Annual Report 2022

arXiv connects

you to the world of open science

About arXiv

arXiv is a curated research-sharing platform open to anyone. As a pioneer in open access, arXiv.org now hosts more than 2.1 million scholarly articles in eight subject areas, curated by our strong community of volunteer moderators who balance content quality with distribution speed. arXiv provides an article submission portal, a TeX compilation service, search and discovery tools, web distribution for human readers,API access, machine readable data sets, and community-developed tools. Our emphasis on openness, collaboration, and scholarship provides the strong foundation on which arXiv thrives.

arXiv is organized exclusively for educational and scientific purposes. It is part of Cornell University and reports organizationally to the Dean of Cornell Tech, who acts as arXiv's steward.

Mission

arXiv is an open platform where researchers can share and discover new, relevant, emerging science and establish their contribution to advancing research.

Vision

Our vision is for all researchers around the world to have immediate, free, and open access to established and emerging research in their field.

Values

- **arXiv is open**, above all. The foundation of arXiv is based on open access, transparency, open mindedness, collaboration, and flexibility.
- **arXiv is a community.** Our institutional members, collaborators, moderators, authors, and readers are not passive recipients—they are arXiv.
- **arXiv is passionate about science**—and science is for everyone.
- **We do more with less**, for the purpose of serving researchers and research.
- **We look out for each other**. To meet the challenges of the future, we are collectively passionate about our work.
- **We value excellence** within ourselves and our collaborators.

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Message from Greg Morrisett, Jack and Rilla Neafsey Dean and Vice Provost at Cornell Tech

arXiv is a wonderful, critical service that greatly benefits society, and I firmly believe in its mission to serve science by sharing research papers openly, quickly, reliably, and sustainably. This is not an easy task: scaling up as submissions increase, building resilient technical systems, and meeting the needs of the global research community are all immense – and immensely important – challenges to overcome.

I am pleased that Ramin Zabih, arXiv's new faculty director, has stepped up to lead arXiv. Ramin is also a valued member of the Cornell Tech faculty, and he has done an excellent job in his role as the president of the Computer Vision Foundation (CVF), which has given him experience with and an appreciation for running an organization committed to open science. This serves arXiv and the community very well. Already, his leadership has made a significant impact, as he has hired new program and technical directors.

arXiv is not, as many of our users believe, simply an information system. In fact, it's a community of researchers, plus dedicated advisors and moderators who volunteer their time so we can realize our mission. The arXiv staff work incredibly hard to keep the service running and scaling, to move the software forward, and to work with stakeholders from around the world. I am also very thankful for the unwavering support of the Simons Foundation and all of our members and donors. I am deeply grateful to the community for ensuring that arXiv thrives well into the future.

> "Scaling up, building resilient technical systems, and meeting the needs of the global research community are all immense – and immensely important – challenges to overcome."

Message from Ramin Zabih, arXiv Faculty Director and Professor of Computer Science, Cornell Tech

> We are grateful to our community for joining us on this journey to ensure scientific research papers are openly accessible to all.

I'm honored to have been appointed as arXiv's inaugural faculty director. I know firsthand how important arXiv is to scientists around the world. My goal is to reinforce arXiv's existing strengths while updating it to take advantage of new technologies that have developed in the decades since its founding.

Our critical priorities during 2022 were to secure additional funding, hire technical and program directors, and ramp up our efforts to modernize arXiv's software by moving it to the cloud, which will provide better stability, scalability and maintainability. I'm pleased to report that we were able to make significant progress on all of these fronts. arXiv brought in more funding than expected in the form of grants, memberships, and donations, and we hired Stephanie Orphan as program director and Charles Frankston as technical director. Both bring strong and complementary expertise to the team. Moving the technical operations of arXiv – a service with a 30 year history – off of Cornell's on-premises servers is a major, complicated task. The move to the cloud is currently in progress and on track.

Looking ahead to 2023, we expect to engage with a broader cross section of our community and provide more opportunities for feedback and input as we undertake this challenging but crucial update. We are grateful to our community for joining us on this journey to ensure scientific research papers are openly accessible to all.

> At its core, arXiv is a community resource, one that has proven to be resilient and robust over the past year.

—Carol Hoover, MLIS, Chair of the Member Advisory Board and Digital Information Resources Manager, Los Alamos National Laboratory Research Library

> arXiv works due to hundreds of scientists volunteering as moderators, and a small, very committed staff.

—Ralph Wijers, Scientific Advisory Board Chair and Professor of High-Energy Astrophysics, University of Amsterdam

> In October 2022, arXiv received the most submissions ever: 17,551. This shows just how much the scientific community relies on arXiv to share knowledge.

—Steinn Sigurðsson, arXiv Scientific Director and Professor of Astrophysics at the Pennsylvania State University

> 2022 was a particularly significant year at arXiv; a robust structure is now in place to maintain arXiv as the world leader in open access to scientific research.

—Licia Verde, arXiv Advisor and ICREA Professor of Physics and Astronomy at University of Barcelona

Stephanie Orphan, arXiv Program Director

As a seminal research sharing platform, arXiv has served a unique and important role in scientific scholarly communications for more than three decades, and it is an honor to play a role in its ongoing growth and success. I am eager to work alongside arXiv staff and stakeholders to ensure that arXiv serves the current and future needs of the research community.

Charles Frankston, arXiv Technical Director

The arXiv service has been an indispensable resource to the scientific community for more than 30 years now. I view the task in front of us as ensuring arXiv can continue to serve the community for the next 30 years and beyond. There is significant work to be done in improving our stability, usability, and accessibility as we migrate to a more modern cloud-oriented architecture.

arXiv connects

your research to the latest results in your field

arXiv in Numbers

2.6 billion total downloads

5 million+ monthly active users

2.2 million total submissions

185,692 new submissions in 2022

30,000 user support tickets this year

15,500 submissions per month

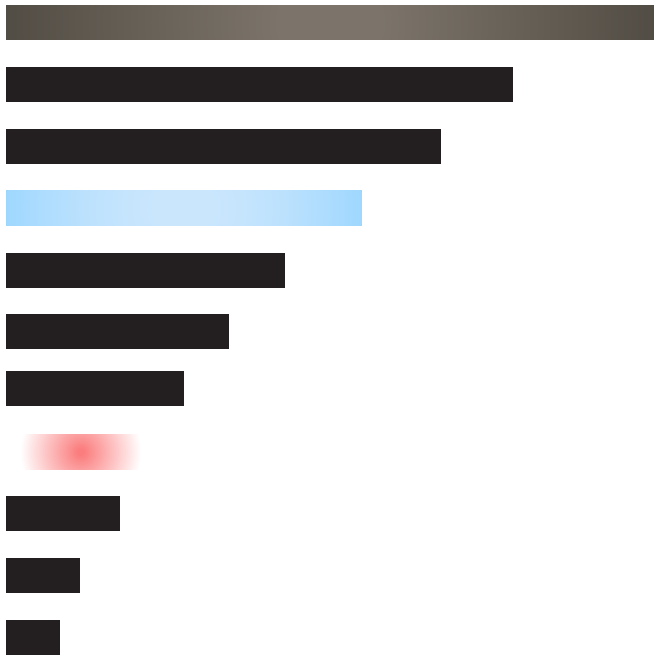
278 members

204 moderators

153 categories

22 board members

15 staff members



Most submissions in a month, ever

17,551 October 2022

A Sustainable Organization

During 2022, arXiv welcomed a new leadership team: Ramin Zabih, faculty director; Stephanie Orphan, program director; and Charles Frankston, technical director all joined Steinn Sigurdsson, scientific director, to lead arXiv.

Our staff also welcomed Kim Laine, a new User and Member Support Specialist, and Jonathan Young, Lead Machine Learning Engineer, and said heartfelt goodbyes to Helen Wang, Product Manager, and Martin Lessmeister, Head of Technology, who left for new opportunities.

arXiv held strong throughout 2022, buttressed by new fundraising assistance from the Global Sustainability Coalition for Open Science Services (SCOSS), steadfast ongoing support from the Simons Foundation, and administrative support from our host institution, Cornell University. arXiv raised more funds in 2022 than any previous year.

This means that arXiv is well-positioned to fulfill our core mission, strengthen our technical foundation, and engage with our global community in 2023. All in all, we concluded 2022 with strong leadership, increased funding, and renewed optimism.

Financial Report

Fiscal year 2022 (July 1, 2021 - June 30, 2022)

arXiv ended fiscal year 2022 in a strong financial position. Member contributions exceeded budget expectations by a significant margin, which, combined with several large gifts, allowed us to forego the planned use of more than $500K from programmatic reserves. Both personnel and non-personnel expenses came in under budget which, along with the higher-than-anticipated revenue, allowed us to contribute $520K to reserves.

Fiscal year 2023 (July 1, 2022 - June 30, 2023)

Budget

The FY2023 budget is substantially larger than that of FY2022 to accommodate our technology migration to the cloud and related work to update our code base. This work will ensure the ongoing stability of arXiv and allow us to be more responsive to the needs of our communities. Budgeted programmatic reserves are to support increased staffing.

Year-to-date performance (July 1, 2022-December 22, 2022)

Revenues through December 22, 2022 are as anticipated. Our membership program operates on a calendar year cycle, with most invoices going out in January. We anticipate meeting budget expectations for gifts and member contributions. As of midyear, both sponsored funding and the corresponding planned staff expense are below expected levels due to the timing of the release of funds and related delays in hiring to support the technology migration. We expect that this will change in early calendar year 2023. While our YTD actuals indicate use of programmatic reserves, we expect that arXiv will, once again, end the fiscal year without having to draw on our reserves.

Despite the challenges of recent years, arXiv has maintained a healthy financial position due to its growing membership program, successful fundraising activities, and responsible spending. We're happy to present our financial report to you covering fiscal years 2022 and 2023.

Financial Report: 2022-23 Actuals and Budget

	FY22		FY23	
REVENUE	*(Actuals)*		*(Budget)*	*(Actuals, 12/22)*
Gifts and Member Contributions	$ 1,504,250		$ 1,000,000	$ 282,788
Simons Foundation Funding	$ 475,000		$ 500,000	$ 75,000
Cornell Contribution (Direct)	$ 112,858		$ -	$ -
Cornell Contribution (In Kind)2	$ 572,656		$ 1,316,089	$ 383,052
Sponsored Funding	$ 57,451		$ 1,545,894	$ 243,428
Developmental Reserve Funding1	$ -		$ 511,104	$ 462,897
TOTAL REVENUE	$ 2,722,215		$ 4,873,087	$ 1,447,166
EXPENSES				
Personnel Expenses				
Executive and Scientific Directors	$ 242,148		$ 278,801	$ 117,332
Staff - Technical & Operational	$ 1,171,096		$ 1,587,002	$ 701,570
Staff - Planned			$ 1,444,650	$ -
Total Personnel Expenses	*$ 1,413,244*		*$ 3,310,453*	*$ 818,902*
Non-Personnel Expenses				
Services - Technical	$ 99,986		$ 128,953	$ 108,472
Services - Professional	$ 35,819		$ 20,369	$ 50,472
Services - Legal	$ 4,422		$ 25,000	$ 344
Meetings and Travel	$ 15,901		$ 62,222	$ 14,667
Other General Expense	$ 38,942		$ 10,000	$ 42,418
Indirect Costs2	$ 595,076		$ 1,316,089	$ 411,889
Total Non-Personnel Expenses	*$ 790,146*		*$ 1,562,633*	*$ 628,263*
TOTAL EXPENSES	**$ 2,203,389**		**$ 4,873,087**	**$ 1,447,166**
TOTAL NET OPERATING	**$ 518,826**		**$ -**	**$ -**

In FY22, arXiv was awarded a **NASA grant** to fund the project "Enhancing arXiv Interoperability: Steps Towards Interdisciplinary Research"

1. Anticipated drawing of funds from developmental reserves to fund operational deficit.

2. Indirect costs covered by Cornell include those for Administration, Staff Support (Finance/Budget, HR, Facility, and Staff IT), Facilities (utility and other facility related cost for building), maintenance, custodial, utility, and other facility related costs for the building.

Membership and Donation Report FY2022

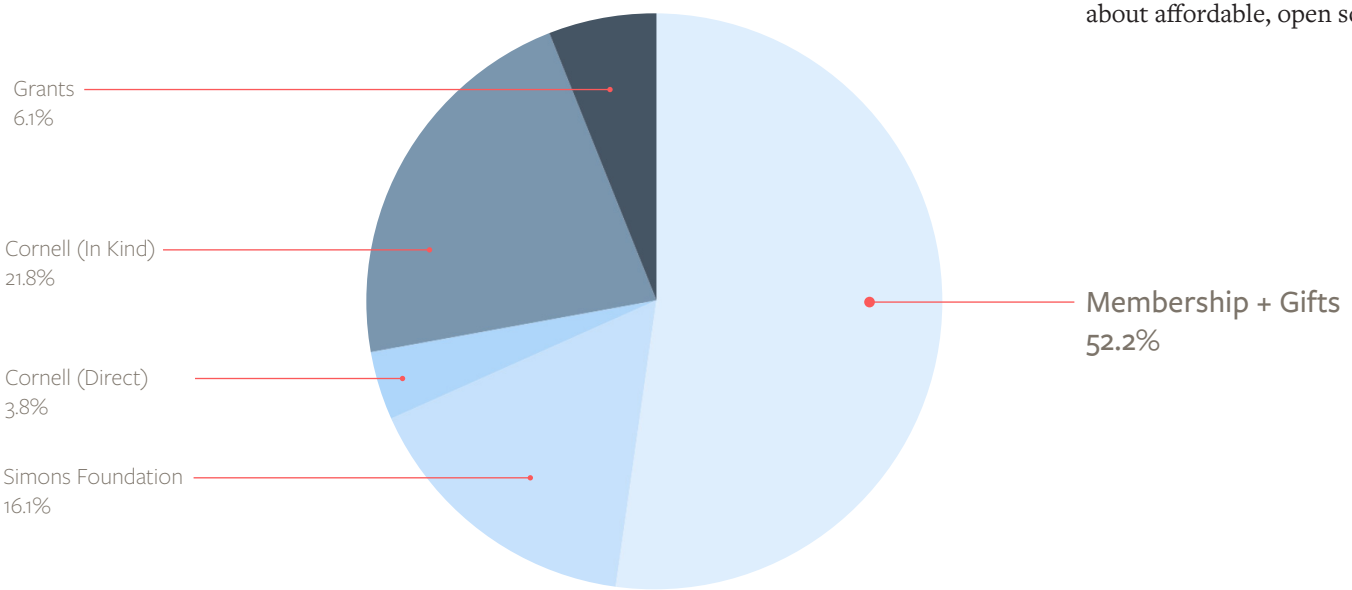
Membership + Gifts	$1,534,874
Simons Foundation	$475,000
Cornell (Direct)	$112,858
Cornell (In Kind)	$643,707
Grants	$179,359

Since 2020, arXiv has increased its fundraising efforts to prepare for its planned infrastructure modernization. After launching the updated membership program, in fiscal year 2022, memberships and other donations totaled $1,543,874—more than double the expected amount.

This fundraising success is due to several factors. First, we communicated a strong and compelling strategy that reflects our current efforts around technical modernization and interoperability with the scholarly communications community. Second, we created a new fee structure, based on submissions. This fee structure kept membership fees low while also increasing the number of institutions in each category. The net result was an increase in total membership fees requested from existing members.

We also benefited from our collaboration with SCOSS, the Global Sustainability Coalition for Open Science Services, who helped organize and host webinars with institutions in different geographic locations around the world. This effort recruited **nearly 50 new institutional donors, bringing the total number to 278**. A portion of those universities are represented by ten consortia, **an increase of four consortia** compared with 2021.

We are grateful for the financial contributions that members and donors provide for arXiv, which ensures arXiv remains a noncommercial community service supported by diverse and stable funding sources. But more importantly, we are grateful for the involvement of members in arXiv, ranging from specific expertise shared through the member advisory board to broad conversations about affordable, open scholarly communications.

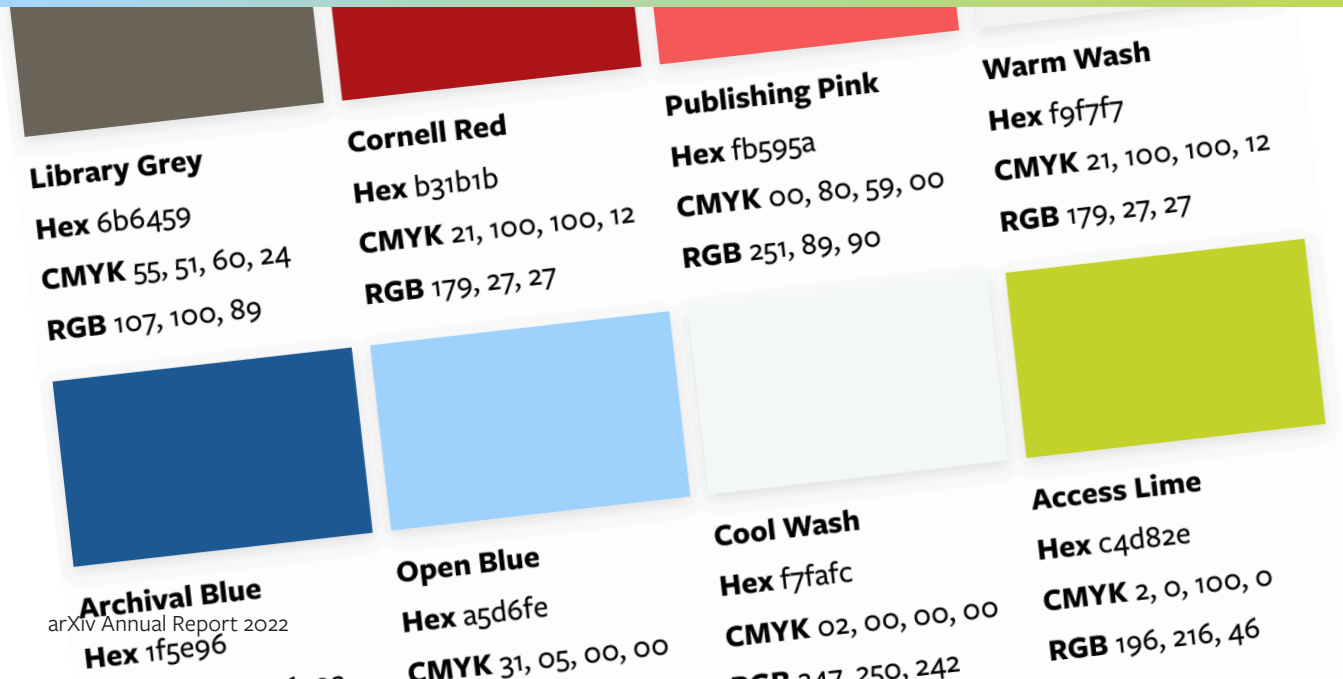


Brand and Identity Report

2022 saw the adoption of arXiv's logo on the website itself, and the expanded use of our identity in materials for events, presentations, and at our conference booth. Socks were a particular favorite and an opportunity to celebrate arXiv's historic and quirky 'smileybones.'

Our public Brand Guide launched in 2022 to help arXiv preserve and strengthen our identity. It will serve both internal staff and the public as a reference for correct usage of our trademarked logo, and our accompanying arXiv colors, fonts, tagline, and other assets.

Strengthening our identity is one way that we protect an open pre-print culture and keep arXiv free for everyone.

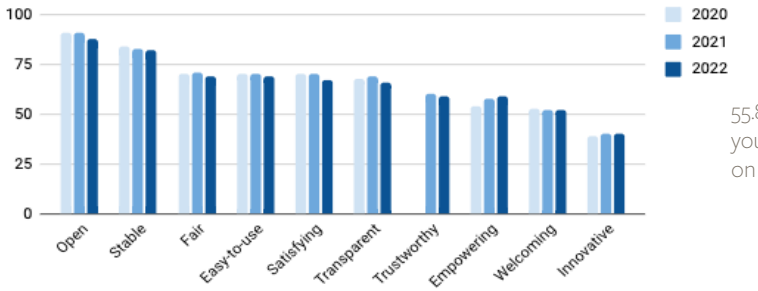


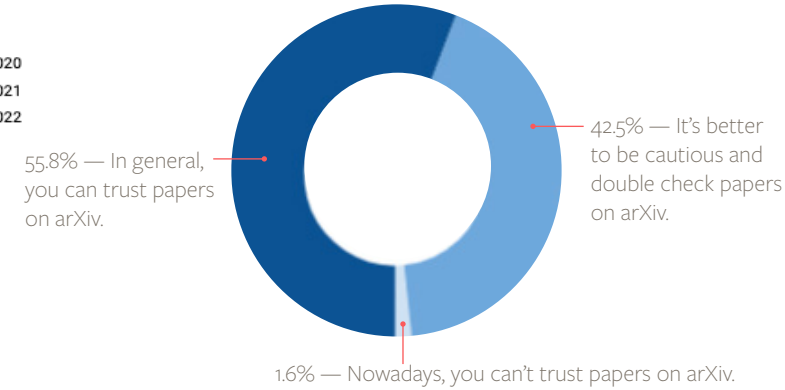
Annual Brand Perception Survey 2022

arXiv is seen as highly Open and Stable—our most important attributes and where arXiv has focused it's energies for over 30 years. Areas for improvement include Innovative and Welcoming.

Each year we ask the community to answer a brief survey about how they see arXiv. This honest annual assessment helps us understand how our global community sees arXiv and how it is changing over time. We ask community members how closely they associate arXiv with ten crucial attributes, and convert responses into a numerical score. In 2022, we received over 4,700 responses in just 24 hours. Thank you to everyone who took the survey!

Open	Stable	Fair	Easy-to-use	Satisfying	Transparent	Empwering	Trustworthy	Welcoming	Innovative
88	82	70	69	67	67	59	59	53	40





Perception of arXiv has remained fairly stable over the three years we have run the survey, though some changes fall outside of our 1.4% marging of error. 2022 saw major changes in leadership and staff at arXiv, and while our goal is to significantly improve scores below 80, remaining steady is a small victory under the circumstances. It speaks to arXiv's stability and commitment even in periods of great change.

This year, we asked respondents **"How likely are you to trust the CONTENT of papers hosted on arXiv?"** 55.8% chose "In general, you can trust papers that are on arXiv", while 42.5% chose "It's better to be cautious and double check." This healthy skepticism **compares favorably against other surveys on trust in research** and speaks to the high level of engagement and investment that scientists have in the arXiv service.

The arXiv Experience

Every day, researchers visit arXiv.org to find the latest cutting edge results, the seminal papers in their field, and inspiration. Every day, arXiv delivers. What makes this possible? The trust of the global research community and the dedication of the arXiv staff and volunteers.

A research article is the culmination of so much hard work, local and global collaboration among colleagues, and perhaps years of setbacks and successes. Authors of such work turn to arXiv for worldwide free, open, fast dissemination of their findings and long term safe keeping.

Entrusted with this body of knowledge, the staff of arXiv take their responsibilities seriously, showing up every workday and sometimes weekends to address questions and submissions snags, to repair bugs and write new code – all in the service of researchers and their submission work.

At the same time, highly committed advisors and moderators volunteer their time to curate content, help develop policies, and propose improvements.

It's not just the research results themselves on arXiv.org that inspire – it's the collaborative, global effort to collect, protect, and disseminate this knowledge for all.

In early 2022, arXiv surpassed two million articles.

Content Moderation and User Support

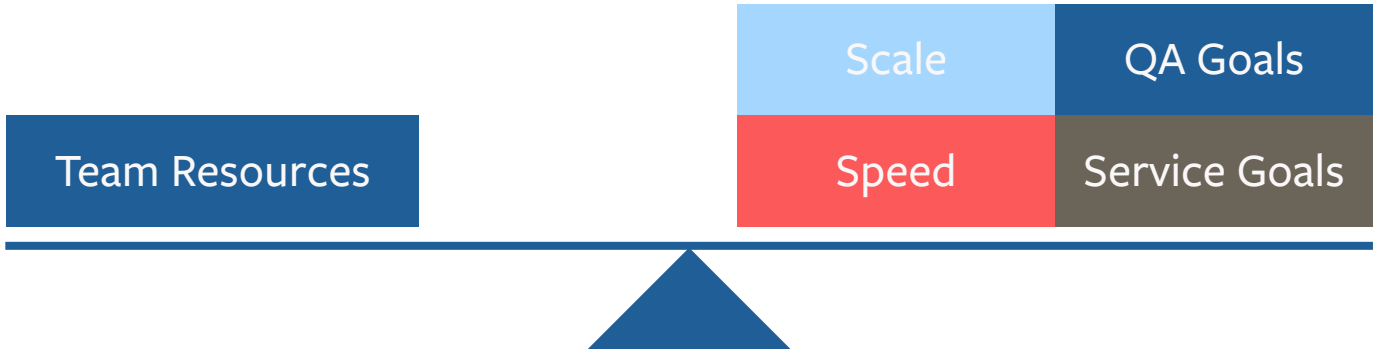
In 2022, the arXiv content moderation and user support team addressed **over 30,000** user support tickets.

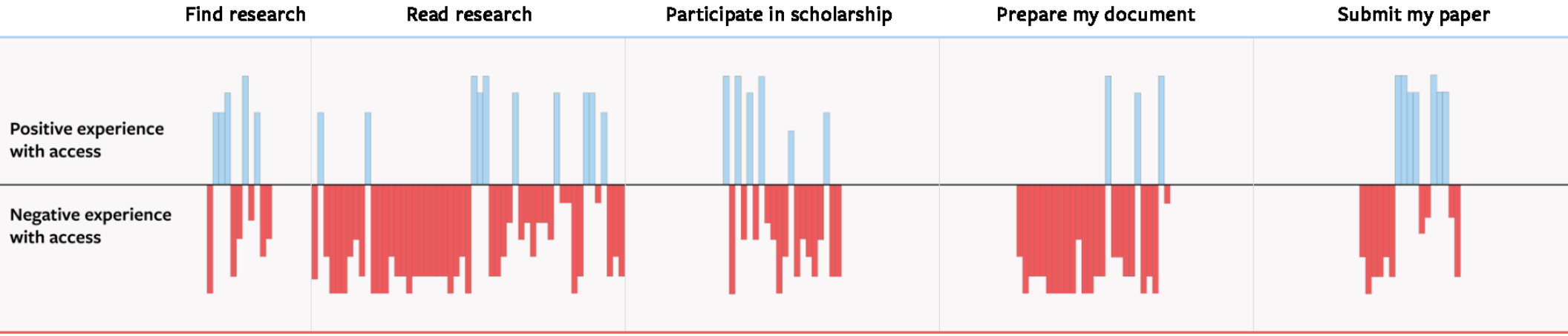
arXiv's content moderation and user support team curates submissions for moderation and technical standards. In addition to the Scientific Director, six staff members and several part time students balance team resources with scale, speed, quality assurance goals, and service goals. This year, twelve new volunteers joined the existing moderation team, which now totals 204.

Submissions are announced five days a week for nearly the entire year. Each day papers are announced, new submissions number anywhere between 650 to 1,300. An additional 450 to 1,000 other types of submissions, such as replacements or crosslistings, are also handled by the team.

This year, the team launched a new user support portal, which ensures that readers and authors are prompted to provide detailed information needed to receive the appropriate help. Internally, the portal also directs inquiries to the right staff members.

The team received and sent approximately 2,000 messages per month related to technical support, such as TeX compilation errors. This is in addition to about 700 requests monthly for moderation support, such as those related to submission status and appeals.





Most steps in the research process were reported as overwhelmingly negative experiences, with regards to accessibility.

Accessibility

arXiv is internationally known for open access and credited with launching the movement. arXiv has no paywalls to read or submit work, requires no login for reading, and boasts no geographic or institutional barriers. This approach to sharing papers openly and before peer review has transformed the research process. However, access is not the same as accessibility, which is ***the practice of ensuring access regardless of disability***. For researchers with disabilities, accessibility of research is paramount.

Accessibility is one of the next frontiers of the open access movement. In 2022, arXiv completed intensive user research with over 40 accessibility experts and members of the arXiv community and published the results on arXiv (arxiv:2212.07286). They included scientists who rely on assistive technology, research experts in accessibility, and more. We asked about their experiences accessing research on arXiv and beyond.

The solutions to making research accessible are known. It's time to take action and fulfill the promise of Open Access.

Accessible Research Report

We learned that finding research, reading research, participating in scholarship, preparing documents, and submitting are all steps in the research process where researchers encounter barriers. Some of the most critical barriers are math, figures, and charts frequently being unreadable to screen readers. Even authors who want to make their papers accessible for others have difficulty doing so.

We learned that, to address many varied disabilities and barriers to accessibility, we need flexible content. Our research participants told us what this means for arXiv: offer HTML formatted papers, alongside the existing PDF and source files.

We plan to add **an HTML button** to arXiv abstract pages, alongside current PDF and Source Files, by the end of 2023.

Recent Accessibility Updates

- PDF download buttons now announce the title and the first author to screen readers. This makes it easier to quickly determine if you want to download the paper.
- Our new help and documentation subdomain, info.arxiv.org, is fully compliant with web accessibility standards.
- We published our report on accessible research papers (arxiv:2212.07286) and have begun to share it more widely. We are hearing input from the community and building momentum for the work ahead.

Technical Modernization

arXiv.org has been providing access to research papers for 31 years. The site averages 300,000 hits per hour, twenty four hours a day, seven days a week, with most visitors landing directly on abstract pages or PDFs. The service receives about 15,500 submissions per month and serves 32 million downloads per month.

In 2022, arXiv was online and fully operational at least 99.99% of the time each month thanks to our small team of four developers now led by our new technical director. The team maintained and improved the system, including extensive work on reliability. Specifically, most virtual machines running unsupported operating systems were replaced, and bugs causing spurious server errors were fixed, reducing the frequency of such errors dramatically.

The arXiv-CE ("Cloud Edition") project – to move all arXiv services to the cloud, was formally launched. The multi-year plan will improve stability and capacity, ease expansion into new subject categories, and allow easier integration with other services. In 2022, in addition to arXiv's search function being hosted in the cloud, we started to "live test" serving some of our article downloads from the cloud.This work will continue, with the expectation that all browsing and article downloads will be served from the cloud by the end of 2023. Additionally, we plan to provide a more user-friendly TeX/LaTeX pipeline, better submission tools, and the ability to view articles as HTML.

> "Moving to the cloud will improve stability and capacity, ease expansion into new subject categories, and allow easier integration with other services."

arXiv in conversation

Nothing exists in isolation. Research is an increasingly interconnected endeavor, whether it's sharing data and code, collaborating across institutions and continents, or pushing the boundaries of interdisciplinary thinking.

arXiv itself is also increasingly interconnected. In addition to connecting researchers to research, arXiv connects people and technologies. arXiv users create community-developed tools that link to other services, adding value to arXiv's core service. Open access and open science advocates, university librarians, researchers, and funders connect at online events for conversation.

We continue to ask the big questions—*How can we best harness the possibilities of AI to accelerate effective research sharing? What will be the next disruption in academic publishing? What opportunities can we seize to ensure that the open access movement continues to equalize and democratize access to research?*—and we invite others to join us in conversation.

Interoperability and arXivLabs

At its most basic, arXiv is a website where researchers can share and read research articles without a paywall. But behind the scenes, arXiv is so much more. With more than 2.1 million articles, arXiv represents a vast source of information. The research results, content of the articles, and their metadata can all be accessed by public APIs. This means that articles on arXiv are discoverable across platforms like Google Scholar, Semantic Scholar, NASA's Astrophysics Data System, Europe PMC, and SciRate. Researchers in natural language processing, machine learning, and other fields can mine arXiv data for their projects via Kaggle. Successful overlay journals have been built on top of arXiv's infrastructure.

arXiv integrates tools in four areas: 1) related papers and recommenders, 2) bibliography and citations, 3) code, data, and media and 4) related demos.

arXivLabs is a framework for integrating community-built tools into the arXiv platform – in other words, another type of interoperability that allows computer systems to exchange and make use of information.

Outreach

To serve researchers' needs, arXiv must deeply understand the shifting landscape that spans open science, preprints, conventional academic publishing – and university and funder expectations. Conversations with colleagues and collaborators around the world are at the heart of this understanding.

In 2022, arXiv celebrated International Open Access Week by hosting an online panel discussion about "Trends in Peer Review of Open Access Preprints" including overlay journals and open peer review. Additionally, we presented a lightning talk, "Making Research Papers Available to All," about our accessibility efforts. We later presented an update on our accessibility report to the TeX Hour, a gathering of TeX users and developers.

arXiv also hosted a booth at the (US) National Society of Black Physicists in Virginia. We presented virtually at The First International Conference on Open Science and Innovation in Ukraine and at smaller gatherings such as the TeX Hour group.

These efforts reached hundreds of people, in person, online, and through recordings, building relationships while also reinforcing arXiv's mission to share research quickly and openly around the globe.

> Even when the paper is in a journal, I go to arXiv because it is easy.
>
> —NSBP Conference attendee

arXiv connects

your institution to a constellation of open science services

Thank you to our supporters in 2022

Major Funding

Simons Foundation

Cornell University

Champion Consortia

Big Ten Academic Alliance (USA)

California Digital Libraries (USA)

Consortia

arXiv DH and HGF Consortium (Germany)

Canadian Research Knowledge Network (Canada)

Consortium of Swiss Academic Libraries (Switzerland)

Council of Australian University LIbrarians (Australia)

Couperin (France)

Centre National de la Recherche Scientifique (France)

FinELib Consortium (Finland)

French National Fund for Open Science (France)

Jisc (UK)

NII Japan Consortium (Japan)

Champion Members

California Institution of Technology (USA)

CERN - European Organization for Nuclear Research (Switzerland)

Georgia Institute of Technology (USA)

Imperial College of Science, Technology and Medicine (UK)

Los Alamos National Laboratory (USA)

Massachusetts Institute of Technology (USA)

University College London (UK)

Gold Affiliates

American Physical Society

Computer Vision Foundation

Silver Affiliates

Adam Weissman Foundation

American Astronomical Society

American Institute of Physics Publishing

American Mathematical Society

Association for Computing Machinery

Austrian Science Fund

Institute of Physics Publishing

NWO Dutch Research Council

Gold Sponsors

Google, Inc

Facebook AI

Silver Sponsors

Kepler Science, Inc

arXiv connects

278 members from 30 countries

Thank you to our members

Top 100 Submitting Institutions

Australian National University (Australia)
Brookhaven National Laboratory (USA)
Carnegie Mellon University (USA)
Columbia University (USA)
CSIC - Spanish National Research Council (Spain)
DESY (HGF - Helmholtz Association, German Research Centers) (Germany) arXiv-DH and HGF
Duke University (USA)
Durham University (UK) Jisc
ETH Zurich (Switzerland)
Fermilab (USA)
Harvard University (USA)
Italian Institute for Astrophysics - INAF (Italy)
Indiana University (USA) BTAA
Johns Hopkins University (USA)
Karlsruher Institut für Technologie (Germany) arXiv-DH and HGF
Kings College London (UK) Jisc
KTH Royal Institute of Technology (Sweden)
Kyoto University (Japan) NII Japan Consortium
Lawrence Berkeley National Laboratory (USA) CDL
Max Planck Digital Library (Germany)
McMaster University (Canada) CRKN
Memorial University of Newfoundland (Canada) CRKN
Michigan State University (USA) BTAA
New York University (USA)
Northwestern University (USA) BTAA
The Ohio State University (USA) BTAA
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Penn State University (USA) BTAA
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Universität Mainz (Germany) arXiv-DH and HGF
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University of Amsterdam (Netherlands)

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University of Colorado (USA)
University of Maryland (USA) BTAA
University of Michigan (USA) BTAA
University of Minnesota (USA) BTAA
University of Ottawa (Canada) CRKN
University of Pennsylvania (USA)
University of Saskatchewan (Canada) CRKN
University of Sydney (Australia)
University of Texas at Austin (USA)
University of Tokyo (Japan) NII Japan Consortium
University of Toronto (Canada)
University of Waterloo (Canada)
University of Wisconsin, Madison (USA) BTAA
Yale University (USA)
York University (Canada) CRKN

Frequent Submitters

Aalto University (Finland) FinELib
Argonne National Lab (USA)
Boston University (USA)
Brock University (Canada) CRKN
Brown University (USA)
Cardiff University (UK) Jisc
Commonwealth Scientific and Industrial Research Organisation (CSIRO) (Australia)
Curtin University (Australia) CAUL
EPF Lausanne (Switzerland) CSAL
Forschungszentrum Julich (Germany) arXiv-DH and HGF
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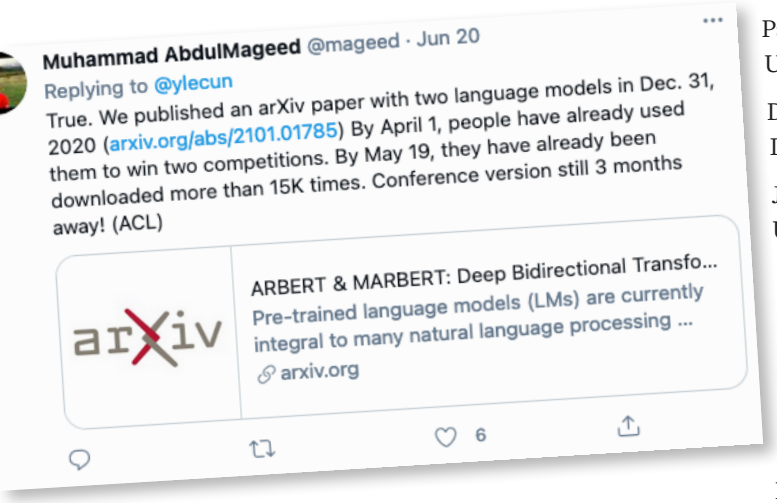

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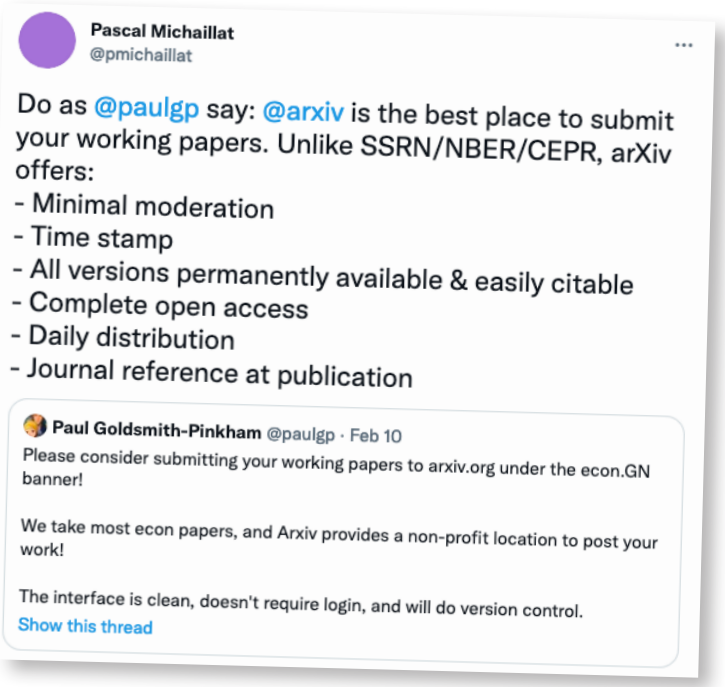

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