

# The Big O

Algorithms and Analysis

Splash C5450; 11/20/11; 9:05-10:55am

Instructor: Zach Minster

# THE BIG PROBLEM

Topic 1: "Zach Minster's  
Fundamental Theorem of CS"





# Pessimism

“ Murphy’s Law: Anything that can go wrong will go wrong!

“ We always assume the WORST CASE – the “big O” runtime

“ What’s the worst possible case for our comparison card sort?



# Bulbasaur

“ The most basic of all  
Pokemon

“ **Iteration** (vs. Recursion)

“ What's his time  
complexity?





# Bogosort

“ For all your entropy/physics nuts out there!

“ What's the time complexity? (think Murphy's Law!)

# Insertion Sort

6 5 3 1 8 7 2 4

“ Can we improve Bulbasaur?

“ What if we make him adaptive to our list?

“ But how!?

“ You must believe in the heart of the cards!



# Pessimism Again

“ We’ve improved...but  
Murphy won’t have it.

“ Time complexity isn’t  
*everything*, but it’s rather  
fantastic...it’s formal.

Ugh, Zach...

“Is **ANYTHING** more efficient than  $O(n^2)$ ?”



# Divide and CONQUER

“ What if we split up the list and do the works in little chunks?

“ Iteration vs. **Recursion**

“ Little excursus:  
<http://www.youtube.com/watch?v=t8g-iYGHpEA>

# Topic 2: Recursion, Induction, Proofs

Prepare to become a boss.





**TAIL RECURSION**

# Recursion

- “ Enormously beautiful concept
- “ Factorial !
- “ Sum of all integers 0-n!
- “ Tricky in its simplicity
- “ Fibonacci Sequence!
- “ Beauty, wondrous beauty

# Recurrence Relations

“There’s gotta be a way to look at these algorithms mathematically...”

“Remember piecewise functions?”



# Closed Forms – Elusive, Wonderful



- “ Calculating the closed form explicitly – what’s  $n$  for any  $n$  without recursion?
- “ We can PROVE big  $O$  bounds on recursive methods with these, but we have to prove them first!

# Induction

“ Flashy mathematical cheating, more like it!

“ The domino effect...

“ First domino  $\rightarrow$  second domino

“ Any domino  $\rightarrow$  next domino

“ So for “integer” dominos...

“  $P(0)$

“  $P(k) \rightarrow P(k+1)$



# Back to Mergesort

“Prepare for a proof that  
will blow your mind!”

# Other Divide & Conquer Algorithms

“ Square Root Approximation

“ Subset Generation

“ Very hard, very cool problem

“ Kills my students at Brown!





# Jerry's Final Thought

Beauty...

# Parting Gift

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**Please enjoy the  
rest of Splash!**

**And thank your teachers!**