Rolling the Dice: Flipping an elementary probability and statistics classroom

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Overview

1. What we inherited
2. What we created
3. Demonstration
4. What we learned
5. Syllabus (if time)

What we inherited

18.05: Introduction to probability and statistics.

- Traditional lecture class for non-math majors
- Dwindling enrollment

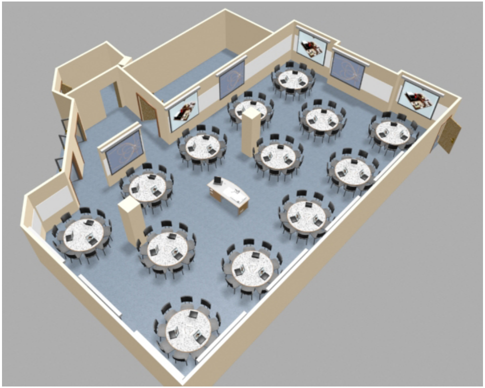
An interest in new approaches.

- active learning (Haynes Miller)
- online learning (the world)

Transition

- New classroom
- New pedagogy
- New technology
- New curriculum (at the end if time)

Room and video



[Show video clip, full video on OCW 18.05 site (link below)]

Active learning, flipped classroom

- Meet 3 x 80min in TEAL room
- 60 students, 2 teachers, 3 assistants

- Reading / reading questions on MITx
- Minimal lecturing
- Group problem solving at boards
- Whole class and table discussions
- Clicker questions
- Computer-based studio using R
- Traditional psets and pset checker

Bayesian dice

Bayesian dice

2

Bayesian dice

2 1

Bayesian dice

2 1 6

Bayesian dice

2 1 6 5

Bayesian dice

2 1 6 5 8

Bayesian dice

2 1 6 5 8 7 3 2 7

Bayesian dice

2 1 6 5 8 7 3 2 7 3 6 5 6

Bayesian dice

2 1 6 5 8 7 3 2 7 3 6 5 6 4 8 8 6 7 8 7 5 1

Active learning notes

- Standing up is beneficial
- Physical space is critical
- Both peer and teacher instruction
- Student self-assessment
- Teachers formative assessment
- Accelerates learning to teach content

Coming soon: EMES talk by David Pengelley on how to flip a class.

Technology and flipped classroom

- Reading questions
- Attendance
- Pset checker

Computer studio

- Once a week
- Used R
- Don't teach programming. Let students do it!
- Heavily scaffolded projects designed to reinforce concepts
- Graded –need efficient grading system
- Tested –open internet
- Took about 3 years to get a good set of projects

Common questions

How much work was all this?

- A tremendous amount, especially at first, because we changed so many things at once.
- Using MITx added some overhead and requires someone willing to fight with it.
- Much less work by the third year.

How much are you able to cover?

- More material with greater understanding.

Other observations

- Active learning is more fun
- Co-teaching is more fun
- Students like getting to know their teachers
- Students like targeted reading more than lecture video
- Students love the pset checker

OpenCourseWare and OCW Educator

All 18.05 course materials and a discussion of the pedagogy and educational decisions is on OCW:

`https://ocw.mit.edu/courses/mathematics/18-05-introduction-to-probability-and-statistics-spring-2014/`

Broad Course Goals

- Learn the language and core concepts of probability theory
- Understand basic principles of statistical inference (Bayesian, frequentist, bootstrap)
- Build a starter statistical toolbox with appreciation for both utility and limitations
- Use software and simulation to do statistics (R).
- Become an informed consumer of statistical information (paper analysis).
- Prepare for further coursework or on-the-job study (active learning).

Curriculum

Traditional course:

- Probability: counting, random variables, gallery of distributions, central limit theorem.

- Statistics: linear regression, estimation, confidence intervals, p-values, NHST, bootstrapping

Changes:

- A Bayesian bridge
- Heavy use of computers for simulation and visualization

The fork in the road

Probability (mathematics)

$$\boxed{P(H|D) = \frac{P(D|H)P(H)}{P(D)}}$$

Everyone uses Bayes' formula when the prior $P(H)$ is known.

Bayesian path

Frequentist path

Statistics (art)

$$\boxed{P_{\text{Posterior}}(H|D) = \frac{P(D|H)P_{\text{prior}}(H)}{P(D)}}$$

Bayesians require a prior, so they develop one from the best information they have.

$$\boxed{\text{Likelihood } L(H;D) = P(D|H)}$$

Without a known prior frequentists draw inferences from just the likelihood function.

Course Arc

- Probability:
  (uncertain world, perfect knowledge of the uncertainty)
  - Basics of probability: counting, independence, conditional probability
- Statistics I: pure applied probability:
  (data in an uncertain world, perfect knowledge of the uncertainty)
  - Bayesian inference with known priors
- Statistics II: applied probability:
  (data in an uncertain world, imperfect knowledge of the uncertainty)
  - Bayesian inference with unknown priors
  - Frequentist confidence intervals and significance tests
  - Resampling methods: bootstrapping
  - Discussion of scientific papers

- Computation, simulation and visualization using R and Javascript applets were used throughout the course.

Thank you

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