COMP2804: Discrete Structures II

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Jump to Lecture Topics

Course Objectives

A second course that is designed to give students a basic understanding of Discrete Mathematics and its role in Computer Science. Computers handle discrete data rather than continuous data. The course presents an overview of some of the major theoretical concepts needed to analyze this type of data.

Office Hours

We have lots of office hours during which TAs or myself can help you with studying course material and offer you guidance for assignments.

Day		Staff	Time	Location
Mon	AM	Yuan Wu	09:00-11:00	4125 Herzberg
Mon	AM	Zoltan Kalnay	11:00-13:00	4125 Herzberg
Mon	PM	Mehrnoosh Javarsineh	14:00-16:00	4125 Herzberg
Tue	AM	Pat Morin	09:00-11:00	5177 Herzberg
Tue	PM	Alexa de Grandmont	14:30-16:30	4125 Herzberg
Wed	AM	Andy Tran	11:30-13:00	4125 Herzberg
Wed	PM	Abdullah Alchihabi	15:30-17:30	4125 Herzberg
Thu	AM	Mathieu Leblanc	09:30-11:30	4125 Herzberg
Thu	PM	Andy Tran	14:30-16:00	4125 Herzberg
Fri	AM	Hao Yan	10:00-12:00	4125 Herzberg
Fri	PM	FX CC	12:00-14:00	4125 Herzberg
Fri	PM	Joyce Bacic	16:00-18:00	4125 Herzberg

Important Dates

Sunday	Jan 26	23:55	Assignment 1 due (in cuLearn)
Sunday	Feb 9	23:55	Assignment 2 due (in cuLearn)
Thursday	Feb 13	13:00	Mid-term exam (in class)
Sunday	Mar 15	23:55	Assignment 3 due (in cuLearn)
Tuesday	Apr 7	23:55	Assignment 4 due (in cuLearn)

Sample Exams

Here are exams for previous offerings of this course (for study purposes).

Assignments

- Assignment 4 is due on Tuesday April 7, before 23:55.
- Assignment 3 was due on Sunday March 22, before 23:55. Sample solutions are available as PDF file and LaTeX file.
- Assignment 2 was due on Sunday February 9, before 23:55. Sample solutions are available as PDF file and LaTeX file.
- Assignment 1 was due on Sunday January 26, before 23:55. Sample solutions are available as PDF file and LaTeX file.

Please note the following rules and requirements about assignments:

- Late assignments will not be accepted.
- Assignments emailed to me will not be accepted.
- I will not respond to emails sent shortly before or after assignment deadlines asking for exceptions to the preceding two rules.
- You can type your solutions, or write them by hand and scan them (for example, using a scan app on your phone or using a real scanner).
- Solutions written-up in LaTeX are preferred, but not strictly required. In case you want to learn LaTeX, here is a tutorial. Learning LaTeX is a useful exercise, since many programs (including Microsoft Word) now use LaTeX for typesetting formulas.
- Each assignment must be submitted as one single PDF file through cuLearn.

Academic Integrity (New—Please Read)

As of 2020, there are new penalties in place for academic integrity violations. These will be issued by the Associate Dean (Undergraduate Affairs) of Science to students who copy, in whole or in part, work they submit for assignments.

- First offence: F in the course
- Second offence: One-year suspension from program
- Third offence: Expulsion from the University

These are minimum penalties. More-severe penalties will be applied in cases of egregious offences. Failure to inform yourself of the expectations regarding academic integrity is not a valid excuse for violations of the policy. When in doubt, ASK your instructor or TA.

Grading Scheme

Assignments	25%
Mid-term exam	25%
Final exam	50%

Textbooks

We will be using the following free (*libre* and *gratis*) textbooks. The first one is the primary textbook for this course. The second contains supplementary and background material:

- Michiel Smid. Discrete Structures for Computer Science: Counting, Recursion, and Probability, 2019.
- Eric Lehman, F Thomson Leighton, and Albert R Meyer. Mathematics for Computer Science, 2018

Accommodation Statement

The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or pmc@carleton.ca for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to

send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). Requests made within two weeks will be reviewed on a case-by-case basis. After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (www.carleton.ca/pmc) for the deadline to request accommodations for the formally-scheduled exam (if applicable).

Lecture topics

You should already be familiar with the following topics from COMP 1805: basic logical reasoning, sets and functions, proof strategies (direct proof, proof by contradiction, proof by induction), Sigma-notation for summations, basic graph theory, Big-Oh, Big-Omega, Big-Theta. You may take a look at Chapter 2 of the textbook and do some of the exercises at the end of that chapter. Review the relevant parts of Lehman et al if you are still struggling.

The following schedule is from the Fall 2019 offering of COMP2804. Dates, videos, and topics will be updated as the course progresses.

- Jan 7: Introduction
  - Course overview.
  - Chapter 1 in the textbook: Ramsey Theory, ~~Sperner's Theorem,~~ Quick-Sort.

- Jan 9: Counting (1)

- Product Rule, Sections 3.1

- Jan 14: Counting (2)
  - Bijection Rule, Complement Rule, Sum Rule, The Principle of Inclusion-Exclusion, Sections 3.2, 3.3, 3.4, 3.5.

- Jan 16: Counting (3)
  - Binomial coefficients, Newton's Binomial Theorem, combinatorial proofs, Vandermonde's Identity, Pascal's Triangle, Sections 3.6, 3.7.

- Jan 21: Counting (4)
  - Sections 3.7 and 3.8.
  - How many strings can be obtained from SUCCESS? Section 3.9.1
  - Counting solutions of linear (in)equalities, Section 3.9.2

- Jan 23: Pigeonhole Principle
  - Simon's Drinking Problem, Section 3.10.1
  - Every $(n+1)$-element subset of $\{1, \ldots, 2n\}$ contains a divisible pair, Section 3.10.2

- Infinity of primes, Section 3.10.4

- Jan 28: Recursion (1)
  - Recursive functions, Section 4.1.
  - Fibonacci numbers, Section 4.2.
  - Proof that $f_n = (\varphi^n - \psi^n)/\sqrt{5}$
  - Counting 00-free bitstrings
  - Counting aa-free strings over $\{a, b, c\}$
  - Counting ab-free strings over $\{a, b, c\}$

- Jan 30: Recursion (2)
  - Exercise 4.38

- Euclid's algorithm, Section 4.5. (gcd.py)

- Feb 4: Recursion (3) (Guest lecturer)
  - MergeSort, Section 4.6.

- Feb 6: Randomization and probability (Guest lecturer)
  - Anonymous broadcasting: Dining Cryptographers, Section 5.1.
  - Probability Theory: Probability spaces, sample spaces, probability functions, Section 5.2.
  - Basic rules of probability, Section 5.3.

- Feb 11:
  - Midterm review

- Feb 13:
  - Midterm exam
- Feb 25:
  - The Birthday Paradox (section 5.5)

- Find the big box (section 5.6)

- Feb 27:
  - Let's Make a Deal, the Monty Hall Problem, Section 5.7.
  - Conditional probability, Section 5.8.
  - Anil's kids, Exercise 5.40, the remarkable set B.

- Mar 3:
  - Independent events, Section 5.11.

- Exercise 5.81.

- Mar 5:
  - Section 5.12, in particular, the probability of a circuit failing, Section 5.12.3.
  - Choosing a random line in a file, Section 5.13.

- Mar 10:
  - Infinite probability spaces, Section 5.15, Exercises 5.85 and 5.91.

- The law of total probability

- Mar 12:
  - Random variables, Section 6.1.
  - Independent random variables, Section 6.2.
  - Expected value, Section 6.4.
  - Linearity of expectation, Section 6.5.

- Mar 17: (—)
  - Indicator random variables, Section 6.8, Exercise 6.57.
  - Expected running time of Insertion-Sort, Section 6.9

- Largest elements in prefixes of random permutations, Section 6.8.2.

- Mar 19: (—)
  - Estimating the harmonic number, Section 6.8.3.
  - Expected running time of Quick-Sort, Section 6.10.

- Mar 24:
  - Geometric distribution and its expected value, Section 6.6, Exercise 6.35.
  - Exercise 6.59 (the Coupon Collector's Problem)

- Binomial distribution and its expected value, Section 6.7.

- Mar 26: Skiplists
  - Skiplists, Section 6.11
- Mar 31: The Probabilistic Method
  - Finding large bipartite subgraphs, Section 7.1
  - Graphs with no large clique or independent set, Section 7.2
  - Jaccard distance satisfies triangle inequality, Section 7.4

- Apr 2: Planar graphs and crossing lemma
  - Planar graphs, Section 7.5.1
  - The crossing lemma, Section 7.5.2
- Apr 7: Exam review (Guest lecturer)

- Solving the Winter 2019 Final Exam

- Solving questions 19-25 on the Winter 2019 Final Exam