

# Asymptotics

## 1 Definitions

- Big-O,  $O(-)$ :
- Big-Theta,  $\theta(-)$ :
- Big-Omega,  $\Omega(-)$ :
- General Case vs Best/Worst/Average Case:

## 2 Useful Rules

- Arithmetic Series:  $1 + 2 + 3 + \dots + (n - 1) + n = \frac{n(n+1)}{2} \in O(n^2)$
- Geometric Series:  $1 + 2 + 4 + \dots + (n/2) + n \approx 2n \in O(n)$
- Log Rules:  
 $\log(x * y) = \log(x) + \log(y)$   
 $\log(\frac{x}{y}) = \log(x) - \log(y)$   
 $\log(x * a) = a \log(x)$
- $1 \in O(\log n) \in O(n) \in O(n^a) \in O(a^n) \in O(n!)$

## 3 Exercises

- Non-recursive function

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```
public static void f1 (int N) {  
    for (int i = 0; i < N; i+= 1) {  
        for (int j = 1; j < N; j=j*2) {  
            System.out.println("hi!");  
        }  
    }  
}
```

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- Recursive function 1

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```
public static void f2 (int n, int[] arr) {  
    if (n==0) {return;}  
    f2(n/2, arr);  
    for (int i=0; i <n; i++) {  
        System.out.println("hello!");  
    }  
    f2(n/2, arr);  
}
```

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- Recursive function 2

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```
public static void f3 (int n) {  
    if (n==1) {return;}  
    f3(n-1);  
    f2(17);  
    f3(n-1);  
}
```

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