

# 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?

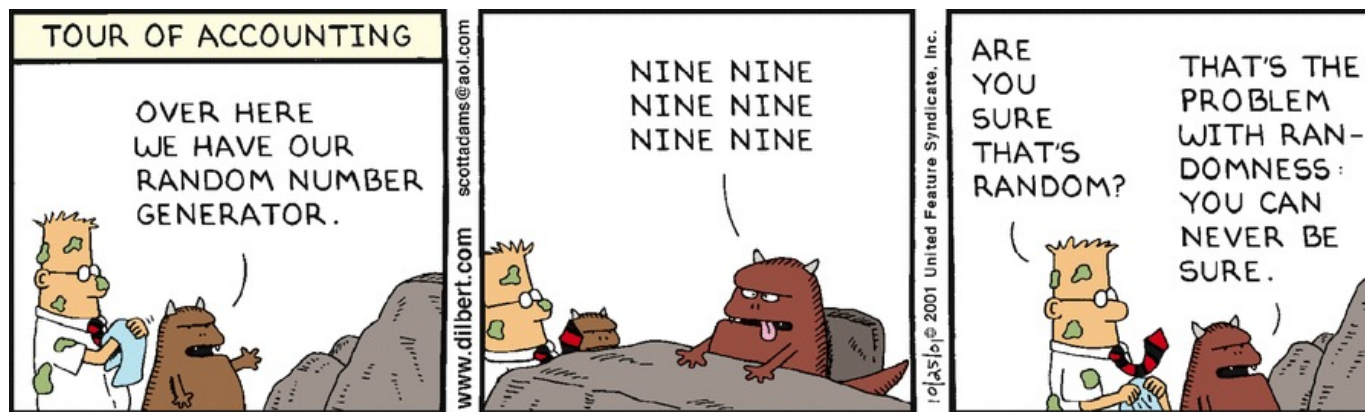
- Establish variance – **Repeatability**
- Establish reliability – **Repeatability**
  
- Evaluate a new method – **Reproducibility**
- Eval. a new environment – **Reproducibility**
- Evaluate a new approach – **Reproducibility**

# *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:  
Make (links dependencies)
- Scripts – sort of 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>