Introduction to Networking and Systems Measurements

Reproducible Experiments

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Reproducibility vs Repeatability

- **Repeatability** measures the variation in measurements taken by a single instrument or person under the same conditions

- **Reproducibility** measures whether an entire study or experiment can be reproduced in its entirety.

Why?

- Establish variance – **Repeatability**
- Establish reliability – **Repeatability**

- Evaluate a new method – **Reproducability**
- Eval. a new environment – **Reproducability**
- Evaluate a new approach – **Reproducability**

Variables and Constants

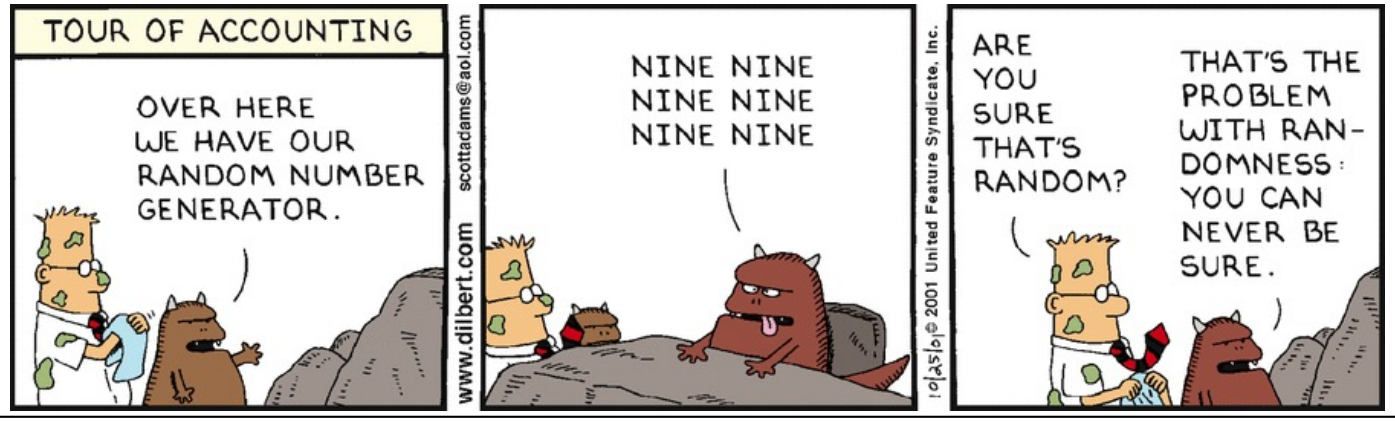
- *Why?* will tell us what we want to *vary*

  and

- *Why?* what we need to hold constant

Random-ish

- Rarely do we want true-random
- Typically we want pseudo-random
- Often we want to specify the seed(s)



Method and Environment

- Simulation?
- Emulation?
- Implementation driven evaluation?
- Deployment?
- Partial emulation?
- Partial implementation driven evaluation?

Software tools: Scripts, Make, etc

- We have some quite useful repeatability tools:

  e.g., Make (links dependencies)

- Scripts – *documents* what you actually need to do to get from (A) to (B)

- So please use them.

Machines (/Hardware)

- Memory? CPU? Disk type and config?
- Hyperthreading and temperature controls?

- Which slots were stuff in?
- Switch config? Switch hardware? Which *actual* Switch?
- Which transceivers? NICs? cables?

- Tell me again which disk did you dump data to?

- (Oh did you mention the periodic process that moved the data from your machine to another machine so the local disk didn't overrun….)

Workloads

- Why is this workload the right one?
  - Stress testing?
- Did you use the workload-generator correctly?
- Record everything from command line options to software and library versions.

Benchmarks

- Often well equipped to run with good reproducibility
- Often not representative of what you want
- Benchmarks might exercise, but just like in fitness training: exercising is not *competing*

Logged data

- Lets talk about time….
  - No god clock
  - Many representations
  - TimeZone is fun
  - UNIX time is fine, sometimes…
- Text records are nice (for humans)
- Binary records are nice (for programs)

So what is meta-data?

The other stuff needed to repeat precisely the same experiment

- Make and Model (and firmware and config)
- DNS (at least the entries for your systems)
- Bootp/dhcp/activedirectory - all state

Documentation

- What is the goal of the experiment?
- How to set it up?
- What are all the dependencies? And versions?
- Are special licenses required?
- What is the command line to run?
- What was the script used in the experiment?
- Can you script the process?

Other Useful Practices

- Snapshot of the code base of the executable we used
  - If the code was change during the experiment – match code to results!
- Photo of the setup
- File headers, comments, README files, …

Try stuff!
(don’t be hipster Flanders)

Other peoples work

To reproduce other peoples work

You must get inside other peoples heads

(so consider their motivations)

Very few *high-bars* in reproducibility, here is one I co-authored earlier…

`http://www.cl.cam.ac.uk/research/srg/netos/qjump/repro.html`

Another – particularly relevant – example

Where Has My Time Gone?

Authors: Noa Zilberman, *et al*.

PAM 2017

- Dataset DOI: https://doi.org/10.17863/CAM.7418
- https://www.cl.cam.ac.uk/research/srg/netos/projects/latency/pam2017/