

CSE 12 – Basic Data Structures and Object-Oriented Design

Lecture 10

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Announcements

- Quiz 10 due Wednesday @ 12pm
- PA3 due Wednesday @ 11:59pm (open collaboration)
- Survey 4 due Friday @ 11:59pm
- Exam 1 on Friday (no class) → Discussion → yes
 - Released @ 2pm on Friday
 - Closes @ 6pm on Saturday
 - More details to be released on Piazza ~~soon~~
 - Lectures 1 – 8
 - Up to and including PA3
 - • 90 minutes
 - • No make-ups

Topics

- Questions on Lecture 10?
- Big O

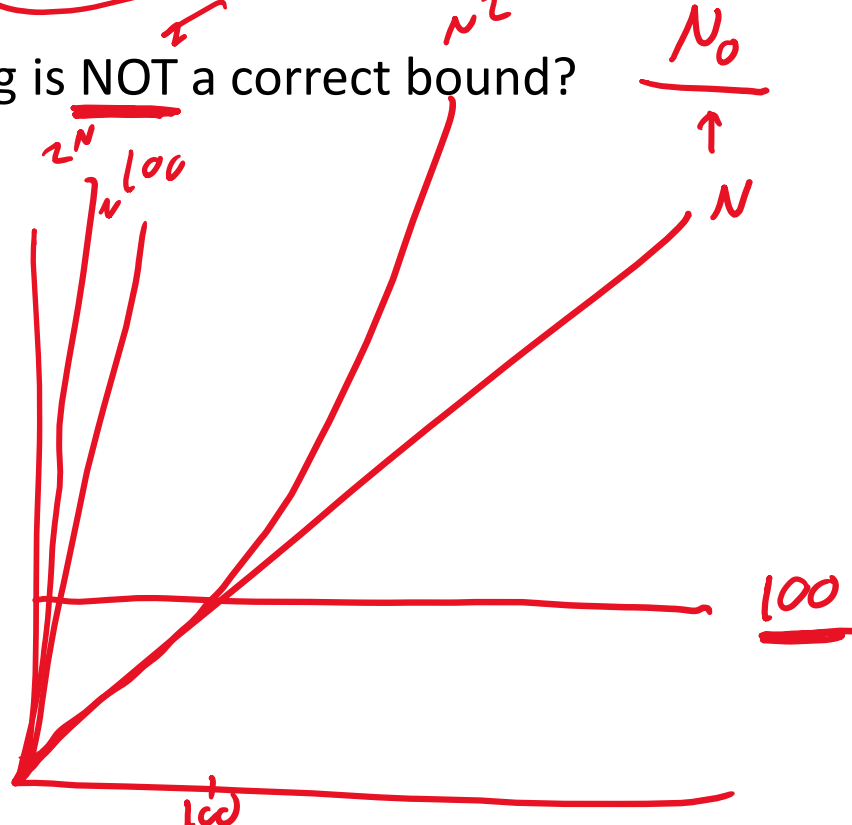
Let $f(n) = 100$

Big O

$$f(n) \leq C * g(n)$$

• Which of the following is NOT a correct bound?

- 1 ~~A.~~ $f(n)$ is $O(2^n)$
- 0 ~~B.~~ $f(n)$ is $O(n^2)$
- 3 ~~C.~~ $f(n)$ is $O(n)$ $N_c = 100$
 $C = 1$
- 3 ~~D.~~ $f(n)$ is $O(n^{100})$
- 22 E. None of these



For each function in the list below, it is related to the function below it by O , and the reverse is **not** true. That is, n is $O(n^2)$ but n^2 is **not** $O(n)$.

- $f(n) = 1/(n^2)$
- $f(n) = 1/n$
- $f(n) = 1$
- $f(n) = \log(n)$
- $f(n) = \text{sqrt}(n)$
- $f(n) = n$
- $f(n) = n^2$
- $f(n) = n^3$
- $f(n) = n^4$
- ... and so on for constant polynomials ...
- $f(n) = 2^n$
- $f(n) = n!$
- $f(n) = n^n$

↓

$$f(n) \leq C * g(n)$$

for some N_0

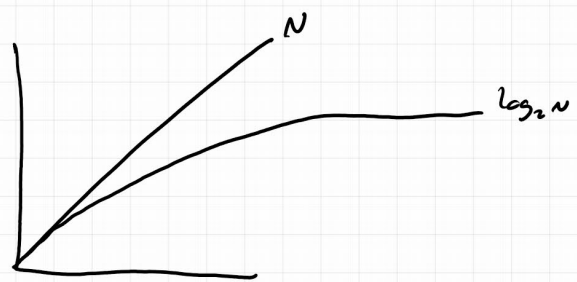


↓
 $\log_2(n)$
↳ # of times you
divide n by 2
to get 0 (or 1)

binary search



4/



$$f(n) \leq C * g(n) \text{ for } N_0$$

Let $f(n) = 3n^3 + 2n + 7$

$$\rightarrow 3n^3 + 2n^3 + 7n^3 = \underline{12n^3}$$

• Which of the following is a correct bound?

- 1 A. $f(n)$ is $O(\log(n))$
- 0 B. $f(n)$ is $O(n^2)$
- 0 C. $f(n)$ is $O(n)$
- 27 ☒ D. $f(n)$ is $O(n^3)$
- 1 E. None of these

$$f(n) \leq \underline{12 * N^3}$$

$$C = 12$$

$$N_0 = 7$$

```
void printAllElementOfArray(int[] arr) {
    for (int i = 0; i < arr.length; i++) {
        printf("%d\n", arr[i]);
    }
}
```

$$1 + (N+1) + N + N$$

$$3N + 2$$

$$\rightarrow \underline{\underline{=}}$$

- Which of the following is a correct bound?

$$3N + 2N = 5N$$

5 ~~A.~~ f(n) is $O(\log(n))$ ~~X~~

19 ~~B.~~ f(n) is $O(n^2)$ ~~✓~~

28 ~~C.~~ f(n) is $O(n)$ ~~✓~~

18 ~~D.~~ f(n) is $O(n^3)$ ~~✓~~

0 ~~E.~~ None of these

out of 30

$$O(N) \quad C = 5$$

$$N_0 = 2$$

$$3N + 2$$

$$f(N) \leq C + g(N)$$

↑


```
void printAllPossibleOrderedPairs(int arr[]) {
    for (int i = 0; i < arr.length; i++) {
        for (int j = 0; j < arr.length; j++) {
            printf("%d = %d\n", arr[i], arr[j]);
        }
    }
}
```

N $[N]$

N^2

$$1 + (N+1) + N +$$

$$(3N+2) + N$$

$$3N^2 + 2N + 2N + 2$$

- Which of the following is a correct bound?

1 ~~A. $f(n)$ is $O(\log(n))$~~ X

31 ☒ B. $f(n)$ is $O(n^2)$ ✓

4 ~~C. $f(n)$ is $O(n)$~~ X

28 ☒ D. $f(n)$ is $O(n^3)$ ✓

0 ~~E. None of these~~

$$3N^2 + \frac{1}{2}N + 2$$

$$\frac{3N^2 + \frac{1}{2}N^2 + 2N^2}{9N^2}$$

$$f(N) \leq 9 \cdot g(N)$$

$$N^2$$

$$\rightarrow C \geq 9 \rightarrow N_0 = 3$$

out of 31

```
int fibonacci(int num) {
    if (num <= 1) return num;
    return fibonacci(num - 2) + fibonacci(num - 1);
}
```

$N = 5$

15 times

$2^5 \rightarrow 32$

• Which of the following is a correct bound?



- 26
4
- ☒ A. $f(n)$ is $O(2^n)$
- 1 B. $f(n)$ is $O(n^2)$
- 2 C. $f(n)$ is $O(n)$
- 8 D. $f(n)$ is $O(n^3)$
- 3 E. None of these

out of 30

$fib(5)$

$\rightarrow fib(3) + fib(4)$

$fib(1) + fib(2)$

↓
1

↓
 $fib(0) + fib(1)$

↓
0

↓
1

$fib(2) + fib(3)$

↓
 $fib(0) + fib(1)$

↓
0

↓
1

$fib(1) + fib(2)$

↓
 $fib(0) + fib(1)$

↓
0

↓
1