**Paper Description:** The goal of this assignment is to learn about and explain a new topic closely related to probability theory. We do not have time to cover all of the exciting aspects of probability theory, so some of it will be up to you! This paper does not need to constitute an original piece of mathematical research; rather, I would like to see you synthesize and digest ideas from a variety of sources.

**Choosing a topic:** There are a large number of sample topics on the next page. I encourage you to think about an aspect of probability theory related to your own interests or coursework. Between now and October 22, look at the list below, Google some of these terms, look at Wikipedia, and write emails to me to get a sense of what you want to work on. By October 22, I would like an email from you with a 1 paragraph proposal of your paper topic. Ideally, I would like to see you in my office hours to discuss your topic in advance. Get started early!

**Formal details:** The final draft of your paper should be typed, double-spaced, and not more than 10 pages long (excluding references). You will need to explain the background material carefully. There should be at least one proof in your paper. All of your references must be cited, including the author(s), title of the work, journal (if applicable), publisher, pages numbers, and year of publication. The specific format of the citations is unimportant, as long as the information is there.

**Presentation:** I will ask you to give a 10-minute presentation on your paper during one of the class periods between November 12 and December 5. Your paper does not need to be complete in order to give a successful presentation. The idea is to give an overview of what you’re reading about and convey at least one interesting idea to your peers. Optimally, I would like volunteers for presentation dates. If no one volunteers, I will pick randomly (according to the uniform distribution).

**Collaboration Policy:** This paper is an individual assignment. You are certainly welcome to speak with me, your classmates, and other professors about it, but in the end the research and writing are your responsibility alone.
Sample topics:

- Random matrix theory over finite fields (requires linear algebra and abstract algebra background)
- Randomized algorithms in computer science (for example, Quicksort or MinCut)
- Randomized polynomial time algorithms in number theory
- Random walks
- Markov chains (linear algebra background)
- Probabilistic number theory — normal numbers, average number of prime factors
- Uniform distribution modulo 1
- Probability that two (or more) randomly chosen integers have no common factor
- Khinchin’s theorem on continued fractions
- Sicherman dice (alternate numbering of the faces of dice)
- Zero-sum game theory (up through the minimax theorem?)
- random Kakeya sets (requires linear algebra background)
- random number generators
- Banach-Tarski paradox and non-measurable sets
- Pierre Raymond de Montmort’s matching problem and the Poisson distribution

(I can suggest references for most of these topics.)