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April 30, 2003 **Data Structure I**

SOLVE EXACTLY THREE OUT OF THE FOLLOWING FIVE PROBLEMS:

1. The following program is applied to an array $\mathbf{a}, a[i] = 7 * i \ \% \ 15 \ - 8$

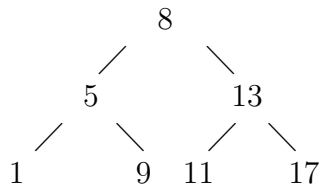
$a[i] = 0 \leq i \leq 14$, a. length = 15.

a) What is the result?

b) What is the running time if the array is of size a.length = n? Give a complete proof.

```
      public int number (int[ ]a)
/*1*/  { int number1 = 0;
/*2*/      for (int i = 0; i < a.length; i++)
/*3*/          for (int j = i; i < a.length; j++)
/*4*/          { int number2 = 0;
/*5*/              for (int k = i; k < j; k++)
/*6*/                  number2 = number2 + a[k];
/*7*/                  if (number2 > number1)
/*8*/                      number1 = number2;
/*9*/              }
/*10*/     return number1
/*11*/  }
```

2. Show the result of each AVL tree when $43, 40, 35, 29, 23, 21$ and 20 are inserted to the following AVL tree consecutively.



3. Let $D(N)$ be the average depth of the binary search trees. Find $D(N)$ as a function of N. (hint: consider the left subtree of size i and right subtree of size $N - i - 1$, let $d(N) = ND(N)$ be the sum of the depth of all nodes of the tree, so $d(N) = d(i) + d(N - i - 1) + N - 1$.

4. What is the minimum number of nodes of an AVL tree of height 5? Justify your answer.

5 a). Use quadratic probing to insert $91, 28, 31, 58, 61$ to the address 0 to 9. Show the content of each address after each insertion.
Where $hash(x) = x \bmod 10$, and $f(i) = i^2$.

b. Use double hashing to insert the same data of 5a to the same address. Show the content of each address after each insertion.
With $hash_2(x) = 7 - (x \bmod 7)$