Pedagogical considerations for simulation-based inference in a large-enrollment introductory biostatistics course.

Matthew Beckman & Kari Lock Morgan
Penn State University

Joint Statistical Meetings
Baltimore, MD
August 3, 2017

Outline:

- Brief Course Description
- Pedagogical opportunities
  - Simulation-based inference (SBI)
  - Large enrollment
  - Intersection of SBI & large enrollment
- Compare/contrast approaches (i.e. informal discussant)

Brief Course Description

- STAT 250: Introduction to Biostatistics
- 225 students enroll each semester
- Lecture Mon & Fri (50 min; all students)
- Lab Wed (50 min; 3 sections x 75 students)
- Design
  - Question of the day (life science; sometimes PSU rsh)
  - StatKey + Minitab
  - In-class exams

Pedagogical opportunities: SBI

- Mathematical exposure
  - Can scaffold as needed
    - Tangible/tactile introduction (Ernst 2004; Rossman, 2008)
    - Permutation distribution as segue to SBI (Ernst, 2004)
  - Intuition built on frequencies (Gigerenzer & Hoffrage, 1995)
- Flexibility of application (Efron, 2000, p. 1294)
- Facilitates some useful conversations
  - Thinking under the null (Wild et al. 2011)
  - p-values and the nature of randomness (Rossman, 2008)
  - Why sample with replacement?
- Introduce key concepts using SBI; revisit with non-SBI
  - Lock et al. (2017)
  - Tintle et al. (2016)
  - Zieffler et al. (2012)

Pedagogical opportunities: Large enrollment

- Large sample size for student generated data (GAISE, 2016)
  - reliable demonstrations of asymptotic properties (e.g. CLT) using data generated in-class
  - unusual observations often generated in-class
    - outliers (e.g. wrong units & typos)
    - legitimate extreme obs. (the tails are real)
    - sensitivity analysis discussions
- (Anonymous) Engagement
  - Crowd-sourced Q&A
  - Live SMS inbox
  - Clickers
    - instant feedback
    - instant run-off

Pedagogical opportunities: Intersection of SBI & large enrollment

- Example: m&m activity in lecture
  - Live capture in Google Sheet
  - class approximates a sampling distribution
  - student builds bootstrap distribution
  - tangible comparison of sampling dist & bootstrap dist
- Example: StatKey on smart phones (during lecture)
  - accessible & scalable technology integration
  - partner work (one run the app; one take notes)

References

Efron, B. (2000). The bootstrap and modern statistics. *Journal of the American Statistical Association, 95* (452), 1293-1296.

Ernst, M. D. (2004). Permutation methods: A basis for exact inference. *Statistical Science, 19*(4), p. 676-685.

GAISE College Report ASA Revision Committee (2016). *Guidelines for Assessment and Instruction in Statistics Education College Report 2016*, `http://www.amstat.org/education/gaise`.

Gigerenzer, G., & Hoffrage, U. (1995). How to improve bayesian reasoning without instruction: Frequency formats. *Psychological Review, 102*(4), p. 684-704.

Lock, R. H., Lock, P. F., Lock-Morgan, K., Lock, E. F., Lock, D. f. (2017). *Statistics: Unlocking the power of data* (second edition). Hoboken, NJ: Wiley.

Rossman, A. J. (2008). Reasoning about informal statistical inference: One statistician's view. *Statistics Education Research Journal 7*(2), p. 5-9.

Tintle, N. L., Chance, B. L., Cobb G. W., Rossman, A. J., Roy, S., Swanson, T. M., VanderStoep, J. L. (2016). *Introduction to Statistical Investigations*. Hoboken, NJ: Wiley.

Wild, C. J., Pfannkuch, M., Regan, M., & Horton, N. (2011). Towards more accessible conceptions of statistical inference. *Journal of the Royal Statistical Society, 174*(2), 247-295.

Zieffler, A., & Catalysts for Change (2015). *Statistical Thinking: A simulation approach to undertainty* (third edition). Minneapolis, MN: Catalyst Press.

Compare/contrast approaches (i.e. informal discussant)