

## *Solutions 1*

### *Jumping Rivers*

#### *Practical 1 Solutions*

The aim of this practical is to understand the syntax of functions and loops. In practical 2, we will use this knowledge in a larger example.

#### *Basic functions*

Consider the following simple function

```
v = 5
def Fun1():
    v = 0
    return v
```

```
Fun1()
```

```
## 0
```

1. Why does the final line return 0 and not 5.

```
print('Fun1 uses the local variable v')
```

```
## Fun1 uses the local variable v
```

1. Delete line 3 in the above piece of code. Now change `Fun1()` to allow `v` to be passed as an argument, i.e. we can write `Fun1(5)`. Call this function to make sure it works.

```
def Fun1(v):
    return v
```

```
Fun1(10)
```

```
## 10
```

#### *Default arguments:*

Consider the two functions defined below:

```
def Fun2(x = 10):
    return x
```

```
def Fun3(x):
    return x
```

1. Why does

```
Fun2()
```

```
## 10
```

work, but this raises an error

```
Fun3()
```

```
print("Fun3 expects an argument x, but \
we haven't given one and there is \
no default.")
```

```
## Fun3 expects an argument x, but we haven't given one and there is no default.
```

2. Change Fun2 so that it returns  $x*x$ .

```
def Fun2(x = 10):
    return x*x
```

*if statements.*

Start with the following function definition:

```
def Fun4(x):
    if x == 5:
        y = 0
    else:
        y = 1
    return y
```

1. Change Fun4 so that it:

- returns 1 if  $x$  is positive;
- returns -1 if  $x$  is negative;
- returns 0 if  $x$  is zero.

```
def Fun4(x):
    if x > 0:
        rtn_value = 1
    elif x < 0:
        rtn_value = -1
    else:
        rtn_value = 0
    return rtn_value
```

*for loops.*

```
total = 0
for i in range(1,6):
    total = total + i
total
```

The `for` loop above calculates

$$\sum_{i=1}^5 i = 1 + 2 + 3 + 4 + 5$$

1. What is the final value of `total` in the above piece of code?

```
print(total)
```

```
## 15
```

2. Change the above loop to calculate the following summations:

$$(i) \sum_{i=1}^{20} (i + 1)$$

```
total = 0
for i in range(1,21):
    total = total + (i + 1)
total
## 230
```

$$(ii) \sum_{j=-5}^{15} j$$

```
total = 0
for j in range(-5,16):
    total = total + j
total
## 105
```

3. Harder: Rewrite the two `for` loops as one `for` loop using the `zip()` function. You will need two separate counters i.e. `total1` and `total2`.

```
totali = 0
totalj = 0
for i, j in zip(range(1,21), range(-5,16)):
    totali = totali + i
    totalj = totalj + j
print(totali + 20)
```

```
## 230
```

```
print(totalj)
```

```
# this will not give the correct answer as the ranges are not the same length
# we could
```

```
## 90
```

```
totali = 0
```

```
totalj = 0
```

```
for i, j in zip(range(0,21), range(-5,16)):
```

```
    totali = totali + i
```

```
    totalj = totalj + j
```

```
print(totali + 20)
```

```
## 230
```

```
print(totalj)
```

```
## 105
```

4. Rewrite the two loops using the `sum()` function from the **numpy** library and the `range()` function. For example, the for loop in the first example can be written as `np.sum(range(1,6))`

```
import numpy as np
```

```
np.sum(range(2,22))
```

```
## 230
```

```
np.sum(range(-5,16))
```

```
## 105
```

*More for loops:*

```
a = 2
```

```
total = 0
```

```
for blob in range(a, 5):
```

```
    total = total + blob
```

```
total
```

```
## 9
```

1. In the code above, delete line 1. Now put the above code in a function called `Fun5`, where `a` is passed as an argument, i.e. we can call `Fun5(1)`

```
def Fun5(a):
    total = 0
    for blob in range(a, 6):
        total = total + blob
    return total
Fun5(1)
```

```
## 15
```

2. Alter the code so that the `for` loop goes from `a` to `b`, rather than `a` to 5. Allow `b` to be passed as an argument, i.e. we can call `Fun5(1,6)`.

```
def Fun5(a, b):
    total = 0
    for blob in range(a, b):
        total = total + blob
    return total
```

3. Change `Fun5` so that it has default arguments of `a = 1` and `b = 10`.

```
def Fun5(a = 1, b = 10):
    total = 0
    for blob in range(a, b):
        total = total + blob
    return total
```

4. The `range()` function also has a step argument, so to create the sequence 1, 3, 5 we would write `range(1, 6, 2)`. Alter the code such that `Fun5()` can now go up in steps of `c`. Allow `c` to be passed as an argument.

```
def Fun5(a = 1, b = 10, c = 1):
    total = 0
    for blob in range(a, b, c):
        total = total + blob
    return total
```

In the notes, we observed that it was straight forward to loop through a data set and select the maximum values. For instance, the maximum value of each column:

```
import pandas as pd
d = {
    "t1": [1,4,7,3,20],
    "t2": [10,21,11,8,5],
```

```
"t3": [8,9,4,8,4]
}
df = pd.DataFrame(d)
```

```
max_cols = []
for i in [0,1,2]:
    max_cols.append(df.iloc[:, i].max())
print(max_cols)

## [20, 21, 9]
```

- Alter the above the code to calculate the **mean** instead of the maximum value
- Now, calculate the variance (via **var**) as well as the mean.

You should only have a single loop!

```
mean_cols = []
var_cols = []
for i in [0,1,2]:
    mean_cols.append(df.iloc[:, i].mean())
    var_cols.append(df.iloc[:, i].var())
```