36–727 Modern Experimental Design

Alex Reinhart

Fall 2018

Instructor Alex Reinhart, areinhar@stat.cmu.edu, BH 232K

Class meetings Mini 1, TR 3–4:20pm, PH 225B

Office hours TBA

Website `https://canvas.cmu.edu/`

Textbook Giesbrecht and Gumpertz (2004), *Planning, Construction, and Statistical Analysis of Comparative Experiments* (PDF freely available through CMU library access to Wiley; doi:10.1002/0471476471); plus course notes and papers posted on Canvas

Designed experiments are crucial to draw causal conclusions with minimum expense and maximum precision. This course introduces the basic principles and theory of experimental design, including randomized designs, blocking, analysis of covariance, factorial designs, and power analysis, along with a selection of more advanced topics, which may include sequential and adaptive designs, A/B testing, the design of observational studies, or other topics depending on time and class interest. Students will learn to design appropriate experiments for a variety of research scenarios, and practice these skills through a course project. Coursework will primarily use R for analysis of experimental data.

Students should have prior or concurrent experience in regression analysis, at the level of 36-401 or 36-707.

Course Objectives

Students will learn

- to recognize the goals, constraints, and limitations involved in designing an experiment for a particular problem,
- to design an appropriate experiment to answer specific substantive questions,
- to analyze experimental data using a variety of statistical methods in R,
- to use simulations and power analyses to explore the weaknesses of a given design, and
- to communicate design decisions, analyses, and substantive results in written reports.

Coursework

There will be two types of work in this course:

Assignments There will generally be a homework assignment due each week. Assignments may involve analysis of experimental data, derivations, simulation tasks, descriptions of appropriate experimental designs for challenging situations, and so on.

Some assignments may be *in-class* assignments, meaning they are activities completed during class and due at the end of the class period or the beginning of the next. For example, you may be asked to derive a result or work out an interesting experimental design in class. Other assignments may be reading assignments for a specific class, requiring you to read a paper or chapter before class and complete some task related to it.

The project There will be a course project in lieu of a final exam. The project will involve designing and running an experiment in a challenging situation with resource constraints, and writing a report describing the design, analysis, and conclusions.

The project will be due in several pieces. A proposed design and analysis will be due midway through the course, and will be returned with comments and suggestions which should be incorporated in the final analysis and report. Further details will be given in class.

Homework may be submitted handwritten, as PDF files from LaTeX, or as HTML output from RMarkdown; all analyses, simulations, and reports (including the project) must be submitted as reproducible RMarkdown files through Canvas.

Grading

The course grade will be 60% from the homework and 40% from the project. Final letter grades will be:

Numeric grade	Letter grade
[98, 100]	A+
[90, 98)	A
[80, 90)	B
[70, 80)	C
[60, 70)	D
[0, 60)	R

One assignment (not the project) will be dropped without consequence, to allow for unexpected illness, coffee spills on laptops, and so on. No late work will be accepted without prior written approval.

Email

Questions about course concepts are best addressed in office hours, not via email. However, the instructor is available to answer questions by email a best-effort basis: don't expect an instant answer to a 3AM email or one just before a deadline. And note that sending an email does not eliminate your responsibility for completing your assignments on time.

If you email us, please do so from your CMU email account, not your Gmail or whatever. I have no way of knowing that fluffybunny4@gmail.com is really you. Write professional emails. If your email is so hip and informal that we can't understand it, we won't reply.

Academic Integrity

Discussing assignments with other students is allowed and encouraged, but it is important that every student gets practice solving problems. This means that *all the work you turn in must be your own.* You must devise and write your own solutions to homework and exam problems and conduct your own project. My policy on collaboration is:

1. You must first make a serious effort to solve the problem on your own.
2. If you are stuck after doing so, you may ask for help from another student. You may discuss strategies to solve the problem, but *you may not look at their solution.* (Nor may you have it read to you.)
3. You must then write your own solution individually, and clearly indicate who you received assistance from.

The same applies in reverse: if someone asks you for help, you must not provide it unless then have already attempted to solve the problem, and you *may not share your solutions.*

You also must not consult any online or other sources which discuss solutions related to homework problems. You can, of course, refer to textbooks or webpages to look things up, but you must independently solve the problem assigned, *not* transcribe a solution from elsewhere.

Please ask me if you have any questions about this policy. Cheating has consequences which can include course failure and a report to the appropriate university authorities. You can also consult the university policy on Academic Integrity: `https://www.cmu.edu/policies/student-and-student-life/academic-integrity.html`

(I may have copied this policy from the 36-750 syllabus, but that's not a valid excuse for you to copy anything!)

Disability Services

If you have a disability and require accommodations, please email Catherine Getchell, Director of the Office of Disability Resources (getchell@cmu.edu) or call her office at 412-268-6121. If you have an accommodations letter from the Office of Disability Resources

office, I encourage you to discuss your accommodations and needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate.

Wellness

All of us benefit from support during times of struggle. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is almost always helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit their website at `https://www.cmu.edu/counseling/`. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

Tentative Schedule

Date	**Topic**	**Project**
Week 1	Causality and ANOVA	
Week 2	Multiway ANOVA	Project introduced
Week 3	Blocking and ANCOVA	
Week 4	Factorials and power analysis	
Week 5	Binary responses and survival	Design report due
Week 6	Adaptive designs	Revisions; experiment begins
Week 7	Designed observational studies	Experiment continues
Week 8	No class (reading period)	Final report due