Nullius in Verba: Reproducibility for Database Systems Research, Revisited

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The Royal Society motto [. . .]:

The determination [. . .] to verify all statements by an appeal to facts determined by experiment. (Wikipedia)

Wolfgang Mauerer

- Industry: Siemens Corporate Research
- Academia: Professor at Technical University of Applied Sciences Regensburg
- Favourite reproducibility badge: ICSE 2019

Stefanie Scherzinger

- Industry (earlier): Software developer (IBM, Google)
- Academia: Professor at University of Passau
- Favourite reproducibility badge: BTW 2021

What to Expect

Long-Term Maintenance in Industry

- Boeing 747 aircraft
  - Development started in 1966
  - Last machines produced in 2022 will be in service until about 2050
- Bitcoin
- Tor Browser
- Civil Infrastructure Platform Initiative: Linux Kernels

Piggyback Strategy for Research

Put your money on open source tools that are massively employed:
as industry has a strong incentive (and the resources) to maintain them.

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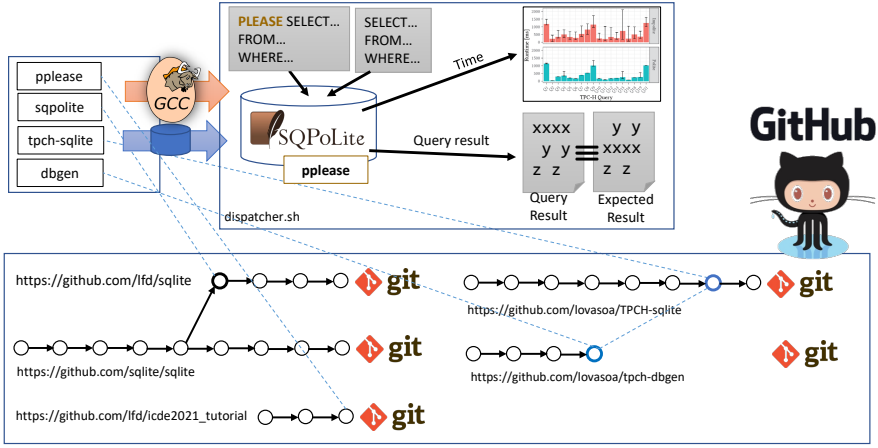
Play-along docker recipe: `https://github.com/lfd/icde2021_tutorial`.

Working Example I



Working Example II

We measure

- Query runtime
- Throughput
- Latency

We encounter:

- Noise
- Variability

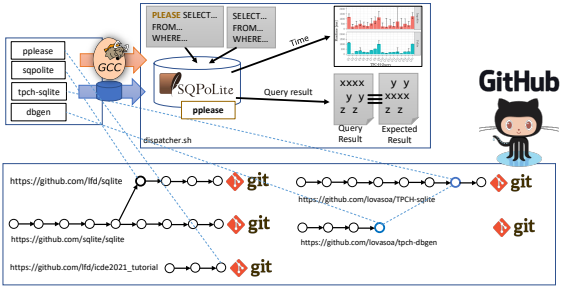
```
1  void measure_query(char *dbfile, char *basepath, char *query, int iterations) {
2      // ... pre-allocate mm buffer to hold time stamps ...
3      // ... open DB connection, open dbfile, read in query string ...
4
5      tstamps[0] = get_tstamp(); // Record start timestamp.
6      for (int count = 1; count < iterations; count++) {
7        rc = sqlite3_exec(db, sql, 0, 0, &err_msg);
8        // ... handle potential errors ...
9
10       tstamps[count]  = get_tstamp(); // Record end timestamp.
11     }
12
13     // ... write durations from mm buffer to to stdout ...
14     // ... free resources ...
15 }
```

latency.c

Working Example IV

```
sqpolite> .load ./pplease
sqpolite>
sqpolite> select pplease(o_comment) from orders limit 3;
What was the magic word again?
nstructions sleep furiously among
 foxes. pending accounts at the pending, silent asymptot
sly final accounts boost, please. carefully regular
sqpolite>
sqpolite>
sqpolite> select pplease(o_comment) from orders limit 3;
nstructions sleep furiously among
 foxes, please. pending accounts at the pending, silent asymptot
sly final accounts boost. carefully regular
```

- Artefacts (data, code, SW tools, scripts)
- Build process
- Need to compare both the artefacts *and* the results.



Various choices for target dimensions:

- Artefacts: bitwise identity, functional identity
- Observables
  - physical quantities (time, energy consumption, ...)
  - functional results (bitwise-identical, permutation-identical, ...)
  - stochastic results (numerical noise, ...)
- Build the toolchain itself (y/n)
- Unspecified dependencies (y/n)
- External sources (y/n)

Hands-On Example: Building & Comparing Artefacts

Hands-on examples: Building & Comparing

- Binaries (C/C++)

Further Challenges

- Linking
- Libraries
- Tarballs

Tool Support

- Reprotest (pypi.org/project/reprotest/)
- Diffoscope (diffoscope.org/)
- See the accompanying website for further links

Create “an island of stability in an ocean of activity”

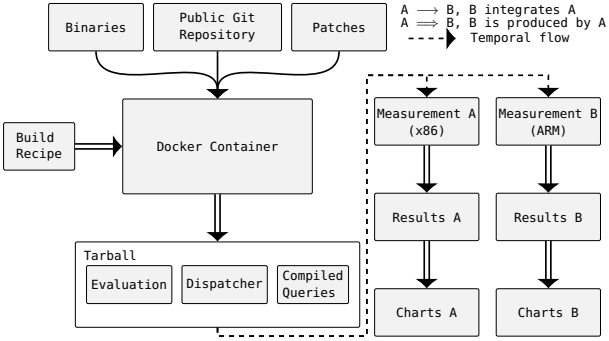
Be independent of updates to external components, because...

- Base system details change (package versions, etc.)
- System runtime configuration (beyond distro and kernel versions) changes
- Github repositories disappear
- Projects move between hosts (Sourceforge, GitHub, ...)
- External software is no longer maintained, download links disappear
- ...

Goal: Build self-contained, complete environments

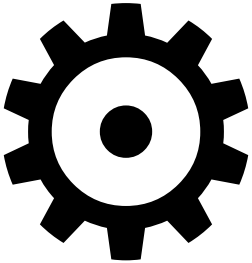
Be ready to build your stuff even when you trapped on an island
without internet access, or 20 years after all the repositories have gone.

Illustration

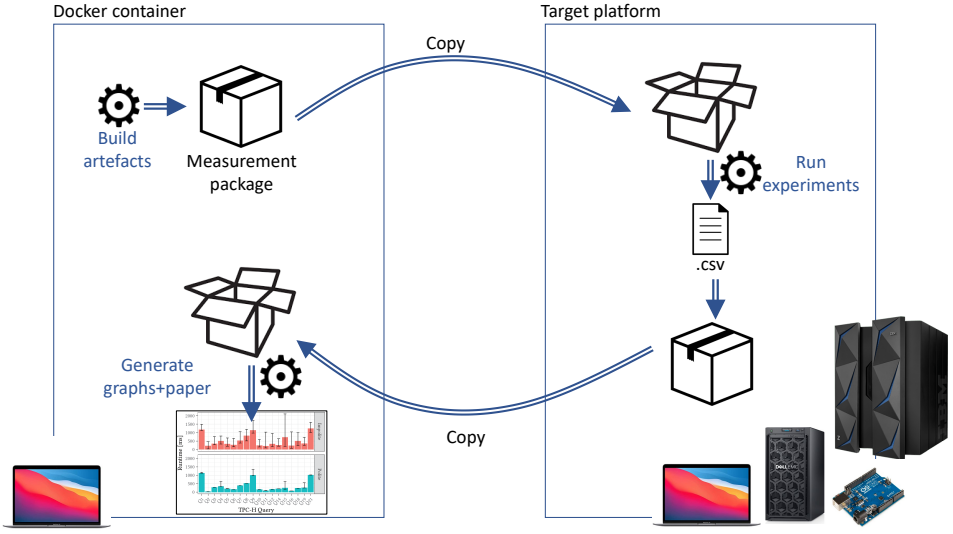


Wolfgang Maurer, Ralf Ramsauer, Edson Ramiro Lucas Filho, Daniel Lohmann, Stefanie Scherzinger: *Silentium! Run-Analyse-Eradicate the Noise out of the DB/OS Stack.* BTW 2021.

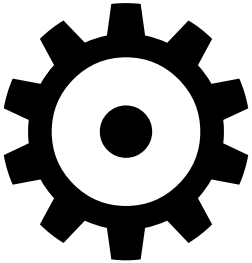
RESULTS REPRODUCED BTW-2021



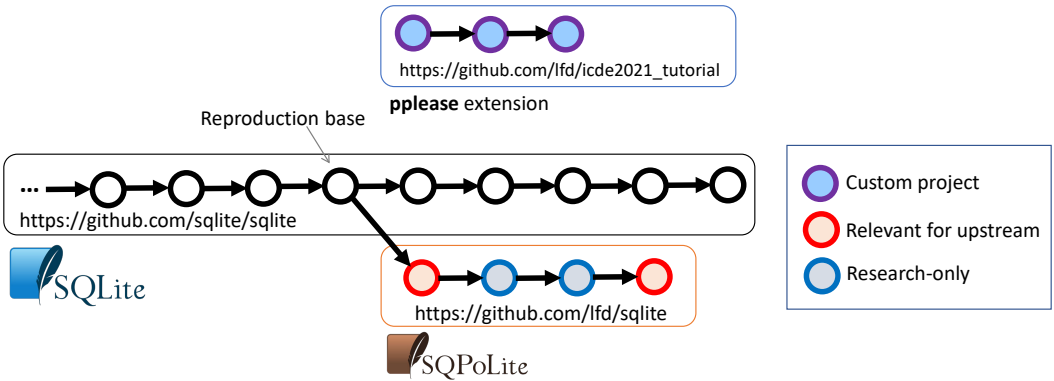
Building Execution Packages



Hands-On Example: Execution



Artefacts extended by Research



Hands-On Example: Patch Stacks

- Presenting thoughts versus presenting results
- Rebasing, squashing, rewriting and all of that
- Self-documenting patches
- Trail of responsibility/lineage and provenance
- Upstream, integrate, externalise?

Steps

- Choosing a license
- Specifying a license
- SPDX

Proprietary, closed-source components

~~Just don't!!~~ Try not to use them.

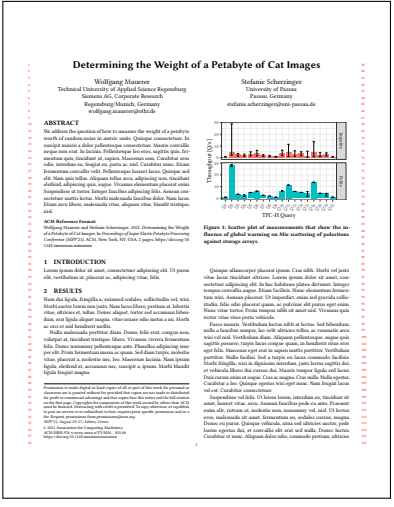
We have solved two problems:

- Our build is reproducible.
- Our results are reproducible.

Two more to go:

- We need to write a paper.
- We need to make our artefacts available.

End-to-end reproduction I



Determining the Weight of a Petabyte of Cat Images

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ABSTRACT

We address the question of how to measure the weight of a petabyte worth of random noise in metric units. Quisque consectetuer. In suscipit mauris a dolor pellentesque consectetuer. Mauris convallis neque non erat. In lacinia. Pellentesque leo eros, sagittis quis, fermentum quis, tincidunt ut, sapien. Maecenas sem. Curabitur eros tellus, interdum eu, feugiat eu, porta ac, nisl. Curabitur nunc. Etiam fermentum convallis velit. Pellentesque laoreet lacus. Quisque sed elit. Nam quis tellus. Aliquam tellus arcu, adipiscing non, tincidunt eleifend, adipiscing quis, augue. Vivamus elementum placerat enim. Suspendisse at tortor. Integer faucibus adipiscing felis. Aenean consectetuer mattis lectus. Morbi malesuada faucibus dolor. Nam lacus. Etiam arcu libero, malesuada vitae, aliquam vitae, blandit tristique, nisl.

ACM Reference Format:
Wolfgang Mauerer and Stefanie Scherzinger. 2021. Determining the Weight of a Petabyte of Cat Images. In *Proceedings of Super-Quick Petabyte Processing Conference (SHPP'21).* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

1 INTRODUCTION

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2 RESULTS

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SHPP'21, August 23–27, Athens, Greece
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ACM ISBN 978-x-xxxx-xxxx-x/YY/MM…$15.00
https://doi.org/10.1145/nnnnnnn.nnnnnnn

Figure 1: Scatter plot of measurements that show the influence of global warming on Mie scattering of polaritons against storage arrays.

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Figure 2: Scatter plot of measurements that show the influence of global warming on Mie scattering of polaritons against storage arrays.

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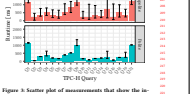

Figure 3: Scatter plot of measurements that show the influence of global warming on Mie scattering of polaritons against storage arrays.

3 CONCLUSIONS

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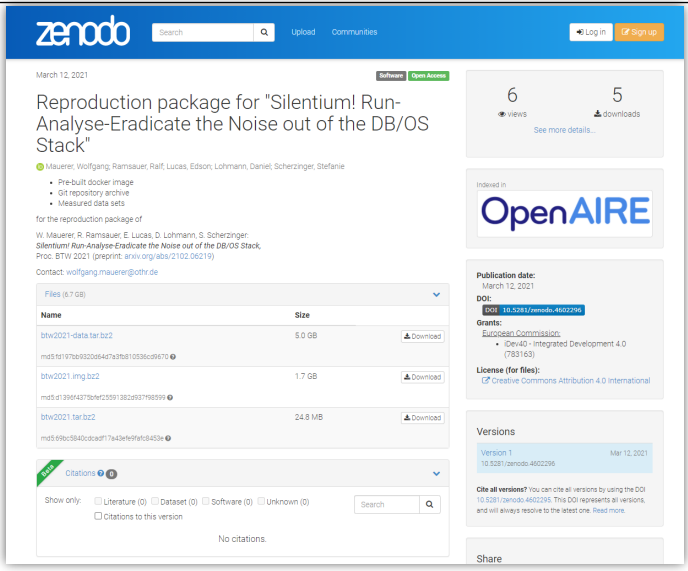
End-to-end Reproduction II



Benefits vs. Costs

- We won't lie to you: Reproducibility engineering is a lot of work.
- Enablers to reproducibility: Testability & automation
- However, there are clear benefits for your team, just imagine:
  - Long-term, automation will save you time.
  - You can build your stuff even after your PhD student has graduated.
  - You can switch to a new notebook without risking your progress in research.
  - You will no longer have to negotiate within the team why s.th. works for you, but only you.

Acknowledgments

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