CSC / CIS 175
Problem Solving and Programming - I

University of Michigan-Flint
Department of Computer Science, Engineering, and Physics (CSEP)

COLLEGE OF ARTS & SCIENCES
COMPUTER SCIENCE, ENGINEERING, & PHYSICS

Fall 2013

October 9, 2013

Homework 5

(100 points)

due by October 23, Wednesday 8:00am

Remarks:

- No emailed homeworks will be accepted.
- Only submission is via the BB system.
- No late submissions will be accepted.

Questions for the deliverable:

1. A palindrome is a number or a text phrase that reads the same backwards as forwards. For example, 12321, 3456543, etc. Write a program that reads in a five-digit integer and determines whether it is a palindrome. Hint: use the integer division and modulus operator to separate the number into its individual digits.

   Sample Output:

```
 (i)
Please Enter a 5-Digit Integer :12345
12345 is NOT a palindrome

 (ii)
Please Enter a 5-Digit Integer :12321
12321 is a palindrome
```

2. A person invests \$10000.00 in a savings account. Assuming that all interest is left on deposit in the account, calculate and print the amount of money in the account at the end of 10 years for interest rates of 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10%. Use the following formula for determining these amounts:

$$a = p * (1 + r)^n \quad (1)$$

where p is the principal, r is the annual interest rate, n is the number of years, and a is the amount on deposit at the end of the nth year.

Sample Output:

```
Rate        Amount at the end of 10th year
====       ===============================
0.01                   11046.22
0.02                   12189.94
0.03                   13439.16
0.04                   14802.44
0.05                   16288.95
0.06                   17908.48
0.07                   19671.51
0.08                   21589.25
0.09                   23673.64
0.10                   25937.42
```

3. Pythagorean Triples: A right triangle can have sides that are all integers. A set of three integer values for the sides of a right triangle is called a Pythagorean triple. These three sides must satisfy the relationship that the sum of the squares of two of the sides is equal to the square of the hypotenuse. Find all **unique** Pythagorean triples for side1, side2 and hypotenuse, all no longer than 500. How many are there? Note that this problem specifically asks you to exclude the duplicates, unlike the one on p.167 of the slides. For example, if you were to check all unique Pythagorean Triples less than 5 (rather than 500) your output must be
3 4 5
That is, it must NOT output both (3,4,5) and (4,3,5).

Sample Output:

```
Number of Pythagorean Triples with duplicates : 772
The Innermost for loop is entered 125000000 times.

Number of Pythagorean Triples (no duplicates) : 386
The Innermost for loop is entered 20708500 times.
```

4. The factorial of a nonnegative integer n is written $n!$ (pronounced "n factorial") and is defined as follows:

$$n! = n * (n - 1) * (n - 2) * (n - 3) * \cdots * 1 \quad (2)$$

0! = 1, 1! = 1 by definition.
For example, 5! = 5*4*3*2*1 = 120

(a) Write a program that reads a nonnegative integer and computes and prints its factorial. Do not use scientific notation for displaying the result.

(b) Write a program that estimates the value of mathematical constant e by using the formula:

$$e = 1 + \frac{1}{1!} + \frac{1}{2!} + \frac{1}{3!} + \quad \cdots \tag{3}$$

Prompt the user for the desired accuracy of e, i.e. the number of terms in the summation. Use 10 digits of precision to display the result.

Sample Output: (combined for a and b)

```
Number for Factorial : 16
16! = 20922789888000.000000
Desired Accuracy for "e"(number of terms in the series) : 10
e with 10 terms = 2.7182815256  (with 10 digits of accuracy)
```

5. Write a program that computes the value of e^x by using the formula

$$e^x = 1 + \frac{x^1}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \quad \cdots \tag{4}$$

Prompt the user for the desired accuracy of e, i.e. the number of terms in the summation and the power of ”e”. Use 10 digits of precision to display the result.

Expected Output:

```
Enter the exponent of "e" :  7
Desired Accuracy (number of terms in the series) : 13
e^7 with 13 terms = 1067.0243116203
```

6. Write a program that finds and prints all of the prime numbers between 3 and 1000. Print them and display the total prime numbers between 3 and 1000.

Expected Output:

```
        3    5    7   11   13   17   19   23
   29   31   37   41   43   47   53   59
   61   67   71   73   79   83   89   97
  101  103  107  109  113  127  131  137
  139  149  151  157  163  167  173  179
  181  191  193  197  199  211  223  227
  229  233  239  241  251  257  263  269
  271  277  281  283  293  307  311  313
  317  331  337  347  349  353  359  367
  373  379  383  389  397  401  409  419
  421  431  433  439  443  449  457  461
  463  467  479  487  491  499  503  509
  521  523  541  547  557  563  569  571
  577  587  593  599  601  607  613  617
  619  631  641  643  647  653  659  661
  673  677  683  691  701  709  719  727
  733  739  743  751  757  761  769  773
  787  797  809  811  821  823  827  829
  839  853  857  859  863  877  881  883
  887  907  911  919  929  937  941  947
  953  967  971  977  983  991  997

There are 167 prime numbers  between 3 and 1000
```

7. In cryptarithmetic puzzles, mathematical equations are written using letters. Each letter can be a digit from 0 to 9, but no two letters can be the same. Customarily, distinct letters stand for different digits Here is a sample problem:

```
SEND + MORE = MONEY

A solution to the puzzle is S = 9, R = 8, O = 0, M = 1, Y = 2, E = 5, N = 6, D = 7
    S E N D
    M O R E
+
------------
  M O N E Y

That is,

    9 5 6 7
    1 0 8 5
+
------------
  1 0 6 5 2
```

Write a program that finds solutions to the following cryptarithmetic puzzle:

```
TOO + TOO + TOO + TOO = GOOD

    T O O
    T O O
    T O O
    T O O
+
-----------
  G O O D
```

The simplest technique is to use a nested loop for each unique letter (in this case T, O, G, D). The loops would systematically assign the digits from 0-9 to each letter. For example, it might first try T = 0, O = 0, G = 0, D = 0, then T = 0, O = 0, G =0, D = 1, then T = 0, O = 0, G = 0, D = 2, etc. up to T = 9, O = 9, G = 9, D = 9. In the loop body test that each variable is unique and that the equation is satisfied. Output the values for the letters that satisfy the equation.

Expected Output:

```
The values are: T = 1 O = 6 G = 0 D = 4
The values are: T = 4 O = 9 G = 1 D = 6
```

8. `Extra credit (3%)`: Extend q6 above to get the lower and upper bounds for the range to look for the prime numbers.

   Expected Output:

```
Lower bound = 1201
Upper bound = 2498
 1201 1213 1217 1223 1229 1231 1237 1249
 1259 1277 1279 1283 1289 1291 1297 1301
 1303 1307 1319 1321 1327 1361 1367 1373
 1381 1399 1409 1423 1427 1429 1433 1439
 1447 1451 1453 1459 1471 1481 1483 1487
 1489 1493 1499 1511 1523 1531 1543 1549
 1553 1559 1567 1571 1579 1583 1597 1601
 1607 1609 1613 1619 1621 1627 1637 1657
 1663 1667 1669 1693 1697 1699 1709 1721
 1723 1733 1741 1747 1753 1759 1777 1783
 1787 1789 1801 1811 1823 1831 1847 1861
 1867 1871 1873 1877 1879 1889 1901 1907
 1913 1931 1933 1949 1951 1973 1979 1987
 1993 1997 1999 2003 2011 2017 2027 2029
 2039 2053 2063 2069 2081 2083 2087 2089
 2099 2111 2113 2129 2131 2137 2141 2143
 2153 2161 2179 2203 2207 2213 2221 2237
 2239 2243 2251 2267 2269 2273 2281 2287
 2293 2297 2309 2311 2333 2339 2341 2347
 2351 2357 2371 2377 2381 2383 2389 2393
 2399 2411 2417 2423 2437 2441 2447 2459
 2467 2473 2477
```

```
There are 171 prime numbers  between 1201 and 2498
```

9. `Extra credit`: Reduce the number of times the innermost loop is executed to about $\frac{1}{12}$th (or more maybe) of the normal case, where we go through all the 3-number combinations. The innermost loop should be executed no more than 10323125 times to get the 10% extra credit. Further improvement will be 15% additional extra credit.

   Expected Output:

   ```
   Number of Pythagorean Triples with duplicates : 772
   The Innermost for loop is entered 125000000 times.

   Number of Pythagorean Triples (no duplicates) : 386
   The Innermost for loop is entered 20708500 times.

   Number of Pythagorean Triples (no duplicates): 386
   The Innermost for loop is entered 10323125 times.


   Number of Pythagorean Triples (no duplicates) faster one: 386
   The Innermost for loop is entered 124750 times.
   ```

Deliverables:

1. Source Code: (**.cpp** file) that must start with a comment block similar to the following:

```
/**************************************************************************
** Author          : Suleyman Uludag
** Program           : hw1, q1
** Date Created      : September 15, 2013
** Date Last Modified : September 16, 2013
** Usage            : No command line arguments
**
** Problem:
Accept the following information from the user (keyboard):
- Hw1, hw2 and hw3 (out of 100)
- Midterm (out of 100)
- Final exam (out of 100)
Calculate the total grade out of 100 based on the following grading scale:
Hws          -->    30% (10% each)
Midterm      -->    30%
Final Exam   -->    40%
** Pseudocode:
** 1)
** 2)
**************************************************************************/
```

2. Executable (.exe file under windows). You must explicitly state the platform of your executable (such as Linux, etc.) if it is not Windows. Please name your file by using the question number: **hw1-q1.exe** (for Windows)

3. Screenshot of your app. For screenshot, you can use the following free program on windows:

   `http://www.wisdom-soft.com/downloads/setupscreenhunterfree.exe`

   For Linux/Unix, there are many alternatives. I personally like shutter.
   File naming convention example:

   `hw1_q1.png` (or .jpg or another graphics format)

4. You must zip all the above three files into ONE .zip file and submit your assignment by the deadline on moodle system. Name your file as Lastname-Firstname-hw#.zip. For example, **Uludag-Suleyman-hw1.zip**

   For generating .zip file, you may use the following free software on Windows:

   `http://www.7-zip.org/download.html`

   Linux/Unix has many built-in.