AUBURN UNIVERSITY

CPSC 3283 M2-Programming Assignment

Objectives of this assignment:

- To verify empirically Theorem 12.4 (Chapter 12, Textbook) that states:
  "*The expected height of a randomly built binary search tree on n distinct keys is O(lg n).*"

What you need to do:

1. Implement the *Tree-Insert(T,z)* operation on a binary search tree.
2. Repeatedly Insert ***n*** randomly picked numbers in a binary search tree and collect the height ***h***. For simplicity, no need to enforce that the keys are distinct.
3. Plot on the same plot the quantity h/lg(***n***) versus ***n***.
4. Discuss the results.

Objective:

The objective of this programming assignment is to verify empirically Theorem 12.3 that states that "the expected height of a randomly built binary search tree on n *distinct* keys is O(lg n)."

In order to conduct this experiment, you must implement in Java the Tree-Insert(T,z) operation. Below, I explain in pseudocode the program you must write to collect data and verify Theorem 12.3. **When randomly generating elements for the tree, you do NOT need to enforce that the keys be distinct.**

Program to implement

```
collectData()
      for n = 500 to 20,000 by step 500 // 500, 1000, 1500, …. 20,000
            sum_height_n = 0
            for j = 1 to 10 do //Take 10 measurements m_j for j=1 to 10
                  for i = 1 to n
                      pick randomly a number p in the range [0,n]
                      create a node z
                      set z.key = p
                      Tree-Insert(T,z)
                  Measure the height h_j of the tree
                  Discard Tree
                  sum_height += h_j
            collect/record Height(n)= sum_height/10 // Average height for n
            Write in a file F the value n and Height(n)
```

Data Analysis

Use any plotting software (e.g., Excel) to plot the quantities Height(n)/lg n and Height(n)/n in File F as a functions of n. File F is the file produced by the program you implemented. Discuss your results based on the plots.

Points Distributions:
1) (20 points) Program collectData()
2) (45 points) Correct Plots
3) (35 points) Pertinent discussion/conclusions of the plots.

Report

- Write a report that will contain, explain, and discuss the plot. The report should not exceed one page.
- In addition, your report must contain the following information:
  - whether the program works or not (this must be just ONE sentence)
  - the directions to compile and execute your program
- Good writing is expected.
- Recall that answers must be well written, documented, justified, and presented to get full credit.

What you need to turn in:

- Electronic copy of your source program (standalone)
- Electronic copy of the report (including your answers) (standalone). Submit the file as a Microsoft Word or PDF file.

Grading

- Program is worth 30% if it works and provides data to analyze
- Quality of the report is worth 70% distributed as follows: good plot (25%), explanations of plot (10%), discussion and conclusion (35%).