

ArsDigitaUniversity
Month2:DiscreteMathematics -ProfessorShaiSimonson

Syllabus

Week1: Introduction,Proofs,Logic,BooleanAlgebraandapplications,Setsand applications,Basicsumsandfunctions.

Reading:Rosen1.1 -1.8,3.1 -3.2,5.5,9.1 -9.3HowtoReadMathematics
(http://academics.stonehill.edu/compsci/History_Math/math-read.htm),Polya, *HowtoSolveIt* .

Lecture1: Whatkindsofproblemsaresolvedindi scretemath?Whatareproofs? Examplesofproofsbycontradiction,andproofsbyinduction:Trianglenumbers, irrationalnumbers,andprimenumbers.(3.1 -3.2)

Lecture2: BooleanAlgebraandformallogic.Applicationsinalgorithms,complexity theory, AI,digitallogicdesignandcomputerarchitecture.(1.1 -1.2,9.1 -9.3)

Lecture3: Morelogic:quantifiersandpredicates . Sets,operationsonsets,using logictoproveidentitiesonsets.(1.3 -1.5)

Lecture4: Sets.Applicationsincounting(theincl usion-exclusiontheorem),theory ofcomputationanddatastructures.(5.5)

Lecture5: Growthrateoffunctions,Big -Onotation,Countability,1 -1 correspondence.Applicationstoalgorithmsandtheoryofcomputation.(1.6 -1.8)

Week2: Induction,recursion,recurrenceequations,graphs.

Reading:Rosen3.3 -3.5,5.1 -5.3,7.1 -7.5

Lecture1: Basicarithmeticandgeometricsums,closedforms.CompoundInterest -asimplerecurrence.Binarysearch -recursion,inductionandcomplexity.Towers ofHanoi -recursion,induction,andgraphs.(3.3 -3.5)

Lecture2: Chineseringspuzzle -Greycodes,graphs,hypercubes,Hamiltonianand Eulercircuits,planargraphs,Euler'stheorem.(7.1 -7.5)

Lecture3: Solvingrecurrenceequations -repeatedsubstitution, theMasterTheorem withapplicationstoalgorithms,changeofvariabletechnique.(5.1,5.3)

Lecture4: Solvingrecurrenceequations -guessingandprovingcorrectby induction,linearhomogeneousustypes.TheJosephusProblem.(5.2)

Lecture5: Mathematicalinduction -aflexibleandusefultool.Manyexamplesand theideaofstronginduction.(3.2)

Week3: Counting and discrete probability. Combinations, permutations, pigeonhole principle, inclusion/exclusion revisited.

Reading: Rosen 4.1 -4.7, 5.6, How to Read Math (re-read from week 1)

Lecture1: Combinations and permutations. Pascal's triangle and binomial coefficients. (4.1, 4.3)

Lecture2: Counting problems using combinations, distributions and permutations. (4.6)

Lecture3: The pigeonhole principle and examples. The inclusion/exclusion theorem and advanced examples. A combinatorial card trick. (4.2, 4.7, 5.6)

Lecture4: Discrete probability, the birthday *paradox*, and many examples. (4.4)

Lecture5: Conditional probability, and more counting. (4.5)

Week4: Generating functions, Number theory for cryptography and computer science, equivalence relations, partial orders, trees.

Reading: Rosen 2.1 -2.5, 5.4, 6.1 -6.6, 8.1 -8.2

Lecture1: Generating functions. (5.4)

Lecture 2: Primes, Greatest Common Divisors and the Euclidean Algorithm. (2.1 -2.5)

Lecture3: The two-jug puzzle as demonstrated by Bruce Willis in **Die Hard III**.

Lecture4: Congruences and Fermat's little theorem. Application to Cryptography. (6.1 -6.6)

Lecture5: Partial orders, trees and equivalence relations. Application to algorithms. (8.1 -8.2)