The arXiv: 14 years of open access scientific communication

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Acknowledgements

arXiv is the work of many people!

Particular thanks to Paul Ginsparg, Thorsten Schwander, Mark Doyle and also to others in the past and present arXiv team.

arXiv has received support from:

- DOE HEP initially,
- the NSF since 1995 (awards 9413208, 0132355, 0404553),
- and recently the Cornell University Library.

In the beginning...

Started by Paul Ginsparg in 1991 at Los Alamos National Laboratory (LANL) as a way for high-energy theoretical physicists to share preprints fairly and efficiently (then `xxx.lanl.gov`).

Initial user-base of 160 email addresses assembled from existing pre-print distribution lists for hep-th.

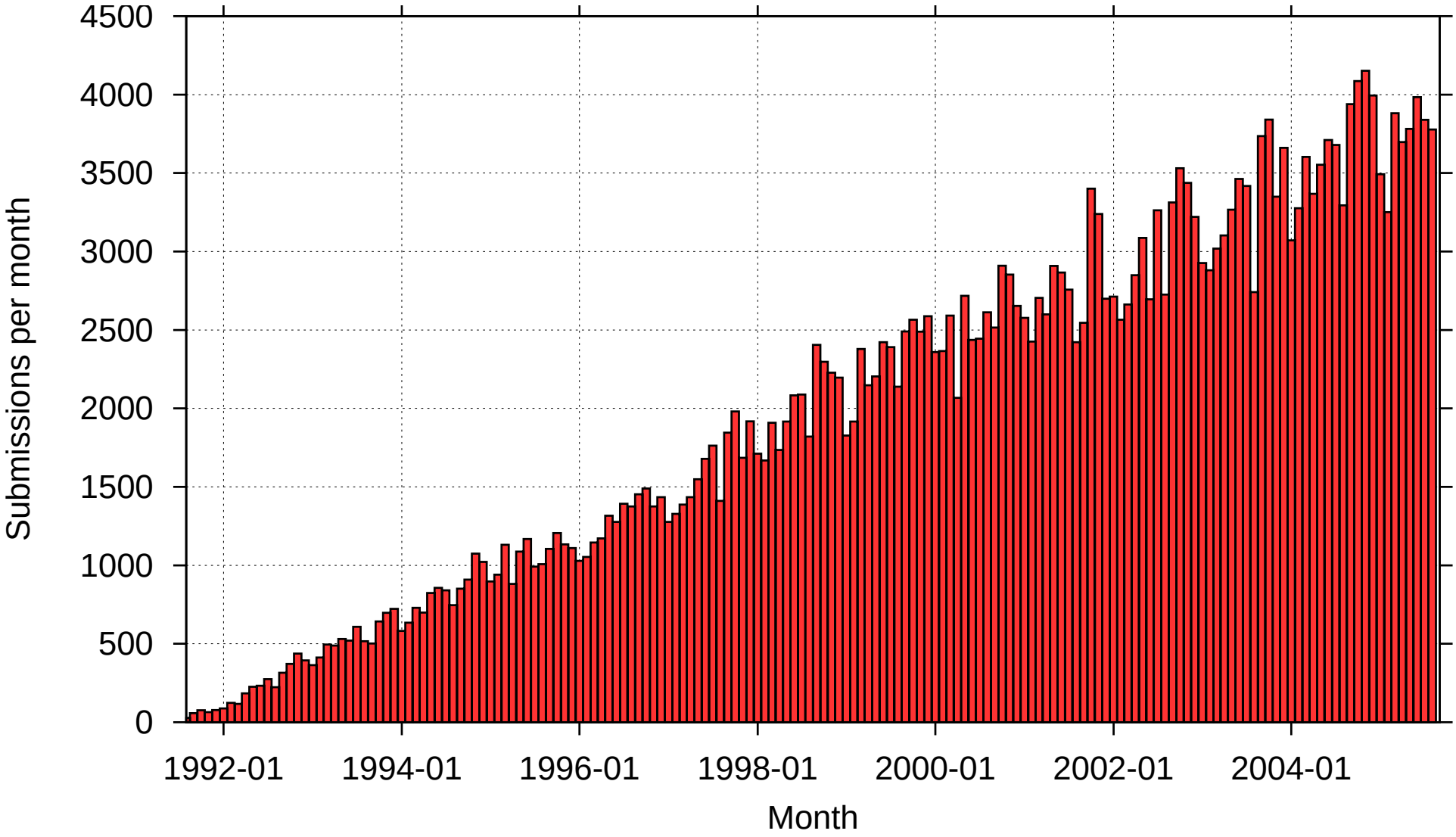
...and now

- 340,000 articles in physics, mathematics, computer science, and quantitative biology.
- ∼4,000 submissions, 1.6 million downloads per month.
- alerting service, search facilities, 17 mirrors...

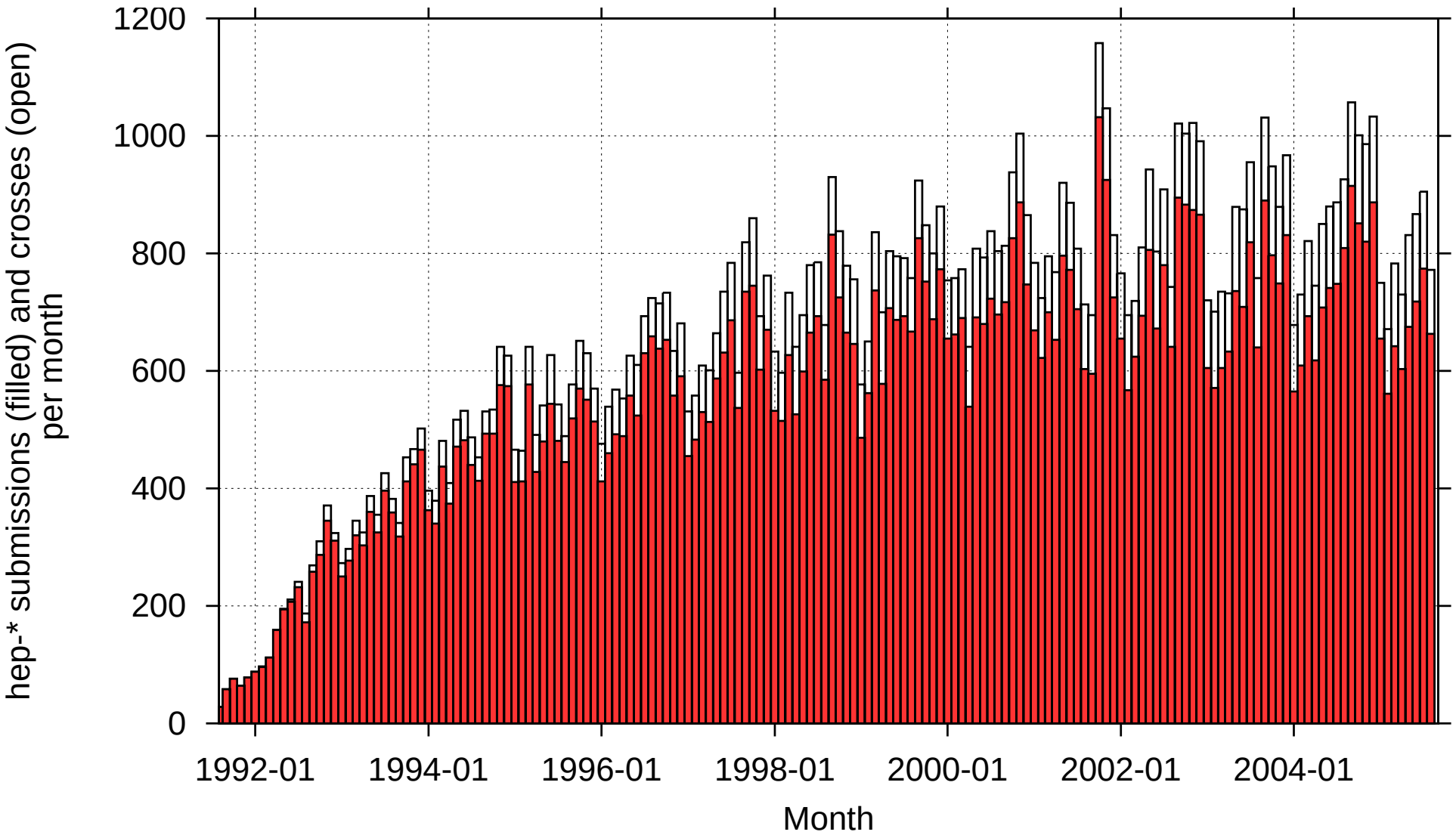
Timeline

Aug 1991	`hep-th` archive with email interface started.
1992	ftp interface. `hep-ph` and `hep-lat` added locally; `alg-geom`, `astro-ph` and `cond-mat` added remotely.
1994	Web interface added, remote archives merged back.
Jun 1995	Automatic PostScript generation from TEX source.
1996	PDF generation and web upload facility added.
Sep 1997	ATMP is first journal overlay on an e-print archive.
Jan 2001	OAI compliant.
Sep 2001	Administrative oversight transferred to Cornell.
Jul 2003	Email submission discontinued, new user registration.
Sep 2003	q-bio archive launched.
Dec 2003	Holiday schedule announced for the first time.
Jan 2004	Submitter endorsement system added.

Monthly submission rate — continued linear increase



Saturation of high-energy physics submission rate



Community and critical mass

"build it and people will come"?

- The physics community was ready and arXiv fit its practices well (Kling and McKim 2000).
- Model might not be a good fit for other communities with different practices.
- Mathematics section took considerable effort to promote but is now very healthy.
- Computer Science section still growing slowly — different practices, different publication habits, other services (notably CiteSeer).

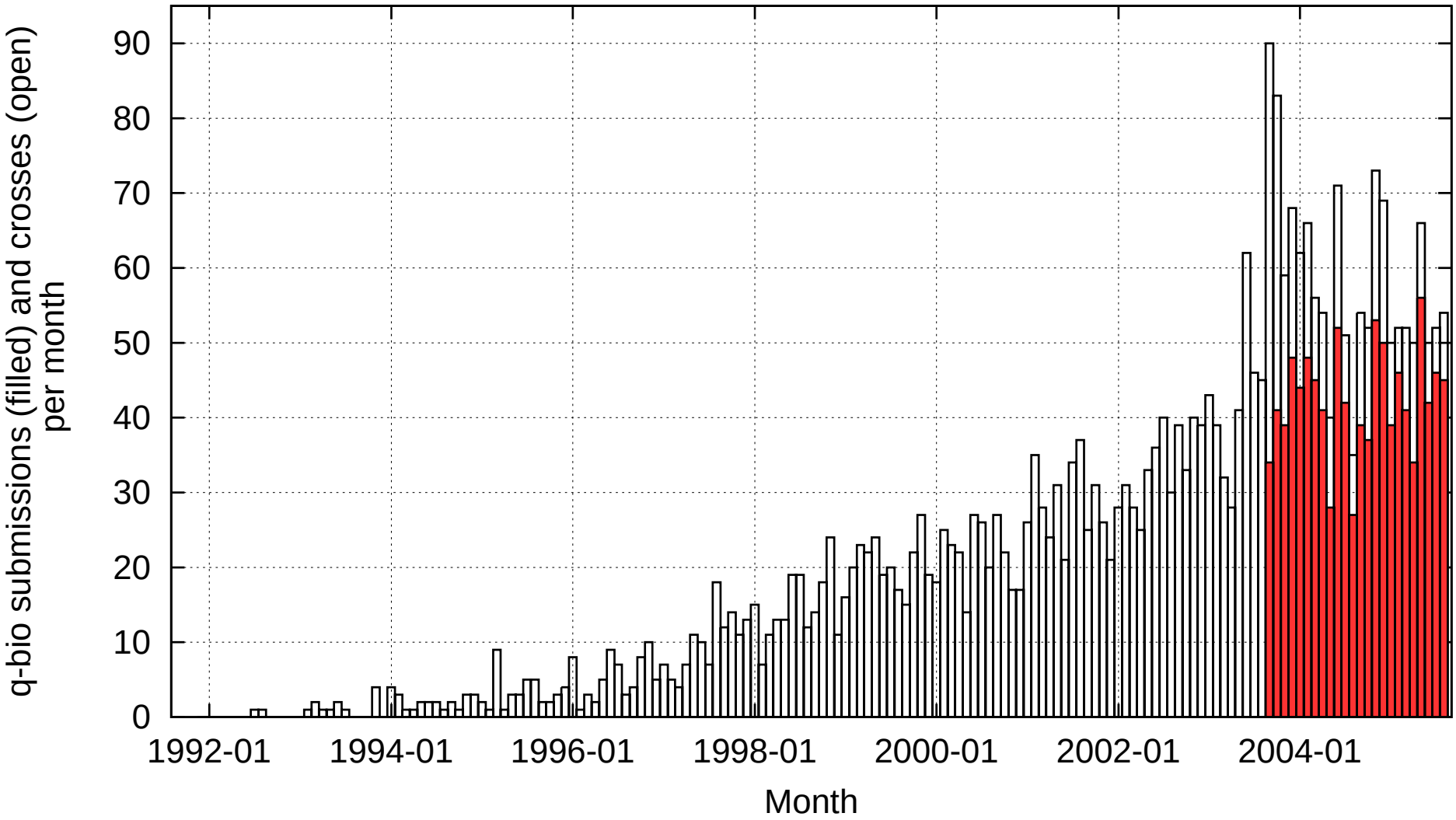
$\Longrightarrow$ cautious expansion policy.

Creation of the q-bio archive

q-bio = *Quantitative Biology* created in September 2003.

1. Why not create a Biology section?
   Unknown demand, don't want to create a underused section.
2. Those requesting q-bio charged with helping guide its creation.
3. Existing arXiv papers identified and cross-listed to seed q-bio .

Monthly submission totals for q-bio (filled bars) and cross-listings (open bars)



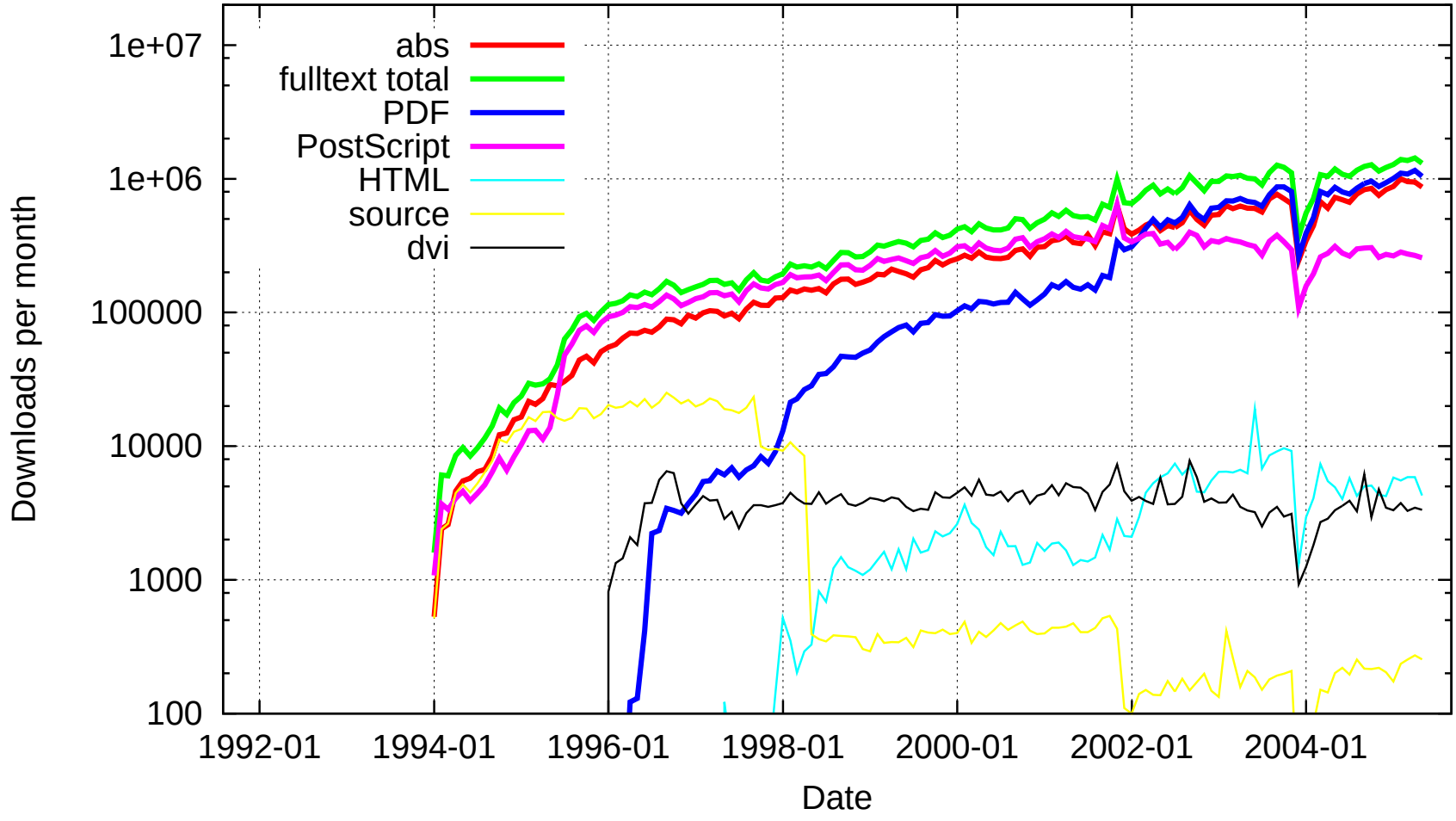
Quality control and the price of popularity

Moderation criterion: *research papers "of refereeable quality" and appropriate to the subject area.*

Vast majority of submissions appropriate, usually very easy to tell those that are not.

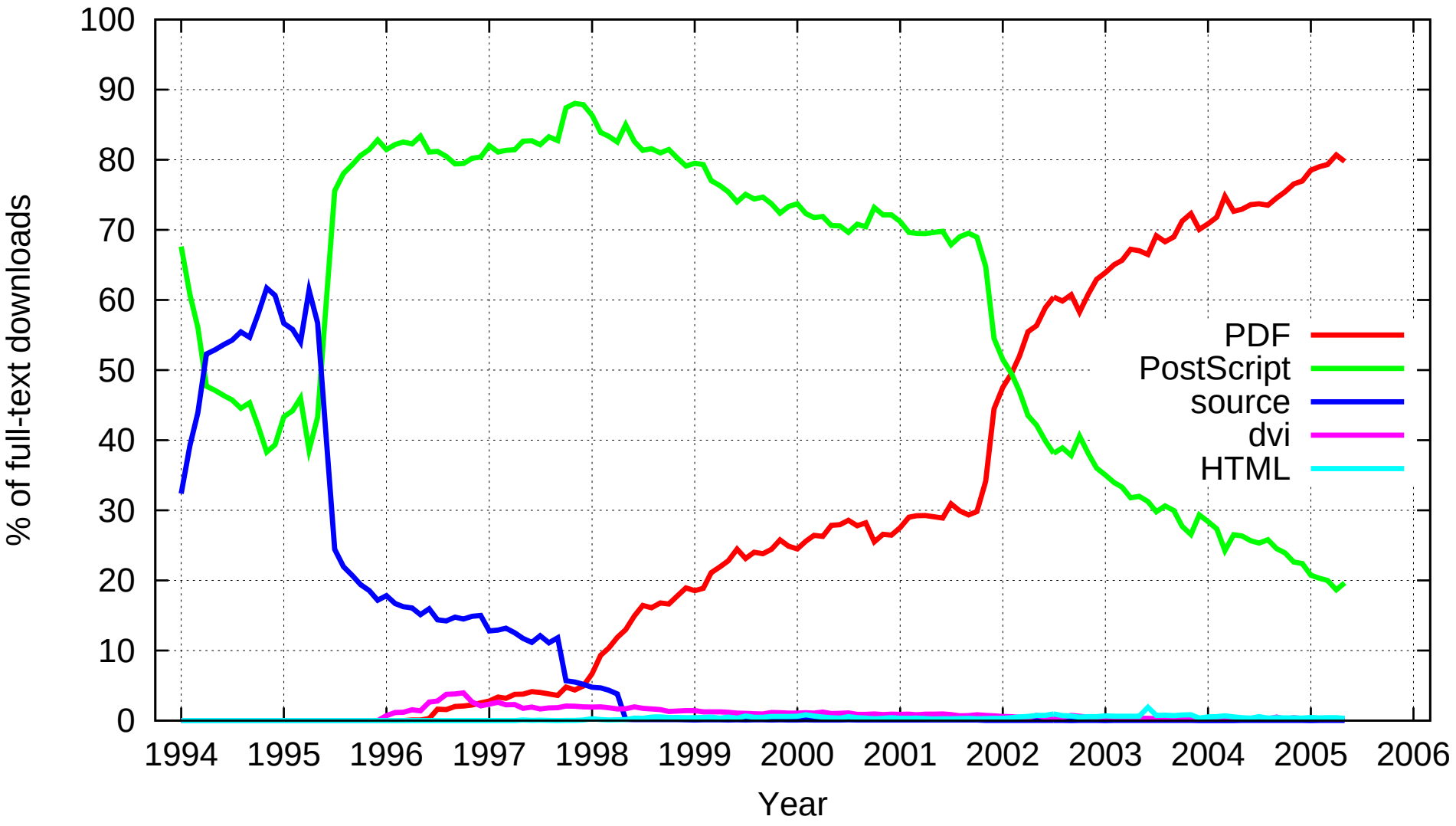
- **arXiv aims to serve established research communities**:
  - open submission was never a goal.
  - open access to all who are interested is good, but secondary.
- use communities: new submitters must be endorsed.
- finally, volunteer moderators for each subject area.

Monthly download totals since the launch of the arXiv web interface in 1994 — note log scale



$\sim$2 year doubling recently, growing faster than number of papers.

Change in preferred download format over time



3 phases: source PostScript PDF

Mirrors account for 37% of downloads

Site	Full-text (millions)	Abstract (millions)
(main site) arXiv.org	12.33	8.57
lanl.arXiv.org	3.34	1.82
jp.arXiv.org	0.68	0.33
it.arXiv.org	0.61	0.30
de.arXiv.org	0.57	0.37
fr.arXiv.org	0.44	0.22
uk.arXiv.org	0.40	0.26
cn|ru|br|tw	$\leq$0.30	$\leq$0.13
il|au|kr|aps|es|in|za	$\leq$0.10	$\leq$0.06
Total for 2005	19.36	12.40

Rights, licenses and access

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2001– Explicit click-through as part of submission.

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A. Verify Your Contact Information

...explanation omitted...

First Name: Simeon
Last Name: Warner
Suffix: ('Jr.', 'II', etc; may be blank)
Affiliation: Cornell University
E-mail: simeon@cs.cornell.edu

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arXiv and the conventional journal system

"The rapid acceptance of electronic communication or research information in my own community of high-energy theoretical physics was facilitated by a pre-existing 'pre-print culture', in which the irrelevance of refereed journals to ongoing research has long been recognized." [Ginsparg, 1994]

NOT an assertion that journals are irrelevant!

$\Longrightarrow$ disconnect between:

practice of physics for which peer review is not considered very important (at least in the short term), and

rewarding or professional progression for which the stamp of authority offered by journals is considered indispensable.

Journal publisher interactions

- early on, confusion and uncertainty.
- American Physical Society (APS) launched an e-print archive in 1996, discontinued in 1998.
- APS broadly supportive of arXiv, in particular they adapted copyright to explicitly permit submission to e-print archives.
- APS, IOP, Elsevier, etc. accept arXiv identifiers as a way to make submissions.

No evidence that arXiv has markedly affected submissions or subscriptions to conventional journals. NOT clear that this is sustainable.

Overlay journals

Advances in Theoretical and Mathematical Physics (ATMP) created in 1997 as an overlay on arXiv.

Growing number of overlays:

- *Geometry and Topology* and *Geometry and Topology Monographs*,
- *Algebraic and Geometric Topology*,
- *Logical Methods in Computer Science*, and
- all Institute of Mathematical Statistics (IMS) journals.

Pose questions about how to modify arXiv's author-centric ownership and authority model.

Data sharing and interoperability

- Citation data exchange with SLAC SPIRES.
- Separate math front-end.
- Proxy submissions (inc. overlays).
- Remote submission site.
- OAI metadata sharing (incorporated in OAIster, Scirus, CiteSeer...).
- Tailored paths for search engine crawlers.
- Automated DOI feed from Elsevier.
- Data sharing for citation analysis and other research.

Usage data: balancing privacy and fairness with utility

Amazon has show us the power of usage data and collaborative filtering.

arXiv has a commitment to user privacy and to producing a system as fair as reasonable $\longrightarrow$ very careful with web log data.

privacy all shared data anonymized.

fairness avoid measures which can be gamed.

Use of citations much easier as information is public and much harder to game.

Institutionalization

arXiv is established as indispensable in some disciplines and of growing importance in others. Move to the Cornell University Library in summer 2001 promises stability and commitment.

- Formalization of previously ad-hoc procedures for daily operation.
- Improvement in tools and practices to separate technical from non-technical.
- Rationalization of policies.
- Better governance through liaison with the overall arXiv advisory board and with subject-area advisory committees.

The future role of arXiv

First, arXiv must just continue to work.

The largely automated distribution system provided by arXiv is the "low hanging fruit" of the broader scholarly communication problem. It has proven the effectiveness of a subject specific archive.

Institutional repositories supplement and might eventually replace.

Challenges

- **review/certification** — arXiv exists alongside traditional journals. Overlay journals provide one model separating functions.
- **interoperability** — corpus is and will be distributed over many repositories, likely with duplicates. Navigation and access should be seamless. Identifier and resolution schemes are helping make inroads, access controls impede.
- **beyond papers** — rich media, data, programs and computation are all part of scholarship that can and should be recorded digitally, interlinked, and reused. Progress in limited subject domains exploiting uniformity/context.

That's all. Questions?