1) Lists

- To insert a single element in a list (called r) use : r.insert(index,value)
- Starting with the list [1,2,4,5,6] insert the value 3 between 2 and 4.

2) Arrays

Create matrices or arrays with the following functions:

- zeros in numpy
- empty in numpy
- array in numpy
- reading from a file (data.txt provided in the syllabus) using loadtxt in numpy

3) Matrix arithmetics

Write a program that does the following calculations.

a) Before writing the code, compute the solution with pen and paper:

$$\begin{pmatrix} 2 & 4 \\ 5 & 6 \end{pmatrix} \begin{pmatrix} 3 & 2 \\ -1 & 1 \end{pmatrix} + 3 \begin{pmatrix} 6 & -6 \\ -3 & 3 \end{pmatrix} =$$

Solution:

b) Now write a program that does the matrix multiplication and sum and verify that the result is the same as the one you obtained with pen and paper. To do this, know that the operation to multiply two matrices is called dot in numpy and that matrices are summed using the usual + sign and a scalar can be multiplied with *.

4) For loop

a) Like the while loop we saw last class, the for loop iterates a set number of times.

```
>>> r=[1,2,3]
>>> for n in r:
...     print n
...
```

Try the above and get used to the interactive mode (without writing it yet to a file).

b) A typical way to run a for loop is to generate a list of numbers with the function range instead of writing a list like we did in 4a.

```
>>> r=range(6)
>>> for n in r:
...     print n
...     print ("Hello")
```

c) Note what happens when you invoke the following calls to range:

- range (10)
- range (3, 9)
- range (2, 9)
- range (5, 38, 2)
- range (5, 38, -2)
- range (38, 5, -2)

5) Performing a Sum:
Let's say that you want to evaluate the following sum:

$$s = \sum_{k=1}^{100} k^{-1}$$

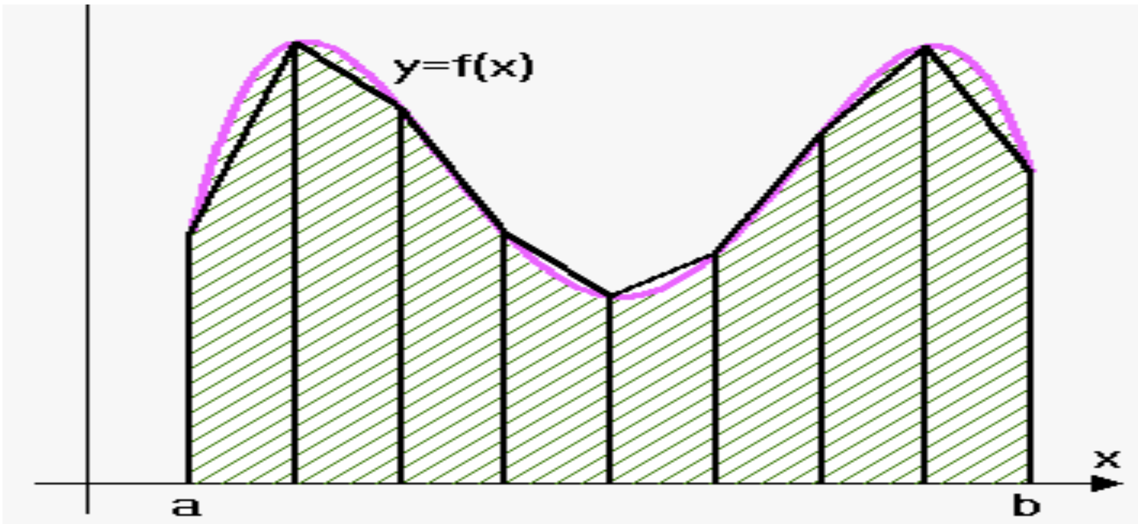
The python code will look like this:

```
s=0.
for k in range(1,101):
  s += 1/k
print(s)
```

Integration:

Now that you know how to sum, we can start integrating. Here we will explore several different methods.

Trapezoidal Rule



The procedure we must follow when using the trapezoidal rule is to divide each interval into trapezoids instead of rectangle

$$\int_a^b f(x)dx = \frac{b-a}{N}\left(\frac{1}{2}f(a) + \frac{1}{2}f(b) + \sum_{k=1}^{N-1} f(a + k\frac{b-a}{N})\right)$$

where N is the number of trapezoids and is the only free parameter in this method.

Use this method to integrate between 0 to 2, the function:

$$f(x) = x^4 - 2x + 1$$

Solve the integral with pen and paper before solving this problem numerically. How big must N be so that the analytical and numerical answers agree within 3 significant figures?