

# Making expert curated knowledge graphs FAIR

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## Abstract

To address the users' need to combine knowledge from different expert curated resources, the biocuration community is heavily invested in the standardization of knowledge with shared ontologies and, more recently, in the representation of data in the form of knowledge graphs (KGs). To easily integrate data from, or query data across, different KGs it is necessary to also standardize the form in which they are published. The W3C standards RDF/OWL and SPARQL were created to address this need and enable the creation of a Semantic Web. Here we describe the use of these standards to publish public SPARQL endpoints for resources such as UniProt, Rhea and SwissLipids and RDF allowing private SPARQL endpoints on premise and in clouds (e.g. AWS, Oracle). At more than 110 distinct billion triples - RDF statements - UniProt is the largest freely available KG. UniProt and other SPARQL endpoints support complex analytical queries and inferences that go beyond queries through graph-based machine learning and other approaches. They integrate - federate - expert curated knowledge of protein function with biological and biochemical data from other KGs available in RDF or OWL like the Gene Ontology (functions), Bgee (expression patterns), OMA (orthology), and IDSMS (chemical structures). They also serve as APIs to enhance website data display and data mining capabilities - for example to select and enrich SwissBioPics images to visualize subcellular location data, or to perform chemical similarity and chemical substructure search with IDSMS directly in Rhea.

## Keywords

protein, UniProt, SPARQL, Rhea, SwissLipids, lipids, reaction

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