Assignment 0 Workshop

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Today's plan:

1. Go through the questions asked for this workshop
2. Go through any questions asked during the workshop

Question 1:

”I am a bit unsure about the concept of nested functions. Particularly, the part of the assignment that says:

> *'The nested function should return func(e, k) where e=eulers_e(x, k)'."*

Problem 0.3.5

Just like numbers, strings and data types, python treats functions as an object. This means you can write functions, that take a function as input and functions that return functions after being executed. This is sometimes a useful tool to have when you need to add extra functionality to an already existing function, or if you need to write *function factories*.

> **Ex. 0.3.5:** Write a function called `exponentiate` that takes one input named `func`. In the body of `exponentiate` define a nested function (i.e. a function within a function) called `with_exp` that takes two inputs `x` and `k`. The nested function should return `func(e, k)` where `e=eulers_e(x, k)`. The outer function should return the nested function `with_exp`, i.e. write something like

```
def exponentiate(func):
    def with_exp(x, k):
        e = eulers_e(x, k)
        value = #[FILL IN]
        return value
    return with_exp
```

> Call the `exponentiate` function on `natural_logarithm` and store the result in a new variable called `logexp`. Then call `logexp(1, 1000)` and store this value in the variable `answer_035`.

In [ ]:
```
# YOUR CODE HERE
raise NotImplementedError()
```

In [ ]:
```
assert round(answer_035) == 1
assert round(logexp(2, 1000)) == 2
assert round(logexp(3, 1000)) == 3
assert round(logexp(4, 1000)) == 4
```

Nested functions

A nested function is a function defined inside another function.

Let's try to make a function that uplifts a number, `x`, to an given exponent, `exponent`.

The function is defined below.

In [69]:

```
def uplift_to(exponent):
    """
    returns the value uplifted to a power
    """
    def uplifted(x):
        return x ** exponent
    return uplifted
```

Let's try to apply the function on the number, x=2 .

In [70]:
```
#Defined functions using the concept of a nested function.
quadratic = uplift_to(2)
cubic = uplift_to(3)
quartic = uplift_to(4)
quintic = uplift_to(5)

#list of the functions defined above
list_of_functions = [quadratic, cubic, quartic, quintic]
function_names = ["Quadratic", "Cubic", "Quartic", "Quintic"]

#Loop through the two lists above, print out the name of the function
# and the value of the funciton evaluated at x = 2
for name, function in zip(function_names, list_of_functions):
    print(f"Function: {name}. Value of function evaluated at x = 2: {function(2)}")
```

```
Function: Quadratic. Value of function evaluated at x = 2: 4
Function: Cubic. Value of function evaluated at x = 2: 8
Function: Quartic. Value of function evaluated at x = 2: 16
Function: Quintic. Value of function evaluated at x = 2: 32
```

Returning to Problem 0.3.5.

The problem basically asks you to define a function, which spits out a function evaluated at `e = eulers_e(x, k)`.

In the case of the natural logarithm, the functions spits out $\log(\exp(x))$ for the approximation that uses the value k.

Using the fact that $\log(\exp(x)) = x$, we expect that the approximations are close to x, thus the assert statements.

Problem 0.3.5

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> **Ex. 0.3.5:** Write a function called `exponentiate` that takes one input named `func`. In the body of `exponentiate` define a nested function (i.e. a function within a function) called `with_exp` that takes two inputs `x` and `k`. The nested function should return `func(e, k)` where `e=eulers_e(x, k)`. The outer function should return the nested function `with_exp`, i.e. write something like

```
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        value = #[FILL IN]
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```

> Call the `exponentiate` function on `natural_logarithm` and store the result in a new variable called `logexp`. Then call `logexp(1, 1000)` and store this value in the variable `answer_035`.

In [ ]:
```
# YOUR CODE HERE
raise NotImplementedError()
```

In [ ]:
```
assert round(answer_035) == 1
assert round(logexp(2, 1000)) == 2
assert round(logexp(3, 1000)) == 3
assert round(logexp(4, 1000)) == 4
```

In [72]:
```
def exponentiate(func):
    def with_exp(x, k):
        e = eulers_e(x, k)
        value = func(e, k)
        return value
    return with_exp
```

Using the function above, apply it to the `natural_logarithm()` and see if the correct answer comes out.

Note that the `natural_logarithm()` and `eulers_e()` need to be correct for the nested function to work correctly :)

Question 2:

Getting an overflow error when applying my natural_logarithm() function at the x=e, where e is eulers number.

What is happening in the code below?

In [66]:
```
def nat_log(x, k_max):
    total = 0
    for k in range (0, k_max+1):
        exp = 2*k+1
        total = total + 1/(exp)*((x-1)/(x+1))**(exp)
        total = total*2
    return total
nat_log(2.71, 10000)
```

Out[66]:
```
inf
```

The function does not compute the equation below

$$log(x) = 2 \cdot \sum_{k=0}^{\infty} \frac{1}{2k+1} \left(\frac{x-1}{x+1} \right)^{2k+1}$$

Let us try to modify the code on the previous slide.

In [71]:
```
def nat_log(x, k_max):
    total = 0
    for k in range (0, k_max+1):
        exp = 2*k+1
        val = 2*(1/(exp)*((x-1)/(x+1))**(exp))
        total +=val
    return total
nat_log(2.71, 1000)
```

Out[71]:
```
0.9969486348916091
```

The function now computes the approximation in the equation below.

$$log(x) = 2 \cdot \sum_{k=0}^{\infty} \frac{1}{2k+1} \left(\frac{x-1}{x+1} \right)^{2k+1}$$

Question 3:

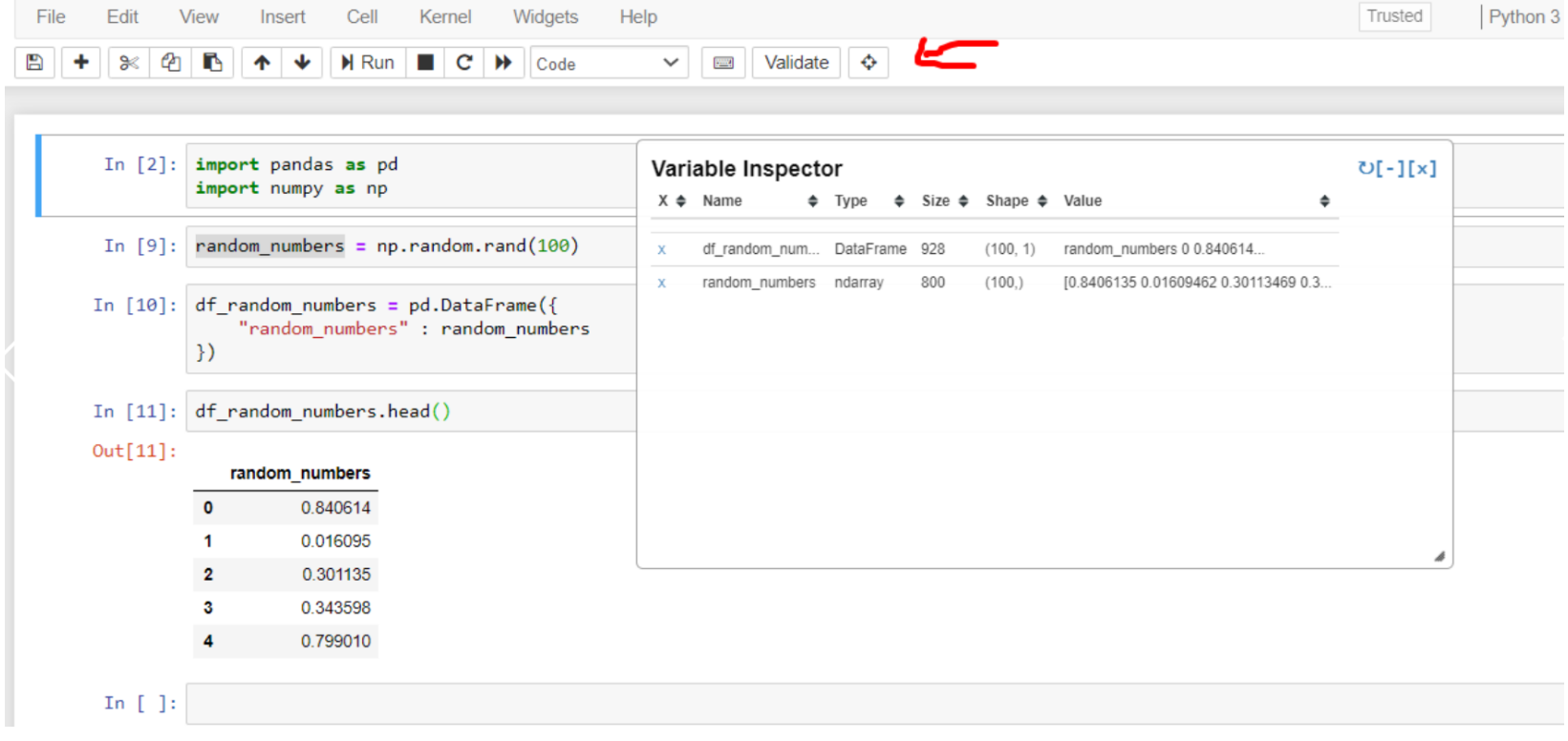
Is it possible to get an extension for jupyter notebook such that you can get an overview of the different variables that you have defined, akin to a "view" in the R environment?

Yes, it is certaintly possible.

The extension that you are looking for is: https://jupyter-contrib-nbextensions.readthedocs.io/en/latest/nbextensions/varInspector/README.html (https://jupyter-contrib-nbextensions.readthedocs.io/en/latest/nbextensions/varInspector/README.html)

A guide to install the nbextension functionality to your jupyter notebook can be found here: https://towardsdatascience.com/jupyter-notebook-extensions-517fa69d2231 (https://towardsdatascience.com/jupyter-notebook-extensions-517fa69d2231),

After you have followed the guide on the previous slide you should be able to do this:



That was pretty much it.

Any other questions?

Note that the format for the course this year is a bit different than last year.

Last year assignment 0 was a bit shorter. Furthermore, it was not interactive, like the one this year.

Thus, it does not come as a surprise that there are not that many questions :)