Announcements

Reminder
- Program 8 – Due December 9th by 11:55pm via Moodle

Final Exam:
- NEW LOCATION: FJ-B
- You can choose between 2 time slots
  - Saturday, December 13th, from 1-3:30pm (regularly scheduled)
  - Tuesday, December 16th from 1-3:30pm (alternate exam time)

Better way to Measure the Run Time

- Idea: Count the number of “basic operation” in an algorithm.
  - “Basic operations” – things the computer can do in a single step
    - Printing a single value (string or number)
    - Comparing two values
    - (simple) math, like adding, multiplying, powers
    - Assigning a variable to a value

Two ways to Search for Item in List

- If you don’t know anything about the list, you must do a linear search to find an item in the list (this is the underlying algorithm that Python uses for find() and index())
- If you know that the list is sorted, you can be more efficient in your search
More Run Times

- Some problems have algorithms that run even slower than quadratic time.
  - Cubic time ($n^3$), higher polynomials, ...
  - Exponential time ($2^n$) is even slower!

- In some cases, we depend on the fact that we don’t have fast algorithms to solve problems.
### One million "basic" operations per second.

<table>
<thead>
<tr>
<th></th>
<th>log.</th>
<th>linear</th>
<th>quadratic</th>
<th>expo.</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 10</td>
<td>0.003 ms</td>
<td>0.01 ms</td>
<td>0.1 ms</td>
<td></td>
</tr>
<tr>
<td>N = 20</td>
<td>0.004 ms</td>
<td>0.02 ms</td>
<td>0.4 ms</td>
<td></td>
</tr>
<tr>
<td>N = 40</td>
<td>0.005 ms</td>
<td>0.04 ms</td>
<td>1.6 ms</td>
<td></td>
</tr>
<tr>
<td>N = 80</td>
<td>0.007 ms</td>
<td>0.08 ms</td>
<td>6.4 ms</td>
<td></td>
</tr>
<tr>
<td>N = 1,000</td>
<td>0.009 ms</td>
<td>1 ms</td>
<td>1 second</td>
<td></td>
</tr>
<tr>
<td>N = 10,000</td>
<td>0.013 ms</td>
<td>10 ms</td>
<td>100 seconds</td>
<td></td>
</tr>
</tbody>
</table>