FAIR Building Blocks

Definition

The mission and vision of the HMC Hub Earth and Environment are operationalized through the **Road-to-FAIR Strategy**. Central to this strategy is the implementation of a common set of **FAIR building blocks**. These building blocks comprise technical, semantic, organizational, and procedural measures that support the Findability, Accessibility, Interoperability, and Reusability of research data.

Within the Helmholtz Research Field Earth and Environment, Findability and Accessibility are already supported by a comparatively mature range of infrastructures and services. Registry services such as re3data.org, FAIRsharing.org, and OpenAIRE facilitate the discovery of disciplinary repositories and relevant research data resources. Their effectiveness, however, depends on the continuous maintenance of accurate, complete, and up-to-date information.

Open-access policies have further improved access to research data held in repositories. Where unrestricted access cannot be provided, for example because of legal, ethical, contractual, or security-related constraints, the publication of comprehensive metadata can nevertheless enable users to discover relevant data and determine the conditions under which access may be granted. The principal challenges addressed by the building blocks presented here therefore concern the practical realization of **Interoperability** and **Reusability**.

The following building blocks primarily support **Interoperability**:

* Common and agreed procedures for referencing systematically described entities through the use of **persistent identifiers (PIDs)**. PIDs reduce ambiguity and redundancy, enrich contextual information, and improve the consistent identification of entities such as people, organizations, instruments, samples, publications, and datasets.

* A shared understanding across systems and disciplines through the coordinated use of **semantic artefacts**. Controlled vocabularies, terminologies, taxonomies, and ontologies support the consistent description of metadata concepts and reduce semantic ambiguity.

* Common methods for structuring and exchanging data and metadata through the application of **interfaces, protocols, exchange formats, and schemas**. Their coordinated implementation enables reliable metadata exchange and supports the integration of heterogeneous information systems.

* Consistent approaches to data dissemination through **self-describing data packages**, such as FAIR Digital Objects and RO-Crates. Such packages combine data, metadata, identifiers, and contextual information in portable structures that facilitate machine actionability and reuse across systems.

The following building blocks primarily support **Reusability**:

* The inclusion of **provenance information** describing the origin of data, the processes and transformations applied to them, and the agents responsible for their creation and management. Provenance information makes data lineage transparent and supports the assessment of reliability, authenticity, and reproducibility.

* Standardized procedures for documenting and assessing **data quality**. Relevant information may include uncertainty, validation procedures, completeness, accuracy, consistency, and versioning. Such information enables potential users to determine whether a data product is suitable for a particular purpose.

* The clear description of **access and use constraints** through standardized and, wherever possible, machine-readable methods. This includes the application of recognized licences and the explicit documentation of legal, ethical, contractual, or institutional restrictions, thereby improving transparency and legal certainty.

Together, these building blocks provide the structural foundation for the detailed recommendations documented in this wiki.

The wiki also contains practical guidance for implementing these recommendations, complemented by examples of established practices and successful use cases.

Finally, it provides guidance for the different stakeholder groups that participate in, support, or are responsible for the implementation of FAIR research data practices.

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