Advanced Databases
Assignment 2

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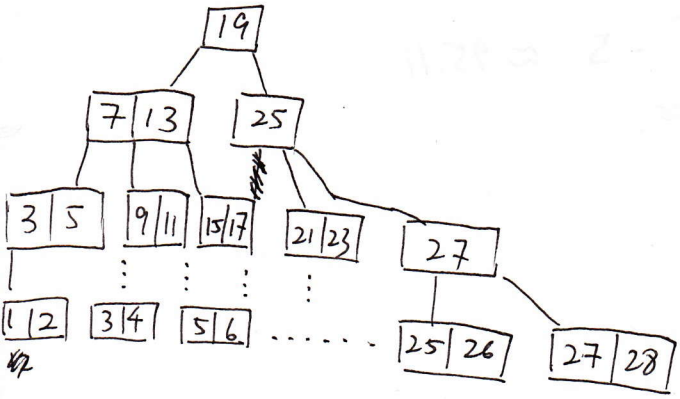
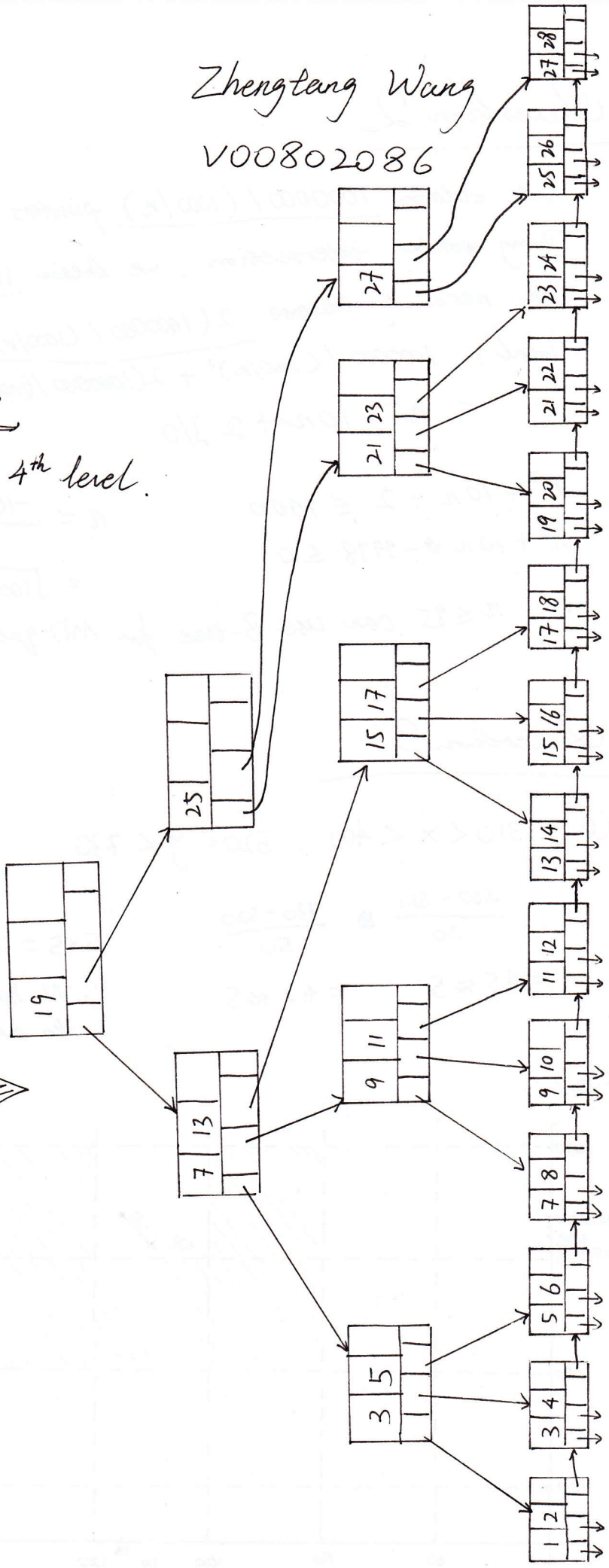
Question 1

At the insertion of key 28
the B-tree will first reach 4th level.
The tree will be like:



Full final tree
is on the right.



Question 2

we obtain $1000000 / (1000/n)$ pointers to follow from each index.
Doing pointer intersection, we obtain $1000000 / (1000/n)^2$ pointers to finally follow.
we need to traverse $2(1000000 / (1000/n)) / 200$ leaves + 2.
Total: $1000000 / (1000/n)^2 + 2(1000000/(1000/n))/200 + 2$.

$= n^2 + 10n + 2$ I/O

$n^2 + 10n + 2 \leq 10000$

$n^2 + 10n - 9998 \leq 0$

$n = \frac{-10 + \sqrt{10^2 - 4 \times (-9998)}}{2}$

$= \sqrt{10023} - 5 \approx 95.11$

$\therefore$ $n \leq 95$ can use B-tree for MD-queries.

Question 3

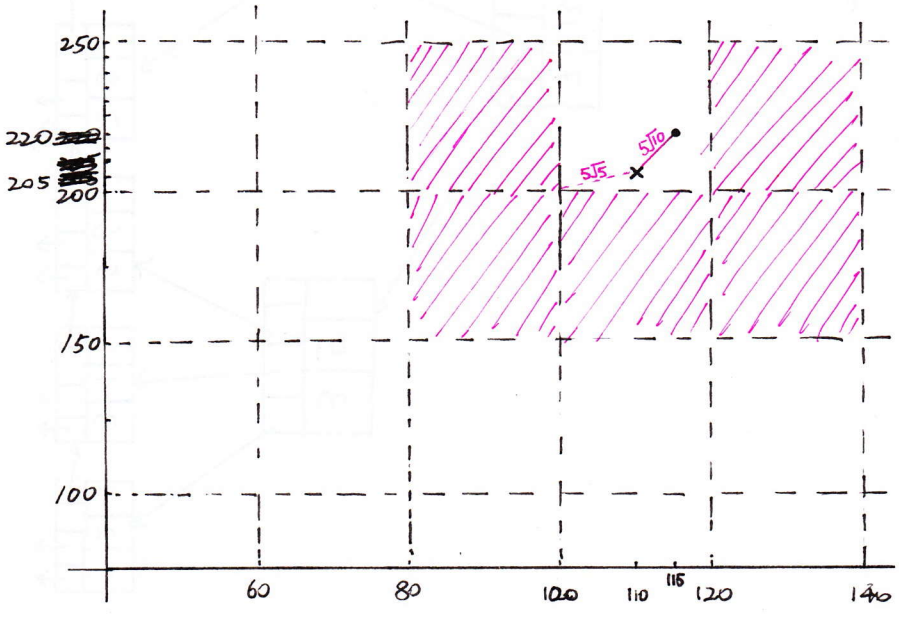
(a) $310 < x < 400$, $520 < y < 730$.

$\frac{400 - 310}{20} = 4.5 \approx 5$ * $\frac{730 - 520}{50} = 4.2 \approx 5$

$5 \times 5 = 25$.

$\therefore$ We have to examine 25 buckets to answer this query.

(b)



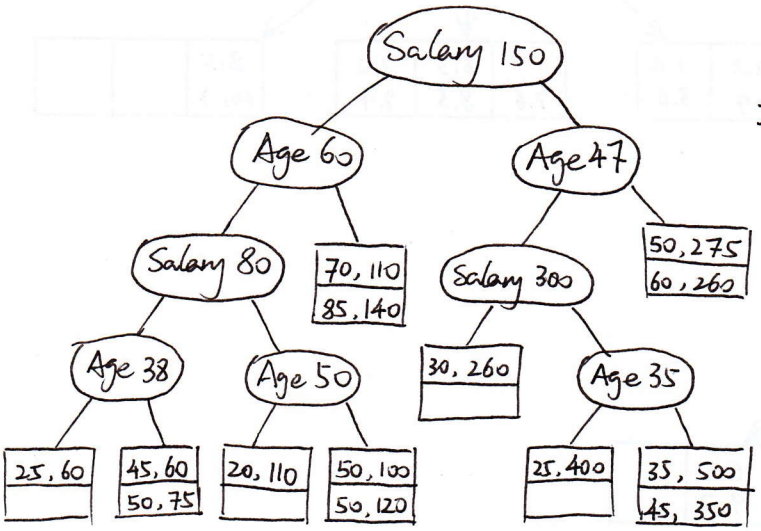
x: point (110, 205).
•: closest point (115, 220).
distance between two point:
$\sqrt{(115-110)^2 + (220-205)^2} = 5\sqrt{10} \approx 15.81$

Draw a circle using $5\sqrt{10}$ as radius. The buckets that covered by this circle are need to be searched.

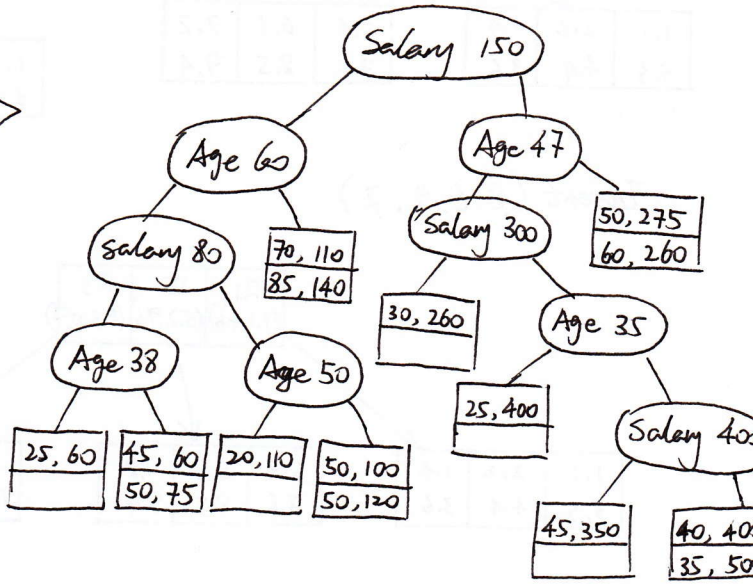
After calculation, the other buskets that must be searched are saded by "▨".

Question 4.

Insert (20,110)

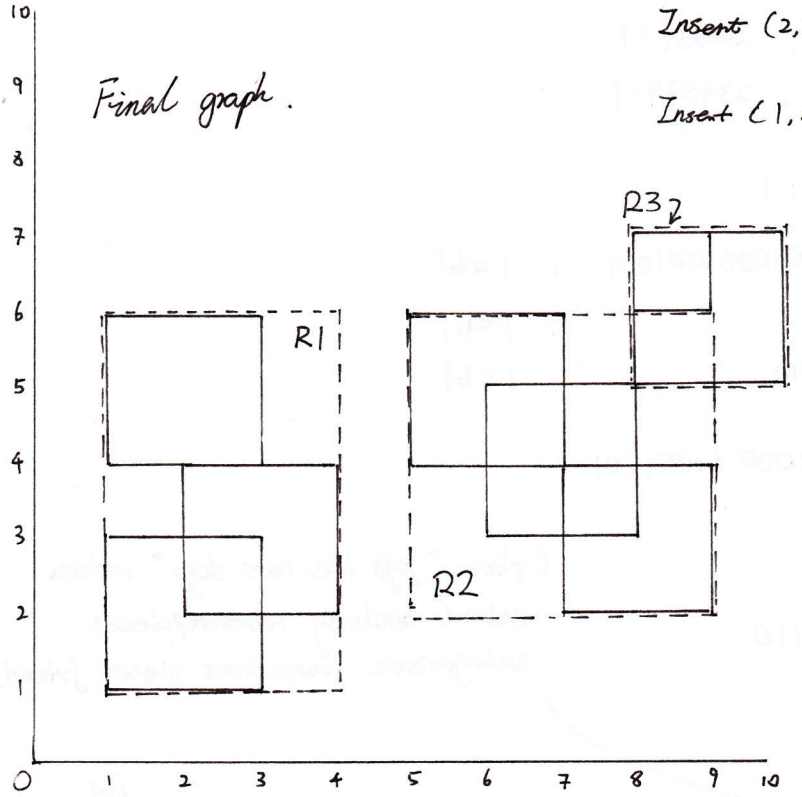


Then insert (40, 400)

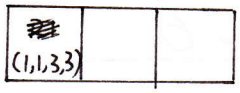


Question 5.

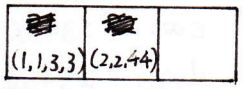
Final graph.



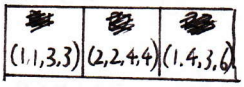
Insert (1,1,3,3)



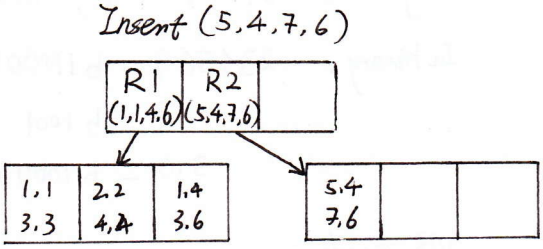
Insert (2,2,4,4)



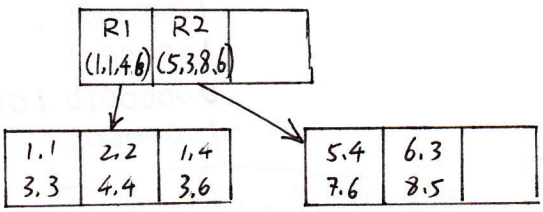
Insert (1,4,3,6)



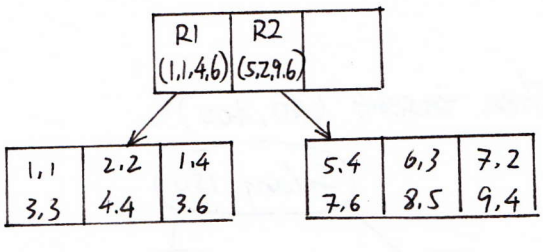
Insert (5,4,7,6)



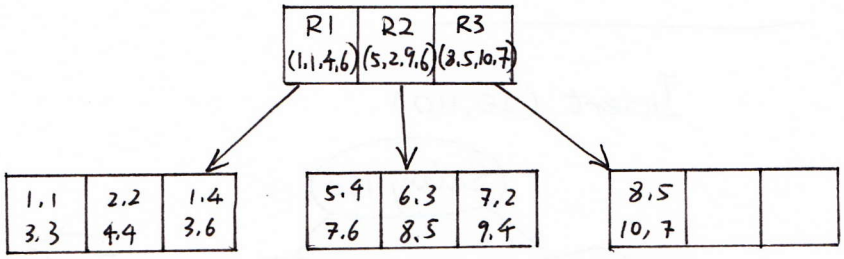
Insert (6, 3, 8.5)



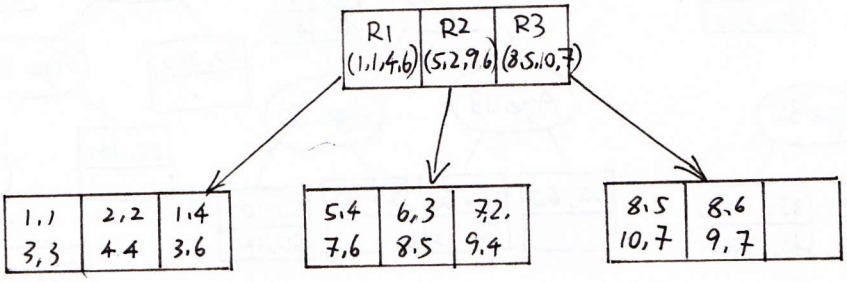
Insert (7,2,9,4)



Insert (8,5,10,7)



Insert (8,6,9,7)



Question 6

1. cat: 234569:1, 234578:1, 234839:1
   dog: 234569:1, 234578:1, 234879:1

2. dog: 234569:1, 9:1, 310:1

   In binary: 234569 = b111001010001001001 : 1 = b1
   9 = b1001 : 1 = b1
   310 = b100110110 : 1 = b1

   VB encoding: 00001110 00101000 11001001
   10000001
   10001001
   10000001
   00000010 10110110
   10000001

3. $q = \sqrt{(\frac{1}{1})^2 + (\frac{1}{1})^2} = \sqrt{2} = 1.41$

   $d_{234569} = \sqrt{14} = 3.74$

   $d_{234578} = \sqrt{4} = 2$ (dogs cats bad relationship)

   $d_{234839} = \sqrt{2} = 1.41$ (cats furry)

   $d_{234879} = \sqrt{3} = 1.73$ (dogs ~~mats~~ best friend)

   (phrase "fight like cats dogs" reflects natural tendency relationship pieces antagonistic sometimes pieces friends).

   $\cos(q, d_{234569}) = \frac{1+1}{3.74 \times 1.41} = 0.38$

   $\cos(q, d_{234578}) = \frac{1+1}{2 \times 1.41} = 0.71$

   $\cos(q, d_{234839}) = \frac{1}{1.41^2} = 0.50$

   $\cos(q, d_{234879}) = \frac{1}{1.73 \times 1.41} = 0.41$