CS 251
Spring 2009
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Assignment 2
Due Thursday January 29, 11:59PM

Running Time Analysis

1. Write a C++ function (standalone, no class) that takes an array of *n* integers and prints out all pairs to the standard output. Given {*a, b, c*}, the function should print out pairs *(a, b), (a, c), (b, a), (b, c), (c, a), (c, b),* regardless of the values of *a, b,* and *c. Warning: pay very close attention to the required input and output format described below, as an error here can be costly.*

2. Measure the function's running time as a function of *n*.
   a. Generate random input arrays and time the function. Measure only the running time for the function but not the other parts (e.g. reading input).
   b. Double the value of *n* starting from 64 until the running time becomes greater than 20 seconds.
   c. Plot the running time as a function of *n* on both a linear and a logarithmic graph.

3. Write a pseudocode description of the function.
   a. Find the number of primitive operations as a function of *n*.
   b. Perform the asymptotic running time analysis using the *O, Ω, Θ, ω,* and *o* notations.
   c. Argue that the problem of printing out all pairs is $\Theta(n^2)$.

4. Consider a function that takes an array of *n* integers and prints out unordered pairs. For the example above, the pairs printed are *(a, b), (a, c),* and *(b, c)*. How does the actual running time change? Does the asymptotic running time change? Explain.

5. Extra-credit (3%): Write a function that takes an array of *n* integers and prints all pairs *(a, b)* where both *a* and *b* are multiples of 5, and that has a linear best case running time. What is the worst case running time? What is the average case running time? Explain. W*arning: pay very close attention to the required input and output format as an error here can be costly.*

6. Turn in instructions:
   a. Assignment specific
      i. Question 1: Name your program file as "a2.cpp". "a2.cpp" will have a main function that reads the file "a2-input" (assumed to be in the current directory) to obtain the length of the array n and the integers. The format of "a2-input" is the following. There is only one integer terminated by a newline at each line. The first line is the length of the array n. The rest of the numbers at each line in the file are integers in the order given. The main function calls the function which prints out all pairs to the standard output. Print one pair terminated by a newline at each line.

A sample input file “a2-sampleinput” and the resulted output file “a2-sampleoutput” are provided. In particular, use this output to determine the expected output for your function. When your program is correctly working, the unix command “diff” should report no difference (no output from diff) between your output from “main” saved into a file “myoutput” and “a2-sampleoutput”. Test this by:

```
./a2 > myoutput

diff myoutput a2-sampleoutput
```

of course once you get this to work you should devise additional test cases to ensure your program truly works.

ii. Question 2-4: Turn in a PDF document named as “a2.pdf” with your answers. **Read General turnin instructions parts E F and G very carefully.**

iii. Question 5: Give separate code named as “a2extra.cpp” and a separate PDF document named as “a2extra.pdf”. For code, the instructions for input and output formats are the same as in Question 1. For PDF, again follow General turnin instructions parts E F and G.

iv. Your codes MUST compile on lore.cs.purdue.edu for it to be graded.

v. All of your documents (a2.cpp, a2.pdf, a2extra.cpp (OPTIONAL), a2extra.pdf (OPTIONAL)) MUST be in the directory A2.

vi. in the directory above A2, run the command on lore.cs.purdue.edu

```
turnin -c cs251 -p A2 A2
```

vii. optionally run the following command to verify what files were submitted

```
turnin -c cs251 -p A2 –v
```

viii. Warning: turnin will be automatically disabled at 01/29/2009 at 11:59PM EST and you will be unable to turnin your assignment after this time.

ix. Warning: turning in multiple times is ok but only the last one will be graded as each turnin permanently overwrites the previous one.

x. Warning: failure to turnin exactly according to the instructions given above will result in your A2 receiving a grade of 0.

b. General: see website