

IS51021B Problem Solving For Computer Science

Duration: 2 ¼ hours

Date and time: May 2015

There are FIVE questions in this paper. You should answer no more than THREE of them. Each question is marked out of 20. The marks for each part of a question are indicated at the end of the part in [.] brackets.

There are several Python programming questions on this test: you will not be marked down for small errors in syntax as you demonstrate that you understand how, in principle, your ideas could be implemented in programming languages

There are 60 marks available on this paper

**THIS PAPER MUST NOT BE REMOVED FROM THE
EXAMINATION ROOM**

Question 1 Data, Numbers, Iteration

a) What is the value of each of the following Python expressions?

- I. `7 // 3`
- II. `7 / 2`
- III. `9 % 4`
- IV. `3 * 2.0`
- V. `5.3 > 5 and 4 > 4.2`

[5 marks]

b) What is the value of each variable, n and m, after the following sequence of commands:

```
n = 2
m = 3
n = n * n
m = n
n = n * n
```

[2 marks]

c) Write a Python function, `printUpTo`, that has an integer input n and has the effect of, if n is greater than 0, printing the numbers from 0 to n in order.

[4 marks]

d) Assume that you have already written a function `isPrime`, which when presented with a positive integer returns `True` if the input is prime and `False` otherwise. Write a function, `primesUpTo`, which when presented with a positive integer prints out the primes less than or equal to it by running through the numbers and checking if they are prime.

[2 marks]

e) Now write the function `isPrime`.

[3 marks]

- f) Sieve of Eratosthenes: We wish to make a more efficient version of `primesUpTo`, which manipulates a list of $n+1$ booleans until, at the end, the item in position k is True if and only if k is a prime. The function then uses that list to determine which numbers to print out. The list manipulation works by passing through the list, turning all the even numbers > 2 , False, then turning all the numbers greater than 3 and divisible by 3 False and so on. Write this function

[4 marks]

Question 2 Guess and Check Algorithms

a) What is the value of each of the following Python expressions?

- I. `8 ** 2`
- II. `3 * 2 + 4`
- III. `3 + 4 * 2`

[3 marks]

b) Write a function, `square`, that returns the square of a number

[2 marks]

c) What does function `mystery(n)` compute with inputs 2, 3 and 4. And what do you think it computes in general?

```
def mystery(n):
    myst = 0
    for i in range(n):
        myst = myst + 2*i + 1
    return(myst)
```

[4 marks]

d) Write a function, `isNear`, that given two numbers returns True if and only if the distance between them is less than .005

[2 marks]

e) If $g = \text{squareroot of } n$, what can you say about n/g ? If $g > \text{squareroot of } n$, what can you say about n/g ?

[2 marks]

Taking note of your answers to e-f, we will write a guess-and-check function that will: when given an input k , compute an approximation to the square root of k . The algorithm should compute the next guess by taking the mean of the last guess and k divided by the last guess.

f) Assume your first guess is $k/2$; what are your second and third guesses, when using this algorithm with $k = 16$

[2 marks]

g) Write the algorithm in Python

[5 marks]

Question 3 Random Numbers and Estimating Pi

In this question you can use the following functions from the random module in Python:

```
random.randrange(a,b)
```

which returns a random whole number between a and b-1 inclusive

```
random.random()
```

which returns a float between 0 and 1

a) What is meant by a *module*?

[1 mark]

b) What do we need to do to allow ourselves to call functions from the random module

[1 mark]

c) What are the possible values of `random.randrange(9,12)`?

d) What does the following function produce:

```
point = 3 + 5*random.random()
```

[2 marks]

e) The variable `dieThrow` will store the value of a single throw of a six-sided die. Write a statement that will give `die` a value.

[2 marks]

f) Write a function `diceThrow()` that will return the sum of throwing two dice.

[3 marks]

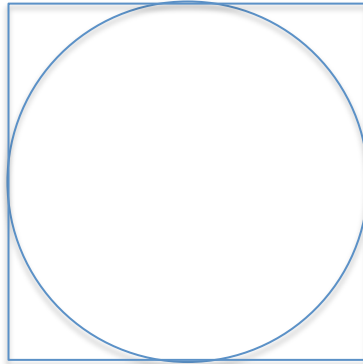
g) What are the possible outcomes of `diceThrow` and which is the most likely to occur?

[2 marks]

h) Write a function `diceThrows(n)` that will simulate `n` throws of two dice and returns a list, `results`, which has 13 members: `results[k]` will be the number of times the answer `k` came up in the `n` throws

[3 marks]

i) Consider the following picture:



This is a circle inscribed in a square. The radius of the circle is 1. Therefore, the size of the square is 2 by 2.

The area of the circle is π (since r is 1)

The area of the square is 4

If you randomly drop points into the square, what fraction of them would you expect to fall in the circle?

Use this idea to write a function that will, given an input n , generate n random points in the square, and return an estimate for π . (You should assume that that shape is centred at $(0,0)$)

[6 marks]

Question 4 Lists , Sorting and Searching

Consider the list

```
aList = [1,2,3,'four']
```

a) What is the value of each of the following Python expressions?

- I. aList[0]
- II. len(aList)
- III. aList[1:3]
- IV. aList[:4]
- V. aList.append('new')

[5 marks]

Consider the following programme:

```
def mystery2(lis):  
    ans =lis[0]  
    for member in lis:  
        if member < ans:  
            ans = member  
    return ans
```

b) Trace the values of the variables, ans and member, when computing

```
mystery2 ([2,0,1])
```

[4 marks]

c) What does `mystery2` compute in general

[2 marks]

d) What will happen if you type in `mystery2 ([])`?

[1 mark]

e) Write a function `swap(lis, i, j)` that swaps, in place, the values of `lis[i]` and `lis[j]`. For example, with `aList` as above after

```
swap(aList, 0,3)
```

the value of `aList` should be: `['four',2,3,1]`

[3 marks]

- f) Write a function, `bubbleUp(inputList)`, that goes through the input list, comparing adjacent elements and swapping them if they are in the wrong order.

[2 marks]

- g) Write a function, `bubbleSort(myList)`, that has calls `bubbleUp` and has the overall effect of sorting `myList` into ascending order.

[3 marks]

Question 5: Objects and Turtle Graphics

a) Consider the python line:

```
tom = turtle.Turtle()
```

What is the role of each of the following:

- I. tom
- II. =
- III. turtle
- IV. .
- V. Turtle
- VI. ()

[6 marks]

b) Draw what will be drawn on the screen by the following code:

```
for i in range(5):  
    tom.forward(20)  
    tom.stamp()
```

[3 marks]

c) Write a function, `tomDrawSquare(n)`, that will get tom to draw a square with sides of length n

[4 marks]

d) Suppose we add the following list of command:

```
Mary = Tom  
Mary.goto(50,100)  
Tom.goto(75,75)
```

Where would each of Mary and Tom be at the end? Briefly explain your answer.

[2 marks]

- e) A sprite is a simple spider shaped thing with n legs, equally spaced and coming out from a centre point. Write a program that gets tom to draw a sprite whose number of legs is provided by user input.

[5 marks]

A seven sided sprite looks like:

