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Lab 6

**Problem 1:**

a) How many triples of integers in the input file 4Kints.txt sum to zero?

There were 4039 triples of integers in the file 4Kints.txt that sum to zero.

b) What is the exact number of times the if statement on line 10 in Snippet 1 gets executed? Give an expression in terms of n

The if statement on line 10 gets executed $\frac{1}{6}n^3 - \frac{1}{2}n^2 + \frac{1}{3}n$ times given n elements in the array.

**Problem 2:**

a) Explain in one sentence what the numbers in the first column are. Explain in one sentence what the numbers in the second column are.

The numbers in the first column represent the number of elements in the array that was tested. The numbers in the second column represent how long the algorithm took to process the input.

b) Suppose the input to ThreeSum.java is an integer array of 8,000 6-digit integers. On your computer, how many seconds does it take ThreeSum.java to find the number of triples of these integers that sum to zero?

With an input array of 8,000 integers, ThreeSum.java takes 143 seconds to complete on my machine.

c) Based on the output you obtained in part (a) as a result of running DoublingTest.java, determine the constant a of Equation 1.

Using the data from the run with 16,000 integers, I calculated a to be approximately $a \approx \frac{206}{16000^3} \approx 5.0293 \text{ x } 10^{-11}$.

**Problem 3:**

a) What is the exact number of times the if statement on line 9 in Snippet 3 on page 8 gets executed? Give an expression in terms of n.

The if statement on line 10 gets executed $\frac{1}{2}n^2 - \frac{1}{2}n$ times given n elements in the array.

b) How many pairs of integers in 16Kints.txt sum to zero?

There were 66 pairs of integers in the file 16Kints.txt that sum to zero.

c) What is the Big-O estimate of the method TwoSum.count() in Snippet 3 (lines 4 – 14)?

My Big-O estimate of the method TwoSum.count() would be $O(n^2)$ as there are two nested for loops, each taking O(n) time. The two times are multiplied together to get $O(n^2)$.

**Problem 4:**

a) What is the Big-O running time of the method TwoSumFast.count() in Snippet 4? Assume that the call to Arrays.sort() on line 5 takes O(n log n) time.

The sort on line 5 takes O(n log n) time. The for loop itself takes O(n) time, with the binary search inside taking on average O(log n) time, making a combined O(n log n) time. Big O is summed, so O(n log n) + O(n log n) = 2*O(n log n). After dropping the constant, the Big O time for the method TwoSumFast is O(n log n).

b) How many pairs of integers sum to zero in the following file of 1 million integers: 1Mints.txt?

There were 249838 pairs of integers in the file 1Mints.txt that sum to zero.

**Problem 5:**

a) Invent a faster solution to the ThreeSum problem based on your experience with Problem 4. Then determine the number of triples of integers that sum to zero in 1Mints.txt.

There were 255,181 triples of integers in the input file 16Kints. I was unable to process the 1Mints file.