Discussion 4: Algorithmic Complexity + Programming Paradigms

Algorithmic Complexity: Definitions

1. What is runtime? How do we measure it?

   Runtime measures at what speed an algorithm/block runs. We measure this using the number of steps it takes. Note: We don’t use time to measure runtime because computers have different speeds, so the time an algorithm takes to run differs from machine to machine.

2. If a function runs in O(n) time, that means it runs…
   - O in linear time at worst
   - O in linear time on average
   - O in linear time at best

Understanding Runtimes

1. Fill in the following chart:

<table>
<thead>
<tr>
<th>Runtime</th>
<th>Notation</th>
<th>As input size increases by…</th>
<th>The number of steps change by…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>O(1)</td>
<td>+1</td>
<td>No change</td>
</tr>
<tr>
<td>Logarithmic</td>
<td>O(log n)</td>
<td>x2</td>
<td>+1</td>
</tr>
<tr>
<td>Linear</td>
<td>O(n)</td>
<td>+1</td>
<td>+1</td>
</tr>
<tr>
<td>Quadratic</td>
<td>O(n^2)</td>
<td>x2</td>
<td>x4</td>
</tr>
<tr>
<td>Exponential (base B)</td>
<td>O(B^n)</td>
<td>+1</td>
<td>xB</td>
</tr>
</tbody>
</table>

2. In the following diagram, label each of lines. Which is the best runtime? The worst?

Runtime: Practice

1. Find the runtime of the following blocks or descriptions of blocks:
   a. ![Diagram of add x and y and report x + y](Constant)
   b. ![Diagram of average list and for each item of list change sum by item and report sum / length of list](Linear)
Programming Paradigms

1. Write down the programming paradigm that best fits the following descriptions:
   
   a. One sprite tells a second sprite to run some code. The second sprite does it. **Object Oriented**
   
   b. You input a global list into a block. It reports a new list with different values, without modifying the input list. **Functional**
   
   c. You give a program a condition as an input and it uses this condition to remove numbers from a list. You input a list and it removes items. **Declarative**
   
   d. You have a global variable set to a secret word. You change the secret word every time you ask a player for a new secret word. **Imperative**
   
   2. Match each of the following scripts to a programming paradigm:

   - **Functional**
     
     **Imperative**
     
     **Object Oriented**

   ```
   Assume sum is a global variable in the second script
   ```

   ```
   when ⌂ clicked
   create a clone of myself
   ```

   ```
   when I start as a clone
   script variables sum
   set sum to 0
   for i = 1 to length of List
   for j = 1 to length of List
   change sum by item j of List
   report sum
   ```

   ```
   for i = 1 to length of List
   change sum by item j of List
   report sum
   ```
**Challenge**

1. What does the following block do? What is its runtime?

   This block checks if there are only even numbers in the input list. Since HOFs take linear time, and the mod and equals blocks take constant time, this runs in linear time.

2. If myList is a list of n words, each of length n, what is the runtime of the following block?

   In this case, word -> list runs in linear time with respect to the length of the word. Since myList has n elements, map will do n actions, one for each element. For each element, word -> list takes n time, so the total runtime is $O(n^2)$. 

   **Note:** We will tell you when a block runs in linear time.