Advancing FAIR Research Software Practices in Hydrology Domain through Metadata Standardization and Evaluation

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Key Takeaways

- **Lowering the barrier**: We simplify FAIR for software adoption by making it easier and more transparent for the hydrology community to apply metadata best practices for software.
- **Flexible and lightweight framework**: We created an automated and customizable framework that standardizes and evaluates software metadata using community standards.
- **Community impact**: We applied the evaluation framework to models in the CSDMS repository to measure FAIRness and highlight value adds of this assessment to the CSDMS community.

Problem Statements

Journal publication receives the most credit.

Data is getting more attention and credit.

Software is critical to both, but often invisible or uncredited.

Limitations in FAIR for research software (FAIR4RS) assessment

- **Automation & Scalability**: Existing FAIR4RS tools often rely on manual checklists or static evaluation, making them hard to scale.
- **Metadata Standardization**: Many research software projects use incomplete or inconsistent metadata, lacking alignment with community standards like CodeMeta.
- **Adaptability**: Most existing solutions are built for specific domains or use cases, leaving hydrologists without flexible tools.
- **Evaluation Criteria**: Different stakeholders (e.g., registers, publishers, funders) have varying FAIR requirements and current frameworks do not support customizable evaluation criteria.

Solution & Methodology

We built a lightweight, Python-based evaluation framework to assess FAIR compliance of research software using structured metadata from **CodeMeta** and **Schema.org**.

The CodeMeta Project

schema.org

CUAHSI

GitHub

Components of the framework:

Mapping CSDMS metadata to CodeMeta:
- CSDMS metadata are mapped to CodeMeta terms to ensure the metadata is structured and uniform across diverse research software and domains.

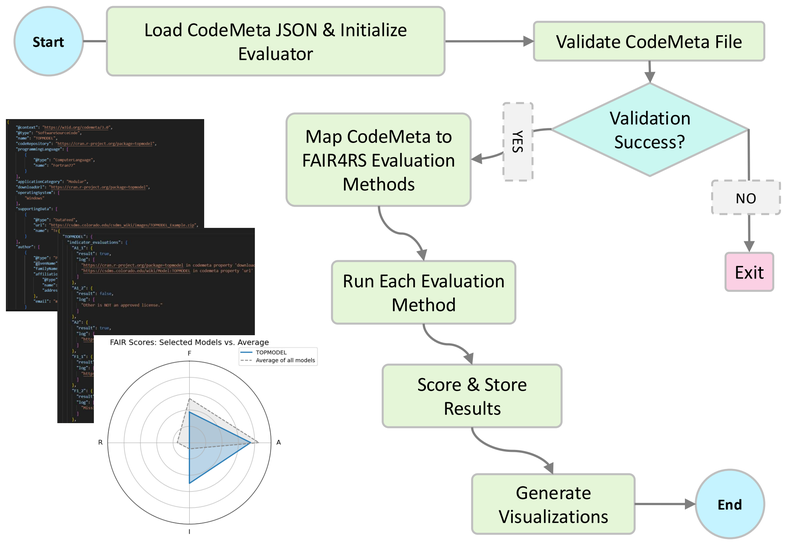
Mapping CodeMeta to FAIR4RS indicators:
- CodeMeta terms are mapped to FAIR4RS indicators to enable FAIR4RS scoring.

Implementing Modular Evaluation Functions
- 17 reusable and customizable functions are employed to validate whether metadata fields satisfy specific and measurable FAIR4RS criteria. This enables extensible and reproducible scoring.

Generating Quantitative & Weighted Scores:
- Normalized and quantifiable FAIR scores are generated through applying configurable weights to reflect community priorities.

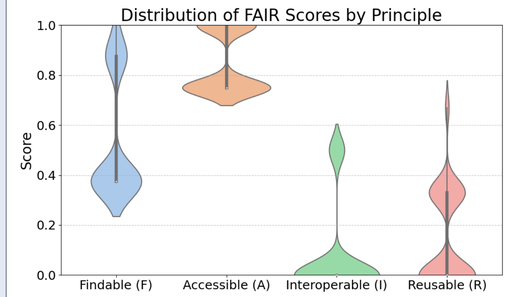
Workflow of the FAIR4RS evaluation tool:

Below is the command line interface for FAIR4RS evaluation tool that supports lightweight integration into CI/CD pipelines.

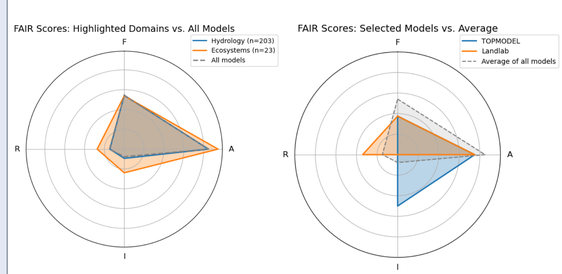


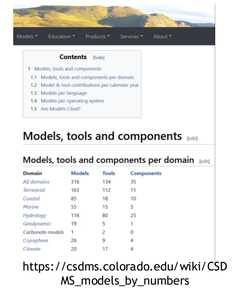
Use Case Examples, Outcomes & Findings

We tested the framework on software from the CSDMS model repository for an initial assessment of FAIR4RS compliance.



491 research software objects across 11 domains from CSDMS model repository assessed in this study.



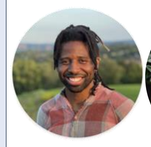


https://csdms.colorado.edu/wiki/CSDMS_models_by_numbers

Findings:

- Metadata fields for license, authors, and identifiers were often missing or inconsistently formatted.
- Evaluations revealed that even highly cited models fall short on key FAIR indicators, especially under interoperability and reusability.
- FAIR scores had notable variation, highlighting the need for standardized metadata practices.
- This framework has potential to supplement "CSDMS models by the numbers" reporting for understanding and improving the quality of CSDMS research software objects

Contact information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Acknowledgment

This work is supported by the National Science Foundation under grant 2103780 "Integrative Cyberinfrastructure for Next-Generation Modeling Science", and aligns with efforts from Open Modeling Foundation, CodeMeta Project, Research Software Alliance, and Earth Science Information Partners.