CS 105: Department Introductory Course on Discrete Structures

Instructor : S. Akshay

Jul 29, 2024

Lecture 01 – Introduction

Logistics

Course hours: Slot 4;

Mon 11:35-12:30, Tue 08:30-09:25, Thu 09:30-10:25

Office hours: To be announced.

Problem Solving/Help Session (Optional): One hour per week, run by teaching assistants. (Time and Venue to be decided)

Course material, references will be posted at

- `http://www.cse.iitb.ac.in/~akshayss/teaching.html`
- Announcements, Problem sheets and Online Discussion: Piazza
  - `https://piazza.com/iit_bombay/fall2024/cs105`
- One problem sheet will be posted almost every week!

Attendance

As per Institute rules: SAFE

More Logistics

Evaluation

- Quizzes: 30%
- Midsem: 25%
- Endsem: 40%
- Other {participation, pop quizzes, assignments}: 5%

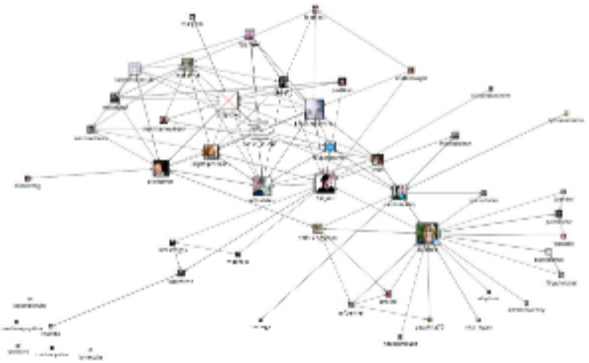
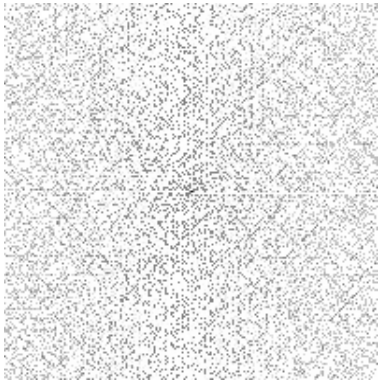
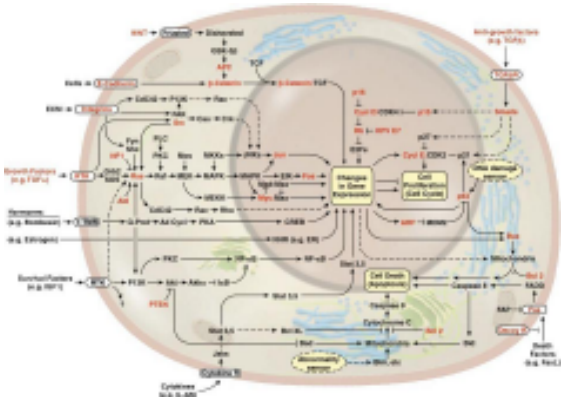
Minimum requirements (Tentative)

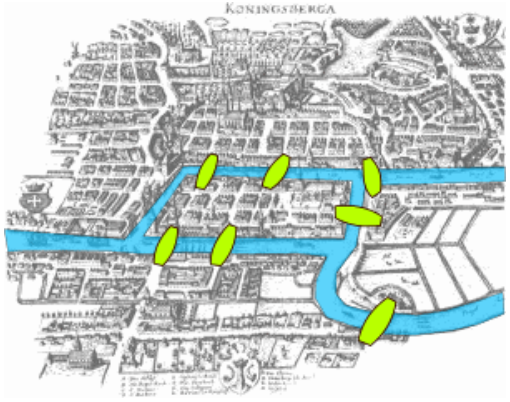
10/40 in endsem + 15/60 in remaining.

How to reach me after class?

- Send a message on piazza
- Drop by my office...
  - CS 507 (5th floor of New CSE/CC building)
  - Temporarily CC 313 (3rd floor!)

Goal



First things first...

- What are discrete structures?
- Why are we interested in them?

Course Outline

What we will broadly cover in this course

1. Mathematical reasoning: proofs and structures
2. Counting and combinatorics
3. Elements of graph theory
4. If time permits: Introduction to some selected topics: e.g, abstract algebra and/or number theory

What we don't cover

1. Logic : predicate, first-order logic– CS228
2. Discrete probability – IC102
3. Algorithms – CS218
4. Data structures – CS213 and CS293
5. Finite automata – CS310
6. Details and applications of everything above – rest of your (academic) life!

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1. Mathematical reasoning: proofs and structures
2. Counting and combinatorics
3. Elements of graph theory
4. If time permits, Selected topics e.g., on abstract algebra and/or number theory

Textbooks

- Discrete Mathematics and its Applications with Combinatorics and Graph Theory, by Kenneth H Rosen.
- Discrete Mathematics by Norman Biggs.
- More will be listed on webpage as we go along.

More lofty aims of the course

1. Introduce mathematical background needed in various branches of computer science.
2. (New and old) techniques for problem solving: how to attack problems that you have never seen before.
3. To convey your ideas clearly: argue logically and write proofs formally.
4. To learn abstractions and abstract reasoning.

Prerequisities

- Nothing! ... Well, high school mathematics
- Logical mind and critical thinking

Chapter 1: Proofs and Logical reasoning

Outline of next few classes

- Propositions, statements
- What/why of proofs and some generic proof strategies
- Mathematical induction

Propositions

What is a proposition?

- It is raining
- $1 + 1 = 2$
- every odd number is a prime
- $2^{67} - 1$ is a prime
- $(n + 1)(n - 1) = (n^2 - 1)$ for any integer n

What is common between these statements?

Propositions

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A proposition is a statement that is either true or false (but not both).

Give an example of a statement that is not a proposition.

- $x + 1 = 8$

Propositional calculus

Figure: Aristotle (384 – 322 BCE)

- propositions are statements that are either true or false.
- Just as we use variables $x, y, \ldots$ for numbers, we will use variables $p, q, \ldots$ for propositions.
- "if it is raining, it will be wet" : $p \to q$
- This is one way to combine propositions!

Propositional calculus and Boolean algebra

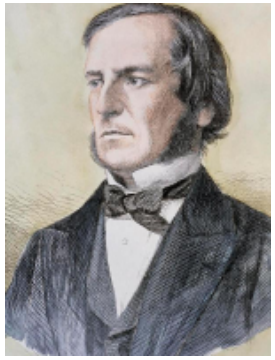

Figure: George Boole (1815 – 1864)

Combining propositions

- $\neg p$: It is not raining
- $p \vee q$: It is raining or there is a sprinkler overhead.
- $p \wedge q$: It is raining and I don't have an umbrella
- $p \rightarrow q$: If it is raining then it will be wet.
- If it is raining or there is a sprinkler overhead and I dont have an umbrella, then I will get wet: $((p \vee q) \wedge r) \rightarrow s$.