Tricks of the Programming Trade

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Problem Definition
The Back of the Envelope
Debugging
Other Tricks

www.programmingpearls.com/tricks

Three Kinds of Knowledge

General

1. Science
2. Project Management
3. ‘‘Tricks of the Trade’’

Examples from Medicine

1. Chemistry, Biology
2. Operating teams, Medical records
3. Blood samples

Examples from Software

1. Program verification, algorithm design
2. Team organization, scheduling
3. This talk

About This Talk

Goals

For the listeners: a few amusing stories, and a prod to think about tricks.

For the talker: more stories and tricks.

Rules

Mandatory: real-time thought, some discussion.

Illegal: note taking, verbal answers from table-lookup.

Problem Definition

Context

A public opinion polling firm wishes to draw a random sample from a (hardcopy) list of precincts.

The User's Idea

Input: The user types n precinct names (10-character strings) and an integer $m < n$. Typically, $m \approx 20$ and $n \approx 200$.

Output: Random selection of m names.

A Better Problem

Input: Integers m and n.

Output: A sorted list of m integers in the range 1..n. For example, if $m = 3$ and $n = 8$, the output might be 2, 3, 5.

Better Yet

Input: A hardcopy list of precincts.

Another Randomizing Problem

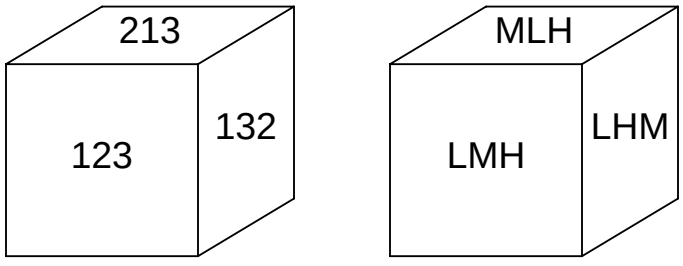
The Problem

For $N = 72$ psychological subjects, randomly permute order of experimenters (1, 2, 3) and stress conditions (High, Medium, Low).

Output of the Program

```
1 3L 2M 1H
2 3H 1M 2L
3 1L 2H 3M
4 1M 2L 3H
  ...
```

A More Elegant Solution



Why it failed

A Quiz

How much water flows out of the Mississippi River per day?

One Possible Answer. The river is about a mile wide, twenty feet deep, and flows at five miles per hour.

$$1 \text{ mile} \times 1/250 \text{ mile} \times 120 \text{ miles/day}$$

$$\approx 1/2 \text{ mile}^3/\text{day}$$

It discharges roughly one-half cubic mile per day.

Two Answers Are Better Than One

How much water flows out? As much as flows in.

The Mississippi basin is about 1000 by 1000 miles, and the annual runoff from rainfall is about one foot. Yearly drainage is

$$1000 \text{ miles} \times 1000 \text{ miles} \times 1/5000 \text{ mile/year}$$

$$\approx 200 \text{ miles}^3/\text{year}$$

so daily outflow is

$$200 \text{ miles}^3/\text{year} \; / \; 400 \text{ days/year}$$

$$\approx 1/2 \text{ mile}^3/\text{day}$$

A cheating triple check: An almanac reports that the river's discharge is 640,000 cubic feet per second, or 0.4 cubic miles per day.

Tabular Computation

How much water flows in per year?

$$\frac{1000\ \text{miles}}{} \cdot \frac{1000\ \text{miles}}{} \cdot \frac{1\ \text{mile}}{5000\ \text{year}}$$

Cancel terms.

$$\frac{\cancel{1000}\ \cancel{\text{miles}}}{} \cdot \frac{\cancel{1000}\ \cancel{\text{miles}}}{} \cdot \frac{\cancel{1}\ \cancel{\text{mile}}}{\cancel{5000}\ \text{year}} \cdot \frac{200\ \text{mile}^3}{}$$

Multiply by 1 year = 400 days (almost).

$$\frac{\cancel{1000}\ \cancel{\text{miles}}}{} \cdot \frac{\cancel{1000}\ \cancel{\text{miles}}}{} \cdot \frac{\cancel{1}\ \cancel{\text{mile}}}{\cancel{5000}\ \text{year}} \cdot \frac{200\ \text{mile}^3}{} \cdot \frac{\text{year}}{400\ \text{days}}$$

Cancel again.

$$\frac{\cancel{1000}\ \cancel{\text{miles}}}{} \cdot \frac{\cancel{1000}\ \cancel{\text{miles}}}{} \cdot \frac{\cancel{1}\ \cancel{\text{mile}}}{\cancel{5000}\ \cancel{\text{year}}} \cdot \frac{\cancel{200}\ \text{mile}^3}{} \cdot \frac{\cancel{\text{year}}}{\cancel{400}\ \text{days}} \cdot \frac{1}{2}$$

Reminders About Quick Calculations

How To Do Them.

Two answers are better than one.
Tabular computations.
Dimension checks.
Quick checks.
Common sense.
Rules of thumb.
Safety factors

When To Do Them.

After a system has been designed, before starting implementation.

Before any efficiency improvements.

Cost-benefits analysis.

Exercises

When is a cyclist with removable media faster than a high-speed data line?

A newspaper asserts that a quarter has ‘‘an average life of 30 years’’. Is that reasonable?

An advertisement asserts that a salesperson drives a car 100,000 miles in a year. Is that reasonable?

How many tons of people are in this room? How many cubic feet of people? Of room?

If every person in this city threw a ping pong ball into this room, how deep would we be?

How long to read a CD-ROM?

How much money will Americans spend on soft drinks this year?

How many words in a book? How many words a minute do you read? How many hours per week do you watch television?

Rules of Thumb

π seconds is a nanocentury.

Rule of 72

Little's Law

90-10 (80-20) Rules. 10% of X accounts for 90% of Y: (population, beer) (code, run time) (code, function)

The cheapest, fastest and most reliable components of a computer system are those that aren't there.

Whenever possible, steal code.

[The Test of Negation] Don't include a sentence in documentation if its negation is obviously false.

[The Principle of Least Astonishment] Make a user interface as consistent and as predictable as possible.

[KISS] Keep it simple, stupid.

Approaches to Debugging

Program Verification

Don’t make any mistakes.

Theory of Test Data Selection

Uncover all mistakes.

Advanced Debuggers

Use ’em if you have ’em.

The Right Attitude

Debugging Steubenville, Ohio

From Roueché's *Medical Detectives* (Penguin, 1991)

Background

36 cases of salmonella from December, 1980 through February, 1982

A Good Debugger

''I was prepared for hard work, for plenty of old-fashioned shoe-leather epidemiology.''

A Key Hint

''In such outbreaks, there is always a common denominator — an eating place, a wedding reception, a picnic, a dinner party, a church social. Something in which everybody is involved.''

Dominant age group: 20-29

Debugging Computer Systems

Some Puzzles

A banking system ‘‘quits’’ on international data.

The programmer can’t log in standing up.

The program worked once twice.

The program works when the programmers are in the room, but fails half the time when they aren’t.

A Moral

Debugging is usually unbelieving.

The key is skepticism: the magician.

Tricks of the Trade

Ten Design Hints

Work on the right problem.
Explore the design space of solutions.
Look at the data.
Use the back of the envelope.
Exploit symmetry.
Design with components.
Build prototypes.
Make tradeoffs when you have to.
Keep it simple.
Strive for elegance.

Nurturing Trickiness

Observe
Read
Discuss
Practice
Reflect