Computer Science Fundamentals

store information digitally

* When we look at a computer, we see text and images and shapes. To a computer, all of that is just binary data, 1s and 0s

* **bit** stores either the value 1 or 0.**byte** is a unit of digital information that consists of those bits

text encoding

* **ASCII Encoding**:Uses 7 bits to represent 128 characters, including English letters, digits, punctuation marks, and control characters.

* **Unicode**:provide a unique number for every character, regardless of language, Includes several encoding forms like **UTF-8, UTF-16**,... .characters have different bytes.

compression

* **Lossless** reduce the size of files without losing any information in the file.(Huffman coding)
* **Lossy** reduce the size of files by discarding the less important information in a file

internt

* **Internet** is a global network of devices,communicating with each other

* **IP**: A protocol that uniquely identify devices

* **TCP/UDP**: Protocols that can transport packets of data from one device to another and check for errors along the way. UDP=fast,TCP=reliable

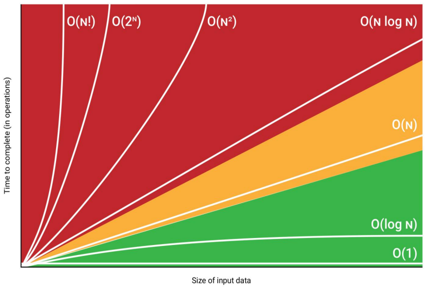
* **TLS**: A secure protocol for sending encrypted data so attackers can't view private information.

* **DNS (Domain Name System)** is like the internet's phone book, translating website names (like www.example.com) into IP addresses (like 192.168.1.1).

* Whenever you visit a page on the web, your computer uses the **Hypertext Transfer Protocol (HTTP)** to download that page from another computer somewhere on the Internet.

Algorithms

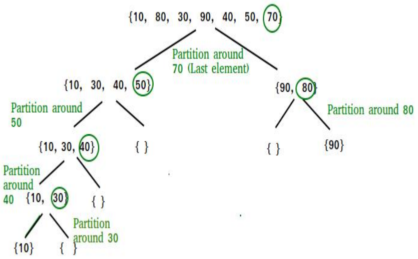
* **Big O** notation describes how the time or space requirements of an algorithm grow as the input size grows



sorting algorithms

Bubble Sort (O(n^2)): Repeatedly swaps element if it is bigger than right element.[31,29,8,36]=>[29,31,8,36]=>[29,8,31,36]

Quick Sort worse=O(n^2)/avg=O(n log(n)): The key process in quickSort is a partition() . The target of partitions is to place the pivot (any element can be chosen to be a pivot) at its correct position in the sorted array and put all smaller elements to the left of the pivot, and all greater elements to the right of the pivot.



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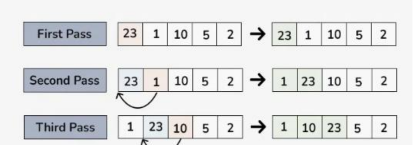
Algorithms

sorting algorithms

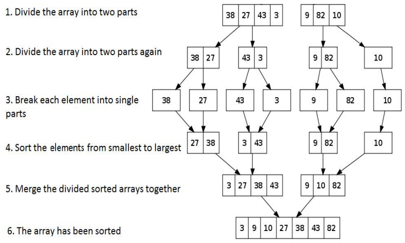
Insertion Sort

(O(n^2)):is like sorting playing cards .You split the cards into two groups: the sorted cards and the unsorted cards. Then, you pick a card from the unsorted group and put it in the right place in the sorted group.



Merge Sort

(O(n log n)): Divides the array into halves, sorts them, and then merges them back together.


1. Divide the array into two parts
2. Divide the array into two parts again
3. Break each element into single parts
4. Sort the elements from smallest to largest
5. Merge the divided sorted arrays together
6. The array has been sorted
38 27 43 3
9 82 10
38 27
43 3
9 82
10
38
27
43
3
9
82
10
27 38
3 43
9 82
10
3 27 38 43
9 10 82
3 9 10 27 38 43 82

selection Sort

(O(n^2)):repeatedly selects the smallest element from the unsorted portion of the list and swaps it with the first element of the unsorted part

	Worst-	**Average-**
Bubble	O(n^2)	O(n^2)
Selection	O(n^2)	O(n^2)
Insertion	O(n^2)	O(n^2)
Quick Sort	O(n^2)	O(nlog(n))
Merge Sort	O(nlog(n))	O(nlog(n))
Timsort	O(nlog(n))	O(nlog(n))

Timsort: Python's built-in sort functions

search algorithms

Linear Search

Best: O(1)

Average/Worst: O(n)

Description: Checks each element in the list until the target is found.

Binary Search

Best/Average/Worst: O(log n)

Repeatedly divides the sorted list in half,compare with middle if smaller search in left side if it is bigger search in right side to find the

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Data Structures

Arrays:is a collection of elements stored at contiguous memory locations, providing fast indexed access but having a fixed size and less efficient insertions and deletions

Linked Lists: collection of elements where each element points to the next, allowing for dynamic resizing and efficient insertions and deletions but requiring sequential access and more memory overhead due to pointers.

	array	linked list
index	O(1)	O(n)
insert/del at start	O(n)	O(1)
insert/del at end	O(1) if we have capacity	O(n)
insert/del at middele	O(n)	O(n)

Hash Table: A data structure that maps keys to values using a hash function.

Hash Function: Converts a key into an index in the hash table.

price["March"]=220 convert March to index with has function.

Collision : Occurs when two keys

Collision Resolution Techniques:

Chaining: Each bucket of the hash table contains a linked list to store all elements that hash to the same index.

Linear Probing: Sequentially checks the next slots for an empty slot.

Average : Insertion: O(1)/Search: O(1)/Deletion: O(1)

Worst :O(n) when many collisions occur or when using a poor hash function.

stack: the last element added to the stack will be the first one to be removed. (LIFO)

use cases: FunctionCalling / Undo(ctrl+z)

```
from collections import deque
# Initialize a stack
stack = deque()
# Push operation
stack.append(10)
# Pop operation
stack.pop()
```

queue: The first element added to the queue will be the first one to be removed (FIFO).

use cases: Order processing

```
from collections import deque
# Initialize a stack
stack = deque()
# Push operation
stack.appendleft(10)
# Pop operation
stack.pop()
```

for **queue** and **stack**

push/pop = O(1)

search =O(n)

genral tree: is a hierarchical data structure where each node can have number of children nodes

```
from anytree import Node
 root = Node("Root")
child1 = Node("Child 1",parent=root)
```

binary tree: each node has at most two children

binary search tree (BST): is a special type of binary tree ,

For each node, the values of all the nodes in the left subtree are less than the node's value.

and The values of all the nodes in the right subtree are greater.

insert= O(log(n))

search =O(log(n))

Deletion=O(log(n))

Node is a leaf node : Simply remove the node.

Node has one child : Replace the node with its child.

Node has two children : Find the smallest value in the right subtree and replace with it.