Addis Ababa institute of Technology

Center of Information Technology and Scientific Computing

Fundamentals of computer science and programming

Lab 07(Fruitful functions and iteration)

---

1. **Circle area:**
   Define a function that calculates and **returns** the area of a circle given the radius as input
   $$A = \pi r^2$$
2. **Distance Calculator**
   Write a function that calculates and **returns** the distance between two points in the Cartesian coordinate system
   P1 = x1, y1
   P2 = x2,y2
   $$\text{distance} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

3. **Circle(again):**

Define a function that calculates and **returns** the area of a circle given the center of the circle and a point on the circumference of the circle

(Hint: use distance calculator and circle area functions you have already defined)

4. **Palindrome**

A palindrome is a word that reads identically backward and forward, such as 'level' or 'noon'. Write a predicate function IsPalindrome(string) that returns true if the string string is a palindrome. In addition, design and write a test program that calls IsPalindrome to demonstrate that it works.

5. Write python programs that print the following patterns to the screen using as few print statements as possible.

```
*                    * * * * *            * * * * *
* *                   * * * *              * * * *
* * *                  * * *                * * *
* * * *                 * *                  * *
* * * * *                *                    *
```

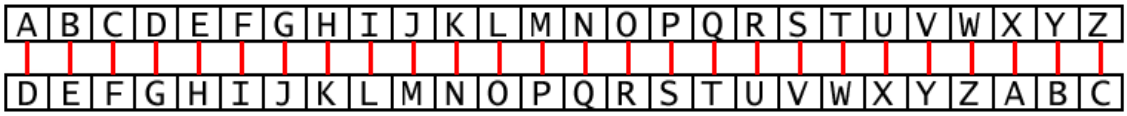
6. **Ramanujan's taxi:** Srinivasa Ramanujan was an Indian mathematician who became famous for his intuition for numbers. When the English mathematician G. H. Hardy came to visit him one day, Hardy remarked that the number of his taxi was 1729, a rather dull number. To which Ramanujan replied, "No, Hardy! No, Hardy! It is a very interesting number. It is the smallest number expressible as the sum of two cubes in two different ways." Verify this claim by writing a program that takes a command-line argument N and prints out all integers less than or equal to N that can be expressed as the sum of two cubes in two different ways. In other words, find distinct positive integers a, b, c, and d such that a3 + b3 = c3 + d3. Use four nested for loops.

Exercise

1. **Crypto: Caesar's cypher:** For thousands of years cryptography has made secret messages that only the sender and recipient could read, even if someone captured the messenger and read the coded message.
   In cryptography, a Caesar cipher, also known as Caesar's cipher, the shift cipher, Caesar's code or Caesar shift, is one of the simplest and most widely known encryption techniques. It is a type of substitution cipher in which each letter in the plaintext is replaced by a letter some fixed number of positions down the alphabet.

   The Caesar Cipher was one of the earliest ciphers ever invented. In this cipher, you encrypt a message by taking each letter in the message (in cryptography, these letters are called symbols because they can be letters, numbers, or any other sign) and replacing it with a "shifted" letter. If you shift the letter A by one space, you get the letter B. If you shift the letter A by two spaces, you get the letter C. Figure 14-1 is a picture of some letters shifted over by three spaces.

   To get each shifted letter, draw out a row of boxes with each letter of the alphabet. Then draw a second row of boxes under it, but start a certain number (this number is the key) of spaces over. After the letters at the end, wrap around back to the start of the boxes. Here is an example with the letters shifted by three spaces:



Alphabet shifted by 3 spaces.

The chr() and ord() Functions

The chr() function (pronounced “char”, short for “character”) takes an integer ordinal and returns a single-character string. The ord() function (short for “ordinal”) takes a single-character string, and returns the integer ordinal value. Try entering the following into the interactive shell:

```
>>> chr(65)
'A'
>>> ord('A')
65
>>> chr(65+8)
'I'
>>> chr(52)
'4'
>>> chr(ord('F'))
'F'
>>> ord(chr(68))
68
```

The isalpha() String Method

The isalpha() string method will return True if the string is an uppercase or lowercase letter from A to Z. If the string contains any non-letter characters, then isalpha() will return False. Try entering the following into the interactive shell:

```
>>> 'Hello'.isalpha()
True
>>> 'Forty two'.isalpha()
False
>>> 'Fortytwo'.isalpha()
True
>>> '42'.isalpha()
False
>>> ''.isalpha()
False
```

Implement the caesar cipher(cypher) encryption with key value 3

BONUS: implement a program that can decrypt a caesar ciphertext and decrypt ‘wkh txlfn eurzq ira mxpsv ryhu wkh odcb grj’

2. **DNA sequencing:** For this problem set, you will develop procedures to solve some problems in genomics.
   Define a program sequence_complement that takes as input a string representing a DNA sequence and print a list of symbols that are the complement of that sequence.

   Most information in biology is encoded in DNA, a nucleic acid with two very useful properties for storing and processing information.The first is that DNA is very stable, so preserves information for a long time.

   The second property is that DNA can be reliably replicated. DNA is composed of two chains of nucleotides that are intertwined in a double helix. The chains are connected by chemical bonds. Each nucleotide is one of four bases:

   - Adenine (A),
   - Cytosine (C),
   - Guanine (G), and
   - Thymine (T)

   Because of their chemical structure, only certain pairs of the bases can form bonds — Adenine bonds with Thymine, and Cytosine bonds with Guanine. We call bases that bond with each other complementary, so the complement of A is T, the complement of T is A, the complement of C is G, and the complement of G is C. These bonds connect the two strands of the double helix, so the two chains are redundant.

   The second chain contains no extra information, it can be completely determined by the first chain because of the chemical bonds. For example, anywhere we know there is an A in the first chain, we know there is a T in the other chain.

   Write a program that could determine the second chain given the sequence of the first as

   ACAAGATGCCATTGTCCCCCGGCCTCCTGCTGCTGCTGCTCTCCGGGGCCACGGCC
   ACCGCTGCCCTGCCCCTGGAGGGTGGCCCCACCGGCCGAGACAGCGAGCATATGC
   AGGAAGCGGCAGGAATAAGGAAAAGCAGCCTCCTGACTTTCCTCGCTTGGTGGTTT
   GAGTGGACCTCCCAGGCCAGTGCCGGGCCCCTCATAGGAGAGGAAGCTCGGGAG
   GTGGCCAGGCGGCAGGAAGGCGCACCCCCCCAGCAATCCGCGCGCCGGGACAGA
   ATGCCCTGCAGGAACTTCTTCTGGAAGACCTTCTCCTCCTGCAAATAAAACCTCACC
   CATGAATGCTCACGCAAGTTTAATTACAGACCTGAA