Feedback — Final Exam Part I

Help Center

You submitted this quiz on **Wed 14 Oct 2015 7:29 PM EDT**. You got a score of **6.09** out of **10.00**. You can attempt again, if you'd like.

```
To specify an array or sequence of values in an answer, separate the value
s in
the sequence by whitespace. For example, if the question asks for the firs
t
ten powers of two (starting at 1), then the following answer is acceptabl
e:

     1 2 4 8 16 32 64 128 256 512

If you wish to discuss a particular question and answer in the forums, ple
ase
post the entire question and answer, including the seed (which can be used
by
the course staff to uniquely identify the question) and the explanation (w
hich
contains the correct answer).
```

Question 1

```
(seed = 642333)
Suppose that you binary search for the key 94 in the following sorted array
of size 15:

    18 25 27 53 55 60 64 76 81 91 93 94 95 97 98

Give the sequence of keys in the array that are compared with 94.
Your answer should be a sequence of integers, separated by whitespace.
```

You entered:

76 94

Your Answer		Score	Explanation
76 94	✔	1.00	
Total		1.00 / 1.00	

Question Explanation

```
The correct answer is: 76 94

Here is the array to be searched after each compare:

     18 25 27 53 55 60 64 76 81 91 93 94 95 97 98
76:   -  -  -  -  -  -  -  - 81 91 93 94 95 97 98
94:   -  -  -  -  -  -  -  -  -  -  -  -  -  -  -
```

Question 2

```
(seed = 787041)
Suppose that you time a program as a function of N and produce
the following table.

        N   seconds
-------------------
      512     0.000
     1024     0.001
     2048     0.002
     4096     0.007
     8192     0.023
    16384     0.082
    32768     0.292
    65536     1.034
   131072     3.624
   262144    12.782
   524288    45.212
  1048576   159.305
  2097152   561.293
  4194304  1979.642
```

Estimate the order of growth of the running time as a function of N. Assume that the running time obeys a power law T(N) ~ a N^b. For your answer, enter the constant b. Your answer will be marked as correct if it is within 1% of the target answer - we recommend using two digits after the decimal separator, e.g., 2.34.

You entered:

4.4157

Your Answer		Score	Explanation
4.4157	✖	0.00	
Total		0.00 / 1.00	

Question Explanation

The theoretical order-of-growth is N ^ (20/11) = 1.82

The empirical order-of-growth is N ^ (log_2 ratio)

N	seconds	ratio	log_2 ratio
512	0.000	-	-
1024	0.001	-	-
2048	0.002	2.00	1.00
4096	0.007	3.50	1.81
8192	0.023	3.29	1.72
16384	0.082	3.57	1.83
32768	0.292	3.56	1.83
65536	1.034	3.54	1.82
131072	3.624	3.50	1.81
262144	12.782	3.53	1.82
524288	45.212	3.54	1.82
1048576	159.305	3.52	1.82
2097152	561.293	3.52	1.82
4194304	1979.642	3.53	1.82

Question 3

(seed = 856092)
What is the order of growth of the worst case running time of the following code fragment
as a function of N?

```
int sum = 0;
for (int i = 0; i*i*i < N; i++)
    for (int j = i+1; j*j*j < N; j++)
        for (int k = j+1; k*k*k < N; k++)
            sum++;
```

Your Answer		Score	Explanation
1			
log N	✖	0.00	
N^(1/2)			
N			
N log N			
N^(3/2)			
N^2			
N^2 log N			
N^(5/2)			
N^3			

N^4

N^5

N^6

N^7

Total	0.00 / 1.00

Question Explanation

The answer is : N

The body of the inner loop is executed N^(1/3) choose 3 ~ N/6 times.

Question 4

(seed = 392354)
The column on the left contains the original input of 24 strings
to be sorted or shuffled; the column on the right contains the strings in sorted
order; the other 5 columns contain the contents at some intermediate
step during one of the 5 algorithms listed below (with different columns
corresponding to different algorithms).

pine	aqua	pear	lust	aqua	aqua	aqua
pink	bark	cyan	gold	bark	bark	bark
bark	ceil	bark	gray	blue	ceil	blue
lust	coal	lust	coal	cafe	coal	cafe
ceil	gray	ceil	cyan	ceil	drab	ceil
gray	lust	gray	dusk	coal	dusk	coal
coal	navy	coal	drab	cyan	gray	cyan
teal	pine	cafe	ceil	drab	lust	drab
aqua	pink	aqua	bark	dusk	navy	dusk
rust	rust	palm	aqua	gold	pine	gold
silk	silk	blue	blue	gray	pink	gray

```
navy   teal   navy   cafe   lust   plum   lust
dusk   blue   dusk   navy   pine   rust   navy
sand   cafe   gold   palm   sand   sand   palm
drab   cyan   drab   pear   teal   silk   pear
plum   drab   pine   pine   plum   teal   pine
pear   dusk   plum   pink   pear   pear   pink
gold   gold   sand   plum   rust   gold   plum
blue   palm   silk   rose   pink   blue   rose
palm   pear   rust   ruby   palm   palm   ruby
rose   plum   rose   rust   rose   rose   rust
ruby   rose   ruby   sand   ruby   ruby   sand
cafe   ruby   teal   silk   navy   cafe   silk
cyan   sand   pink   teal   silk   cyan   teal
----   ----   ----   ----   ----   ----   ----
 0      ?      ?      ?      ?      ?      6
```

Match up each column with the corresponding algorithm from the given list:

0. Original input
1. Selection sort
2. Insertion sort
3. Mergesort (top-down)
4. Quicksort (standard, no shuffle)
5. Heapsort
6. Sorted

Use each number exactly once. That is, your answer should be a permutation of
the 7 integers between 0 and 6 (starting with 0 and ending with 6),
separated by whitespace.

Hint: think about algorithm invariants. Do not trace code.

You entered:

0 2 5 4 3 1 6

Your Answer		Score	Explanation
0	✔	0.14	
2	✖	0.00	

5	✖	0.00
4	✖	0.00
3	✖	0.00
1	✖	0.00
6	✔	0.14
Total		0.29 / 1.00

Question Explanation

```
The correct answer is: 0 3 4 5 1 2 6

 0: Original input
 3: Mergesort (top-down) just before the last call to merge()
 4: Quicksort (standard, no shuffle) after first partitioning step
 5: Heapsort after heap construction phase and putting 12 keys into place
 1: Selection sort after 12 iterations
 2: Insertion sort after 16 iterations
 6: Sorted
```

Question 5

```
(seed = 822234)
Match up each of the following 5 sorting algorithms

  ___  insertion sort

  ___  mergesort (bottom-up)

  ___  randomized quicksort (standard)

  ___  selection sort

  ___  randomized quicksort (3-way)


with the order of growth of its expected running time to sort
```

an input of size N whose keys are reverse sorted (with distinct keys) by choosing from the following 6 options:

A. 1
B. log N
C. N
D. N log N
E. N^4/3
F. N^2

Your answer should be a sequence of 5 letters (each between A and F), separated by whitespace. You may use each letter once, more than once, or not at all.

Assume that the sorting algorithms are the pure, unoptimized versions.

You entered:

F D D F D

Your Answer		Score	Explanation
F	✔	0.20	
D	✔	0.20	
D	✔	0.20	
F	✔	0.20	
D	✔	0.20	
Total		1.00 / 1.00	

Question Explanation

The correct answer is: F D D F D

Question 6

(seed = 747914)
Suppose that you have a data type for a sequence of N items and that it is represented internally using a resizing array (where the ith item in the sequence is stored a[N-i-1]). Assume that the data type is implemented in an efficient and natural manner given the specified representation.

Match up each of the following 6 operations

___ return the ith item in the sequence

___ replace the ith item in the sequence with a specified item

___ insert an item at the beginning of the sequence

___ return the first item in the sequence

___ return the number of items in the sequence

___ insert an item immedidately after the ith item in the sequence

with their amortized running time, by choosing from the following 5 options:

A. 1
B. log N
C. N
D. N log N
E. N^2

Your answer should be a sequence of 6 letters (each between A and E), separated by whitespace. You may use each letter once, more than once, or not at all.

You entered:

A A A A A A

Your Answer		Score	Explanation
A	✔	0.17	
A	✔	0.17	

A	✔	0.17
A	✔	0.17
A	✔	0.17
A	✖	0.00
Total		0.83 / 1.00

Question Explanation

The correct answer is: A A A A A C

Question 7

(seed = 836199)
Suppose that you have a priority queue containing N comparable keys that is represented internally using an array in ascending order (with the ith smallest key at a[i]). Assume that the data type is implemented in an efficient and natural manner given the specified representation.

Match up each of the following 6 operations

___ return a minimum key

___ insert a batch of N keys (given all at once)

___ insert a key

___ return the number of keys

___ does the priority queue contain a specified key?

___ iterate over the keys in ascending order

with their amortized running time, by choosing from the following 5 options:

A. 1
B. log N
C. N
D. N log N
E. N^2

Your answer should be a sequence of 6 letters (each between A and E), separated by whitespace. You may use each letter once, more than once, or not at all.

You entered:

A C A A B C

Your Answer		Score	Explanation
A	✔	0.17	
C	✖	0.00	
A	✖	0.00	
A	✔	0.17	
B	✔	0.17	
C	✔	0.17	
Total		0.67 / 1.00	

Question Explanation

The correct answer is: A D C A B C

Question 8

(seed = 655346)

Suppose that you have a data type that represents a set of N distinct items and that the set of items is represented internally using a linear-probing hash table (that is at most 50% full). Assume that the data type is implemented in an efficient and natural manner given the specified representation.

Match up each of the following 6 operations

___ return the maximum key

___ return the kth smallest key

___ return the minimum key

___ return the number of keys <= a specified key

___ return the number of keys between the keys lo and hi

___ return the smallest key >= a specified key

with their expected running times (under the uniform hashing assumption), by choosing from the following 5 options:

A. 1
B. log N
C. N
D. N log N
E. N^2

Your answer should be a sequence of 6 letters (each between A and E), separated by whitespace. You may use each letter once, more than once, or not at all.

You entered:

C C C C C C

Your Answer		Score	Explanation
C	✔	0.17	
C	✔	0.17	

C	✔	0.17
C	✔	0.17
C	✔	0.17
C	✔	0.17
Total		1.00 / 1.00

Question Explanation

The correct answer is: C C C C C C

Question 9

(seed = 573533)
Match each of the following 6 quantities

___ Expected depth of a node after inserting N distinct keys in random order into an empty BST

___ Max height of a binary heap with N keys

___ Max height of a BST with N keys

___ Max function-call stack size when (top-down) mergesorting an array of N keys

___ Min height of a binary heap with N keys

___ Max height of a weighted quick-union with path compression forest with N sites

by choosing from the following 10 options:

A. 0 or constant
B. ~ lg* N
C. ~ 1/2 lg N

D. ~ log_3 N
E. ~ ln N
F. ~ lg N
G. ~ 2 lg N
H. ~ 2 ln N
I. ~ 4.311 ln N
J. ~ N

Your answer should be a sequence of 6 letters (each between A and J), separated by whitespace. You may use each letter once, more than once, or not at all.

Recall that lg N denotes the binary logarithm (log_2 N); ln N denotes the natural logarithm (log_e N); and lg* N denotes the binary iterated logarithm.

You entered:

G J F F F F

Your Answer		Score	Explanation
G	✖	0.00	
J	✖	0.00	
F	✖	0.00	
F	✔	0.17	
F	✔	0.17	
F	✔	0.17	
Total		0.50 / 1.00	

Question Explanation

The correct answer is: H F J F F F

Question 10

(seed = 900463)
You are applying for a job at a new software technology company. Your interviewer asks you to identify which of the following graph-processing tasks are possible using techniques discussed in Algorithms, Part I. Check all that apply.

Your Answer		Score	Explanation
☑ Design a compare-based sorting algorithm that guarantees to sort any array of N comparable keys using ~ 10 N lg (lg N) compares in the worst case.	✗	0.00	The sorting lower bound says that any compare-based sorting algorithm must use ~ N lg N compares in the worst case.
☑ Perform a left rotation in a BST in	✓	0.20	A left rotation changes only a constant number of pointers.

constant time.			
☐ Implement a deque (double-ended queue) in constant time per operation using a singly-linked list.	✔	0.20	You need a doubly-linked list to support both deleting from the front or the back.
☐ Design an exchanged-based sorting algorithm (rearranges the array entries only via pairwise exchanges) that makes at most ~ 1/2 N	✔	0.20	We argue that any exchanged-based sorting algorithm must make at least N-1 exchanges to sort the input array [N-1, 0, 1, 2, ..., N-2]. Given a permutation array on N elements, consider a digraph in which the edge (i, j) means that a[j] = i. Observe that such a digraph is a set of directed cycles. For example, the input array is a single cycle. Now observe that if two items i and j are in the same cycle, exchanging them divides the cycle into two cycles; if they are in different cycles, exchanging them merges the two cycles. Since the sorted array [0, 1, 2, ..., N-1] contains N cycles and each exchange increases the number of cycles by at most 1, there must be at least N-1 exchanges.

compares in the worst case.			
☑ Given two left-leaning red-black BSTs with N keys each (and with no two equal keys), construct a new left-leaning red-black BST containing those 2N keys in linear time.	✔	0.20	Do an inorder traversal of each BST and merge together to get the 2N keys in sorted order. Then, build a perfectly balanced BST and (uniquely) color the links to make it a red-black BST.
Total		0.80 / 1.00	

Question Explanation