Announcements

- Syllabus posted

- HW 2 is out - due Wed.
Data Structures

- Discrete Math (or Equivalent)
- A finite set of steps...
- Transform data into information.
- A set of steps to solve a problem.
- Problem solving.

What is an algorithm?
What is a program?

- Implementation of an algorithm.
- May combine algorithms.
- Program expresses algorithm.
- Syntax matters!
Here, we care about algorithms. Algorithms are much more general. What is the difference?
3 parts to every question:

1. Algorithm
2. Run time analysis
3. Proof of Correctness
What did you learn in 135 (or 166)?

This week: discrete math boot camp!
O(n lg n) - merge sort

Sorting: O(n^2) - quick sort

Worst case running time

What is big-O?

Runtime:
**Def:** Let \( f \) and \( g \) be functions from \( \mathbb{Z} \) to \( \mathbb{R} \). We say \( f(x) \in O(g(x)) \) if there exist constants \( c > 0 \) and \( N_0 > 0 \) such that for all \( n > N_0 \),
\[
f(n) \leq c \cdot g(n)\]
Let $c = 4$. Then $N_0 = 1$ and

$$x^2 + 2x + 1 = x^2 + 2x + 1$$

So

$$x^2 + 2x + 1 = x^2 + 2x + 1$$

For all $n \geq 1$, $n^2 = n^2$.

For all $n \geq 1$, $2n \geq 2n$.

For all $n \geq 1$, $n^2 - 2n^2$.

Proof:

Ex: Show that $x^2 + 2x + 1$ is $O(x^2)$. 

\[ x^2 + 2x + 1 = x^2 + 2x + 1 \]
(Theorem) Let $c = |a_n| + |a_{n-1}| + \ldots + |a_1| + |a_0|.$

Then $f(x) = O(x^n)$.

For constants $a_i \in \mathbb{R}$,

$s = \frac{a_0}{x} = a_n x^n + a_{n-1} x^{n-1} + \ldots + a_1 x + a_0$

Then $f(x) = \frac{a_0}{x} = \frac{a_0}{x}$.
Other Functions

log n versus n:

2^n versus n: