Math 175: Combinatorics

Course Goals

Combinatorics can be described as the art of counting. The subject is built up from simple concepts but we will quickly run into difficult problems that require clever insights. We will learn what sorts of objects mathematicians are interested in counting and many techniques for studying them.

Another goal, probably more important than learning a body of material, is to develop your mathematical reasoning ability. We will learn lots of problem-solving techniques in this course and use them to solve lots of different kinds of problems. We will also do lots of proofs.

This course will serve as a good foundation for aspiring mathematicians, but will also be very useful even if you never intend to take another math class. Ideas we will encounter have far-ranging applications in computer science, applied mathematics, and other quantitative areas. The experience you will gain here will help prepare you to reason clearly in our increasingly quantitative and data-driven world.

Course Outline

1. Binomial Coefficients, Pascal's Triangle.

2. Fibonacci Numbers, Permutations and Combinations.

3. Proof by Induction, The Principle of Inclusion/Exclusion, The Pigeonhole Principle.

4. Basic Discrete Probability, Conditional Probability, The Law of Large Numbers.

5. Generating functions and recurrence relations.

Books

1. *Discrete Mathematics: Elementary and Beyond*, L. Lovász, J. Pelikán, K. Vesztergombi.
   ISBN: 0387955852

   Note: We plan to cover Chapters 1-5 of this book.

2. *Combinatoics and Graph Theory, 2nd ed.*, J. Harris, J. Hirst, M. Mossinghoff.
   ISBN: 978-0-387-797710-6

   Note: We plan to cover Sections 2.1-2.6 of this book.