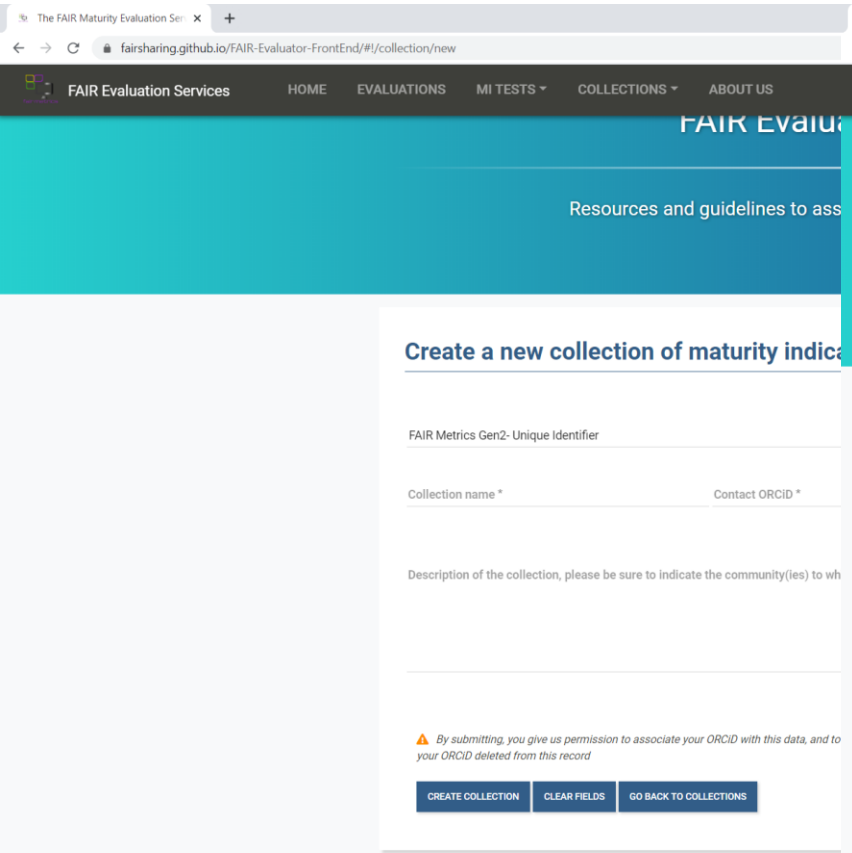
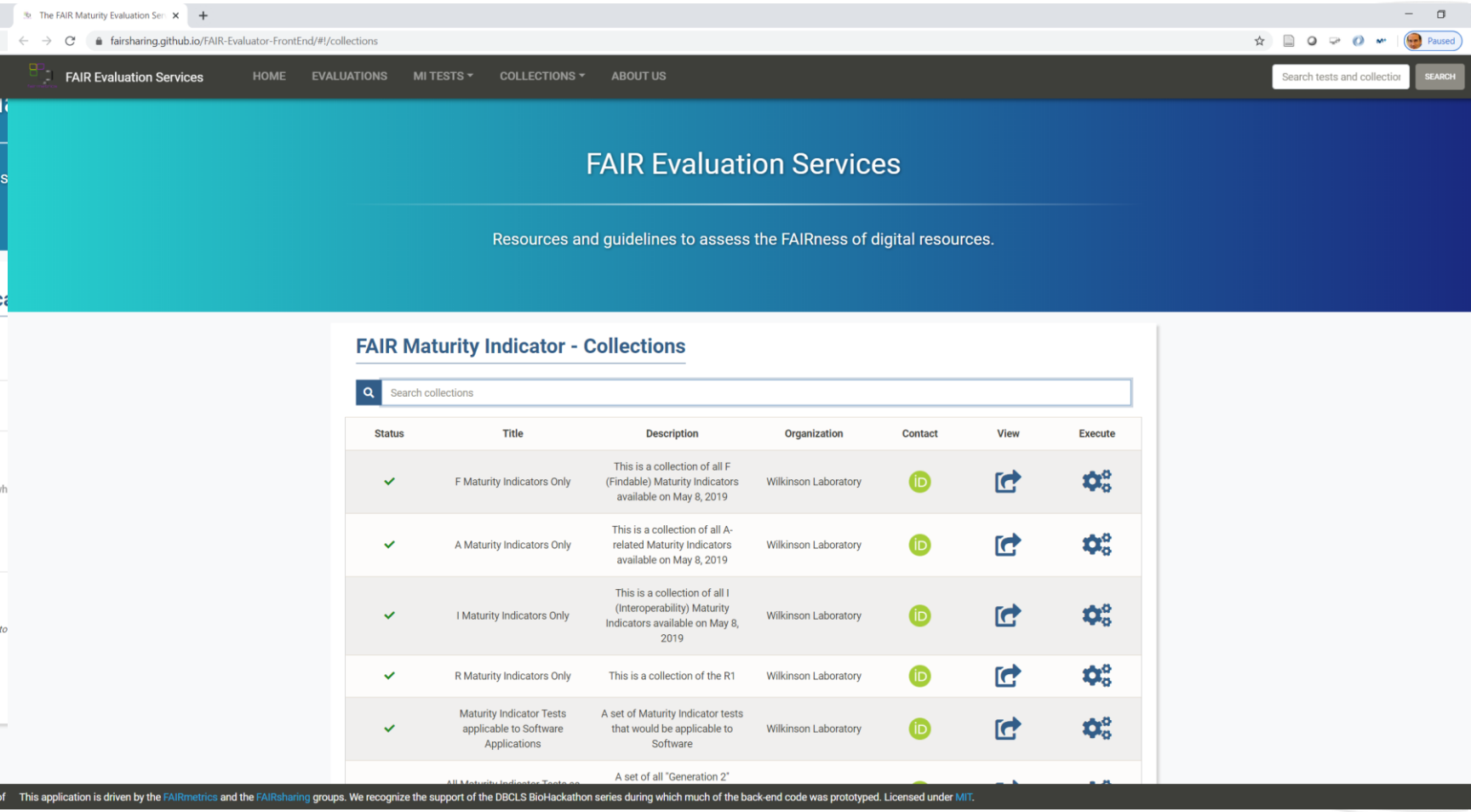
Pasos para la ejecución de FAIRness de recursos (paso 1)





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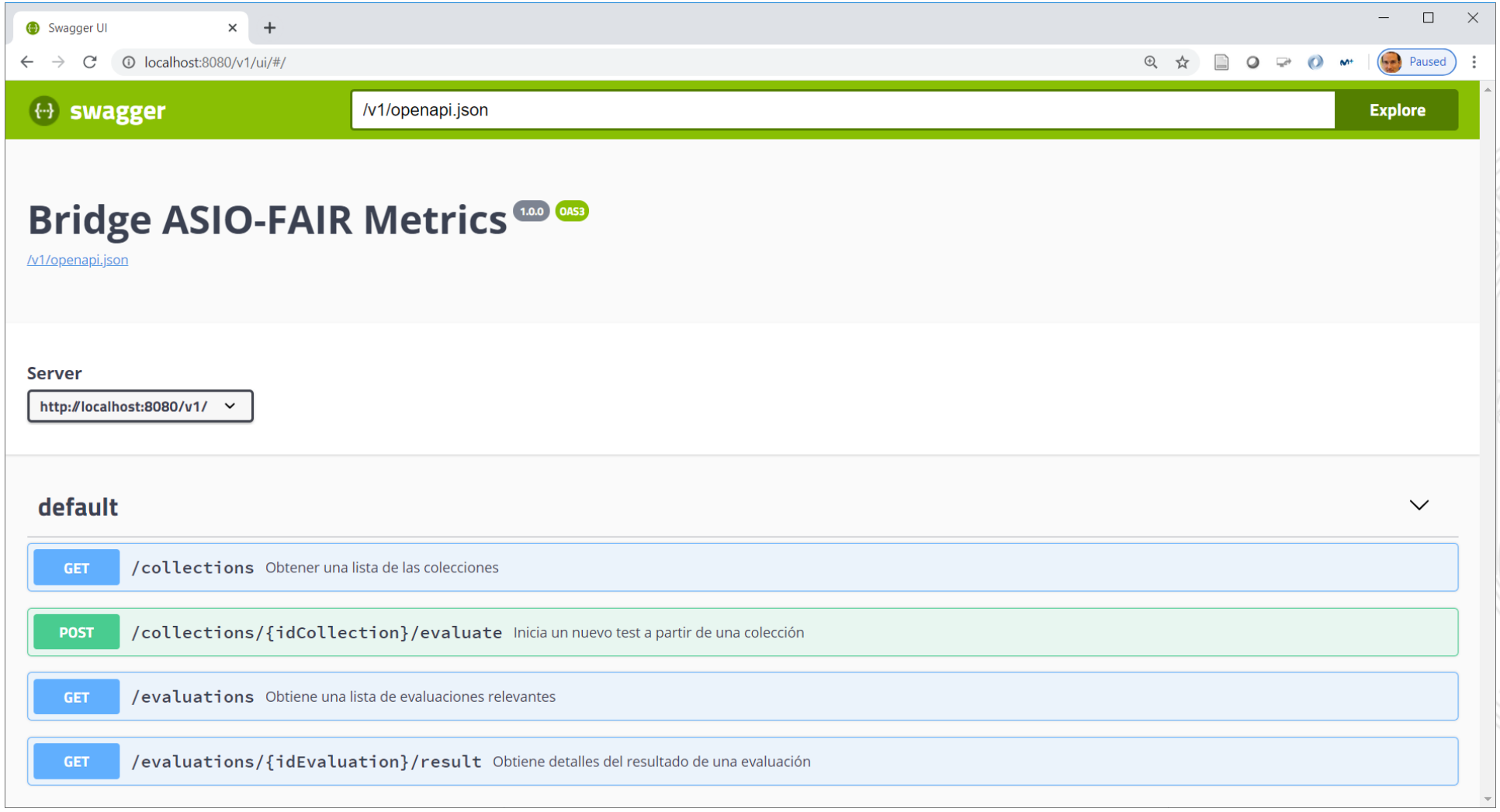
Ejecución de puente Bridge ASIO-FAIR Metrics (paso 2)



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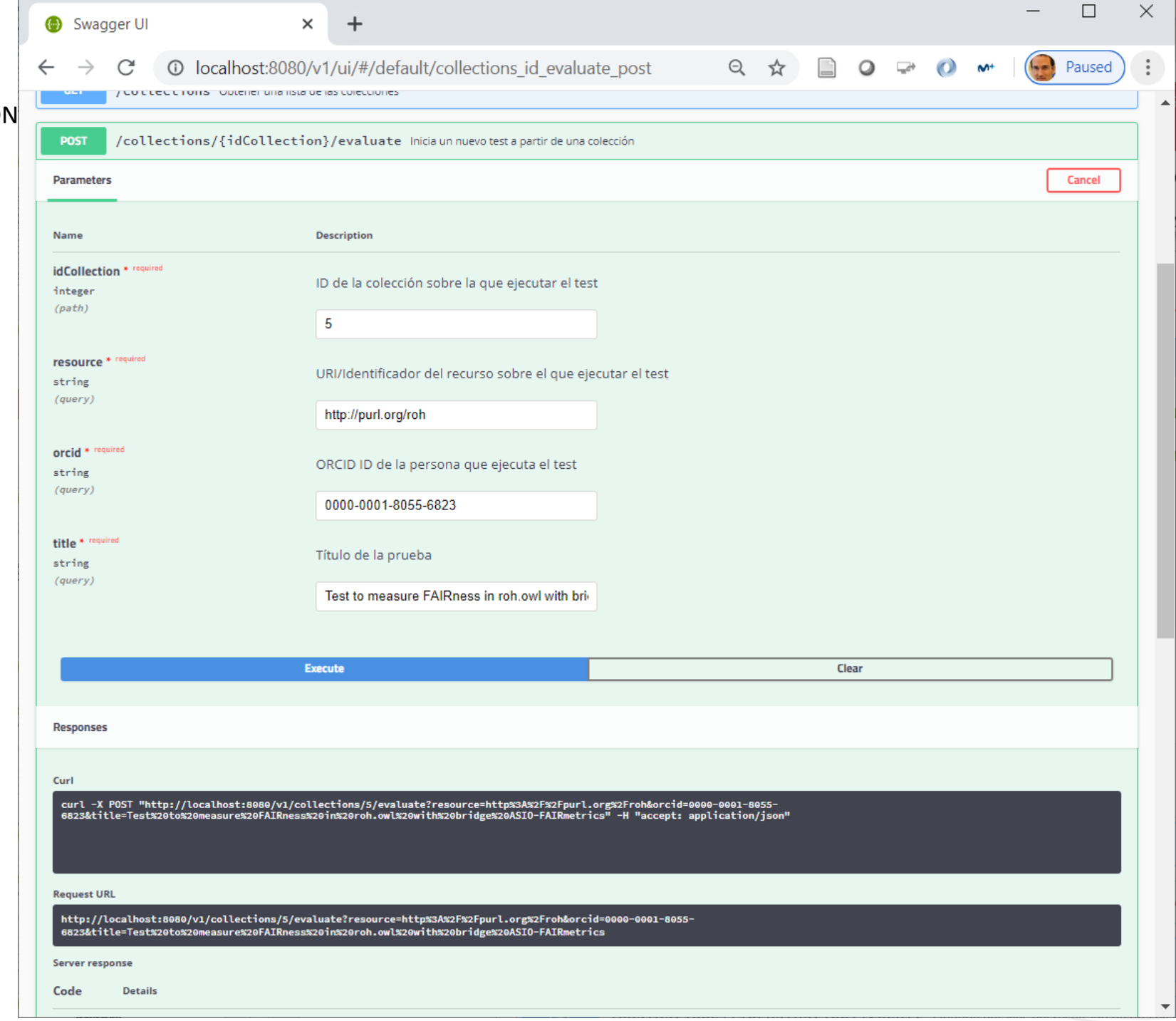
Ejecución de colección de métricas en puente bridge ASIO-FAIR Metrics (paso 3)

http://herc-as-front-desa.atica.um.es/bridgeswagger/v1/ui/#/default/collections_id_evaluate_post



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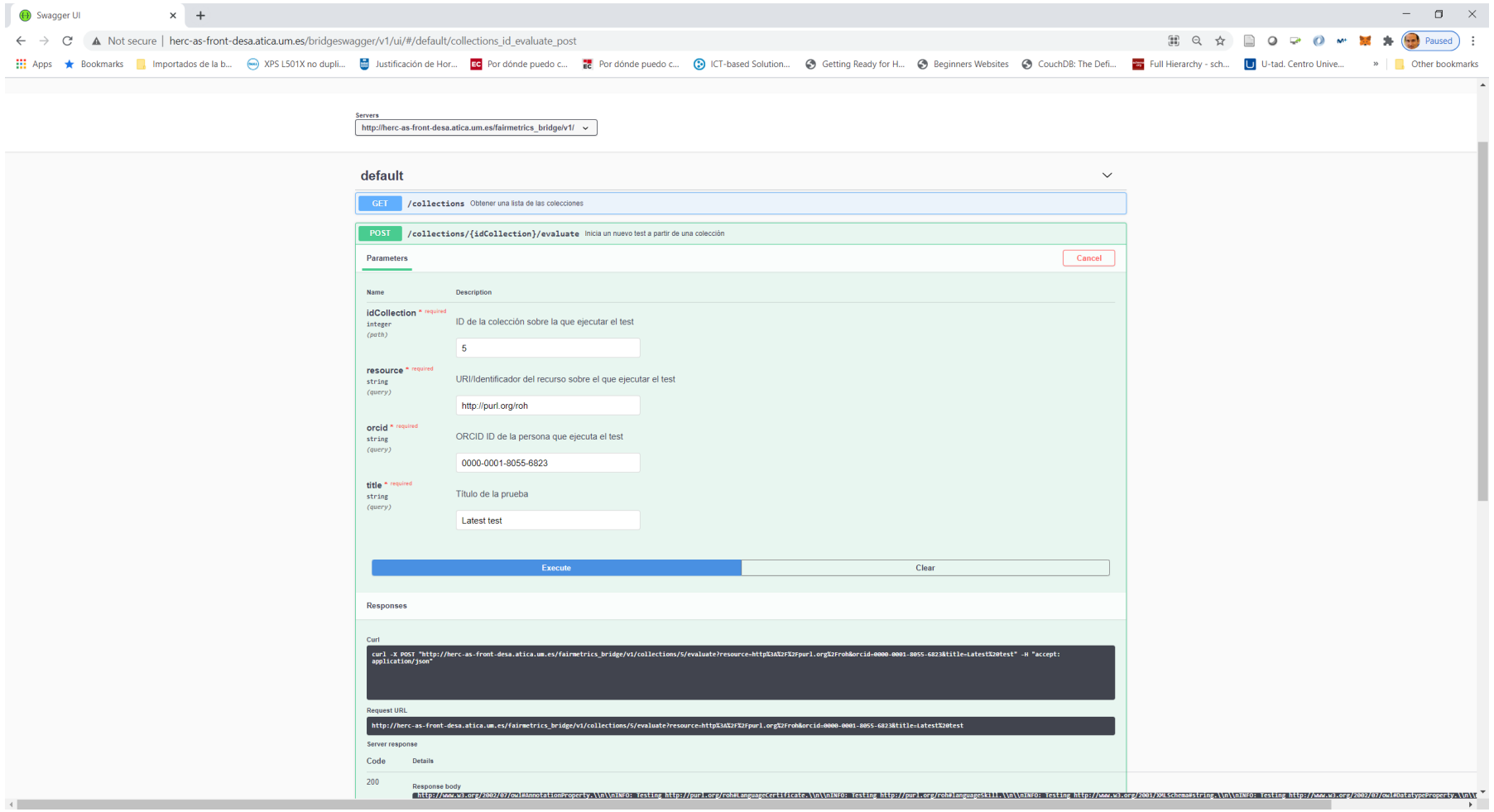
Validación FAIRness publicación con puente ASIO-FAIRmetrics



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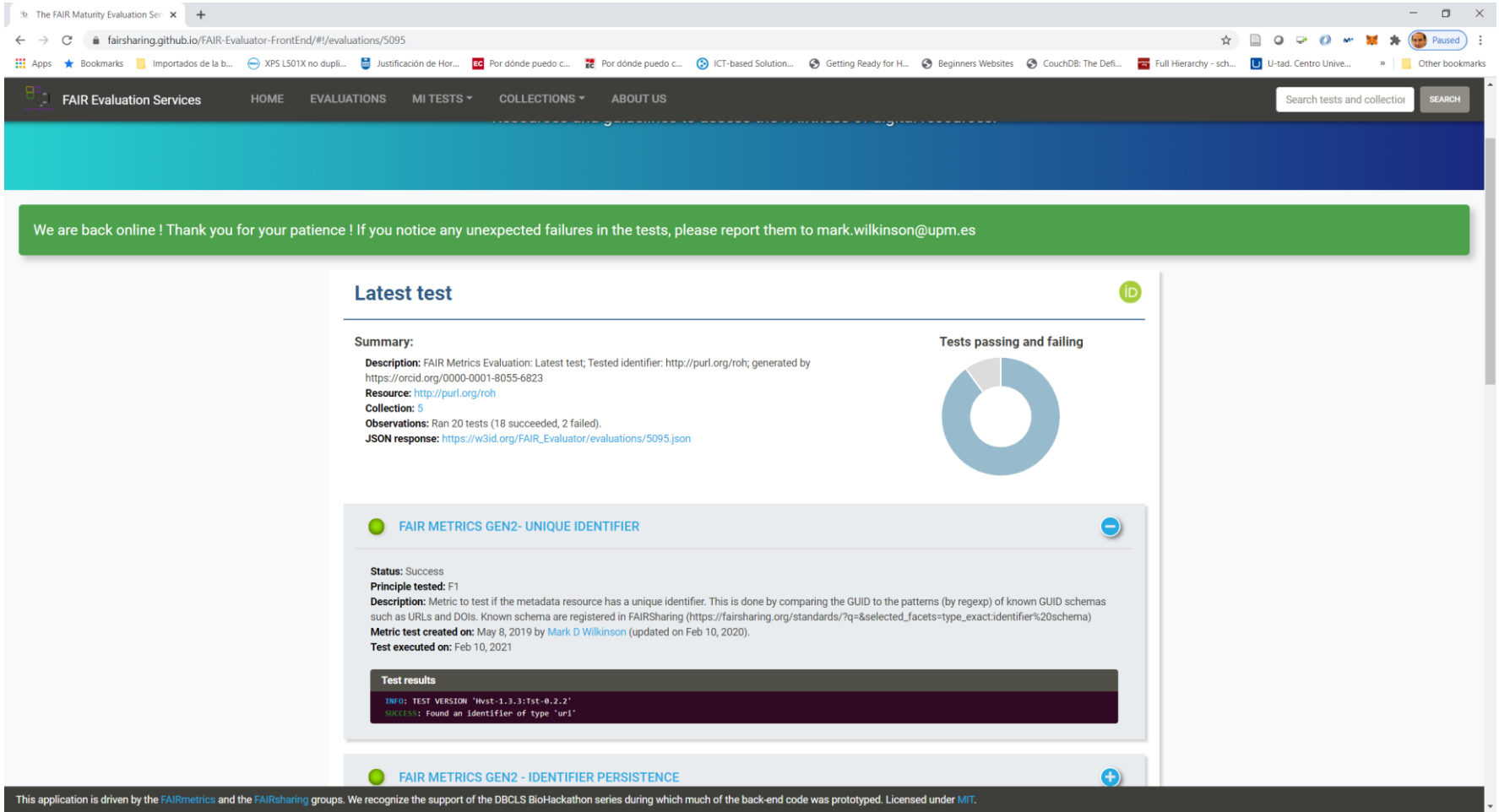
Validación FAIRness Red de Ontologías Hercules (ROH)



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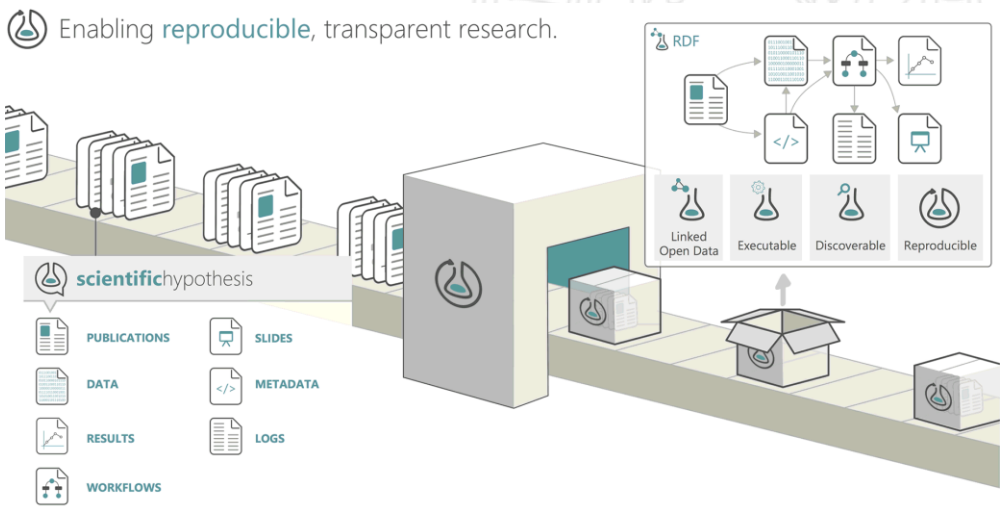
Science advances on a foundation of trusted discoveries. Reproducing an experiment is one important approach that scientists use to gain confidence in their conclusions.
Marcia McNutt, Editor-in-Chief of Science

Research Objects

- An **emerging approach to the publication, and exchange of scholarly information on the Web**.
- Research Objects aim to **improve reuse and reproducibility** by:
  - Supporting the publication of more than just PDFs, making data, code, and other resources first class citizens of scholarship
  - Recognizing that there is often a need to publish collections of these resources together as one shareable, cite-able resource.
  - Enriching these resources and collections with any and all additional information required to make research reusable, and reproducible!



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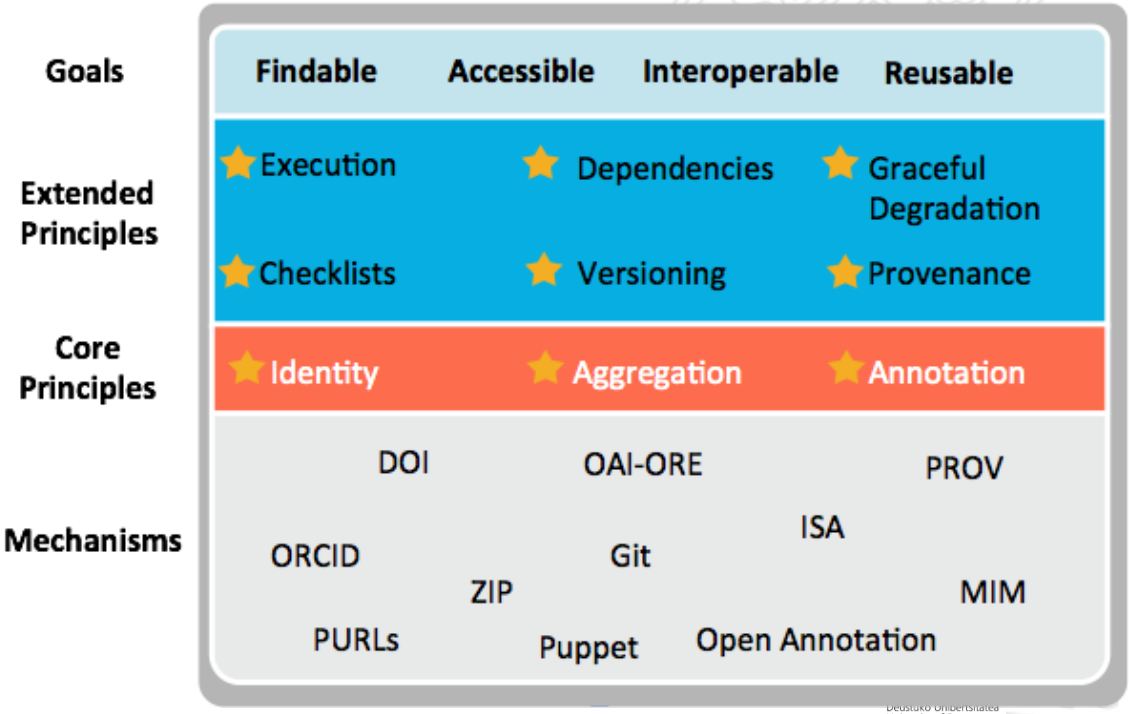
Research Objects: going beyond PDFs

- The **goal** of research objects is to **improve the potential for understanding and reuse of research** by making sure that the information that is needed to make a published resource useful is associated with it and shared as a whole.
- As part of one research investigation, you might for example have:
  - Slides hosted on slideshare,
  - Code in a GitHub repository,
  - Data in figshare,
  - Data in ArrayExpress.
- **A research object not just a publication but everything else that goes into, and supports an investigation**
- Initiatives and approaches to bring content together in a **machine-readable mechanism so that it can be more easily shared and exchanged**.



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Research Objects: principles

- **Identity:**
  - Use globally unique identifiers as names for things. For example DOI's for publications or ORCID IDs for researchers. This is for two reasons
    1. So that we can talk unambiguously about things.
    2. So that people can find those things.
- **Agregation**
  - Use some mechanism of aggregation to associate things that are related or part of the broader investigation, study, etc.
    - Core to the value of Research Objects - providing the supporting artefacts that make the research potentially useful to someone else.
- **Annotation:**
  - Provide additional metadata about those things, how they relate to each other, where they came from, when etc.
    - This helps people discover data that are relevant and potentially useful.

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Research Objects: benefits

- A way to refer to (and cite!) a bundle of research artefacts as a whole.
- A mechanism to associate human and machine-readable metadata with those research artefacts. Anything that can understand that metadata can therefore benefit.
- A graceful degradation of understanding.

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Research Objects: modelling ROs with RO-CRATE

- RO-Crate is a community effort to establish a lightweight approach to packaging research data with their metadata.
  - It is based on schema.org annotations in JSON-LD.
- The RO-Crate effort brings together practitioners from very different backgrounds, and with different motivations and use-cases. Among our core target users are:
  1. **researchers** engaged with computation and data-intensive, workflow-driven analysis;
  2. **digital repository managers** and infrastructure providers;
  3. **individual researchers** looking for a straight-forward tool or how-to guide to “FAIRify” their data;
  4. **data stewards** supporting research projects in creating and curating datasets.
- RO-CRATE metadata specification: https://www.researchobject.org/ro-crate/1.1/
  - Reference: Eoghan Ó Carragáin; Carole Goble; Peter Sefton; Stian Soiland-Reyes (2019): **A lightweight approach to research object data packaging** *Bioinformatics Open Source Conference (BOSC2019)* https://doi.org/10.5281/zenodo.3250687

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Research Objects: tools to ROs with RO-CRATE

- Describo interactive desktop application to create, update and export RO-Crates for different profile
- More tools at: https://www.researchobject.org/ro-crate/implementations.html

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Research Objects: RO structure

- The structure an RO-Crate MUST follow is:

```
<RO-Crate root directory>/
|   ro-crate-metadata.json     # RO-Crate Metadata File MUST be present
|   ro-crate-preview.html      # RO-Crate Website homepage MAY be present
|   ro-crate-preview_files/    # MAY be present
|    | [other RO-Crate Website files]
|   [payload files and directories]  # 0 or more
```

- Documented in https://www.researchobject.org/ro-crate/1.1/metadata.html

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Research Objects: RO metadata

- Documented in https://www.researchobject.org/ro-crate/1.1/metadata.html
- The **Root Data Entity** is a Dataset that represent the RO-Crate as a whole; a Research Object that includes the Data Entities and the related Contextual Entities.
- The primary purpose for RO-Crate is to gather and describe a set of **Data entities** in the form of (linked with the root entity with hasPart property):
  - Files
  - Directories
  - Web resources
- The data entities can be further described by referencing **contextual entities** such as persons, organizations and publications.
  - Contextual entities however primarily exist outside the digital sphere (e.g. People, Places) or are conceptual descriptions that primarily exists as metadata, like GeoCoordinates and ContactPoint.

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Research Objects: example 1

```
<RO-Crate root>/
  |   ro-crate-metadata.json
  |   cp7glop.ai
  |   lots_of_little_files/
  |     | file1
  |     | file2
  |     | ...
  |     | file54
```

```
{ "@context": "https://w3id.org/ro/crate/1.1/context",
  "@graph": [
    {
      "@type": "CreativeWork",
      "@id": "ro-crate-metadata.json",
      "conformsTo": {"@id": "https://w3id.org/ro/crate/1.1"},
      "about": {"@id": "./"}
    },
    {
      "@id": "./",
      "@type": [
        "Dataset"
      ],
      "hasPart": [
        {
          "@id": "cp7glop.ai"
        },
        {
          "@id": "lots_of_little_files/"
        }
      ]
    },
    {
      "@id": "cp7glop.ai",
      "@type": "File",
      "name": "Diagram showing trend to increase",
      "contentSize": "383766",
      "description": "Illustrator file for Glop Pot",
      "encodingFormat": "application/pdf"
    },
    {
      "@id": "lots_of_little_files/",
      "@type": "Dataset",
      "name": "Too many files",
      "description": "This directory contains many small files, that we're not going to describe in detail."
    }
  ]
}
```

Research Objects: example 2

Documentación de contextual entities:

- https://www.researchobject.org/ro-crate/1.1/contextual-entities.html

```
{ "@context": "https://w3id.org/ro/crate/1.1/context",
  "@graph": [

 {
    "@type": "CreativeWork",
    "@id": "ro-crate-metadata.json",
    "conformsTo": {"@id": "https://w3id.org/ro/crate/1.1"},
    "about": {"@id": "./"}
 },
 {
    "@id": "./",
    "identifier": "https://doi.org/10.4225/59/59672c09f4a4b",
    "@type": "Dataset",
    "datePublished": "2017",
    "name": "Data files associated with the manuscript:Effects of facilitated family case conferencing for ...",
    "description": "Palliative care planning for nursing home residents with advanced dementia ...",
    "license": {"@id": "https://creativecommons.org/licenses/by-nc-sa/3.0/au/"}
 },
 {
  "@id": "https://creativecommons.org/licenses/by-nc-sa/3.0/au/",
  "@type": "CreativeWork",
  "description": "This work is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Australia License. To view a copy of this license, visit http://creativecommons.org/licenses/by-nc-sa/3.0/au/ or send a letter to Creative Commons, PO Box 1866, Mountain View, CA 94042, USA.",
  "identifier": "https://creativecommons.org/licenses/by-nc-sa/3.0/au/",
  "name": "Attribution-NonCommercial-ShareAlike 3.0 Australia (CC BY-NC-SA 3.0 AU)"
 }
 ]
}
```

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