EC 504
Spring, 2021
HW 2

Due Friday, Feb. 19, 8PM on Gradescope.

1. (20 pts) Consider the following list of elements:

$$22, 34, 11, 98, 55, 66, 77, 80$$

   (a) Insert the following items into a binary search tree, in the order given. Show the binary trees after each insert.

   (b) From the last tree in the previous part, show the tree that remains when you delete 55.

   (c) Insert the following items into a red-black tree. binary search tree, in the order given. Show the red-black trees after each insert. Put a b next to each black node, r next to each red node (or use color pens...)

   (d) From the last tree above, show the tree that remains when you delete 55.

2. (20 pts) Insert the following items into an empty B^+-tree where every node and leaf must have between 1 and 3 keys in it (so internal nodes have a minimum of 2 children and a maximum of 4 children):

   12; 10; 20; 9; 13; 18; 4; 2; 1; 15; 19; 21; 5; 8; 14; 17; 7; 11; 16;

   Draw the tree after the inserts of 18, 8, 16.

3. (20 pts) Consider a Lazy Sorting Data Structure, which maintains two ArrayLists: unsorted [U] and sorted [S], and implements the following public methods:

   - INSERT(Integer x): inserts x into U
   - QUERY(Integer x): Performs a binary search to see whether x is in S, and if not found, searches linearly to see whether x is in U. Returns true if x is found in either array.

   The data structure has a private access to a resorting method, which works as follows:

   - RESORT(): Removes all elements from U and appends them to S, and then mergesorts the array.

   Compute (with a reasonable explanation) the amortized cost of a worst-case sequence of n Lazy Data Structure public operations in these cases:

   (a) All elements are stored in U so one never does a sort.

   (b) RESORT is called whenever the size of U reaches 10.

   (c) RESORT is called whenever the size of U reaches the size of S.

4. (10 pts) Please answer the following questions:

   (a) How many binomial trees will be part of a Binomial heap with 12 elements?

   (b) Draw the three binary heap that results from the following sequence of operations:

      - 1) Insert 1,2,3,4,5,6,7,8,9,10,11,12. 2) Then delete 1. 3) Then,delete 2.