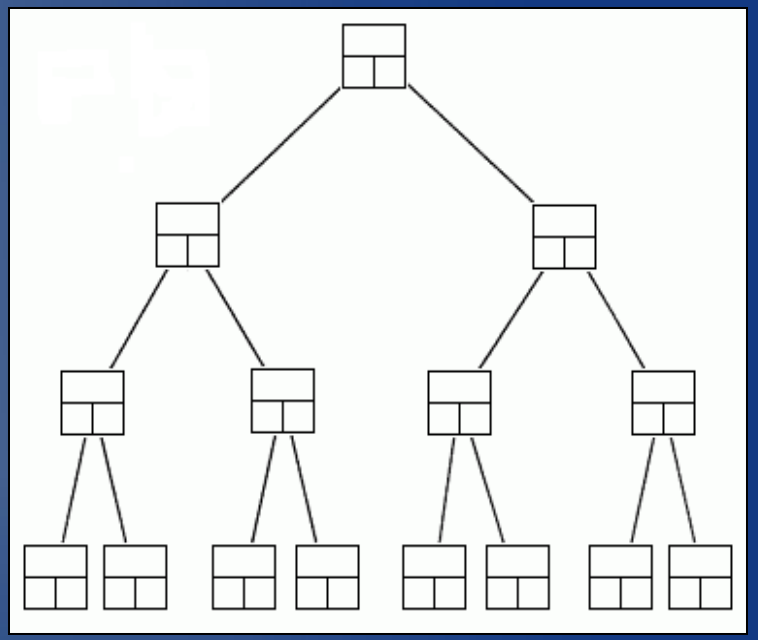
Introduction to Data Structures

Data Structures

A data structure is a scheme for organizing data in the memory of a computer.

Some of the more commonly used data structures include lists, arrays, stacks, queues, heaps, trees, and graphs.

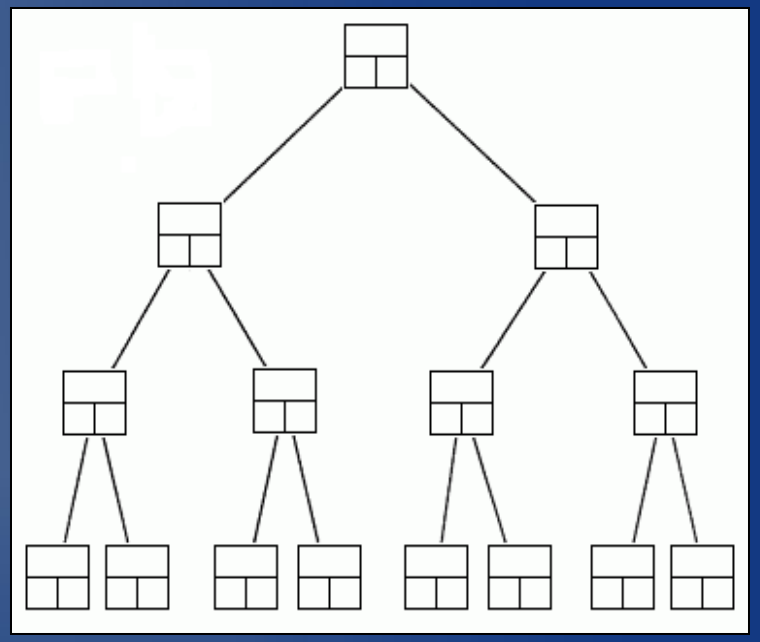


Binary Tree

Data Structures

The way in which the data is organized affects the performance of a program for different tasks.

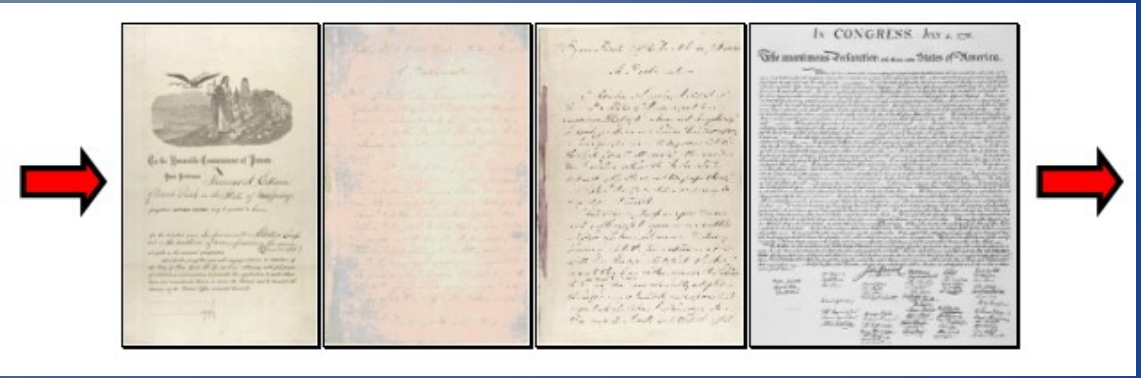
Computer programmers decide which data structures to use based on the nature of the data and the processes that need to be performed on that data.



Binary Tree

Example: A Queue

A *queue* is an example of commonly used simple data structure. A queue has beginning and end, called the *front* and *rear* of the queue.



Data enters the queue at one end and leaves at the other.

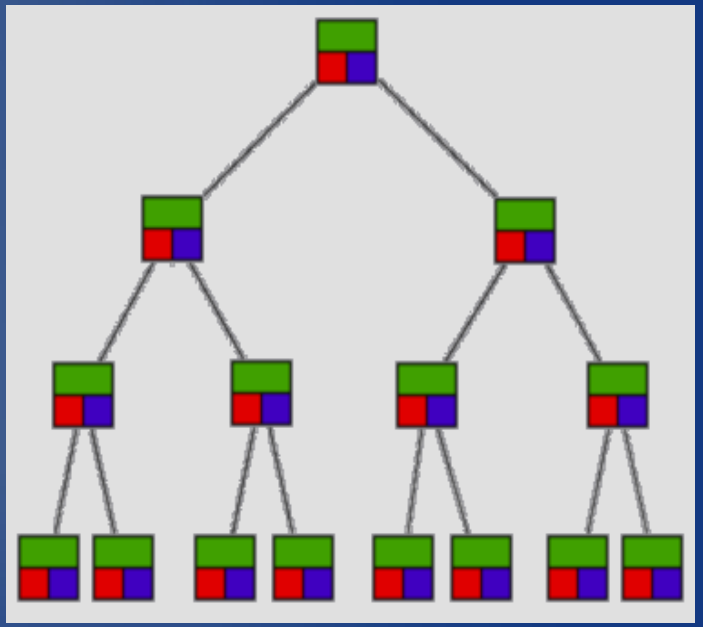
Because of this, data exits the queue in the same order in which it enters the queue, like people in a checkout line at a supermarket.

Example: A Binary Tree

A *binary tree* is another commonly used data structure.

It is organized like an upside down tree.

Each spot on the tree, called a *node*, holds an item of data along with a left pointer and a right pointer.



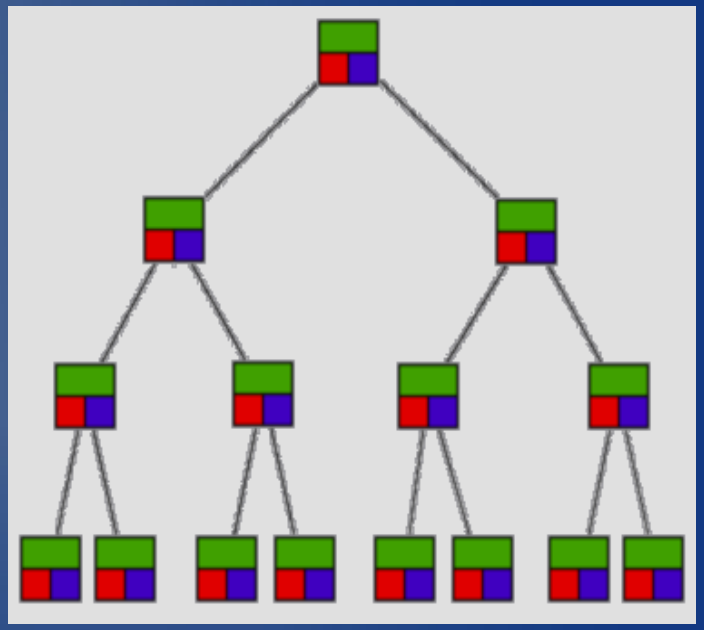
Binary Tree

Example: A Binary Tree

The pointers are lined up so that the structure forms the upside down tree,

with a single node at the top, called the root node,

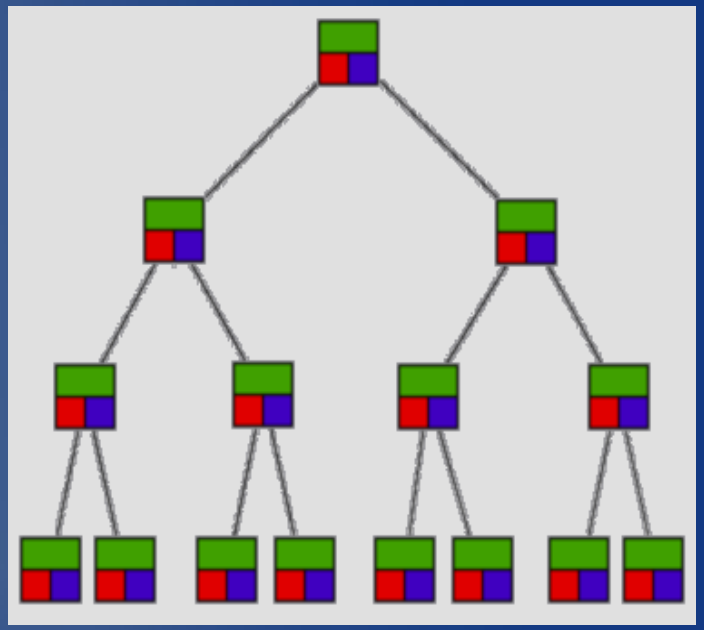
and branches increasing on the left and right as you go down the tree.

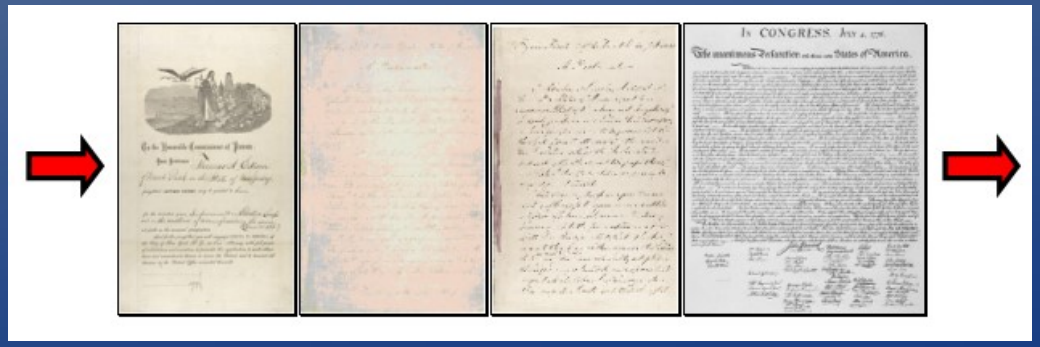


Binary Tree

Choosing Data Structures

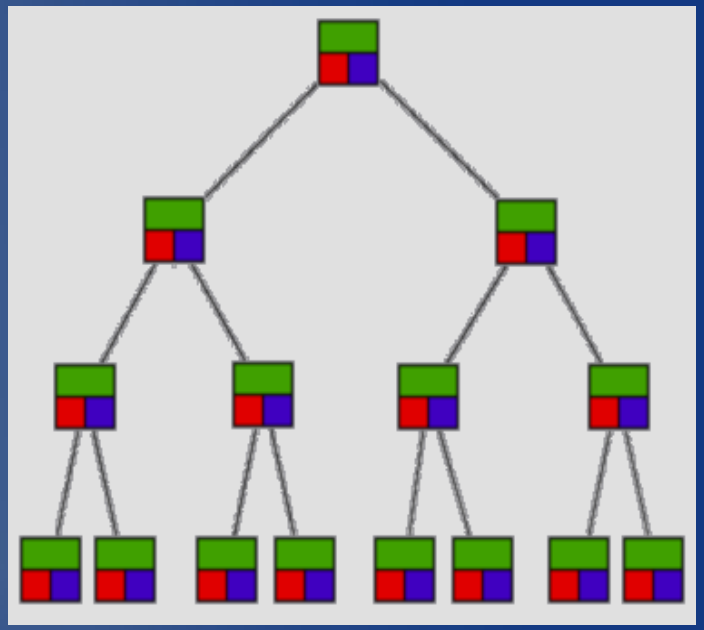
By comparing the queue with the binary tree, you can see how the structure of the data affects what can be done efficiently with the data.

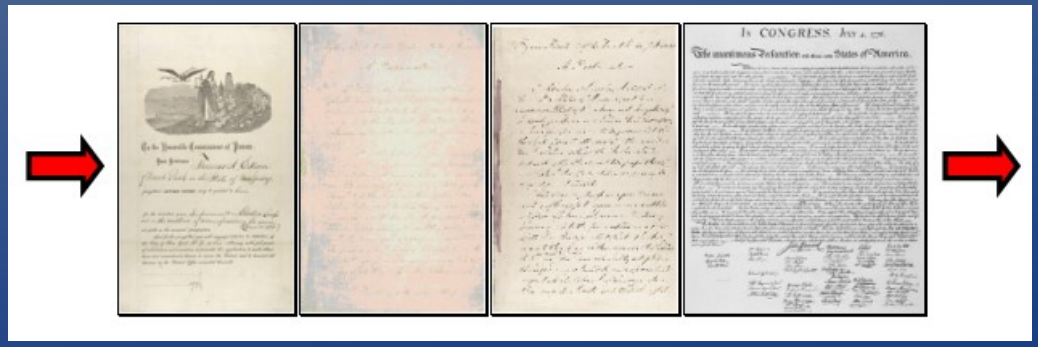




Choosing Data Structures

A queue is a good data structure to use for storing things that need to be kept in order, such as a set of documents waiting to be printed on a network printer.





Choosing Data Structures

The jobs will be printed in the order in which they are received.

Most network print servers maintain such a *print queue*.

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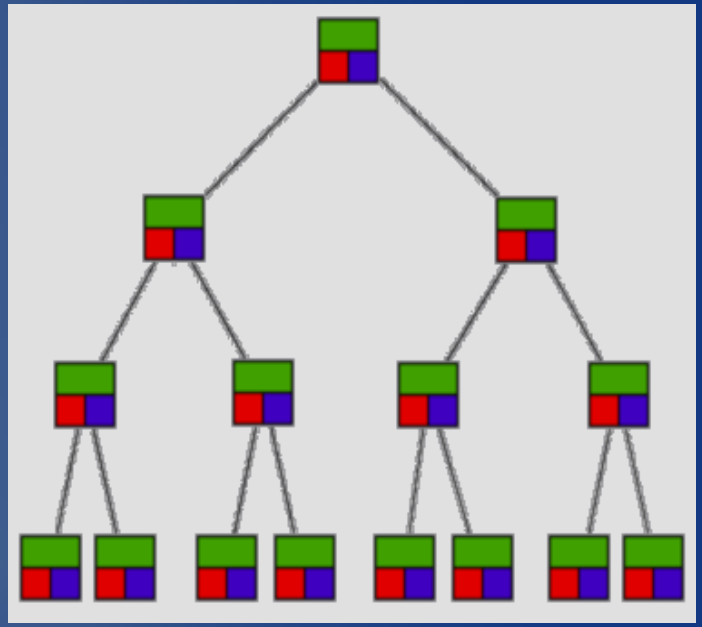
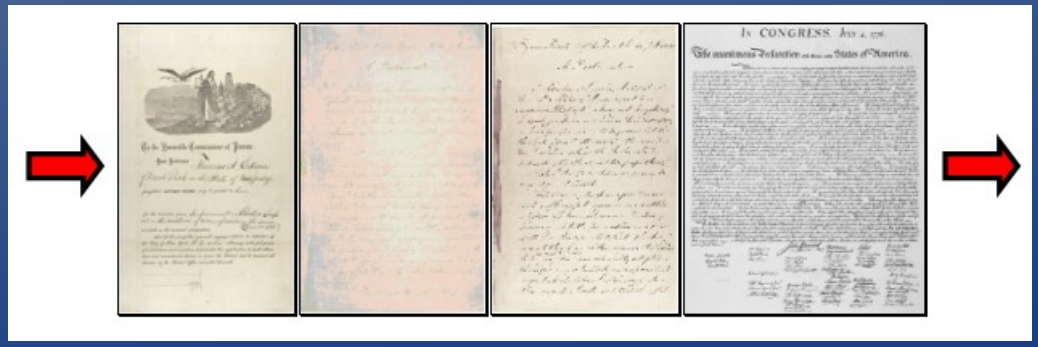
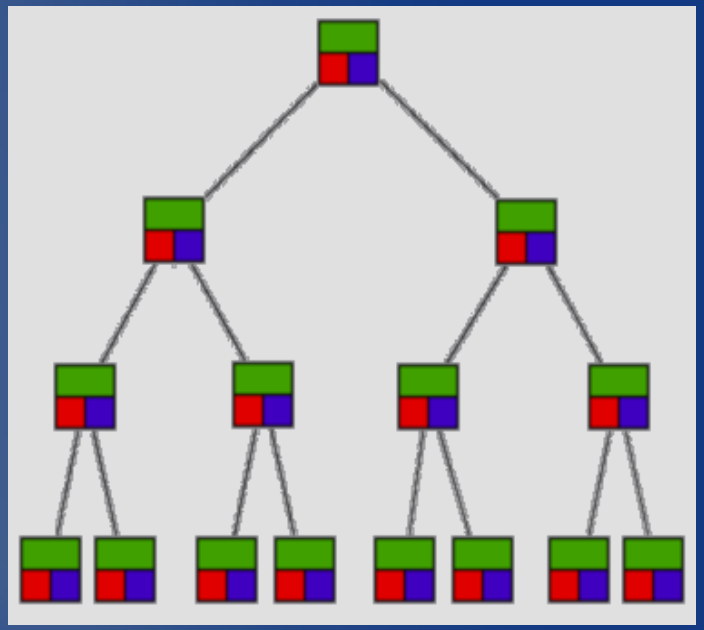


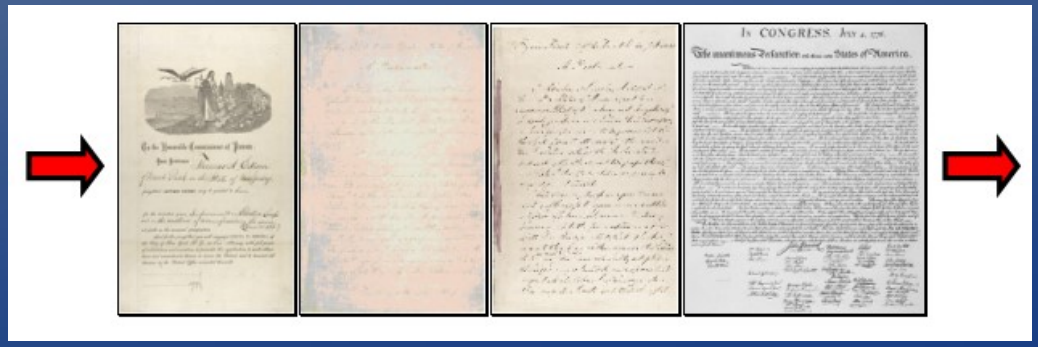


Choosing Data Structures

A binary tree is a good data structure to use for searching sorted data.

The middle item from the list is stored in the root node, with lesser items to the left and greater items to the right.

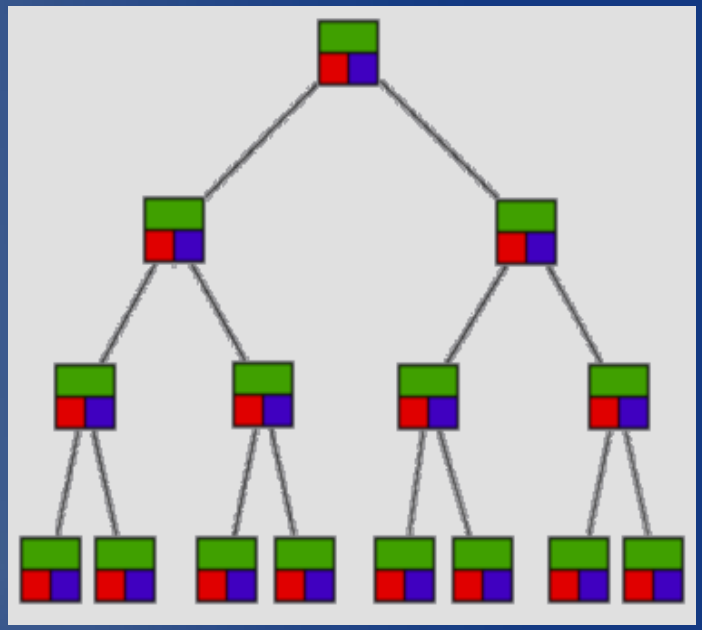


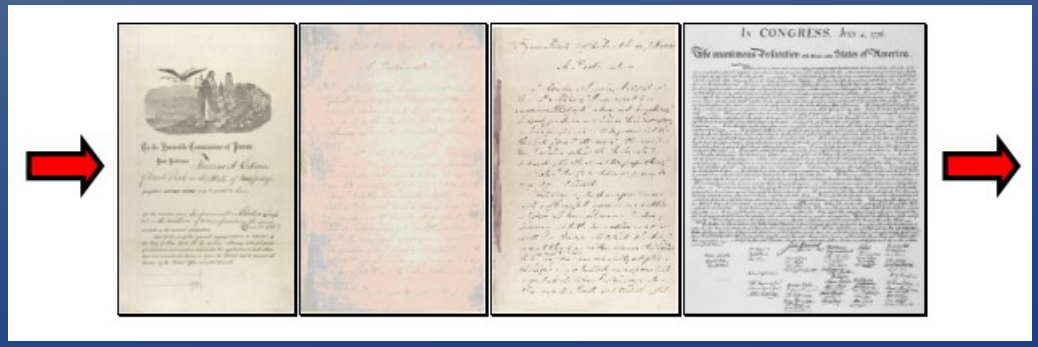


Choosing Data Structures

A search begins at the root. The computer either find the data, or moves left or right, depending on the value for which you are searching.

Each move down the tree cuts the remaining data in half.

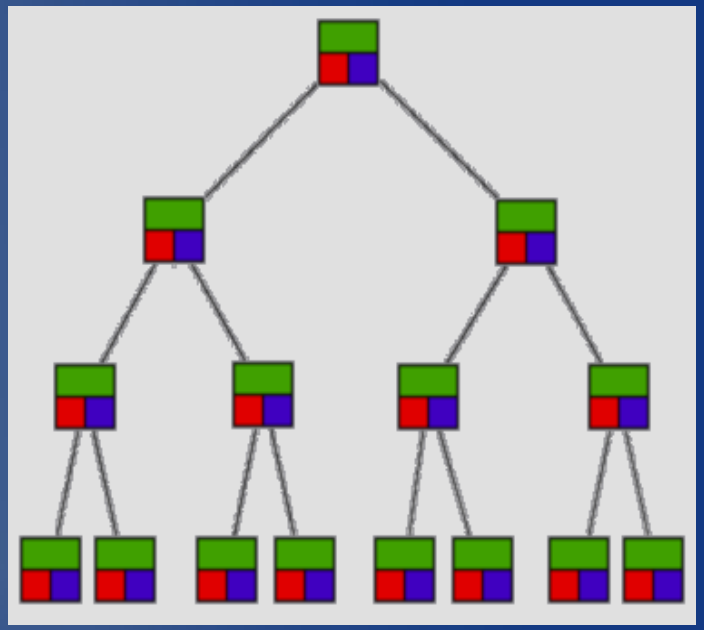


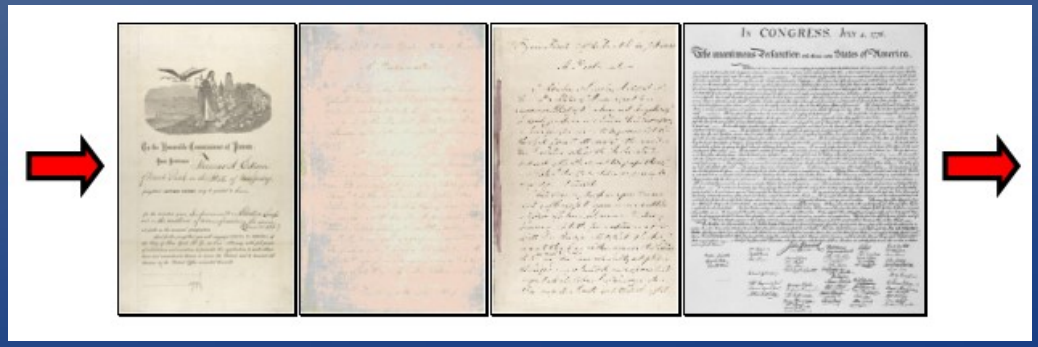


Choosing Data Structures

Items can be located very quickly in a tree.

Telephone directory assistance information is stored in a tree, so that a name and phone number can be found quickly.



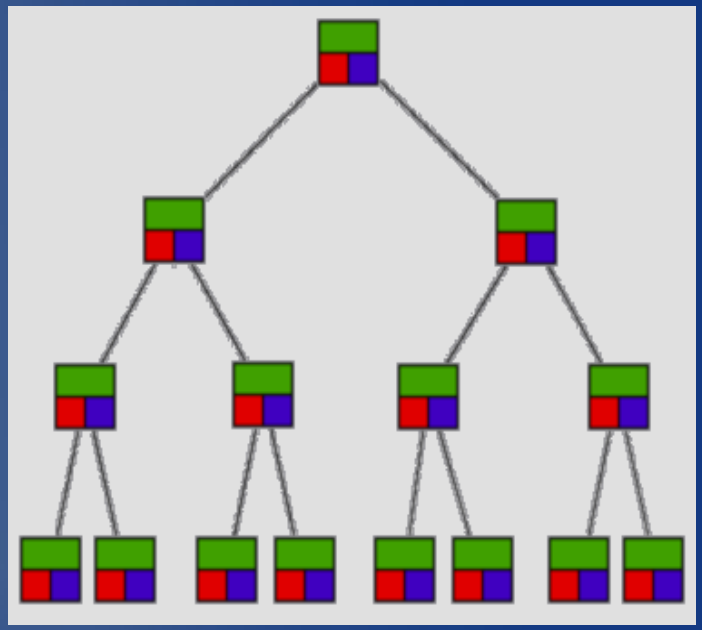


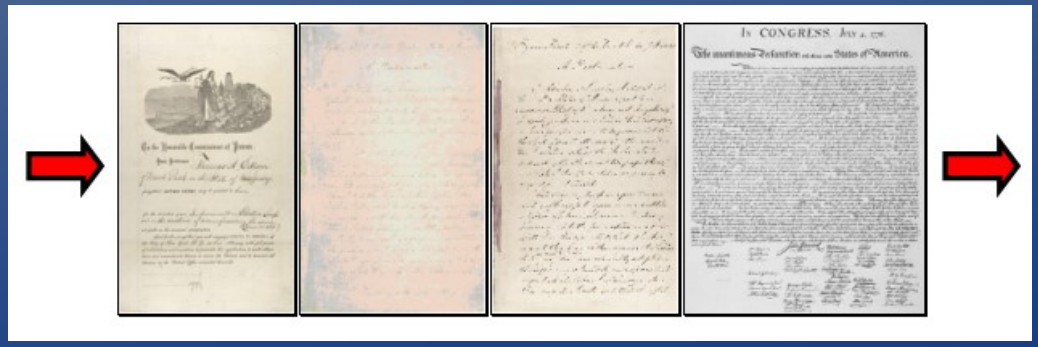
Choosing Data Structures

For some applications, a queue is the best data structure to use.

For others, a binary tree is better.

Programmers choose from among many data structures based on how the data will be used by the program.





Data Structures in Alice

Alice has two built-in data structures that can be used to organize data, or to create other data structures:

- Lists
- Arrays

Lists

A list is an ordered set of data. It is often used to store objects that are to be processed sequentially.

A list can be used to create a queue.

Arrays

An array is an indexed set of variables, such as $dancer_{[1]}$, $dancer_{[2]}$, $dancer_{[3]}$,… It is like a set of boxes that hold things.

A list is a set of items.

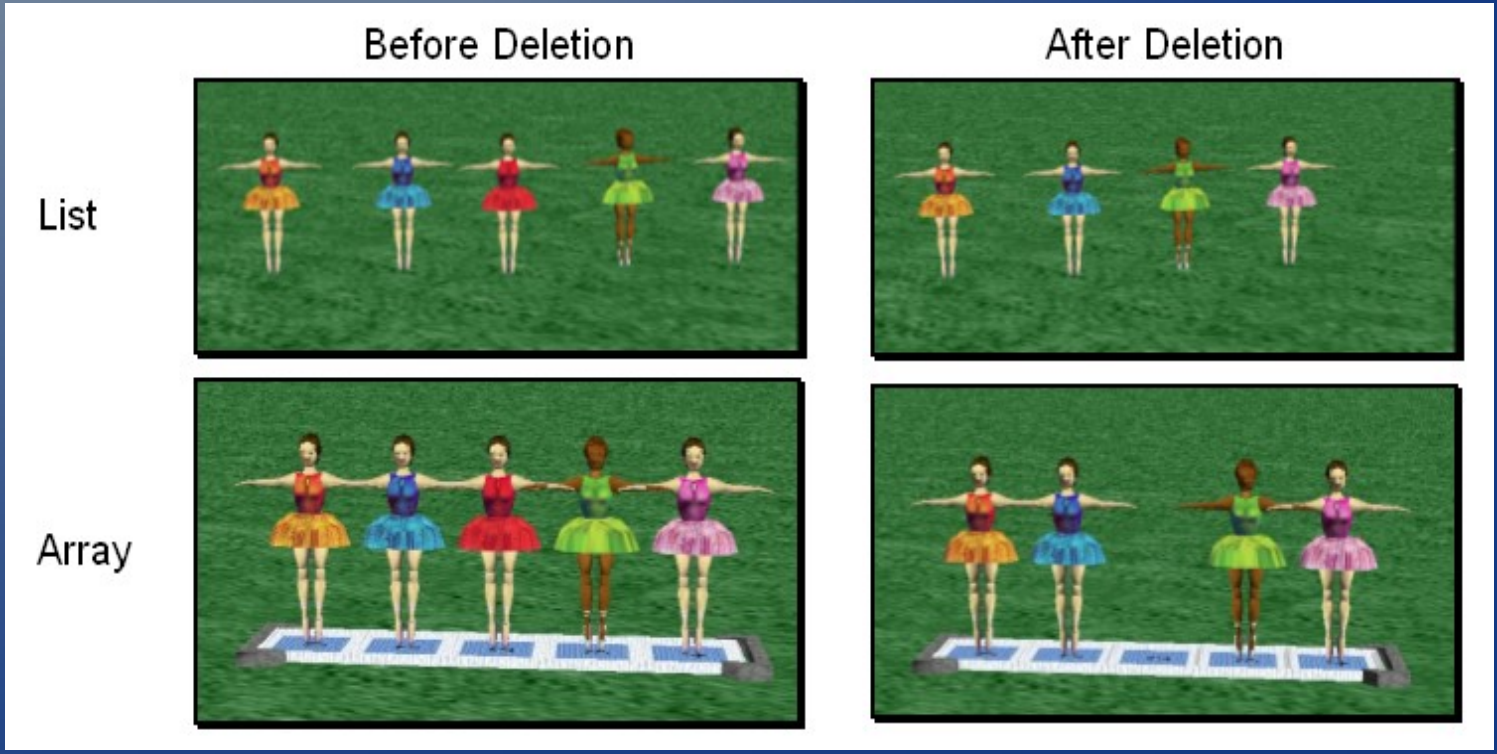
An array is a set of variables that each store an item.

Arrays and Lists

You can see the difference between arrays and lists when you delete items.

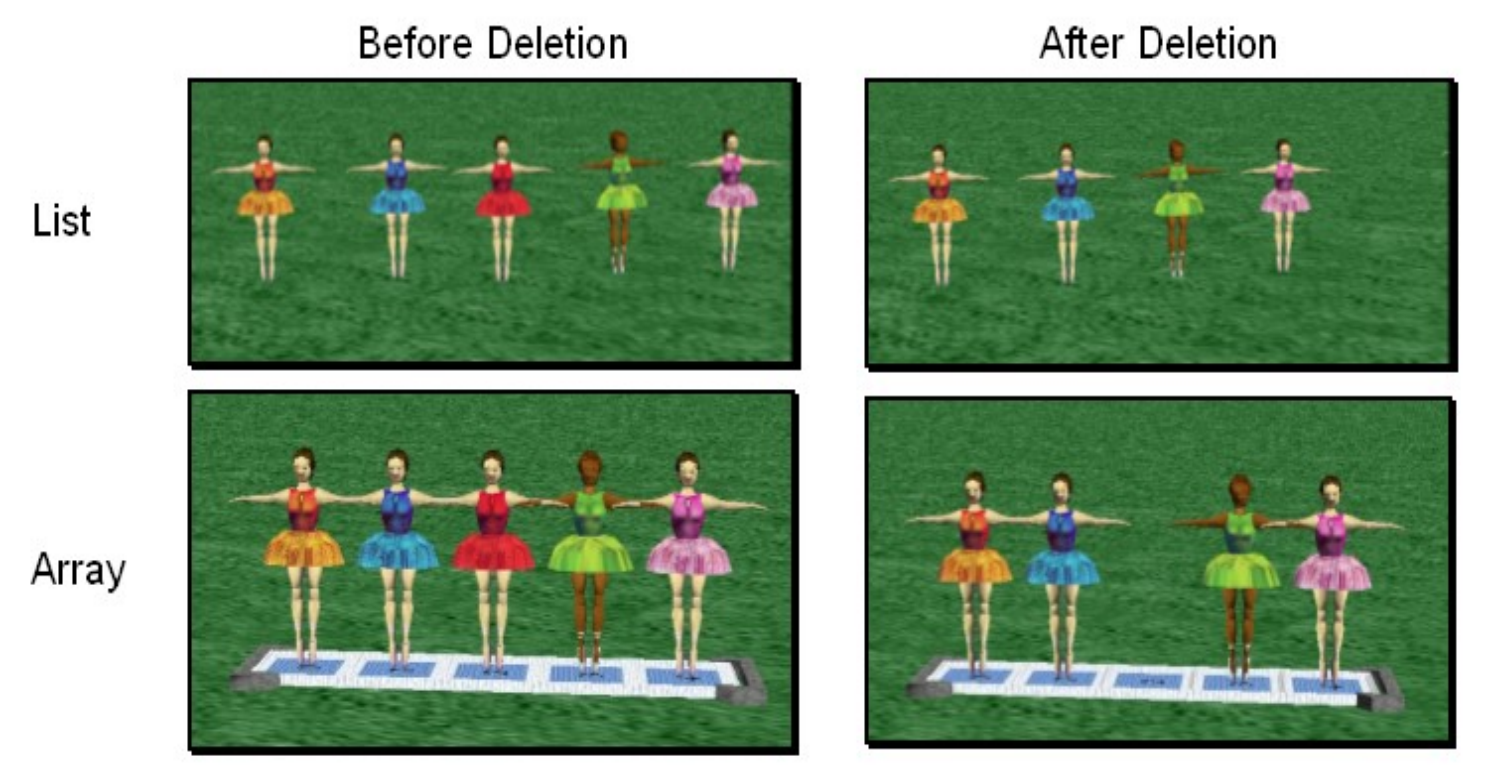
Arrays and Lists

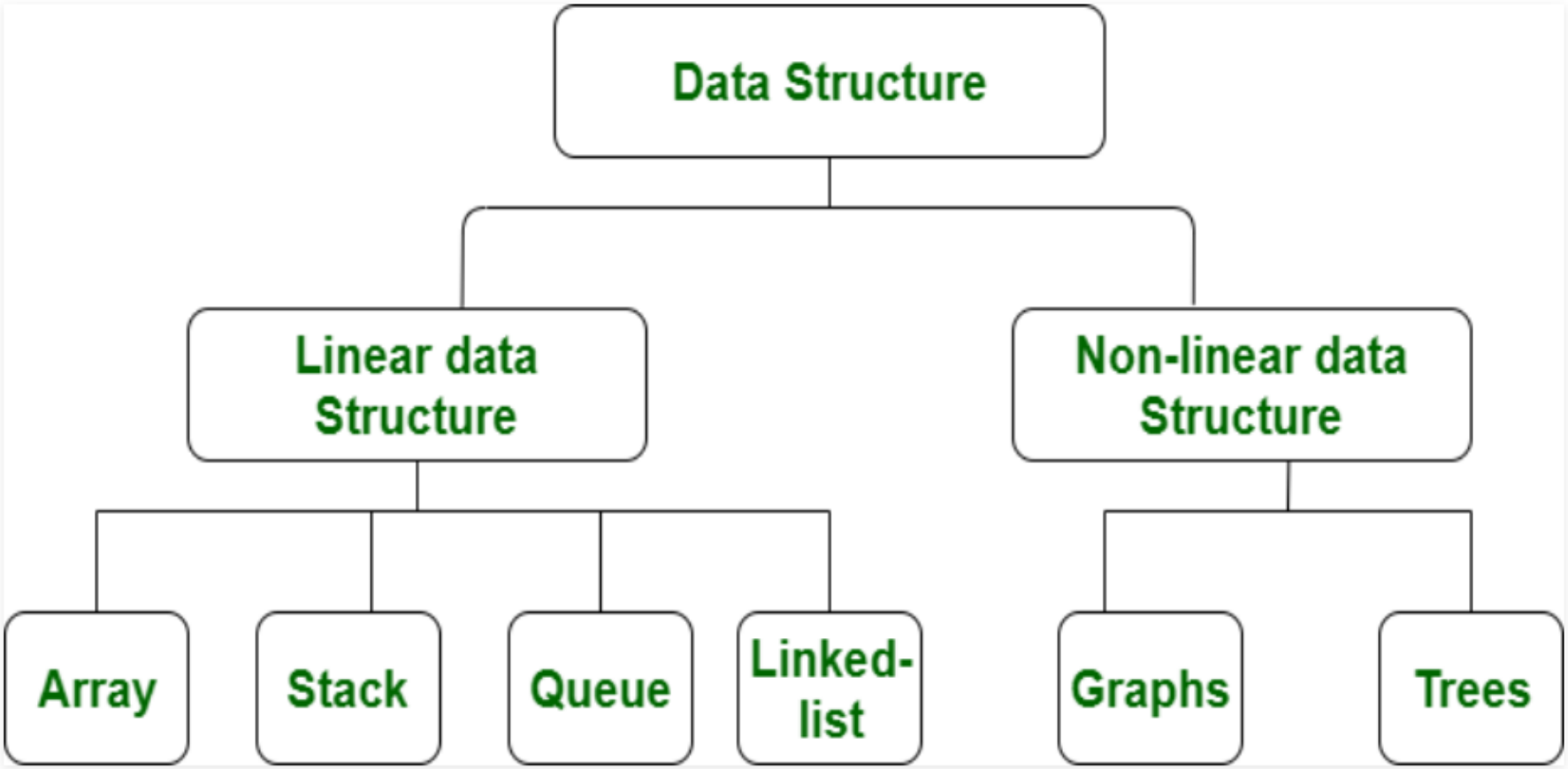
In a list, the missing spot is filled in when something is deleted.



Arrays and Lists

In an array, an empty variable is left behind when something is deleted.




Data Structure
Linear data Structure
Non-linear data Structure
Array
Stack
Queue
Linked-list
Graphs
Trees

Difference between Linear and Non-linear Data Structure

Linear Data Structure	Non-linear Data Structure
Data elements are arranged in a linear order where each and every elements are attached to its previous and next adjacent.	Data elements are attached in hierarchically manner.
Single level is involved.	Multiple levels are involved.
Its implementation is easy in comparison to non-linear data structure.	Its implementation is complex in comparison to linear data structure.
Data elements can be traversed in a single run only.	Data elements can't be traversed in a single run only.
Memory is not utilized in an efficient way.	Memory is utilized in an efficient way.
Examples: array, stack, queue, linked list, etc.	Examples: trees and graphs.
Applications: mainly in application software development.	Applications: Artificial Intelligence and image processing.