The Research Software Engineering Revolution

Gabriele Bozzola, PhD


TIMEO

Combien il est en sus de terre


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IN
VERBA

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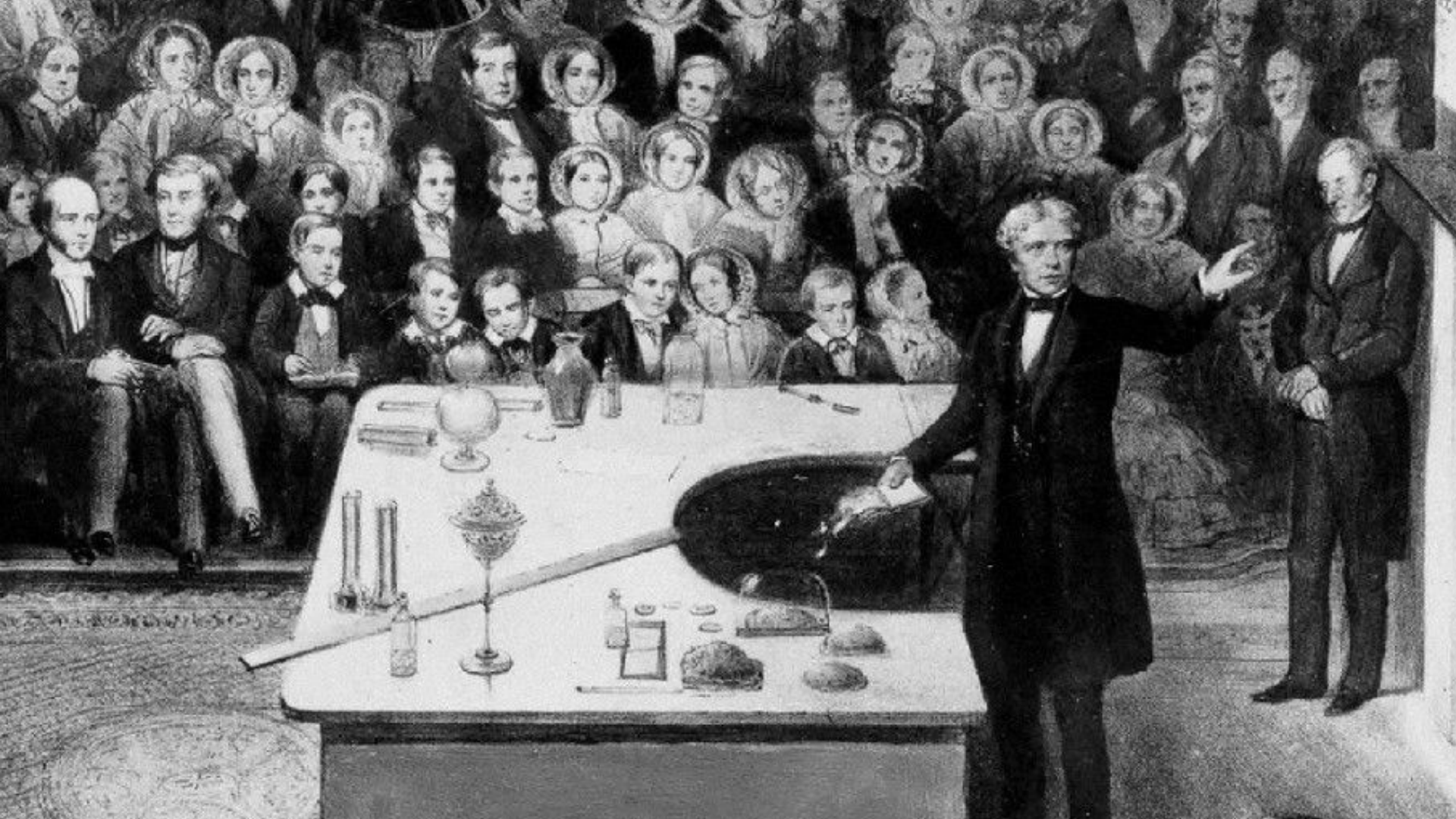

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ELSEVIER

SCIENCE = PAPERS

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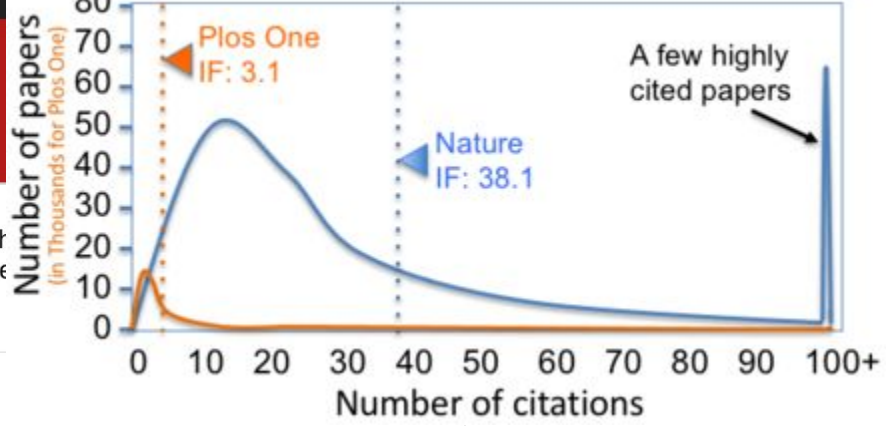

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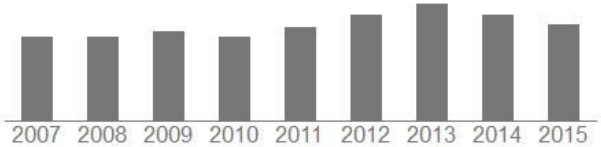
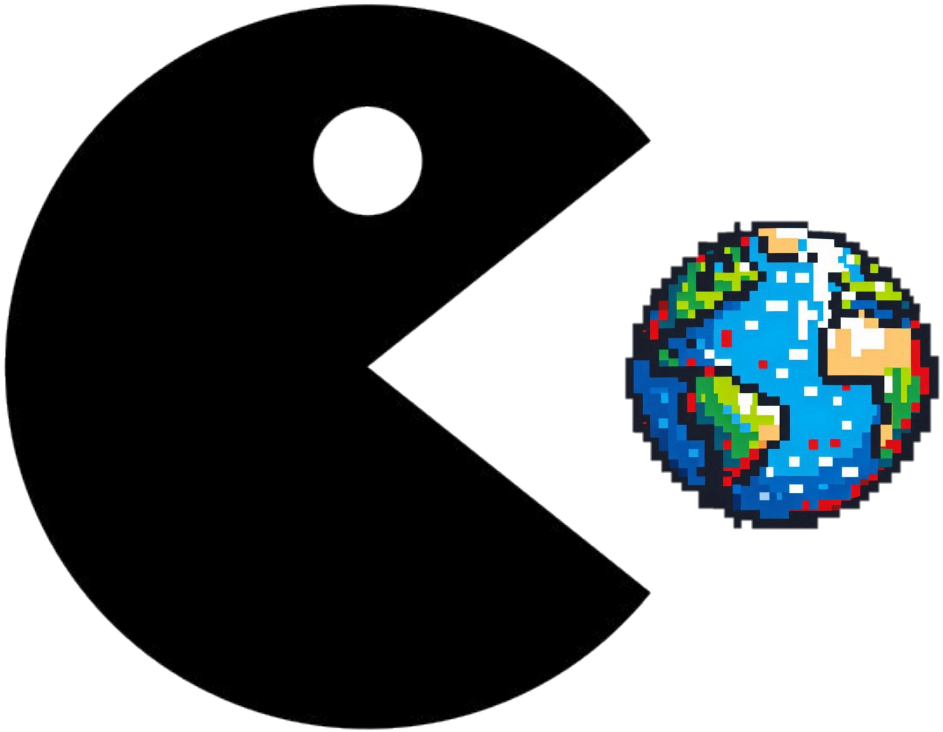


SCIENCE = PAPERS

THIS IS A PROBLEM!

TOPIC FOR ANOTHER TALK…

SOFTWARE IS EATING THE WORLD



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Of 2,000 scientists Jo Hannay and colleagues surveyed online,[2] 91 percent said using scientific software is important for their own research, 84 percent said developing scientific software is important for their own research, 53.5 percent claimed to spend more time developing scientific software than they did 10 years ago, and 38 percent spend at least one fifth of their time developing software. Scientists aren't just using software; they are its prime producers.

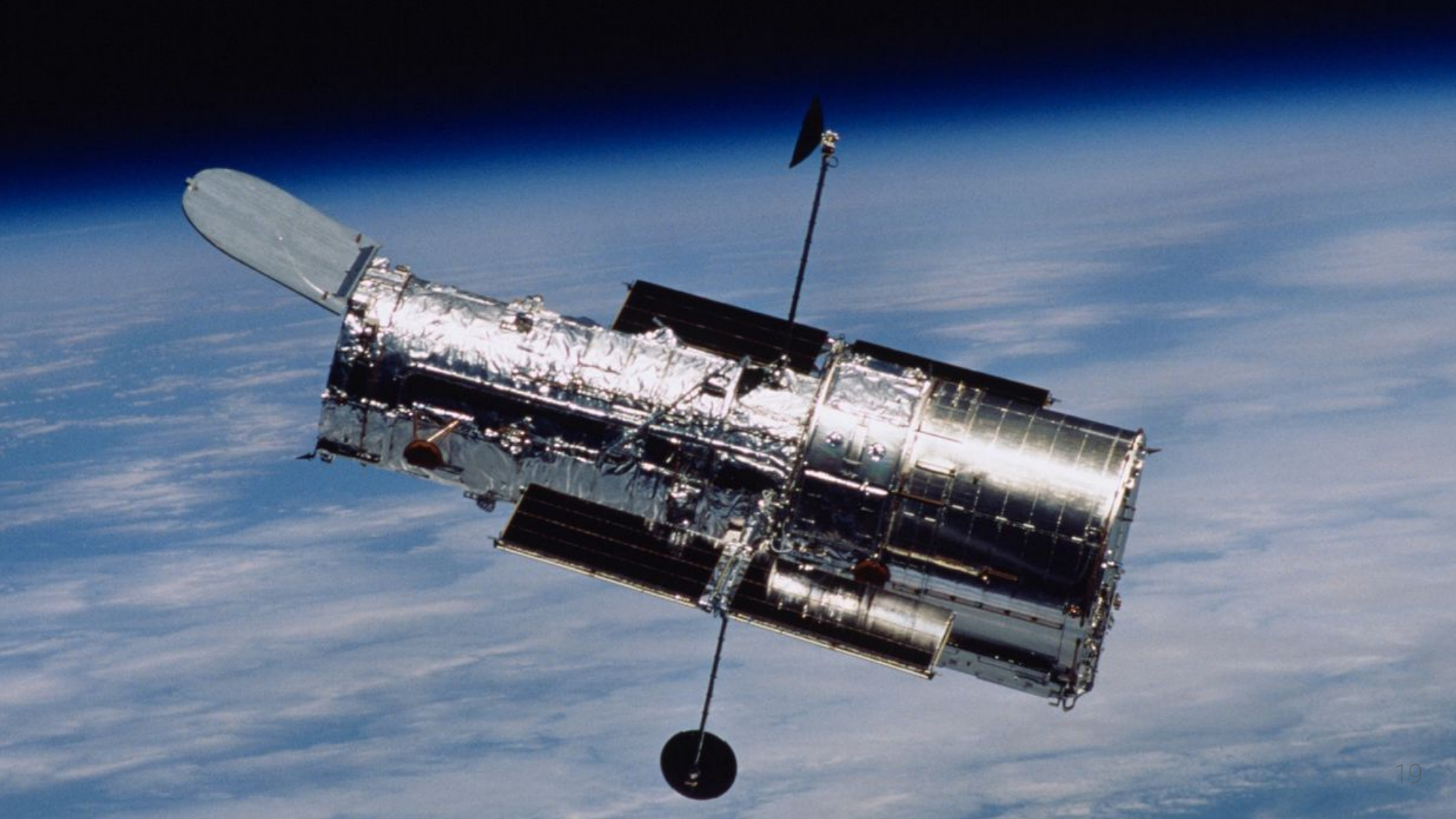
Research software is critical to supporting science. Between 1998-2016, the NSF made more than 18k awards totaling $9.6 billion related to research software.

MODERN SCIENCE RUNS ON SOFTWARE

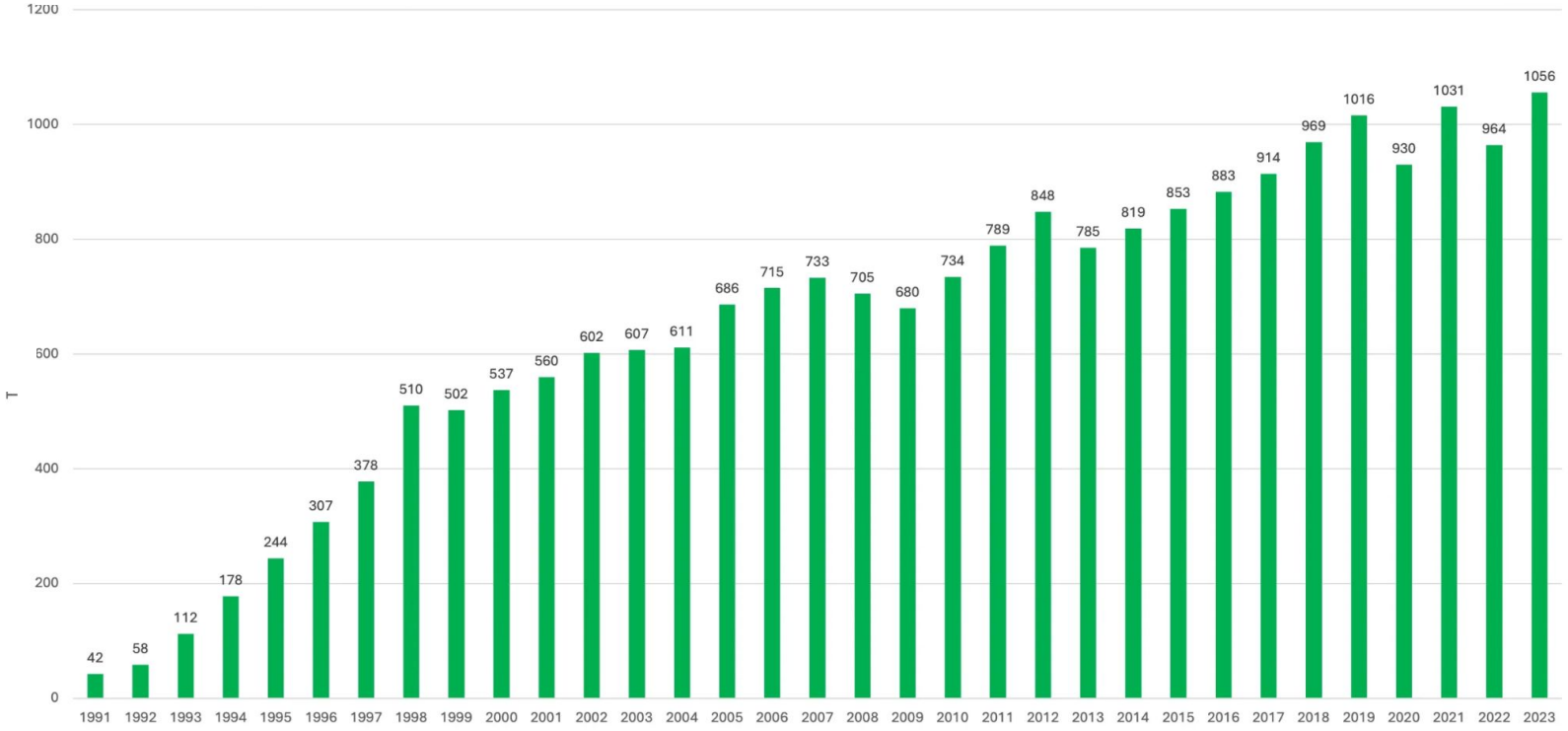
Research software plays such a critical role in day to day research that a comprehensive survey reports 90–95% of researchers in the US and the UK rely upon it and more than 60% were unable to continue working if such software stopped functioning (Hettrick, 2014).

38%

of total spend invested into software-reliant research in 2017

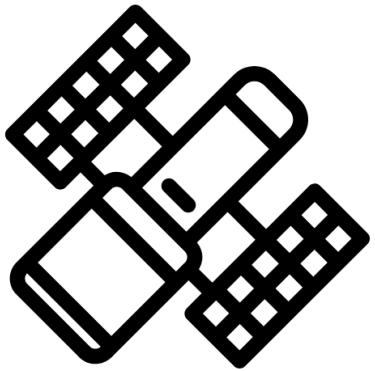


Hubble Space Telescope Peer-Reviewed Scientific Papers Published



Data from NASA

21,000 papers in 30+ years



≈

22,000 citations in 4 years

NumPy

Image credits for HST icon: Fourup Corporate

10,000 citations in 10 years

≈

AstroPy

9,000 citations in 28 years

≈

SExtractor

12,000 citations in 12 years

emcee

≈

6,000 citations in 17 years

GADGET-2

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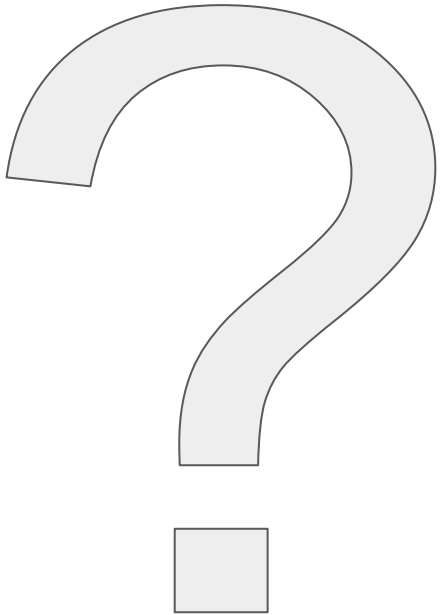
UNRECOGNIZED CONTRIBUTIONS

SOFTWARE THAT WAS NOT BUILT



Do not spend too much time on software!

Software-oriented people leave academia

Impactful software is not built/maintained

Quality of research software is lowered

Frequency of using *best* practices As a follow-up question, we asked the respondents how frequently they used a number of standard software engineering practices. The response options were *Never*, *Sometimes*, *Half of the time*, *Most of the time*, *Always*. The following list reports those who responded *Most of the time* or *Always* for the most commonly used practices (in decreasing order):

- Continuous Integration – 54% (54/100)
- Use of coding standards – 54% (54/100)
- Architecture or Design – 51% (52/101)
- Requirements – 43% (43/101)
- Peer code review – 34% (34/99)

RQ7. *How reproducible are notebooks?*
Answer: We were able to successfully run 24.11% of the unambiguous execution order Python notebooks. This number is close to the results of a previous reproducibility study [32] about general computer systems research (24.9%). However, the rate is way smaller (4.03%) when we count only notebooks that produce the same results. The most common causes of failures were related to missing dependencies, the presence of hidden states and out-of-order executions, and data accessibility.

THE STATE OF RESEARCH SOFTWARE IS NOT GREAT

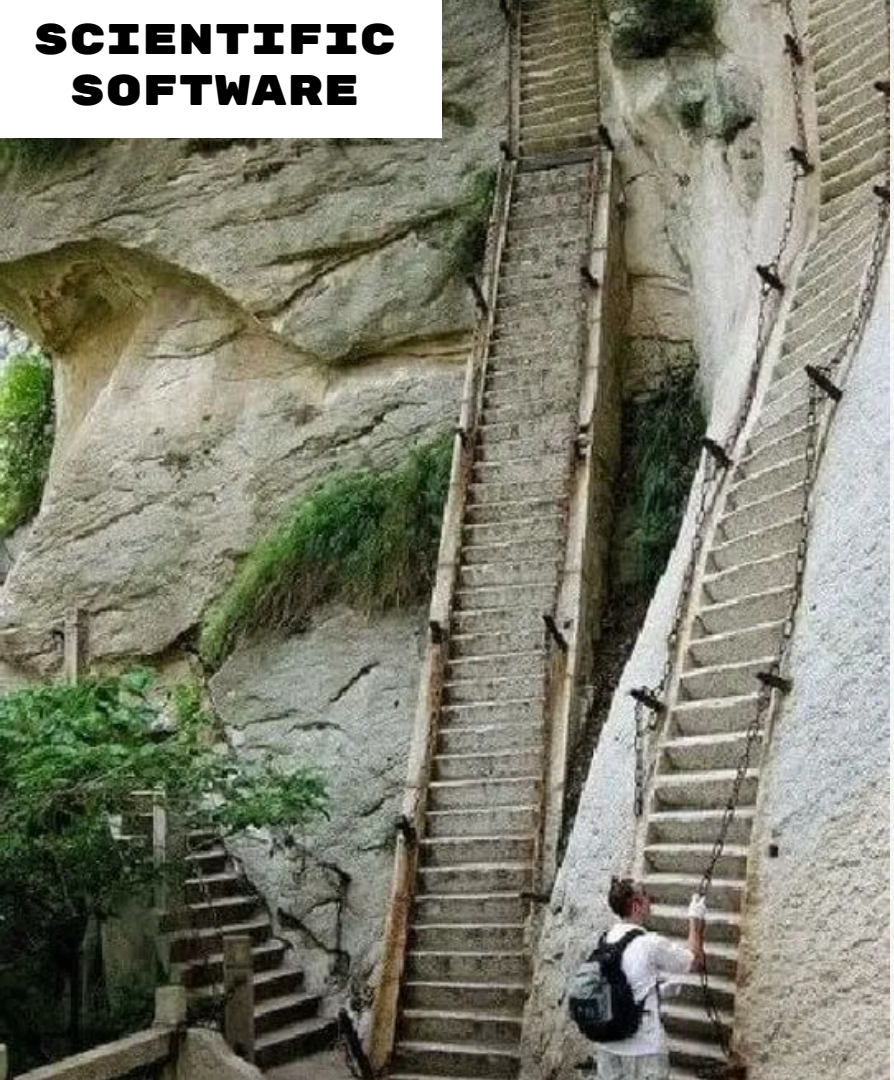
We find that 74% of R files failed to complete without error in the initial execution, while 56% failed when code cleaning was applied, showing that many errors can be prevented with good coding practices.

Wikipedia
https://en.wikipedia.org › wiki › Replication_crisis

Replication crisis

The **replication crisis** is an ongoing methodological crisis in which the results of many scientific studies are difficult or impossible to reproduce.

SCIENTIFIC SOFTWARE



THE ENTIRE ACADEMIC SYSTEM

UNREWARDED SOFTWARE CONTRIBUTIONS

Better incentives

Better software

Better research

2010:
WIND OF CHANGE

SOFTWARE SUSTAINABILITY INSTITUTE

SSI was "***founded on the premise that helping individuals and institutions understand the vital role that software plays in research would accelerate progress in every field of scientific and academic endeavour***"

2012, Oxford, collaboration meeting:

Why is there no career for software developers in academia?

Research Software Engineers

Analyst Developer Analyst Programmer Analyst Programmer - SITS (x 3) Analyst/Programmer Applications Developer Applied Scientist Architectural Robotics Developer Assistant Data Programmer Assistant Project Manager Atmospheric Correction and Radiative Transfer Model Scientist Audio Software Developer - KTP Associate Bioinformatician Bioinformatician In Potato Genomics and Genetics Bioinformatician/Computational Bioscientist in Microbiology Bioinformaticians Bioinformatics Analyst Bioinformatics Postdoctoral Researcher Bioinformatics scientist Biometric Software Systems Developer Biorespository Software Developer C++ / 3D Graphics Software Engineer Casebooks Project Editor (Research Assistant/Associate) Climate Researcher (Research Associate) Clinical Study Programmer CoMPLEX Research Associate Computational Biologist / Bioinformatician Computational Scientist Computational Scientist in Computational Fluid Dynamics & Industrial Applications Computational Scientist in Structural Mechanics and Industrial Applications Computer Scientist Computer Vision Researcher Content Developer/Programmer Control Engineer-IMG - 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Statistical and Computational Genetics of Autism Principal / Senior Bioinformatician Principal Bioinformatician Product Development Engineer (Rail) Publishing Portal Web Developer Radio Frequency Engineer Reader in Computer Science Reporting Analyst Research (Software) Engineer Research Assistant Research Associate Research Fellow Research Image Data Manager, Biomedical Engineering Research Officer Research Officer â€" Social Protection Research postgraduate Research Programmer Research Scientist Research Scientist / Senior Research Scientist Research Scientist in Machine Learning and Computer Vision Research Software Developer Research Software Developer for the Herchel Smith Professor of Organic Chemistry Research Software Engineer Research Studentship Research Worker Researcher SAP Trainee Technical Analyst Scientific Officer with Michela Garofalo Scientist SEAHA Studentship: Extracting epidemiological data from collections SEEG Data Archive Manager Senior / Research Associate in Clinical Integration and Image Analysis for Fetal Surgery Senior Analyst Programmer (Business Analysis) Senior Analyst/Programmer Senior Bioinformatician Senior Bioinformatician / Bioinformatician Senior Computational Statistician - 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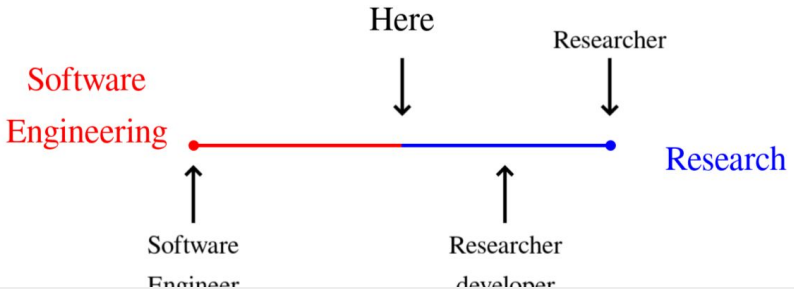
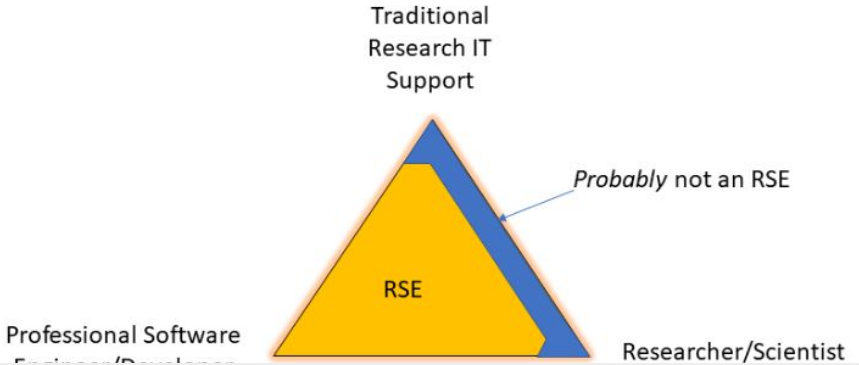
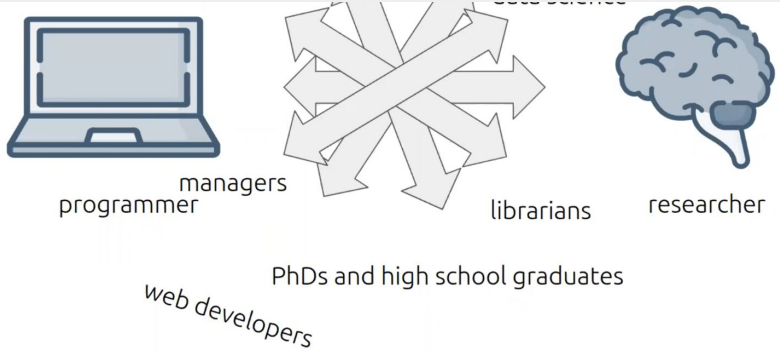




RSE = Those who regularly use expertise in programming to advance research



According to Simon Hattrick, Ian Cosden, and Vanessa Sochat respectively

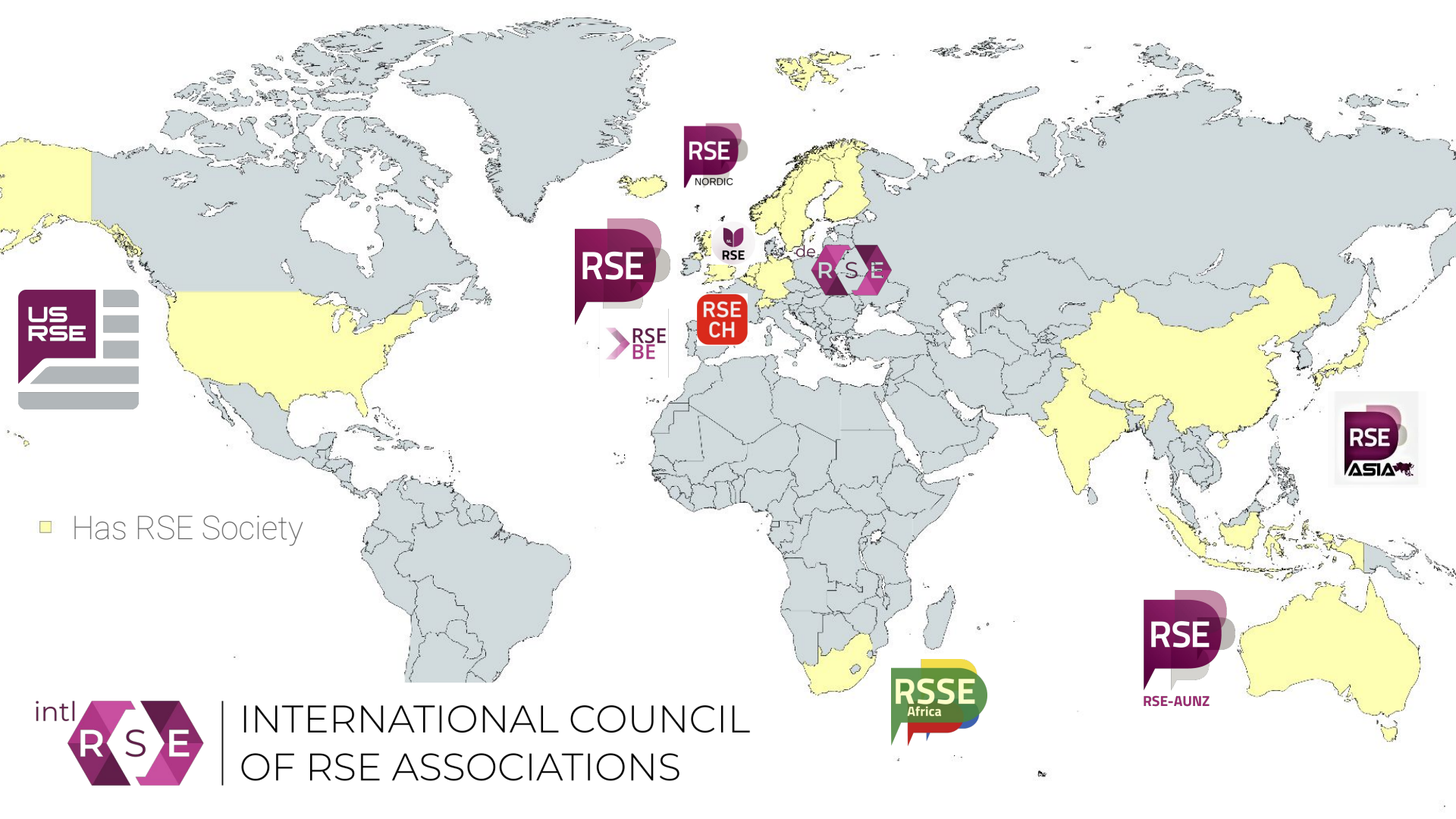
SOFTWARE SUSTAINABILITY INSTITUTE

RSE

US RSE

2010 2012 2014 2016 2018 2021

intl RSE



- Has RSE Society

intl RSE | INTERNATIONAL COUNCIL OF RSE ASSOCIATIONS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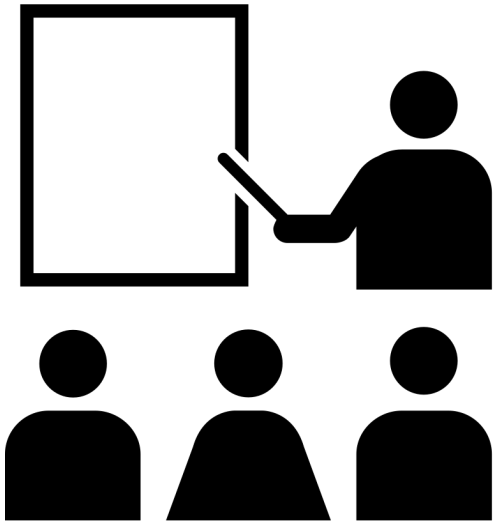
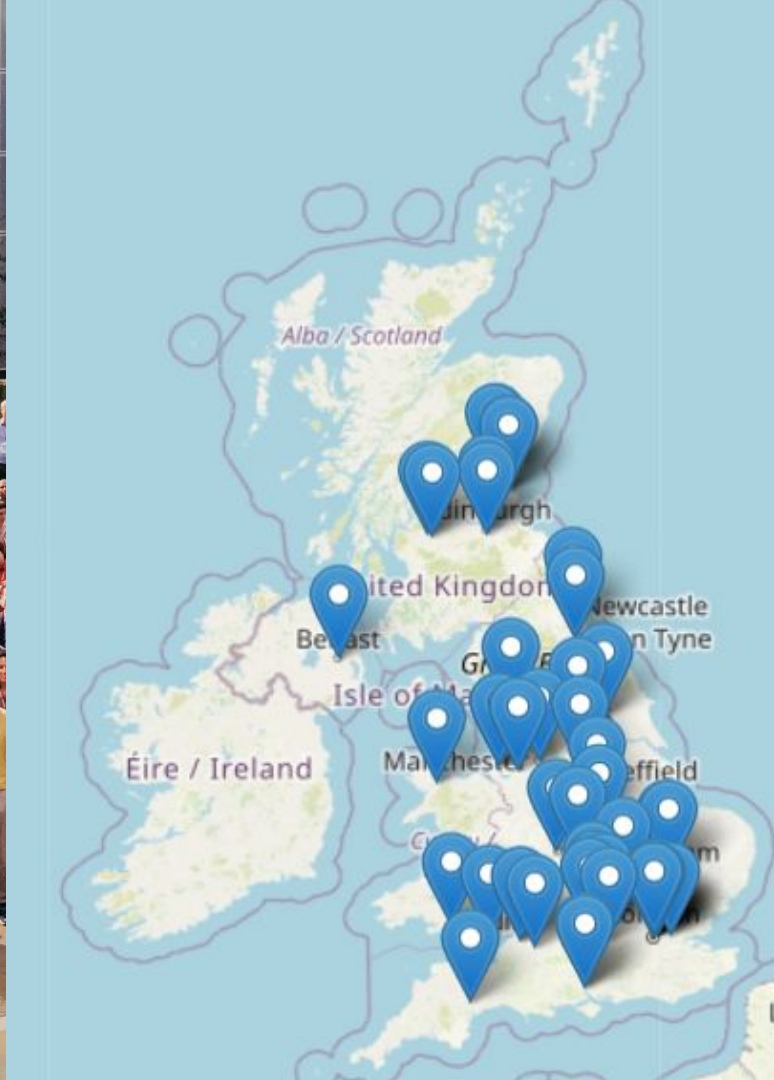
www.software.ac.uk



The Society of Research Software Engineering was founded on the belief that a world which relies on software must recognise the people who develop it.

Our mission is to establish a research environment that recognises the vital role of software in research.

We work to increase software skills across everyone in research, to promote collaboration between researchers and software experts, and to support the creation of an academic career path for Research Software Engineers.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Search universities...

University	RSE Group	Link
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sbozzolo.github.io/has_rse

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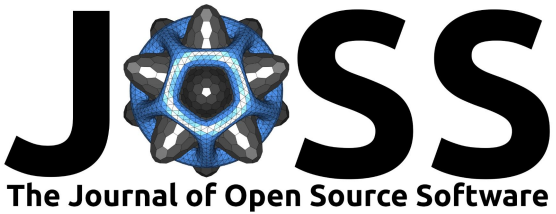
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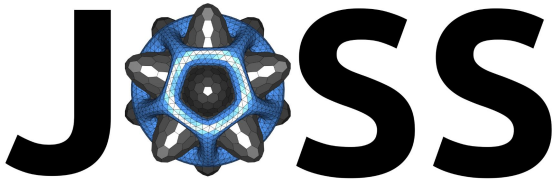

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Submitting author: @Sbozzolo (Gabriele Bozzola)
Repository: https://github.com/Sbozzolo/kuibit/
Version: 1.0.0
Editor: @eloisabentivegna
Reviewer: @Yurlungur, @eloisabentivegna
Archive: 10.5281/zenodo.4681119

Assignees

Yurlungur

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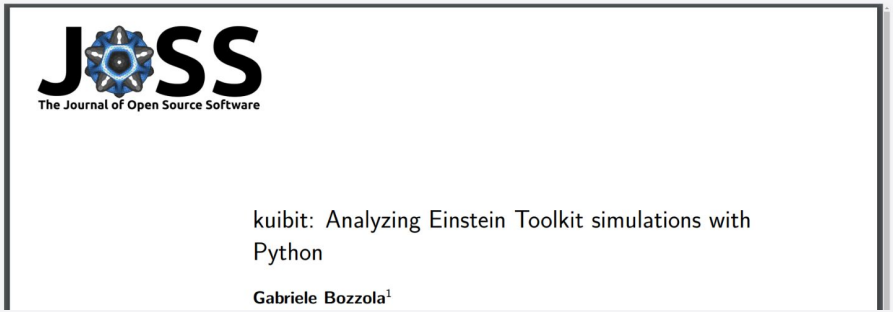
Labels

Python accepted published recommend-accept review

kuibit: Analyzing Einstein Toolkit simulations with Python

Submitted 30 January 2021 • Published 13 April 2021



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Python Package Peer Review

Community Partnerships

Simplifying Packaging

pyOpenSci

ROpenSci

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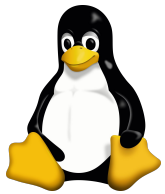
RSE

Openness
Collaboration
Reproduciability
Accessibility



RSE Opportunities

Current RSE Openings

1. Staff or Senior Research Engineer or Scientist: University of Illinois Urbana-Champaign, Urbana, IL *Posted: Sep 26, 2024*
2. Research Software Engineer II (RSEII), HPC & AI Software Engineer: Dartmouth College ITC, Hanover, NH (Hybrid) *Posted: Sep 25, 2024*
3. Research Software Developer: National Center for Ecological Analysis & Synthesis, UC Santa Barbara, Santa Barbara, CA *Posted: Sep 23, 2024*
4. Quantum Architect, Simulation & Software: PsiQuantum, Palo Alto, CA or remote *Posted: Sep 21, 2024*
5. Engineering Scientist: Texas Advanced Computing Center, Austin, Texas *Posted: Sep 20, 2024*
6. Research Software Engineer II: Center for Digital Humanities at Princeton University, Princeton, NJ *Posted: Sep 18, 2024*
7. Computer Systems Engineer: Lawrence Berkeley National Laboratory, Berkeley, CA *Posted: Sep 11, 2024*
8. Senior Full-Stack Geospatial Developer: Eagle Rock Analytics, Sacramento, CA / Remote *Posted: Sep 10, 2024*
9. Research Scientist II/Senior: Georgia Institute of Technology, Remote Eligible *Posted: Sep 10, 2024*

Join us in our mission to push for research world where

- Code is treated as a first-class research output
- Software development is recognized and rewarded
- Research code is FAIR (Findable, Accessible, Interoperable, and Reusable)
- Researchers are equipped with the necessary skills and tools to develop high-quality, sustainable software
- There are meaningful career paths for those who wish to focus on software

How to start helping:

Be the first one to **recognize the value of research software**

gbozzola@caltech.edu
sbozzolo.github.io
linkedin.com/gabrielebozzola

Connect and find your community

Check these out for grants, fellowships, trainings, events, and additional resources

- US RSE (us-rse.org)
- Research Software Alliance (researchsoft.org)
- Software Sustainability Institute (software.ac.uk)
- Better Scientific Software (bssw.io)