Open Science, Open Access, Open Source

By Dr Hamish MacDonald, Research Fellow, The University of Queensland

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In some situations, the owner of intellectual property may not wish to restrict access to their property. Open science, open access, and open source are mechanisms for widely distributing intellectual property, with or without associated conditions.

Although often used together, these three terms describe distinct movements with different origins and motivations. *Open source* emerged from the computing community of the 1980s and 1990s, where programmers championed the freedom to use, study, modify, and share software code. *Open access* grew largely out of a rights-based legal movement, associated with legal scholars such as Lawrence Lessig, focused on removing price and permission barriers to published knowledge. *Open science* is broader still, and is primarily concerned with the transparency and reproducibility of research, including the sharing of data, methods, and materials.

Contract law provides the legal mechanism through which open access and open source operate. The intellectual property is provided pursuant to a contractual licence. In exchange for receiving the property free of charge, the receiver agrees to certain conditions. These vary depending on the precise model of openness used, but commonly include restrictions on commercialising any resulting intellectual property.

Open initiatives generally revolve around copyright, which can be used to protect documents, images, data, and computer code. There have been attempts to use patents in a similar way, but the transaction costs of patents are generally prohibitive for open access movements. [1]

'Copyleft' is a term referring to agreements which contain a condition requiring that the same terms be preserved in derivative works. These provisions are sometimes also called 'share-alike' conditions. This has the effect of making open access conditions propagate through any future works derived from the original work.

Established open licensing agreements are generally customisable. For instance, Creative Commons offers six standard licences, built from combinations of a few simple conditions [2]:

Licence	Key conditions	Example use by a researcher
CC BY	Attribution required. Anyone may copy, adapt, and reuse the work, including commercially.	Publishing a journal article or preprint so that anyone can reuse figures and text with citation. Many research funders require this licence.
CC BY-SA	As CC BY, but any adapted work must be released under the same licence ('share-alike').	Contributing to a community-maintained resource which requires share-alike, such as Wikipedia.
CC BY-NC	Attribution required; commercial use is not permitted.	Sharing a dataset freely with other academics while prohibiting commercial use or adaptations.
CC BY-NC-SA	As CC BY-NC, plus the share-alike condition.	Releasing open-source software that is required to stay both open and non-commercial in all future versions.
CC BY-ND	Attribution required; the work may be shared but not modified.	Circulating a report or policy submission that should not be altered or excerpted out of context.
CC BY-NC-ND	Attribution required; no commercial use and no modifications. The most restrictive option.	Depositing an accepted manuscript in a university repository where the publisher restricts reuse.

A publisher can also write their own open access contract incorporating whatever terms they desire.

It is worth noting that complete openness is not always appropriate. Indigenous data governance frameworks, for example, emphasise that communities should retain control over data about their people, knowledge, and resources. [3]

Examples of Open Initiatives

- Creative Commons
- GNU General Public Licence (software only)
- MIT and Apache licences (permissive software licences)
- arXiv and other preprint repositories

Why is it relevant?

Principles of open science, open access, and open source should be considered by researchers and research institutions wherever possible. Open access publishing leads to more citations, advances citizen science initiatives and public engagement with research, and levels the playing field for researchers in developing countries. [4] Similarly, open science and open source initiatives facilitate broader distribution of scientific findings and novel inventions, facilitate collaboration between researchers, and increase the transparency of scientific findings and computer programs.

The choice of licence deserves careful thought. Share-alike (copyleft) conditions are sometimes described as 'viral' in the software community: building upon copyleft-licensed code can oblige you to release your own software under the same terms. Conversely, a highly permissive licence may allow commercial companies to profit from a researcher's work with no return to the researcher or their institution.

Because public disclosure of an invention generally destroys the ability to patent it later, researchers should speak to their institution's intellectual property or technology transfer office before openly releasing work with commercial potential.

Practical Steps

1. *Open access publishing is most commonly conducted through a publisher, such as a peer-reviewed journal*. This generally involves the payment of a one-off open access fee (which may be covered by a broad university-level open access publishing agreement). In many fields, researchers may deposit manuscripts free of charge in repositories such as arXiv. This is sometimes called 'green' open access, as distinct from fee-funded 'gold' open access.
2. *It is also possible to self-publish documents or computer code with an open access licence*. This may be done by including one of the above licensing agreements, and by making it clear that the intellectual property is accessible in accordance with the terms of this agreement. Open access licence organisations generally provide instructions on how to do this.
3. *Check before you share*. Review the licences attached to any code or data your work builds upon (share-alike conditions may bind your own outputs), choose the licence for your own work deliberately, and consult your technology transfer office if the work may be patentable.

Case Study

In 2019, Australian researchers at RMIT University published their discovery of a new technique to turn carbon dioxide back into solid carbon. This was published open access in the journal *Nature Communications*. [5] The first author, Dr Dorna Esrafilzadeh, explained that this open publication attracted a broader audience to her research, including school students and other researchers, and helped the team to find an industry partner. [6] Notably, publishing openly did not prevent the researchers from commercialising the work themselves: in 2021, Dr Esrafilzadeh and Professor Kourosh Kalantar-Zadeh co-founded a university spin-off company established to commercialise the technology, backed by seed investment and a licence agreement with the university. [7] However, publishing work in a journal open access generally requires researchers to pay a fee, creating disparity between those who can afford to pay to publish open access and those who cannot.

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