MIT AITI
Problem Set 1 - Introduction to Python
Due: Jun 21, 2012 4pm

You must enter your solution by modifying the solution template (lab1.py) which is available on the course website.

1. Fibonacci

Write the definition of a Python procedure fib, such that fib(n) returns that nth Fibonacci number. Recall the definition of fib(n):

fib(n) = 0 if n = 0
fib(n) = 1 if n = 1
fib(n) = fib(n-1) + fib(n-2) if n >= 2

Note that, although the definition is recursive, you do not need to write a recursive program to solve it, though if you want to do it that way, it is fine. Once simple alternative strategy is to construct a list of all Fibonacci numbers up to the nth one and return that last element of the list.

Complete the implementation of the fib function.

2. Zeller's Algorithm

Zeller's algorithm computes the day of the week on which a given date will fall (or fell). In this exercise, you will write a program to run Zeller's algorithm on a specific date. The program should use the algorithm outlined below to compute the day of the week on which the user's birthday fell in the year you were born and print the result to the screen.

Ask the user for the month as a number between 1-12 where March is 1 and February is 12. If born in Jan or Feb, enter previous year (see the notes below). In the end, print out the name of the user and the day of the week they were born.

Zeller's algorithm is defined as follows:

> Let A, B, C, D denote integer variables that have the following values:
> A = the month of the year, with March having the value 1, April the value 2, … December the value 10, and January and February being counted as months 11 and 12 of the preceding year (in which case, subtract 1 from C)
> B = the day of the month (1, 2, 3, … , 30, 31)
> C = the year of the century (e.g. C = 89 for the year 1989)

D = the century (e.g. D = 19 for the year 1989)
Note: if the month is January or February, then the preceding year is used for computation. This is because there was a period in history when March 1st, not January 1st, was the beginning of the year.

Let W, X, Y, Z, R also denote integer variables. Compute their values in the following order using integer arithmetic:
W = (13*A - 1) / 5
X = C / 4
Y = D / 4
Z = W + X + Y + B + C - 2*D
R = the remainder when Z is divided by 7

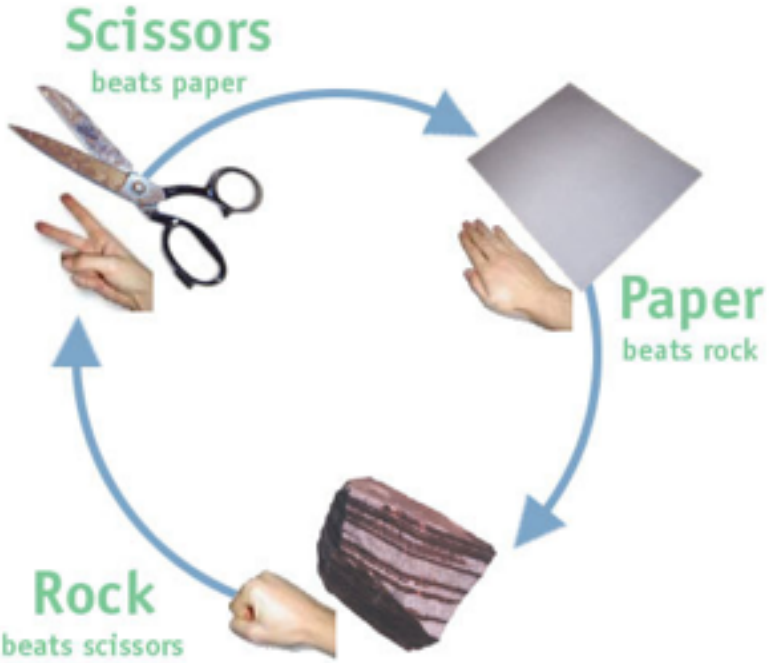
The value of R is the day of the week, where 0 represents Sunday, 1 is Monday, ... , 6 is Saturday. If the computed value of R is a negative number, add 7 to get a non negative number between 0 and 6.

Print out R. You can check to be sure your code is working by looking at http://www.timeanddate.com/calendar/.

Run some test cases- try today's date, your birth date, any other dates you like.

3. Rock Paper Scissors

In this exercise, we are going to practice using the if statement. Here are the rules:



3.1. First create a truth table for all the possible choices for player 1 and 2 and the outcome of the game, e.g.

Player 1	Player 2	Outcome
Rock	Rock	Tie
Rock	Scissors	Player 1

This should help you with the next part.

3.2. Complete the function rock_paper_scissors() that will generate the outcome of the rock, scissors, paper game. The program should work as follows:

```
>>>Player 1? rock
>>>Player 2? scissors
>>>Player 1 wins.
```

The only valid inputs are rock, paper, and scissors. If the user enters anything else, your program should output "This is not a valid object selection". Use the truth table you created to help with creating the conditions for your if statement.

Note If you have a long condition in your if statement and you want to split it into multiple lines, you would want to enclose the entire expression in parenthesis, e.g.

```
if (player1 == 'rock' and
     player2 == 'scissors'):
     print 'Player 1 wins.'
```

4. **Secret Messages**

The goal of this exercise is to write a cyclic cipher to encrypt messages. This type of cipher was used by Julius Ceasar to communicate with his generals. It is very simple to generate but it can actually be easily broken and does not provide the security one would hope for.

The key idea behind the Ceasar cipher is to replace each letter by a letter some fixed number of positions down the alphabet. For example, if we want to create a cipher shifting by 3, you will get the following mapping:

```
Plain:   ABCDEFGHIJKLMNOPQRSTUVWXYZ
Cipher:  DEFGHIJKLMNOPQRSTUVWXYZABC
```

To be able to generate the cipher above, we need to understand a little bit about how text is represented inside the computer. Each character has a numerical value and one of the standard encodings is ASCII (American Standard Code for Information Interchange). It is a mapping between the numerical value and the character graphic. For example, the ascii value of 'A' is 65 and the ascii value of 'a' is 97. To convert between the ascii code and the character value in Python, you can use the following code:

```
letter = 'a'
# converts a letter to ascii code
ascii_code = ord(letter)

# converts ascii code to a letter
letter_res = chr(ascii_code)

print ascii_code, letter_res
```

Start small. Do not try to implement the entire function cipher() at once. Break the program into parts as follows:

3.1. Start your program by asking the user for a phrase to encode and the shift value. Then create a new string that contains the original phrase value using a for loop as follows:

```
encoded_phrase = ''

for c in phrase:
   encoded_phrase = encoded_phrase + c
```

3.2. Now modify the program above to replace all the alphabetic characters with 'x'. For example:

```
Enter sentence to encrypt: Mayday! Mayday!
Enter shift value: 4
The encoded phrase is:  Xxxxxx! Xxxxxx!
```

We are going to apply the cipher only to the alphabetic characters and we will ignore the others.

3.3. Now modify your code, so that it produces the encoded string using the cyclic cipher with the shift value entered by the user. Let's see how one might do a cyclic shift. Let's say we have the sequence: 012345

If we use a shift value of 4 and just shift all the numbers, the result will be: 456789

We want the values of the numbers to remain between 0 and 5. To do this we will use the modulus operator. The expression x%y will return a number in the range 0 to y-1 inclusive, e.g. 4%6 = 4, 6%6 = 0, 7%6 =1. Thus the result of the operation will be:

```
450123
```

Hint: Note that the ascii value of 'A' is 65 and 'a' is 97, not 0. So you will have to think how to use the modulus operator to achieve the desired result. ***Apply the cipher separately to the upper and lower case letters.***

Here is what you program should output:

```
Enter sentence to encrypt: Mayday! Mayday!
Enter shift value: 4
The encoded phrase is:  Qechec! Qechec!
```