Indian Institute of Information Technology Kottayam

Introduction to Data Structures

BY

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About the lecture

- Computers a brief History
- Introduction
- When selecting a data structure
- Logical Vs Physical

Computers and their history

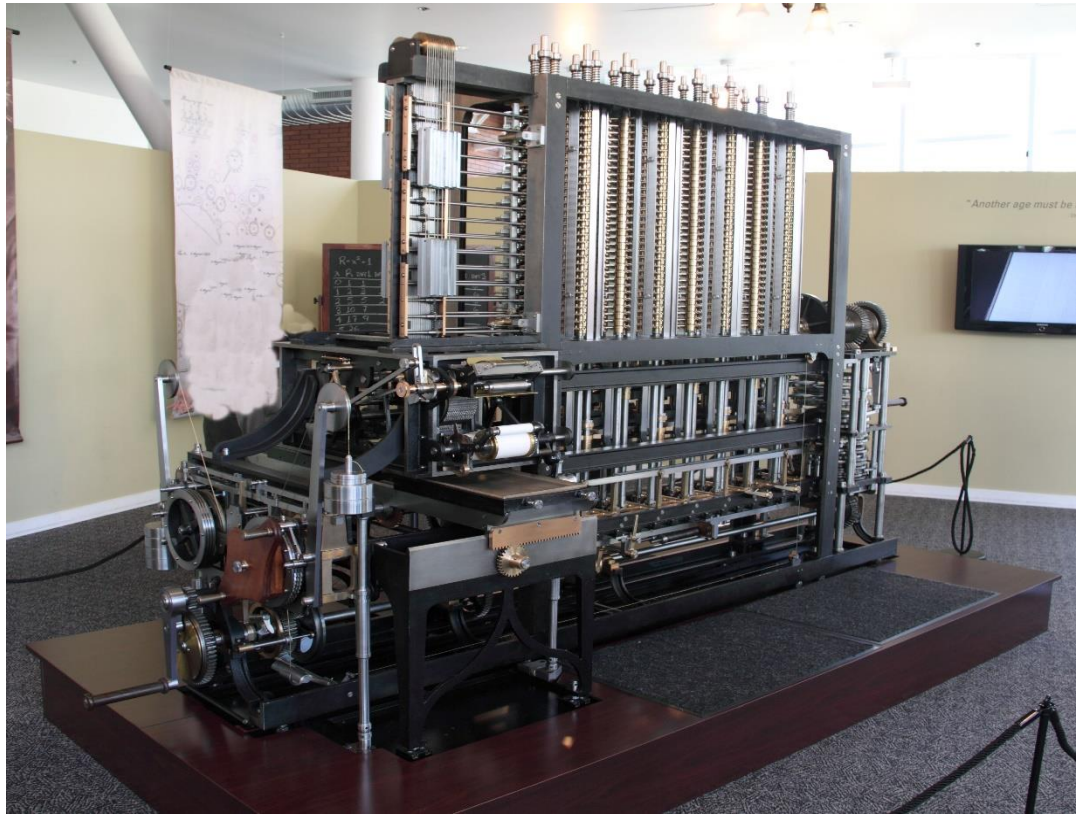
- Computer is arguably the most important invention.
- Why???
- Any arguments??
- You may argue: Wheels, Electricity, Penicillin etc.…
- Wheels: Have you heard the phase “the best invention since the wheel”
- Electricity: Thomas Alva Edison, Nikola Tesla, Michael Faraday.
- Penicillin: in 1928 by Scottish scientist named Alexander Fleming.

Charles Babbage, Difference Engine

- In 1823, **Charles Babbage** received a grant from the British government to build a mechanical device he called the **Difference Engine** for computing and printing mathematical tables.
- The design utilized rotating wheels and a single crank. [Very Mechanical]
- Technology at the time was not advanced for his design.
- Project abandoned.

- How would you know this design worked ????

Charles Babbage, Difference Engine

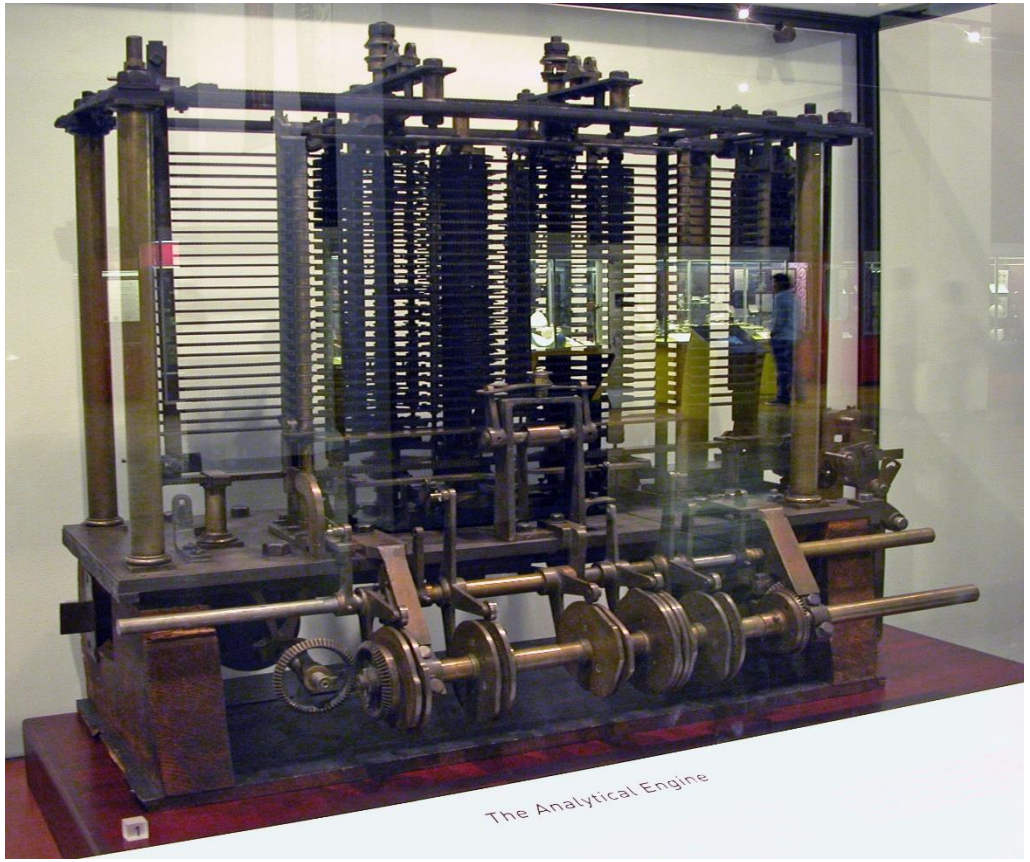


Fully operational difference engine at the *Computer History Museum* in Mountain View, California

Charles Babbage, Analytical Engine

- Later, **Charles Babbage** proposed the design of a far better machine, which he called the Analytical Engine.
- Proposed design was way ahead of its time.
- Never built due to Engineering limitations.
- Design was essentially based on the same fundamental principles of modern computer.
- Stand out was its programmability.

Charles Babbage, Analytical Engine



Model of a part of the Analytical Engine, built by Babbage, as displayed at the Science Museum in London

Punched cards used to program the Analytical Engine

So far…

- Made friends…

- Algorithms
- Basic programming.

- Pointers.

- What is the primary purpose of computers??

Introduction

- We need to store and retrieve information efficiently.

- Does efficiency really matter?
  - Processing power and storage capabilities going up, so…?

- Data structure: Any data representation and its associated operations.
- Have you used any data structures in your program??
- Integers and floating point numbers??

Introduction

- Organization or structuring for a collection of data items.
- Sorted list of integers stored in an array is an example of such a structuring.

- We have stored the data, what do we have to consider next?
  - Search for specified items
  - Print or process the data items
  - Modify the value of any particular data item

Introduction

- Why are DS important?

- Efficiency ??
- Resource constraints.
  - Space available to store the data: primary/secondary storage
  - Time allowed to perform each subtask
- Cost of a solution ??

When selecting a data structure

- Analyze your problem to determine which are basic operations that must be supported.
- Quantify the resource constraints for each operation.
- Select the data structure that best meets these requirements.

- Do you think one DS is better than another?

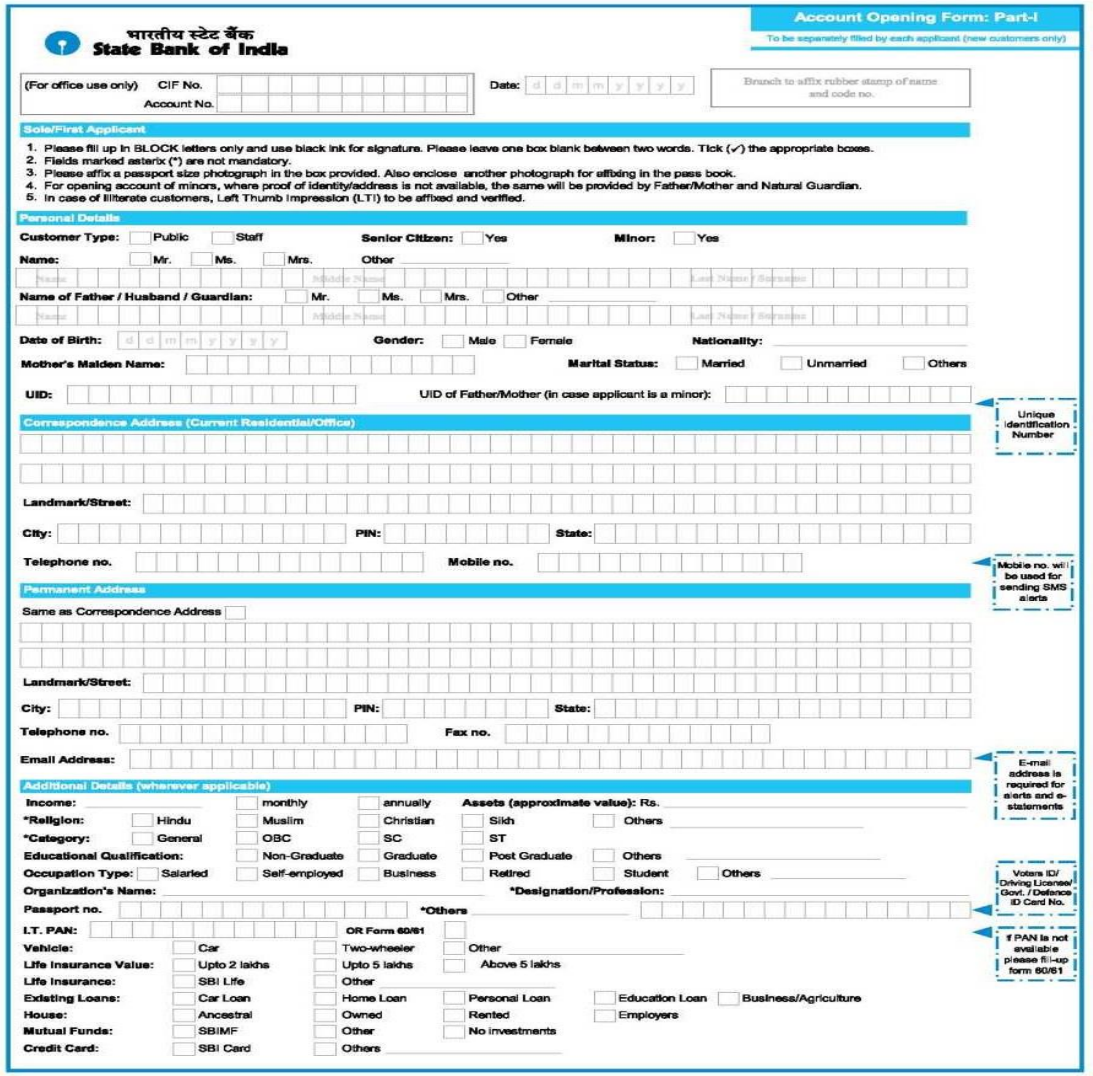
When selecting a data structure

- Your Bank Account Example
  - Database perspective

- System containing information about cities and towns in India.
  - Operations

Data Structures and Abstract Data Types

- **Type** is a collection of values.
  - Boolean, Integer.
- **Data type** is a type together with a collection of operations to manipulate the type.
- Bank Account?
- **Aggregate** or **composite** type.
- A *data item* is said to be a member of a type.
- Piece of information or a record whose value is drawn from a type



भारतीय स्टेट बैंक
State Bank of India

Account Opening Form: Part-I

To be separately filled by each applicant (new customers only)

(For office use only) CIF No. / Account No. | Date: d d m m y y y y | Branch to affix rubber stamp of name and code no.

Sole/First Applicant

1. Please fill up in BLOCK letters only and use black ink for signature. Please leave one box blank between two words. Tick (✓) the appropriate boxes.
2. Fields marked asterix (*) are not mandatory.
3. Please affix a passport size photograph in the box provided. Also enclose another photograph for affixing in the pass book.
4. For opening account of minors, where proof of identity/address is not available, the same will be provided by Father/Mother and Natural Guardian.
5. In case of illiterate customers, Left Thumb Impression (LTI) to be affixed and verified.

Personal Details

Customer Type: Public Staff | Senior Citizen: Yes | Minor: Yes

Name: Mr. Ms. Mrs. Other

Name of Father / Husband / Guardian: Mr. Ms. Mrs. Other

Date of Birth: d d m m y y y y | Gender: Male Female | Nationality:

Mother's Maiden Name: | Marital Status: Married Unmarried Others

UID: | UID of Father/Mother (in case applicant is a minor):

Unique Identification Number

Correspondence Address (Current Residential/Office)

Landmark/Street:

City: | PIN: | State:

Telephone no. | Mobile no.

Mobile no. will be used for sending SMS alerts

Permanent Address

Same as Correspondence Address

Landmark/Street:

City: | PIN: | State:

Telephone no. | Fax no.

Email Address:

E-mail address is required for alerts and e-statements

Additional Details (wherever applicable)

Income: monthly annually | Assets (approximate value): Rs.

*Religion: Hindu Muslim Christian Sikh Others

*Category: General OBC SC ST

Educational Qualification: Non-Graduate Graduate Post Graduate Others

Occupation Type: Salaried Self-employed Business Retired Student Others

Organization's Name: | *Designation/Profession:

Passport no. | *Others

Voters ID/ Driving License/ Govt. / Defence ID Card No.

I.T. PAN: | OR Form 60/61

If PAN is not available please fill up form 60/61

Vehicle: Car Two-wheeler Other

Life Insurance Value: Upto 2 lakhs Upto 5 lakhs Above 5 lakhs

Life Insurance: SBI Life Other

Existing Loans: Car Loan Home Loan Personal Loan Education Loan Business/Agriculture

House: Ancestral Owned Rented Employers

Mutual Funds: SBIMF Other No investments

Credit Card: SBI Card Others

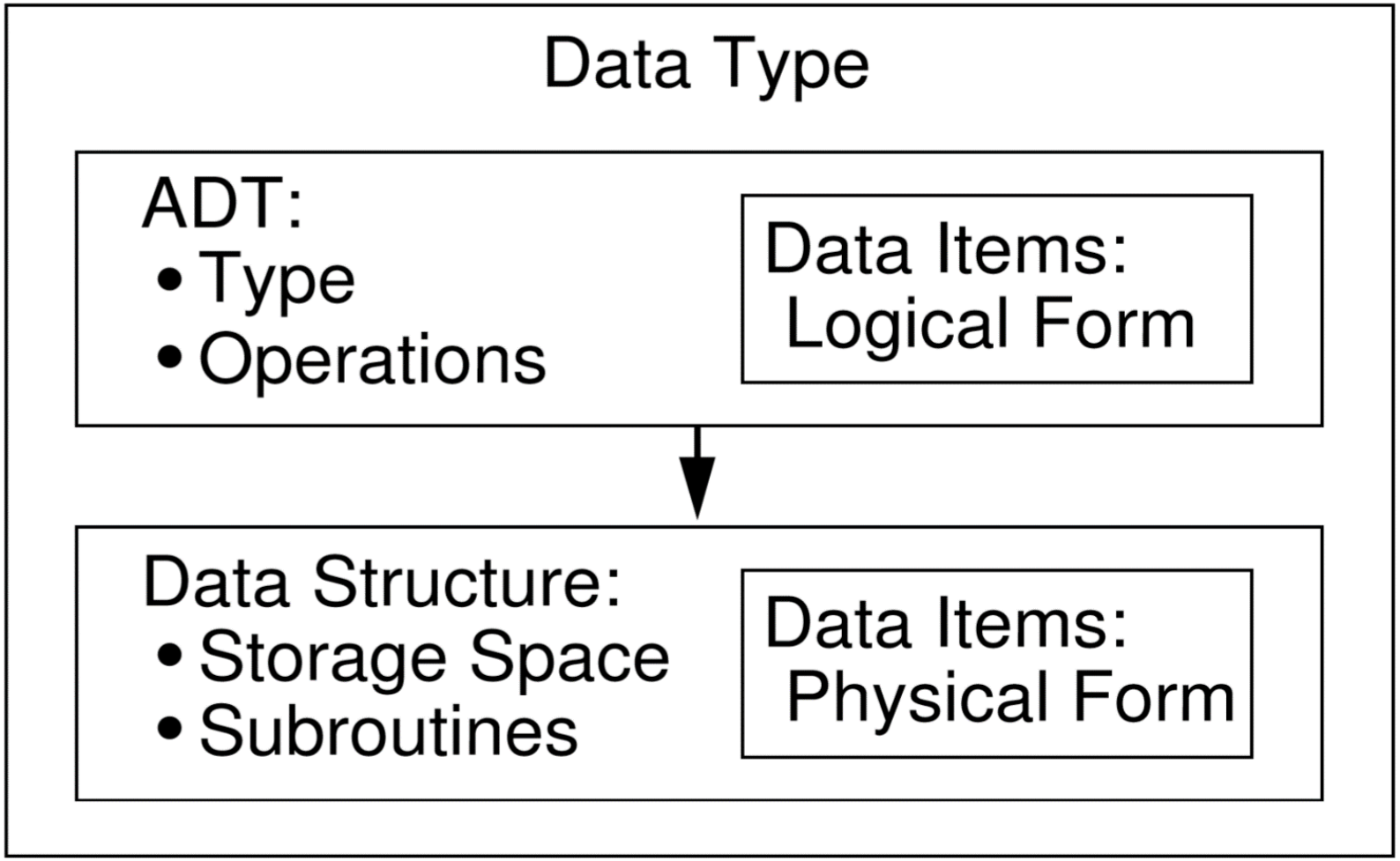
Logical Vs Physical

- **Abstract Data Type** (ADT) is the realization of a data type as a software component.
- Defined in terms of a type and a set of operations on that type.
- Does not specify how the data type is implemented.
  - Implementation details are hidden from the user and protected from outside access: Encapsulation
- Consider your car…

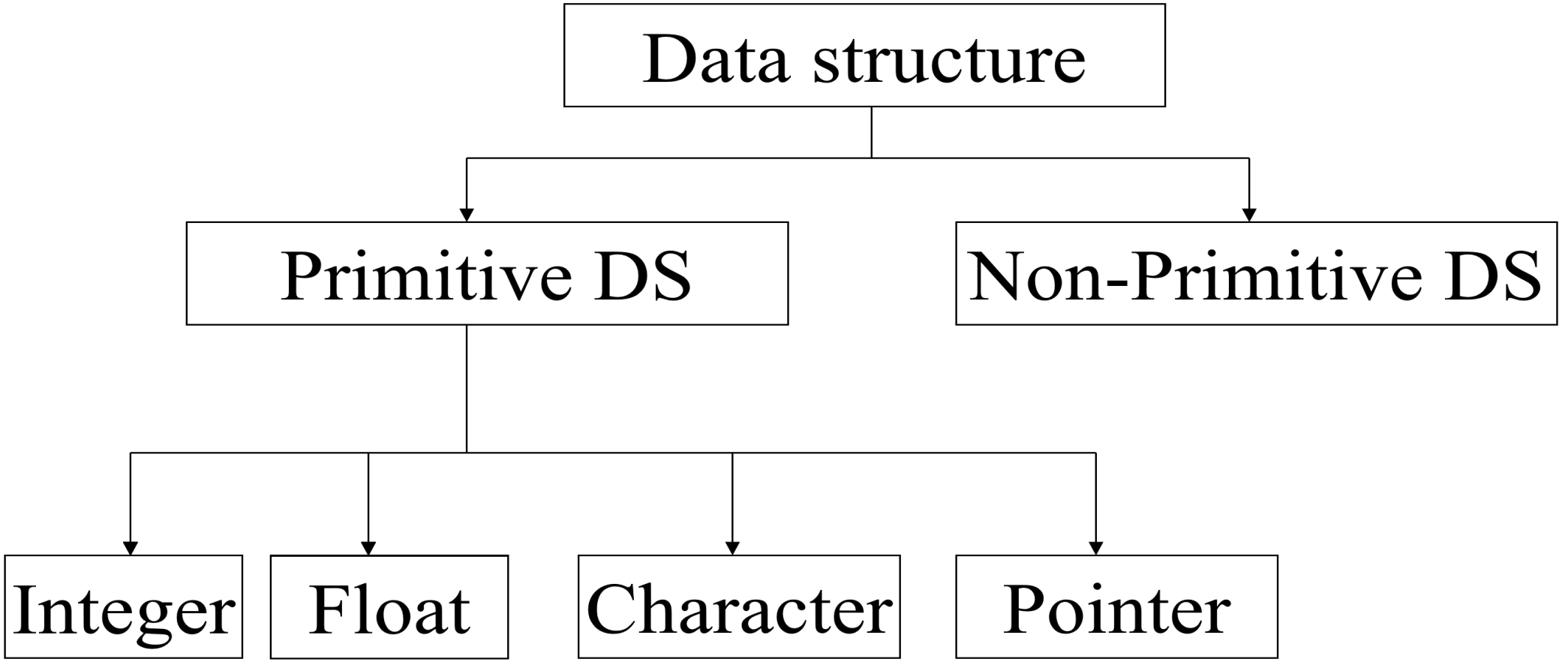
Logical Vs Physical

- **Data structure** is the implementation for an ADT.
- Object-oriented language such as C++, JAVA an ADT and its implementation together make up a *class*.
- Operation associated with the ADT is implemented by a *member function* or method.
- Data types have both a **logical** and a **physical form**.
- The definition of the data type in terms of an ADT is its logical form.
- The implementation of the data type as a data structure is its physical form.

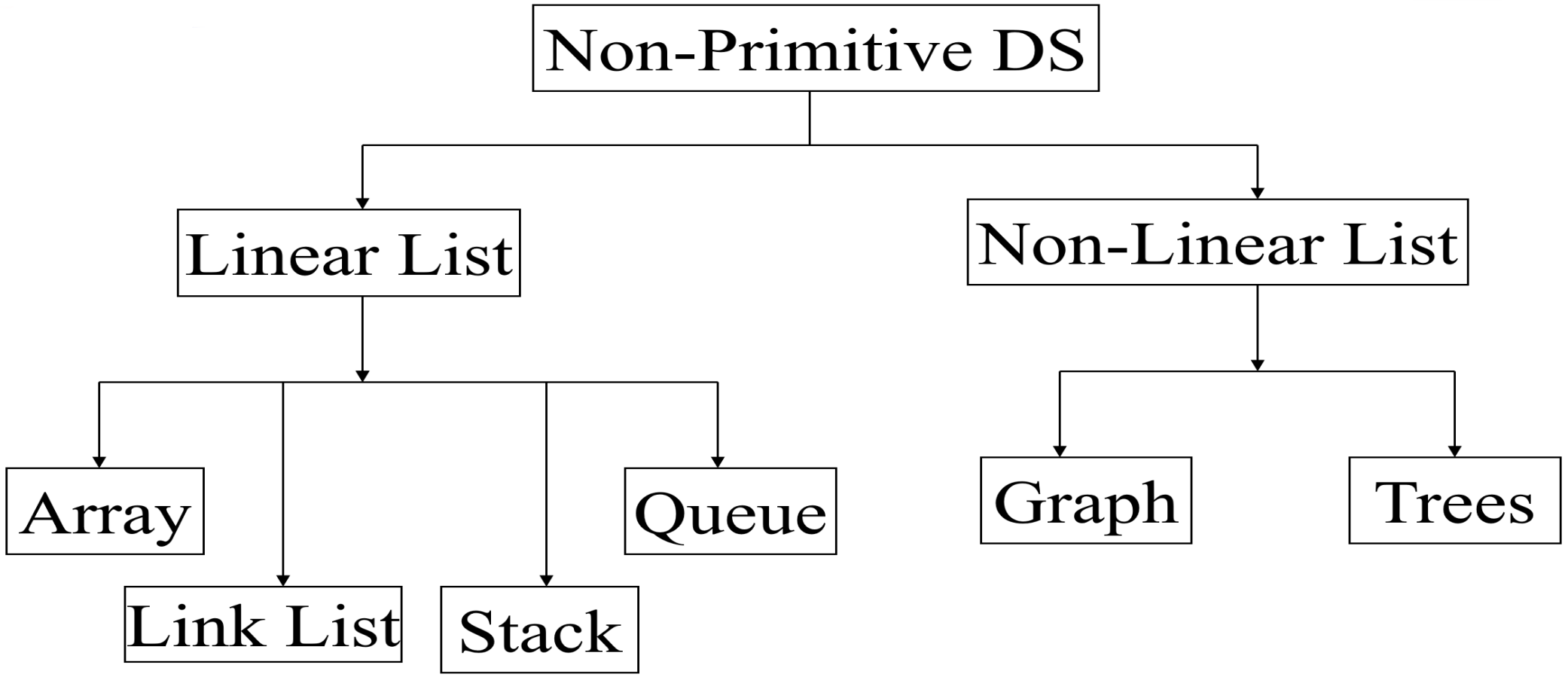
Logical Vs Physical



Data Structures



Data Structures



Data Structure Operations

- Traversing: Accessing each record exactly once so that certain items in the record may be processed.
- Searching: Finding the location of the record with a given key value.
- Inserting: Adding a new record to the structure.
- Deleting: Removing a record from the structure.
- Sorting: Arranging the records in some logical order.
- Merging: Combing the records in two different sorted files into a single sorted file.