Algorithm Analysis

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Merge Sort

- A merge sort has two algorithms
  - One for the sort
  - One for the merge
- The sort part of the algorithm is v easy if done recursively (algorithm in notes from last class)
- The merge part of the algorithm is a little longer
  - You need $\Theta(n)$ space
- A difference between an insertion sort and a merge sort is that an insertion sort is *in place*, it doesn't need any extra space to run. A merge sort is **not** in place, it needs the extra space.

Asymptotic Notation

Big O

- Big O is just an upper bound for the complexity of an algorithm
  - Any time you're taking an equation and turning it into Big O notation, you take the highest value of n
  - This means that if you have an equation $2n^2 + 100n$, your Big O is $O(n^2)$
  - This could be written as $2n^2 + 100n \in O(n^2)$
  - Everyone uses = instead of $\in$ though

Big Ω

- Omega is a lower bound
- For example, $n^3 = \Omega(n^2)$ is true

Big Θ

- Theta is a tight bound (i.e. f(n) is in between the bound in Theta)
- $n^2 + \log^4(n) = \Theta(n^2)$

Little o

- Little o is an upper bound like Big O, but it's strict (i.e. the difference can't be constant)
- $n^2 = o(n^3)$ is true
- $\frac{n^2}{2} - 100n = o(n^2)$ is false
- $2^n = o(n!)$ is true
- $n! = o((n+1)!)$ is true

Little ω

- Little omega is a strict lower bound
- $(n+1)! = \omega(n!)$ is true

Recap

$$\begin{aligned} O: &\quad \leq \\ o: &\quad < \\ \Omega: &\quad \geq \\ \omega: &\quad > \\ \Theta: &\quad = \end{aligned}$$

Quiz

- On our next quiz, we will get an unsorted array and will be asked to run the merge algorithm
  - You basically split the array in half, put a pointer at the head of each subarray, then compare the two numbers and put the smaller one in the array. Then the pointer in that array moves up and you continue to compare numbers until the end
- Big O notation stuff, true or false problems. Chapter 3 section 2, asymptotic notation
  - For example
    * $2n^2 + 100n = O(n^2)$ is true
    * $2n^2 + 100n = O(n^3)$ is true
    * $n^3 = O(n^2)$ is false
  - JUst keep in mind that Big O is an **upper bound** and you should be good