

# Introduction: Asymptotic Notation

Daniel Kane

Department of Computer Science and Engineering  
University of California, San Diego

Algorithmic Design and Techniques  
Algorithms and Data Structures at edX

# Learning Objectives

- Understand the basic idea behind asymptotic runtimes.
- Describe some of the advantages to using asymptotic runtimes.

# Last Time

## Computing Runtimes Hard

- Depends on fine details of program.
- Depends on details of computer.

# Idea

All of these issues can multiply runtimes by (large) constant.

# Idea

All of these issues can multiply runtimes by (large) constant. So measure runtime in a way that ignores constant multiples.

# Problem

Unfortunately, 1 second, 1 hour, 1 year only differ by constant multiples.

# Solution

Consider *asymptotic* runtimes. How does runtime *scale* with input size.

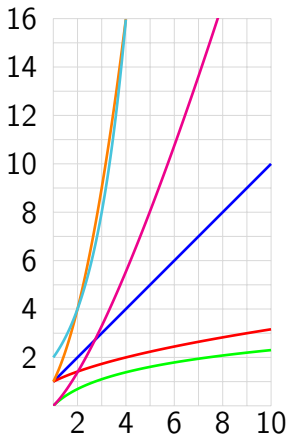
# Approximate Runtimes

	$n$	$n \log n$	$n^2$	$2^n$
$n = 20$	1 sec	1 sec	1 sec	1 sec
$n = 50$	1 sec	1 sec	1 sec	13 day
$n = 10^2$	1 sec	1 sec	1 sec	$4 \cdot 10^{13}$ year
$n = 10^6$	1 sec	1 sec	17 min	
$n = 10^9$	1 sec	30 sec	30 year	
max $n$	$10^9$	$10^{7.5}$	$10^{4.5}$	30



$$\log n \prec \sqrt{n} \prec n \prec n \log n \prec n^2 \prec 2^n$$

$$\log n \prec \sqrt{n} \prec n \prec n \log n \prec n^2 \prec 2^n$$



$$\log n \prec \sqrt{n} \prec n \prec n \log n \prec n^2 \prec 2^n$$

