FAIR, FLOSS and Sustainable: Complementary Paradigms for Research Software

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My "hat" collection / disclosures

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Talk outline

- *Code* as Digital Object in Research
- Paradigms for *Code*
  - FAIR Software
  - Free/Libre/Open Source Software (FLOSS)
  - Sustainable Software
- Synthesis
- Outlook

What is "Code"

- *Code* is any set of machine-executable instructions that processes *data* in the course of a research project
- It therefore inherently documents the research process and allows (theoretically) for simple and direct replication of results
- Depending on its definition, "software" is either equal to or a subset of *Code*

Code as Digital Object

Code is distinct from other digitial objects in several ways:

(1) *Code* requires maintenance in order to ensure its continued usability in changing hard- and software environments

(2) *Code* evolves over time, due to necessary adaptations and continuous development

(3) *Code* receives external contributions after the initial publication, thus acknowledgement, accountability and IP/licensing issue can arise

(4) *Code* has different demands to RDM infrastructure (less space, fine-grained versioning, no universally accepted PID system)

(5) *Code* depends on libraries, which are also *code* objects (i.e., also change over time)

(6) *Code* can be conveyed as source or as binaries, which is critical for re-use/licensing

Code is an object class of its own

Treating code as "data"
is like
treating an animal as "sausage"

(it is a transformation that you can perform, but you must be aware of the implications)

- Important to recognize that *code* is an own class of digital objects
- If a *code* object is treated as *data,* only the common properties remain

FAIR Software

- Can the original FAIR paradigm[1] be applied to *code*?
- Should we:
  - change FAIR criteria,
  - extend them (more "letters") or
  - consider them as "base layer"?
- "Towards FAIR principles for research software"[2]
  - ➔ Re-interpret FAIR criteria for *code* objects
- As usual, "FAIR" is not necessarily "Open"

[1] Wilkinson MD *et al.*, Sci Data 3:160018 (2016) DOI:10.1038/sdata.2016.18
[2] Lamprecht AL *et al.*, Data Science 3:37 (2019) DOI:10.3233/DS-190026

Free/Libre/Open Source Software (FLOSS)

- *Free Software*[1] grants Four Freedoms to the user:
  - Use
  - Study
  - Share
  - Adapt
- *Open Source*[2] uses different criteria, but functionally the definitions are nearly identical
- Well understood paradigm in software development, used for decades
- Focus is typically on licensing (i.e. "the R in FAIR")

➔ Clarity and compatibility: REUSE project[3]

[1] FSF – Free Software Definition
[2] OSI – Open Source Definition
[3] REUSE Project

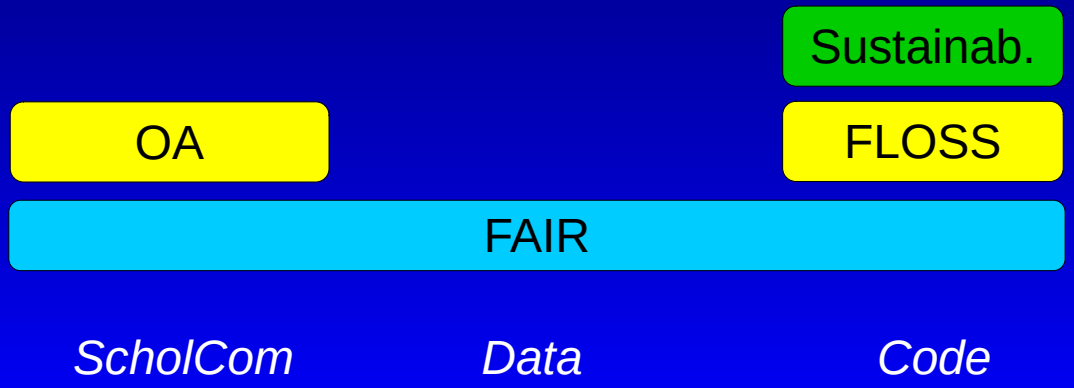
Sustainable Software

- *Code* objects have a dependency graph that must be maintained to ensure continued functionality
- Software Heritage[1]
  - ➔ Conserve the current version of *code* and its dependencies
- Maintenance requires use of Good Development Practices
  - ➔ Development is a *process*, but FAIR and FLOSS only describe a *state*
- Maintenance requires limited resources (funds, work force)[2]
  - ➔ Selection/decision processes on level of scientific domain or research institution
- Recognition of work, how to cite, what to cite[3]
- Sustainable use of funding
  - ➔ Open Data Directive[4]
  - ➔ Public Money, Public Code[5]

[1] Software Heritage
[2] Anzt H *et al.* F1000 Res (2020) DOI:10.12688/f1000research.23224.1
[3] DOI:10.1109/MCSE.2019.2963148
[4] EU Directive 2019/1024
[5] PMPC

Synthesis

- The paradigms are complementary and can be considered as layers
- FAIR is a necessary requirement for all digital objects in Open Science
- *Code* objects should fulfill additional criteria, i.e., FLOSS and Sustainable
- We are already using this principle for scientific publications (FAIR + OA)



Outlook / Recent developments

- Joint effort[1] of RDA/ReSA/Force11 to address FAIR for Research Software
- "Software" is now increasingly recognized as first-class research output by policy makers[2,3]
- "An environment for sustainable research software in Germany and beyond"[4]
- NFDI4RSE Cross-cutting initiative[5]

[1] RDA - FAIR4RS WG
[2] EOSC Strategic Implementation Plan DOI:10.2777/202370
[3] Draft Proposal EOSC Partnership
[4] Anzt H *et al.* F1000 Res (2020) DOI:10.12688/f1000research.23224.1
[5] NFDI4RSE