
QF205 0910T1 EXAM**1. PYTHON PROGRAMMING BASICS (20 MARKS)**

(1) What is the output of each of the following statements on the Python interactive command line?

(a) `>>> 2 ** 10`

(b) `>>> s = 'abcdefghij'`

`>>> s[2:-2:2]`

(c) `>>> 1 / 2`

(d) `>>> (0) == 0`

(e) `>>> def f(w, x, y=1, z=2): print w, x, y, z`

`...`

`>>> f(1, *(5,6))`

(2) It is often necessary to test a condition more than once before concluding whether it is true or false. For instance, in obtaining data from the internet, this may be necessary due to unreliable server connection. Illustrate in code how this may be implemented.

(3) A *list with focus* is a list that has a distinguished member which may be modified by the addition of an integer. For instance, if the list `['a', 'b', 'c', 'd']` has focus on 'b' and is represented by `X`, then

(a) `X+2` will represent the same list but with focus on 'd'

(b) `X+5` will represent the same list but with focus on 'c'

(c) `X-2` will represent the same list but with focus on 'd'

Implement a list with focus using classes.

- (4) Write a script that may modify a text file so that its lines are reversed in order.
- (5) Explain what the Python interpreter does when it encounters the following two statements on the Python interactive command line:

```
>>> import M
>>> import M
```

2. C# PROGRAMMING BASICS (20 MARKS)

- (1) A C# console application project opens with the basic class file containing the following code:

```
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;

namespace ConsoleApplication1
{
    class Program
    {
        static void Main(string[] args)
        {
        }
    }
}
```

Explain briefly the purpose of each of the statements.

- (2) What are some of the major differences between Python and C#?
- (3) Describe 3 C# constructs that can alter the execution flow of a program. Briefly explain how they work.

- (4) What will the following code do?

```
for (;;)
    Console.WriteLine("Hello!");
```

- (5) A simplistic view of biology is this:

- (a) Living things may be classified as animals or plants. Animals can move while plants cannot move.
- (b) Animals may be classified as birds, mammals or reptiles. Birds can fly, while mammals and reptiles cannot. Mammals are furry while reptiles are scaly.

Use classes and subclasses to model this view.

3. TASKS AND ALGORITHMS (60 MARKS)

Instruction:

You may use Python or C# for each of the questions below.

You may make any reasonable assumption(s) before you write your code - make sure these assumptions are stated clearly.

- (1) An equity index comprises a list of component companies. Each company is identified by its name as well as a ticker symbol, has its stock traded at a stock market at a certain current price P_i , and has a certain number n_i of shares issued in total. An equity index may be price-weighted or capitalization-weighted. A price-weighted index is the average of the stock prices of its component companies (i.e. each stock price is weighted by $\frac{1}{n}$, where n is the number of component companies in the index). A capitalization-weighted index is the capitalization-weighted average of the stock prices of its component companies (i.e. each stock price is weighted by $\frac{n_j}{\sum_i n_i}$).

Propose and describe carefully a data structure to model equity indices.

- (2) A yield curve is a function $t \mapsto y(t)$ that maps a positive real number t which represents time (in years) to the interest rate $y(t)$ that corresponds to a fixed deposit for t years. In reality, data is only available for times

$$\frac{1}{12}, \frac{3}{12}, \frac{6}{12}, 1, 2, 3, 5, 7, 10, 20 \text{ and } 30,$$

which correspond to the maturities of the US Treasury bills, notes and bonds.

Write a function to model the yield curve, taking care to compute $y(t)$ for any positive real values of t by a reasonable method.

- (3) Write a program to find the time period(s) of the largest price drop(s) when a list of prices is given. For instance, if the list is $[300, 301, 303, 299, 300, 298, 301, 305]$, then there is one period of the largest price drop: from time 2 with price 303 to time 5 with price 298.

- (4) You are given csv files which have been downloaded from Yahoo finance, a sample of which looks like this:

```
Date,Open,High,Low,Close,Volume,Adj Close
2009-10-16,1094.67,1094.67,1081.53,1087.68,4894740000,1087.68
2009-10-15,1090.36,1096.56,1086.41,1096.56,5369780000,1096.56
2009-10-14,1078.68,1093.17,1078.68,1092.02,5406420000,1092.02
2009-10-13,1074.96,1075.30,1066.71,1073.19,4320480000,1073.19
2009-10-12,1071.63,1079.46,1071.63,1076.19,3710430000,1076.19
2009-10-09,1065.28,1071.51,1063.00,1071.49,3763780000,1071.49
```

Each of these files is named *CompanyName.csv* after the company from which the data is obtained. Write a function to process each such file, returning:

- (a) a number of csv files equal in number to the number of years over which the data from the file spans
 - (b) each of these files is named in the format *CompanyName-YYYY.csv*
 - (c) The file *CompanyName-YYYY.csv* contains the data from the file *CompanyName.csv* which belongs to the year *YYYY*
- (5) You are given a function f which accepts a real-valued argument x . Write a program to implement the *bisection method* which locates a root of f given two initial values $x_1 < x_2$ such that $f(x_1)f(x_2) < 0$ (i.e. $f(x_1)$ and $f(x_2)$ have different signs, so that by continuity there is a root between x_1 and x_2).

The bisection method is described as follows:

- (a) Compute the midpoint y of x_1 and x_2
- (b) If $f(y) = 0$, we have found the root; otherwise set z to be the value of x_1 or x_2 so that $f(z)f(y) < 0$
- (c) Set x_1 (respectively x_2) to be the smaller (respectively, bigger) of y and z .
- (d) If $\text{abs}(x_1-x_2) < \text{tolerance}$, then return the midpoint of x_1 and x_2 and exit; otherwise go back to Step (a)

Here, **tolerance** is a preset value to prevent the algorithm from running indefinitely.