6.4 Actors in Reproducibility

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Reproducibility is a component of a greater activity (e.g. reviewing, reusing) undertaken by actors (e.g. reviewer, author) who have their own behaviours (inherent or induced by external drivers). Interventions to motivate reproducibility behaviours, through positive incentives or the removal of obstacles, requires us to first classify actors and then layout behavioural standard

6.4.1 Actors

- **Creators**: authors, academic leaders/lab directors, research software engineers, thesis supervisors
- **Consumers**: readers, authors, students, policy makers, educators, adopters, technical communities, IT services, industry, user, research software engineers, PhD students
- **Moderators**: editors
- **Examiners**: reviewers, thesis examiners, research evaluation committees,
- **Enablers**: funders, publishers, institutions, academic leaders/lab directors, data providers, thesis supervisors, digital archives, professional societies, industry, research software engineers
- **Auditors**: funders, policy makers, institutions, professional societies

6.4.2 Questions

- What are the properties of reproducibility for each actor?
- What are the interventions they can invoke?
- What are the current behaviours, and how might they shift?
- What aspects of behaviour are important to whom?
- What timeframes apply?
- What are the obstacles to good behaviour?
- What are the incentives to encourage change in behaviour?
- What are the interventions to action change in behaviour?

6.4.3 Authors

This section summarizes the main obstacles and expectations for an author.

6.4.3.1 Obstacles (real or perceived) to good behaviour for authors

Obstacles may be external drivers over which the authors have limited control, or internal where the authors can be responsible for their own behaviour. Table 1 describes the obstacles in detail.

Table 1 Obstacles for authors.

Recognition	Lack of explicit recognition of the need for reproducibility within a lab Lack of credit for achieving reproducibility
Cultural pressure	Lab culture Publication (volume) pressure Time pressure
Ambition/Personal Pressure	Paranoia – fear of losing competitive advantage Embarrassment, limitations as a developer Fear of having mistakes exposed (security through obscurity)
Awareness	Ignorance of the benefits of reproducibility, lack of mentoring and guidance Misjudgement of the difficulty of achieving reproducibility Lack of planning for reproducibility – it cannot be an afterthought Perception of achievability
Intention	Code/data was meant to be disposable (ephemeral)
Resources	Lack of access to appropriate resources Inertia, apathy, lack of incentives
Institutional restrictions	Legal and licensing issues, Corporate privacy requirements
Innate restrictions	Code or data cannot be encapsulated

Three tiers of standard – sufficient, better, exemplary – set out a rubric of expected behaviour. Interventions and incentives have the capacity to move up the reproducibility ramp.

6.4.3.2 Standards: Sufficient

These elements, if present in a paper and appropriate to that paper, represent a minimum expectation of authors – with regard to both ethical requirements and the demands of reproducibility.

- Methods section – to a level that allows imitation of the work
- Appropriate comparison to appropriate benchmark
- Data accurately described
- Can re-run the experiment
- Verify on demand (provide evidence that the work was done as described)
- Ethical considerations noted, clearances listed
- Conflicts noted, contributions and responsibilities noted
- Use of other authors' reproducibility materials should respect the original work and reflect an attempt to get best-possible results from those materials

6.4.3.3 Standards: Better

Addition of elements such as these represent a substantial increment beyond sufficient, while not yet being best practice.

- Black/white box
- Code is made available, in the form used for the experiments
- Accessible or providable data

Table 2 Obstacles to good behaviour for reviewers.

Recognition	Lack of explicit recognition of the need for reproducibility within the discipline Lack of credit for examining reproducibility
Cultural pressure	Time pressure Volume pressure
Ambition/Personal Pressure	Embarrassment, technical limitations Lack of understanding of why reproduction failed – is it really the fault of the reviewer or authors?
Awareness	Ignorance of the benefits of reproducibility, lack of mentoring and guidance Misjudgment of the difficulty of examining reproducibility Perception of achievability
Intention	None
Resources	Lack of access to appropriate resources – technical, personnel Inertia, apathy, lack of incentives
Institutional restrictions	None
Innate restrictions	None

6.4.3.4 Standards: Exemplary

Addition of these elements, in or accompanying a paper, represent best practice for authors.

- Open-source software
- Engineered for re-use
- Accessible data
- Published in trustworthy, enduring repository
- Data recipes, to allow construction of similar data
- Data properly annotated and curated
- Executable version of the paper; one-click installation and execution

6.4.4 Reviewers

Noting the potential for reviewers to be explicitly assigned to provide either technical review or scientific review:

6.4.4.1 Obstacles (real or perceived) to good behaviour for reviewers

Table 2 describes the obstacles in detail.

6.4.4.2 Standards: Sufficient

- Assesses reproducibility
- Fair assessment, respect of strengths and weaknesses
- Clarity on what was assessed and what the limits of the review are
- Conflicts noted

6.4.4.3 Standards: Better

- Checks that reproducibility is in fact possible

Table 3 Obstacles to good behaviour for editors.

Recognition	Lack of explicit recognition of the need for reproducibility within the discipline Lack of credit for examining reproducibility
Cultural pressure	Time pressure Volume pressure
Ambition/Personal Pressure	None
Awareness	Ignorance of the benefits of reproducibility, lack of mentoring and guidance Misjudgment of the difficulty of examining reproducibility Perception of achievability
Intention	None
Resources	Inability to find technically accomplished reviewers
Institutional restrictions	None
Innate restrictions	None

6.4.4.4 Standards: Exemplary

- Reproducible, within limits of materials and resources
- Timely reviews

6.4.5 Editors

6.4.5.1 Obstacles (real or perceived) to good behaviour for editors

Table 3 describes the obstacles in detail.

6.4.5.2 Standards: Sufficient

- Find reviewers who can assess the science
- Have reviewing policies that require examination of reproducibility/methodology
- Have instructions for authors on expectations with regard to reproducibility/methodology
- 'Reproducibility compacts' (or contracts) for authors, in which they must state availability of code and so on [1]

6.4.5.3 Standards: Better

- Find reviewers who can assess the technical contribution
- Separation of assessment of papers on science grounds from reproducibility/methodology grounds
- Have processes for working with authors to improve reproducibility

6.4.5.4 Standards: Exemplary

- Advocacy to the publisher of requirements for reproducibility
- Advocacy of standards
- Leadership regarding all aspects of reproducibility
- Participation in relevant advocacy bodies

Table 4 Obstacles to good behaviour for institutions.

Recognition	Lack of explicit recognition of the need for reproducibility Lack of credit for achieving reproducibility
Cultural pressure	Publication (volume) pressure Fear of having mistakes exposed (security through obscurity)
Ambition/Personal Pressure	Lack of enduring commitment – long-term budgeting Lack of communication plansResistance to openness Paranoia – fear of losing competitive advantage Fear of having mistakes exposed (security through obscurity)
Awareness	Ignorance of the benefits of reproducibility, lack of mentoring and guidance Misjudgment of the difficulty of examining reproducibility Perception of achievability Legal and licensing issues
Intention	None
Resources	Resources, services, infrastructure, repositories Lack of standards and tools Lack of access to appropriate resources Lack of understanding of the resources requiredInertia, apathy, lack of incentives
Institutional restrictions	Confused lines of responsibility, mixed ownership of the problem Human resources structures: mentoring, training, staffing Mismatch between academic and organizational goals Conflicting or missing or ill-informed policies Legal and licensing issues Corporate privacy requirements
Innate restrictions	None

6.4.6 Institutions (also as transmitted via academic leaders)

6.4.6.1 Obstacles (real or perceived) to good behaviour for institutions

Table 4 describes the obstacles in detail.

6.4.6.2 Standards: Sufficient

- Clear policies on reproducibility, ethic

6.4.6.3 Standards: Better

- Compliance framework
- Resourcing of reproduction – technical, financial
- Constructive environment with recognition of demands of reproduction

6.4.6.4 Standards: Exemplary

- Trusted, enduring repository
- Reproduction as a primary research goal

References

1 C. Collberg, T. Proebsting and A. M. Warren. Repeatability and Benefaction in Computer Systems Research. University of Arizona TR 14-04.