CS2100

More on housekeeping
Asymptotic analysis

Announcements

Last time

- Stacks implementation

2 options:

Trade off:

Finishing up "housekeeping":
3 functions:

We (mostly) finished, but
let's re-check the details.

<u>Next:</u> Asymptotic Analysis

<u>Motivation</u>:

How should we compare 2 programs?

Speed:

- Exact speed can depend on many variables besides the algorithm.

Issues at play:

Alternative approach:

Count <u>primitive</u> <u>operations</u>, which are smallest operations.

In addition: generally only examine <u>worst case</u> running time.

Why?

Now: How to actually compare?

- Remember small difference may be due to processor, language, or any number of things that aren't dependent on the algorithm.

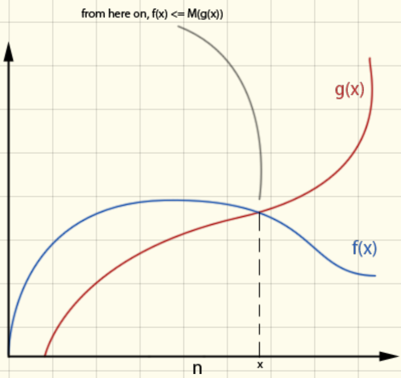
- Also: need a way to account for inputs changing

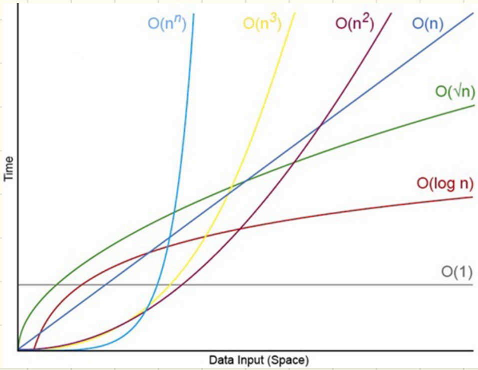
  eg searching a list

Big-O notation

We say $f(n)$ is $O(g(n))$ if
$\forall n > n_0$, $\exists c > 0$ such that

$$f(n) \leq c \cdot g(n)$$





Examples

1. $5n$ is $O(n^2)$

2. $5n$ is $O(n)$

3. $16n^2 + 21n$ is $O(n^2)$

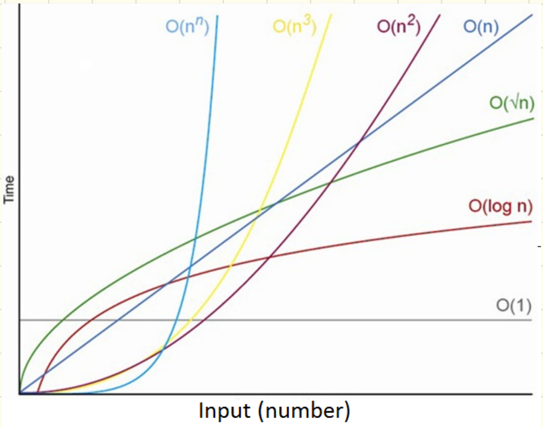
Common runtimes

1. $O(1)$
2. $O(\log n)$
3. $O(n)$
4. $O(n \log n)$
5. $O(n^2)$

(polynomial)

And: $O(2^n)$

$O(n!)$



Claim: Inserting a new element at the beginning of an array is $O(n)$ time.

pf:

<u>Claim</u>: Inserting an element at the head of a list is $O(1)$ time.

Nested for loops:

Ex: find if any 2 elements in the array are equal.

```
for (int i=0; i<n; i++)
    for (int j=1; j<n; j+1)
        if (A[i] == A[j])
            return true;
return false;
```

From here on out, we'll use this analysis for any function or data structure we code.

Some may be obvious:

Some harder:

Runtime of stack operations