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CSCI 377 Textbook Notes

Computer Algorithms

Chapter 4: Divide and Conquer

- *Recall* that in a divide and conquer problem, we solve problems recursively using three steps at each level of recursion
    - ***Divide*** the problem into a number of sub-problems that are smaller instances of the same problem
    - ***Conquer*** the sub-problems by solving them recursively, or in a straightforward manner
    - ***Combine*** the solutions to the subproblems into the solution for the original problem
- *Recursive case* requires further recursion, after which we can say the recursion "bottoms out" and reaches the
- *Base case*, which can then be solved in a straightforward manner
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Recurrences

- Recurrences go hand in hand with the divide and conquer paradigm
- A *recurrence* is an equation or inequality that describes a function in terms of its value on smaller inputs, for example
    - $T(n) = \Theta(1)$ if $n = 1$
    - $T(n) = 2T(n/2) + \Theta(n)$ if $n > 1$

    - *Solution:* $T(n) = \Theta(nlog(n))$

- There are three methods covered in this chapter for obtaining asymptotic Θ or O bounds on the solution
    - *The Substitution Method:* where we can use mathematical induction to find our bounds
    - *The Recursion-Tree Method:* where we turn the recurrence into a tree whose nodes represent the costs incurred at various different levels of the recursion
        - We can then use this tree and mathematical reasoning to solve for the bounds
    - *The Master Method:* Which generalizes a form — $T(n) = aT(n/b) + f(n)$ — of the recurrence and provides rules for the bounds based on the values of a, b, and $f(n)$