Tutorial 1: Complexity

1. Reorder the following efficiencies from the smallest to the largest:
   a. 2^n
   b. n!
   c. n^5
   d. 15,000
   e. $n\log_2(n)$

2. Reorder the following efficiencies from the smallest to the largest:
   a. $n\log_2(n)$
   b. $n + n^2 + n^3$
   c. 10^5
   d. $n^{0.5}$

3. Determine the big-O notation for the following:
   a. $5n^{5/2} + 11n^{2/5}$
   b. $9\log_2(n) + 6n$
   c. $3n^4 + 8n\log_2(n)$
   d. $5n^2 + n^{3/2} + 3n^{5/3}$

4. Calculate the run-time efficiency of the following program segment:

```
1 i = 1
2 loop (i <= n)
  1 print (i)
  2 i = i + 1
3 end loop
```

5. Calculate the run-time efficiency of the following program segment:

```
1 i = 1
2 loop (i <= n)
  1 j = 1
  2 loop (j <= n)
    1 k = 1
    2 loop (k <= n)
      1 print(i,j,k)
      2 k = k + 1
    3 end loop
    4 j = j + 1
  3 end loop
  4 i = i + 1
3 end loop
```

6. If the algorithm `doIt` has an efficiency factor of 7n, calculate the run time efficiency of the following program segment.

```
1 i = 1
2 loop (i <= n)
  1 doIt(...)
  2 i = i + 1
3 end loop
```

7. If the efficiency of the algorithm doIt can be expressed as $O(n) = n^2$, calculate the efficiency of the following program segment.

```
1 i = 1
2 loop (i <= n)
  1 j = 1
  2 loop (j < n)
    1 doIt(...)
    2 j = j + 1
  3 end loop
  4 i = i + 1
3 end loop
```

8. If the efficiency of the algorithm doIt can be expressed as $O(n) = n^2$, calculate the efficiency of the following program segment.

```
1 i = 1
2 loop (i < n)
  1 doIt(...)
  2 i = i * 2
3 end loop
```

9. Given that the efficiency of an algorithm is $5n^2$, if a step in this algorithm takes 1 nanosecond (10^{-9}), how long does it take the algorithm to process an input of size 10000?

10. Given that the efficiency of an algorithm is $3n^3$, if a step in this algorithm takes 1 nanosecond (10^{-9}), how long does it take the algorithm to process an input of size 10000?

11. Given that the efficiency of an algorithm is $3n\log_2(n)$, if a step in this algorithm takes 1 nanosecond (10^{-9}), how long does it take the algorithm to process an input of size 8000?