CS70
Discrete Mathematics and Probability Theory
Spring 2015

Instructor and Lecture

- Instructor: Umesh Vazirani
- Lecture: Tuesday and Thursday, 5:00-6:30 pm, 1 Pimentel
- Office: 671 Soda Hall
- Office hours: Monday 1:15-2:00 pm, Tuesday 6:30-7:15 pm

Syllabus

Discrete mathematics and probability theory provide the foundation for many algorithms, concepts, and techniques in the field of Electrical Engineering and Computer Sciences. For example, computer hardware is based on Boolean logic. Induction is closely tied to recursion and is widely used, along with other proof techniques, in theoretical arguments that are critical to understanding the foundations of many things, ranging from algorithms to control, learning, signal processing, communication, and artificial intelligence. Similarly for modular arithmetic and probability theory. CS70 will introduce you to these and other mathematical concepts. By the end of the semester, you should have a firm grasp of the theoretical basis of these concepts and their applications to general mathematical problems. In addition, you will learn how they apply to specific, important problems in the field of EECS.

This course is divided into two main units, each of which will introduce you to a particular mathematical concept as well as its applications. The units are:

1. Proofs and Discrete Structures

Proofs

- Propositions and quantifiers
- Proof techniques: direct proofs, proofs by contradiction and contraposition
- Induction in its various forms
- The stable marriage problem

Graphs

- Eulerian tours
- Trees and hypercubes

Modular Arithmetic

- Congruence relations
- Euclid's GCD algorithm and multiplicative inverses
- The RSA cryptosystem
- Polynomials over finite fields
- Error correcting codes

Diagonalization and Self-Reference

- Cardinality of infinite sets
- Cantor's diagonalization proof
- Uncomputability and the halting problem

2. Probability Theory

Counting and Discrete Probability

- Combinatorics and combinatorial proofs
- Probability spaces and events
- Conditional probability and Bayes' rule
- Hashing
- Random variables and distributions
- Expectation, variance, and Chebyshev bounds
- Polling and the law of large numbers
- Joint distributions and Bayesian inference

Continuous Probability

- Continuous probability spaces and random variables
- Uniform and exponential distributions
- Normal distributions and the Central Limit Theorem

Weekly schedule

Time	Monday	Tuesday	Wednesday	Thursday	Friday
9AM	DIS 101 - Allen 102 Latimer		DIS 101 - Allen 102 Latimer		
10AM	DIS 103 - Chenyang 123 Wheeler		DIS 103 - Dibyo 123 Wheeler		HW Party Woz Lounge
11AM	DIS 104 - Chi Pang B56 Hildebrand / DIS 105 - Amy 175 Barrows		DIS 104 - Chi Pang B56 Hildebrand / DIS 105 - Amy 175 Barrows		
12PM	DIS 106 - Ajay B56 Hildebrand / DIS 107 - Manish (Advanced) 122 Wheeler		DIS 106 - Ajay B56 Hildebrand / DIS 107 - Manish (Advanced) 122 Wheeler		
1PM	DIS 108 - Alex 102 Latimer / DIS 109 - Ajay B56 Hildebrand		DIS 108 - Alex 102 Latimer / DIS 109 - Ajay B56 Hildebrand		
2PM	DIS 110 - David 24 Wheeler / DIS 111 - Ajay B51 Hildebrand		DIS 110 - David 24 Wheeler / DIS 111 - Ajay B51 Hildebrand		HW Party Woz Lounge
3PM	DIS 112 - Chi Pang 121 Wheeler / DIS 113 - Chenyang 3109 Etcheverry		DIS 112 - Chi Pang 121 Wheeler / DIS 113 - Dibyo 3109 Etcheverry		
4PM	DIS 115 - Sean (Gentle) 121 Wheeler / DIS 116 - Hugh 24 Wheeler / DIS 117 - Manish 254 Sutardja Dai		DIS 115 - Sean (Gentle) 121 Wheeler / DIS 116 - Hugh 24 Wheeler / DIS 117 - Manish 254 Sutardja Dai		
5PM	DIS 118 - Moor 100 Wheeler	Lecture 1 Pimentel	DIS 118 - Moor 100 Wheeler	Lecture 1 Pimentel	
6PM					

Schedule of Lectures

January

- Jan 20: Propositions + quantifiers
- Jan 22: Proofs
- Jan 27: Induction
- Jan 29: Induction (continued) + recursion

February

- Feb 3: Stable marriage
- Feb 5: Graphs, Eulerian tour
- Feb 10: Trees, hypercubes
- Feb 12: Modular arithmetic
- Feb 17: Midterm 1
- Feb 19: Bijections, RSA
- *Drop deadline: Feb 20*
- Feb 24: Fermat, RSA, polynomials
- Feb 26: Polynomials, secret sharing

March

- Mar 3: ECC (error-correcting codes)
- Mar 5: Infinity + uncountability
- Mar 10: Uncountability, Godel
- Mar 12: Counting
- Mar 17: Probability spaces
- Mar 19: Conditional probability
- *Spring break: Mar 23-27*
- Mar 31: Midterm 2

April

- Apr 2: Two killer apps
- *P/F deadline: Apr 3*
- Apr 7: Random variables
- Apr 9: Linearity of expectation, Markov
- Apr 14: Variance, Chebyshev
- Apr 16: Some important distributions
- Apr 21: Continuous probability
- Apr 23: Inference
- Apr 28: Zipf's Law and power law distributions
- Apr 30: How to lie with probability

Final: May 15, 11:30-2:30