

# Coopetition as a Model to Advance a FAIR Data Ecosystem

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## Abstract

The Generalist Repository Ecosystem Initiative (GREI) is an effort supported by the National Institutes of Health (NIH) to align seven generalist repositories, and develop shared capabilities, services, metrics, and infrastructure to support data sharing while promoting principles that make data findable, accessible, interoperable and reusable (FAIR). Here we show how coopetition (a partnership approach combining cooperation and competition) provided a model for these seven competing actors to generate common value beyond what each could

individually achieve. This approach helped address system-wide challenges encountered when developing an open science ecosystem with multiple competing actors. Simultaneously, coopetition supports research reproducibility, encourages data reuse, and prevents data duplication across repositories. Ultimately, the coopetition model itself emerges as a defining outcome for GREI, enabling a cost-effective, impactful, and sustainable catalyst in the FAIR data ecosystem.

## **Introduction**

### **The Collaborative Nature of Modern Research**

Modern research is often team-based, highly collaborative, and geographically dispersed; a trend that has only increased in recent years.<sup>1</sup> Team science creates competition among people and institutions,<sup>2,3</sup> for example over authorship designations, funding acquisition, and visibility, which may be counterproductive to achieving shared research goals and an overall healthy work culture in academia.<sup>4</sup> In response to these challenges, some have presented the notion of “friendly competition” to promote more effective team science through the use of holistic assessment methods (e.g., giving more weight to team-based outputs) and encourage culture change to reward team players.<sup>5</sup> Open science advocates, however, have mostly focused on promoting transparency,<sup>6,7</sup> arguing that open sharing of data and using reproducible methods not only foster a collaborative environment, but also support accountability, allow examination of the research for flaws and biases, and enable better understanding of limitations.<sup>8</sup>

Within this team-based and open science dynamic, generalist repositories act as a nexus between all involved actors. Generalist repositories provide the means for responsible data sharing and management, and enable research communication, validation, and access among researchers and the general public.<sup>9</sup> Domain-specific repositories (e.g., GenBank, Protein Data Bank, Gene Expression Omnibus) support specific data types, formats, and disciplinary needs to facilitate field-specific data reuse and discovery. However, generalist repositories are agnostic to data type, format, content, or disciplinary focus, enabling broader accessibility and facilitating interdisciplinary data sharing. This flexibility enables researchers to share data that spans multiple domains or falls outside the scope of domain-specific repositories. Generalist repositories also increase the potential to reach different audiences (e.g., researchers across multiple disciplines, policymakers, educators, and the public), thereby increasing data visibility and potential for reuse.

Just as an open market allows different entities to thrive and compete, an open science ecosystem provides an opportunity for various generalist repositories to coexist and flourish. Currently, competition among generalist repositories is reflected in their differing value propositions and approaches, for example, in terms of file size and storage limits, user interfaces, analytics, visualizations, curation and other unique features. Despite these differences, generalist repositories share similar aims and use cases. Accordingly, they can benefit from deeper collaboration on common standards, features, and activities to advance a shared vision of a more modern and collaborative research ecosystem.

### **Leveraging Cooperation and Competition**

The concept of "coopetition," was introduced in the 1990s, and describes an approach to strategic partnership that combines both cooperation and competition.<sup>10</sup> Such partnerships seek to build value and achieve mutually beneficial aims such as strengthening industry supply chains or expanding a marketplace's offerings.<sup>11</sup> Thus far, coopetition has been employed in numerous fields such as biotech, technology, and healthcare delivery.<sup>12</sup> These previous experiences have bolstered inter-organizational knowledge exchange, eased tensions, and enabled greater trust, positively impacting resource development, transaction costs, and customer benefits.<sup>13</sup>

Given the challenges of modern collaborative research (especially regarding competition for access to resources), adopting a coopetition approach to science could be beneficial. Coopetition can mitigate negative effects brought about by "fierce competition," such as information blocking, sabotage and interference,<sup>14</sup> or wasting resources and harming reliability,<sup>15</sup> all of which contribute towards compromising research integrity.<sup>16</sup> In fact, while competition can incentivize researchers, the history of science shows that many transformative discoveries happen in the *absence* of competition.<sup>17</sup> When considering the research enterprise as a form of service intended to build scientific value, coopetition can provide a model for solving common social and technical problems, adopting data standards that promote discovery, ensuring the sustainability of data resources, reinforcing opportunities for reproducible science, and producing generalizable knowledge.

### **The GREI Coopetition Model**

The National Institutes of Health (NIH) Strategic Plan for Data Science outlines the need for developing and strengthening a scalable infrastructure for FAIR data.<sup>18</sup> The NIH Office of Data

Science Strategy (ODSS) has developed various initiatives to enable standardized practices and increase public access to federally-funded research data in alignment with the NIH Data Management and Sharing Policy.<sup>19</sup> In 2020, the NIH hosted a workshop on the Role of Generalist Repositories to Enhance Data Discoverability and Reuse, which “highlighted the breadth and depth of activities of generalist and institutional repositories in supporting biomedical researchers and biomedical data.”<sup>20</sup> Discussions across the two days indicated that a healthy ecosystem characterized by ‘coopetition’ [was] starting to emerge,” filling an important need in the NIH data repository landscape by offering flexible, standards-compliant repository resources when discipline-specific repositories are unavailable.<sup>20</sup> In his keynote address, “A Blueprint for the Research Data Landscape,” Sayeed Choudhury introduced the theme of coopetition, which “relies on the concept of ‘the value line’...used in commercial business to distinguish between capabilities and services that offer competitive advantage, thus warranting competition, and those that do not, warranting cooperation”.<sup>21</sup>

Building on this vision, NIH ODSS launched the GREI Program in 2022 to enhance discovery and reuse of NIH funded data by employing a coopetition model among seven generalist repositories: Dataverse, Dryad, Figshare, Mendeley Data, OSF, Vivli, and Zenodo. These repositories cooperate on shared standards and infrastructure and compete on service-level features. (Figure 1) Coopetition supports data best practices and helps ensure that repository capabilities are aligned with NIH goals to make research data more FAIR. Despite the complexities of coordinating across seven different repository organizations, by leveraging coopetition, GREI has driven progress in the data sharing ecosystem, demonstrating how strategic collaboration can help scale FAIR practices and strengthen the generalist repository landscape.<sup>22</sup>



**Figure 1.** The GREI Coopetition Model.

### **A Strategic Approach to Coopetition**

The GREI coopetition partners balance repository *competition* and advance *cooperation* through four key strategies: 1) clear governance frameworks to advance work and ensure alignment; 2) strategic partnerships with the data community; 3) technical cohesion to enable FAIR data practices; and 4) a user centered approach to meet the needs of both data contributors and

consumers. As described below, coopetition in these areas offered a practical roadmap for collaboration, enhanced data sharing, interoperability, and scientific impacts.

#### *1) Clear governance framework*

Early in the project, GREI used standing subcommittees to identify shared goals and map out strategies. As GREI evolved, and the coopetition model was more firmly established, these formal subcommittees transitioned into nimble, time-bound task groups (composed of members representing each repository) focused on specific deliverables and priorities. These task groups streamlined decision-making, and fostered innovation on shared deliverables to enhance repository functionality and services. Furthermore, a GREI code of conduct helped establish a positive culture and build trust across the seven repositories by reinforcing responsibilities and information sharing practices both within the project and to the community. The code of conduct is updated annually to reflect project evolution and progress. GREI's governance framework has been a cornerstone of its success.

#### *2) Critical strategic partnerships*

The GREI coopetition model has fostered a dynamic, interoperable ecosystem, through leveraging community feedback and established infrastructures. For example, partnerships with organizations and initiatives such as DataCite, Research Organization Registry (ROR), MakeDataCount, Signposting, and The Carpentries has enabled GREI to align with mature, trusted systems, and accelerate progress in synergy with the broader research community.

#### *3) Technical cohesion for responsible data stewardship*

Responsible data practices that reinforce FAIR Principles are essential for ensuring effective data sharing and reuse in ways that support reproducibility and long term value. Coopetition enabled GREI partners to achieve this by adopting data standards from established communities and initiatives like DataCite and Make Data Count instead of devising their own data stewardship framework. Through sharing best practices and responsible metrics, coopetition has supported discoverability (e.g., through using common metadata schemas and standard use of PIDs), and improved consistency (e.g., through linking data assets). Coopetition also enabled GREI partners to use metrics more consistently, streamlining workflows for both researchers and repositories.

#### *4) A user-focused approach*

GREI activities are guided by a deep commitment to user perspectives. By embedding PIDs and offering a harmonized approach to metadata across participating repositories, the GREI coopetition model has made it easier for researchers to navigate data sharing, through making data more FAIR across disciplines and reducing friction for repository users. Furthermore, GREI has established several key mechanisms for engaging the communities it supports, directly engaging them in discussions about priorities and resource development. Through coordinated calls and other engagements, the community learns about the resources GREI has developed and can provide real-time input on key components to ensure they align with their needs. Each partnering repository in the coopetition also brings insights and feedback from their own user communities to the discussion, further enriching the community's voice in GREI activities and priorities.

GREI has successfully fostered a collaborative environment where each repository's unique strengths support a shared vision. Improvements to interoperability and standardization are adopted across repositories, albeit at different times depending on each platform's roadmap and capacity. Prior to GREI, these seven repositories may have used similar standards and infrastructure but did not benefit from direct collaboration and intentional alignment. Without GREI, such advancements in the generalist repository space would likely not have occurred with the current scale and impacts, demonstrating how coopetition provided a pathway to shared progress.

## Results

GREI's success thus far demonstrates the transformative potential of coopetition for facilitating collaborative and open research. Several key achievements have been accomplished through this approach.

**Metadata Standards and Interoperability Advancements.** In compliance with the NIH Data Management and Sharing Policy,<sup>19</sup> GREI developed metadata recommendations to enhance data discoverability across repositories.<sup>23</sup> These recommendations are based on the DataCite Metadata Schema,<sup>24</sup> a common standard now used by all GREI repositories to mint Digital Object Identifiers (DOIs). GREI includes metadata fields deemed optional by DataCite, and recommends controlled vocabularies where relevant, resulting in a common metadata schema that adheres to NIH data sharing and reuse policies. GREI's ongoing metadata work builds on coopetition achievements in establishing common metadata standards and supports the

adoption of ROR identifiers for affiliations and funding information. Future GREI metadata efforts will further integrate PIDs for datasets, researchers, and institutions, ensuring robust linkage between datasets and the broader research ecosystem. GREI is also implementing interoperability standards such as FAIR Signposting to enhance machine-readable discovery of scholarly objects.<sup>25</sup> Through metadata standards, GREI aims to streamline workflows and facilitate the interoperability, discovery, reuse, and ultimate impact of open data across disciplines.

**Common Open Metrics Development and Implementation.** Open metrics play a pivotal role in data citation best practices for repositories<sup>26</sup> and evaluating and improving data sharing practices. GREI's adoption of the Make Data Count principles<sup>27</sup> laid the groundwork for harmonized metrics that capture data usage, citation, and subsequent impact. GREI continues to work toward the full implementation of these metrics across participating repositories, ensuring that data sharing is recognized and incentivized. These metrics will also provide researchers, funders, university leadership, grant administrators, and communication teams with actionable insights into the reach and reuse of their datasets, reinforcing the value of open and transparent data practices.

**Data Sharing Best Practices.** GREI has developed a catalog of use cases that illustrate real-world scenarios where generalist repositories are used for data sharing.<sup>28</sup> This catalog serves as a practical guide for researchers and other community members, illustrating how various GREI repositories can accommodate different data types and formats to drive real benefits for researchers, funders, industry, and the public. Data sharing and reuse can reduce costs, accelerate innovation, support better decision-making, establish accountability, and improve outcomes. GREI coopetition partners have also recently developed “real-world user stories” to highlight specific examples of data sharing and data reuse in the generalist repositories.<sup>29</sup>

**Community Engagement and Capacity Building.** GREI's focus on community engagement has been essential for sustaining the coopetition model. Through webinars,<sup>30</sup> workshops,<sup>31</sup> and training resources (flowchart,<sup>32</sup> comparison chart,<sup>33</sup> data deposit guide,<sup>34</sup> data management and sharing plan guide<sup>35</sup>), GREI has established itself as a valuable resource for researchers, librarians, data specialists, grant administrators and sponsored programs offices, and others who navigate data management and sharing requirements. By continually refining its training materials and outreach strategies, GREI can proactively address emerging needs, including

targeted resources for early-career researchers, and partnerships with professional societies (e.g., Federation of American Societies for Experimental Biology (FASEB) DataWorks! Prize) to reach and engage researchers from a greater range of disciplines. Furthermore, ongoing dialogue with the research community ensures that GREI tools and recommendations remain relevant and impactful. Feedback mechanisms like surveys, community calls, and a GREI GitHub page<sup>36</sup> support transparency and help surface community priorities by design. Collaborative engagement (e.g., in partnership with DataCite, Make Data Count, and The Carpentries) has also expanded GREI's reach, enabling each repository to not only reinforce existing relationships, but engage with new audiences across disciplines. These efforts will continue to foster trust, transparency, and greater access to and adoption of GREI repositories.

**Table 1.** Domains where coopetition has amplified GREI's impact.

Domain	GREI Achievements	Future Work
<b>Metadata Standards &amp; Interoperability</b>	Finalized a core <a href="#">metadata recommendation</a> to enhance data discoverability and interoperability; Integrated ROR for funder and affiliation.	Integrate PIDs for datasets, researchers, and institutions to ensure robust linkage within the research ecosystem.
<b>Common Metrics</b>	Adopted MDC principles for harmonized metrics capturing data usage, <a href="#">citation</a> , and impact.	Fully implement MDC metrics across all participating repositories, providing actionable insights into data reuse and reach.
<b>Catalog of Use Cases</b>	Developed a cross-disciplinary <a href="#">catalog of use cases</a> demonstrating successful data sharing across various fields.	Expand catalog to include AI-focused and complex data use cases, as well as data reuse.
<b>Community Engagement and Capacity Building</b>	Produced <a href="#">webinars</a> , <a href="#">workshops</a> , and training resources ( <a href="#">flowchart</a> , <a href="#">comparison chart</a> , <a href="#">data deposit guide</a> , <a href="#">data management and sharing plan guide</a> ) to support researchers in data sharing practices.	Create targeted resources for early-career researchers and anyone not adequately experienced in data management best practices, and leverage partnerships with professional societies and other organizations for broader outreach.

Artificial Intelligence (AI), Make Data Count (MDC), Persistent Identifier (PID), Research Organization Registry (ROR)

## Discussion

### Opportunity through Coopetition

Coopetition may offer an important framework to help address “wicked problems”: those complex, multifaceted issues that are difficult to solve using traditional approaches because they involve uncertainty, multiple actors, and conflicting goals (e.g., effective communication of patient health data<sup>37</sup>). Coopetition also offers a framework to manage large multi-partner projects. Large consortia often leverage a central coordinating center model to support governance, logistics, progress monitoring, coordinated collaboration, and effective



communication. Beyond improving efficiency, coopetition fosters a partnership-oriented mindset among organizations that might otherwise compete.

Coopetition has proven to be a highly effective and efficient alternative to a traditional coordinating center model for GREI, one that could serve as a valuable framework for other large multi-component programs. GREI's experience attests to coopetition as a valuable strategy for developing system-level synergies that surpass what any single researcher or organization could achieve independently. This approach aligns with contemporary models of team-based research, underscoring the power of synergistic and symbiotic relationships among researchers, teams, and organizations at scale.

### **Advancing Data Sharing Together**

Coopetition as a strategy will be critical as data reuse becomes more frequent and complex, particularly as generalist repositories work to address the demands of big data. This includes supporting emerging needs such as making data available for artificial intelligence (AI) and machine learning applications. To advance this goal, we have developed initial considerations as to how repositories can account for AI in their workflows and leverage it to facilitate FAIR practices,<sup>38</sup> and anticipate additional coopetition efforts in this area. Engagement with the research community through the coopetition has afforded real-time feedback to the GREI partnership to meet the needs of data producers and consumers. An example is the community feedback gathered on the Generalist Repository Comparison Chart,<sup>33</sup> which led to the development of the Generalist Repository Flowchart<sup>32</sup> to directly address the needs of the community to have an easy to follow logic model for selecting an appropriate repository for data.

GREI demonstrates the power of coopetition to drive meaningful progress in data sharing, creating a scalable, interoperable, and sustainable repository ecosystem that serves the broader research community. Furthermore, by addressing practical barriers (e.g., interoperability and compliance) as well as the resulting real-world impacts of the coopetition, GREI repositories have demonstrated that shared progress is not only achievable but also broadly beneficial to the partners as well as the wider data community and society at large. Through its collaborative efforts, GREI ensures that generalist repositories meet researchers' evolving needs as they work to accelerate scientific discovery. We strongly encourage others to adopt coopetition strategies when building similar interorganizational partnerships to nurture a vibrant FAIR data ecosystem.

## Methods

This article is the result of a collaborative writing process by members of the GREI team. Contributions were made by authors representing multiple organizations, each bringing unique perspectives and expertise relevant to the project's scope. The writing process followed an iterative, co-authored model that combined asynchronous drafting with synchronous review sessions. Initial content was developed through collaborative brainstorming sessions and structured around agreed-upon thematic areas. The group employed Google Docs to facilitate collaborative, real-time editing and commenting, followed by feedback integration and language refinement. All authors reviewed the final manuscript, and consensus was reached on its structure, arguments, and conclusions. This collaborative approach reflects the shared governance and inter-institutional nature of the project itself.

## About GREI

The Generalist Repository Ecosystem Initiative (GREI) is a U.S. National Institutes of Health (NIH) initiative which has brought seven generalist repositories together into a collaborative working group.<sup>38</sup> GREI is focused on establishing “a common set of cohesive and consistent capabilities, services, metrics, and social infrastructure” to enhance NIH data sharing and reuse and increasing awareness and adoption of the FAIR principles.<sup>38</sup> Engage with the GREI Community through the GREI GitHub space<sup>36</sup> and contribute to community discussions.<sup>39</sup> All GREI resources including recordings and slides from past events and guides are publicly available in the GREI Community page on Zenodo.<sup>40</sup> Information on upcoming training events is available on the GREI Training & Outreach Calendar.<sup>41</sup>

## Data Availability

No data has been generated or used in the development of this work.

## Code Availability

No custom code has been used in the development of this work.

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## **Author Contributions**

All authors contributed to the GREI coopetition presented in this paper and all authors actively promote FAIR practices. Contributor roles include (in alphabetical order): Writing – original draft: Matt Carson, Ishwar Chandramouliswaran, John Chodacki, Lisa Curtin, Kristi Holmes, Mohammad Hosseini, Nici Pfeiffer, Joshua E. Richardson. Writing – review & editing: Ceilyn Boyd, Matt Carson, Ishwar Chandramouliswaran, John Chodacki, Lisa Curtin, Jennifer Gibson, Pearl Go, Sara Gonzales, Mark Hahnel, Lars Holm Nielsen, Kristi Holmes, Mohammad Hosseini, Stefano Iacus, Rebecca Li, Nici Pfeiffer, Joshua E. Richardson, Traci Snowden, Ana Van Gulick, Julie Wood. Funding Acquisition: Jennifer Gibson, Kristi Holmes, Lars Holm Nielsen, Stefano Iacus, Rebecca Li, Nici Pfeiffer, Ana Van Gulick, Julie Wood. The collaborative nature of this work reflects the shared commitment to coopetition and distributed expertise across the project team.

## **Competing Interests**

The authors declare no competing interests. All views expressed are those of the authors and do not necessarily reflect the National Institutes of Health or GREI partner organizations.

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