AE1MCS: MATHEMATICS FOR COMPUTER SCIENTISTS

Code: COMP1046

School of Computer Science
University of Nottingham Ningbo China

Autumn 2022

TEACHING STAFF

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- Anthony Bellotti
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  - Office hours: Tuesdays 1500-1600 and Wednesdays 1000-1100 (PMB419)

Contact

- You are welcome to visit us during office hours or contact us by email.
- For questions regarding course material, we encourage you to use the **Module Forum** on **Moodle**. These will be answered quicker than emails.

EDUCATION AIM

To provide students with mathematical skills needed for our Computer Science undergraduate degree course.

LEARNING OUTCOMES

- Understanding of basic *mathematical concepts*, definitions and notations.
- The ability to understand and apply *logical reasoning*.
- The ability to use mathematics to *solve problems*.

TEXTBOOKS

- K. H. Rosen, *Discrete Mathematics and Its Applications*, 7th Edition, 2013.
- Ferrante Neri, *Linear algebra for computational sciences and engineering*, 2nd edition, 2019
- Robert T. Smith, Roland B. Minton. Calculus, 2nd ed.+, McGraw-Hill 2002

Note: We do not cover *all* the content in these books.

TOPICS COVERED BY AE1MCS: PART 1

Logic and Proofs (Rosen; Chapters 1 and 5)

- Propositional Logic
- Predicate Logic
- Inference methods
- Proof Techniques

TOPICS COVERED BY AE1MCS: PART 1

Basic Structures (Rosen; Chapters 2 and 9)

- Sets
- Functions
- Relations

Counting (Rosen; Chapter 6)

- Combinatorics and Permutations

Probability

- Discrete Probability (Rosen; Chapter 7)
- Continuous Probability

TOPICS COVERED BY AE1MCS: PART 2

Linear Algebra

(Neri; chapters 2, 3, 8, 10)

- Matrices
- Systems of Linear Equations
- Vector Spaces
- Linear Mappings

TOPICS COVERED BY AE1MCS: PART 2

Calculus and optimization

(Smith and Minton; sections 1.1 to 1.5, 2.1 to 2.4, 2.7 and 3.7)

- Limits and Derivatives
- Maxima and Minima
- Optimization

TEACHING

- Lecture:
  - three hours a week
  - 0900-1100 on Tuesdays, DB-A05
  - 1000-1100 on Thursdays, DB-A05
- Tutorial:
  - two hours a week
  - group 1: 1300-1500 on Thursdays, DB-B05
  - group 2: 0900-1100 on Fridays, DB-B05
- Moodle Page
- Homework: You are expected to spend several hours a week following up and preparing for tutorials in self-study.

ONLINE RESOURCES

- For students off-campus, we endeavour to provide live feeds and recordings of lectures and tutorials via MS Teams.

- All lecture notes, solutions and recordings will be available via Moodle and MS Teams.

TEACHING

- Part 1: Huan Jin
  - Weeks 2, 3, 5 to 8 (19 Sep to 6 November).
- Part 2: Tony Bellotti
  - Weeks 9 to 13 (7 November to 11 December).
- Exam during weeks 16 to 18.

ASSESSMENT

- 75% final exam
  - 2 hour written exam; 4 questions
- 25% coursework
  - Coursework 1 based on Part 1: 10%
  - Coursework 2 based on Part 2: 10%
  - Miniquizzes: 5%

Miniquizzes

Run at the end of tutorials as multichoice questions on Moodle.

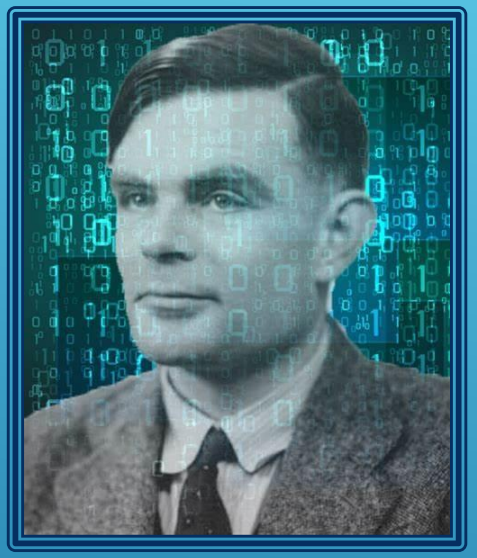
Five miniquizzes during the semester; each is worth 1%.

COMPUTER SCIENCE AND MATHEMATICS

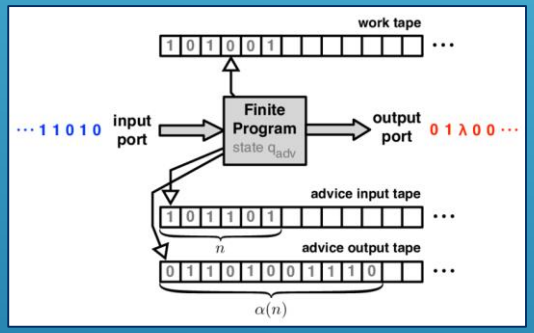
A BRIEF INTRODUCTION

COMPUTER SCIENCE AND MATHEMATICS

- Very strong connection between Computer Science and Mathematics



- Early connection: Turing machine 1936!



- **Alan Turing** described the universal computer using mathematics, 10 years before the first general-purpose computer was built! (ENIAC 1946).

COMPUTER SCIENCE AND MATHEMATICS

- Mathematics is not only about numbers!

  "Mathematics, the **science of structure**, **order**, and **relation that has evolved from elemental practices of counting**, **measuring**, and **describing the shapes of objects**. It deals with logical reasoning and quantitative calculation"

  Encyclopedia Britannica

- What is Computer Science?

  "…In its *most* fundamental essence, the stuff of computing is symbol structures. … Computer science is, ultimately, the science of automatic symbol processing…"

  Computer Science: A Very Short Introduction (Subrata Dasgupta)

- In Computer Science, whenever we want to describe an algorithm working on data structures, we can use Mathematical language.

COMPUTER SCIENCE AND MATHEMATICS

Just a few examples of where mathematics is needed in computer science:-

- Databases = Logic and Set Theory
- Programming = Logic
- Networks = Graph Theory / Linear Algebra
- Algorithms and Computational Complexity = Logic, Combinatorics
- Computer Graphics = Linear Algebra
- Machine Learning = Linear Algebra, Multivariate calculus, Probability theory
- Image Processing = Linear Algebra
- …..

Something to think about:

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The $25,000,000,000 Eigenvector: The Linear Algebra behind Google*

Kurt Bryan†
Tanya Leise‡

Abstract. Google's success derives in large part from its PageRank algorithm, which ranks the importance of web pages according to an eigenvector of a weighted link matrix. Analysis of the PageRank formula provides a wonderful applied topic for a linear algebra course. Instructors may assign this article as a project to more advanced students or spend one or two lectures presenting the material with assigned homework from the exercises. This material also complements the discussion of Markov chains in matrix algebra. Maple and *Mathematica* files supporting this material can be found at www.rose-hulman.edu/∼bryan.