Problem 1

Suppose that a disk has storage capacity of 1TB and a block size of 4096 bytes. We have a table with 100,000 records each record has a size of 2050 bytes. Answer these questions:

1. What is the total capacity of RAID 0 with 10 drives?

   Because RAID 0 has no data redundancy, so the total capacity is 10*1TB = 10TB.

2. What is the total capacity of RAID 5 with 10 drives?

   RAID 5 needs one additional drive per RAID group for parity information, so the capacity would be 9*1TB = 9TB.

3. How many blocks are needed for spanned and unspanned records, respectively?

   For unspanned configuration, each record takes up one block, so 100,000 blocks are required. For spanned configuration, ceiling (100,000*2050/4096) = 500489 blocks are required.

4. What is the block (space) utilization in both cases?

   For unspanned case, the space utilization rate is 2050/4096 = 0.5. For spanned case the utilization rate is 1.

5. Assume that the disk has a read bandwidth of 1 GB/sec. Suppose that data is stored sequentially. What is the time to read all records in the unspanned configuration?

   t = 1e5*2052/1e9 = 0.2052s.

If records do not exactly fit in a block, we have two choices: (i) Waste the space at the end of each block and (ii) Start a record at the end of a block and continue on the next. Choice (i) is the **unspanned** option. Choice (ii) is the **spanned** option.

Problem 2

Consider a disk with the following specifications: sector size = 1024, 4000 tracks per surface, 100 sector s per track, 10 double-side platters, average seek time of 10 msec, and the disk platters rotate 7,200 rpm (revolutions per minute).

1. What is the capacity of a track in KBs (an KB = 1024 bytes)?

   100*1024 bytes = 100 KB

2. What is the capacity of each platter surface?

For one-side surface, the capacity = 100*4000 KB = 390.625 MB

For double-side surface, the capacity = 2*390.625 MB = 781.25 MB

3. What is the capacity of the disk?

   The capacity of the disk = 781.25 MB * 10 = 7812.5 MB

4. How many cylinders does the disk have?

   4000

5. What is the maximum rotational delay?

   60*1000/7200 = 8.333 msec

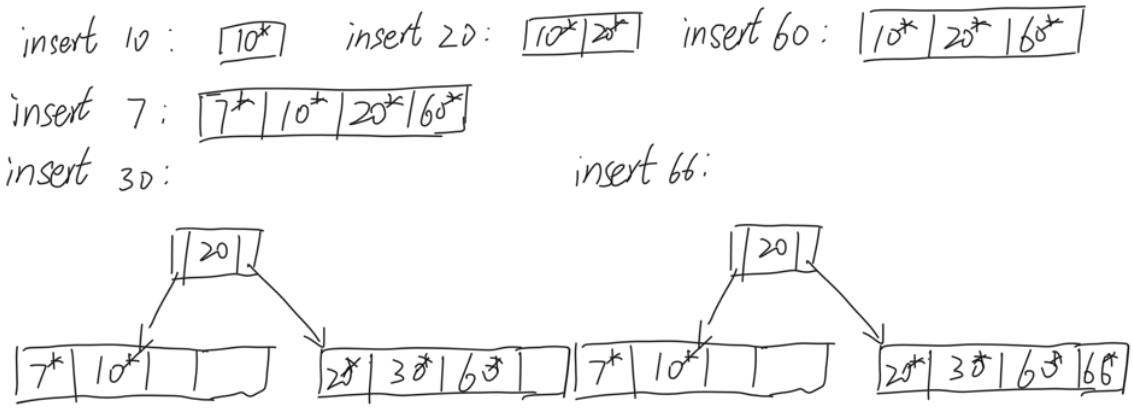
6. If an entire track of data can be transfer per revolution, what is the transfer rate?

   Transfer rate = data capacity per track/(seek time + maximum rotational delay) = 12 MB/s

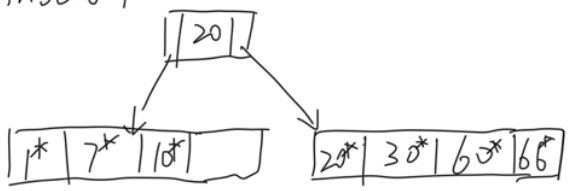
Problem 3

Consider a B+-tree of order 2 (i.e., d = 2 and max. keys=4). Insert the following keys in order: 10, 20, 60, 7, 30, 66, 1, 73, 2, 85, 9, 88, 95, and 90.

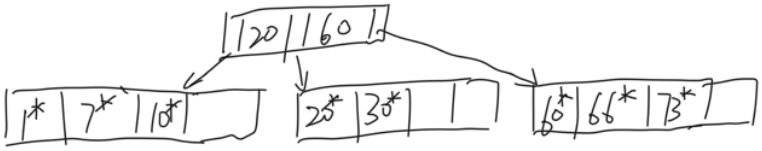
1. Show the final tree. Part points will be awarded for each correct insert if you show your intermediary work.



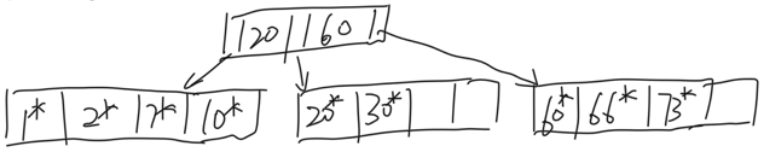
insert 1:



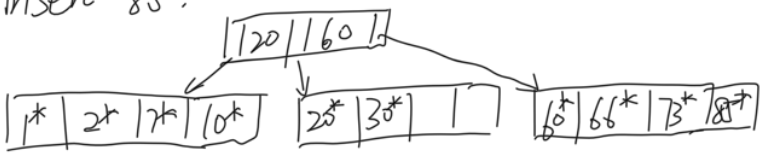
insert 73:



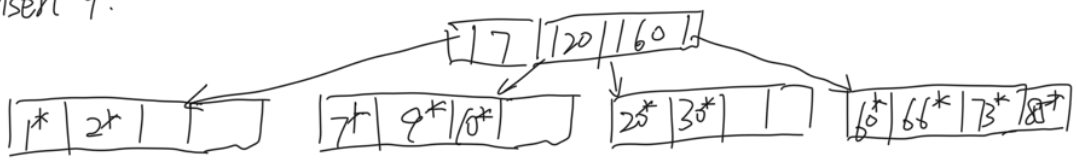
insert 2:



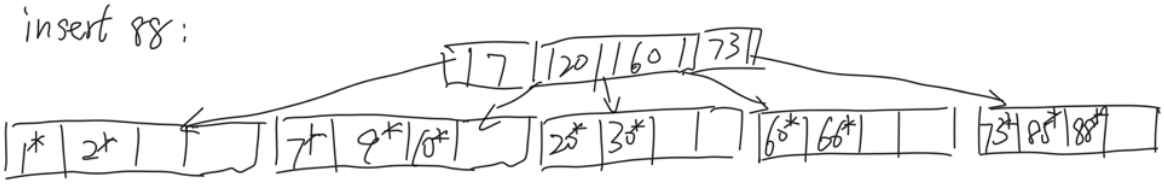
insert 85:



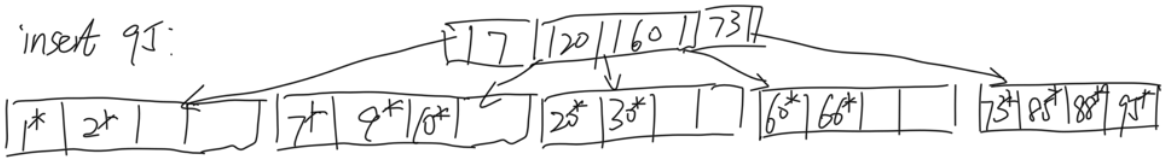
insert 9:



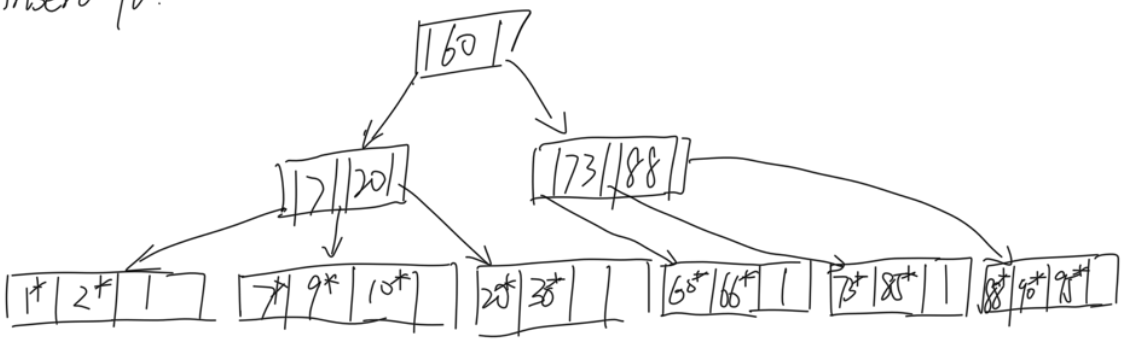
insert 88:



insert 95:

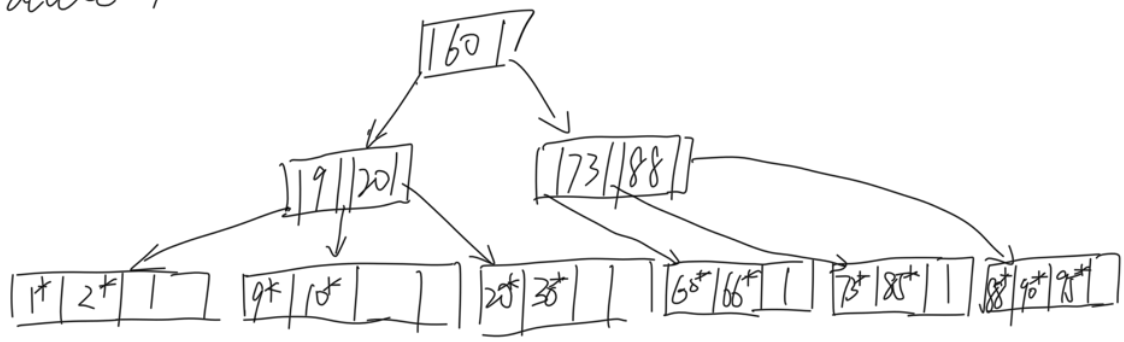


insert 90:

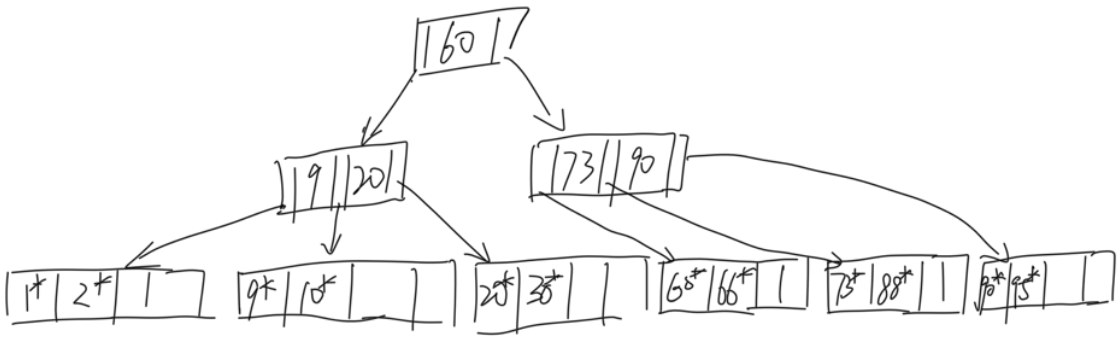


2. Show the tree after each of the following deletions: 7, 85, 60.

delete 7:



delete 85:



delete 60: