Tutorial 12 - Compression & External Memory
CS 240E Winter 2022
University of Waterloo
Monday, April 4th, 2022

1. **Burrows-Wheeler Transform:**

   a) Encode the following string using BWT: `TORONTO`

   b) Decode the following string using the inverse BWT: `IPSSM$PISSII`

2. **(2, 4)-Trees Insert/Delete:**
   For the following(2, 4)-Tree, perform the following operations:

   a) Insert 30, Insert 75, Insert 24, Insert 56

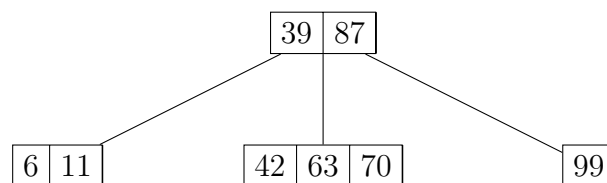   b) Delete 56, Delete 24, Delete 75, Delete 30

   When deciding between successor/predecessor, choose the successor. When deciding between left or right sibling for transfer/merge, select the right sibling.
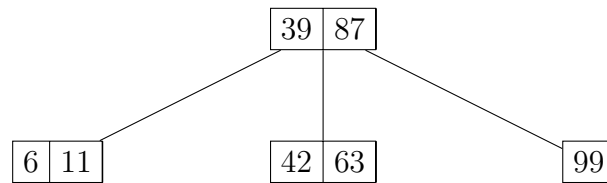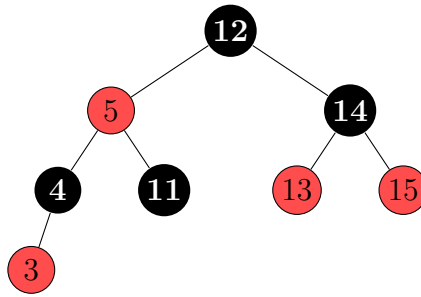

3. **Red Black Trees:**
   This problem involves converting between 2-4 trees and red black trees.

   a) Convert the following 2-4 tree to a red-black tree.

   b) Convert the following red-black tree to a 2-4 tree:

4. **(a, b)-Trees:**
   Let T_n^M be a $(M/2, M)$-tree obtained by inserting $1, 2, ..., n$ (in this order). What is the smallest n for which T_n^M has height 1? What is the largest n for which T_n^M has height 1?