Experiments in Computer Science

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"*The fundamental principle of science, the definition almost, is this: the sole test of the validity of any idea is experiment*"
– Richard P. Feynman

- Tried and true experimental scientific methodology from Physics, Biology, Chemistry ...
  - Often *not* followed in Computer Science
- Let's be better Computer S*cientists*!

Scientific Methodology

- Observe
  - (Devise solution)
- Hypothesize
- Design
- Experiment
- Analyze
- Report

Methodology: Observe and Understand

- Find Problem
  - Test: *make of Linux kernel*
  - Build: *memory intensive programs*
  - Read: *Linux Hacker's guide says …*
- Understand Relationships
  - *Hard page faults are expensive*
  - *Logical memory larger than physical*

Methodology: Devise and Hypothesize

- Devise Solution (unless empirical)
  - *Claypool Reliable Audio Protocol (CRAP)*
  - *Claypool buffering algorithm*
- Make Hypothesis
  - Generalization about relationships
  - *Soft page faults are common*
  - *Malloc does not cause page fault*
  - Needs to be tested (not proven)

Methodology: Experiment

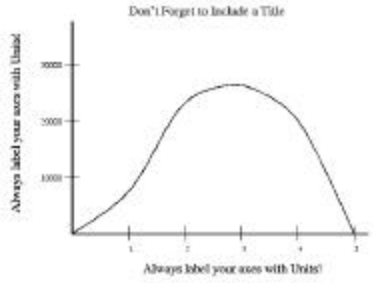
- Design Experiment
  - Variable: *variable workload*
  - Control: *baseline workload*
- Run Experiment

  "Whoa! That's not what I expected!"
  - Bug in code
    - Back to "Run"
  - Uncontrolled event (*system backup*)
    - Back to "Design"
  - Insufficient understanding *(Unix scheduling)*
    - Back to "Understanding"

Methodology: Analyze

- Interpretation and Evaluation
  - Statistical significance
    - + mean, confidence intervals, correlation, goodness of fit
  - Does data *support* or *reject* hypothesis?
  - Explanation of other phenomena
    - + *Better code reduces page faults, improves performance*

Graph: A Data Analysis Tool



- A picture is worth a thousand words
- Title, label axes (units!), legend

Dirty Little Secrets

- Mini-experiments (no, "Pilot Tests")
- Hypotheses after the fact
  - Running yields understanding
- Results *here* mean results *there*
- Controlled system still says meaningful things about the real world
- Observing a system will not change it