

# Computing for Mathematics: Handout 4

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 combinatorics chapter of Python for Mathematics.

## 1 Summary

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

The topics covered are:

- Generating and counting permutations and combinations of elements.
- Directly computing binomial coefficients.

## 2 Activity

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

The digits 1, 2, 3, 4 and 5 are arranged in random order, to form a five-digit number.

1. How many different five-digit numbers can be formed?
2. How many different five-digit numbers are:
  - (a) Odd
  - (b) Less than 23000

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

1. Create a variable `digits` which has value the collection of integers 1, 2, 3, 4 and 5.
2. Use the `itertools.permutations` tool to create the variable `permutations` which has value the permutations of the integers 1, 2, 3, 4 and 5.
3. Convert the `permutations` variable to a `tuple` and use the `len` command to count the number of different permutations that exist.
4. Use the `sum` command to calculate:

$$\sum_{\pi \in \Pi} \pi_5 \mod 2$$

where  $\Pi$  is the collection of all permutations.

5. Use the `sum` command to calculate:

$$\sum_{\pi \in \Pi \text{ if } \pi_1 10^4 + \pi_2 10^3 + \pi_3 10^2 + \pi_4 10 + \pi_5 \leq 23000} 1$$

where  $\Pi$  is the collection of all permutations.

### 3 Summary examples

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Create the collection:  $(A, A, B)$ .

```
collection = ("A", "A", "B")
```

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

```
collection = ("A", "A", "B")
collection[1]
```

Check a boolean condition like if  $"C" \in (A, A, B)$ .

```
collection = ("A", "A", "B")
"C" in collection
```

Create the collection of integers from 1 to 11:

```
range(1, 12)
```

Create the permutations of the collection  $(A, A, B)$  of size 2.

```
import itertools
collection = ("A", "A", "B")
itertools.permutations(collection, r=2)
```

Create the combinations of the collection  $(A, A, B)$  of size 2.

```
import itertools
collection = ("A", "A", "B")
itertools.combinations(collection, r=2)
```

Calculate  $\sum_{i=1}^{20} \text{if } i \text{ even } i^2$

```
sum(i ** 2 for i in range(1, 21) if (i % 2 == 0))
```

Obtain  $5!$ :

```
import math
math.factorial(5)
```

Obtain  $\binom{5}{2}$ :

```
import scipy.special
scipy.special.comb(5, 2)
```

Obtain  ${}^5P_2$ :

```
import scipy.special
scipy.special.perm(5, 2)
```