# CS2001- Data Structures
# Week 01

Muhammad Rafi
September 06, 2021

## Agenda

- Introduction to Course & Conduct
  - Description
  - Objective
  - Learning Outcomes
  - Grading Scheme
  - Textbook
- Data Vs. Information Vs. Knowledge Vs. Wisdom
- Abstract Data Types
- Algorithm + Data Structures = Program
- Man vs. Machine
- Conclusion

## Course Description

- Data Structures is a core course in Computer Science curriculum.
- It is an essential building block for solving applied problems with computers.
- The course will introduce the fundamentals of data structures and will provide thorough understanding of how to systematically organize data inside a computer system.

## Course Description

- The course discusses basic memory management for efficiently solving problems on both time and space requirements.
- A variety of data structures will be discussed theoretically, their efficient implementations and application cases will also be discussed.
- The student will learn abstraction, encapsulation and structures for efficiently processing information in a variety of scenarios.

## Course Objectives

- To understand the design of fundamental data structures and algorithms for problem solving through computer system.
- To study the tradeoff choices in the design and implementation of data structures
- To provide a rigorous “hands-on” experience with implementing different data structures in a high-level programming language
- To analyze time/space tradeoff for different solutions to the same problem.

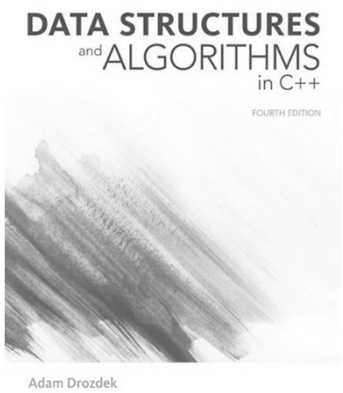
## Learning Outcomes

- Student will be able to learn and understand basic/advanced data structures
- Student will be able to perform analysis of data structures choices for any real-world application.
- Student will learn the tradeoff with different choices of data structures
- Student will be able to write computer solutions for efficiently store, retrieve manipulate and update the data stored inside computers.

# Grading Scheme

- Programming Assignments 15%
- Quizzes 05%
- Midterm Exam 20%
- Class Project 10%
- Final Exam 50%

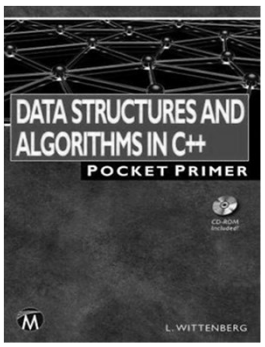
# Textbook & References

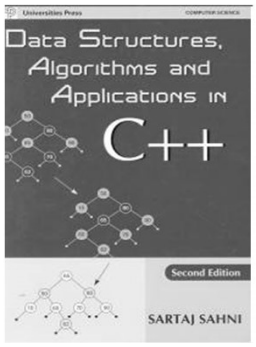


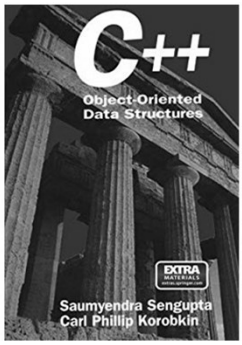

**Leading Text in CS**

- Strengthen your understanding of data structures and their algorithms for the foundation you need to successfully design, implement and maintain virtually any software system

# Some Good References

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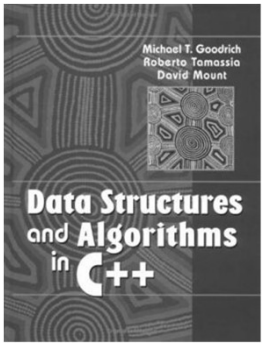
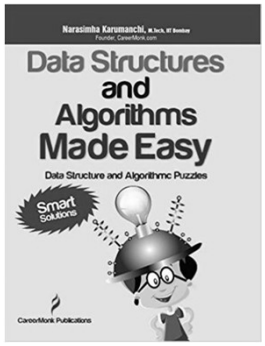
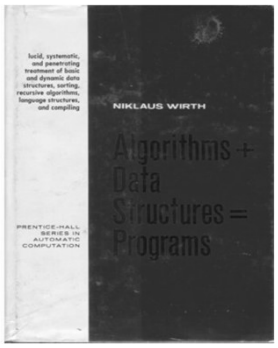


## Programming Assignments

- There will be 3 programming assignments, each assignment may contains 2-4 problems.
- These programming assignments will be on provided with sample input/output test cases.
- The assignments are for individual, plagiarism will not be tolerated.
- You need to access the platform with your nu mail IDs.
- There may be more hidden test-cases for the problems.

## Programming Assignments

- Deadline and Penalty
  - Deadline is mentioned for each Programming Assignment (Usually 2 weeks time)
  - After the deadline – there will be a penalty of 25% if the assignment submitted after first 48 hours, for each 48 hours it reduced to 25%  hence there will be no marks after 8 days.
  - Marks are only given if the submission passed plagiarism check and manual check.
  - Plagiarism cases may be awarded an F grade.

## Quizzes

- There will be 4-5 quizzes – all surprise quizzes
- Best n-1 will be counted
- Weightage 05 %

## Midterm Exam

- Two midterm exams – one hour each as per policy.
- Weight 10% each

## Final Exam

- There will be a 3 hours exam as per policy.
- Weightage 50%

## Class Participation

- Very important instrument for creating an impact.
- I appreciate questioning…
- Weightage 5%

## Class Projects

- There will be a class project -You can have 2-3 members- members allow within sections.
- Weightage 10%
- The “Theme” for CS201- Data Structures class project is “Data Structures for Large Datasets”
- We will have 3-4 BOF meeting during the course for the class projects.
- Class project call and schedule will be announced on slate later.

## Class Projects

- Call for class project
  - You need to submit a proposal mentioning team members name, project title and a brief description about the project. ( 1 mark for each submitted proposal)
  - Class Project Demos – 2 marks
  - Code review – 2 marks
  - Idea and completion – 4 marks
  - Project report – 1 mark

# Weekly Plan

| Session | Topics | Chapters |
|---|---|---|
| 1 | Course Overview, Introduction to Course & Conduct, Grading Scheme, Text Book, Quizzes, Assignments | |
| 2 | C++ Language Specification & OOP | Chapter 1 |
| 3 | C++ Language Specification & OOP | |
| 4 | Recursion - 1 | Chapter 5 |
| 5 | Recursion - 2 | |
| 6 | Recursion - 3 | |
| 7 | C++ Dynamic Memory Management | |
| 8 | Arrays (1D) – Dynamic Safe Arrays | |
| 9 | Arrays (2D) | |
| 10 | Different Type of Arrays | |
| 11 | Node and List (Singly Linked List) | Chapter 3 |
| 12 | Some utility functions of List (Singly Linked List) | |
| 13 | List (Circular Linked List) | |
| 14 | List (Doubly Linked List) | |
| 15 | Elementary Sorting Techniques -1 | Chapter 9 |
| 16 | Midterm I – Exam | |

# Weekly Plan

| 17 | Elementary Sorting Techniques -2 | Chapter 9 |
|---|---|---|
| 18 | Advanced Sorting | |
| 19 | Searching | |
| 20 | Stack -1 | Chapter 4 |
| 21 | Stack - 2 | |
| 22 | Stack – application | |
| 23 | Queues + Priority Queues | |
| 24 | Queue Application | |
| 25 | Heap | |
| 26 | Trees – BT, BST, MWT-- 1 | Chapter 6-7 |
| 27 | Trees – BT, BST, MWT-- 2 | |
| 28 | Trees – BT, BST, MWT-- 3 | |
| 29 | Trees – BT, BST, MWT-- 4 | |
| 30 | Hashing - 1 | Chapter 10 |
| 31 | Hashing - 2 | |
| 32 | Graphs - 1 | Chapter 8 |
| 33 | Graphs Traversals- 1 | |
| 34 | Graphs Traversals- 2 | |
| 35 | Weighted Graphs | |
| 36 | Graph Algorithms | |

## Consultancy Hours

- Consultancy Hours:

  Monday: 2-4 PM in my office – prior appointment required

  Thursday: 2-4 PM in my office – prior appointment required

  Friday: 8-9am at café informal (individual + groups)- this will not be regular, I will announce it on slate but it will be more often.

- Contact me

  email: muhammad<dot>rafi@nu<dot>edu<dot>pk

  Office: 111-128-128 ext: 222

  Cell: 0300-2326840

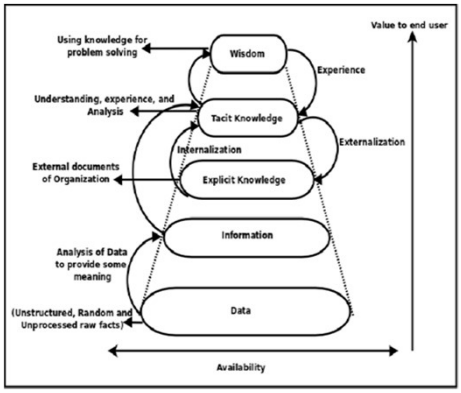
## Data vs. Information vs. Knowledge

- Data
  - Raw – facts
  - Data in electronic form is easy to retrieve, manipulate, fused and remember(recall).
  - Data is not always in a shape to facilitate information and knowledge
- Information
  - Interplay with data in context
- Knowledge
  - Some actionable information for ROI

# Information vs. Knowledge vs. Wisdom

- Wisdom
  - Related to the interplay of knowledge and apply some deductive reasoning.
  - The power to make things happen.

# Information vs. Knowledge vs. Wisdom

## Information vs. Knowledge vs. Wisdom

- Data – unprocessed facts, obtained via receptors/instruments
- Information – Processed data, structured data with context (Increases understanding)
- Knowledge – ability to use information, strategic use to achieve certain objectives.
- Wisdom – ability to select best possible objective using knowledge ( make to happen)

## Abstract Data Types (ADT)

- ADTs are a theoretical concept in computer science.
- An abstract data type (ADT) is basically a logical description or a specification of components of the data and the operations that are allowed, that is independent of the implementation.

## Definition – Data Structures

- Logical and formal abstract way to represent and store data in such a way that it will quickly available for processing within the application context.
- It is an organized collection of data which perform a set of operations effectively on the data. These set of operations are formally related to an idea of specific processing related to problem solving.

## Definition – Algorithm

- An algorithm is a fancy to-do list for a computer. Algorithms take in zero or more inputs and give back one or more outputs.
- You explicitly need to tell a computer to perform each step that eventually transform some input into a desire output. It should be finite set of instruction.

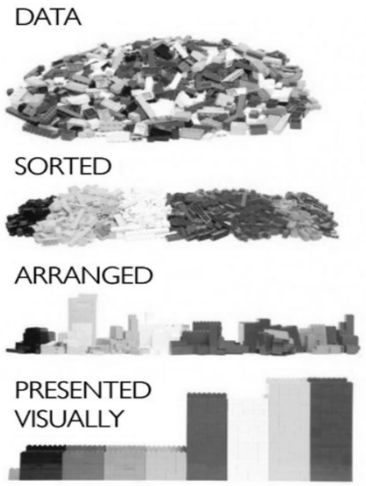
## Algorithm+ Data Structures = Program

- This was title of a very good book by Niklaus Wirth
- Half of the problem is selecting the right data structures and half of the problem is to select right algorithm.

## Man Vs. Machine

- Computation -Processing
- Memory
- Abilities
  - Sequential vs. Parallel
  - Optimized vs. Satisfier
  - Algorithmic vs. Non-Algorithmic

# Data vs. Story

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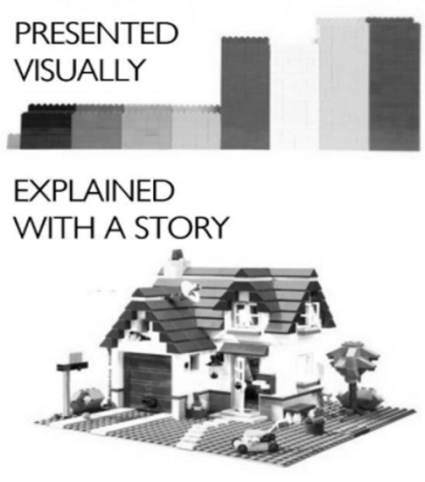

## Conclusion

- Data structures and algorithm are integral parts of problem solving through computer.
- Human and computer ways of solving problems are different.
- Data, Information, Knowledge and wisdom are distinguishable concepts for representation.