CS460 Algorithms and Their Analysis
Assignment Question Set 3

Total points: 10

Question 1 (**3.5 points**) Quicksort

a) Illustrate the final outcome of calling PARTITION procedure on the input array $A = \langle 13,19,9,5,12,8,7,4,21,2,6,11 \rangle$. What value of q does the procedure return?

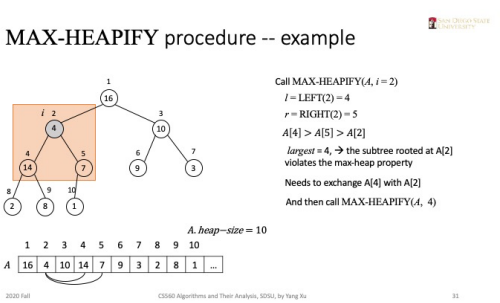
b) What value of q does PARTITION return when all elements in the array $A[p..r]$ have the same value? State why.

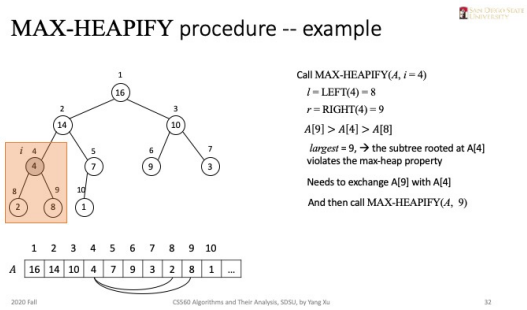
c) What is the running time of QUICKSORT when all elements of array A have the same value? Briefly state why (no strict proof required). *Hint*: Consider what recurrence it would be using the answer from b).

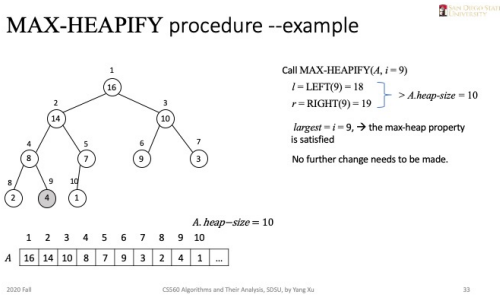
Question 2 (**3.5 points**) Heapsort

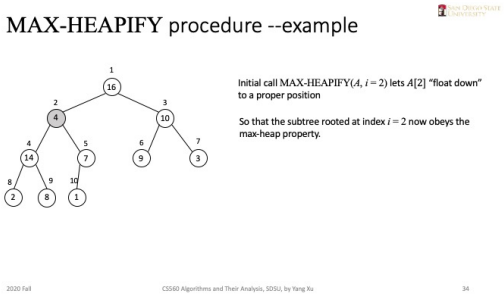
a) Is the array with values $\langle 23,17,14,6,13,10,1,5,7,12 \rangle$ a max-heap? Draw the tree-like plot, and identify the nodes that violate the max-heap property.

b) Using the plots below as a model, illustrate the final outcome of calling MAX-HEAPIFY(A, 3) on the input array: $A = \langle 27,17,3,16,13,10,1,5,7,12,4,8,9,0 \rangle$. (Just need to draw *two* heap plots, one before the calling and one after.)

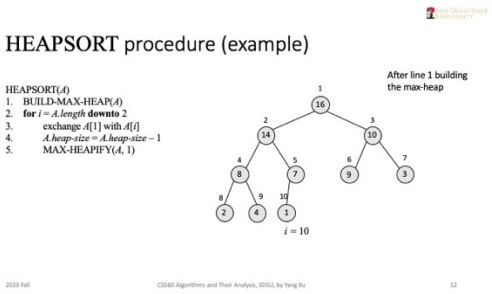


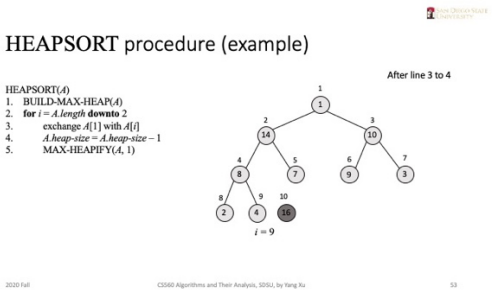






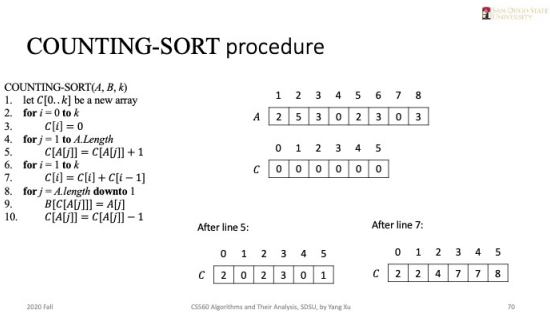
c) Call HEAPSORT on the input array $A = \langle 5,13,2,25,7,17,20,8,4 \rangle$. First, draw the resulting max-heap of calling BUILD-MAX-HEAP on A (line 1); then illustrate the elements in A after the first 2 iterations of the **for** loop (line 2 to 5) respectively, following the plots shown below.





Question 3 (**3 points**) Linear time sort

a) Call COUNTING-SORT on the input array $A = \langle 6,0,2,0,1,3,4,6,1,3,2 \rangle$. Using the plots shown below as a model, illustrate array C after the second **for** loop (line 4 to 5) and the third **for** loop (line 6 to 7) are executed, respectively; then illustrate array B and C after executing the first 2 iterations of the fourth **for** loop (line 8 to 10), respectively.



b) Using the plots shown below as a model, illustrate the array B after the second **for** loop (line 5 to 6) is executed in calling BUCKET-SORT procedure on the input array $A = \langle .79, .13, .16, .64, .39, .20, .89, .53, .71, .42 \rangle$.