COMP 585: Probabilistic Toolkit for Learning and Computing

Lecture 1

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Today's lecture

- Introduction
- Class format
- Policies
- Introduction to the topic

Introduction

Instructor: Maryam Aliakbarpour

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Office hour: By appointment

Lectures: Tuesdays & Thursdays, 10:50 am -12:50 pm, on zoom

Website: https://maryamaliakbarpour.com/courses/S26/index.html + Canvas

Introduction

Your turn!

- Name
- Program (department/major)
- Year
- Your advisors name
- Research interest

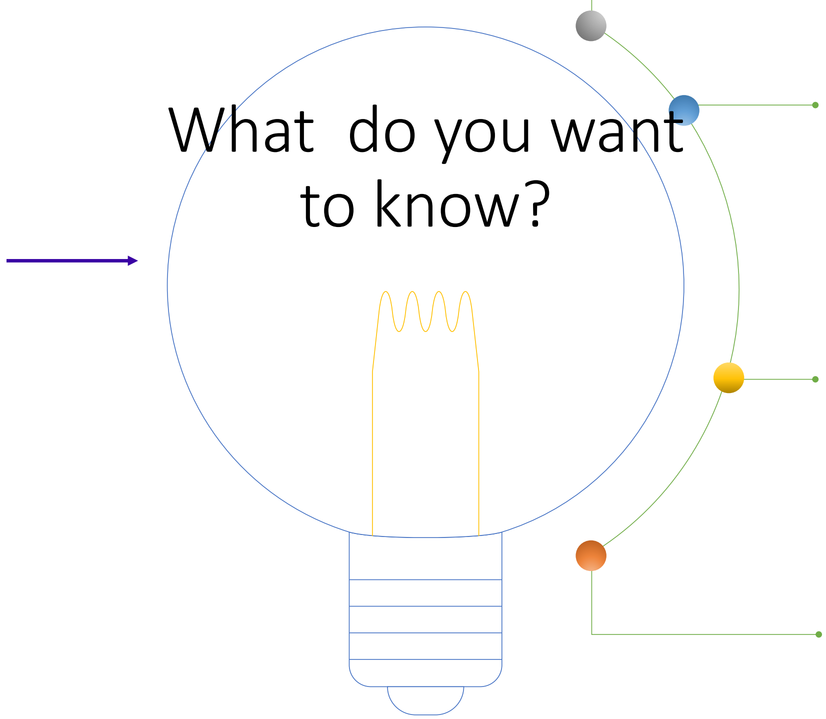
Class objectives

In this class, we explore randomness and its fundamental applications, including:

- Modeling and analyzing data: We extract meaningful information from data using statistical methods.

Statistical inference

Data:
samples from D
$x_1, x_2, \dots, x_m$



Testing:
Test distribution D has a specific property
e.g. uniformity, unimodal

Estimation:
Estimate parameters of distribution
e.g. mean, variance

Learning:
Learn distribution D in a class
e.g. Gaussians

Classification:
Learn a classifier from labeled data
e.g. learning half-spaces

Class objectives

In this class, we explore randomness and its fundamental applications, including:

- Modeling and analyzing data: We extract meaningful information from data using statistical methods.
- Increasing Efficiency: We design randomized algorithms that are fast / use few data points / work with limitations on other computational resources / etc.

Class objectives

Our Goals:

- Understand fundamental probabilistic methods.
- Explore their applications in algorithms, learning theory, and statistical inference.
- Ultimately, engage in research, especially in theoretical domains.

Class topic

- Fundamentals: random variables, concentration, moments, Gaussians, Sub-Gaussians, and Sub-Exponentials
- Applications: hypothesis testing, property testing, hashing, etc
- Application in foundation of machine learning:

  - Linear Regression
  - Dimensionality Reduction, Johnson-Lindenstrauss lemma
  - Vapnik-Chervonenkis (VC) Dimension
  - PAC Learning
- Additional Topics (Time Permitting): methods for proving lower bounds

Class topic

What we do not cover:

- Coding for Stat/ML: R, Tensorflow, etc
- Reinforcement learning/unsupervised learning

Class prerequisites

- An undergraduate-level course in algorithms, discrete mathematics, and probability is highly recommended.
- Solid understanding of mathematical proofs.
- Basics of algorithms, including O, Ω, and Θ notation,
- Basic probability concepts, such as expected value, variance, and conditional probability.

Grading

Task	Grade percentage
Class participation	5%
Scribed notes	10%
Assignments	50%
Project	35%

- ❑ Active class participation
- ❑ Scribe notes for two lectures
- ❑ Assignments: 4 main assignments
- ❑ Class project
    - Report (proposal, mid-point evaluation, final)
    - Class presentation
- ❑ Readings for some lectures (Optional)

Assignments

- Assignments will be on Canvas.
- Turn on Canvas email notification.
- Indicate your availability for scribing by next Tuesday (1/22):
- https://docs.google.com/spreadsheets/d/1i0jfBJtQkGWqCkCZmKga9_O9eqEoV9J_Y1atLM71XzA/edit?usp=sharing

Policies

Read Syllabus

- An inclusive environment
- Rice Honor Code
- Disability Resource Center
- Wellbeing and Mental Health
- Title IX Responsible Employee Notification