Data Structures and Algorithms

Introduction

Dr. Zubair Ahmad

Ever Read or Heard About DSA??

Your Expectation from this course in terms of real life application??

About me!

Zubair Ahmad

Education

- Ph.D. in Computer Science –
  ` University of Venice Italy (2020-2024)
- Visiting Scholar - CISPA Helmholtz Center for Information Security Germany
- European Parliament – EU AI Act 2023
- OPLSS Summer School Uni of Oregon and Boston Uni USA 2021

Research Interests

- Web Security and Privacy
- Data Privacy and Protection
- Internet and Web Measurements
- EU Compliance regulations, GDPR
- Internet of Things

More about me -->https://zahmaad.github.io/

Schedule

- **When?**

  - Will Share soon

- **Where?**

  - Here!
  - LH2 ES

- **What?**

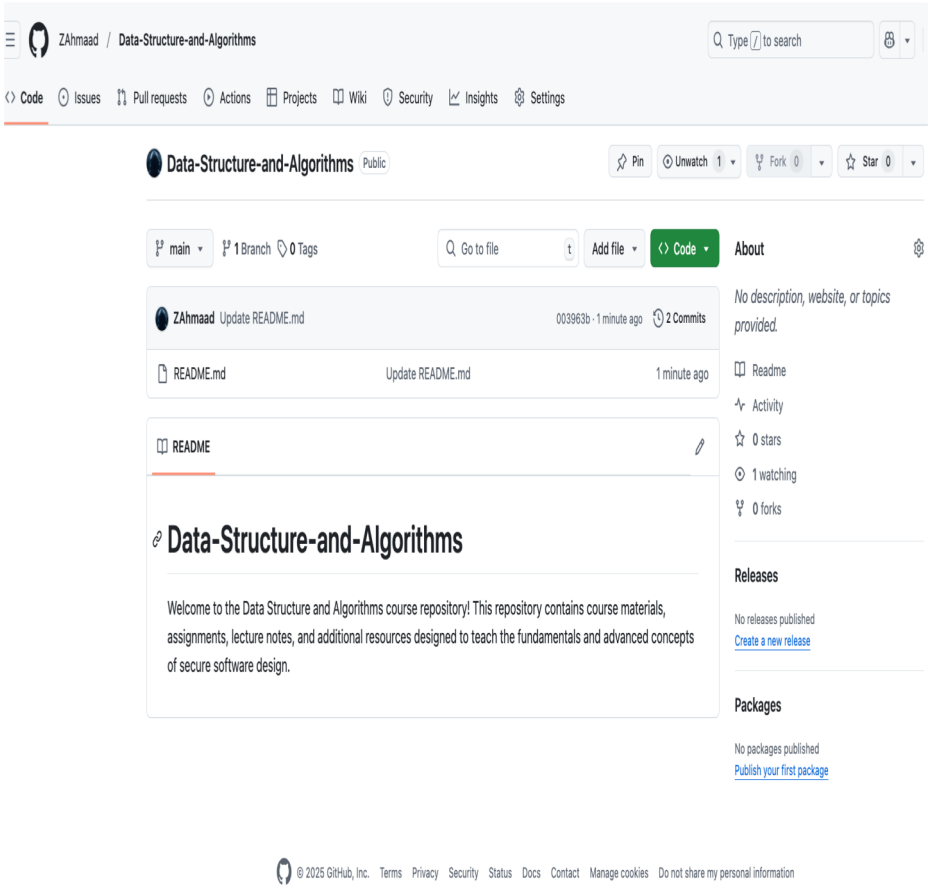
  - Lecturers and exercises
  - Quizzes/Assignments/ Projects
  - Mid/Final Exams

- **Attendance?**

  - Active Attendance
  - **Dead Bodies.**
  - **Active Minds**
  - Mobiles in hands -> Mark as absent
  - 80% mandatory

Webpage

- Lectures/ Slides
- Books
- Assignments/Project
- News



https://github.com/ZAhmaad/Data-Structure-and-Algorithms/tree/main

Assignments- Project-Quizzes

- A number of assignments/project and quizzes will be taken
- Announced and/or unannounced quizzes

- Github
- Overleaf

} Project/Assignments

- Python

What Should you expect in this Course?

- Utilize the basic techniques of data structure/algorithm analysis
- Apply the primitive data structures to design solutions for the computational problems
- Analyzing problems and writing program solutions to problems using the algorithmic techniques using a variety of data structures and techniques

Grading

Assessment Items	Percentage
Quizzes	15%
Assignment/Project	15%
Midterm Exam	30%
Final Exam	40%

Why this course?

- Improves Problem-Solving Skills
- Builds Efficient Software
- Critical for Technical Interviews
- Optimizes Resource Usage
- Universal Applicability
- Empowers Creativity
- Essential for Advanced Computer Science Topics

What We will learn?

1st Week

- Fundamentals of data structures
- An overview of computer programming
- Data types, abstract data types
- Programming background

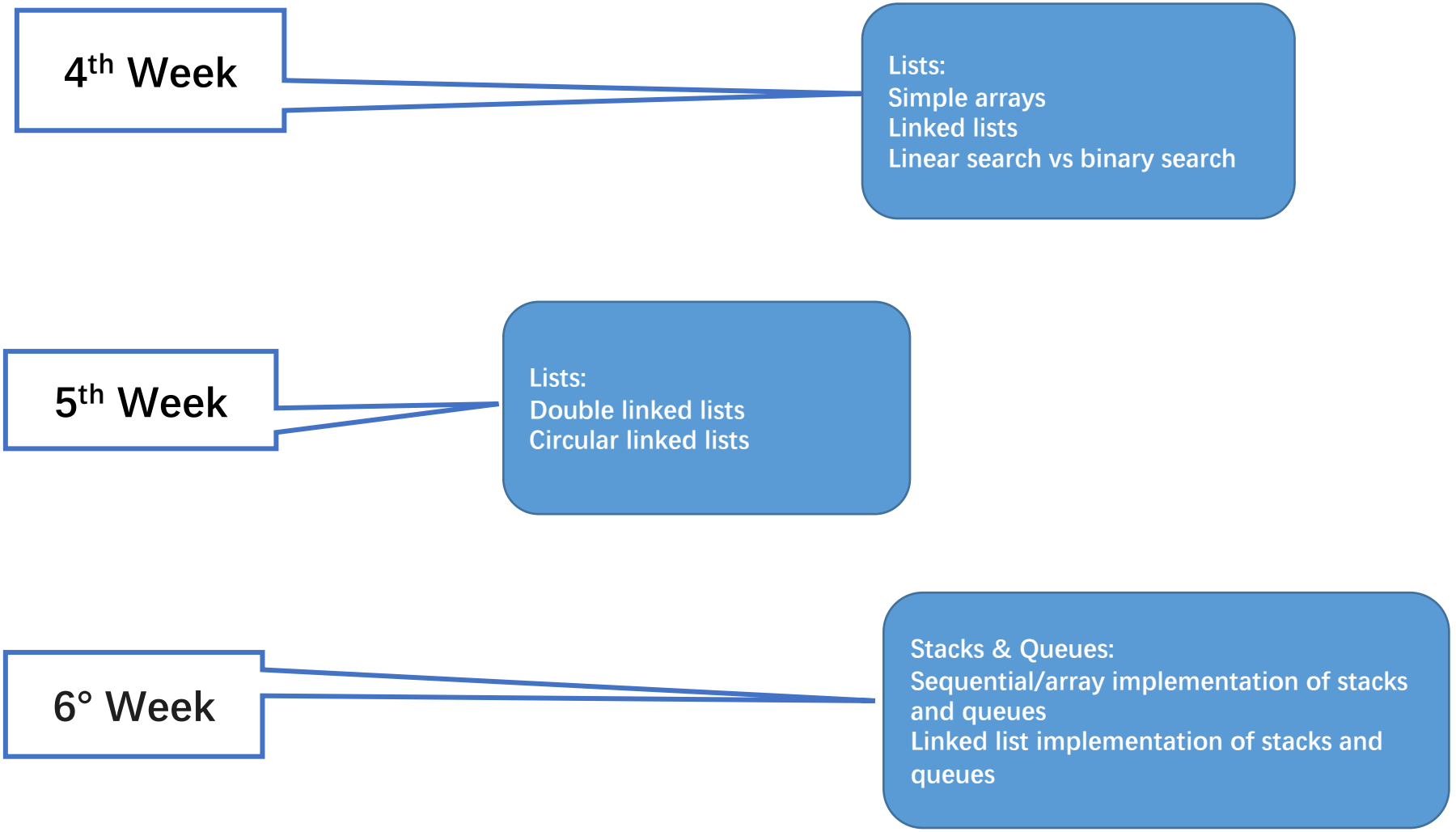
2nd Week

Review of pointers:Pointers and arrays
Pointer indirections
Structures and pointers
Passing pointer arguments to a function and returning pointers from a function

3° Week

Computational complexity of algorithms and their time-space analysis:Running time calculations
Asymptotic notations for algorithmic complexity analysis

What We will learn?



What We will learn?

7th Week

Arithmetic expressions, polish notation
Recursion:
Recursive implementation of stacks
Recursive implementation of queues

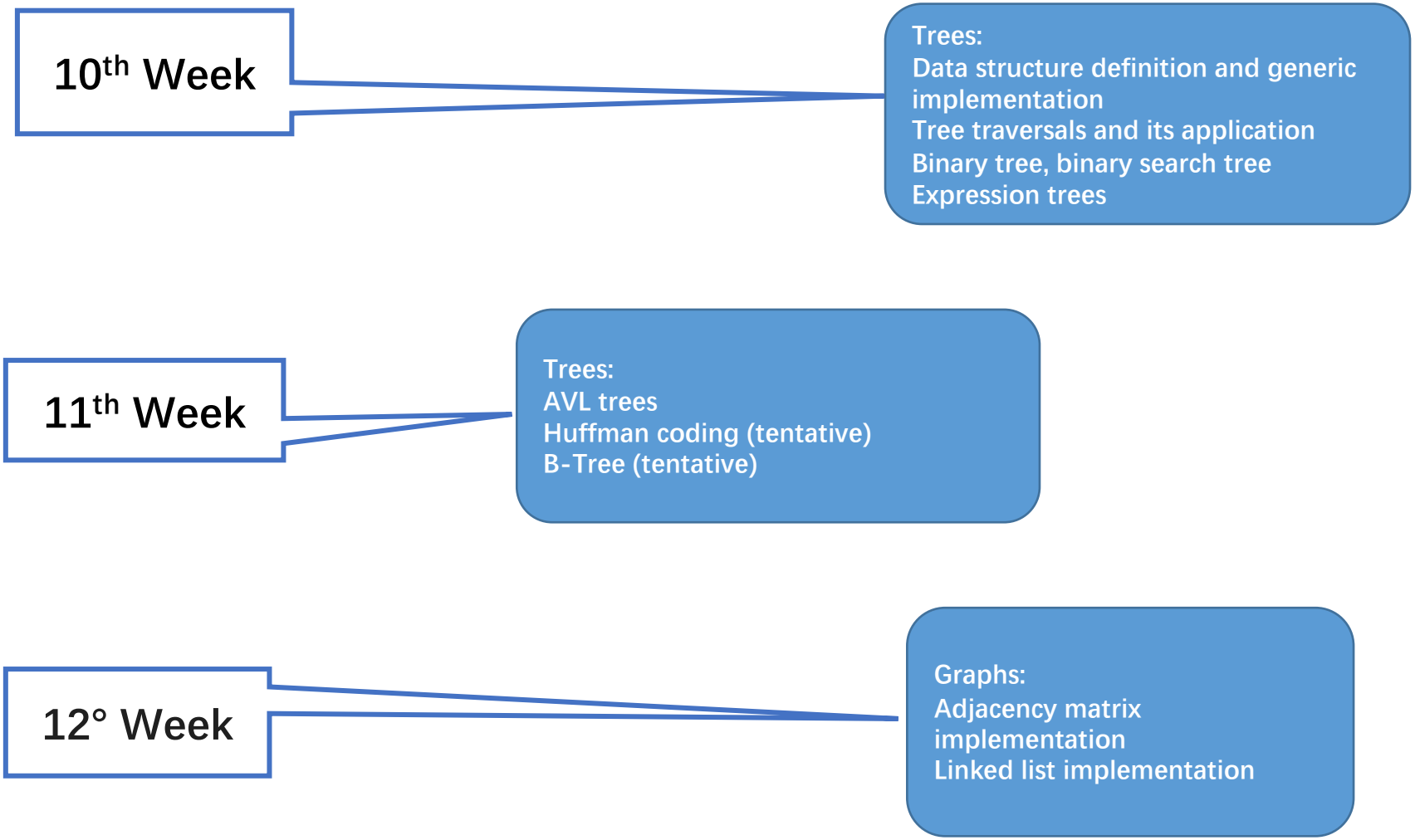
8th Week

Sorting:
Bubble sort
Insertion sort
Selection sort

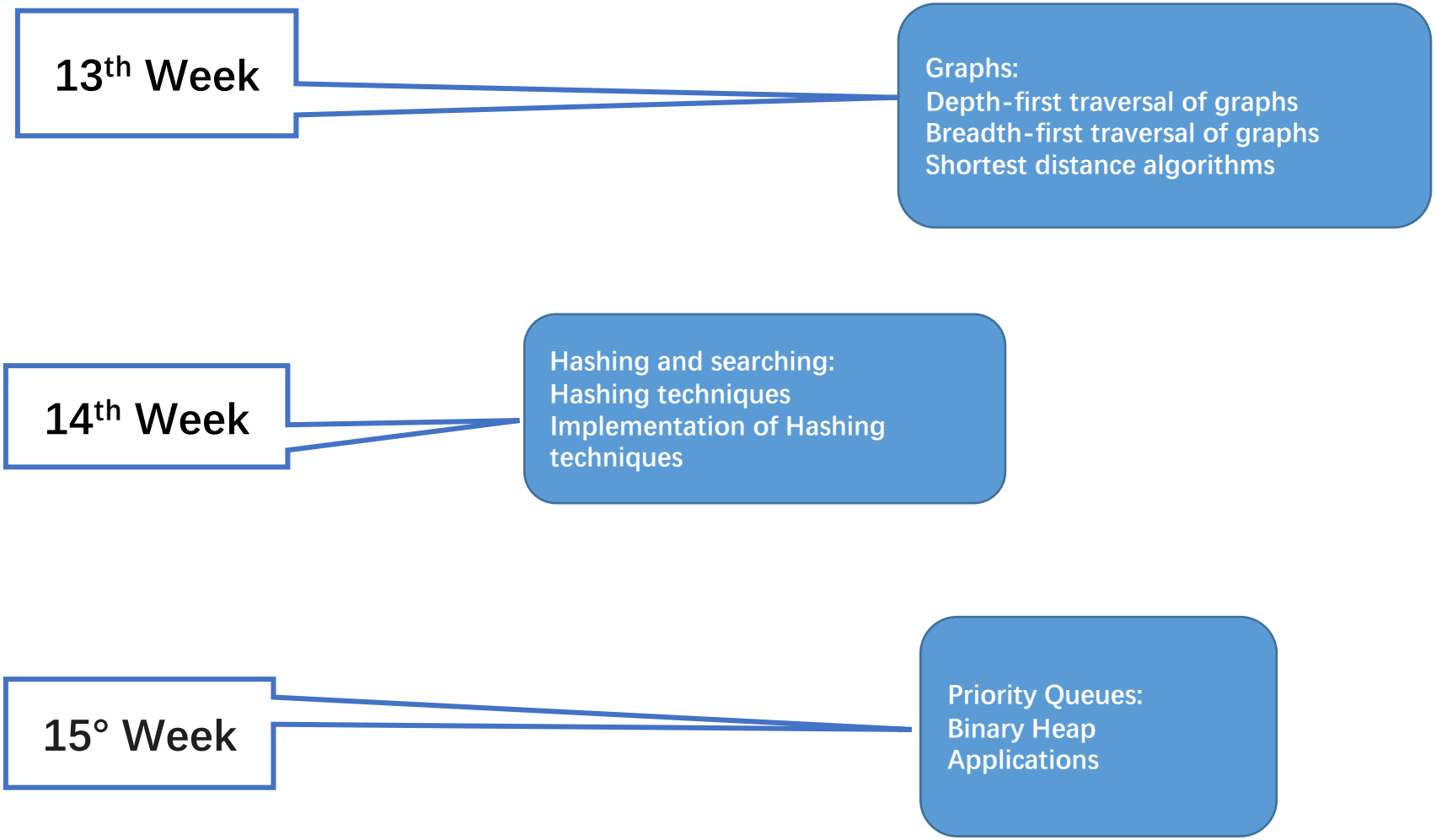
9° Week

Sorting:
Merge sort
Quick sort
Counting Sort & Radix sort
Heap sort (tentative)

What We will learn?



What We will learn?



Data = Information?

Is it same or different?
Example??

Information
Any Knowledge in the basic form that can be communicated including abstract ideas and concepts

Data:
In a form that a computer can use

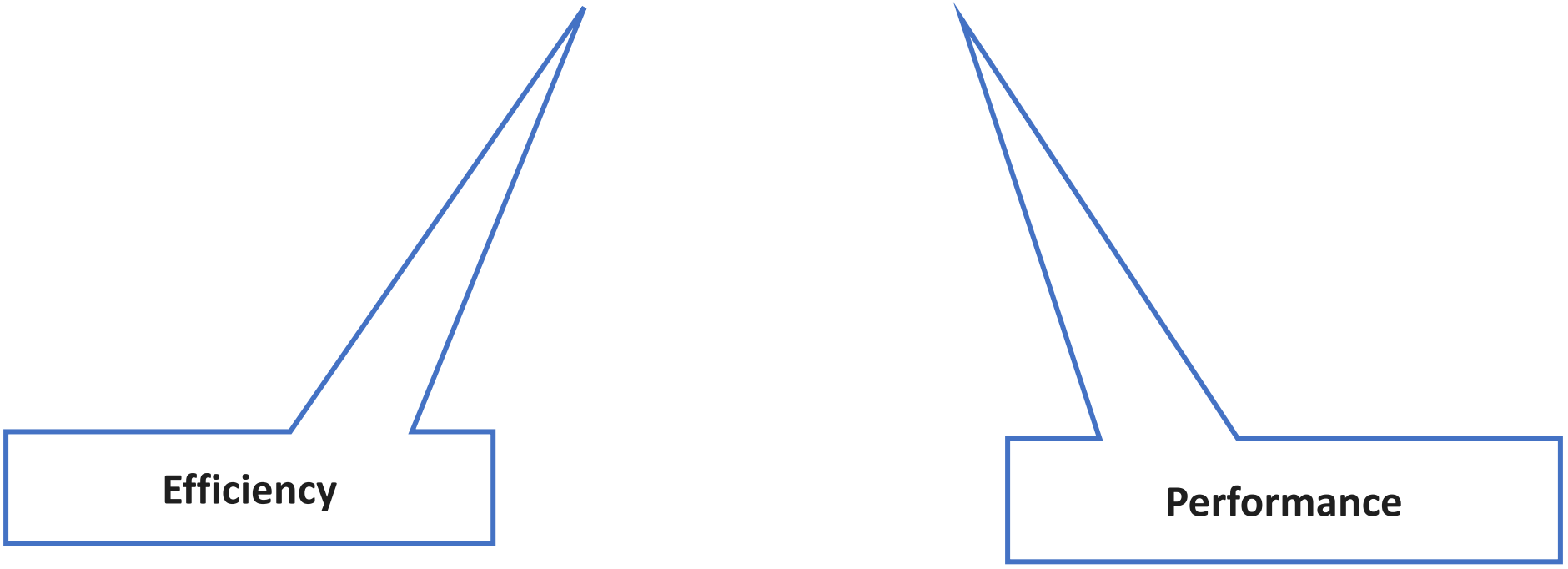
London is located in UK

GPS Coordinates
(51.5074° N, 0.1278° W)

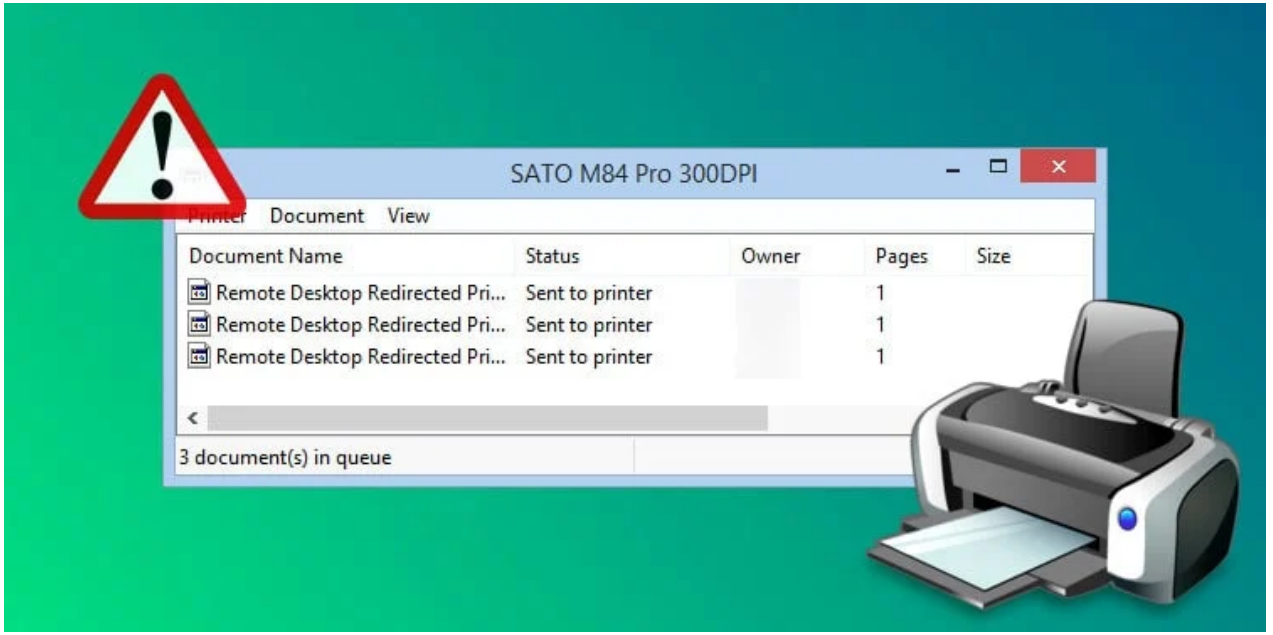
Why we need Data Structure?

Big amount of Data store in a rough way leads to complications and poor performance

Data Strucutre is how data can be stored in different structures



Data Structures – Real Life Scenarios

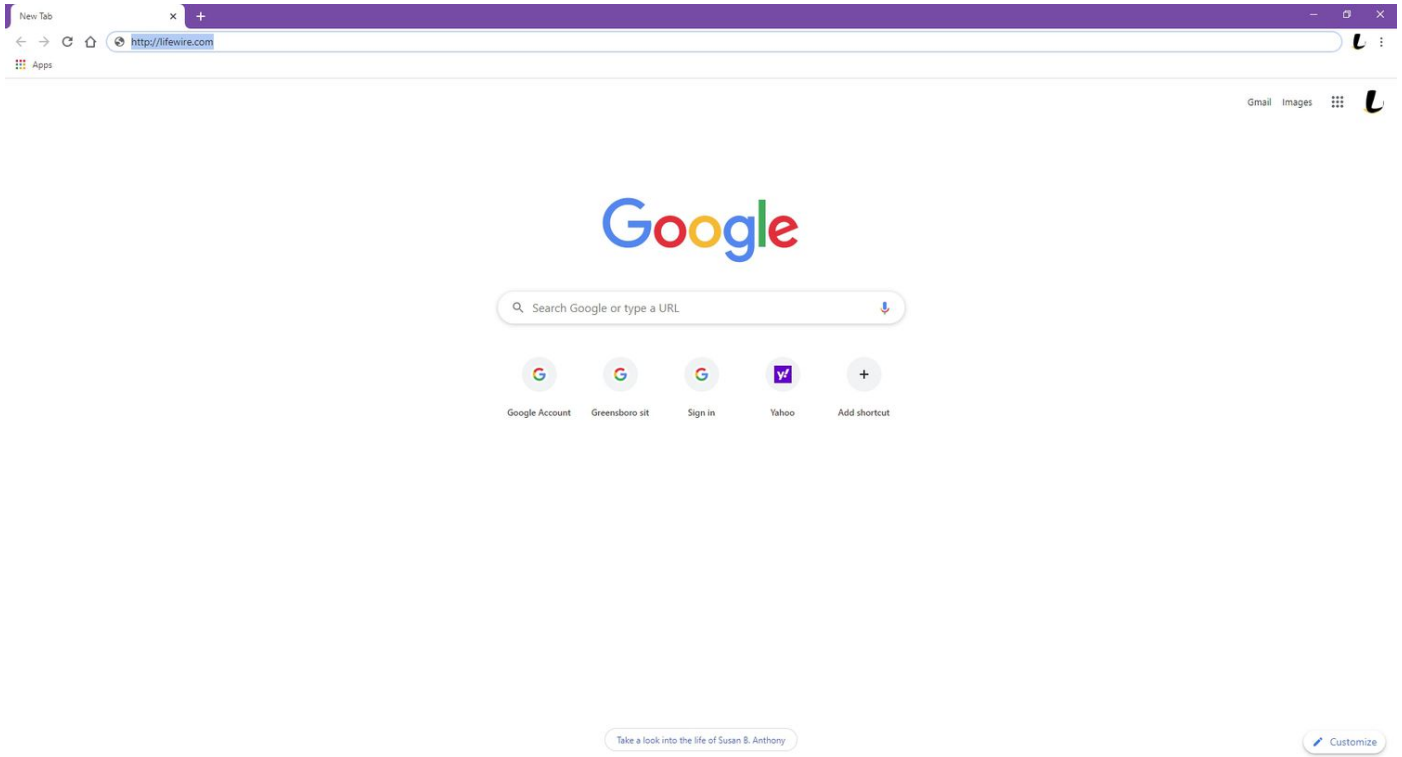


Printing Jobs:
The first document sent to the printer is processed first (FIFO).

QUEUE?

Any other example? → Customer Support Systems

Data Structures – Real Life Scenarios



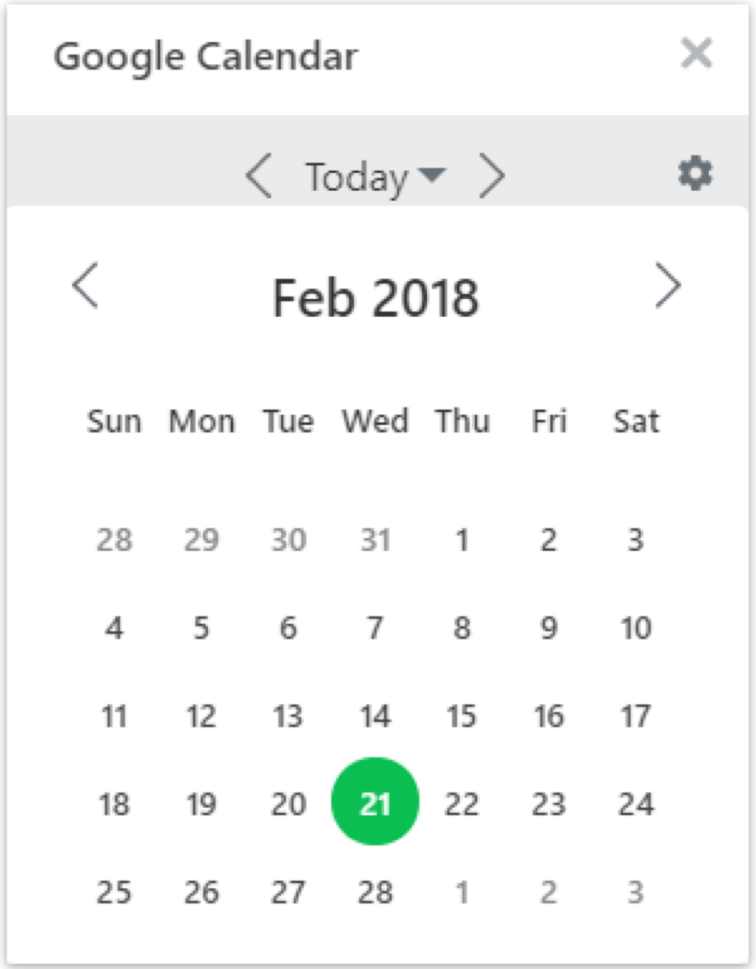
Web Browser Back Button

When you visit pages, the browser stores URLs in a stack. The most recently visited page is at the top, and pressing "back" pops it off

Stack

Any other example? → Text Editors

Data Structures – Real Life Scenarios



Calendar App

Days of the week or months of the year are stored in arrays for quick access.

Array

Any other example?

Data Structures – Real Life Scenarios

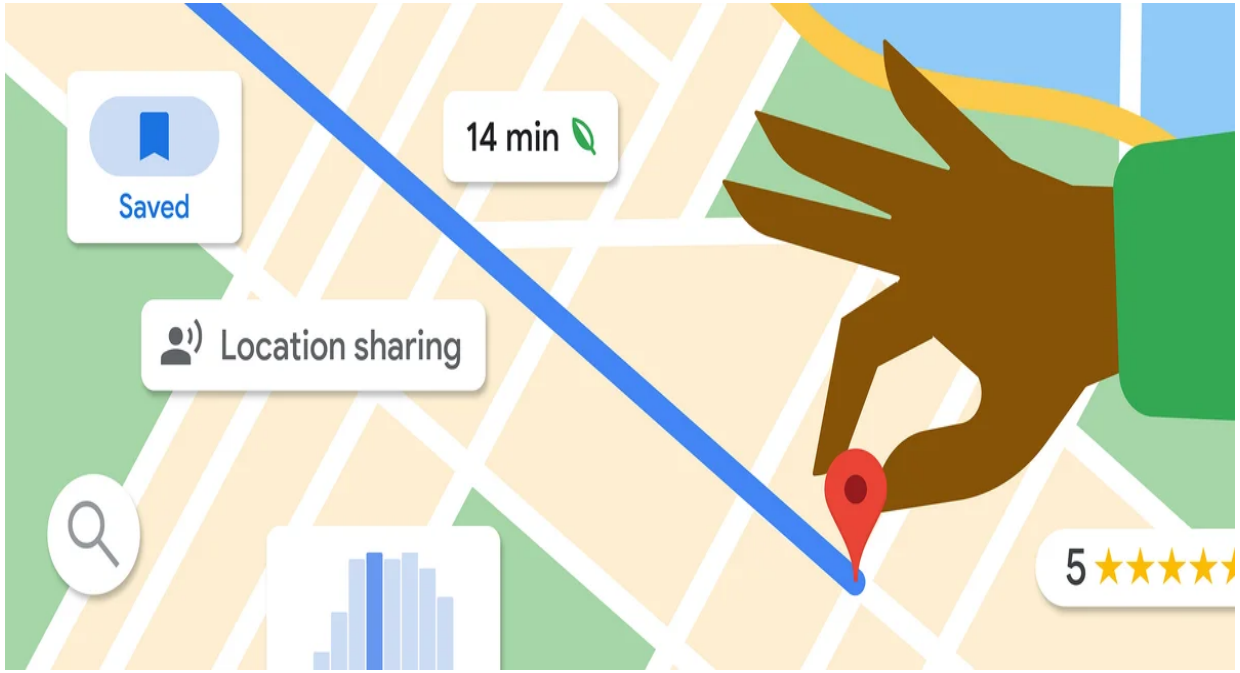
File System

Your computer's directory structure is a tree. Each folder (node) can contain files or subfolders (child nodes)

Tree

Any other example? → Organizational Hierarchy

Data Structures – Real Life Scenarios



Google Maps or GPS Navigation:

Locations are represented as nodes, and roads are edges connecting them. Algorithms like Dijkstra's are used to find the shortest path

Graph

Any other example? → Social Networks

Data Structures – Real Life Scenarios

Airline Route Maps

Airports are nodes, and flights between them are edges. Weights represent distances or travel costs.

Graph with Weighted Edges

Any other example? → E-commerce Recommendation Systems

Data Structures – Real Life Scenarios

Autocomplete in Search Engines

Stores prefixes of words, enabling fast suggestions as you type.
Example: Typing "san f" shows results like "san Francisco weather", etc

Trie

Any other example? → Spell Checkers

Data Structures – Real Life Scenarios

Emergency Services

Tasks with the highest priority (e.g., critical patients) are processed first

Heap

Any other example? → Job Scheduling in Operating Systems

Algorithm?

- **An algorithm is a set of step-by-step instructions to solve a given problem or achieve a specific goal**

- A cooking recipe written on a piece of paper is an example of an algorithm, where the goal is to make a certain dinner. The steps needed to make a specific dinner are described exactly.

- Algorithms in Computer Science, the step-by-step instructions are written in a programming language, and instead of food ingredients, an algorithm uses data structures.

Algorithm Examples?

- Finding the fastest route in a GPS navigation system
- Navigating an airplane or a car (cruise control)
- Finding what users search for (search engine)

Data Structures together with Algorithms

By understanding DSA, you can:

- Decide which data structure or algorithm is best for a given situation.
- Make programs that run faster or use less memory.
- Understand how to approach complex problems and solve them in a systematic way.

Questions?

zahmaad.github.io