Living Artifacts
Enabling Vertical Progress in Cybersecurity Research

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Motivation and Need

- Like many scientific fields, cybersecurity struggles with reproducibility and reuse
- Artifact evaluation efforts at top conferences since at least 2017
  - Successfully evaluated artifacts earn badges, displayed on papers
  - Helps motivate artifact sharing: Olszewski et al. found that the percentage of papers with artifacts has increased by 36% from 2013 to 2023
- Sharing is necessary, but not sufficient for successful reuse
  - Code artifacts may not easily compile and run
  - Data preprocessing, output validation, hyperparameter tuning may be missing
  - Datasets may be hard to interpret
- Successful reuse is important
  - Allows future independent researchers to build on prior published work
  - Over time, leads to more sophisticated and impactful solutions ⇒ **vertical progress!**

25-40%
released code artifacts

Olszewski et al. 2023, 2025

40-44%
ran w/o modifications

Current Artifact Evaluation

- Human-centered practice
  - Poorly standardized metadata - sometimes in PDF
  - Loose packaging instructions
  - README files instead of installation and run scripts
- Focus on author claim validation
  - Similar to paper review - double-check that the authors' work is valid
  - **A few other researchers** were able to validate claims **on their own hw** or on authors' hw
  - Possibly with authors' help, but fixes may not propagate or apply to other platform
- May lead to incomplete artifacts
  - Private data, scaled-down models, portion of results
- Resulting artifacts are
  - Hard to find - appendix and metadata are separate from the artifact and paper
  - Hard to reuse - hw, sw, paid APIs, packaging challenges
  - May become less reusable over time

Interoperable ❌

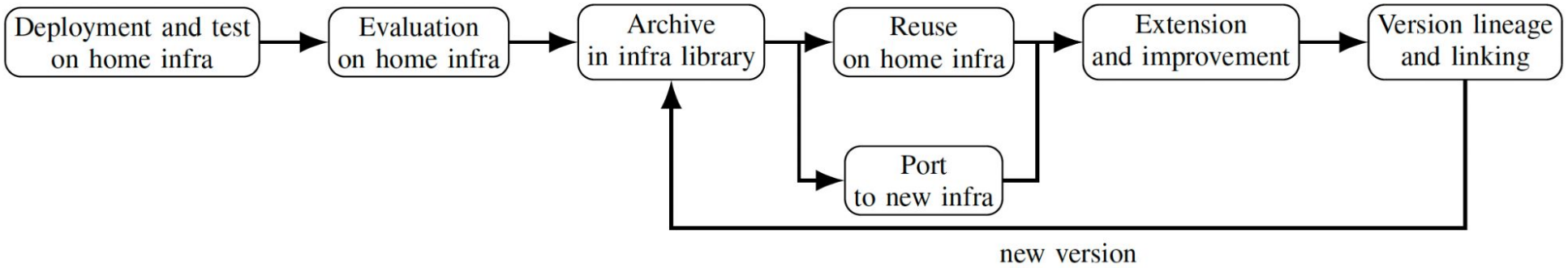
standard metadata and install/running scripts

Findable ❌
Accessible ❌
Reusable ❌

code installs and runs

Living Artifacts

- Standardized metadata
  - Including links to paper, hw/sw dependencies, install scripts, claim-verify scripts
- Packaged and evaluated on a public research infrastructure (home)
  - Author interactions feed into the final artifact
  - Easy to reuse on the home infrastructure, can be archived there
- Others can build on and version the artifact
  - Add new features, port to new infrastructure, modernize over time
  - Facilitates vertical science
- Some artifacts will die out
  - Remain in permanent repository, can be revived by future researchers



Traditional Versus Living Artifacts

Property	Traditional	Living
Publicly available	✓	✓
Runs during evaluation	✓	✓
Standardized execution environment		✓
Easy reuse after publication		✓
Machine-readable metadata		✓
Claim-level execution scripts		✓
Supports versioned extension		✓
Traceable lineage		✓
Designed for long-term reuse		✓

Living Artifacts and Vertical Science

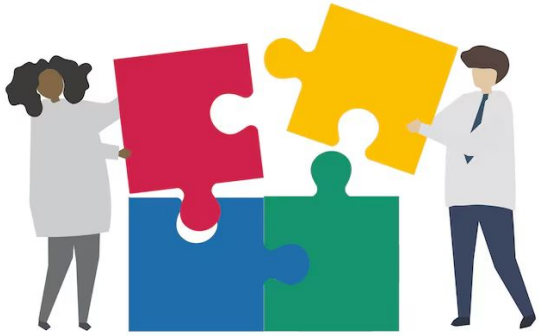
- Living artifacts should
  - Be easier to reuse on their home infrastructure
  - Easier to extend, port and incorporate into future security solutions
  - Facilitate vertical science where teams build on each other's work
  - Improve visibility of evaluators, authors and contributors
- Packaging and metadata standards are also needed
  - Enable automated search over metadata - better findability
  - Enable easy extension (build scripts instead of VM/Docker images)
- Necessary, but not sufficient for vertical science
  - Current paper reviews view work building on prior research as incremental
  - We could define specific criteria for evaluation of work that advances prior results, reusing and improving existing artifacts

Reusable ✅

Findable ✅
Accessible ✅
Interoperable ✅

Path Forward

- Artifact evaluation committees can:
  - Require standardized metadata and packaging
  - Require evaluation on public research infrastructure, wherever possible
- Authors can:
  - Package their artifacts on public research infrastructure, making it more reusable
- Research infrastructures can:
  - Provide specialized support to the AECs
  - Support artifact archiving, cloning, modification and version linkage
- Research community can:
  - Reward artifact reuse and building on prior work

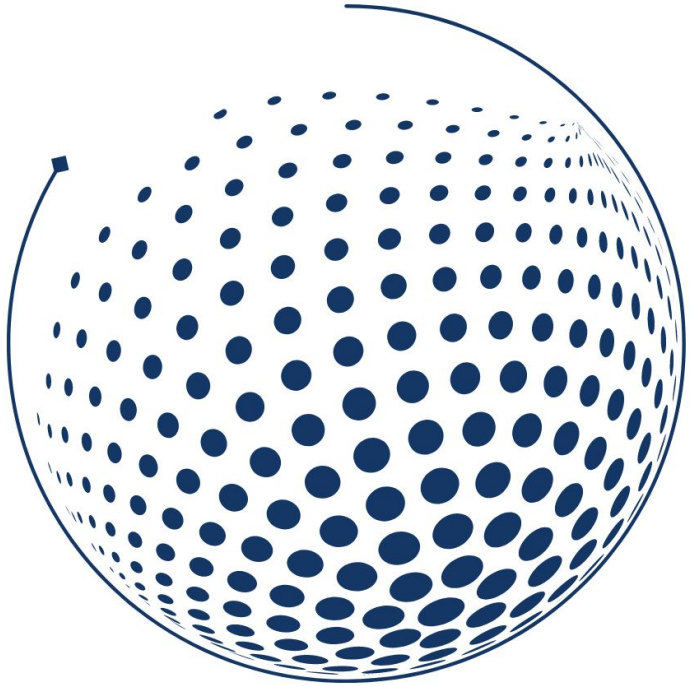


QUESTION: How should living artifacts handle work that depends on private infrastructure, private data, or specialized hardware?

Thank you!

https://sphere-project.net
https://sphere-testbed.net

contact@sphere-project.net



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