



Experimentation & empirical reasoning are becoming increasingly important in CS

- to evaluate software and hardware systems
- to apply in interdisciplinary research (HCI, Scientific Computing, ...)
- to utilize computers as tools in traditional sciences

See [Reed,Miller&Braught, SIGCSE 2000] for further rationale & references

Similar to programming & problem-solving skills, empirical skills must be developed incrementally

- start with fundamental concepts, well-defined experiments
- revisit and reinforce concepts throughout the curriculum
- with experience, build independence

At the intro level



want to lay a foundation for experimentation and empirical reasoning skills:

- carry out a well-defined experiment using a program model/simulation
- analyze experimental data, explain results

concepts:

- consistency vs. accuracy, Law of Large Numbers, ...

CS0/CS1 example: Given a Web page that generates random 3-letter sequences, estimate the number of 3-letter words in the English language.

- framework for the experiment is provided, but exposes students to process
- can introduce consistency, accuracy, Law of Large numbers right away

CS1 example: In 2001, women's college volleyball shifted from sideout scoring to rally scoring. Why?

- Shorter games? More exciting games? Fairer? More predictable?
- can involve students in hypothesis formation, program implementation, analysis
- reinforces basic concepts (e.g., how many simulations are required?)

At the intermediate level



build upon foundational concepts & skills

skills:

- carry out more open-ended experiments (following the scientific method)
- form hypotheses, design programs for testing hypotheses, support/refute
- follow the revise-and-repeat cycle

concepts:

- variance, standard deviation, causality, ...

DS Example: Assuming random insertions and searches in a binary search tree, is maintaining tree balance worth it?

- avg depth of trees after random insertions? avg search cost over trees?

DS Example: Compare old style bank lines (1 line per teller) and new style bank lines (1 line serving all tellers).

- maximum wait time? avg wait time? predictability of wait time? throughput?

At the advanced level



apply empirical skills in various domains

skills:

- recognize the applicability of experimentation
- design, conduct, analyze experiments

concepts:

- statistical and empirical concepts specific to the domain

HCI Example: conduct usability studies of software interfaces

AI Example: refine heuristics for state space searches, game playing, ...

SE Example: profile software performance through experimentation