CSC1015F Assignment 3B (70 Marks)

Control (if, for)

Learning objectives

In line with the lesson objectives, by the end of this assignment, you should be able to:

- Understand the need for iteration (otherwise known as looping) and the difference between the two major forms:
  - counter-controlled (for) and condition-controlled (while) loops.
- Be able to identify when and where to use the break, continue, else, and pass statements, which can be used to modify the behaviour of a loop structure.
- Be able to use for loops effectively in your programs.

Assignment Instructions

This assignment involves constructing Python programs that use input and output statements, '`if`' and '`if-else`' control flow statements, '`for`' statements, and statements that perform numerical manipulation.

NOTE Your solutions to this assignment will be evaluated for correctness. The next assignment and subsequent assignments will also be evaluated for the following qualities:

- Documentation
  - Use of comments at the top of your code to identify program purpose, author and date.
  - Use of comments within your code to explain each non-obvious functional unit of code.
- General style/readability
  - The use of meaningful names for variables and functions.
- Algorithmic qualities
  - Efficiency, simplicity

These criteria will be manually assessed by a tutor and commented upon. In future assignments, up to 10 marks will be deducted for deficiencies.

Question 1 [20 marks]

In Biology, the animal kingdom is separated into nine taxonomic ranks. Below is a very rough sketch of classification tree for animals. Write a program called '`biology.py`' to determine the type of an animal based on the following simple classification scheme:

Does the organism have a backbone?

- Yes → Vertebrate
    - Is it warm-blooded?
        - Yes → Endotherm
            - Does it have feathers?
                - Yes → Bird
                - No → Does it have fur?
                    - Yes → Mammal
                    - No → Other vertebrate
        - No → Ectotherm
            - Does it have scales?
                - Yes → Reptile or Fish
                    - Does it live in water?
                        - Yes → Fish
                        - No → Reptile
                - No → Amphibian
- No → Invertebrate
    - Does it have an exoskeleton?
        - Yes → Arthropod
            - Does it have six legs?
                - Yes → Insect
                - No → Arachnid or Crustacean
                    - Does it have eight legs?
                        - Yes → Arachnid
                        - No → Crustacean
        - No → Soft-bodied invertebrate
            - Does it have a segmented body?
                - Yes → Annelid (e.g., Earthworm)
                - No → Mollusc
                    - Does it have a shell?
                        - Yes → Snail or Clam
                        - No → Octopus or Squid

Your program must ask a series of questions to determine the type of animal. Assume that there are no errors in the input.

This type of program is a simple variant of artificial intelligence known as an **expert system** and the classification tree is known as a **decision tree**.

Sample IO *(The input from the user is shown in* ***bold*** *font – do not program this*):

```
Welcome to the Biology Expert
-------------------------------------------------------------
Answer the following questions by selecting from among the options.
Does the organism have a backbone? (yes/no):
yes
Is it warm-blooded? (yes/no):
no
Does it have scales? (yes/no):
```

```
yes
Does it live in water? (yes/no):
no
It is a Reptile.
```

Sample IO *(The input from the user is shown in* ***bold*** *font – do not program this*):

```
Welcome to the Biology Expert
---------------------------------------------------------------------
Answer the following questions by selecting from among the options.
Does the organism have a backbone? (yes/no):
yes
Is it warm-blooded? (yes/no):
yes
Does it have feathers? (yes/no):
no
Does it have fur? (yes/no):
yes
It is a Mammal.
```

Sample IO *(The input from the user is shown in* ***bold*** *font – do not program this*):

```
Welcome to the Biology Expert
---------------------------------------------------------------------
Answer the following questions by selecting from among the options.
Does the organism have a backbone? (yes/no):
NO
Does it have an exoskeleton? (yes/no):
NO
Does it have a segmented body? (yes/no):
yes
It is an Annelid (e.g., Earthworm).
```

Question 2 [20 marks]

Write a program called '`perfect.py`' to determine if a given number is a perfect number or not. *A perfect number* is a positive integer that is equal to the sum of its proper divisors. For example, 6 is a perfect number because its proper divisors are `1, 2, 3` and `1+2+3=6`. However, 12 is not a perfect number because its proper divisors are `1, 2, 3, 4, 6` and their sum is not equal to 12.

Your program should print all the proper divisors of a number followed by a statement that prints whether the number is a perfect number or not.

Sample IO *(The input from the user is shown in* ***bold*** *font – do not program this*):

```
Enter a number:
28
The proper divisors of 28 are:
1 2 4 7 14

28 is a perfect number.
```

Sample IO *(The input from the user is shown in* ***bold*** *font – do not program this*):

```
Enter a number:
63
The proper divisors of 63 are:
1 3 7 9 21

63 is not a perfect number.
```

Question 3 [30 marks]

Write a program called `amicable.py` to determine if two given numbers, *A* and *B*, are amicable or not. Follow the example given below to determine the best algorithm for this problem.

Amicable numbers are two different positive integers, say *A* and *B*, such that the sum of the proper divisors (**excluding** the number itself) of *A* is equal to *B*, and the sum of the proper divisors of *B* is equal to *A*.
In other words, if:

$$\sigma(\mathrm{A}) - A = B$$
$$\sigma(B) - B = A$$

where $\sigma(n)$ is the sum of all divisors of *n*, then *A* and *B* are **amicable numbers**.

Example: (220, 284)

- Proper divisors of **220**:
  $1,\ 2,\ 4,\ 5,\ 10,\ 11,\ 20,\ 22,\ 44,\ 55,\ 110$
  Sum:
  $$1 + 2 + 4 + 5 + 10 + 11 + 20 + 22 + 44 + 55 + 110 = 284$$

The sum of the proper divisors of 220 is 284.

- Proper divisors of **284**:
  $1,\ 2,\ 4,\ 71,\ 142$
  Sum:
  $$1 + 2 + 4 + 71 + 142 = 220$$

The sum of the proper divisors of **284** is 220.
Since 220 and 284 satisfy the condition, they are **amicable numbers**.

Sample IO *(The input from the user is shown in* ***bold*** *font – do not program this*):

```
Enter first number:
220
Enter second number:
284
220 and 284 are amicable numbers.
```

Sample IO *(The input from the user is shown in* ***bold*** *font – do not program this*):

```
Enter first number:
660
Enter second number:
840
660 and 840 are not amicable numbers.
```

Submission

Create and submit a Zip file called '`ABCXYZ123.zip`' (where ABCXYZ123 is YOUR student number) containing `biology.py`, `perfect.py` and `amicable.py`.

NOTES:

1. FOLDERS ARE NOT ALLOWED IN THE ZIP FILE.
2. As you will submit your assignment to the Automarker, the Assignment tab will still say "Not Complete". THIS IS COMPLETELY NORMAL. IGNORE IT.