

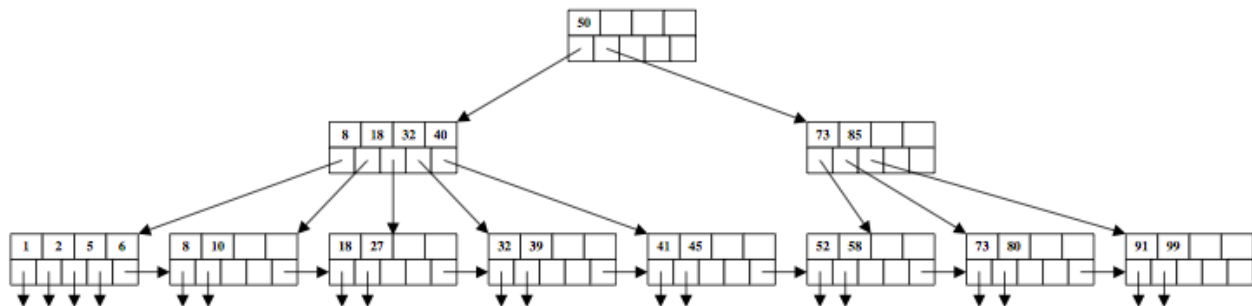
**Homework Assignment 8 [15 points] – due November 8<sup>th</sup> at 11:59PM**

Note 1: Please remember that you are allowed to discuss the assigned exercises, but you should write your own solution. Identical solutions will receive 0 points.

Note 2: For full credit, show your work (not only the final answers).

**Exercise I (B+ trees) [12 points]**

Consider the following B-tree of degree  $d = 2$  (i.e., each index node can hold at least  $d = 2$  keys and at most  $2d = 4$  keys):



- (a) What is the maximum and minimum number of records that the tree can hold (without increasing its height)? Explain your answer.
  
- (b) Show the steps in executing the following operation: Lookup the record 40. [See example 14.14 in the textbook]

(c) Show the steps in executing the following operation: Lookup all records in the range from 10 to 58 (including 10 and 58). [See example 14.15 in the textbook]

(d) Show the B+ tree that would result from inserting the data entry with key 4 in the original tree. [It's ok to redraw only the part of the tree where changes occur.]

(e) Show the B+ tree that would result from deleting the data entry with key 32 from the original tree. [It's ok to redraw only the part of the tree where changes occur.]

- (f) Show the B+ tree that would result from deleting the data entry with key 91 from the original tree. [It's ok to redraw only the part of the tree where changes occur.]

**Exercise II (Sparse versus dense indexes) [3 points]**

Suppose a block holds either 20 records, or 50 key-pointer pairs. If a data file has 100,000 records, how many blocks do we need to hold this data file and:

(a) A dense index?

(b) A sparse index?