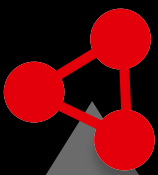


RDF AS A BRIDGE TO DOMAIN-PLATFORMS LIKE OMERO



or, There and back again

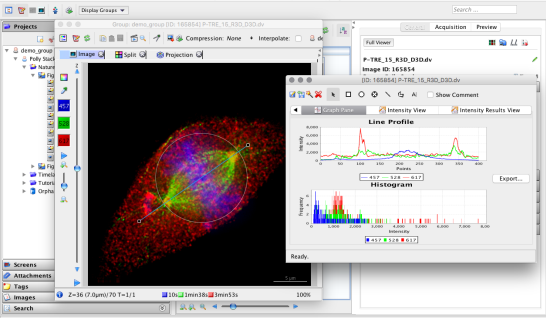
In 2005, the first version of OMERO stored RDF natively. However, just a year after the 1.0 release of RDF, performance considerations led to the development of a more traditional SQL approach for OMERO. A binary protocol makes it possible to query and retrieve metadata but the resulting information cannot immediately be combined with other sources. This is the adventure of rediscovering the benefit of RDF triples as a – if not **the** -- common exchange mechanism.

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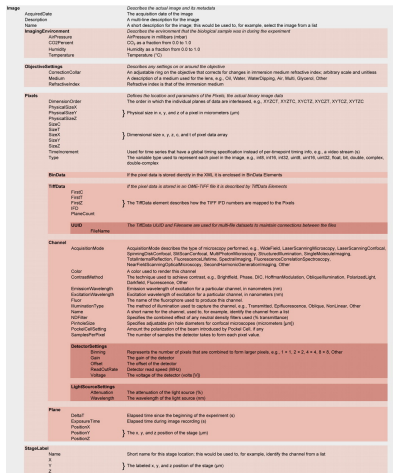


The production of digital images in biomedical research is a field in rapid evolution, with 500 newly indexed articles on PubMed each day in the life-sciences alone. The ever-increasing volume of bioimages and the granularity of metadata and annotations complicate data management.

OMERO is an open-source platform built to manage information from the over 160 bioimaging file formats produced by microscopes using the Open Microscopy Environment (OME) data model.



Screenshot of the OMERO client visualizing an image saved in DeltaVision. All screenshots are used with permission from <https://openmicroscopy.org> (CC-BY) unless otherwise noted.



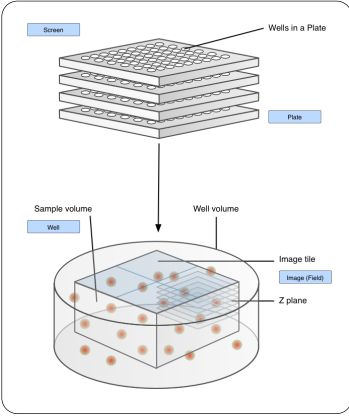
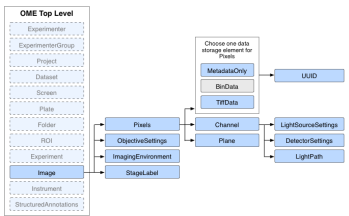
The OME Model, defined in XML Schema, consists of over 160 classes representing a common vocabulary for describing multi-dimensional imaging experiments. In OMERO, these values are stored in PostgreSQL tables with numerous foreign key constraints and made available through a bespoke API.

Extracting all information about an imaging experiment can be time-consuming and error-prone. By providing a mapping via the **omero-rdf** library, integration is made possible with a host of other platforms.

\$ omero rdf Image:165854

```
@prefix dcat: <http://www.w3.org/ns/dcat#> .
@prefix dcterms: <http://purl.org/dc/terms/> .
@prefix efo: <http://www.ebi.ac.uk/efo/> .
@prefix fhir: <http://hl7.org/fhir/> .
@prefix jerm: <http://jermontology.org/ontology/JERMOntology#> .
@prefix obi: <http://purl.obolibrary.org/obo/obi/> .
@prefix ome: <http://www.openmicroscopy.org/Schemas/OME/2016-06#> .
@prefix rocrate: <https://w3id.org/rocrate/1.1/context> .
@prefix sio: <http://semanticscience.org/resource/> .
@prefix sioc: <http://rdfs.org/sioc/ns#> .
...
```

#1 Take-home: By translating domain-specific OMERO metadata to RDF, it is more readily combinable with other domains.



Description: RO-Crate is a lightweight approach to packaging research objects with structured metadata based on schema.org annotations in JSON-LD.

Bioimaging: Exporting OMERO datasets to RO-Crate provides a standardized interface around a collection of domain-specific files. Bioimaging brings complex data formats which, like a puzzle, describe the spatial relationship between independent files representing regions of an image.

Challenge: How best to bridge to these domain-specific protocols is still unclear.

#2 Take-home: Rather than being “hidden” in a domain-specific OME-XML file, extracted triples can be made discoverable in RO-Crate’s JSON-LD.



Description: The Annotated Research Context (ARC) by DataPLANT is a self-contained data format originally designed for plant research, including assay or measurement data, workflow and computation results accompanied by metadata. It combines the Investigations, Studies, Assays (ISA) model, Common Workflow Language (CWL), and RO-Crate standards.

Bioimaging: OMERO-based data can be transformed into or from this format.

Challenge: The need to return to a file-based view on the data when users are accustomed to an image-centric view.

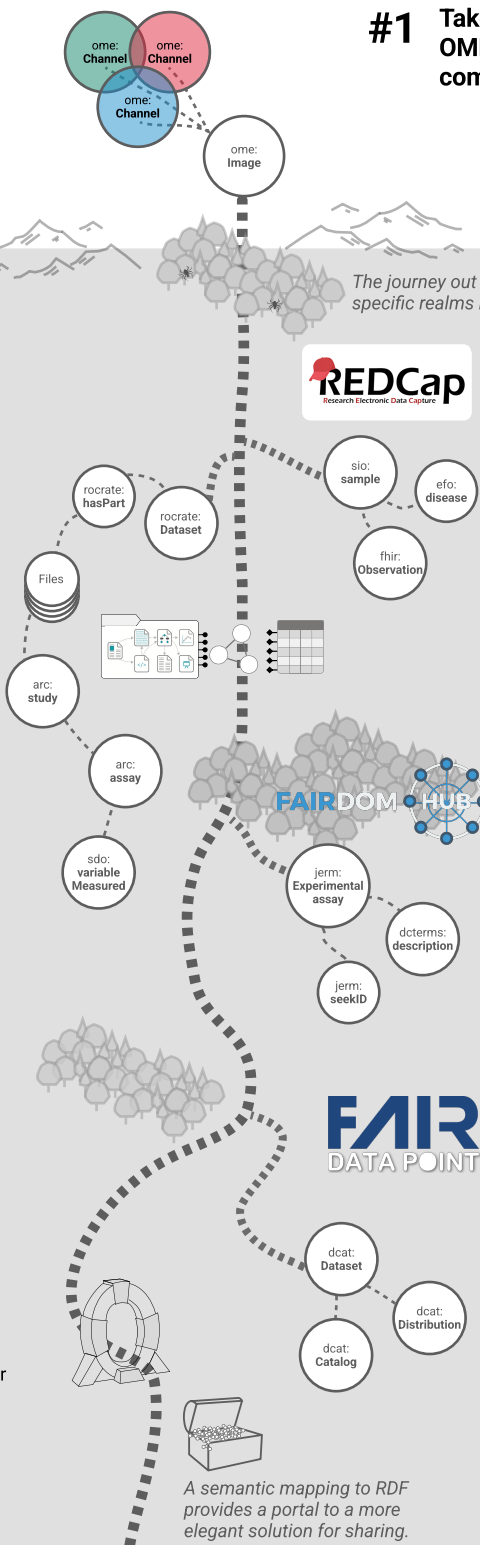
#3 Take-home: An ARC extends the RO-Crate model providing versioned metadata and ISA support which aligns closely with OMERO.



Description: Provides a flexible yet expressive standard for describing many kinds of data models from value sets and flat, checklist-style standards to complex normalized data structures that use polymorphism and inheritance (<https://f1000research.com/posters/12-1101>).

Bioimaging: Many groups in the bioimaging community are now moving to describing their models with LinkML with the hope of creating an extensible network of schemas

#4 Take-home: LinkML provides a modeling language that can capture the richness of OMERO while providing URIs for each Class and Predicate.



Description: “REDCap (Research Electronic Data Capture) is a browser-based, metadata-driven EDC software and workflow methodology for designing clinical and translational research databases.” (<https://en.wikipedia.org/wiki/REDCap>)

Bioimaging: Thousands of groups use REDCap to capture detailed information about critical human diseases, such as tuberculosis in our current work. Images of the diseased tissue, however, along with annotations from pathologists are stored in OMERO, making it difficult to get a complete view of all research materials.

Challenge: To construct a single knowledge graph, it is necessary to implement an automated process for mapping REDCap tables to RDF using the referenced URIs provided by OMERO.

#5 Take-home: By embedding an R script in REDCap, the relational tables making up the clinical records can be exported to RDF

Description: The FAIRDOMHub is an ELIXIR-approved public resource for sharing heterogeneous research assets - datasets, models, processes, workflows and research outcomes. It is based on the FAIRDOM-SEEK platform, where research assets are available in RDF. They can be aggregated and shared as RO-Crate Research Objects and published using DOIs.

Bioimaging: The LISym Cancer Project has integrated FAIRDOM-SEEK with OMERO by extracting metadata into SEEK and providing external links to the OMERO server.

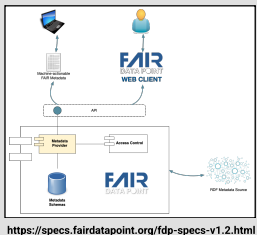
Challenge: A more comprehensive solution would make the images directly accessible as FAIR objects.

#6 Take-home: Exported triples can be exposed in FAIR platforms with no need for further transformation or encoding.

Description: FAIR Data Points (FDP) are “a software architecture aiming to define a common approach to publish semantically-rich and machine-actionable metadata according to the FAIR principles” (https://doi.org/10.1162/dint_a_00160) based on the Data Catalog Vocabulary (DCAT).

Bioimaging: By implementing the FDP protocol, domain-specific services like OMERO can make data sets available to a wider community.

Challenge: This is a work-in-progress that we will be continuing at the hackathon.



#7 Take-home: FDP offers a registry for OMERO datasets into which exported triples can be loaded.

Join us at the hackathon to help make it happen!

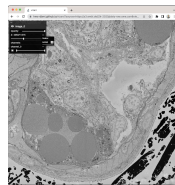
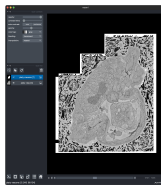
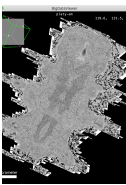
#swat4hcls2024-hack-1-publishing-fair-datasets-from-bioimaging-repositories



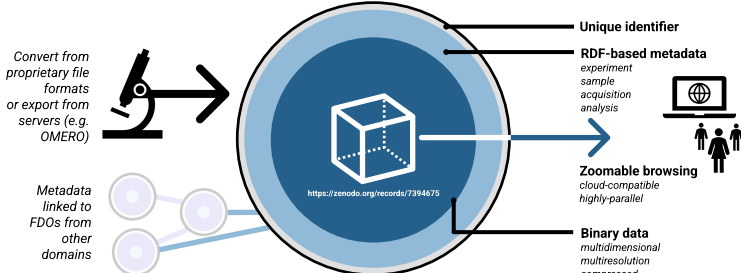
FAIR Image Objects

Description: FDO-compatible datatype for bioimaging to ensure data is open and web-accessible. Terabytes of pixels as well as analytical results can be made shareable, linkable, browsable, re-usable, archivable. A pyramidal structure allows Google Maps-style zooming. A cloud-optimized (“chunked”) format – **OME-Zarr** – allows referencing individual regions of an image in parallel.

#8 Take-home: To establish links to other domains, it's essential to leverage more than just custom APIs.



8-TB electron microscopy volume of a 6 day old *Platyneis* larva from Vergara et al. 2020 (doi: 10.1101/2020.02.26.961037)
Available at: <https://s3.embl.de/2k-2020/platy-raw.ome.zarr>



Have you been on a similar journey in your domain? We'd love to hear.

[josh@openmicroscopy.org](https://openmicroscopy.org)

This poster can be found under:
DOI: 10.5281/zenodo.1068769

