UNIVERSITÀ
DEGLI STUDI DI BARI
ALDO MORO

DIPARTIMENTO
DI INFORMATICA

(Re)Use of Research Results … why should we?

Maria Teresa Baldassarre
Department of Informatics – University of Bari
mariateresa.baldassarre@uniba.it

SERLAB
Software Engineering Research
UNIVERSITÀ DEGLI STUDI DI BARI

SER&P
Software Engineering Research & Practices

Software Engineering Research LABoratory

Who am I

mariateresa.baldassarre@uniba.it

@mtbaldassarre

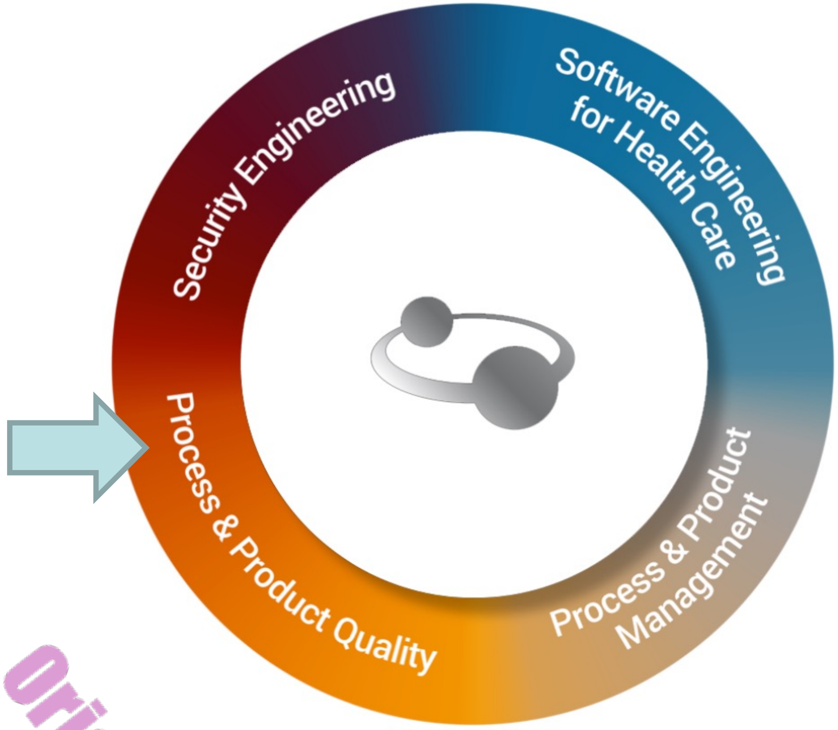
- ⇨ **Associate Professor** at the Department of Informatics - University of Bari (www.di.uniba.it)
- ⇨ **Coordinator of the «Process & Product Quality»** area @Software Engineering Research LAB (serlab.di.uniba.it)
- ⇨ **Quality Manager** @SER&Practices Spin-Off (https://serandp.com/en/)
- ⇨ **Member** of the International Software Engineering Research Netwok (**ISERN**)

CS Department –
Dipartimento di Informatica
BARI - Puglia

Bari is
here

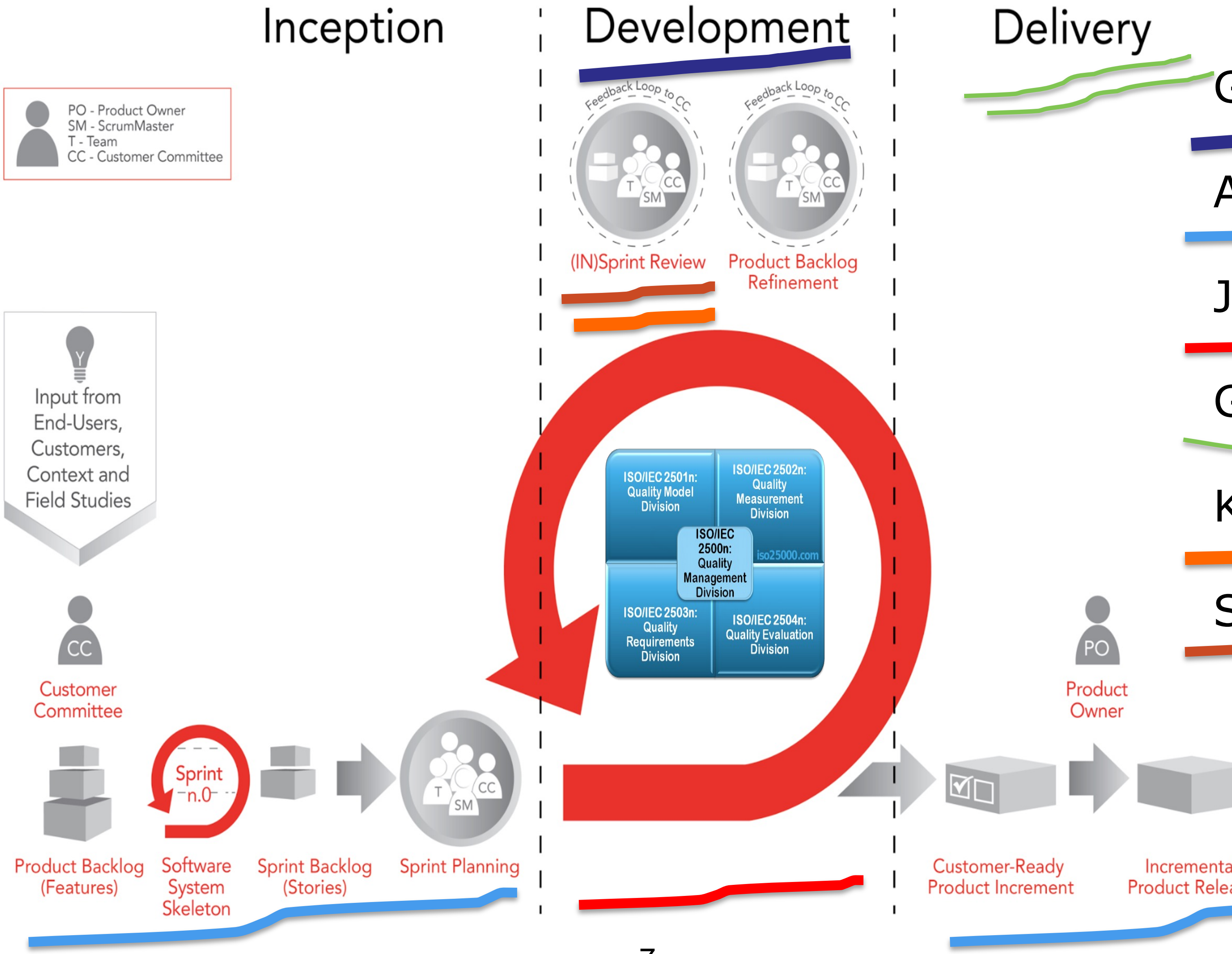
Campus
Universitario
Via Ulpiani
Hotel Campus
Sede Workshop
Via Orabona, 4
Ingresso
principale

SERLAB
Software Engineering Research
UNIVERSITÀ DEGLI STUDI DI BARI


Security Engineering
Software Engineering for Health Care
Process & Product Management
Process & Product Quality

- ⇨ Main research interests:
  - ❑ SOFTWARE PROCESS AND PRODUCT QUALITY
  - ❑ HUMAN FACTORS IN SOFTWARE ENGINEERING
  - ❑ EMPIRICAL SOFTWARE ENGINEERING

Agile User&Quality Oriented Development…


Inception
Development
Delivery
PO - Product Owner
SM - ScrumMaster
T - Team
CC - Customer Committee
Input from End-Users, Customers, Context and Field Studies
CC
Customer Committee
Product Backlog (Features)
Sprint n.0
Software System Skeleton
Sprint Backlog (Stories)
T
SM
CC
Sprint Planning
Feedback Loop to CC
(IN)Sprint Review
Feedback Loop to CC
Product Backlog Refinement
ISO/IEC 2501n: Quality Model Division
ISO/IEC 2502n: Quality Measurement Division
ISO/IEC 2500n: Quality Management Division
iso25000.com
ISO/IEC 2503n: Quality Requirements Division
ISO/IEC 2504n: Quality Evaluation Division
PO
Product Owner
Customer-Ready Product Increment
Incremental Product Release
Feedback Loop to Company
Experience Factory
Organization
Quality Improvement
Project Retrospective

GIT

ASANA

JENKINS

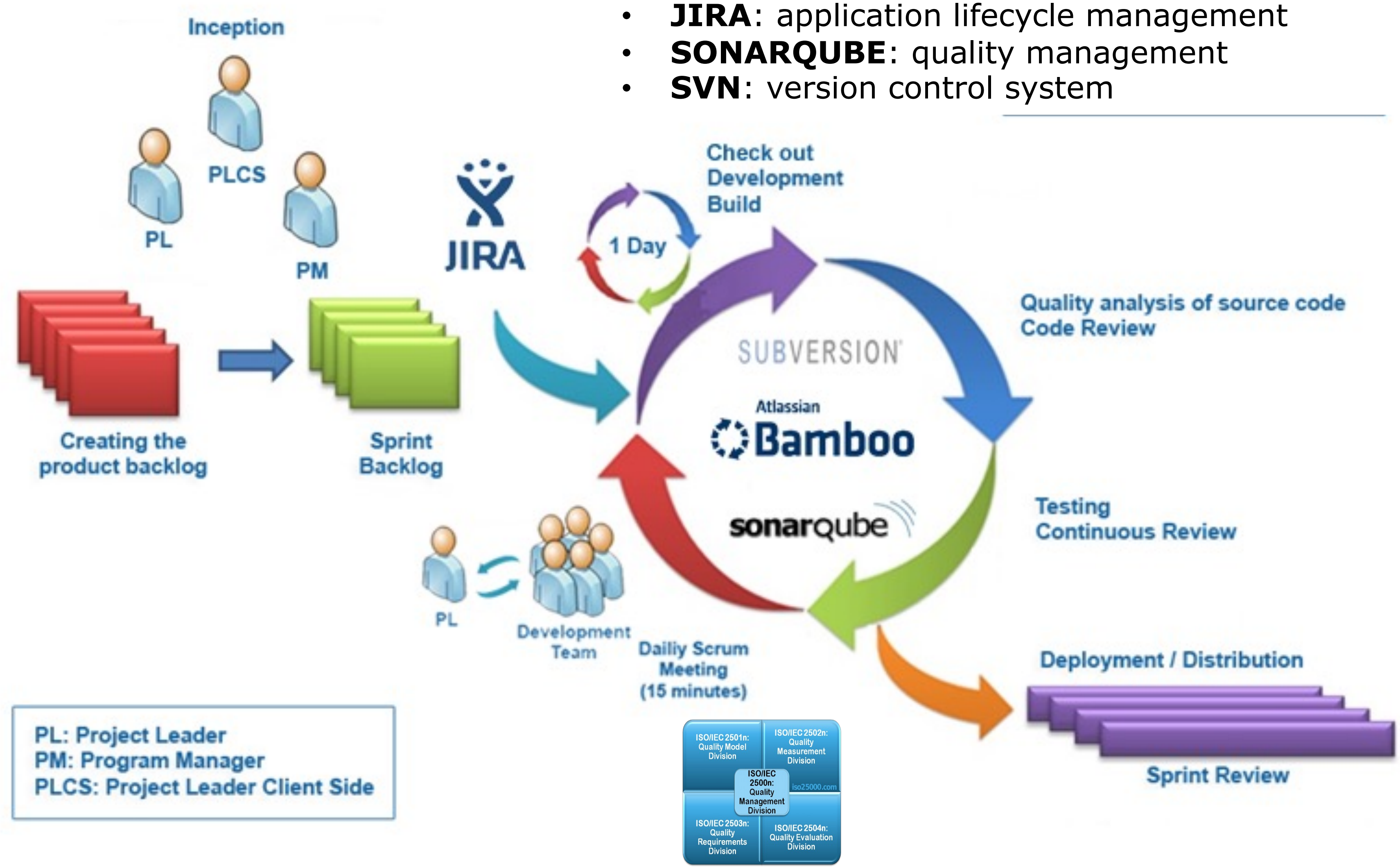
GRADLE

KIUWAN

SONAR CUBE

…Agile User&Quality Oriented Development

- **BAMBOO**: continuous integration/deployment
- **JIRA**: application lifecycle management
- **SONARQUBE**: quality management
- **SVN**: version control system


Inception
PLCS
PL
PM
JIRA
1 Day
Check out
Development
Build
SUBVERSION
Atlassian
Bamboo
sonarqube
Quality analysis of source code
Code Review
Testing
Continuous Review
Creating the product backlog
Sprint Backlog
PL
Development Team
Dailiy Scrum Meeting (15 minutes)
Deployment / Distribution
Sprint Review
ISO/IEC 2501n: Quality Model Division
ISO/IEC 2502n: Quality Measurement Division
ISO/IEC 2500n: Quality Management Division
iso25000.com
ISO/IEC 2503n: Quality Requirements Division
ISO/IEC 2504n: Quality Evaluation Division

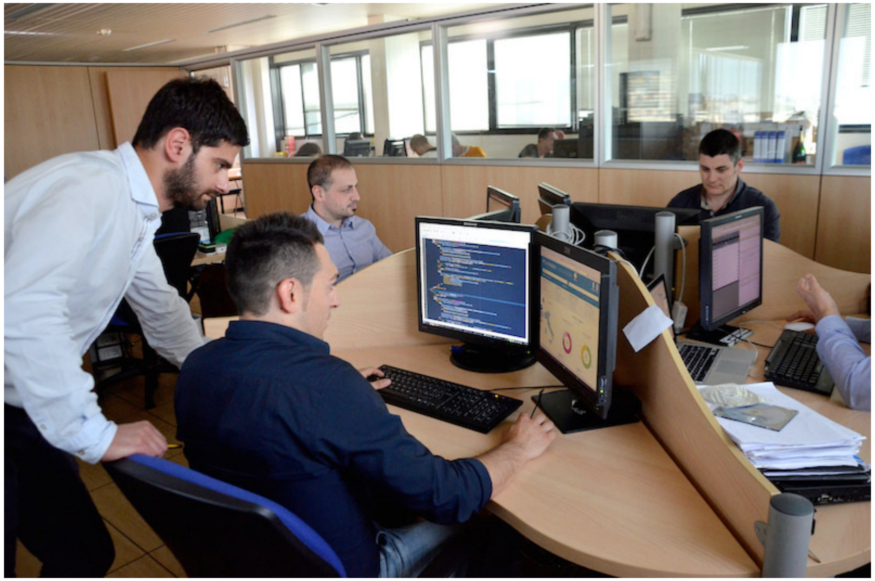
PL: Project Leader
PM: Program Manager
PLCS: Project Leader Client Side

SER&P

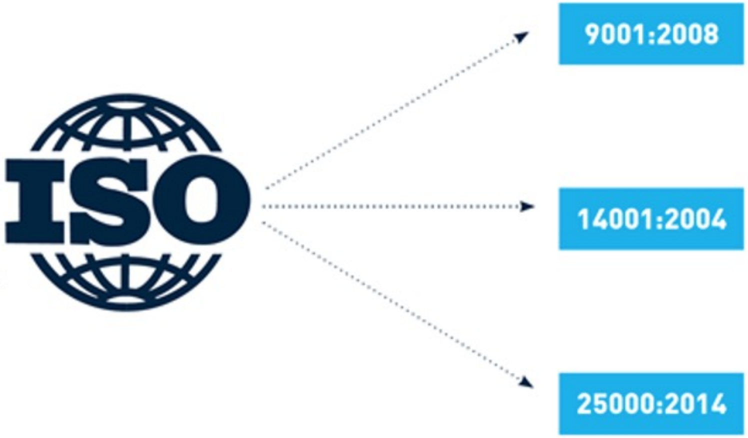
Software Engineering Research & Practices

Spin-off of the University of Bari - established in 2006.

30 employees



- ❑ 9001:2008 - Quality management systems - Requirements
- ❑ 14001: 2004 - Environmental management systems
- ❑ 25000:2014 - Systems and software engineering – **First in Italy to assess certification of a sofware product**



Software Engineering Research LABoratory

SERLAB
Software Engineering Research
UNIVERSITÀ DEGLI STUDI DI BARI

- ❑ SERLab carries out research and empirical validation of results
- ❑ SER&P transfers the results of these activities to industry; provides data and industrial context for field experimentation

SER&P
Software Engineering Research & Practices

SOFTWARE SYSTEM DESIGN & DEVELOPMENT

SOFTWARE PROCESS & PRODUCT QUALITY

SOFTWARE SYSTEM GOVERNANCE & SECURITY

PROJECT MANAGEMENT

RESEARCH COLLABORATIONS

ISERN

Quality Improvement

International Software Engineering Research Network

UCLM Universidad de Castilla-La Mancha

CAMPUS DE EXCELENCIA INTERNACIONAL

Centro de Informática

U · F · P · E

University of Victoria

SERLAB

Software Engineering Research

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NC STATE UNIVERSITY

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INDUSTRIAL COLLABORATIONS

CONFCOOPERATIVE

exprivia

SINCON

openwork
Just solutions

SIDEA
GROUP

CYBERTECH
ENGINEERING GROUP

NTT DaTa
Trusted Global Innovator

Br@inIT
cyber security solutions

[EP|CO]
PLAY

Hevolus | Innovation

LENVIROS
AIR PROBLEM SOLVING

ICAM
INTELLIGENT SPACE SOLUTIONS

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Is it important for a scientist to Report Research Results so others can (Re)Use them?

" … the ideas we can most trust are those that have been the most tried and tested.

For that reason many of us are involved in this process called ‘science’ which produces trusted knowledge by sharing one’s ideas and trying out and testing the ideas of others … "

cit. Popper

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Produce & Report research results

ReUse results/findings …

… to improve reproducibility and transparency

«RESULTS PARADOX»

«RESULTS PARADOX»

«FACTS & TRUTH»

Keep research results at arm’s length

Objective investigator – detective

Follows data with discipline; never indulges in data massaging or cherry picking

«BE PERSUASIVE»

Pressure of publishing clear novel and positive findings on behalf of funding agencies, evaluation committees

Good lawyer

Arguments and produces amounts of beautiful and convincing results

Chambers, C.D., Tzavella, L. The past, present and future of Registered Reports. *Nat Hum Behav* **6**, 29–42 (2022). https://doi.org/10.1038/s41562-021-01193-7

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- Researchers attempt to solve this paradox … questionable research practices … reduce confidence of conclusions … harm reproducibility …

Questionable Research Practices (QPRs) Hurt Science …

HARKing (Hypotheszing After Results are Known)

Neat data, what explains it?

- Acceptable in explanatory not confirmatory

Post-hoc Rationalizing

Story-telling to explain the data found in a study

- Acceptable in explanatory/inductive theory building not confirmatory

John LK, Loewenstein G, Prelec D (2012) Measuring the prevalence of questionable research practices with incentives for truth telling. Psychol Sci 23(5):524–532. https://doi.org/10.1177/0956797611430953

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… Questionable Research Practices Hurt Science

File-drawer effect

- Hmm, bad outcome, bin it. Negative result – reject. Not published. Do not appear in meta-analysis and SLRs

Forking paths in data analysis choices after seeing the data (Researcher Bias)

- Let’s use a Kruskal-Wallis test and then a Lewandoski-Neymar test of significance (instead of?)

QRPs result when publication **venue** and publication **significance/novelty** are emphasized over replication & soundness of the method

Registered Reports

free researchers from the preasure to engage in QRPs

Avoid the RESULTS-ORIENTATION

Deal with RESEARCHER BIAS

Focus on SOUNDNESS OF THE RESEARCH PLAN & SIGNIFICANCE OF THE RESEARCH QUESTION

⇨ Ernst, N.A., Baldassarre, M.T. Registered reports in software engineering. *Empir Software Eng* **28**, 55 (2023). https://doi.org/10.1007/s10664-022-10277-5

Registered Reports … why?

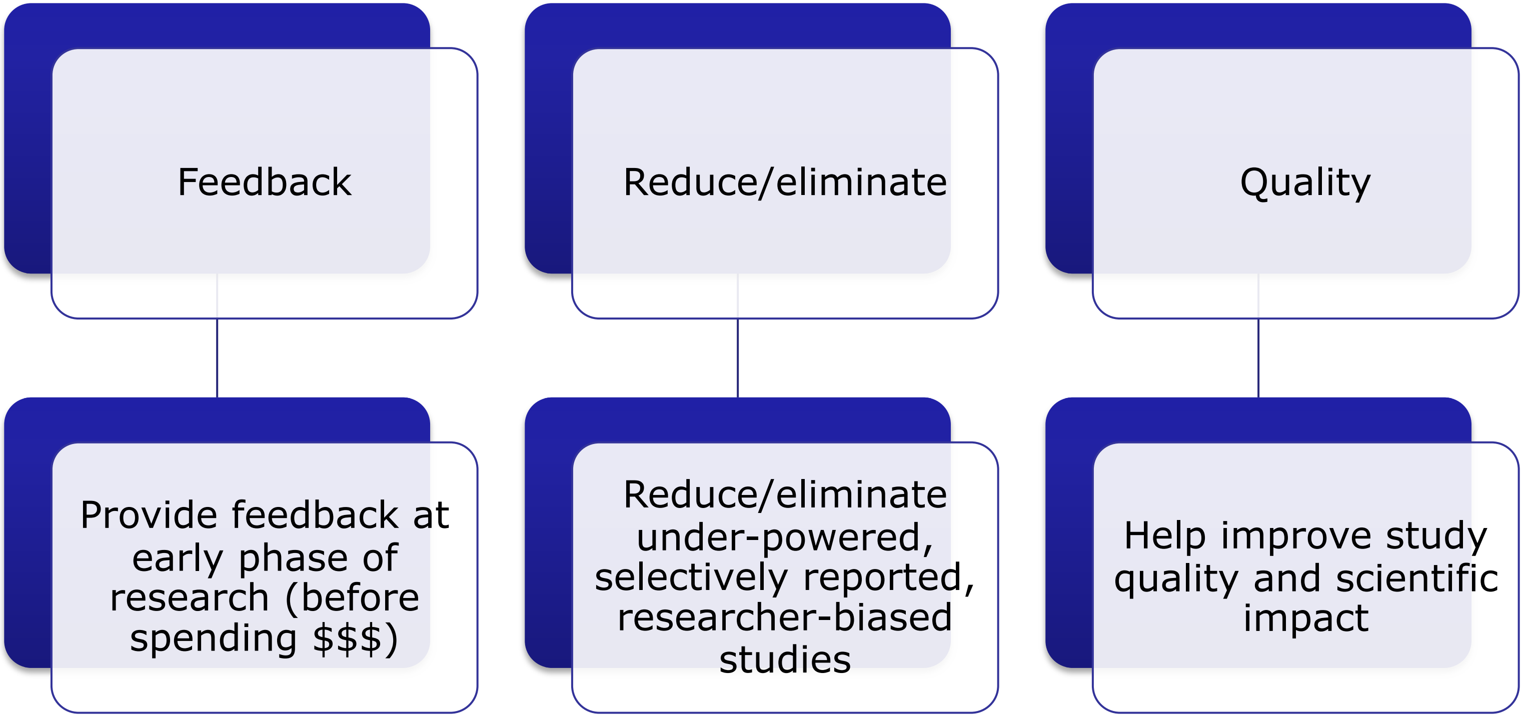
Pre-registration (clinical trials): register your protocol including planned hypothesis, data collection, data analysis that is «registered» BEFORE the study is conducted

Protocol comits to analysis and expected outcomes

Registered Report: Peer-reviewed pre-registration

… Registered Reports … why?

⇨ Benefits



Feedback

Provide feedback at early phase of research (before spending $$$)

Reduce/eliminate

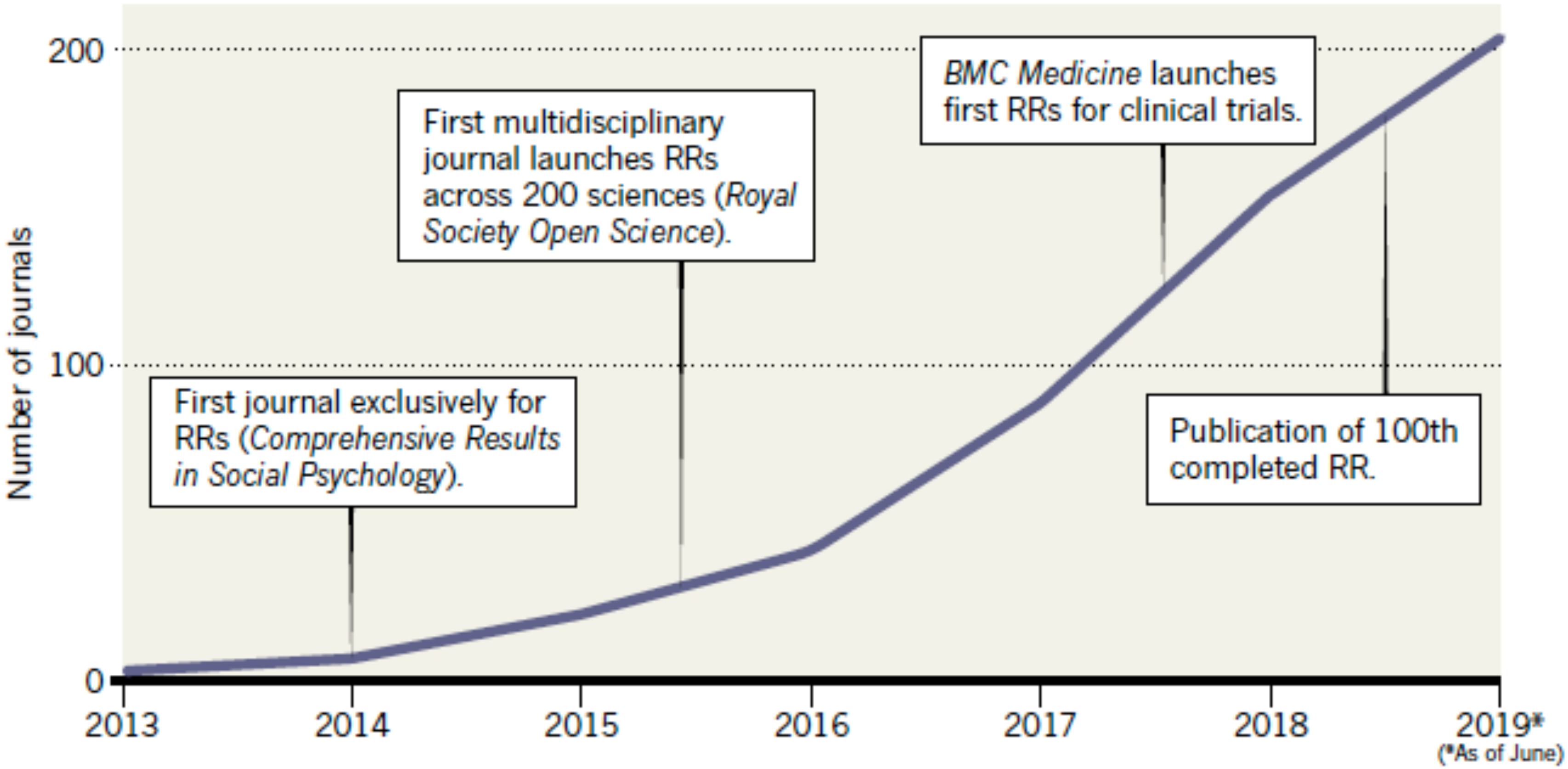
Reduce/eliminate under-powered, selectively reported, researcher-biased studies

Quality

Help improve study quality and scientific impact

RAPID RISE

Since 2013, the number of journals offering Registered Reports (RRs) has risen to more than 200 titles.



First journal exclusively for RRs (*Comprehensive Results in Social Psychology*).

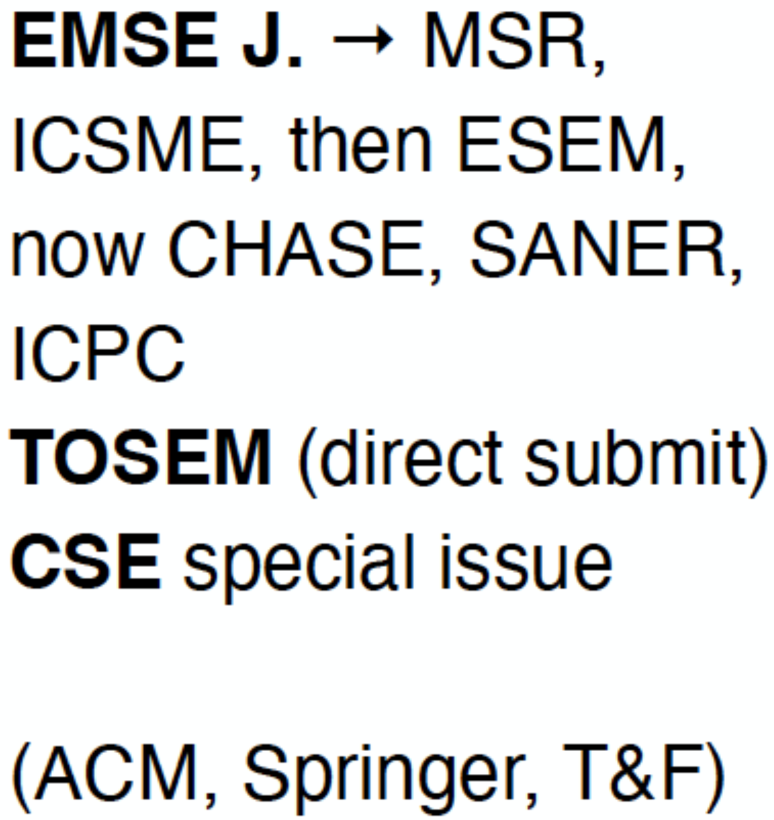
First multidisciplinary journal launches RRs across 200 sciences (*Royal Society Open Science*).

BMC Medicine launches first RRs for clinical trials.

Publication of 100th completed RR.

SOURCE: C. CHAMBERS

RR in SW_Engineering

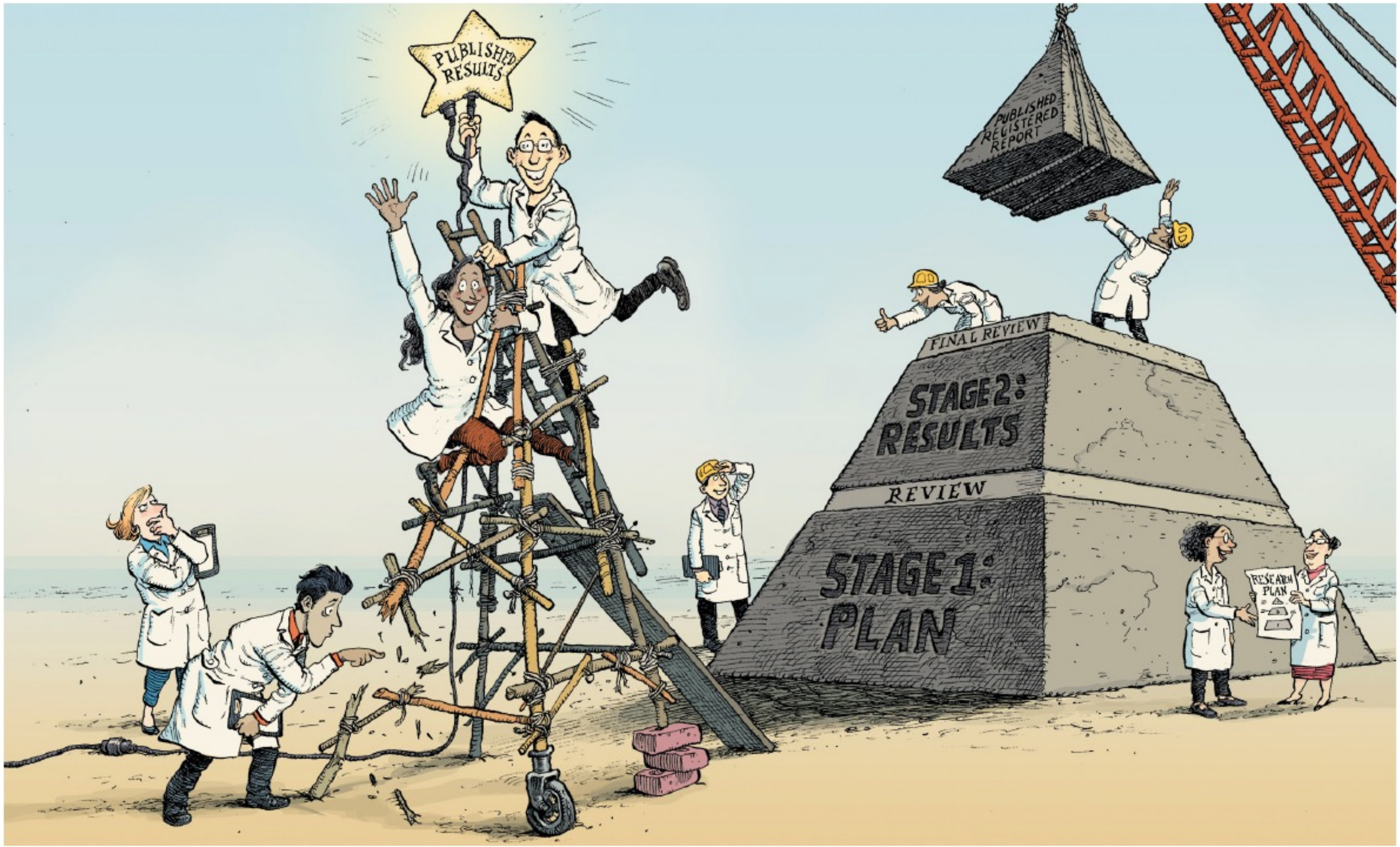


EMSE J. → MSR, ICSME, then ESEM, now CHASE, SANER, ICPC

TOSEM (direct submit)

CSE special issue

(ACM, Springer, T&F)



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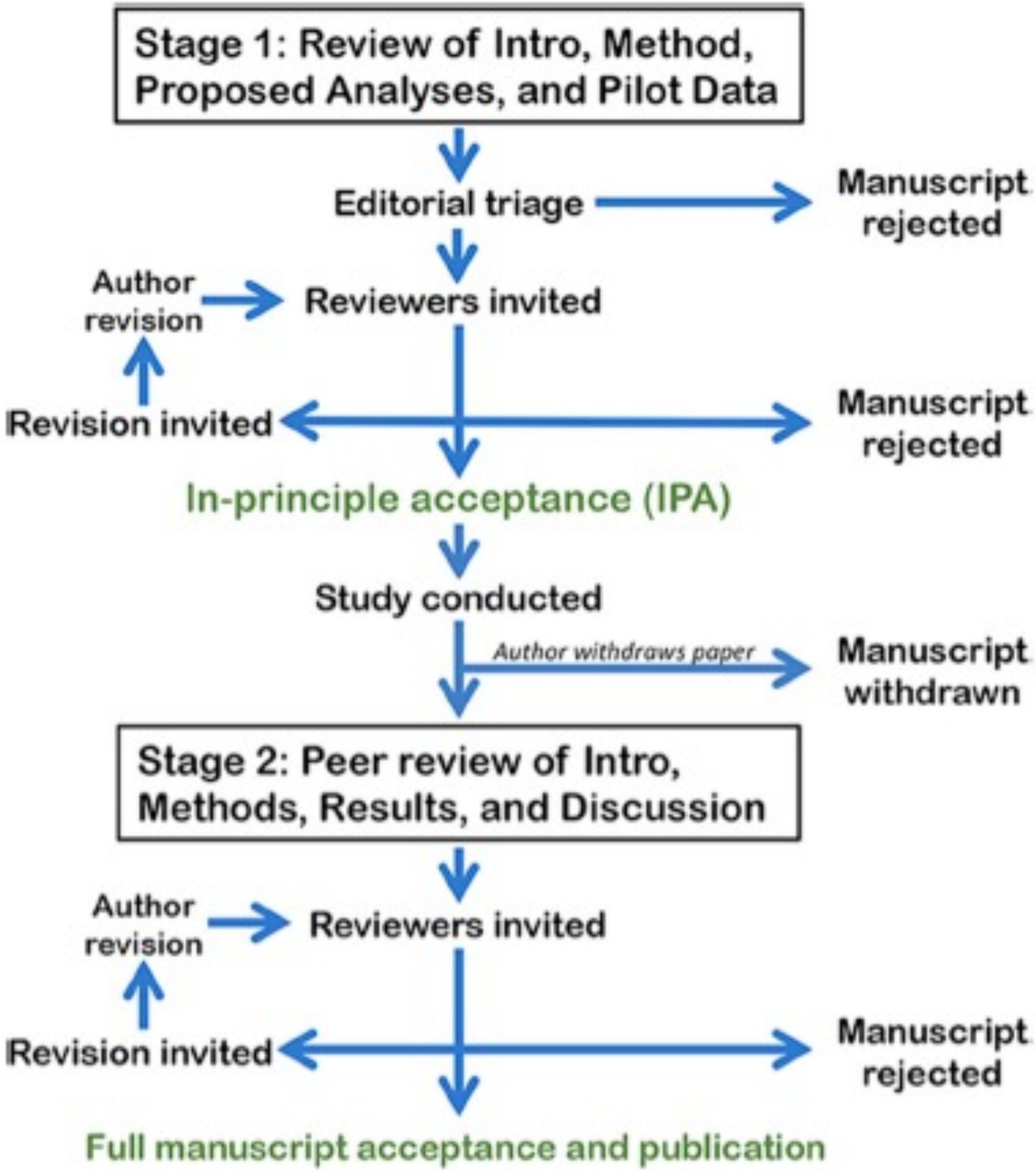
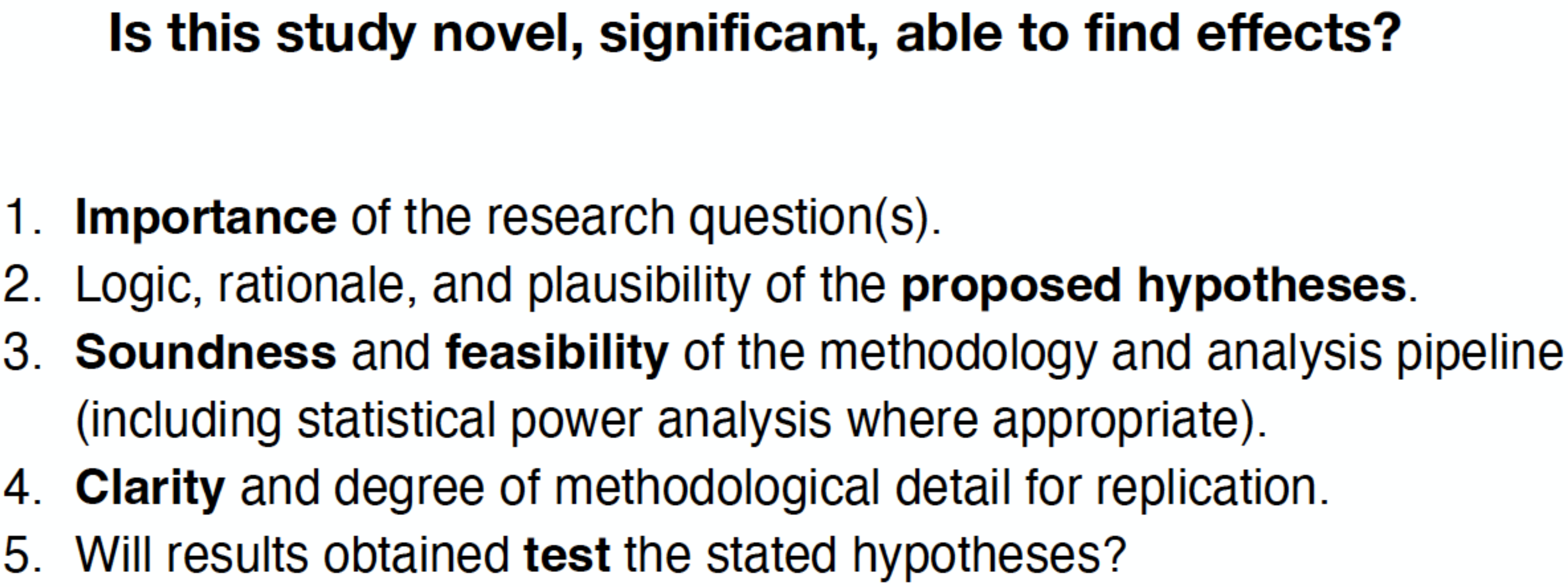


Fig. 1 Stages of the Registered Reports workflow. Center for Open Science (https://www.cos.io/initiatives/registered-reports?#tabid3) CC-BY-NoDerivs 4.0

Phase 1 – Review Criteria

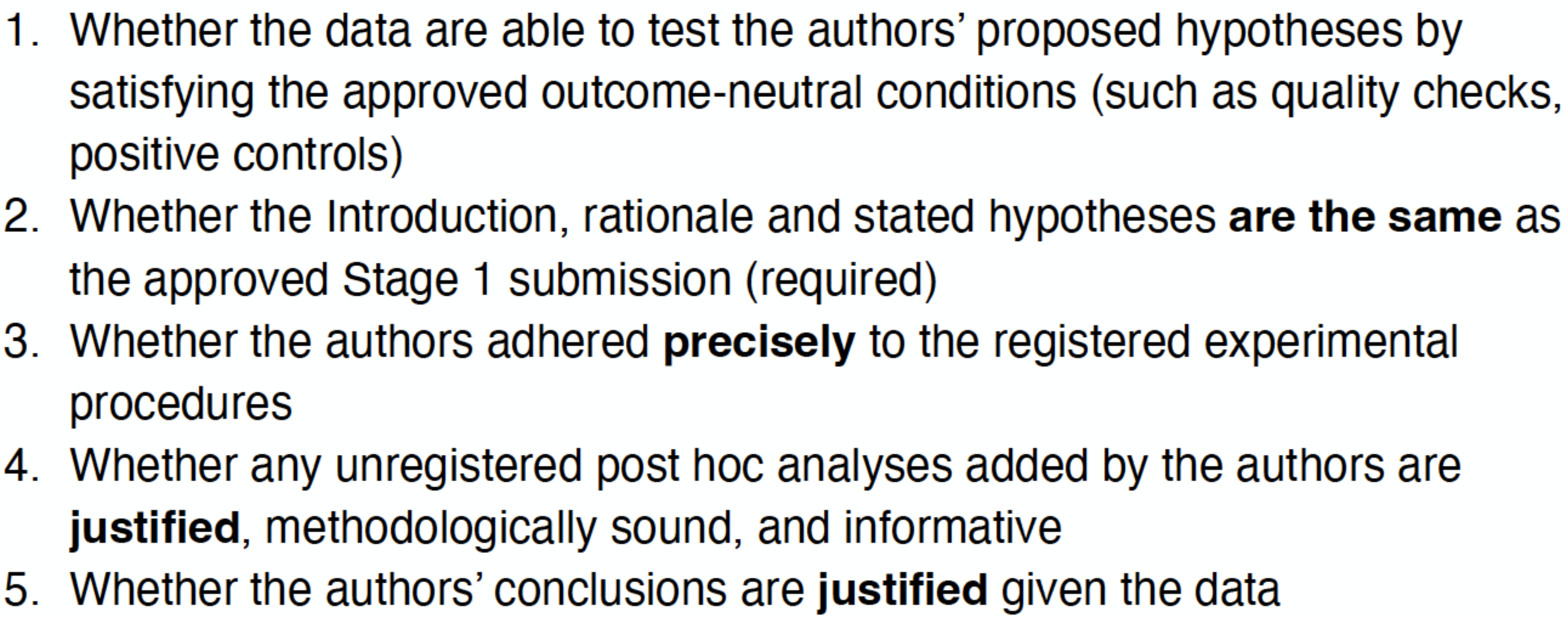


Is this study novel, significant, able to find effects?

1. **Importance** of the research question(s).
2. Logic, rationale, and plausibility of the **proposed hypotheses**.
3. **Soundness** and **feasibility** of the methodology and analysis pipeline (including statistical power analysis where appropriate).
4. **Clarity** and degree of methodological detail for replication.
5. Will results obtained **test** the stated hypotheses?

Phase 2 – Review Criteria

Did the authors execute on Phase 1 plan?



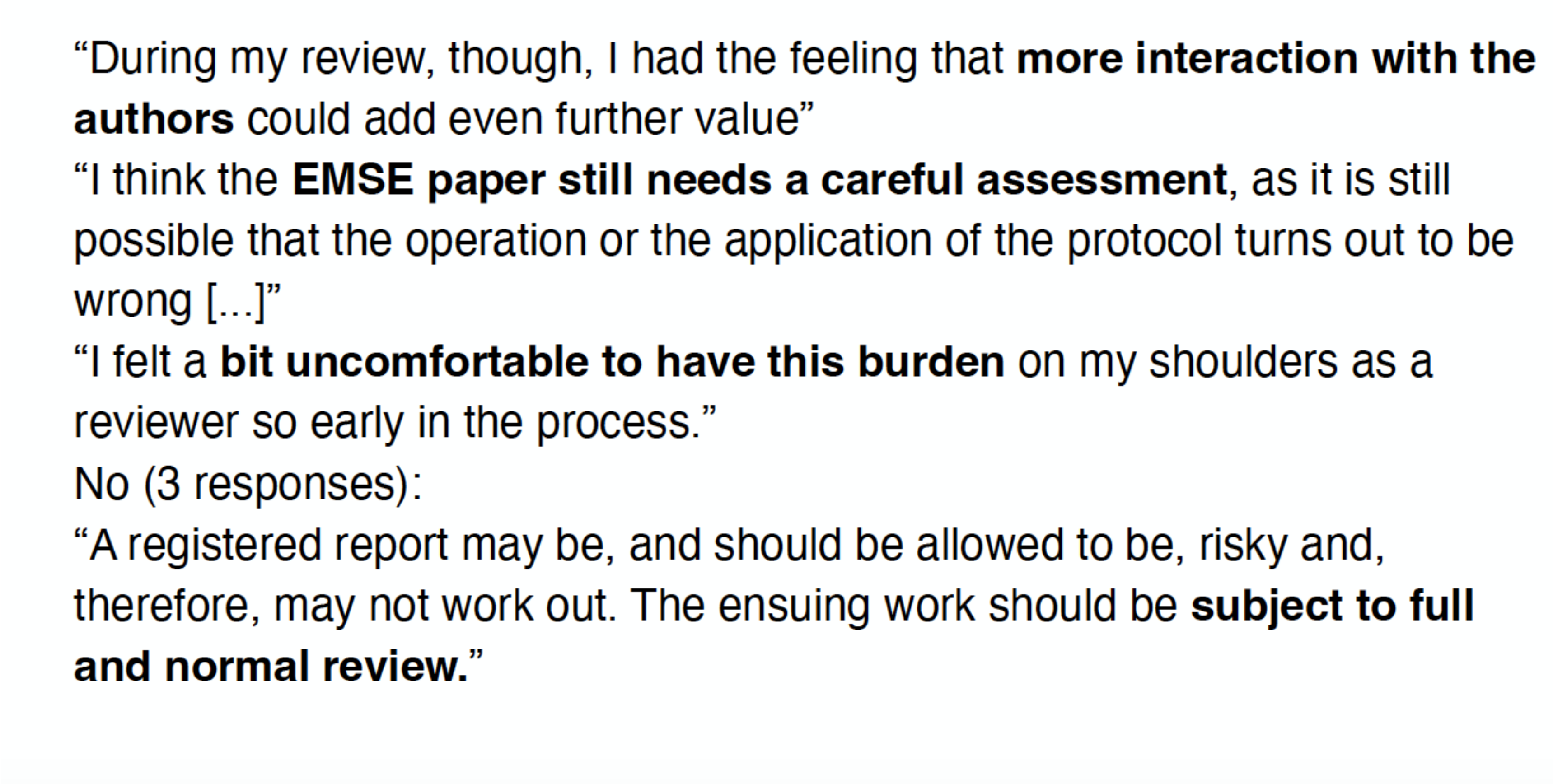
1. Whether the data are able to test the authors' proposed hypotheses by satisfying the approved outcome-neutral conditions (such as quality checks, positive controls)
2. Whether the Introduction, rationale and stated hypotheses **are the same** as the approved Stage 1 submission (required)
3. Whether the authors adhered **precisely** to the registered experimental procedures
4. Whether any unregistered post hoc analyses added by the authors are **justified**, methodologically sound, and informative
5. Whether the authors' conclusions are **justified** given the data

Current state of RR in SE

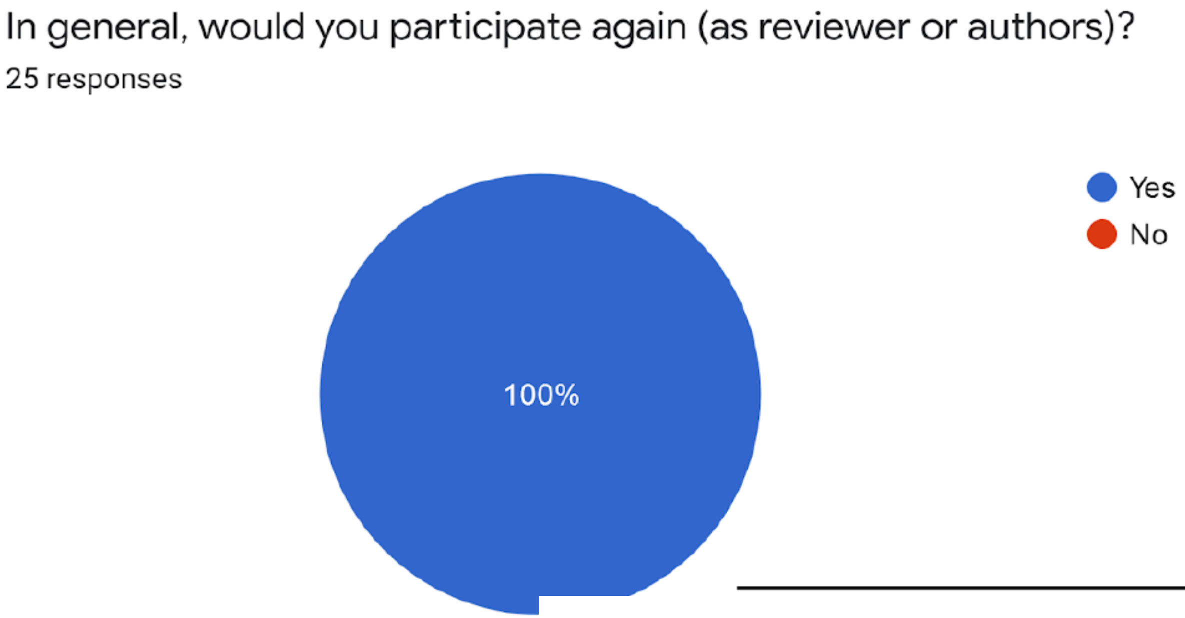
MSR 2020 feedback on IPA:

> “I think it is a key principle. However, in a way it also **raises the bar** significantly for the Registered Reports”
> “[...] the fact that the results are missing, helps reviewers and authors **focus on the methodological issue**, which is a great added value in the review process [...]”

MSR Results - IPA



“During my review, though, I had the feeling that **more interaction with the authors** could add even further value”
“I think the **EMSE paper still needs a careful assessment**, as it is still possible that the operation or the application of the protocol turns out to be wrong [...]”
“I felt a **bit uncomfortable to have this burden** on my shoulders as a reviewer so early in the process.”
No (3 responses):
“A registered report may be, and should be allowed to be, risky and, therefore, may not work out. The ensuing work should be **subject to full and normal review.**”



In general, would you participate again (as reviewer or authors)?

25 responses

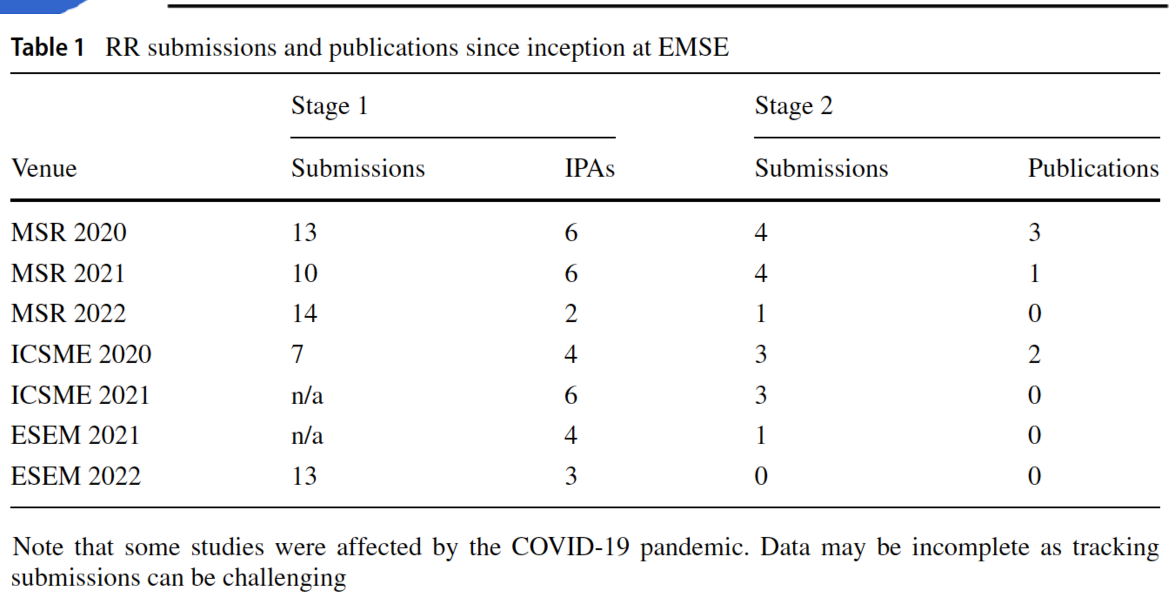


Table 1 RR submissions and publications since inception at EMSE

	Stage 1		Stage 2	
Venue	Submissions	IPAs	Submissions	Publications
MSR 2020	13	6	4	3
MSR 2021	10	6	4	1
MSR 2022	14	2	1	0
ICSME 2020	7	4	3	2
ICSME 2021	n/a	6	3	0
ESEM 2021	n/a	4	1	0
ESEM 2022	13	3	0	0

Note that some studies were affected by the COVID-19 pandemic. Data may be incomplete as tracking submissions can be challenging

Open Issues and Questions

Pros & Cons of RR

RRs provide early-stage feedback to authors and reduce researcher bias problems

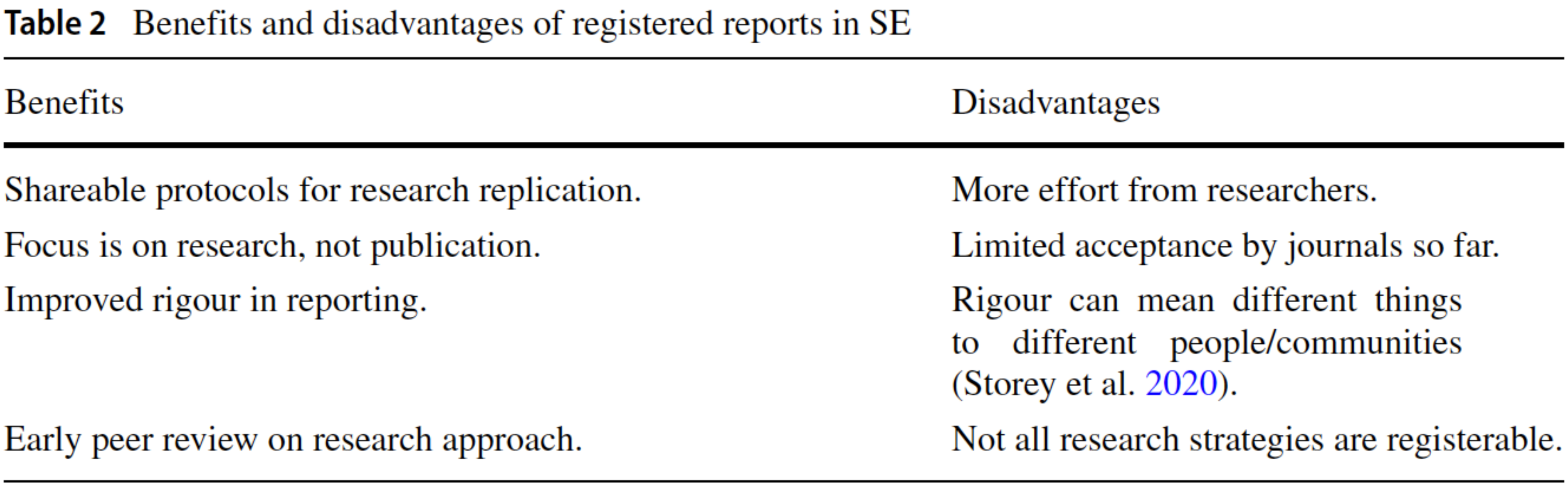


Table 2 Benefits and disadvantages of registered reports in SE

Benefits	Disadvantages
Shareable protocols for research replication.	More effort from researchers.
Focus is on research, not publication.	Limited acceptance by journals so far.
Improved rigour in reporting.	Rigour can mean different things to different people/communities (Storey et al. 2020).
Early peer review on research approach.	Not all research strategies are registerable.

Three faces of RR

RR to prevent questionable research practices

Tell the world what you will do, then do it

RR as doctoral symposium

Early feedback before expensive data collection

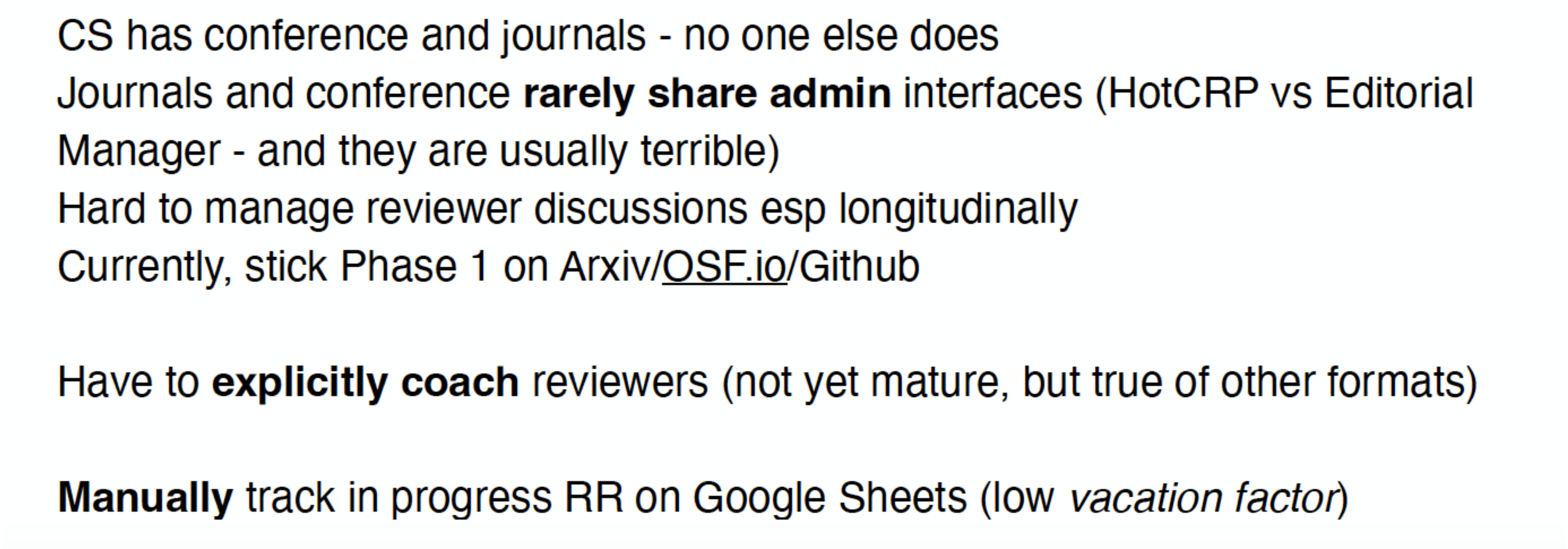
RR as 1st round review

Pre-empt journal review with in-principle acceptance

To what CS studies could it apply?

Most suited to post-positivist, confirmatory studies with clear hypotheses.

Admin Challenges



CS has conference and journals - no one else does

Journals and conference **rarely share admin** interfaces (HotCRP vs Editorial Manager - and they are usually terrible)

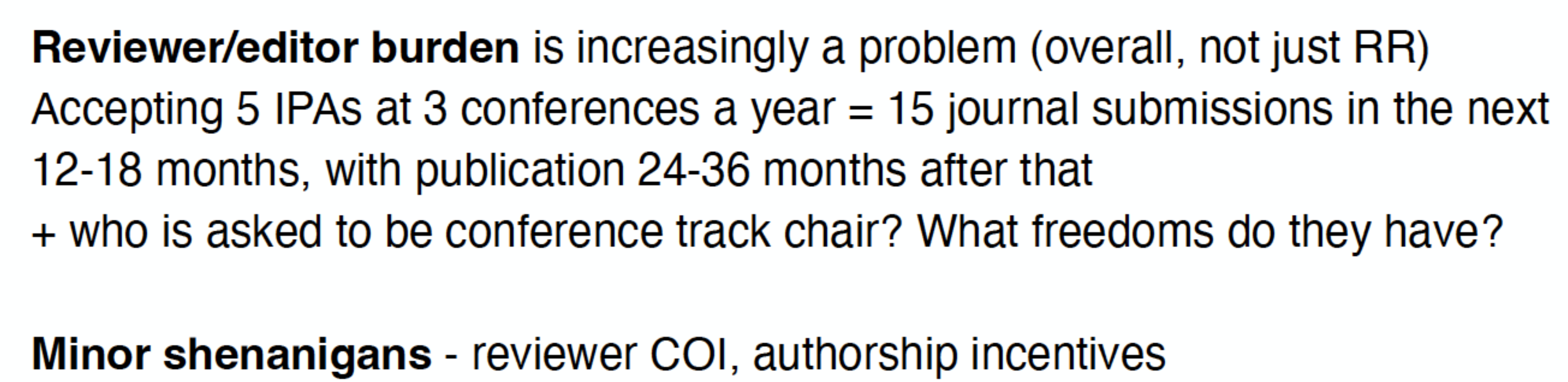
Hard to manage reviewer discussions esp longitudinally

Currently, stick Phase 1 on Arxiv/OSF.io/Github

Have to **explicitly coach** reviewers (not yet mature, but true of other formats)

Manually track in progress RR on Google Sheets (low *vacation factor*)

Admin Challenges



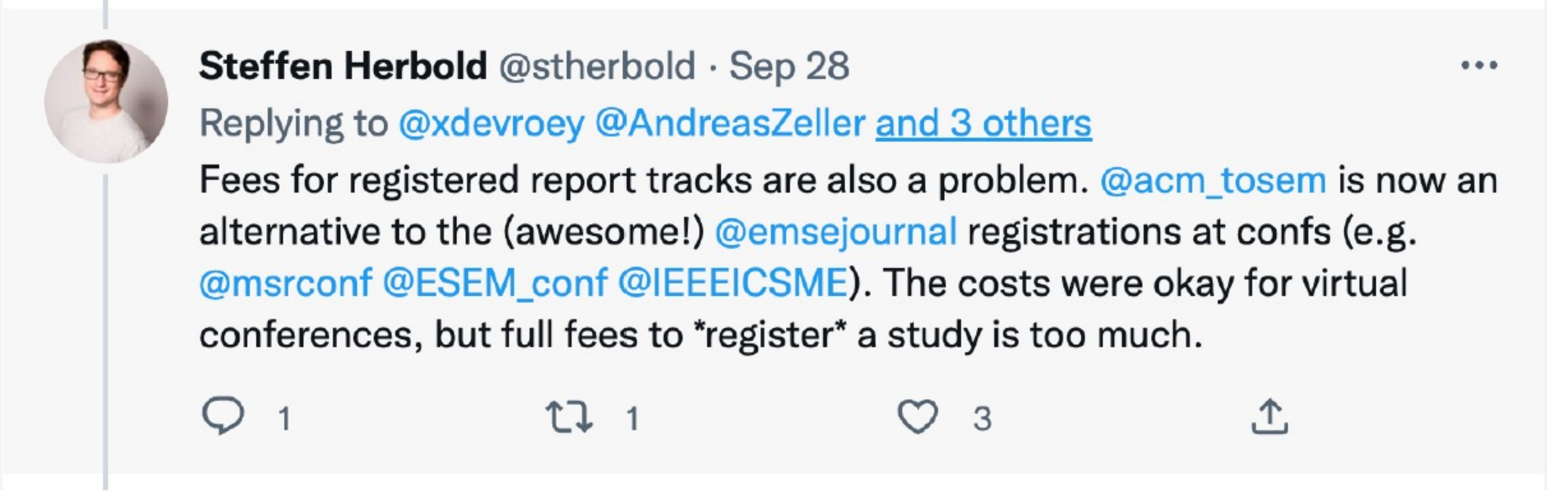
Reviewer/editor burden is increasingly a problem (overall, not just RR)
Accepting 5 IPAs at 3 conferences a year = 15 journal submissions in the next 12-18 months, with publication 24-36 months after that
+ who is asked to be conference track chair? What freedoms do they have?

Minor shenanigans - reviewer COI, authorship incentives

Admin Challenges – J1C2?

Publication models run into journal profit models

First phase - Journal - then present at conference?



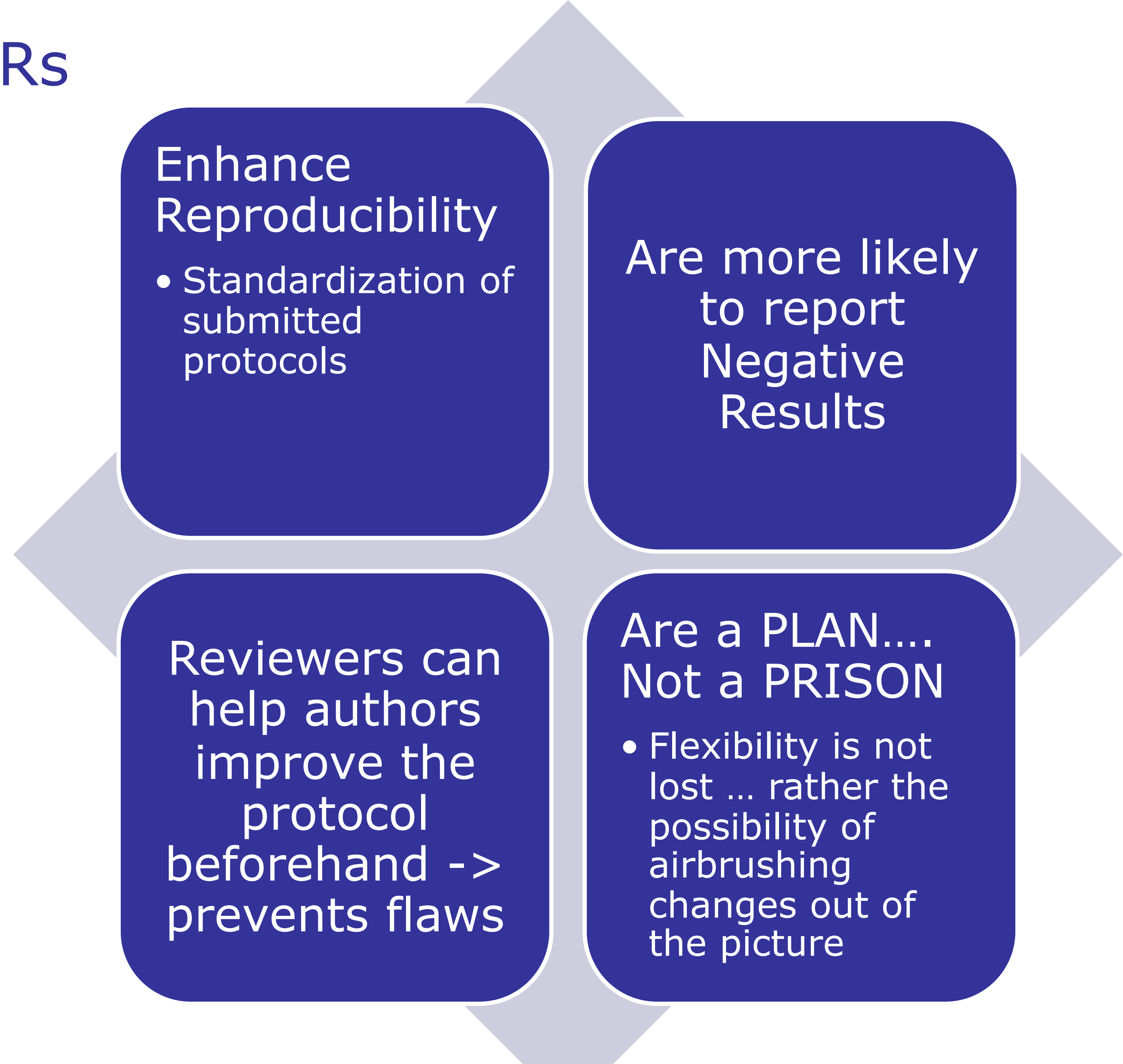
Steffen Herbold @stherbold · Sep 28

Replying to @xdevroey @AndreasZeller and 3 others

Fees for registered report tracks are also a problem. @acm_tosem is now an alternative to the (awesome!) @emsejournal registrations at confs (e.g. @msrconf @ESEM_conf @IEEEICSME). The costs were okay for virtual conferences, but full fees to *register* a study is too much.

💬 1 🔁 1 ♡ 3

RRs



Enhance Reproducibility

- Standardization of submitted protocols

Are more likely to report Negative Results

Reviewers can help authors improve the protocol beforehand -> prevents flaws

Are a PLAN…. Not a PRISON

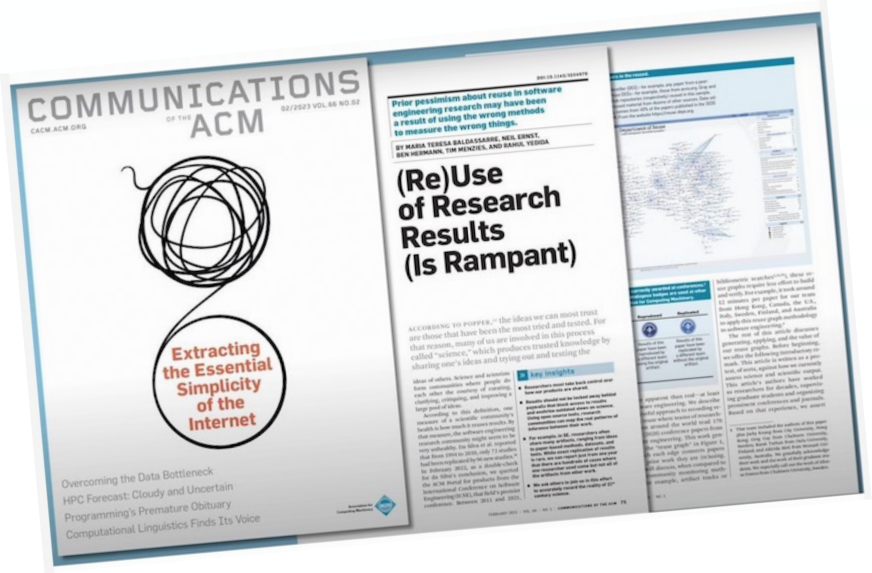
- Flexibility is not lost … rather the possibility of airbrushing changes out of the picture

Department of Reuse

Ultimately RR is about pre-specifying analysis. One way to do that is to reuse analysis protocols from other papers.

Done all the time in medicine; rarely in CS except in benchmarks.

Q: to what extent are artifacts such as protocols reused?



COMMUNICATIONS OF THE ACM

CACM.ACM.ORG 02/2023 VOL.66 NO.02

Extracting the Essential Simplicity of the Internet

Overcoming the Data Bottleneck
HPC Forecast: Cloudy and Uncertain
Programming's Premature Obituary
Computational Linguistics Finds Its Voice

Prior pessimism about reuse in software engineering research may have been a result of using the wrong methods to measure the wrong things.

BY MARIA TERESA BALDASSARRE, NEIL ERNST, BEN HERMANN, TIM MENZIES, AND RAHUL YEDIDA

(Re)Use of Research Results (Is Rampant)

ACCORDING TO POPPER, the ideas we can most trust are those that have been the most tried and tested. For that reason, many of us are involved in this process called "science," which produces trusted knowledge by sharing one's ideas and trying out and testing the

key insights

https://reuse-dept.org/

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Artifafct Creation, sharing and Reuse

SE researchers share artifacts

Not only publications …

Ideas, methods, datasets, tools

Artifacts engage replication and reproducibility

Science produces more types of artifacts than just publications

Researchers use some but not not necessarily all artifacts from other work

HOW DO WE CAPTURE REUSE?

Badging – Artifact Evaluation Committees

The authors of accepted conference papers submit software packages that, in theory, let others re-execute that work.
These evaluation committees award “badges”

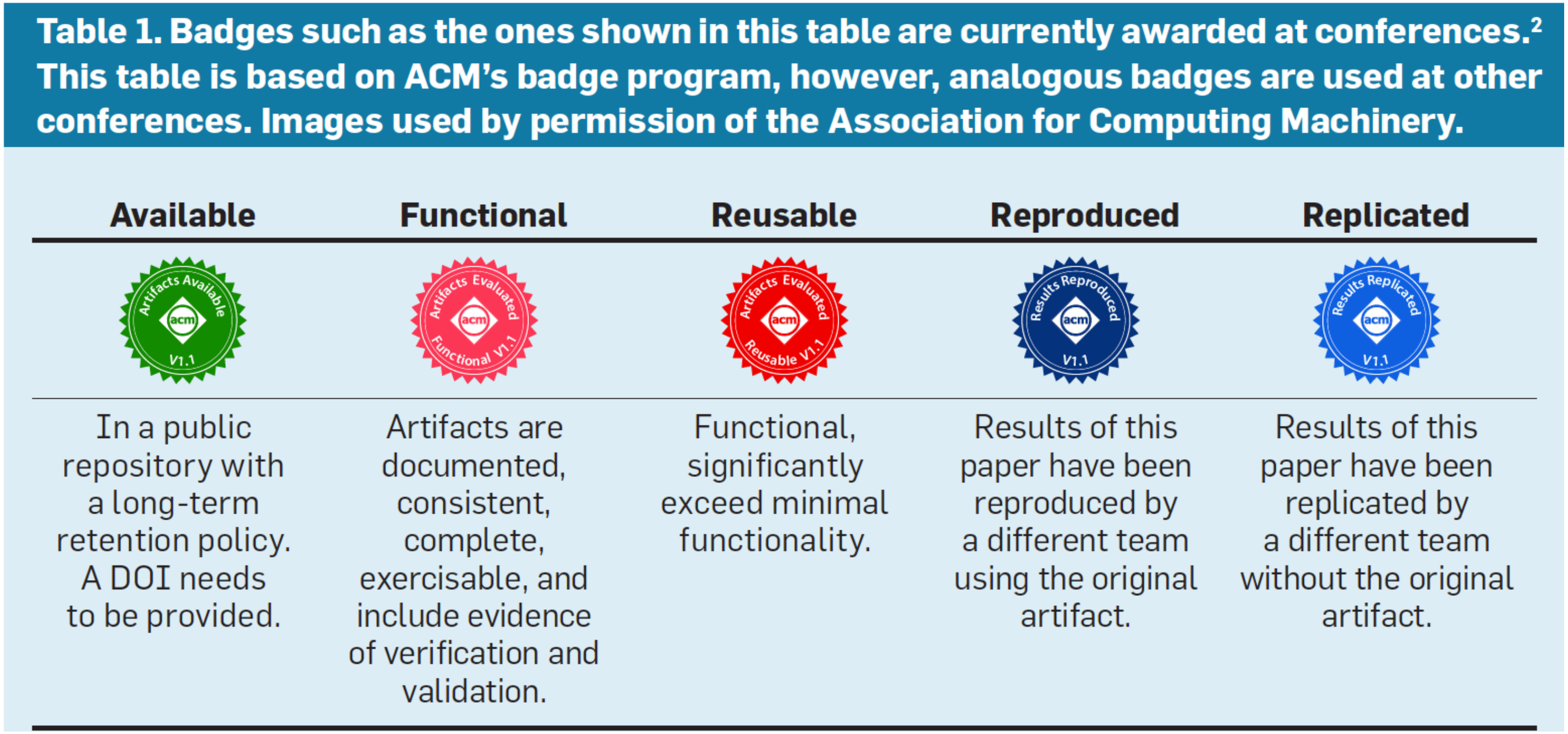


Table 1. Badges such as the ones shown in this table are currently awarded at conferences.[2] This table is based on ACM’s badge program, however, analogous badges are used at other conferences. Images used by permission of the Association for Computing Machinery.

Available	Functional	Reusable	Reproduced	Replicated
Artifacts Available acm V1.1	Artifacts Evaluated acm Functional V1.1	Artifacts Evaluated acm Reusable V1.1	Results Reproduced acm V1.1	Results Replicated acm V1.1
In a public repository with a long-term retention policy. A DOI needs to be provided.	Artifacts are documented, consistent, complete, exercisable, and include evidence of verification and validation.	Functional, significantly exceed minimal functionality.	Results of this paper have been reproduced by a different team using the original artifact.	Results of this paper have been replicated by a different team without the original artifact.

Badging – Artifact Evaluation Committees

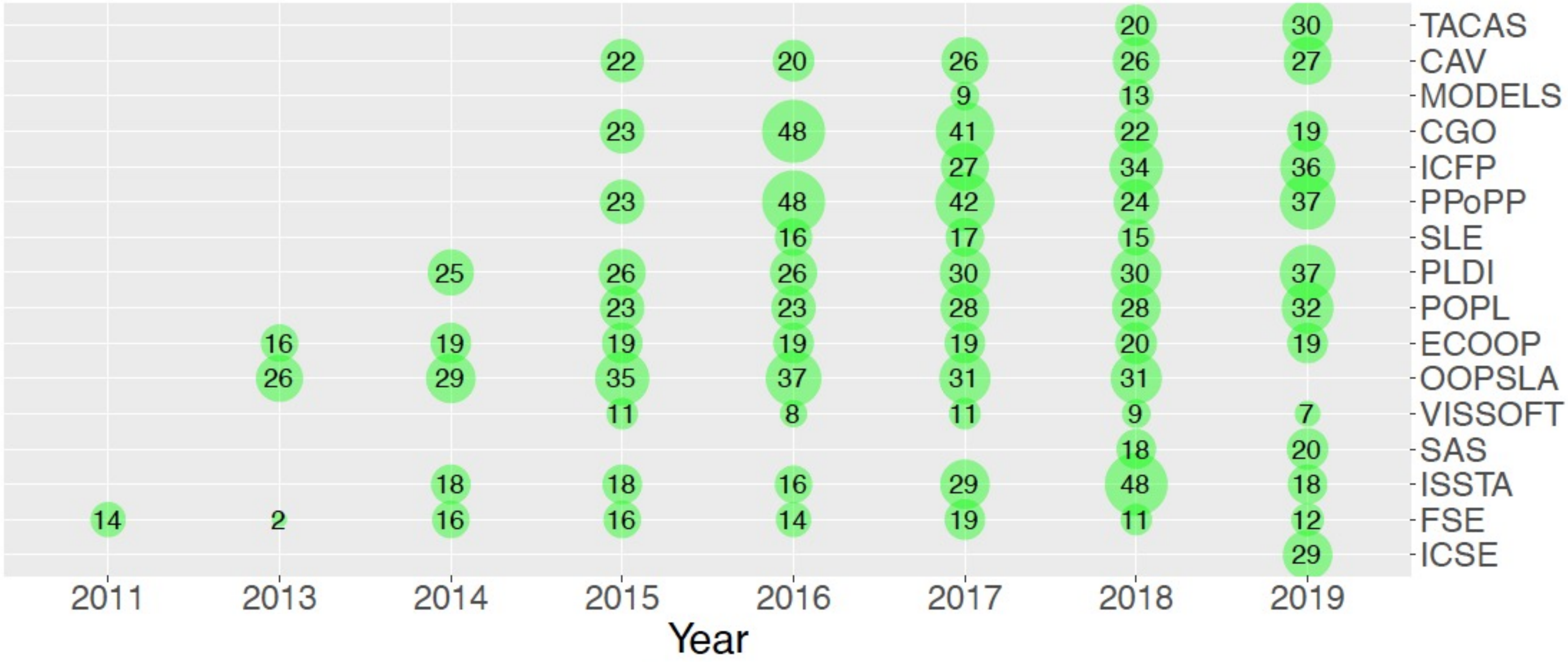
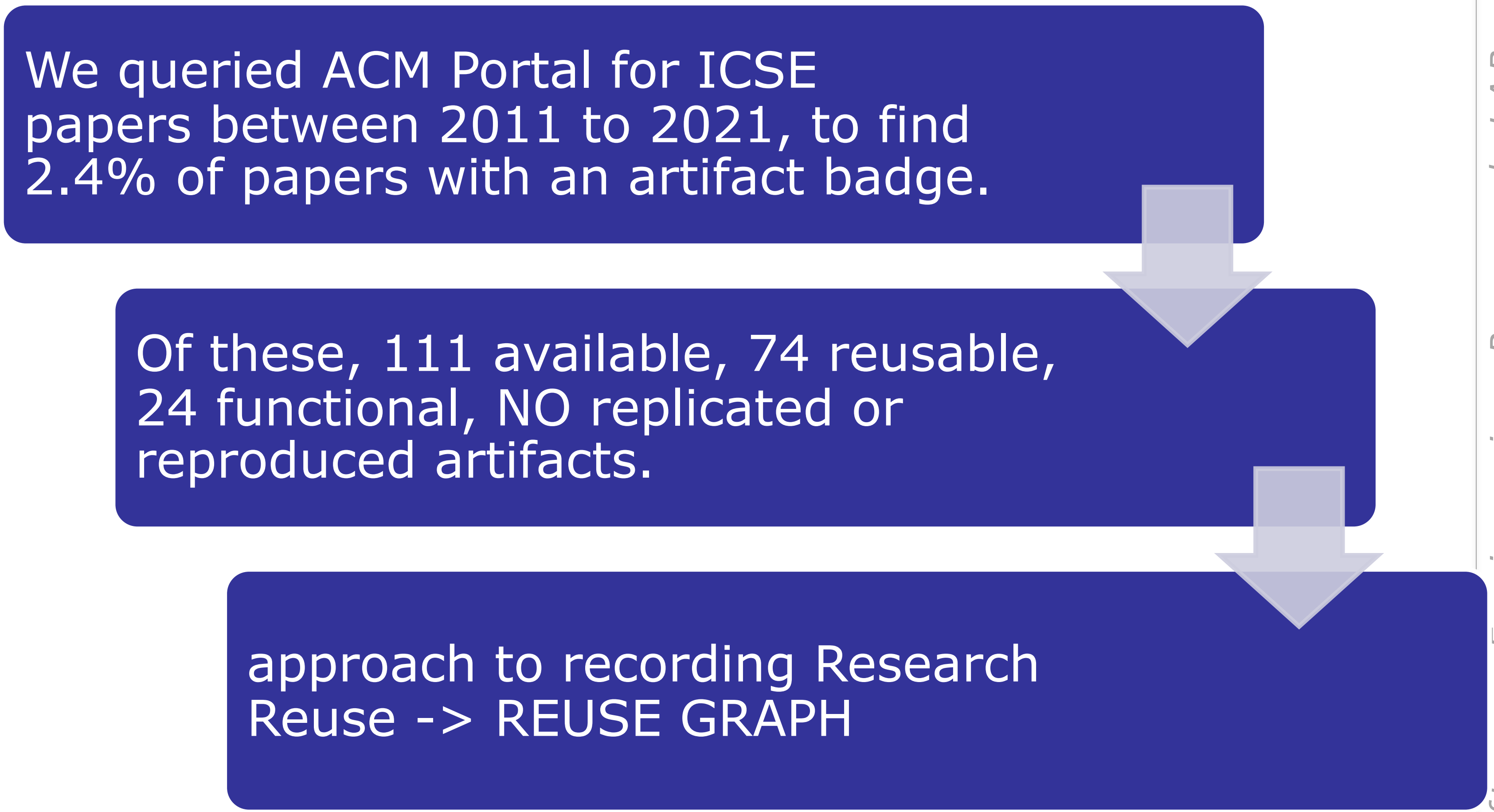


Fig. 4. Artifact evaluation committee sizes 2011-2019. From Hermann et al. [8]

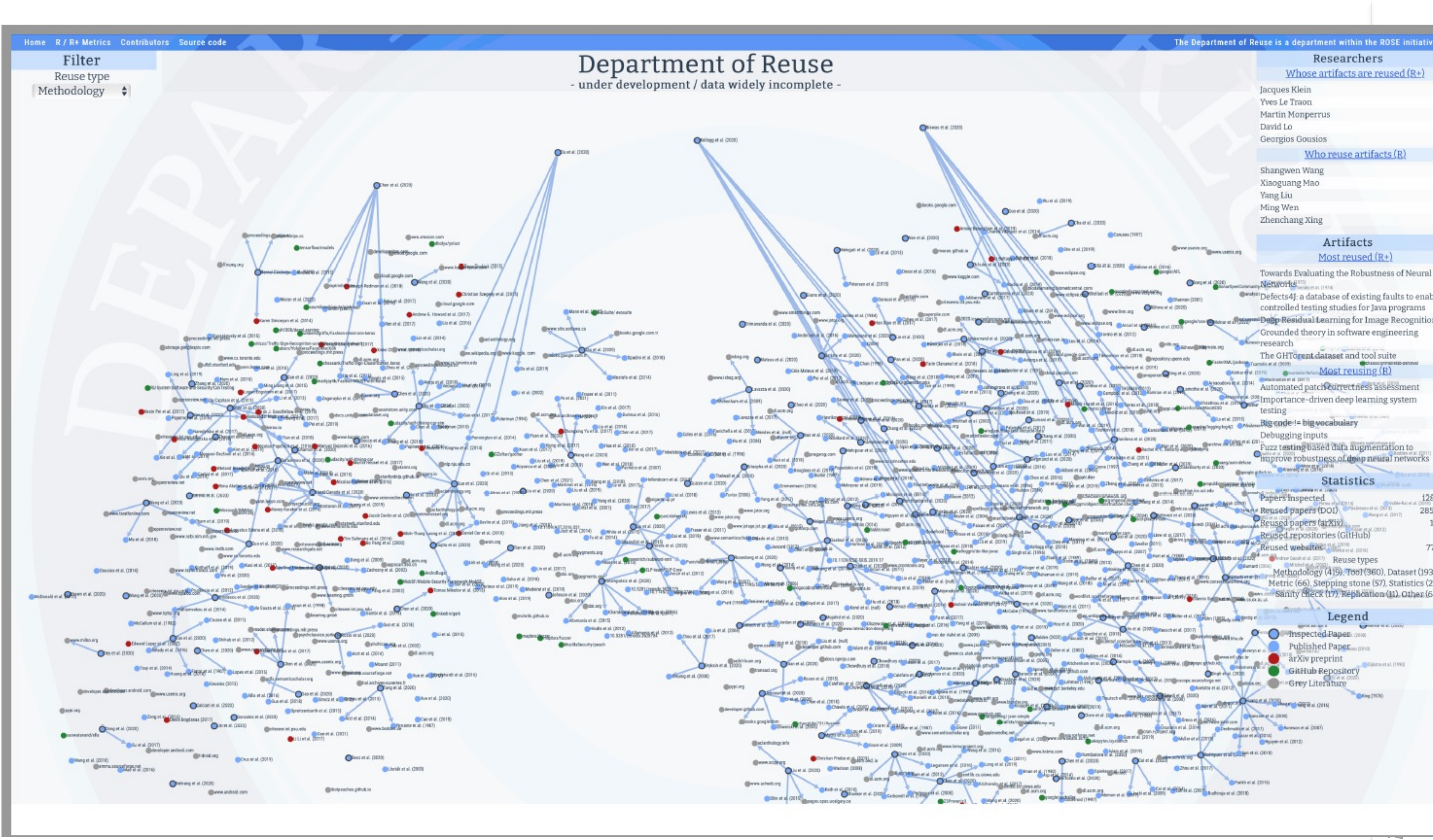
Is the artifact evaluation process is creating reused artifacts?



We queried ACM Portal for ICSE papers between 2011 to 2021, to find 2.4% of papers with an artifact badge.

Of these, 111 available, 74 reusable, 24 functional, NO replicated or reproduced artifacts.

approach to recording Research Reuse -> REUSE GRAPH



Home
R / R+ Metrics
Contributors
Source code
The Department of Reuse is a department within the ROSE initiativ

Department of Reuse

- under development / data widely incomplete -

Filter

Reuse type: Methodology

Researchers

Whose artifacts are reused (R+)

Jacques Klein
Yves Le Traon
Martin Monperrus
David Lo
Georgios Gousios

Who reuse artifacts (R)

Shangwen Wang
Xiaoguang Mao
Yang Liu
Ming Wen
Zhenchang Xing

Artifacts

Most reused (R+)

Towards Evaluating the Robustness of Neural Networks
Defects4J: a database of existing faults to enab controlled testing studies for Java programs
Deep Residual Learning for Image Recognitio
Grounded theory in software engineering research
The GHTorent dataset and tool suite

Most reusing (R)

Automated patch correctness assessment
Importance-driven deep learning system testing
Big code != big vocabulary
Debugging inputs
Fuzz testing based data augmentation to improve robustness of deep neural networks

Statistics

Papers inspected	128
Reused papers (DOI)	285
Reused papers (arXiv)	1
Reused repositories (GitHub)	
Reused websites	77

Reuse types

Methodology (419), Tool (360), Dataset (193 Metric (66), Stepping stone (57), Statistics (2 Sanity check (17), Replication (11), Other (6

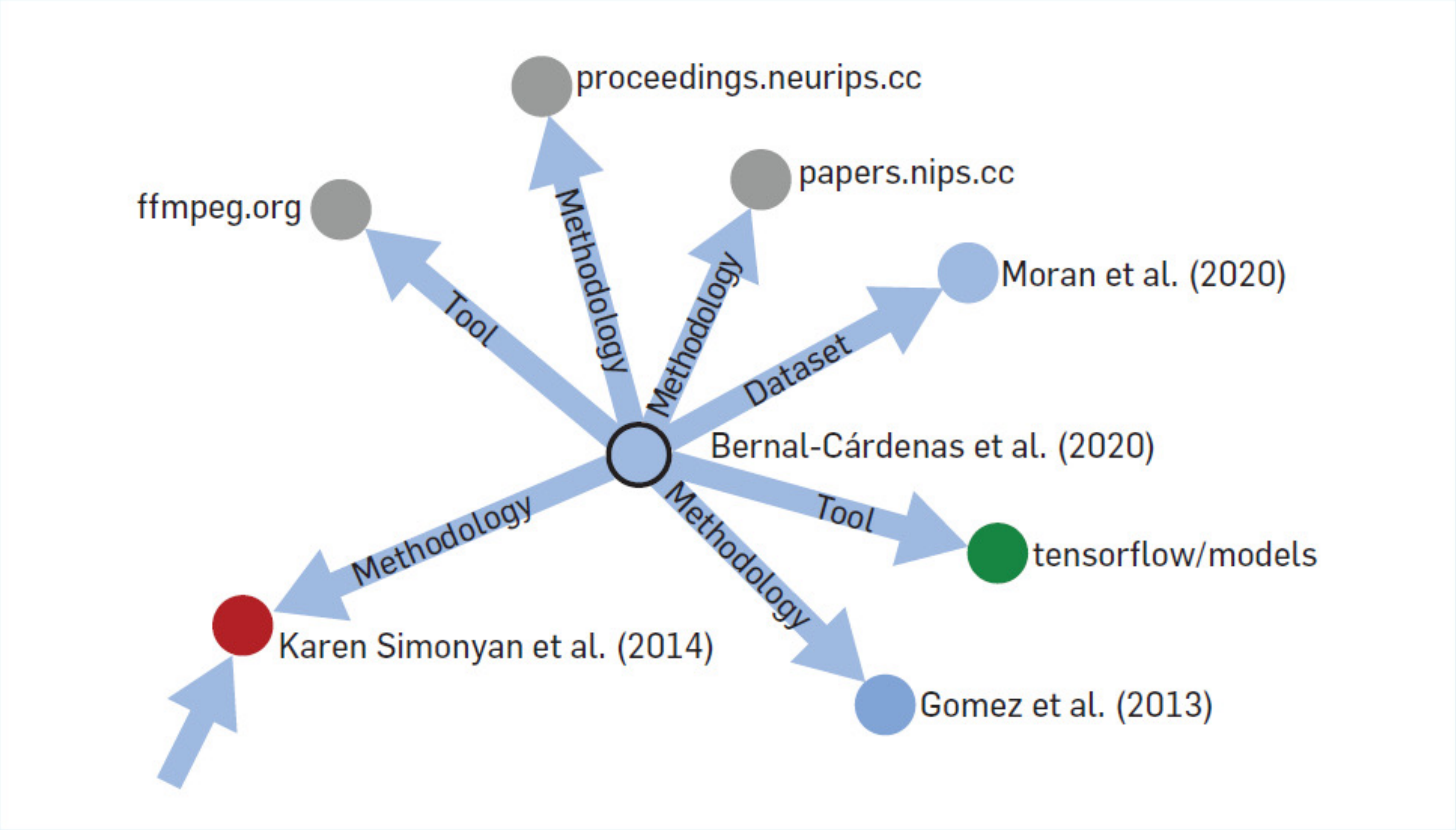
Legend

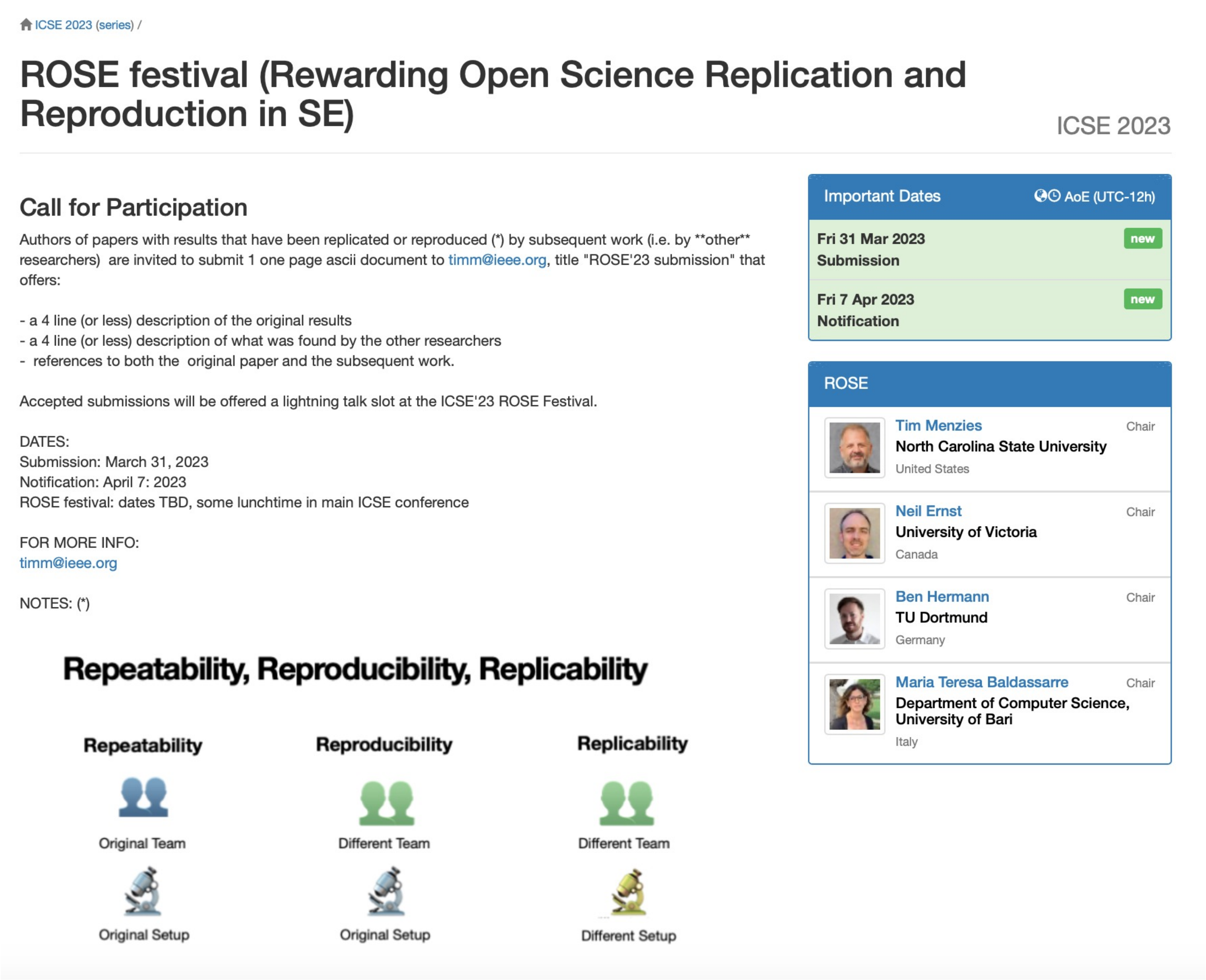
◯ Inspected Paper
● Published Paper
● arXiv preprint
● GitHub Repository
● Grey Literature

So

- ⇨ Researchers read 170 SE papers selected from 6 major 2020 conferences
- ⇨ Teams were asked to record six types of reuse
- ⇨ Each edge connects papers to the prior work they are (re)using

This figure shows reuse from Bernal-Cárdenas et al.[7] Edges reflect tool, dataset, and methodology reuse. Red nodes indicate arXiv preprint; green represents a GitHub repository; blue denotes a published paper, and grey indicates other websites or grey literature locations. https://www.reuse-dept.org/doi/10.1145/3377811.3380328.





ICSE 2023 (series) /

ROSE festival (Rewarding Open Science Replication and Reproduction in SE)

ICSE 2023

Call for Participation

Authors of papers with results that have been replicated or reproduced (*) by subsequent work (i.e. by **other** researchers) are invited to submit 1 one page ascii document to timm@ieee.org, title "ROSE'23 submission" that offers:

- a 4 line (or less) description of the original results
- a 4 line (or less) description of what was found by the other researchers
- references to both the original paper and the subsequent work.

Accepted submissions will be offered a lightning talk slot at the ICSE'23 ROSE Festival.

DATES:
Submission: March 31, 2023
Notification: April 7: 2023
ROSE festival: dates TBD, some lunchtime in main ICSE conference

FOR MORE INFO:
timm@ieee.org

NOTES: (*)

Repeatability, Reproducibility, Replicability

Repeatability	Reproducibility	Replicability
Original Team	Different Team	Different Team
Original Setup	Original Setup	Different Setup

Important Dates — AoE (UTC-12h)

Fri 31 Mar 2023 **Submission** new

Fri 7 Apr 2023 **Notification** new

ROSE

Tim Menzies — Chair
North Carolina State University
United States

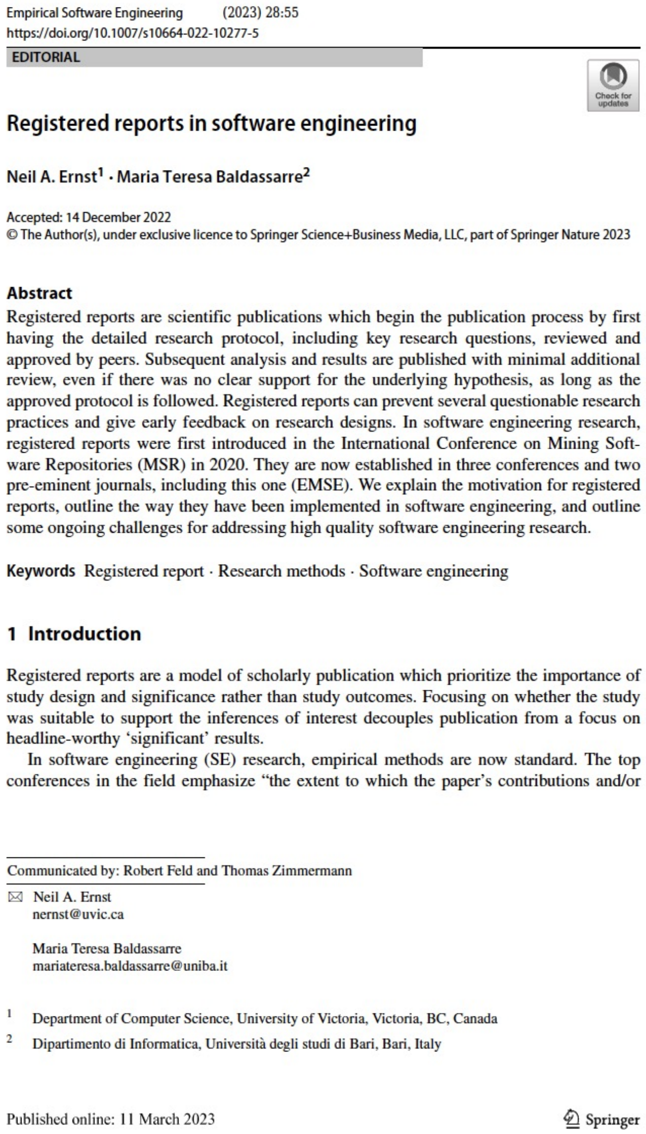
Neil Ernst — Chair
University of Victoria
Canada

Ben Hermann — Chair
TU Dortmund
Germany

Maria Teresa Baldassarre — Chair
Department of Computer Science, University of Bari
Italy

The Rose Initiative (Recognizing and Rewarding Open Science in Software Engineering) is an international, multi-conference workshop that will continually report updates to the software engineering reuse graphs.

Credits & Special Thanks



Empirical Software Engineering (2023) 28:55
https://doi.org/10.1007/s10664-022-10277-5

EDITORIAL

Registered reports in software engineering

Neil A. Ernst[1] · Maria Teresa Baldassarre[2]

Accepted: 14 December 2022

Abstract

Registered reports are scientific publications which begin the publication process by first having the detailed research protocol, including key research questions, reviewed and approved by peers. Subsequent analysis and results are published with minimal additional review, even if there was no clear support for the underlying hypothesis, as long as the approved protocol is followed. Registered reports can prevent several questionable research practices and give early feedback on research designs. In software engineering research, registered reports were first introduced in the International Conference on Mining Software Repositories (MSR) in 2020. They are now established in three conferences and two pre-eminent journals, including this one (EMSE). We explain the motivation for registered reports, outline the way they have been implemented in software engineering, and outline some ongoing challenges for addressing high quality software engineering research.

Keywords Registered report · Research methods · Software engineering

1 Introduction

Registered reports are a model of scholarly publication which prioritize the importance of study design and significance rather than study outcomes. Focusing on whether the study was suitable to support the inferences of interest decouples publication from a focus on headline-worthy 'significant' results.

In software engineering (SE) research, empirical methods are now standard. The top conferences in the field emphasize "the extent to which the paper's contributions and/or

Communicated by: Robert Feld and Thomas Zimmermann

✉ Neil A. Ernst
nernst@uvic.ca

Maria Teresa Baldassarre
mariateresa.baldassarre@uniba.it

[1] Department of Computer Science, University of Victoria, Victoria, BC, Canada
[2] Dipartimento di Informatica, Università degli studi di Bari, Bari, Italy

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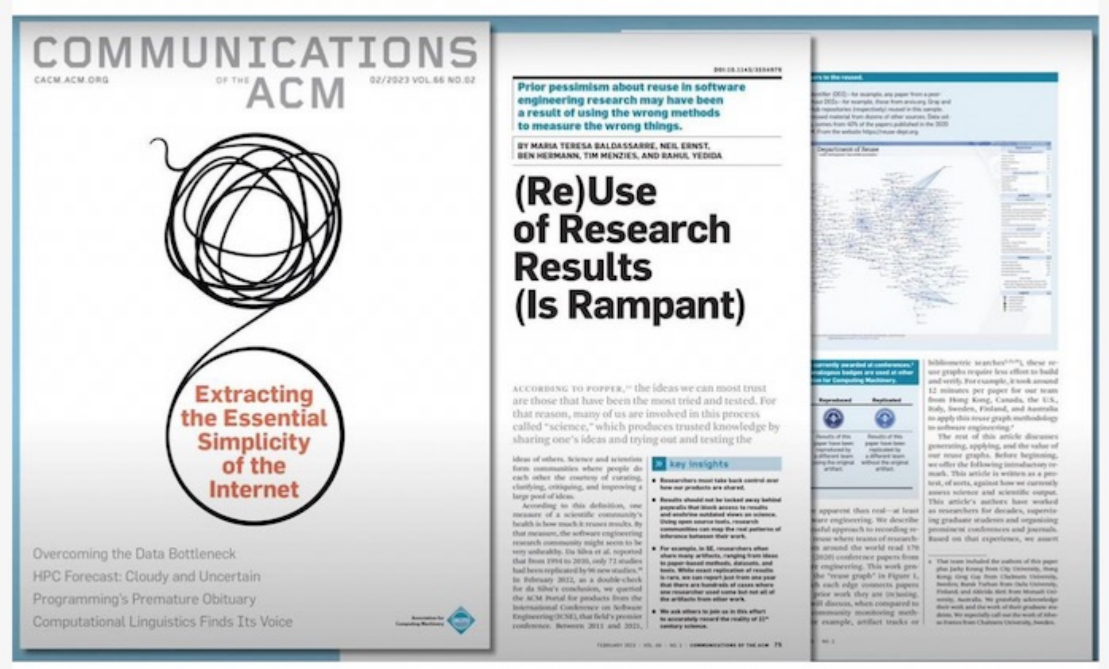

COMMUNICATIONS OF THE ACM

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02/2023 VOL.66 NO.02

Extracting the Essential Simplicity of the Internet

Overcoming the Data Bottleneck

HPC Forecast: Cloudy and Uncertain

Programming's Premature Obituary

Computational Linguistics Finds Its Voice

Association for Computing Machinery

DOI:10.1145/3554976

Prior pessimism about reuse in software engineering research may have been a result of using the wrong methods to measure the wrong things.

BY MARIA TERESA BALDASSARRE, NEIL ERNST, BEN HERMANN, TIM MENZIES, AND RAHUL YEDIDA

(Re)Use of Research Results (Is Rampant)

ACCORDING TO POPPER,[18] the ideas we can most trust are those that have been the most tried and tested. For that reason, many of us are involved in this process called "science," which produces trusted knowledge by sharing one's ideas and trying out and testing the ideas of others. Science and scientists form communities where people do each other the courtesy of curating, clarifying, critiquing, and improving a large pool of ideas.

According to this definition, one measure of a scientific community's health is how much it reuses results. By that measure, the software engineering research community might seem to be very unhealthy. Da Silva et al. reported that from 1994 to 2010, only 72 studies had been replicated by 96 new studies.[7] In February 2022, as a double-check for da Silva's conclusion, we queried the ACM Portal for products from the International Conference on Software Engineering (ICSE), that field's premier conference. Between 2011 and 2021,

key insights

- Researchers must take back control over how our products are shared.
- Results should not be locked away behind paywalls that block access to results and enshrine outdated views on science. Using open source tools, research communities can map the real patterns of inference between their work.
- For example, in SE, researchers often share many artifacts, ranging from ideas to paper-based methods, datasets, and tools. While exact replication of results is rare, we can report just from one year that there are hundreds of cases where one researcher used some but not all of the artifacts from other work.
- We ask others to join us in this effort to accurately record the reality of 21st century science.

FEBRUARY 2023 | VOL. 66 | NO. 2 | COMMUNICATIONS OF THE ACM 75

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- Ernst, N.A., Baldassarre, M.T. Registered reports in software engineering. Empir Software Eng 28, 55 (2023). https://doi.org/10.1007/s10664-022-10277-5

Figure. Watch the authors discuss this work in the exclusive *Communications* video.
https://cacm.acm.org/videos/reuse-of-research

mariateresa.baldassarre@uniba.it

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