Computing for Mathematics: Handout 5

This handout contains a summary of the topics covered and an activity to carry out prior or during your lab session.

At the end of the handout is a specific coursework like exercise.

For further practice you can do the exercises available at the probability chapter of Python for Mathematics.

1   Summary

The purpose of this handout is to cover probability which corresponds to the probability chapter of Python for Mathematics.

The topics covered are:

- Generating random numbers
- Randomly sample from a given collection of items.
- Write python functions to be able to repeat experiments.

2   Activity

We will be tackling the problem from the tutorial of the probability chapter of Python for Mathematics.

An experiment consists of selecting a token from a bag and spinning a coin. The bag contains 5 red tokens and 7 blue tokens. A token is selected at random from the bag, its colour is noted and then the token is returned to the bag.

When a red token is selected, a biased coin with probability $\frac{2}{3}$ of landing heads is spun.

When a blue token is selected a fair coin is spun.

1. What is the probability of picking a red token?
2. What is the probability of obtaining Heads?
3. If a heads is obtained, what is the probability of having selected a red token.

There are instructions for how to do all of this is in the probability chapter of Python for Mathematics.

1. Create a variable `bag` which has value the list with 5 copies of the string `"Red"` and 7 copies of the string `"Blue"`.
2. Write a python function `pick_a_token` which can be used to randomly choose an element from any given container.
3. Create a variable `samples` which has value a list with 10,000 random choices from `bag`.
4. Count how many of the elements of `samples` are `"Red"` and use this to approximate the probability of picking a red token.

5. Write a python function `sample_experiment` which carries out a single instance of the experiment described in the question. This function should return both the color of the token and the face of the coin.

6. Create a variable `samples` which has value a list with 10,000 outcomes of the experiment.

7. Use `samples` to approximate the probability of picking Heads.

8. Use `samples` to approximate the probability of picking a red token given that Heads is selected.

3 Summary examples

Create the collection (A, A, B) as a list.

```
collection = ["A", "A", "B"]
```

Modify the 2nd element in the collection (A, A, B).

```
collection = ["A", "A", "B"]
collection[1] = "C"
```

Include a new element in a collection:

```
collection = ["A", "A", "B"]
collection.append("C")
```

Define and call $f(x) = x^2 + 1$:

```
def square(x):
    """
    Returns x ^ 2 + 1
    """
    return x ** 2 + 1

square(5)
```

Running conditional code:

```
def absolute_value(x):
    """
    A function that returns -x if x is
    negative and returns x otherwise
    """
    if x < 0:
        return - x
    return x
```

Create a list with the numbers $(0^2, 1^2, 2^2, 3^2, 4^2)$:

```
[x ** 2 for x in range(5)]
```

Sample from the numbers $(0, 1, 2)$

```
import random

random.seed(0)
random.choice(range(3))
```

Sample a random number between 0 and 1:

```
import random
random.seed(0)
random.random()
```