CS541 Spring 2012

Assignment 3 Sample Solution

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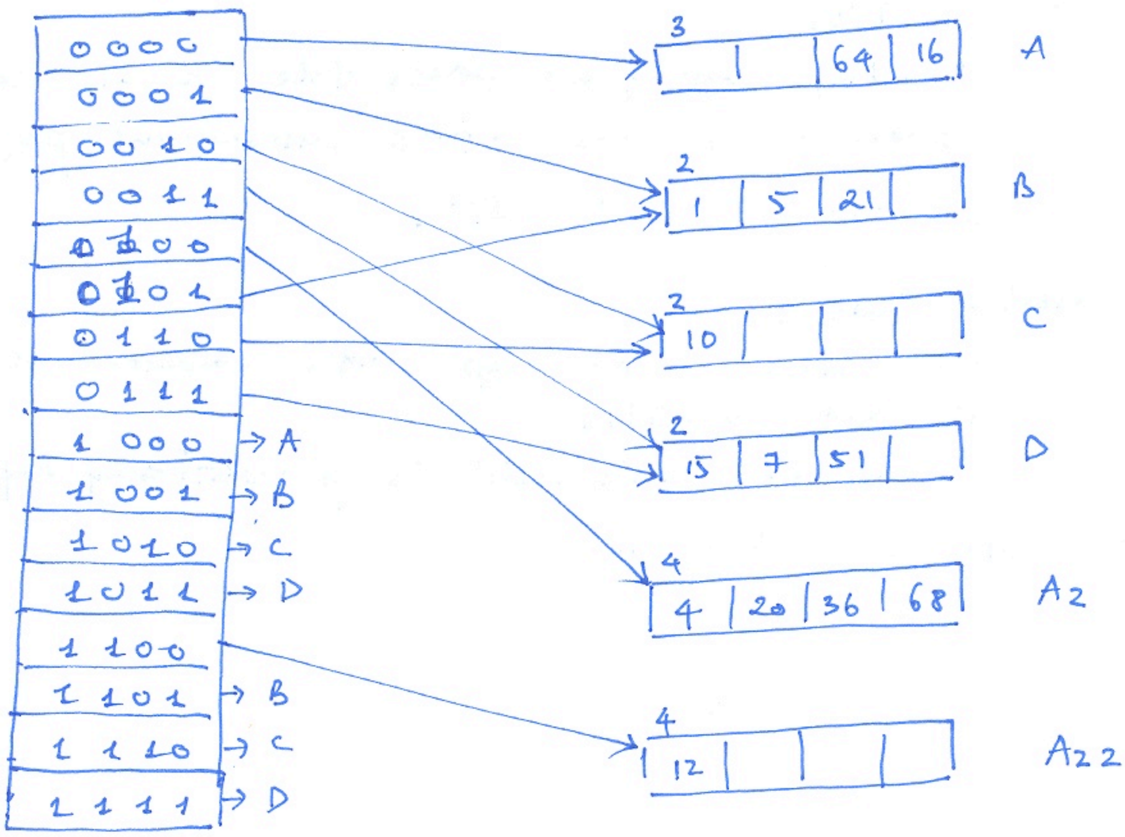
Textbook Exercises

1. (Ex 11.1)

1, The last entry that was inserted into the extendible hash index can be any of the entries. For any entry, we can find a sequence of inserts with that entry at last that produce the configuration.
The last entry inserted doesn't cause a split because:
if it belongs to buckets B, C, D, those buckets still have enough free slots. On the other hand, those buckets don't have split image.
if it belongs to bucket A or A_2, then in order to be the result of a split, the total entries in A and A_2 must be 5, not 6.

2, Insert 68 causes a split



2. (Ex 12.2) : Just consider I/O cost.

1, $\sigma_{a<50.000}(R)$

Sorted File:

Locate the (first) page containing the first record satisfying the condition takes a constant time of computation.

Load that page takes 1 I/O

Then we load subsequent pages take 1 I/O for each page.

we load ~~into~~ in total 5000 pages → 5000 I/Os

Clustered B+ tree:

Locate the first data page takes $\log_F 500.000$ I/O

where F is fan-out of B+ tree

500.000 is the total number of pages

when F = 100 ⇒ locate first page take 3 I/O.

Loading subsequent pages take 1 I/O each page ⇒ we load 4999 subsequent pages.

In total: 5002 I/Os

Linear ~~hashed~~ hashed index:

Hash index is no help with condition that is not equality.

Scan the hash index is prohibitively expensive

⇒ Sorted File is cheapest.

2, $\sigma_a = 50{,}000$ (R)

Sorted File:

If we use binary search we can compute the page containing the record (just 1 since R.a is a candidate key) in $\log_2 500.000 = 19$ I/Os.

(Assume pages have continuous page IDs).

However, if we take into account the fact that each page has 10 records ~~them~~ and values of R.a ranges from 0 to 4.999.999 then we can locate the page to be page 5000 th. And the task is done in just 1 I/Os.

B + tree:

Takes $\log_F 500.000 = 3$ I/Os (typical case)

Hashed index:

It takes about 1.2 I/O to retrieve the (linear) hash bucket

It takes 1 more I/O to retrieve the data page

=> in total 2.2 I/Os.

=> The cheapest plan is sorted file or linear hash index (depending on the search algorithm used in sorted file).

3, $\sigma_{a > 50,000 \wedge a < 50,010}(R)$

Sorted File:

Locate the page that contains the first record with R.a > 50.000 takes

$\log_2 500.000 = 19$ I/Os if we use binary search

or 1 I/Os if we compute directly, i.e. it must be the page ~~5~~ 5000th.

All records that satisfy $a > 50000 \wedge a < 50,010$ are in the same page, thus no additional I/O is required. (Note the last record of that page has a = 50.010 and it confirms that no more record can be found).

B+ tree:

Locate the first page takes $\log_F 500.000 = 3$ I/Os.

No additional page is needed.

Hashed index:

Hash index doesn't help with this query.

Scan hash index is prohibitedly expensive.

⇒ cheapest plan is Sorted File or B+ tree, depending on the search algorithm used in sorted file.

4, $\sigma_{a \neq 50.000}(R)$

Sorted File:

Scan the whole file : takes 500.000 I/Os.

B+ tree:

Get to the left most data pages takes

$\log_K 500.000 = 19$ I/Os

Scan the whole file via the linked list takes 500.000 I/Os

=> in total 500019 I/Os.

Hashed index:

Scan the index is prohibitedly expensive. The total number of I/Os depends on the hash function and other factors. In worst case, each ~~data entr~~ index data entry can cause an I/O. Caching pages can reduce the number of I/Os but it is still very large.

=> cheapest plan: Sorted File.

3. (ex 15.6.2)

$\sigma_c(\pi_\ell(R \times S))$

Clearly, attributes involved in c must be a subset of attributes involved in ℓ.

Assume R has 3 attributes r_1, r_2, r_3

S has 3 attributes s_1, s_2, s_3.

a. $\sigma_c(\pi_l(R \times S)) = \pi_{l_1}(\sigma_{c_1}(R) \times S)$

Then:

$c \equiv c_1$

$l \equiv l_1$.

c_1 involves only attributes of R

(*): otherwise we can push projection of R on those attributes.

l_1 has all attributes of R.(*) ~~that appear in c_1~~ ~~(and may be some other attribute of R)~~

has all attributes of S or has no attribute of S, otherwise, we can push projection of S on those attributes.

Example:

c_1 involves r_1

l_1 involves $r_1\ r_2\ r_3$

$$\sigma_{r_1=1}(\pi_{r_1 r_2 r_3}(R \times S)) \equiv \pi_{r_1 r_2 r_3}(\sigma_{r_1=1}(R) \times S)$$

b. $\sigma_c(\pi_l(R \times S)) = \pi_{l_1}(\sigma_{c_1}(R) \times \sigma_{c_2}(S))$

Then:

$c = c_1 \wedge c_2$

c_1 involves attributes of R only

c_2 " S "

$l_1 = l$.

If the attributes of R appear in l_1 is just a subset of all R's attributes, then we can push the projection ahead, i.e. perform projection before the cartesian product. Thus l_1 must have all attributes of R. (l_1 can't have no attribute of R since $c_1 \subseteq l_1$).

The same for S, i.e. l_1 has all attributes of S.

Example:

c_1 involves r_1

c_2 involves s_1

l_1 involves all attributes of R and S

$$\sigma_{r_1=1 \wedge s_1=2}(\pi_{r_1 r_2 r_3 s_1 s_2 s_3}(R \times S))$$

$$\equiv \pi_{r_1 r_2 r_3 s_1 s_2 s_3}(\sigma_{r_1=1}(R) \times \sigma_{s_1=2}(S))$$

c. $\sigma_c(\pi_l(R \times S)) \equiv \sigma_c(\pi_{l_1}(\pi_{l_2}(R) \times S))$

Then:

$l_1 = l$

l_2 involves only R

c : all conjuncts in c involve both R and S; otherwise we can push the conjunct ahead.

Since we don't push projection of S ahead, l_1 either:

+ contains all attributes of S
+ contains no attribute of S. This doesn't make sense because if that is the case, l_1 contains only attributes of R and l_1 must be subset of l_2, and thus we just need l_1, no need for l_2, i.e. the equivalent expression is $\sigma_c(\pi_{l_1}(R) \times S)$.

For those attributes of R appear in l_1, they must also appear in l_2, i.e. $(l_1 \cap R) \subseteq l_2$. Also $l_1 \cap R = l_2$, otherwise we should $\pi_{l_1 \cap R}(R)$ instead of $\pi_{l_2}(R)$.

example:

l_2 involves r_1

l_1 involves r_1, s_1, s_2, s_3

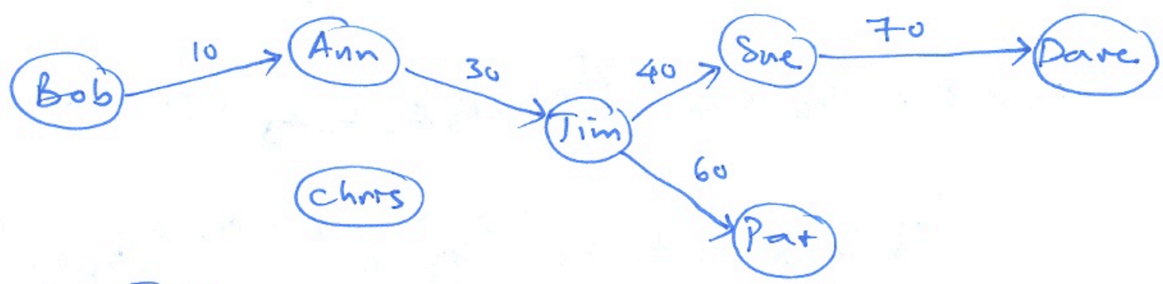
c involves r_1, s_1

$$\sigma_{r_1=s_1}(\pi_{r_1 s_1 s_2 s_3}(R \times S)) \equiv \sigma_{r_1=s_1}(\pi_{r_1 s_1 s_2 s_3}(\pi_{r_1}(R) \times S)).$$

Security / Access Control

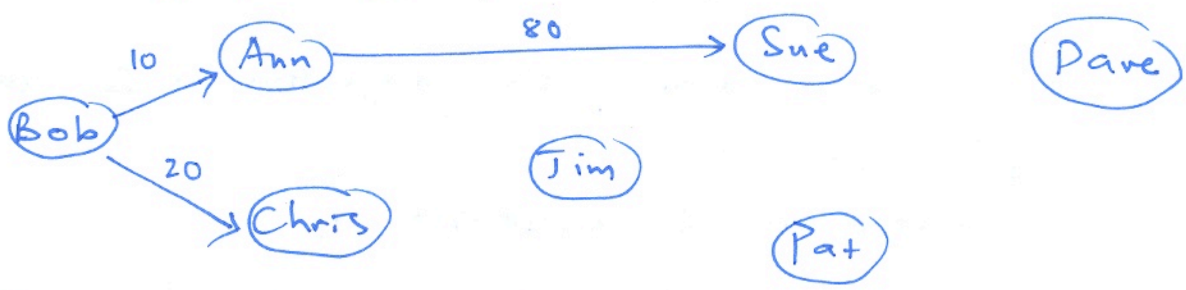
1. At time 100, Bob ~~into~~ execute
   REVOKE SELECT ON T FROM CHRIS

   Then the graph will be



   1. True
   2. True
   3. Sue, Jim, Ann, Bob.

2. At time 100 Ann: REVOKE SELECT ON T FROM JIM
   At time 110 Chris: REVOKE SELECT ON T FROM JIM
   The graph after that will be:



   1. True
   2. False
   3. Sue, Jim, Ann, Bob. (in old graph)
      in new graph, Dave doesn't have select privilege anymore.