CS 202: Introduction to Computation
Fall 2011: Exam #2

Name: Answer Key

Question	Possible Points	Received Points
1	20	
2	20	
3	20	
4	20	
5	20	
Total	100	

This exam is closed notes.

You have 50 minutes to complete the 5 questions on this exam.

Please write your answers clearly.

Good luck!

1 pt each

Question 1: Truth or Consequences
Consider whether each of the following statements is True or False. Circle the correct answer.

(True) False With an unsorted list, a linear search must look through every element of the list to find the maximum element

(True) False A binary search assumes that the keys in the list are sorted

True (False) A binary search assumes that the key being searched for exists in the list

True (False) In a game of twenty questions, the best guessing strategy allows one to identify on the order of 20^2 different items

(True) False A recursive algorithm can be defined by a base case and a set of rules reducing other cases towards the base case

(True) False An insertion sort requires $O(N^2)$ operations

True (False) Merging two lists of size N into a list of size 2*N requires O(N log N) operations

(True) False A successful merge of the list "2 6 8 9" with the list "4 7 10 11" is "2 4 6 7 8 9 10 11"

True (False) For a very large number of keys, Selection Sort is usually faster than Merge Sort.

True (False) For Quicksort, the best pivot is the key with the maximum value in the list.

(True) False In Quicksort, a correct partition of the List "8 9 3 2 0 7 2 1" around the pivot 7 is "3 2 0 2 1 7 8 9"

True (False) For very large values of N, an algorithm that requires $O(N^2)$ operations is probably faster than one that requires O(N log N) operations

(True) False Web browsers contact web servers with a special type of address called a URL

True (False) A correct simulation computes the same output regardless of the initial conditions

True (False) With cryptography, clear text is confidentially sent over an unprotected network

True (False) The complexity of solving a problem is equivalent to the complexity of creating that problem

(True) False The algorithm for finding a minimal spanning tree is greedy

True (False) The minimal spanning tree of a weighted graph is the path a traveling salesperson should use to minimize his or her distance

(True) False An algorithm that requires $2N^5$ steps has complexity represented by $O(N^5)$

True (False) All computational problems can be solved in polynomial time

either answer accepted

"It is known that"

Question 2: List your complaints here

Imagine you have eight different Scratch programs, each which manipulates a list "Mystery List" Your job is to "execute" the scripts in your head to repeat the exact same steps and operations that Scratch would. For each of the following 8 scripts, **show the contents of "Mystery List" at the end of the script**. Be careful of the tiny but important differences across scripts!

2 pts

0 5 5

2

0 5 10

2

empty

2

0 1 5 6 10 11

3 pts

0 5 10 1 6 11

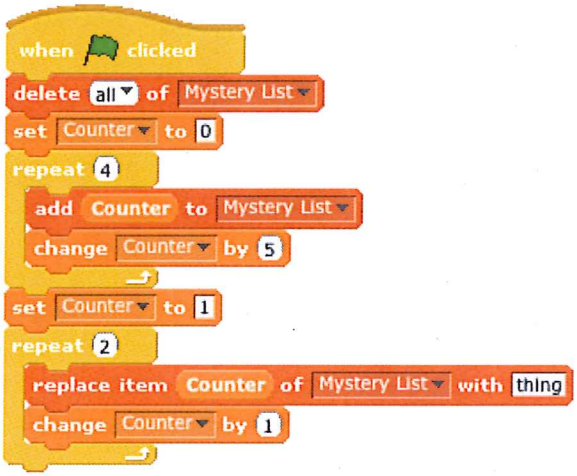
3

6 4 2 0

3

0 2 ~~4~~ ~~6~~

3

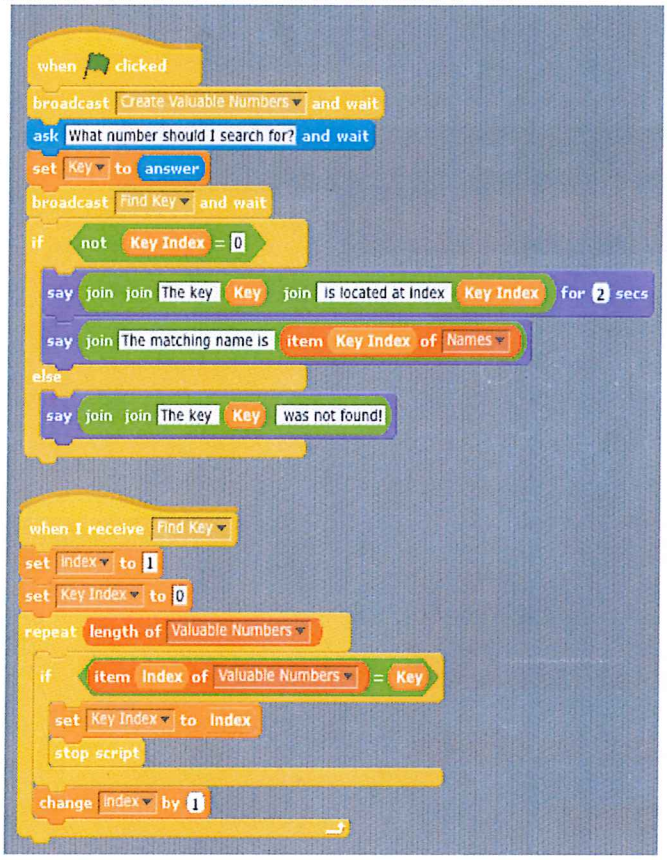


~~0~~ ~~5~~ 10 15

thing thing

Question 3: Searching doesn't have to be difficult

Imagine that the Green Flag is clicked and the script "Create Valuable Numbers" creates the two Lists "Valuable Numbers" and "Names" shown below.



If Key is set to each of the following numbers, what will the scripts "say" to the user? (In other words, what will be the output of the program?) In each case, how many items in Valuable Numbers list will be **accessed** (or examined)? In each case, how many items in the Names list will be accessed (or examined)?

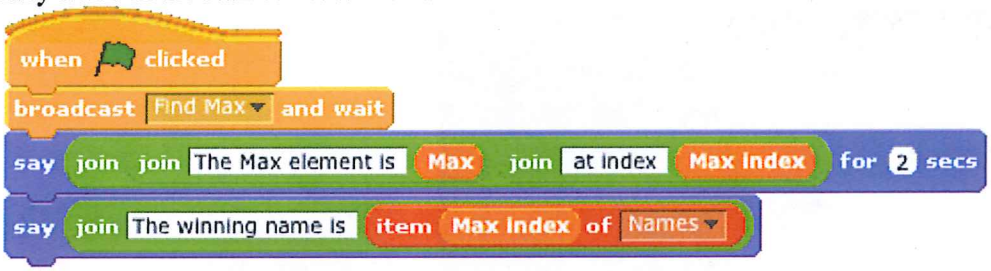
Key Input	Say?	# Items examined in Valuable Numbers List?	# Items examined in Names List?
785	Key: 785 at index 5 Matching name: aldnj	5	1
166	Key: 166 at index 15 Matching name: ckhgs	15	1
121	Key 121 not found	15	0
734	Key 734 at index 3 Name: ljuhg	3	1

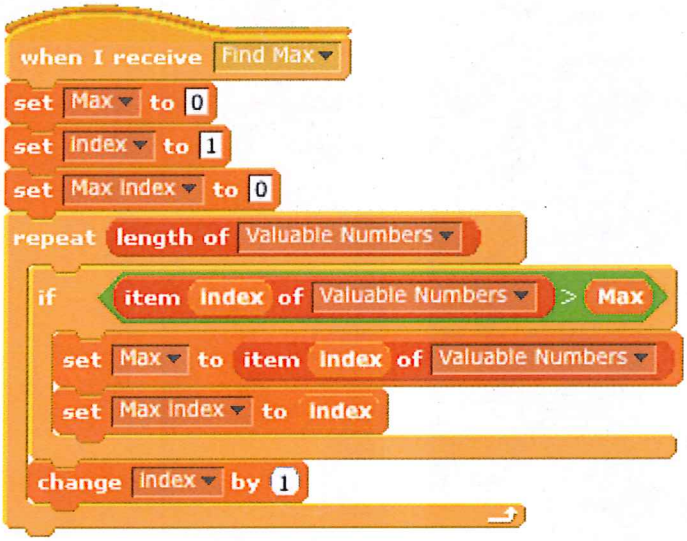
4
3
3
3

13

Imagine that a similar script "Find Max" is run instead with the same Valuable Numbers and Names lists.

What will the scripts "say" to the user? How many items in Valuable Numbers list will be accessed? How many items in the Names list will be accessed?





Say?	# Items examined in Valuable Numbers List?	# Items examined in Names List?
Max is 884 at index 1 Name is uwygr	15	1

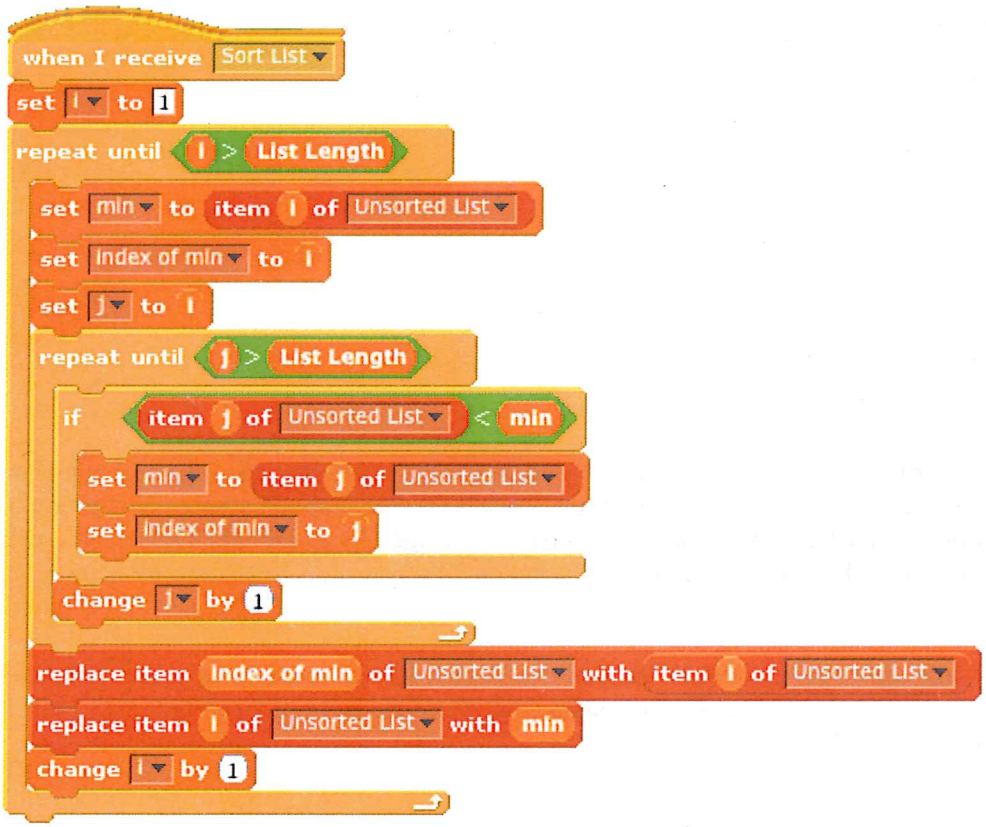
5 pts

What assumptions does this implementation of "Find Max" make about the list of Valuable Numbers?

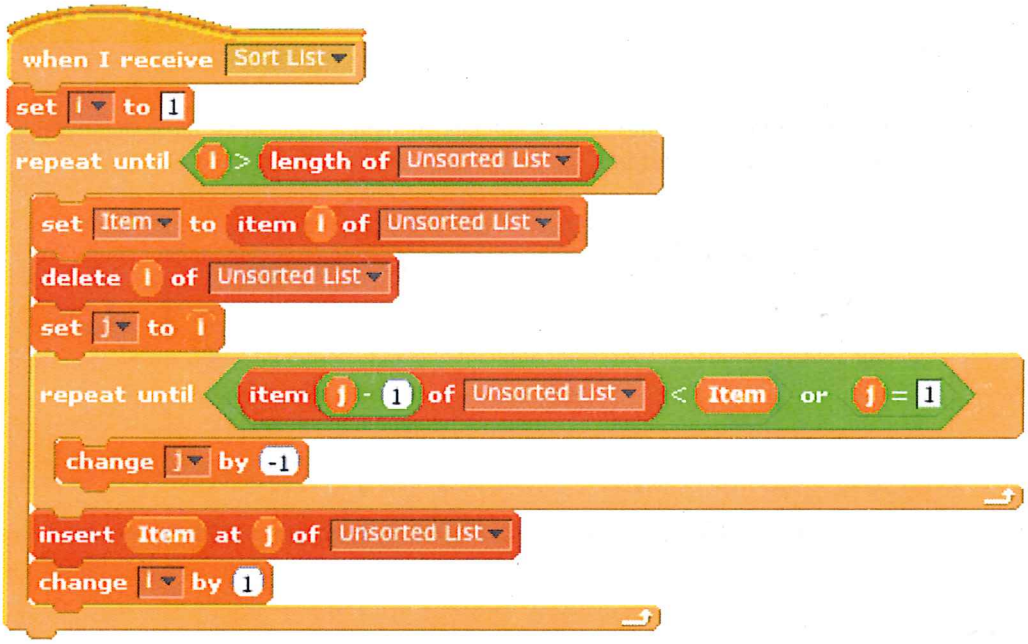
2 pts — Contains at least one element > 0

Question 4:

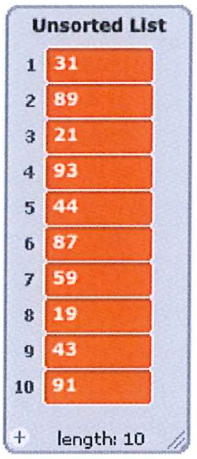
Consider the following implementations of Selection Sort:



and Insertion Sort:



Assume Unsorted List begins by containing the following 10 integers in this order:



Now, either Selection Sort or Insertion Sort is started on the list of 10 integers. The problem is, we don't know which algorithm is being used! The sorting algorithm is then stopped after **each** iteration of the "repeat until" outer loop (that is, just after the last block "change i by 1" increments i to some value) and the contents of the Unsorted List are displayed. We've taken 10 screenshots of Unsorted List over time lettered (a) - (j).

The following page shows the contents of each of the Unsorted Lists, but they have been all mixed up! That is, the picture (a) of Unsorted List could have happened after picture (b) of Unsorted List. Your job is to figure out the correct order!

1. Using the contents of the Unsorted Lists and your knowledge of the algorithms, was Selection or Insertion sort used?

7 pts

Insertion Sort

2. Order the pictures of Unsorted List to show the sequence in which they must have occurred when the algorithm was run. Write the correct order here.

10 pts

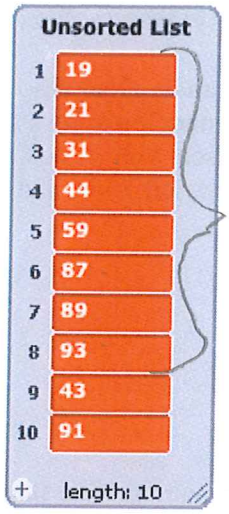
b, c e f d h i a j g

3. You will notice that some of the Unsorted Lists from different iterations are identical; explain why this is the case!

3 pts

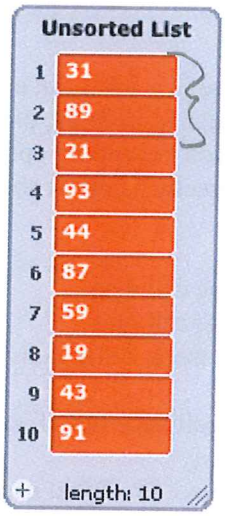
The keys are not moved because the next key in the unsorted portion of the list is in its correct position for the next iteration - it is the greatest key in the sorted portion of list.

a)



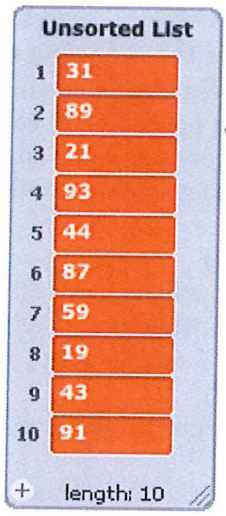
8

b)



2

c)



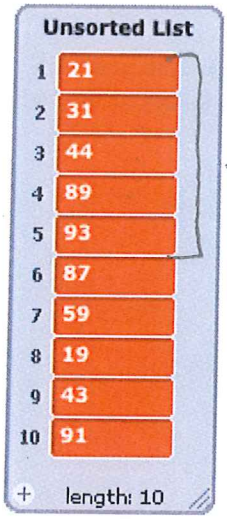
2

b, c

e, f

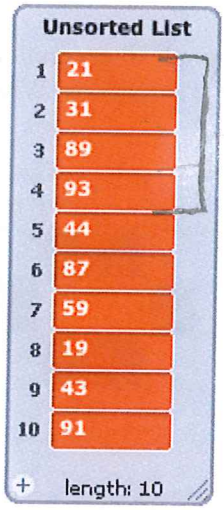
d, h i a j g

d)



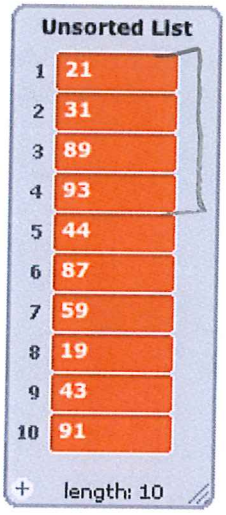
5

e)



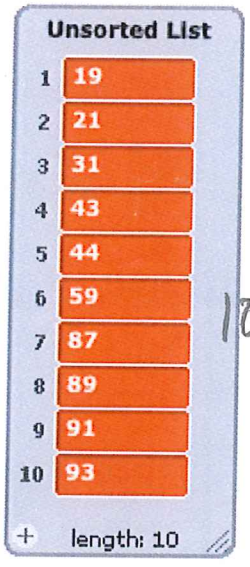
4

f)



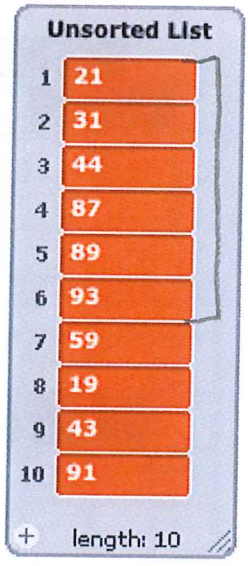
4

g)



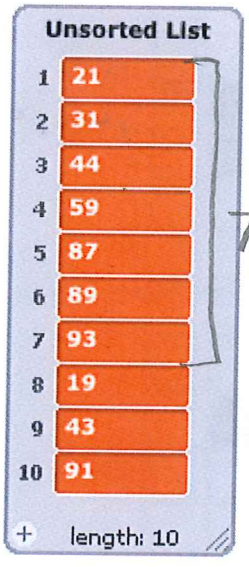
10

h)



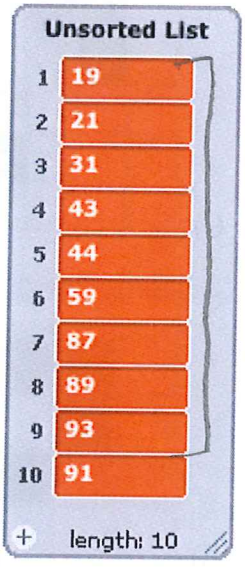
6

i)



7

j)



9

-4 pts for any world in list that should not be, or omitting world

Question 5: What is the meaning of Life?

The Game of Life is a simulation in which cells are in a 2-D grid; each cell can be either alive (black) or dead (white). The next generation of cells is calculated from the previous generation using a set of rules. Each cell will be alive or dead in the next generation depending upon the current state of its 8 nearest neighbors (the 8 nearest neighbors are the cells directly adjacent above, below, left, right, and the four diagonal cells).

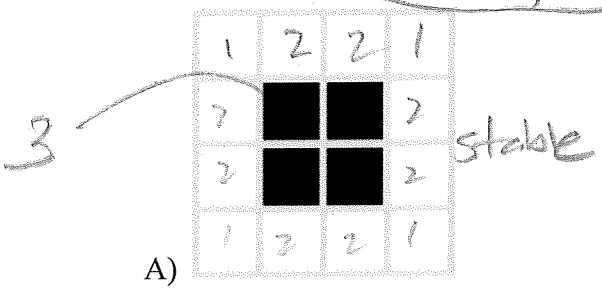
If (cell is alive)
- If < 2 neighbors are alive, then the cell dies
- If > 3 neighbors are alive, then the cell dies
- If 2 or 3 neighbors are alive, then the cell stays alive

If (cell is dead)
- if 3 neighbors are alive, then the cell becomes alive

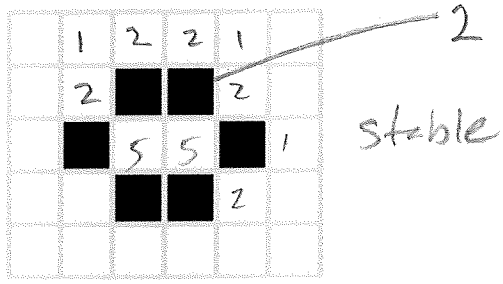
Consider the following six (6) different worlds lettered A-F that each has the current state shown. Some of the shown worlds are stable and will remain constant across future generation while others of the shown worlds will change in some way across generations (e.g., die out, move, or oscillate).

Which worlds are stable and will remain identical through all generations? To help you with your reasoning, you may want to label each cell with its number of live neighbors. Write the letters of the stable worlds here: A, B, E

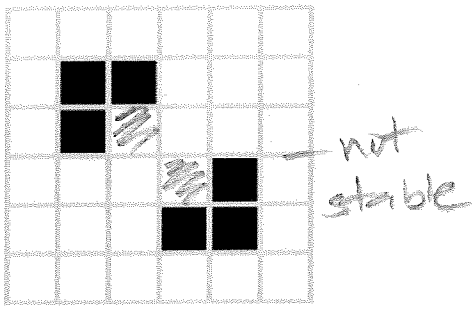
A)



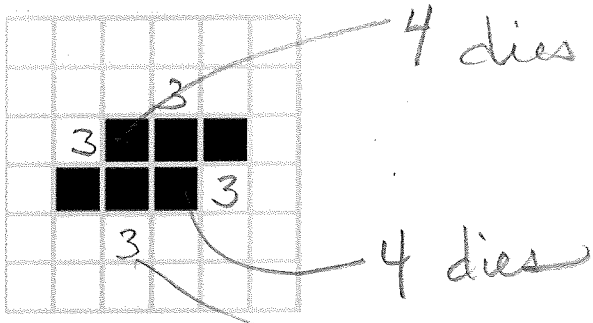
B)



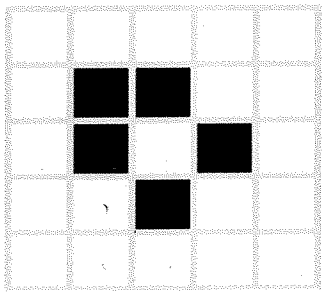
C)



D)



E)



F)