Artifact Evaluations for Stronger Research Results

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Tutorial Materials



https://www.stefan-winter.net/ae-materials.html

Linked from FSE 2025 program

Outline and Objectives

- Introduction and historical perspective
- ACM's artifact evaluation (AE) policy and terminology
- AE processes
- Common problems with research artifacts
- Timeline for AE chairs
- Recommendations for authors
- Recommendations for reviewers

Introduction and Historical Perspective

The Reproducibility Crisis in Science

- 2016: >70 % of 1576 scientists unable to reproduce peers' results (https://doi.org/10.1038/533452a)
- In the following years: Numerous confirming reports (see https://en.wikipedia.org/wiki/Replication_crisis)
- Many follow-up studies, mainly focused on medical and social sciences
- How about computer science?

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- NASEM report 2019: Root cause for non-reproducibility often lies in artifact deficiencies (https://doi.org/10.17226/25303)
- Artifact evaluations in software engineering since 2011

Artifacts in Software Engineering (SE) and Programming Languages (PL) Research

Artifact: "a digital object that was either created by the authors to be used as part of the study or generated by the experiment itself"

https://www.acm.org/publications/policies/artifact-review-and-badging-current

Examples:

- Software tools
- Scripts to run experiments
- Data (raw or processed/aggregated)
- Documentation
- Mathematical proof (manual or automated)
- Audio and video materials

Systematic Assessment of Artifacts in SE/PL: Artifact Evaluations

- Pioneered at FSE 2011 & OOPSLA 2013
- Initial criteria

(https://artifact-eval.org/about.html)

- consistent with the paper
- as complete as possible
- well documented
- easy to reuse, facilitating further research

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Artifact Evaluation – Adoption in SE/PL



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- Problem: Prototypes maybe not easy to reuse, but useful for reproducibility



Orthogonal aspects:

- Functionality
- Reusability

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- Functionality
- Reusability
- Availability
 - Intellectual property, licensing
 - Security
 - Privacy

contributed articles

000101145/281203

To encourage repeatable research, fund repeatability engineering and reward commitments to sharing research artifacts.

BY CHRISTIAN COLLBERG AND TODD A. PROEBSTING

Repeatability in Computer Systems Research

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We next made a formal request to the university for the source code under the broad Open Records Act (ORA) of the authors' home state. The university's

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https://doi.org/10.1145/2812803

legal department responded with: "We have been unable to locate a confirmed instance of [system's] source code on any [university] system."

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» key insights

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 Sharing research software preservis many challenges, so handing opencies should previde support for the engineering resources necessary to enable repeatable research.

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The Current Artifact Badging System

Artifact Evaluation – Revised Badges

ACM initiative 2017:

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Does the artifact work?

Is the artifact permanently available?

Can the results be confirmed?

Artifact Evaluation – Alternative Badges

Alternative badges from other publishers have similar semantics:



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Alternative badges from other publishers have similar semantics:



ACM permits badge usage outside ACM if they comply with ACM definitions

Artifact Evaluation – Processes



Artifact Evaluation – Processes



TACAS & CAV (tool papers), ECOOP (2022-2024)



ACM Artifact Policies and Terms

Different Levels of Research Reliability

Repeatability The measurement can be obtained with stated precision by the **same team** using the **same measurement procedure**, the **same measuring system**, under the **same operating conditions**, in the **same location** on multiple trials. For computational experiments, this means that a researcher can reliably repeat her own computation.

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Replicability The measurement can be obtained with stated precision by a **different team**, a **different measuring system**, in a **different location** on multiple trials. For computational experiments, this means that an independent group can obtain the same result using artifacts which they develop completely independently.

https://www.acm.org/publications/policies/artifact-review-and-badging-current

Different Levels of Research "Reliability"

Repeatability Same team, same setup Reproducibility Different team, same setup Replicability Different team, different setup

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Terminological Variations

Property	NISO ¹ (ACM since 2020)	VIM ² (ACM pre 2020)
Repeatability	Same team, same setup	Same team, same setup
Reproducibility	Different team, <mark>same</mark> setup	Different team, <mark>different</mark> setup
Replicability	Different team, <mark>different</mark> setup	Different team, same setup

¹https://doi.org/10.3789/niso-rp-31-2021 ²https://doi.org/10.59161/JCGM200-2012 Beyer, Winter

ACM Badge Categories



Artifacts evaluated

Artifacts available

Results validated

These [badge categories] are considered independent and any one, two or all three can be applied to any given paper depending on review procedures developed by the journal or conference.

Artifacts Evaluated

Two levels are distinguished, only one of which should be applied in any instance



- Documented
- Consistent
- Complete
- Exercisable
- All properties of "Functional"
- Well documented and structured
- Meets community norms and standards

Artifacts Available



- Publicly accessible
- DOI or link + unique object identifier
- Long-term retention policy (≥ 10 y)
 - Zenodo, Figshare, Dryad, ...
 - Not GitHub, institute website, ...
- "Formal evaluation" not strictly needed

Results Validated



- Subsequent study from other authors exists
 - uses some of the original work's artifacts
 - confirms results
 - deviations from exact results tolerable if conclusions do not change

By definition not artifact-related
Recommendations for AE Organizers

Timeline

- 1. Process/submission-system decisions
- 2. Load/resources planning/decisions
- 3. AE committee assembly
- 4. AE timeline planning and call for artifacts (CfA)
- 5. Awards and process evaluation planning
- 6. Bidding, Assignment, Evaluation
- 7. Publication preparations

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- Whom to recruit: Mix of junior (30-40%) and senior artifact reviewers https://doi.org/10.1145/3368089.3409767
- ▶ How to recruit: PC/open nominations, scan prior committees

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- General CfA advice: Do not restrict nor extend ACM's badge definitions
- Provide clear guidance for packaging and documentation

Awards

- Academic evaluations and reward based on citation counts
- Evaluated artifacts not linked with higher citation counts → Alternative reward mechanisms needed! https://doi.org/10.1145/3540250.3549172
- Distinguished artifact/reviewer awards as intermediate remedy

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- ► If possible:
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 - Check artifacts behind such links to correspond to evaluated version

Recommendations for Artifact Authors



Unless there are legal or ethical restrictions, go for the Available badge.

Artifact Badges

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AE	Available	Papers with	ls
Evaluated	Badge Status	Artifact Link	Accessible
AE	Av. Badge	676	675 (99.9%)
	No Av. Badge	473	431 (91.1%)
NonAE	Av. Badge	67	65 (97.0%)
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Artifact Hosting

If you go for Available, use a DOI-issuing platform for submission.



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- Ideally also ship Docker/Vagrant files for transparency

Artifact Documentation

Follow the CfA's documentation requirements (if none, use FSE 2018) and include a license (as file)

Search Term	Matched Artifacts		Avg. Word Count	
Search Term	AE	NonAE	AE	NonAE
No match	13	12	-	-
^read.*me ^install ^doc/	84 6 1	86 1 8	1 389 324 2 431	645 593 13 901
^copyright ^license	0 50	1 46	0 850	268 1 220

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What to Include in an Artifact README?

- Abstract: summarize contents, purpose, and required computing resources
- Contents: list the important files/directories and table of contents
- ► TL;DR: simple instructions to run the tools and perform small experiments
- System requirements and installation guide
- Instructions to execute the tools: command line, input/output, configurations
- Instructions to perform the experiments: demo and full evaluation
- Instructions to process and understand the experimental results
- Others: known issues and reference logs for listed commands

README — Takeaways

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 - Ideally, the selected tasks can partially validate the claims in the paper
- Check consistency between the paper and artifact!

Artifact Development

- Artifact evolves alongside the research project
- Always keep the experimental setup reproducible
Recommendations for Artifact Reviewers

Artifact Hosting

- Many hosting platforms undermine double-blind reviews by tracking IP addresses
 - URL redirects
 - Personal/institute websites
 - ▶ ...

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 - ▶ ...
- Solution: obfuscate IP address (proxies, tor)
- Better: Inform AEC chairs
- \blacktriangleright \Rightarrow Insist on using DOIs exclusively

Artifact Pre-Assessment ("Kicking-the-Tires")

- Can the artifact be downloaded?
- Are HW requirements (GPU, x86-46 vs. ARM silicon) met?
- Are input data or external software dependencies included or (if not) accessible?

The sooner you realize, the sooner the AEC chairs can react.

Serve the Community

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- Help authors improve artifact quality.
- Reject broken artifacts that cannot or will not be improved.

Checklists



Goal: Fair and unbiased assessments

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- If none provided, create one based on CfA and structure your review accordingly

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- ► For a template, see our extended abstract.

Further Reading & Hands-On Experience

Reading Suggestions

- Christian Collberg, Todd A. Proebsting: "Repeatability in Computer Systems Research" (https://doi.org/10.1145/2812803)
- Robert Heumüller, Sebastian Nielebock, Jacob Krüger, Frank Ortmeier: "Publish or perish, but do not forget your software artifacts" (https://doi.org/10.1007/s10664-020-09851-6)
- Ben Hermann, Stefan Winter, Janet Siegmund: "Community expectations for research artifacts and evaluation processes"

(https://doi.org/10.1145/3368089.3409767)

- Christopher S. Timperley, Lauren Herckis, Claire Le Goues, and Michael Hilton: "Understanding and improving artifact sharing in software engineering research" (https://doi.org/10.1007/s10664-021-09973-5)
- Stefan Winter, Christopher S. Timperley, Ben Hermann, Jürgen Cito, Jonathan Bell, Michael Hilton, and Dirk Beyer: "A retrospective study of one decade of artifact evaluations"

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Beyer, Winter



Select an artifact from our list:

https://www.stefan-winter.net/ae-materials.html

Or from FSE 2025: https://dl.acm.org/toc/pacmse/2025/2/FSE



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