

Section 3: BSTs and Recurrences

0. Interview Question: Binary Search Trees

Write pseudo-code to perform an in-order traversal in a binary search tree without using recursion.

1. Recurrences and Closed Forms

For the following code snippet, find a recurrence for the worst case runtime of the function, and then find a closed form for the recurrence.

Consider the function f :

```
1 f(n) {  
2   if (n == 0) {  
3     return 1;  
4   }  
5   return 2 * f(n - 1) + 1;  
6 }
```

- Find a recurrence for $f(n)$.

- Find a closed form for $f(n)$.

2. Recurrences and Big-Oh Bounds

Consider the function f . Find a recurrence modeling the worst-case runtime of this function and then find a Big-Oh bound for this recurrence.

```
1 f(n) {
2   if (n == 0) {
3     return 0
4   }
5
6   int result = 0
7   for (int i = 0; i < n; i++) {
8     for (int j = 0; j < i; j++) {
9       result += j
10
11     }
12   }
13   return f(n/2) + result + f(n/2)
14 }
```

(a) Find a recurrence $T(n)$ modeling the worst-case time complexity of $f(n)$.

(b) Find a Big-Oh bound for your recurrence.

3. Recurrences and Closed Forms

Consider the function g . Find a recurrence modeling the worst-case runtime of this function, and then find a closed form for the recurrence.

```
1 g(n) {
2   if (n <= 1) {
3     return 1000
4   }
5   if (g(n/3) > 5) {
6     for (int i = 0; i < n; i++) {
7       println("Yay!")
8     }
9     return 5 * g(n/3)
10  }
11  else {
12    for (int i = 0; i < n * n; i++) {
13      println("Yay!")
14    }
15    return 4 * g(n/3)
16  }
17 }
```

(a) Find a recurrence $T(n)$ modeling the worst-case time complexity of $g(n)$.

(b) Find a closed form for the above recurrence.

4. Runtime Complexity

Consider the function h :

```
1 h(n) {  
2   if (n <= 1) {  
3     return 1  
4   } else {  
5     return h(n/2) + n + 2*h(n/2)  
6   }  
7 }
```

(a) Find a recurrence $T(n)$ modeling the *worst-case runtime complexity* of $h(n)$.

(b) Find a closed form to your answer for (a).