

Exercise 1. Which is the running time $T(n)$ of following function, where the argument **a** is a list of n floats?

```
def f(a):  
    return sum(a) / len(a)
```

Exercise 2. Suppose the running time $T(n)$ of an algorithm on inputs of size 1000, 2000, 3000, 4000, and 5000 is 5 seconds, 20 seconds, 45 seconds, 80 seconds, and 125 seconds, respectively. Which is the mathematical form of $T(n)$?

Exercise 3. How much memory (in bytes) does the list ['Alice', 'Bob', 'Carol'] occupy, assuming that a string of n characters occupies $2n$ bytes and a list of n items occupies $8n$ bytes?

Exercise 4. Suppose we are searching each of 1000 keys in a sorted list of 8192 keys.

- a. How many comparisons are necessary in the worst case if we use linear search?
- b. How many comparisons are necessary in the worst case if we use binary search (use base-2 logarithm)?

Exercise 5. Consider sorting an array **a[]** containing the following keys, by calling the **sort()** method (shown below) from insertion sort:

E A S Y Q U T I O N

```
def sort(a, key=None):  
    n = len(a)  
    for i in range(1, n):  
        for j in range(i, 0, -1):  
            v, w = a[j], a[j - 1]  
            if key:  
                v, w = key(v), key(w)  
            if v >= w:  
                break  
            _exchange(a, j, j - 1)
```

What is **a[]** when $i = 5$ (ie, 5th iteration of the outer loop) and the inner loop (lines 4 – 10) is complete?

Exercise 6. Which of the following sequences can be merged using the merge operation?

- a. H E L L O and W O R L D
- b. E H L L O and D L O R W

Exercise 7. Suppose that a minus sign in the input indicates pop the stack and write the return value to standard output, and any other string indicates push the string onto the stack. Further suppose that following input is processed:

it was - the best - of times - - - it was - the - - worst - of times -

- a. What is written to standard output?
- b. What are the contents (top to bottom) left on the stack?

Exercise 8. Consider the following code fragment:

```
s = Stack();
while n > 0:
    s.push(n % 2)
    n = n / 2
while not s.isEmpty():
    stdio.write(s.pop())
stdio.writeln()
```

- What does the following code fragment print when `n` is 50?
- Give a high-level description of what it does when presented with a positive integer `n`.

Exercise 9. Suppose that a minus sign in the input indicates dequeue the queue and write the return value to standard output, and any other string indicates enqueue the string onto the queue. Further suppose that following input is processed:

it was - the best - of times - - - it was - the - - worst - of times -

- What is written to standard output?
- What are the contents (head to tail) left on the queue?

Exercise 10. What does the following code fragment do to the queue `q`?

```
s = Stack()
while not q.isEmpty():
    s.push(q.dequeue())
while not s.isEmpty():
    q.enqueue(s.pop())
```

Exercise 11. Consider the following functions:

```
def f(x):
    st = SymbolTable()
    for i in range(1, x):
        st[i] = i
    return st

def g(x):
    return sum(f(x).values())

def h(x):
    y = 1
    for v in f(x).keys():
        y *= v
    return y
```

- What is the value of the expression `f(6)[4]`?
- What does `g(6)` return?
- What does `h(6)` return?
- What is the value of the expression `g(6) + h(6)`?

SOLUTIONS

Solution 1. $T(n) = n$ (linear)

Solution 2. $T(n) = n^2$ (quadratic)

Solution 3. $26 + 24 = 50$ bytes

Solution 4.

a. $1000 \times 8192 = 8.192 \times 10^6$

b. $1000 \times \log 8192 = 1.3 \times 10^4$

Solution 5. A E Q S U Y T I O N

Solution 6.

a. No.

b. Yes.

Solution 7.

a. was best times of the was the it worst times

b. of it

Solution 8.

a. 110010

b. The binary representation of n

Solution 9.

a. it was the best of times it was the worst

b. of times

Solution 10. Reverses the items on the queue.

Solution 11.

a. 4

b. 15

c. 120

d. 135