

# Computer Science

## Data type

String - collection of characters. Concatenation refers to pushing two or more together

Int - Integer bounded by some power of  $2^n$  and  $-2^n$ .

Double/float - floating point numbers

## Languages

C++ - improvement upon C by adding object oriented functionality. Developed at Bell Labs by Bjarne Stroustrup. Printing to the screen is done with `cout <<`. Uses pointers for linked lists unlike Java. Follows the rule of three that states that if an assignment operator, copy constructor, or destructor must be explicitly defined, then all three must. Boost package provides supports for GUIs.

Java - object oriented language originally called Oak. developed by Sun Microsystems. "Write once, run everywhere" motto allows it to make Apps and Applets. Has automatic garbage collection. Linked Lists do not have pointers. Oracle released JDK with built-in objects. Its bytecode is executed by its virtual machines, meaning it's interpreted. Does not support multiple inheritance but does allow interfaces. Swing interface allows for GUIs.

## Languages

Scripting languages - JavaScript (client side) vs. PHP (server side). Python

Functional programming - treats programs as functions to be evaluated. Includes Haskell, Scheme, and Lisp. Info is stored in Monads.

Dynamic vs. Static - Dynamic (Python) allows for on the fly data type changes whereas Static (Java) does not.

HTML and web based - developed by Tim Berners-Lee (who also developed HTTP). Encloses text in tags and begins with a doctype declaration. CSS modifies look including position, color, font, etc.

## Database

SQL - uses "queries" to create and modify a relational-database, which follow the ACID properties. Data is divided into multiple tables

## Theoretical

Object Oriented - classes are instructions which contain constructors used to create objects. Objects no longer needed are eliminated by garbage collection. Non-static methods/functions manipulate data within an object. Inheritance allows one class to retain properties from another class. Polymorphism allows one object to interact with objects of a superclass.

Big O notation - used to describe the performance and memory allocations of algorithms using parent functions instead of specifically derived ones. The smaller the output, the faster the algorithm.

Recursion - a function calling itself, typically carrying information from the previous iteration. Ackermann function is recursive.

## Algorithms

Quicksort - divide and conquer algorithm that recursively partitions a set and sorts elements.

Bubble sort - continuously swaps adjacent elements. Incredibly slow.

Merge sort - developed by John von Neumann. Partitions into two sets, sorts them, and then merges them.

Insertion and selection - nested loops to compare one element to every other element in the structure.

## Algorithms

Linear search - starts from the beginning and searches elements one-by-one.

Binary search - only works on a sorted structure. Partitions structure and recursively shrinks the structure until the element it located or determined not to exist.

Grover's - searching algorithm for quantum computers (store info in qubits. First proposed by Feynman)

Dijkstra's - searches for a minimum path in weighted graph by employing a priority queue to provide favorable options. Replaced by Bellman-Ford and improved upon by the A\* algorithm by adding a directional heuristic.

## Algorithms

Cooley-Tukey - Fast Fourier transforms.

Shor's - polynomial factorization for quantum computers.

Prim & Kruskal - find minimum spanning trees from a weighted graph.

Hash functions - determine placement of an object in a hash table by creating a code unique to that object. Much more efficient than search algorithms.

## Data structures

Trees - balanced variety equalizes the amount of children on each side. Examples include Red and Black, K-D, AVL, B (used in databases), and binary search (lowest value is on far left and increases while moving to the right). Leaves are elements with no children.

Heaps - root element is smallest and goes in ascending order. Heap search has  $O(n \log n)$ . Includes a Fibonacci tree

Stacks - "last in, first out". Push pushes an element on top while pop puts it on. Used to order function calls in programs. Reverse Polish notation explains usage for operators and data

## Data structures

Queue - "First in, first out" like a normal line. Priority queue orders elements largest to smallest based on priority parameter.

Linked List - elements connected together where last element references the first. "Doubly" type allows it to be traversed either way. Pointers (not in Java) includes a reference from one element to another. Sentinel nodes prevent out of bounds exception error.

Array - "stretched out linked list". Index corresponds with an element. Matrices are two-dimensional varieties.

## Computer Scientists

Turing - cracked German Enigma code. "Turing Machine" is a set of instructions on an infinitely long piece of tape with a read-write head. He and Alonzo Church name a thesis that states that any computable function can be solved by a Turing machine. Those two worked on lambda calculus together. Turing completeness refers to Turing machine being able to carry out a set of instructions.

Dijkstra - shunting yard algorithm converts syntax into Reverse Polish notation.

Donald Knuth - Stanford professor who wrote *The Art of Computer Programming*