Date:
Name 1:
Name 2:

Assume you have a relation R(a,b,c). Suppose the blocks can hold either 10 tuples (heap) or 100 search keys (b+tree index). Nodes of the index are 70% full. The relation contains 1 million records. The values of a are expected to be >=0 and < 10^6.

Consider the following two queries:

a) $\sigma_{a=5}R$

b) $\sigma_{a>=10{,}000 \text{ and } a < 20{,}000}R$

1. Determine for each query:
   - the number of expected matching records

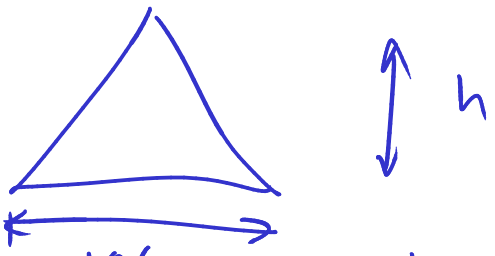
2. Determine, for each of the structures below:
   i) Expected number of leaf blocks of each index
   ii) The expected height of each index
   iii) The average number of disk I/Os needed to answer each query

Assume that nothing is in memory initially, and that the search key is the primary key of the table.

a) The B+tree is dense and the heap is unsorted
b) The B+tree is a sparse.

Redo assuming that a is not a primary key, values of a vary from >=0 and <= 10^5

a) B+ tree dense



$$h = \left\lceil \log_{70} \left[\frac{10^6}{7} \cdot \right] \right\rceil$$

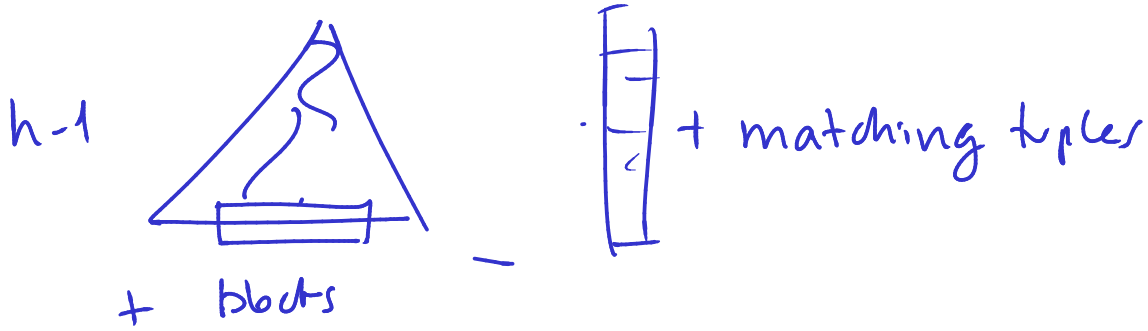
$$= \left\lceil \frac{\log_{10} \left(\frac{1}{7} \cdot 10^5 \right)}{\log_{10} 70} \right\rceil$$

$h = 3$

Block index $= \frac{10^6}{70} = \frac{1}{7} \cdot 10^5$ blocks.

For $\sigma_{a=5} R \Rightarrow h + 1 = 4.$

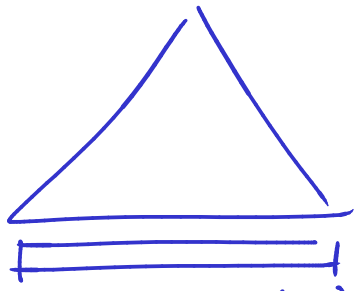
For $\sigma_{a>10k \text{ and } a<20k} R$



$$\text{blocks} = \left\lceil \frac{10^4}{70} \right\rceil = 143$$

$$\text{Cost} = 2 + 143 + 10{,}000 = 10{,}145$$

b) Tree is sparse.

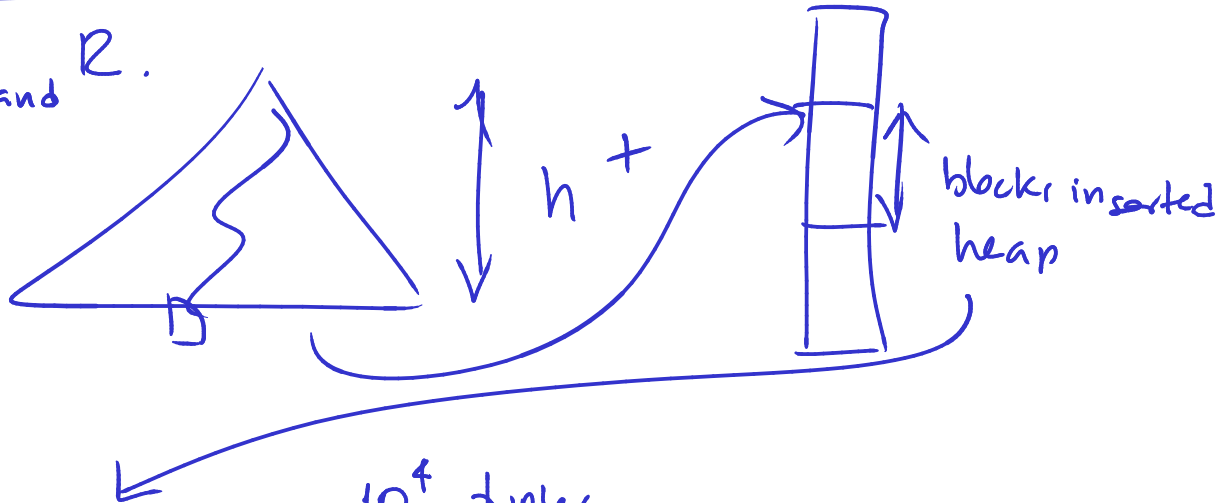


$$\#\text{index records} = \frac{B(R)}{70} = \frac{10^5}{70}$$

$$h = \left\lceil \log_{70} \frac{10^5}{70} \right\rceil = \left\lceil \frac{\log_{10}\left(\frac{10^5}{70}\right)}{\log_{10} 70} \right\rceil = \lceil 1.70 \rceil = 2.$$

$$\sigma_{a=5} R \Rightarrow h+1 = 3.$$

$\sigma_{a \geq 10k \text{ and } a < 20k} R.$



$$\text{blocks in heap} = \frac{10^4 \text{ tuples}}{10 \text{ tuples/block}} = 1{,}000 \text{ block.}$$

Cost = 1002 blocks.

$\sigma_{a=s} R$ a not primary key.

Indexes will be the same

matching tuples $\underline{\underline{10}}$ (each value is repeated 10 times).

Cost = $h + 10 = 13$

(10 index records found in one block of index)

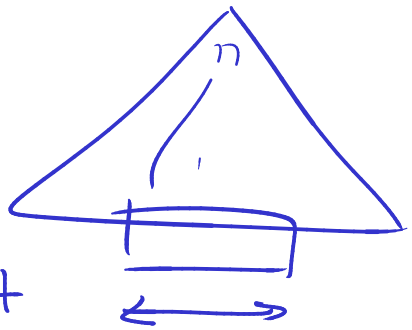
Sparse index 10 tuples can be found in one block of heap (most likely 2 if they don't start in the beginning of block

Cost = $h + 1$ or $h+2$

$= 3$ or 4.

$\sigma_{a>=10k \text{ and } a<20k} R$. $\Rightarrow 10^5$ tuples would match.

Dense:



block index

block index = $\frac{10^5 \text{ tuples}}{70}$

Cost = $h - 1 + \frac{10^5}{70} + 10^5$

$= 2 + \frac{10^5}{70} + 10^5$

Sparse index

h + # blocks in heap.

$$\text{Cost} = h + \frac{10^5}{10} = 2 + 10^4 = 10,002 \text{ blocks.}$$