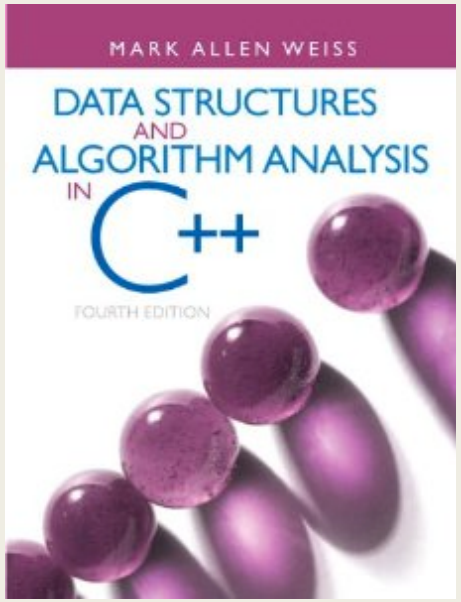
CSCI 33500
SOFTWARE DESIGN AND ANALYSIS III

Class #1

Introduction



- Adjunct: Felix Grezes fg297@hunter.cuny.edu
  - *Email me using your @hunter email or I may not answer.*
- Course Coordinator: Ioannis Stamos istamos@hunter.cuny.edu
- Textbook : Data Structures and Algorithm Analysis in C++, 4 Edition, by Mark Allen Weiss
- CS LAB: http://www.geography.hunter.cuny.edu/tbw/CS.Linux.Lab.FAQ/department_of_computer_science.faq.htm
  - *email: twalter@hunter.cuny.edu*
- Mentoring is available.
- Syllabus: http://speech.cs.qc.cuny.edu/~felix/CSCI335-Spring16-Syllabus.pdf
- Grading, homework, slides: http://speech.cs.qc.cuny.edu/~felix/Courses-Taught/Hunter-Spring2016-CSCI335.html

What is this class about?

- What makes an algorithm good or bad?
  - *This section will focus more on the mathematics of algorithms.*
  - *Participation in class is expected. The only way to learn is practice.*
  - *Half the class will be lecture, half will be practice.*

- As always, ask questions! This is your class.

Chapter 1 – Overview
Math Review

- Exponents

$$X^A X^B = X^{A+B}$$
$$\frac{X^A}{X^B} = X^{A-B}$$
$$(X^A)^B = X^{AB}$$
$$X^N + X^N = 2X^N \neq X^{2N}$$
$$2^N + 2^N = 2(2^N) = 2^{N+1}$$

- Logarithms
- Definition

$$X^A = B \; if \; and \; only \; if \; \log_X B = A$$

- Conversion

$$\log_A B = \frac{\log_C B}{\log_C A} \; ; A, B, C > 0, A \neq 1$$

- Multiplication to Addition (fundamental)

$$\log AB = logA + logB \; ; A, B > 0$$

Chapter 1 – Overview
Math Review

- Modulo Arithmetic
  - We say that *A* is *congruent* to *B modulo N* if *N* divides *A-B*
    written $A \equiv B \ mod \ N$
  - Properties:
    $\text{if } A \equiv B \ mod \ N \text{ then } A + C \equiv B + C \ mod \ N \text{ and } AC \equiv BC \ mod \ N$
  - Theorems if *N* is prime:
    $AB \equiv 0 \ mod \ N \text{ iff } A \equiv 0 \ mod \ N \ or \ B \equiv 0 \ mod \ N$
    $\text{if } AX \equiv 1 \ mod \ N \text{ and } 0 < A < N, \text{then there is a unique solution } 0 < X < N$
    $X^2 \equiv A \ mod \ N \text{ has either two solutions for all } 0 < A < N \text{ or no solution.}$

Chapter 1 – Overview
Math Review

- Proof by contradiction: assume *Hypothesis*, prove that it leads to a contradiction
- Proof by Induction
  - *Two step process:*
    1- Verify the base case
    2- Prove the Inductive Hypothesis
- Induction applied to programming: Recursion
  - *1- Terminating condition(s)*
    2- Progress towards the terminating condition(s)

For next class: Thursday February 4th

- Finish Chapter 1
- Read Chapter 2
- Get back in shape by practicing c++ on Hackerrank.com

Now on to practice!

Exercises

- Prove:

$$\log AB = \log A + \log B$$
$$\log A^B = B \log A$$

- Induction/Recursion
  - *Prove that* $\sum_{i=o}^{N} 2^i = 2^{N+1} - 1$
  - *Write a recursive function that returns the number of 1 in the binary representation of N*