

EE4017 Internet Finance

Laboratory 2 - Computing Time Value of Money with Python

1. Overview

In this laboratory, students will be walked through various financial concepts and learn to solve different computational problems with Python and its modules.

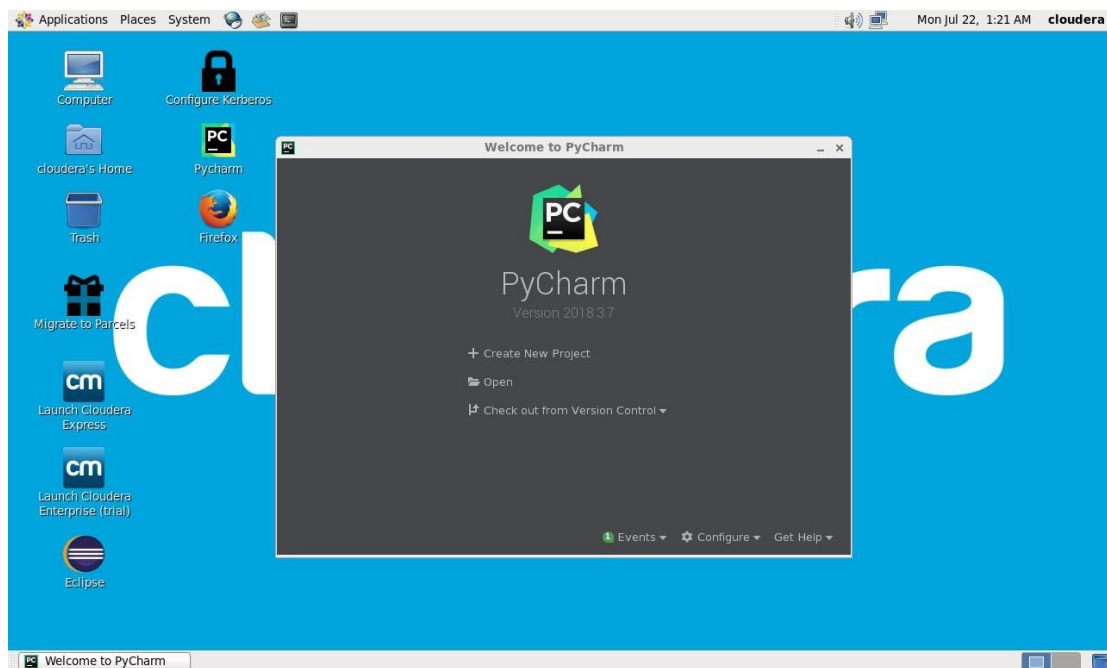
2. Environment and Tools

This laboratory will make use of Pycharm as the development tool for Python 3.6.8 with modules SciPy, NumPy, SymPy and Matplotlib.

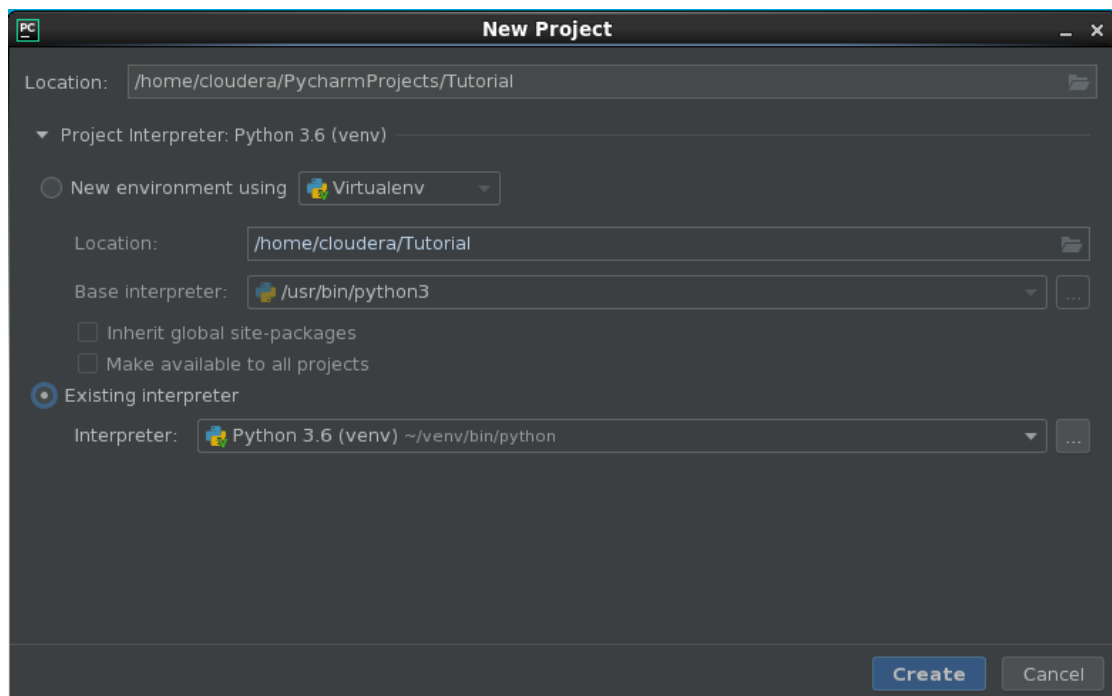
3. Creating a Project using Pycharm

To begin a new project:

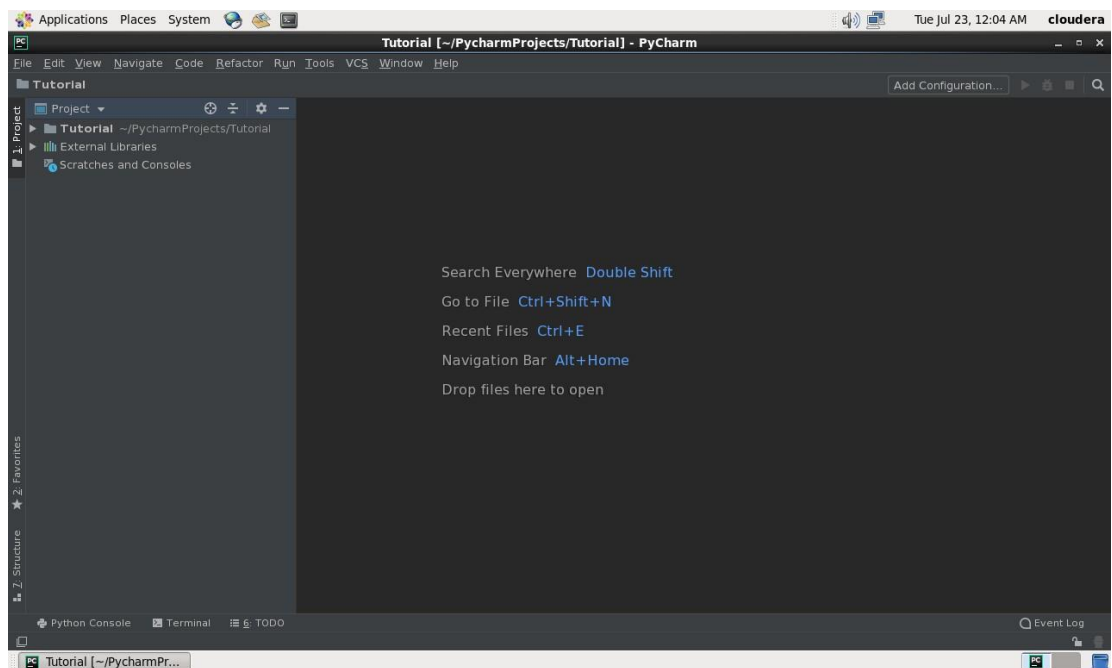
1. Open PyCharm and click “Create New Project”



2. Change the name of the working folder to “Tutorial” and choose the project Interpreter. Python 3.6 environment has already been installed. Choose “Existing interpreter”.



3. You should now see the development interface



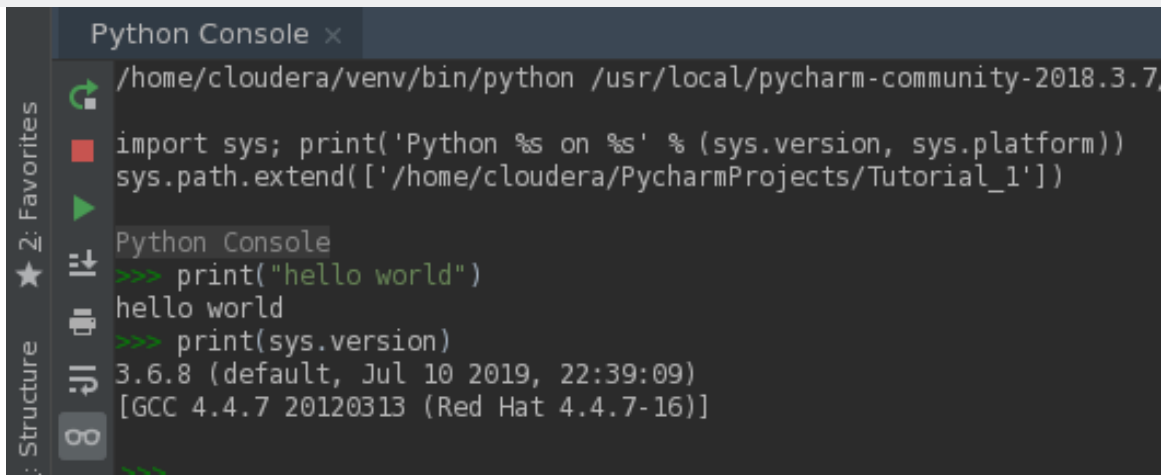
Using python console and Terminal

PyCharm integrates the python console and terminal into the development interface.

You can test a few lines of code before writing it into your project.

For example, you can type the following codes to see if everything works.

```
print("Hello World")
print(sys.version)
```

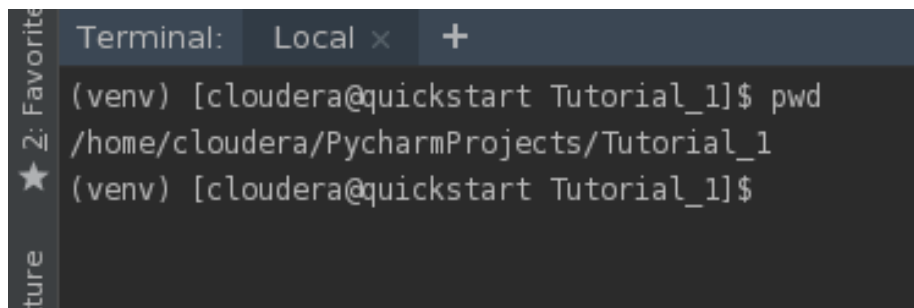


```
Python Console x
/home/cloudera/venv/bin/python /usr/local/pycharm-community-2018.3.7
import sys; print('Python %s on %s' % (sys.version, sys.platform))
sys.path.extend(['/home/cloudera/PycharmProjects/Tutorial_1'])

Python Console
>>> print("hello world")
hello world
>>> print(sys.version)
3.6.8 (default, Jul 10 2019, 22:39:09)
[GCC 4.4.7 20120313 (Red Hat 4.4.7-16)]
```

The terminal is the same as your OS. You may test it by printing the current working directory.

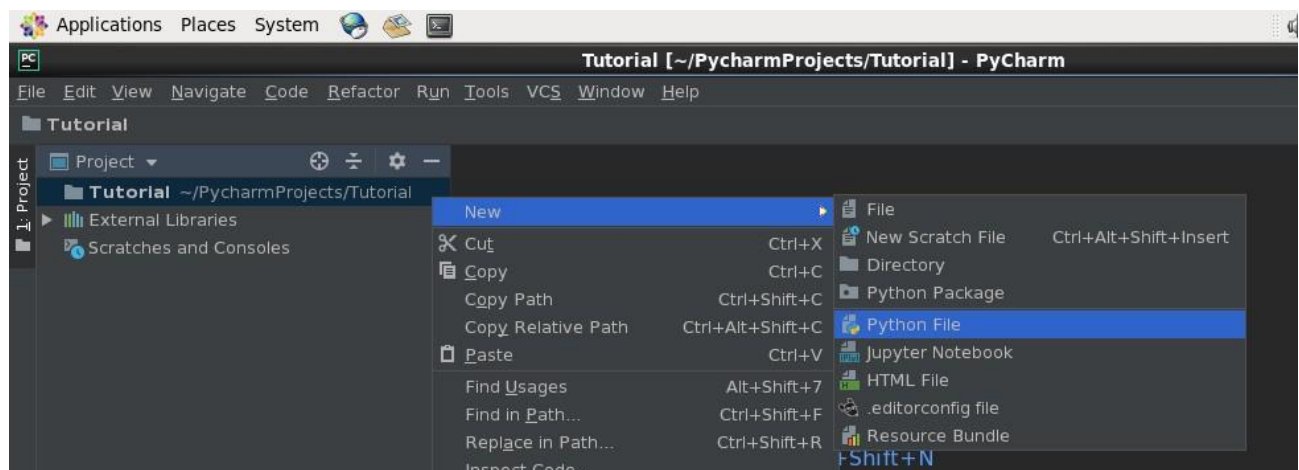
```
pwd
```



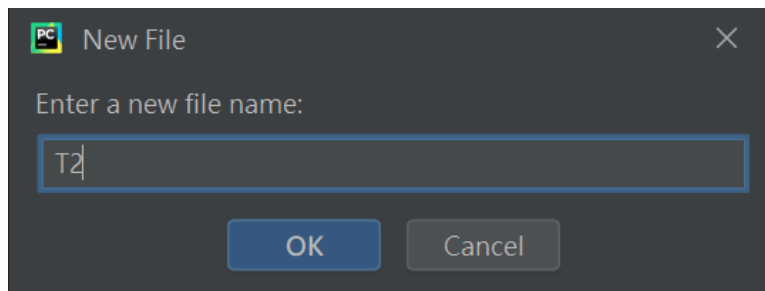
```
Terminal: Local x +
(venv) [cloudera@quickstart Tutorial_1]$ pwd
/home/cloudera/PycharmProjects/Tutorial_1
(venv) [cloudera@quickstart Tutorial_1]$
```

Create a new Python File

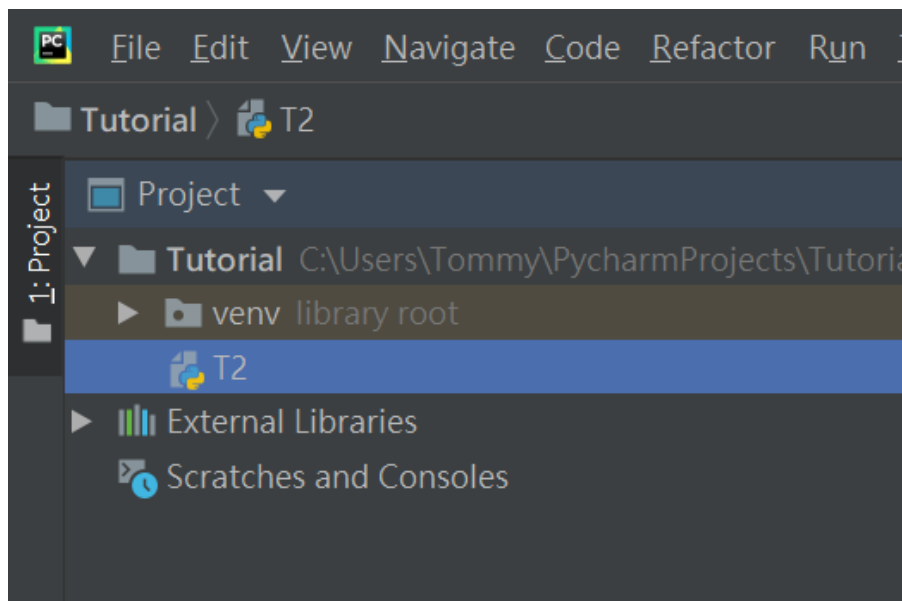
To create a new Python file, right click the working folder (Tutorial) on the left side. A menu will show up. Navigate to New->Python File.



Pycharm will ask for the name of this new Python file. For convenience, name it “T2” and press “OK”.



T2.py should be created under the working folder “Tutorial” like the screenshot below.



This is the second part of the lab that was done last week.
You have done steps 1 to 5, so go on with step 6.

6. Visualizing the Data

To visualize our data in Python, we can make use of the module NumPy and Matplotlib. For instance, if we want to plot a graph for the equation $y=4x+3$, we may first generate a list of x coordinates with *numpy.linspace*:

```
from matplotlib.pyplot import *  
import numpy as np  
x = np.linspace(-10,10,1000)
```

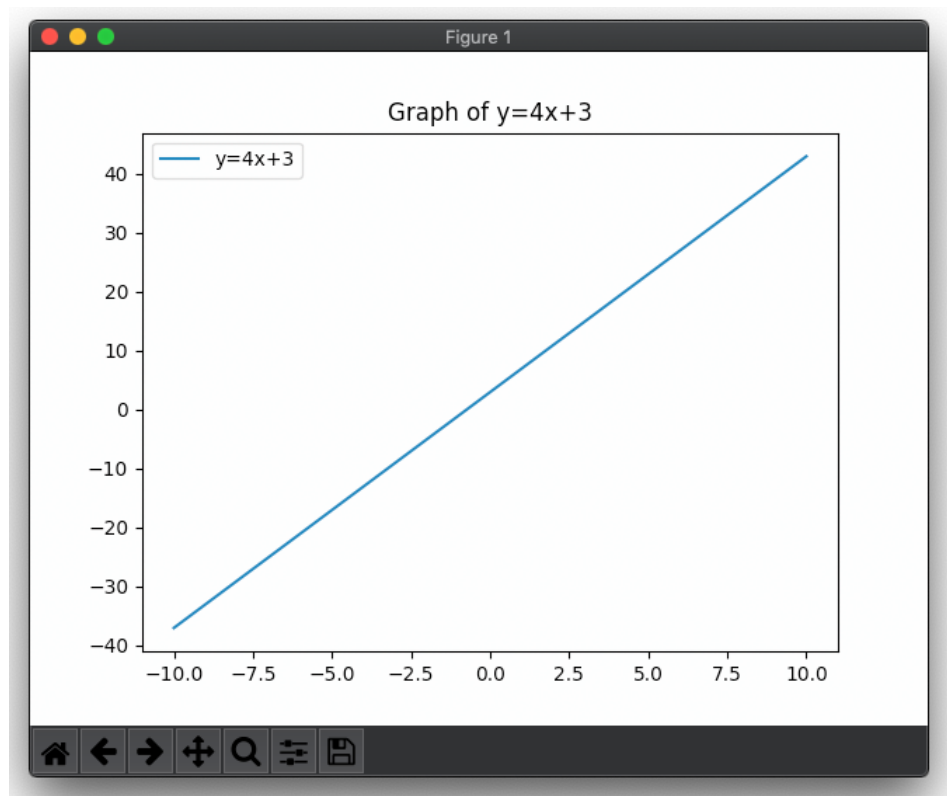
The above generates 1000 evenly spaced points over the interval $[-10,10]$

After that, compute the list of y coordinates from x and the equation accordingly:

```
y = 4*x+3
```

Finally, plot the line with legend using the function *plot()* and show the plotted graph:

```
plot(x, y, label='y=4x+3')  
title('Graph of y=4x+3')  
legend()  
show()
```



Task 3

Consider a scenario with an annual cash flow of \$100 and a discount rate of 7%. Using the functions you implemented in *financial.py*, plot a graph showing the present value of perpetuity as well as the present value of annuity and annuity due for a variable of n years, where n is $[0, 100]$.

You may observe from the graph that the present value of annuity approaches the present value of perpetuity, their difference becomes significantly smaller (~10%) with a 40 years payment and beyond. The present value of annuity due with 41 years and beyond overtakes the present value of perpetuity.

7. Net Present Value

The Net Present Value (NPV) is defined by the following formula:

$$NPV = PV(\text{all benefits}) - PV(\text{all costs})$$

Consider a project, **project A**, with an initial investment of \$100. The cash inflows in the next five years are \$50, \$60, \$70, \$100, and \$20, starting from year one. If the discount rate is 11.2%, the project's NPV value is as follows:

$$\begin{aligned} NPV &= -100 + 50/1.112 + 60/1.112^2 + 70/1.112^3 + 100/1.112^4 + 20/1.112^5 \\ &= 121.55722687966407 \end{aligned}$$

Q7

We can use the function `scipy.npv()` to calculate NPV values. Consult the help manual and show how you can obtain the NPV value of **project A** using `scipy.npv()`.

Task 4

Plot the relationship between NPV and discount rate of **project A** using Python. Note `scipy.npv()` does not accept `List[ ]` as the discount rate argument, you may need to use other method (instead of `linspace()`) to generate a list of NPV values for the plot)

Q8

Is the NPV value negatively correlated or positively correlated with the discount rate?

Explain why.

Q9

The NPV rule is to accept a project when $NPV > 0$, reject when $NPV < 0$. What is range of discount rate for accepting **project A** according to the NPV rule? Answer in percentage and roundup to the nearest integer.