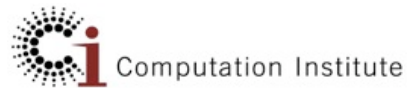


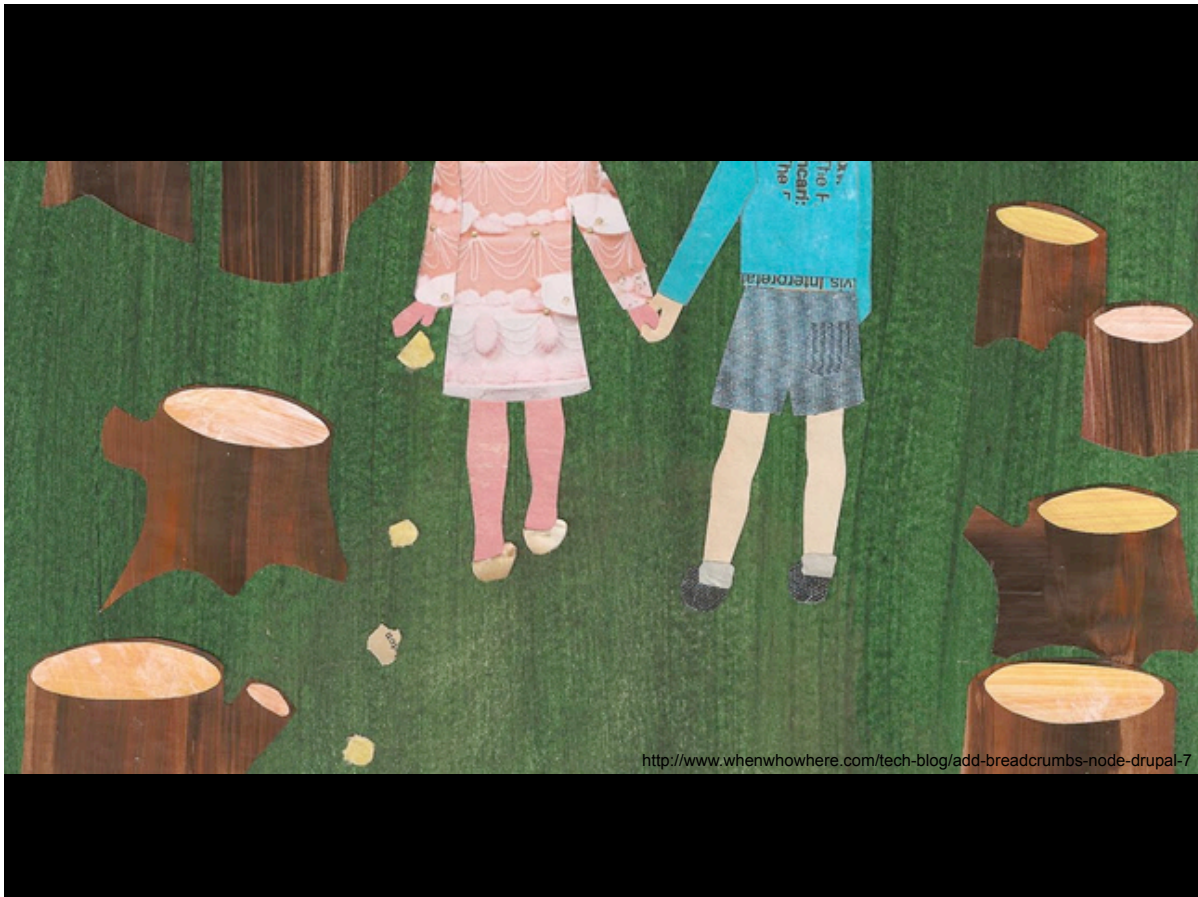
# Fairly sharing the costs of Reproducibility: Precedents and Possibilities

Gordon Kindlmann  
glk@uchicago.edu



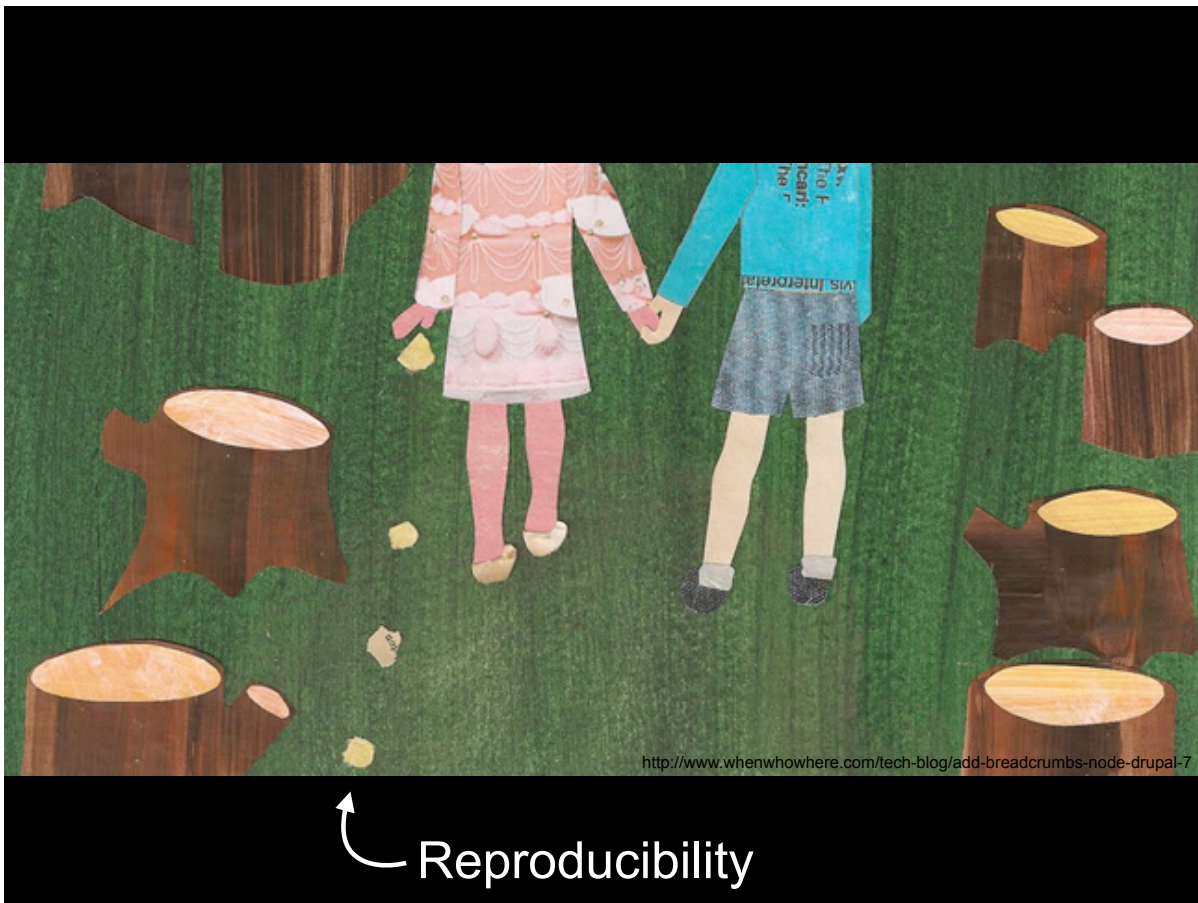
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## EuroRV<sup>3</sup> topics

### Reproducibility

Verification

Validation



Discussed by  
Torsten yesterday,  
and Mike today

## in Visualization

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**Growing ways to facilitate reproducibility is an active and vital research area.**

**How will Visualization choose to build on this?**

<http://vgc.poly.edu/~juliana/ReproducibleScience/SoftwareInfrastructure/agenda.pdf>

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## Outline

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**Motivation**

**Space of reproducibility**

**Selected samples**

**Looking forward**

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# Outline

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## Motivation

Space of reproducibility

Selected samples

Looking forward

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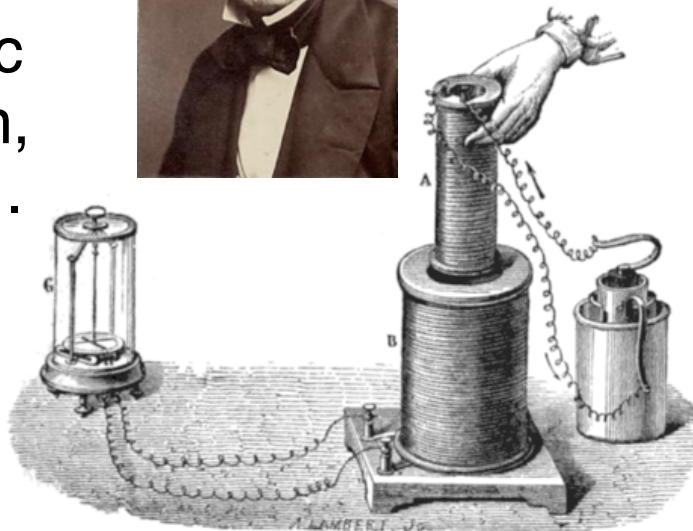
## Historic Scientific Reproducibility

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Michael Faraday  
(1791-1867)

Described  
electromagnetic  
fields, induction,  
diamagnetism...

Clearly written  
notebooks  
enabled  
reproduction



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# Current Scientific Reproducibility

## Proceedings of the National Academy of Sciences (PNAS)

(x) **Materials and Data Availability.** To allow others to replicate and build on work published in PNAS, authors must make materials, data, and associated protocols available to readers. Authors

<http://www.pnas.org/site/misc/iforc.pdf>

## Science

“... To address the growing complexity of data and analyses, *Science* is extending our data access requirement ... **to include computer codes involved in the creation or analysis of data.** ...”

<http://www.sciencemag.org/content/331/6018/649.short>

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The screenshot shows the top portion of a Nature journal article page. At the top left is the 'nature' logo with the tagline 'International weekly journal of science'. To the right is the URL <http://www.nature.com/news/2010/101013/full/467753a.html>. Below the logo is a navigation bar with links: 'nature news home', 'news archive', 'specials', 'opinion', 'features', 'news blog', and 'nature journal'. The main content area features a red 'Column: World View' header above the article title 'Publish your computer code: it is good enough'. The author is identified as Nick Barnes, with a small portrait photo. A quote from him reads: 'Freely provided working code – whatever its quality – improves programming and enables others to engage with your research, says Nick Barnes.' The article text begins: 'I am a professional software engineer and I want to share a trade secret with scientists: most professional computer software isn't very good. The code inside your laptop, television, phone or car is often badly documented, inconsistent and poorly tested.' To the left of the article are social media links: 'Comments on this story', 'Blogs linking to this article', 'Add to Digg', 'Add to Facebook', 'Add to Newsvine', 'Add to Del.icio.us', and 'Add to Twitter'. To the right are sections for 'Naturejobs' (with links for 'Laboratory Tec' and 'Scientist for NI') and 'Resources' (with links for 'PDF Forma', 'Send to a F', 'Reprints &', and 'RSS Feeds').

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# Reproducibility and Impact

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## V Stodden et al. “How Journals are Adopting Open Data and Code Policies”

1st Global Thematic IASC Conference on the Knowledge Commons:  
Governing Pooled Knowledge Resources, Belgium, Sept 2012  
<http://www.stanford.edu/~vcs/papers/IASC2012-STODDEN-Sept122012.pdf>

- Journal publication offers a *quid pro quo*: you give us (publisher) reproducibility info, we give you professional visibility
- Correlation (0.55;  $p=0.0017$ ) between **Impact Factor** and having open data/code requirement for publication

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## Outline

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### Motivation

### Space of reproducibility

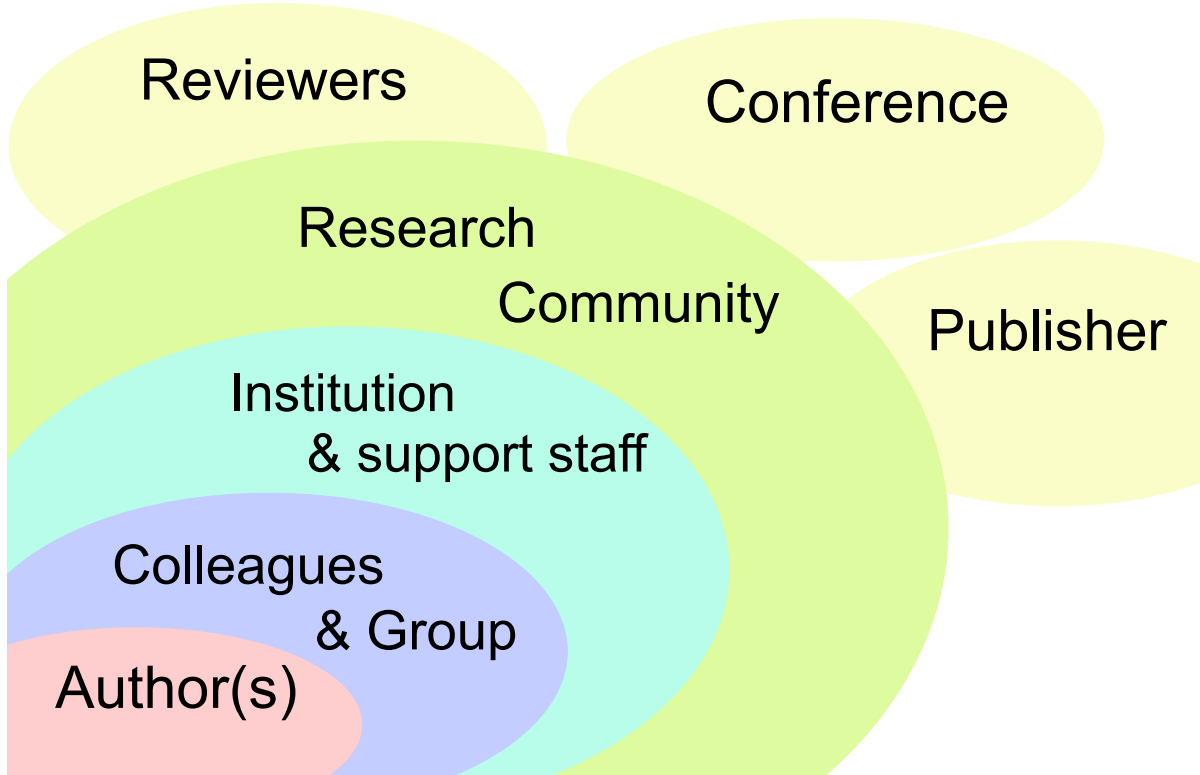
### Selected samples

### Looking forward

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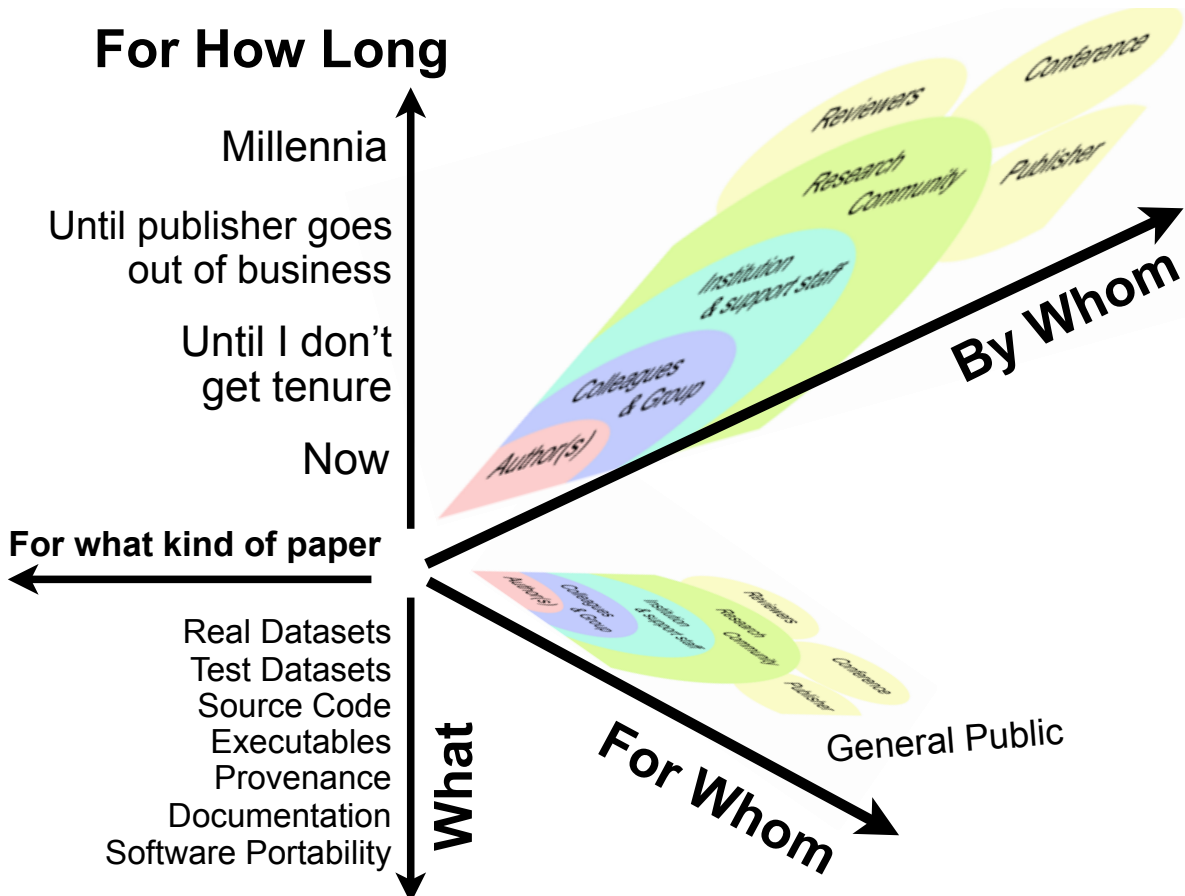
12

# Who pays for reproducibility?



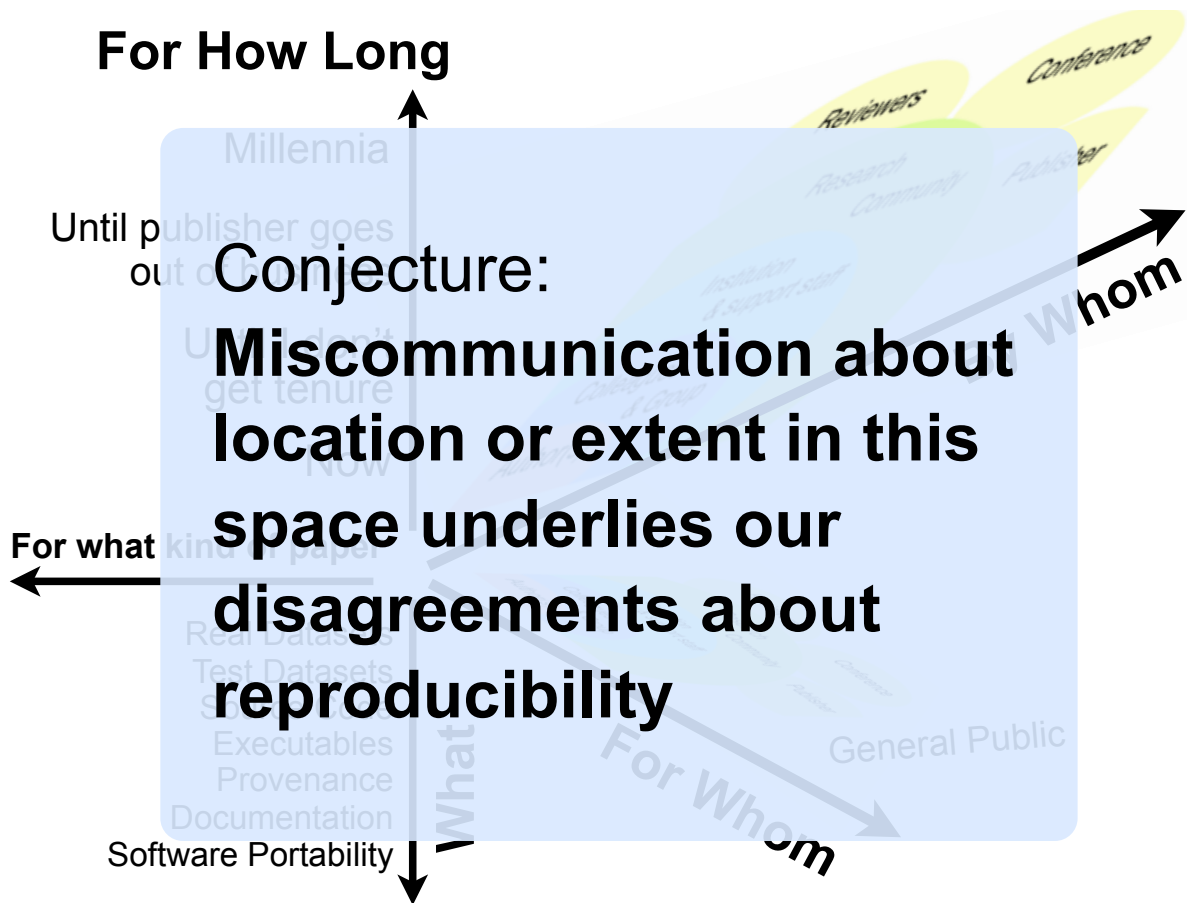
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## Costs we already pay

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**Learning to code**

**LaTeX .tex, .bib, .cls**

**Presenting in English**

**Airfare, registration**

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# Outline

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Motivation

Space of reproducibility

**Selected samples**

Looking forward

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## Who pays for reproducibility?

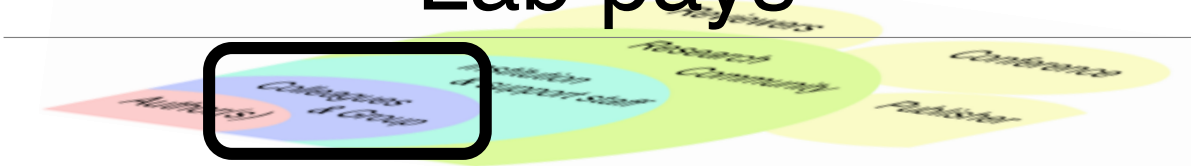
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# Lab pays



**Wavelab**

<http://www-stat.stanford.edu/~wavelab/>

[http://www-stat.stanford.edu/~wavelab/Wavelab\\_850/wavelab.pdf](http://www-stat.stanford.edu/~wavelab/Wavelab_850/wavelab.pdf)

Matlab routines for wavelet analysis

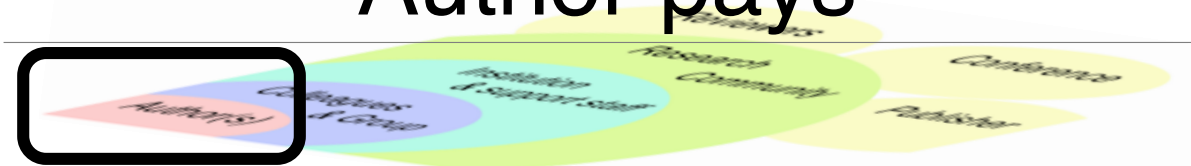
Using & building Wavelab is part of  
Donoho's lab culture

“An article about computational science in a scientific publication is not the scholarship itself, it is merely advertising of the scholarship. The actual scholarship is the complete software development environment and the complete set of instructions which generated the figures.” --David Donoho on WaveLab

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# Author pays



**Sweave**

<http://www.stat.uni-muenchen.de/~leisch/Sweave/>

Embed data analysis R code in LaTeX

“Literate Programming” -Knuth

**PTU**

<https://www.usenix.org/system/files/conference/tapp13/tapp13-final18.pdf>

Provenance-to-Use: software, its  
inputs, and its execution, are  
packaged into self-contained unit

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# Author, lab, others?



VisTrails <http://www.vistrails.org>

Open-source scientific workflow and  
provenance management system

Does entail a new way of working

Pay-off: **Knowledge Reuse**

User community increases power

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# Lab/Institution pays

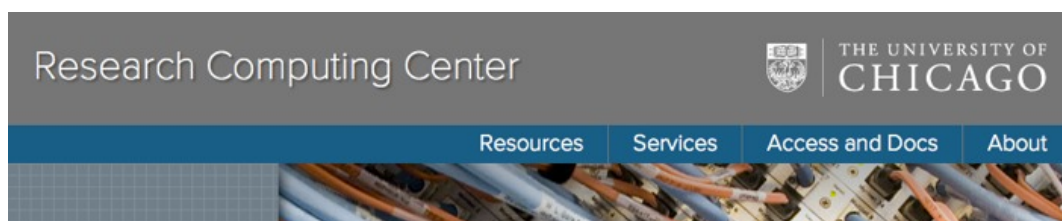


(Network connectivity, web servers)

University of Chicago Research

Computing Center <http://rcc.uchicago.edu>

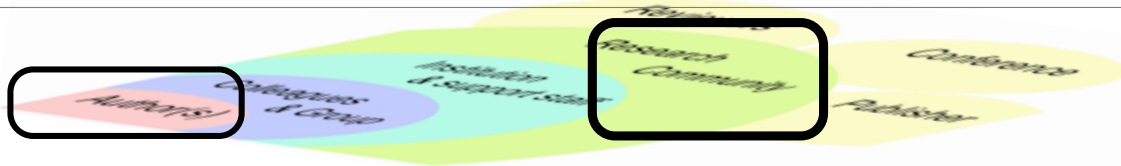
“We’ll help write and implement your  
NSF Data Management plan”



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# Author, Community pays



ROOT <http://root.cern.ch/drupal/>

Software from CERN to handle and analyze large amounts of High Energy Physics (and other areas)

<http://www.runmycode.org/>

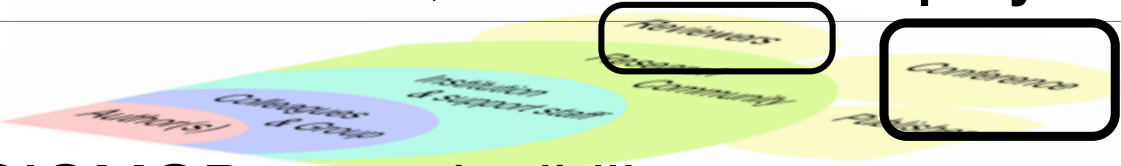
Authors create companion website to paper; computation behind figures runs in the cloud

Vis Contest: <http://ieeevis.org/year/2012/contest-session/all/all>

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# Reviewers, Conference pays



SIGMOD reproducibility <http://www.sigmod.org/2013/reproducibility.shtml>

Large-scale data management and databases

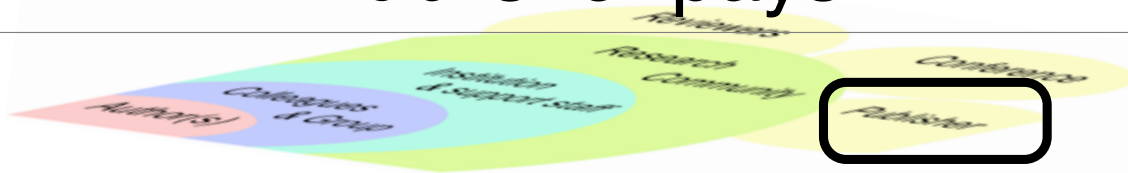
Papers can earn different levels of reproducibility, as assessed by Reproducibility Committee

**“Experimental papers will be most useful when their results have been tested and generalized by objective third parties”**

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# Publisher pays



## Elsevier **executable paper** challenge

<http://www.executablepapers.com/index.html>

<http://www.sciencedirect.com/science/article/pii/S1877050911001220>

“Publish” from  
Latin *publicare*  
“make public,”  
from *publicus*

ACM Trans on Mathematical  
Software <http://toms.acm.org>

Procedia Computer Science  
Volume 4, 2011, Pages 608-617  
Proceedings of the International Conference on Computational Science, ICCS 2011

**The Collage Authoring Environment**  
Piotr Nowakowski<sup>a</sup>, Eryk Ciepiela<sup>b</sup>, Daniel Haręziak<sup>b</sup>, Joanna Kocot<sup>d</sup>, Marek Kasztelnik<sup>a</sup>,  
Tomasz Bartyński<sup>b</sup>, Jan Meizner<sup>a</sup>, Grzegorz Dyk<sup>a</sup>, Maciej Malawski<sup>b, c</sup>  
<sup>a</sup> ACC CYFRONET AGH, ul. Nawojki 11, 30-950 Kraków, Poland  
<sup>b</sup> Institute of Computer Science AGH, al. Mickiewicza 30, 30-059 Kraków, Poland  
<sup>c</sup> Center for Research Computing, University of Notre Dame, USA  
<http://dx.doi.org/10.1016/j.procs.2011.04.064>, How to Cite or Link Using DOI  
Permissions & Reprints

### Abstract

The Collage Authoring Environment is a software infrastructure which enables domain scientists to collaboratively develop and publish their work in the form of executable papers. It corresponds to the

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# Outline

## Motivation

## Space of reproducibility

## Selected samples

## Looking forward

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# How VIS requests reproducibility now

<http://ieevis.org/year/2013/info/call-participation/paper-submission-guidelines>

## Paper Submission Guidelines

All conferences at IEEE VisWeek 2013 use similar submission and review processes. Please read the Individual Call for Papers for each of the conferences here: [SciVis](#), [InfoVis](#), and [VAST](#).

Make sure that you carefully read the guidelines below before submitting your paper!

1. Important dates
2. Submission Criteria and Review Process
3. Supplemental Material and Formatting Guidelines
4. General Expectations and Ethics Guidelines
5. Paper Types

### 1. IMPORTANT DATES

|   |                           |
|---|---------------------------|
| Abstract submission (MANDATORY)               | Wednesday, March 21, 2012 |
| Paper submission                              | Saturday, March 31, 2012  |
| Notification of results of first review cycle | Wednesday, June 5, 2012   |
| Paper submission for second review cycle      | Wednesday, June 27, 2012  |
| Final notification                            | Wednesday, July 11, 2012  |
| Camera ready due                              | Wednesday, August 1, 2012 |

All deadlines are at 5:00pm Pacific Time (PDT).

### 2. SUBMISSION CRITERIA AND REVIEW PROCESS

All conferences at IEEE VisWeek will now accommodate double-blind review processes for those authors that want to submit their work anonymously. Therefore, these authors should NOT include the name or institution on the cover page of the initial submission, and should make an effort to ensure that there is no revealing information in the text such as obvious citations to authors' previous work, or making acknowledgments to colleagues of long standing. Authors should also review their submitted manuscript on the web until the final notification date to reiterate the choice of complete anonymity is optional. Authors may reveal their names and affiliations in the final round of the review cycle if they choose not to anonymize their work.

Note that submission of an abstract for each paper is **mandatory** by Wednesday, **March 21, 2012** and full papers are due **Saturday, March 31, 2012**. Late submissions, or submissions without a previously submitted abstract will not be accepted. All submissions must be original works that have not been published previously in any archived conference proceedings, magazines, or journals. All past and present work by the authors must be cited (appropriately if deemed appropriate), and the differences to work described in the submitted manuscript must be clearly explained. Concurrent submissions are entirely prohibited. If it is determined that an identical or substantially similar manuscript is simultaneously under consideration at another publication venue or forum (e.g., conference, journal, edited book) the manuscript will be rejected.

A paper is considered published if it has appeared in a peer-reviewed archival journal or in published meeting proceedings that are commercially available (physical or non-physical) in the form of archives (including digital). However, work described in the Interactive Papers, Contact Entries, or Late-Breaking Not Topics venues from previous VisWeek conferences is not considered formally published, and may be resubmitted provided it has substantial additional new material.

### 3. SUPPLEMENTAL MATERIAL AND FORMATTING GUIDELINES

Papers can be up to a maximum of ten (10) pages in length, with the caveat that an optional tenth page can hold contact information. Note that we have increased the upper limit for page length only to accommodate those papers whose contribution does not fit the standard 8 page format. When writing your paper keep in mind that overly long papers will add additional burden to the reviewers and that they have been explicitly instructed to make sure paper length is commensurate with its stated contribution. You may be asked to compress your paper in a second round if it is not.

Papers can include full-color figures throughout. We encourage the use of digital color to enhance the submission (which could be embedded directly into the pdf version of the paper, including at the end of the work submission). Submission of code or other supplemental material in order to increase the reproducibility of the work is also encouraged. Those submitting to the conference are urged to make available salient parameter settings of pertinent algorithms and ideally obtain results using open source data. In case specific data sets are employed, we ask that a version of these be made available where possible. We also encourage the placement of a lesser stage in the very first page to introduce your work.

Please take note that this year's review process will be optionally double-blind for those who want to submit their work anonymously (double-blind means that we use, other than the IPC members who know the identity of the authors). When submitting for double-blind reviewing you are asked NOT to include any identifying information. If you do not want to anonymize your submission you are free to leave your name and affiliation on the first page. In that case the review process will be single-blind, i.e. the reviewers know the identity of the authors, but the authors do not know the identity of the reviewers.

Details and guidelines for preparing a proper submission depend on your targeted conference:

- for Vis and InfoVis research papers: <http://www.cs.stu.edu/~vis/>
- for VAST research papers: <http://www.cs.stu.edu/~vis/Track/VisWeek.htm>

### 4. GENERAL EXPECTATIONS AND ETHICS GUIDELINES

At least one author of an accepted paper must attend the conference to present the work, and authors will also be required to present a very brief summary of their talk at the opening papers preview session.

We expect that submissions will clearly discuss the novel and significant contributions and place them in the context of prior art in the field. This will involve highlighting how the current contributions differ from and advance the

state-of-the-art in visualization, especially, but not limited to previous work published in the IEEE Transactions on Visualization and Computer Graphics (TVCG) and other leading journals and conferences including IEEE InfoVis, IEEE SciVis, IEEE VAST, ACM SIGGRAPH, CHI, UIST, EuroVis, and PacificVis.

When submitting your paper you will be asked to provide a complete list of authors even when submitting an anonymized version of the manuscript. This is required to avoid potential conflicts of interest when assigning reviewers. Adding additional authors AFTER the acceptance of a paper is unacceptable and will not be permitted.

Submissions will be treated as confidential communications during the review process, so submission does not constitute public disclosure of any ideas therein. Submissions should contain no information or materials that will be proprietary or confidential at the time of publication (at the conference), and should not be published that are proprietary or confidential at the time of publication.

Our conference will adhere to the VSTC ethics guidelines for reviewers, which can be found at <http://vstc.org/papers/vstc/conferences/ethics-guidelines/>.

### 5. PAPER TYPES

VisWeek paper typically falls into one of five categories: technique, system, domain, evaluation, or model. We briefly discuss these categories below. Although a given paper type has to be specified during the paper submission process, papers can include elements of more than one of these categories. Please see "Process and Details" in *Inviting Information Visualization Research Papers* by Tamara Munzner for more detailed discussion on how to write a successful VisWeek paper.

**Technique papers** introduce novel techniques or algorithms that have not previously appeared in the literature, or that significantly extend known techniques or algorithms, for example by scaling to results of much larger size than before or by generalizing a technique to a larger class of cases. The technique or algorithm description provided in the paper should be complete enough that a competent graduate student in visualization could implement the work, and the authors should create a prototype implementation of the methods. Relevant previous work must be referenced, and the advantage of the new methods over it should be clearly demonstrated. There should be a discussion of the tasks and datasets for which this new method is appropriate, and its limitations. Evaluation through informal or formal user studies, or other methods, will often serve to accept the paper, but are not mandatory.

**System papers** present a series of algorithms, technical requirements, user requirements, and design that solves a major problem. The system that is described is both novel and important, and has been implemented. The rationale for significant design decisions is provided, and the system is compared to documented, best-of-breed systems already in use. The comparison includes specific discussion of how the described system differs from and is, in some significant respects, superior to these systems. For example, the described system may offer substantial advancements in the performance or usability of visualization systems, or novel capabilities. Every effort should be made to eliminate external factors (such as advances in processor performance,

memory sizes or operating system features) that would affect this comparison. For further suggestions, please review "How (and How Not) to Write a Good Systems Paper" by Roy Levin and David Keiser, and "Empirical Methods in GIS and AI" by Toby Martin.

**Application / Design Study papers** explore the choices made when applying visualization and visual analytics techniques in an application area, for example relating the visual encodings and interaction techniques to the requirements of the target task. Similarly, Application papers have been the norm when researchers describe the use of visualization techniques to glean insights from problems in engineering and science. Although a significant amount of application domain background information can be useful to provide a framing context in which to discuss the specifics of the target task, the primary focus of the case study must be the visualization content. The results of the Application / Design Study, including insights generated in the application domain, should be clearly conveyed. Describing new techniques and algorithms developed to solve the target problem will strengthen a design study paper, but the requirements for novelty are less stringent than in a technique paper. Where necessary, the identification of the underlying parametric space and its efficient search must be fully described. The work will be judged by the design teams learned or insights gained, on which future contributors can build. We invite submissions on any application area.

**Evaluation papers** explore the usage of visualization and visual analytics by human users, and typically present an empirical study of visualization techniques or systems. Authors are not necessarily expected to implement the systems used in these studies themselves; the research contribution will be judged on the validity and importance of the experimental results as opposed to the novelty of the systems or technique under study. The conference committee appreciates the difficulty and importance of designing and performing rigorous experiments, including the definition of appropriate hypotheses, tasks, data sets, selection of subjects, measurement, validation and conclusions. The goal of such efforts should be to move from mere description of experiments, toward prediction and explanation. We do suspect that potential authors who have not had formal training in the design of experiments involving human subjects may wish to partner with a colleague from an area such as psychology or human-computer interaction who has experience with designing rigorous experimental protocols and statistical analysis of the resulting data. Other novel forms of evaluation are also encouraged.

**Theory/Model papers** present new interpretations of the foundational theory of visualization and visual analytics. Implementations are usually not relevant for papers in this category. Theory should focus on basic advancement in our understanding of how visualization techniques complement and exploit properties of human vision and cognition.

**SUPPLEMENTAL MATERIAL AND FORMATTING GUIDELINES**  
... Submission of code or other supplemental material in order to increase the reproducibility of the work is also encouraged. Those submitting to the conference are urged to make available salient parameter settings of pertinent algorithms and ideally obtain results using open source data. In case specific data sets are employed, we ask that a version of these be made available where possible.

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# Will happen at the decade time-scale

NSF and NIH have long encouraged sharing

2011: NSF Data Management Plan

1980 Bayh-Dole → Tech-Transfer Offices

Grasped open source licensing within last decade

Journal of the American Statistical Association (JASA)

(from Victoria Stodden <http://www.stanford.edu/~vcs/talks/RRJuly152011-STODDEN.pdf>)

articles using computation: 1996 <50% → 2011 100%

articles w/ code available: 1996 0% → 2011 21%

“Visualization + Info Vis” → “Visualization + Info Vis + VAST”  
→ “SciVis + InfoVis + VAST + Lдав + BioVis @ VisWeek → VIS”

World is changing, and moving towards reproducibility.

We are changing. Let's move towards reproducibility.

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# Lets help each other!

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“Evaluation” is expensive

Authors: comparing with results from previous methods

Reviewers: determining if new results are in fact what is claimed

**Both easier with reproducibility**

**Community practices drive this**

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## Lets walk our talk **together**

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Thank you

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