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Problem Set 2:

CS525 – Advance Database Organisation

Exercise 4.1.1: Suppose blocks hold either three records, or ten key-pointer pairs. As a function of *n,* the number of records, how many blocks do we need to hold a data file and:
a) A dense index?
b) A sparse index?

Answer 4.1.1:

- **a)** For the dense Index we need n/3 blocks are needed for records and n/10 for the index and in total n/3+n/10 = **13n/30**
- **b)** In the Sparse Index we still need n/3 for the records but typically in sparse index we need only room for n/3 in the index file as well. So in total n/30 blocks for total of **11n/30** blocks.

Exercise 4.3.3 : Suppose pointers are 4 bytes long, and keys are 12 bytes long. How many keys and pointers will a block of 16,384 bytes have?

Answer 4.3.3:

$4n + 12(n+1) >= 16384$

$16n + 12 >= 16384$

$16n >= 16372$

$n >= 10.23.25$

n = 1024

Exercise 4.3.4: What are the minimum numbers of keys and pointers in Btree *(i)* interior nodes and (M) leaves, when:
a) *n* = 10; i.e., a block holds 10 keys and 11 pointers.
b) *n* = 11; i.e., a block holds 11 keys and 12 pointers.

Answer 4.3.4:

- **a)** For the interior nodes there would be 5 keys and 6 pointers and at the Leaf Node there would be 5 keys and 5 pointers not counting the extra pointer for the next leaf node.
- **b)** For the interior nodes there would be 6 keys and 7 pointers and at the leaf node there would be 6 keys and 6 pointers.

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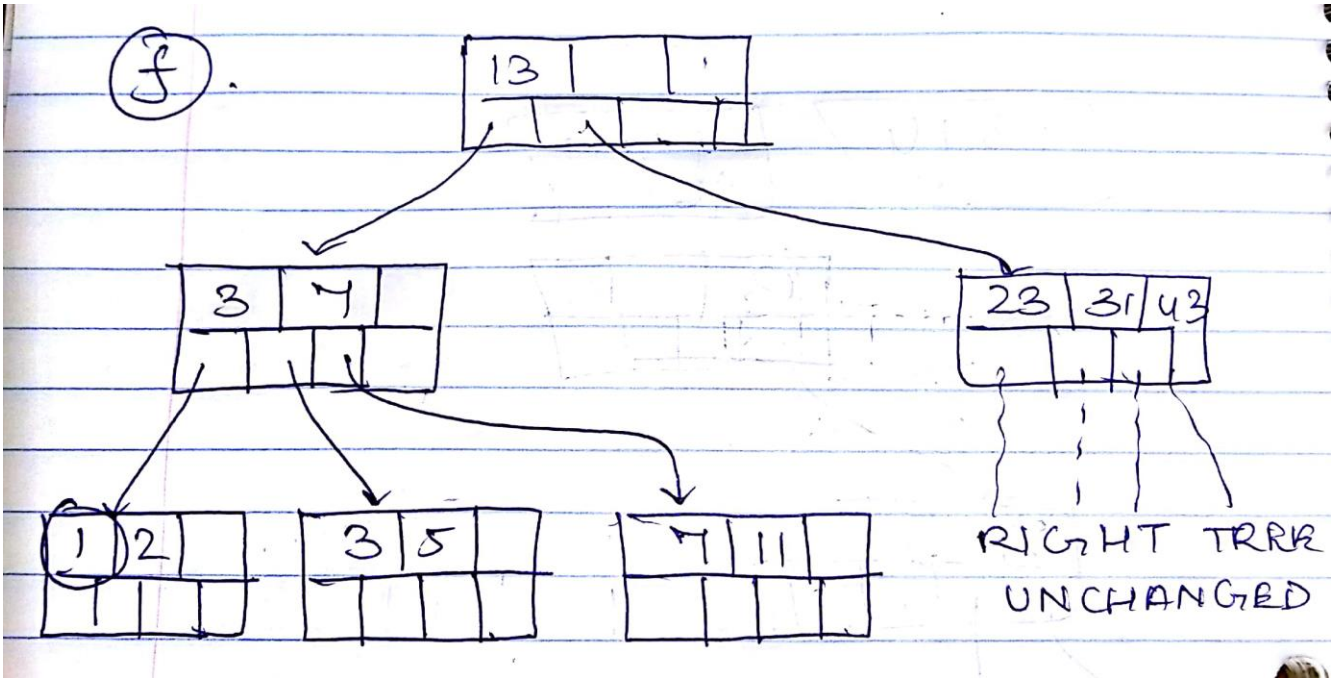
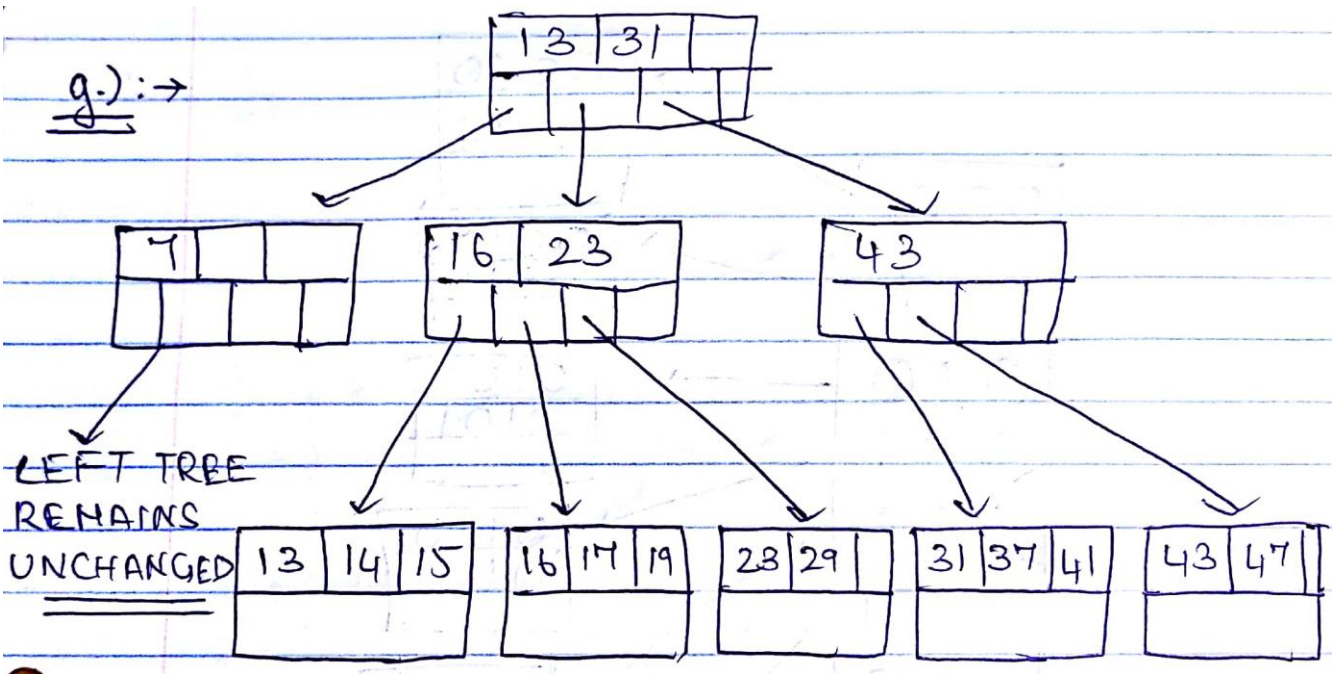
Exercise 4.3.5: Execute the following operations on Fig. 4.23. Describe the changes for operations that modify the tree.
a) Lookup the record with key 41.
b) Lookup the record with key 40.
c) Lookup all records in the range 20 to 30.
d) Lookup all records with keys less than 30.
e) Lookup all records with keys greater than 30.
f) Insert a record with key 1.
g) Insert records with keys 14 through 16.
h) Delete the record with key 23.
i) Delete all the records with keys 23 and higher.

Answer 4.3.5:

a) Lookup 41:
   i. As 41 > 13, we will go for the right sub-tree.
   ii. In the right subtree as 41 > 23 and 41 > 31 but 41 < 43, so 41 fits exactly between 31 < 41 < 43 (keys).
   iii. Then we will go for keys 31, 37 and **41.**
   iv. We find 41 as the last key in level 3, so we return 41 key with the record with it.
b) Lookup 40:
   i. As 40 > 13, go for the right sub-tree.
   ii. In the right subtree at level 2 we find keys 23, 31 and 43.
   iii. As 40 fits perfectly between 23 < 40 < 43, we go for the keys 31, 37 and 41 but conclude that record with key 40 is not present at the leaf node.
c) Lookup all records in the range 20 to 30:
   i. As 20 and 30 both are > 13 so we go for the right subtree straight away.
   ii. In the right subtree we go for keys which are less than 23 and less than 31.
   iii. So as 13, 17 and 19 don't fall into the criteria we go for the next leaf node that is 23 and 29.
   iv. As 23 and 29 falls in the range 20 to 30. Return the record attached to keys 23 and 29 in this case.
d) Lookup all records with keys less than 30.:
   i. As now the range is from 0 to 30 and 0 is less than 13, and 30 is greater than 13, so go to leaf node and see the records with keys 0 to 30 and return the data files attach with it.
   ii. So, the data returned will be with keys: 2,3,5,7,11,13,17,19,23,29.
   iii. Total of 10 records.
e) Lookup all records with keys greater than 30:
   i. Similar as the above case.
   ii. 5 data records will be returned, they are: 31,37,41,43 and 47 as they are all greater than the key 30.
f) Insert a record with key 1:



g) Insert records with keys 14 through 16:



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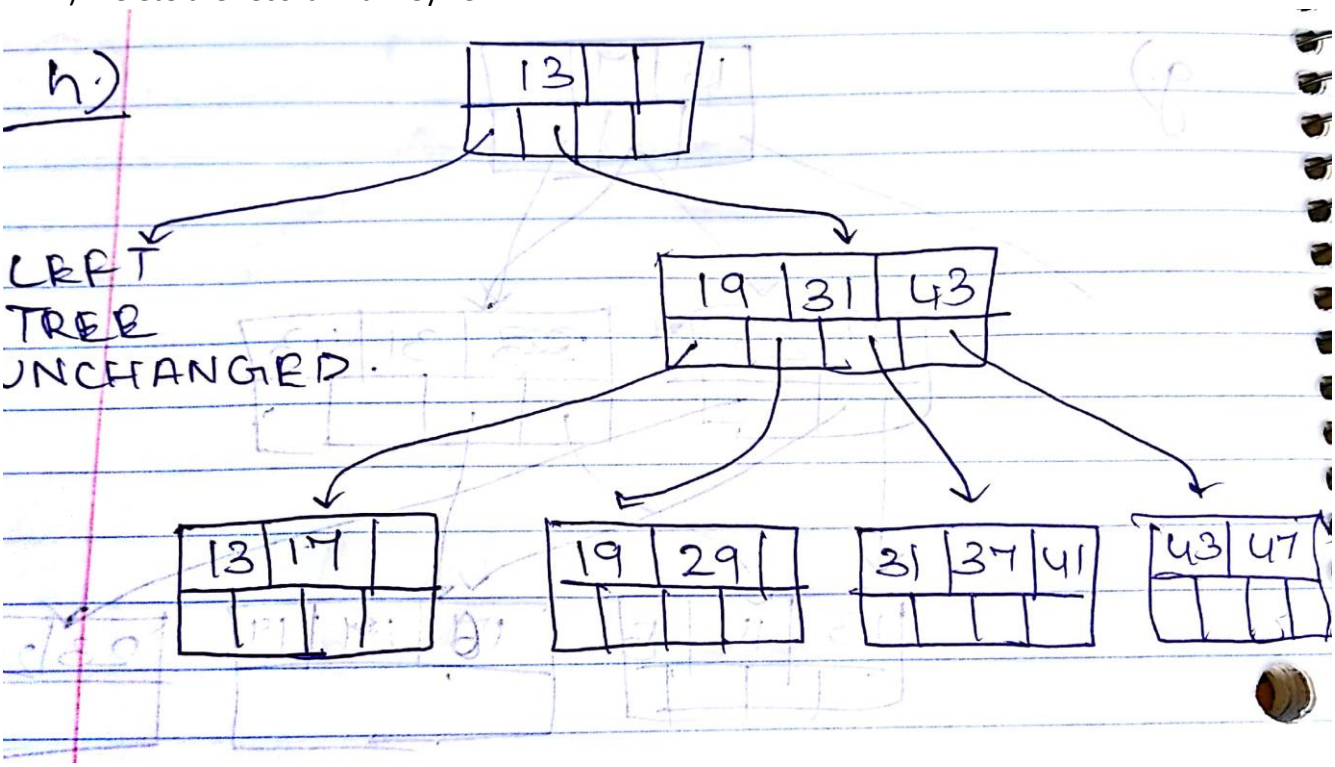
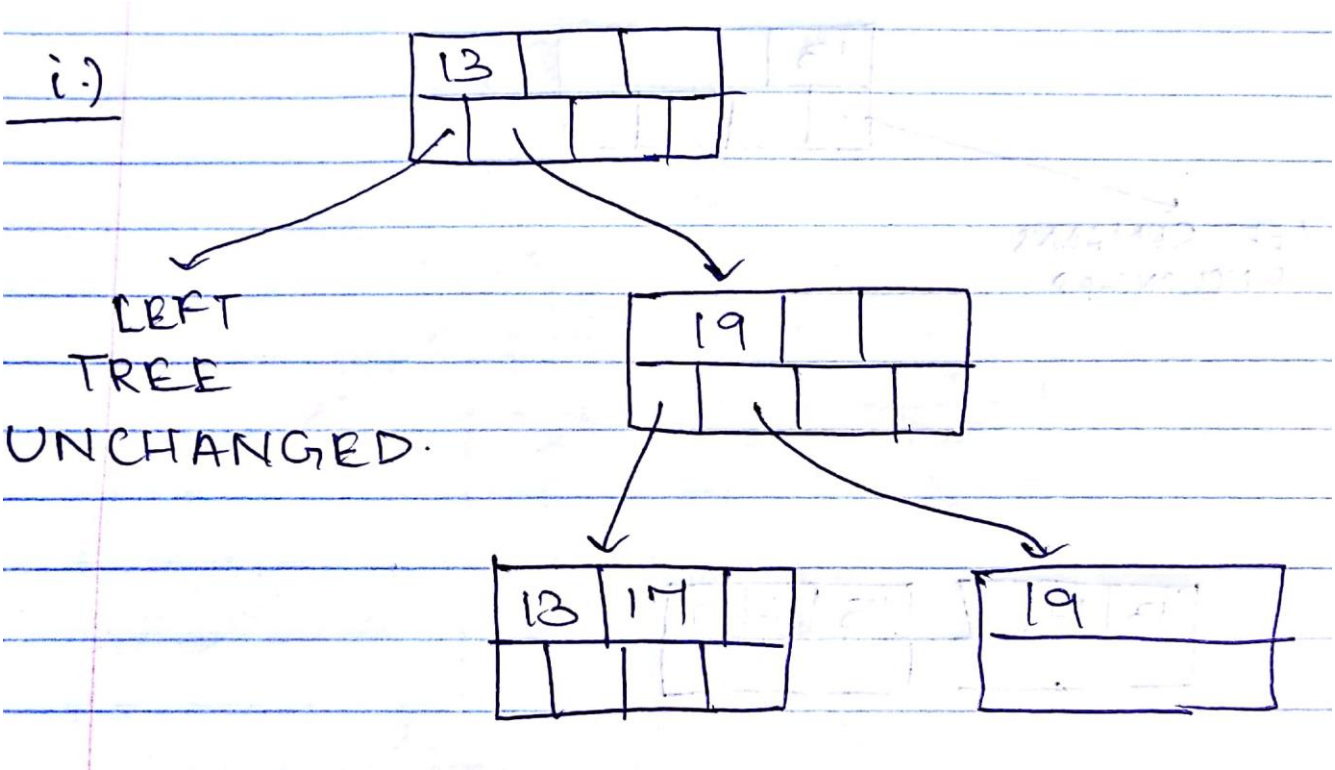
h). Delete the record with key 23:



i). Delete all the records with keys 23 and higher:



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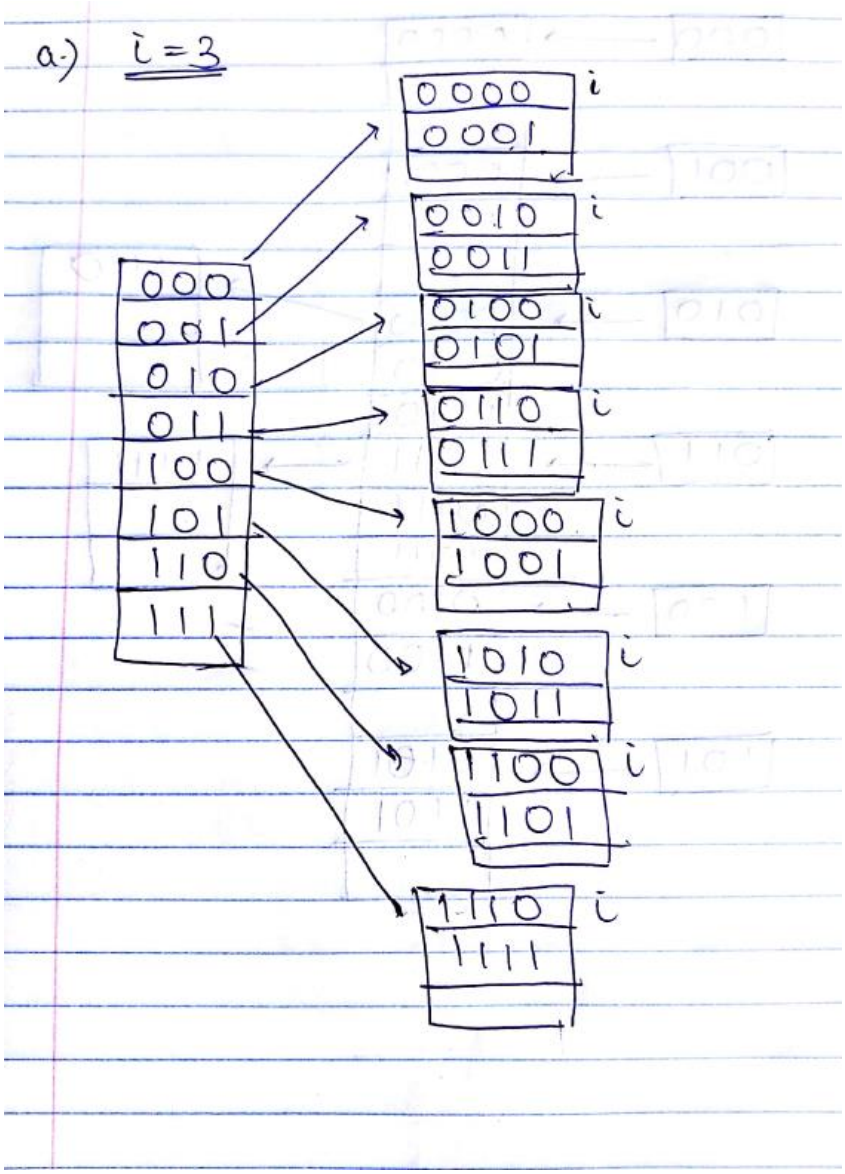
Exercise 4.4.6: Suppose keys arc hashed to four-bit sequences, as in our examples of extensible and linear hashing in this section. However, also suppose that blocks can hold three records, rather than the two-record blocks of our examples. If we start with a hash table with two empty blocks (corresponding to 0 and 1), show the organization after we insert records with keys:
a) 0000,0001,..., 1111, and the method of hashing is extensible hashing.
b) 0000, 0001,..., 1111, and the method of hashing is linear hashing with a capacity threshold of 100%.
c) 1111,1110,..., 0000, and the method of hashing is extensible hashing.
d) 1111,1110,..., 0000, and the method of hashing is linear hashing with a capacity threshold of 75%.

Answer 4.4.6:

a).



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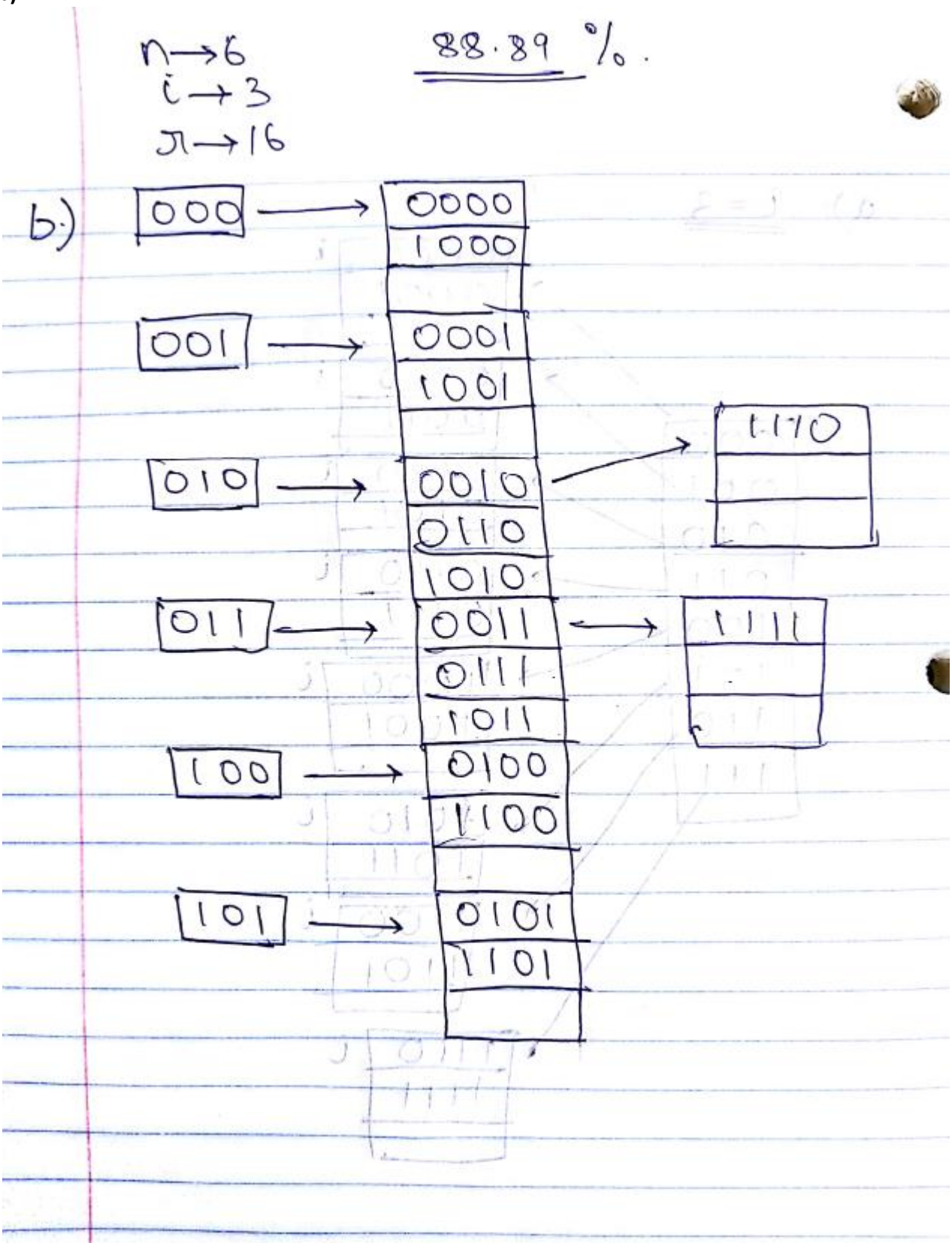
b):



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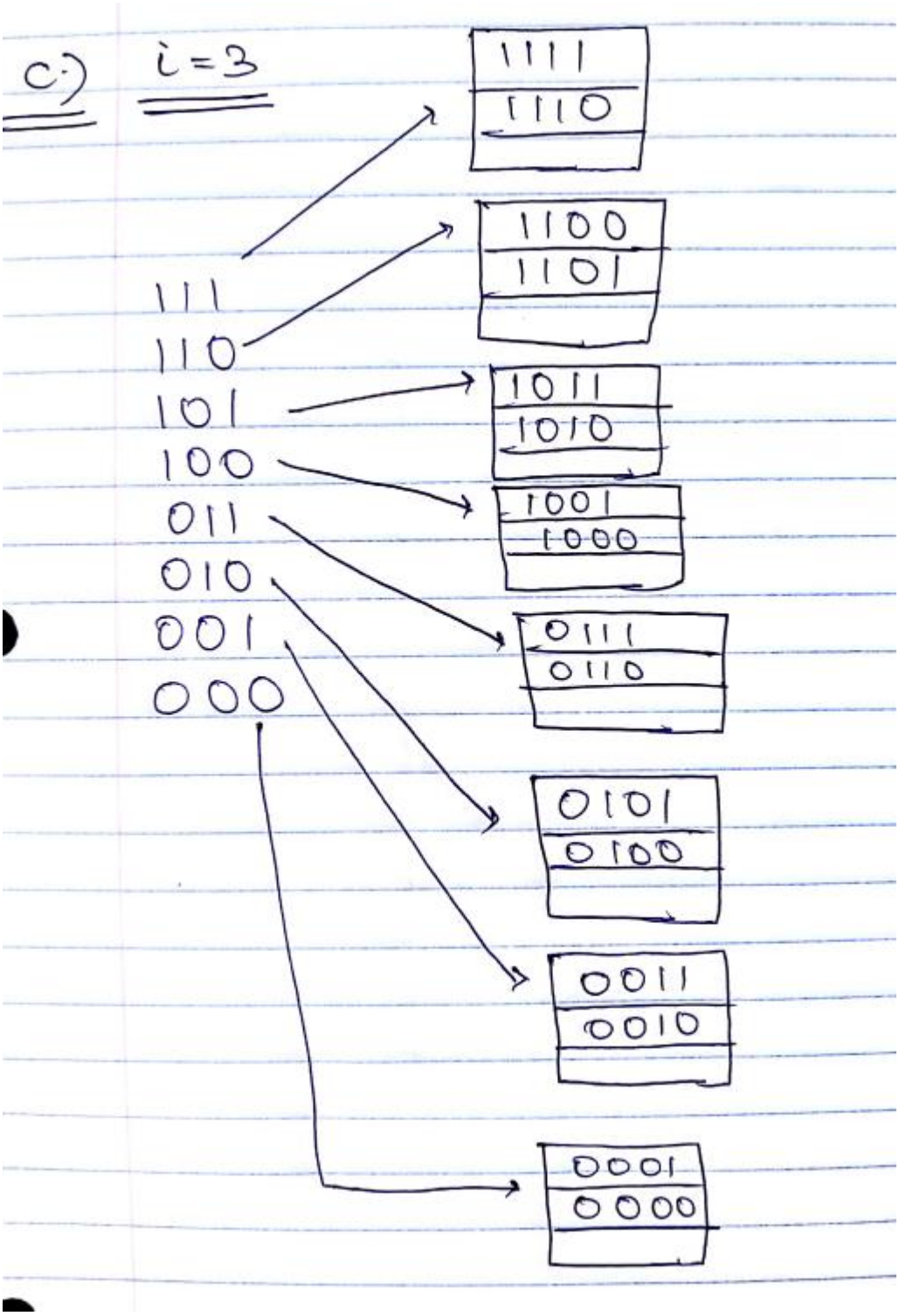
c).



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d).