

Artificial Neural Networks Lab



Introduction

Dr. Konstantinos Karampidis

Grades

Through exercises and a final project.

- 20% Exercises
- 80% Final Project

- ✓ Attendance is mandatory. Only one absence is allowed.
- ✓ No extension is given on delivery dates of the exercises!!!
- ✓ Implementation with **Jupyter Notebooks**.
- ✓ The exercises will be delivered strictly through **eclass!!!** The exercises sent to my email will be rejected.
- ✓ The exercises and the final project are mandatory!!! If you don't submit both exercises (each graded at least with 1) and the final project, the lab is considered failed.
- ✓ Those who copy -or extensively use AI- an exercise or the final project, they fail the lab immediately.
- ✓ Individual submissions only!!!
- ✓ For any subject concerning the lab, you may contact me through email: **karampidis@hmu.gr**

Anaconda

[Anaconda](#) is a Python distribution. A Python distribution provides the Python interpreter, together with a set of Python packages and sometimes other related tools, such as editors.

Why Anaconda ?

- The open-source [Anaconda Distribution](#) is the easiest way to perform Python/R data science and machine learning on Linux, Windows, and Mac OS X. With over 19 million users worldwide, it is the industry standard for developing, testing, and training on a single machine, enabling *individual data scientists* to:
- Quickly download 7,500+ Python/R data science packages
- Manage libraries, dependencies, and environments with [Conda](#)
- Develop and train machine learning and deep learning models with [scikit-learn](#), [TensorFlow](#), and [Theano](#)
- Analyze data with scalability and performance with [Dask](#), [NumPy](#), [pandas](#), and [Numba](#)
- Visualize results with [Matplotlib](#), [Bokeh](#), [Datashader](#), and [Holoviews](#)

Anaconda Installation

- Visit <https://www.anaconda.com/distribution/> and download the installer that corresponds to the operating system you are using
- Make sure you choose latest Python version & 64-bit Graphical Installer



Anaconda

After installing and executing the program you will see this:

The screenshot displays the Anaconda Navigator desktop application. At the top, the title bar reads "Anaconda Navigator" with "File" and "Help" menus. The main header features the "ANACONDA NAVIGATOR" logo and a "Sign in to Anaconda Cloud" button. A left sidebar contains navigation options: "Home", "Environments", "Learning", and "Community". The main workspace shows a grid of application cards under the heading "Applications on base (root) Channels". Each card includes an icon, the application name, version number, a brief description, and a "Launch" or "Install" button. The applications shown are JupyterLab (1.1.4), Jupyter Notebook (6.0.1), Qt Console (4.5.5), Spyder (3.3.6), Glueviz (0.15.2), Orange 3 (3.23.1), RStudio (1.1.456), and VS Code (1.41.1). Social media icons for Twitter, YouTube, and GitHub are located at the bottom left.

Anaconda Navigator
File Help

ANACONDA NAVIGATOR

Sign in to Anaconda Cloud

Home

Environments

Learning

Community

Documentation

Developer Blog

Twitter YouTube GitHub

Applications on base (root) Channels Refresh

lab
JupyterLab
1.1.4
An extensible environment for interactive and reproducible computing, based on the Jupyter Notebook and Architecture.
Launch

jupyter
Jupyter Notebook
6.0.1
Web-based, interactive computing notebook environment. Edit and run human-readable docs while describing the data analysis.
Launch

IP[y]
Qt Console
4.5.5
PyQt GUI that supports inline figures, proper multiline editing with syntax highlighting, graphical calltips, and more.
Launch

Spyder
Spyder
3.3.6
Scientific PYTHON Development Environment. Powerful Python IDE with advanced editing, interactive testing, debugging and introspection features
Launch

Glueviz
Glueviz
0.15.2
Multidimensional data visualization across files. Explore relationships within and among related datasets.
Install

Orange 3
Orange 3
3.23.1
Component based data mining framework. Data visualization and data analysis for novice and expert. Interactive workflows with a large toolbox.
Install

R
RStudio
1.1.456
A set of integrated tools designed to help you be more productive with R. Includes R essentials and notebooks.
Install

VS Code
VS Code
1.41.1
Streamlined code editor with support for development operations like debugging, task running and version control.
Install

Anaconda Installation

Depending on your operating system you can find a detailed installation guide below

[Windows](#)

[Linux](#)

[macOS](#)

Anaconda Environments

Navigator uses conda to create separate environments containing files, packages, and their dependencies that will not interact with other environments.

Create a new environment named snowflakes and install a package in it:

In Navigator, click the Environments tab, then click the Create button. The Create new environment dialog box appears.

In the Environment name field, type a descriptive name for your environment.

Note that in this step you will choose the Python version you want to use. Therefore, you can have environments with different versions of Python according to your needs.

Also, you can choose to install R instead of Python.

Anaconda Environments

Create new environment X

Name:

Location: *C:\Users\builder\Anaconda3\envs\snowflakes*

Packages:

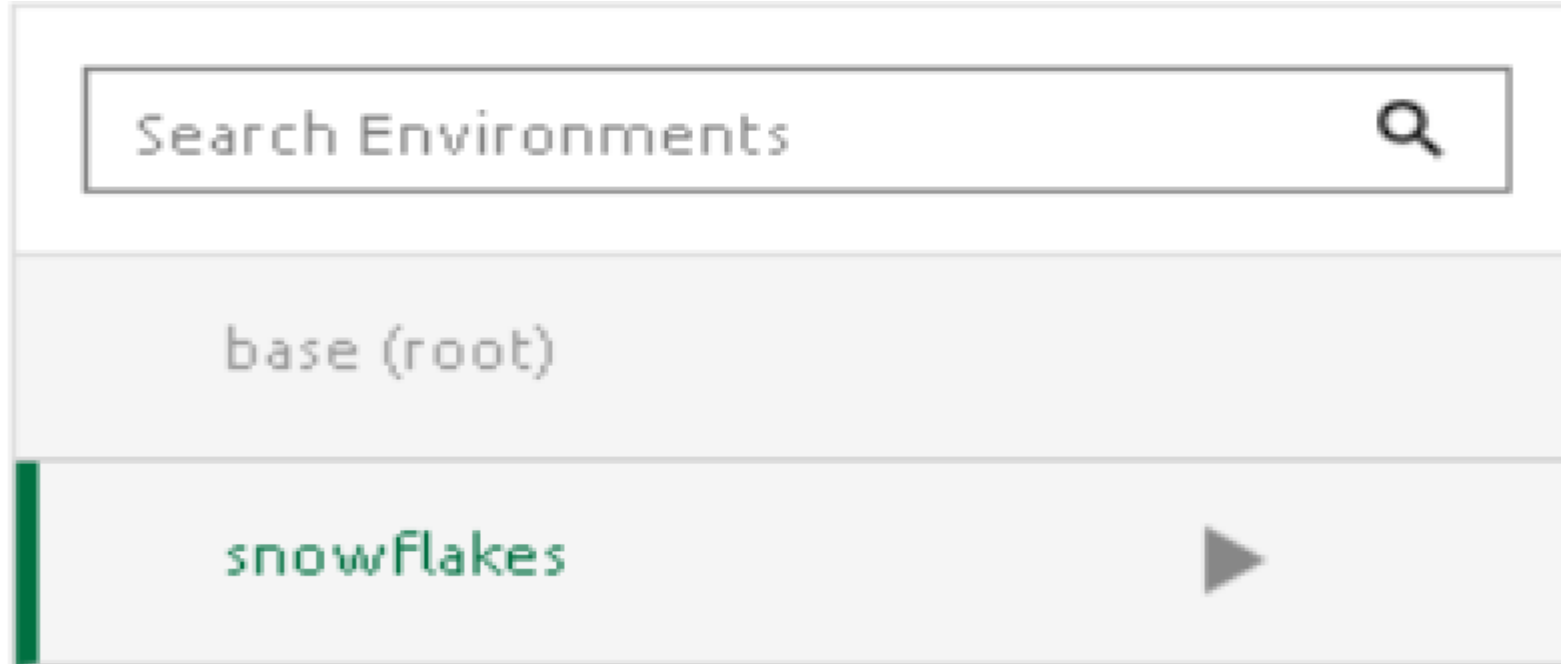
Python v

R v

Cancel Create

Anaconda Environments

Click Create. Navigator creates the new environment and activates it.



Now you have two environments, the default environment base (root), and snowflakes.

Switch between them (activate and deactivate environments) by clicking the name of the environment you want to use.

Return to the other environment by clicking its name.

Anaconda Environments

Managing packages

In this section, you check which packages you have installed, check which are available, and look for a specific package and install it.

To find a package you have already installed, click the name of the environment you want to search. The installed packages are displayed in the right panel.

You can change the selection of packages displayed in the right panel at any time by clicking the drop-down box above it and selecting Installed, Not Installed, Updatable, Selected, or All.

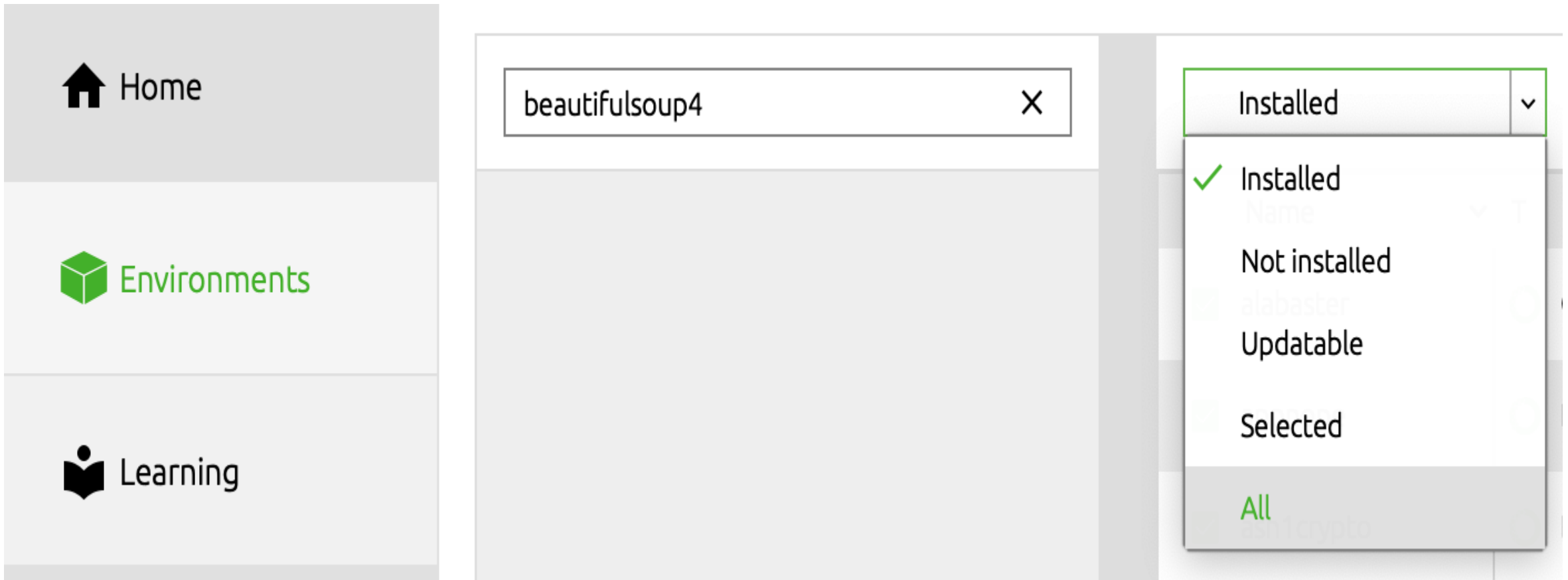
Anaconda Enviroments

The screenshot shows the Anaconda Environments interface. At the top, there is a filter dropdown menu currently set to "Installed". Below the dropdown, there are buttons for "Channels", "Update index...", and a search bar labeled "Search Packages". The main area displays a list of installed packages with columns for Name, Description, and Updateable status.

| Name | Description | Updateable |
|------------|---|--------------------------|
| alabaster | Configurable, python 2+3 compatible sphinx theme. | <input type="checkbox"/> |
| | Disable app nap on os x 10.9 | <input type="checkbox"/> |
| asn1crypto | Python asn.1 library with a focus on performance and a pythonic api | <input type="checkbox"/> |

Anaconda Environments

Check to see if a package you have not installed named “beautifulsoup4” is available from the Anaconda repository (must be connected to the Internet). On the Environments tab, in the Search Packages box, type beautifulsoup4, and from the Search Subset box select All or Not Installed.



The screenshot displays the Anaconda Environments interface. On the left sidebar, there are three main sections: 'Home' with a house icon, 'Environments' with a green cube icon, and 'Learning' with an open book icon. The 'Environments' section is currently active. The main content area shows a search bar containing the text 'beautifulsoup4' with a clear 'X' button. To the right of the search bar is a dropdown menu for 'Search Subset'. The dropdown is open, showing a list of options: 'Installed' (selected), 'Not installed', 'Updatable', and 'Selected'. At the bottom of the dropdown is an 'All' option. The 'Installed' option is highlighted with a green checkmark.

Anaconda Environments

To install the package into the current environment, check the checkbox next to the package name, then click the bottom Apply button.

Not installed ▾ Channels Update index... Search Packages 🔍

| Name | T | Description | Version |
|--|---|--|---------|
| <input type="checkbox"/> _ipyw_jlab_nb_ex... | | A configuration metapackage for enabling anaconda-bundled jupyter extensions | 0.1.0 |
| <input checked="" type="checkbox"/> _mutex_mxnet | | | 0.0.40 |
| <input type="checkbox"/> _nb_ext_conf | | | 0.4.0 |
| <input type="checkbox"/> _py-xgboost-mutex | | | 2.0 |
| <input checked="" type="checkbox"/> _r-mutex | | | 1.0.0 |
| <input type="checkbox"/> _r-xgboost-mutex | | | 2.0 |
| <input type="checkbox"/> _tflow_1100_select | | | 0.0.2 |

1783 packages available 2 packages selected Apply Clear

Jupyter Notebook

The Jupyter Notebook is an interactive programming environment , in which you can combine Python code and execution results with annotations, equations, figures, links, etc.

The Jupyter Notebook will run in the internet browser of our computer and does not require internet access, it will access to our local files via the browser interface.

Notebooks are similar to Word documents and we can edit them interactively in the internet browser. Notebooks are saved in its own format with the '. ipynb extension, but can be also downloaded as PDFs, HTML pages or Python code.

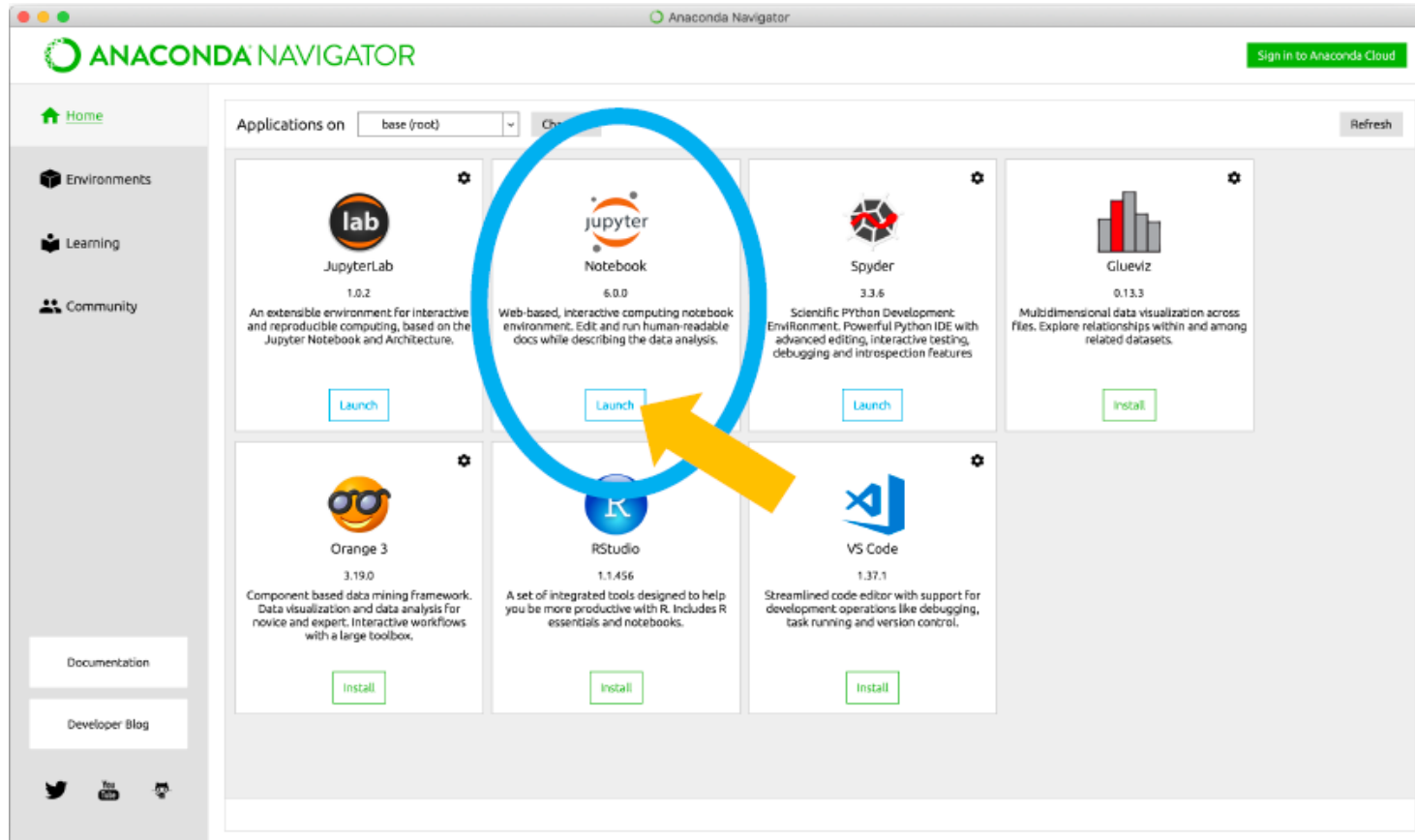
Jupyter Notebook

There are 3 ways to launch Jupyter Notebook:

1) Using Anaconda Navigator

a) Open the application called Anaconda Navigator

b) Click on “Launch” in the Jupyter Notebook box



Jupyter Notebook

2) Using Anaconda Prompt

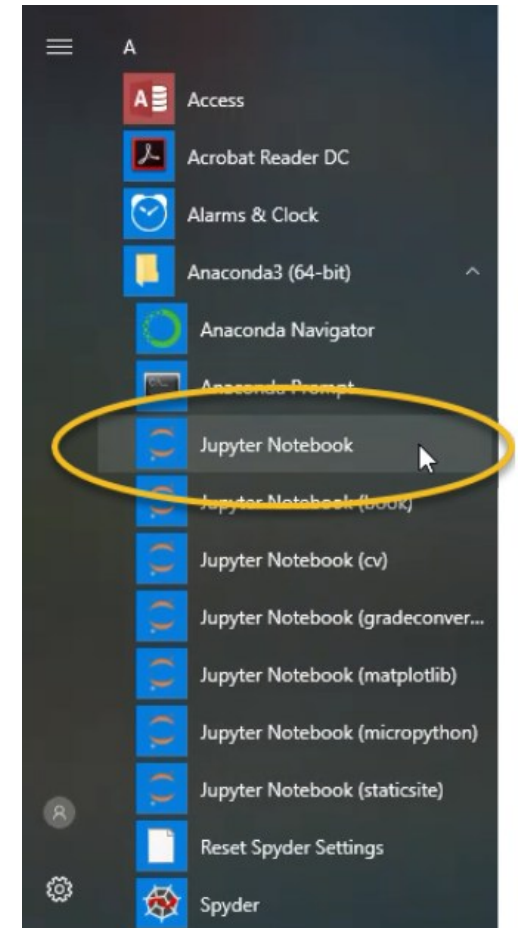
a) Open the application called Anaconda Prompt

b) Type “jupyter notebook” (without quotes) and hit the return key

3) Clicking on the Jupyter Notebook App in the Start Menu

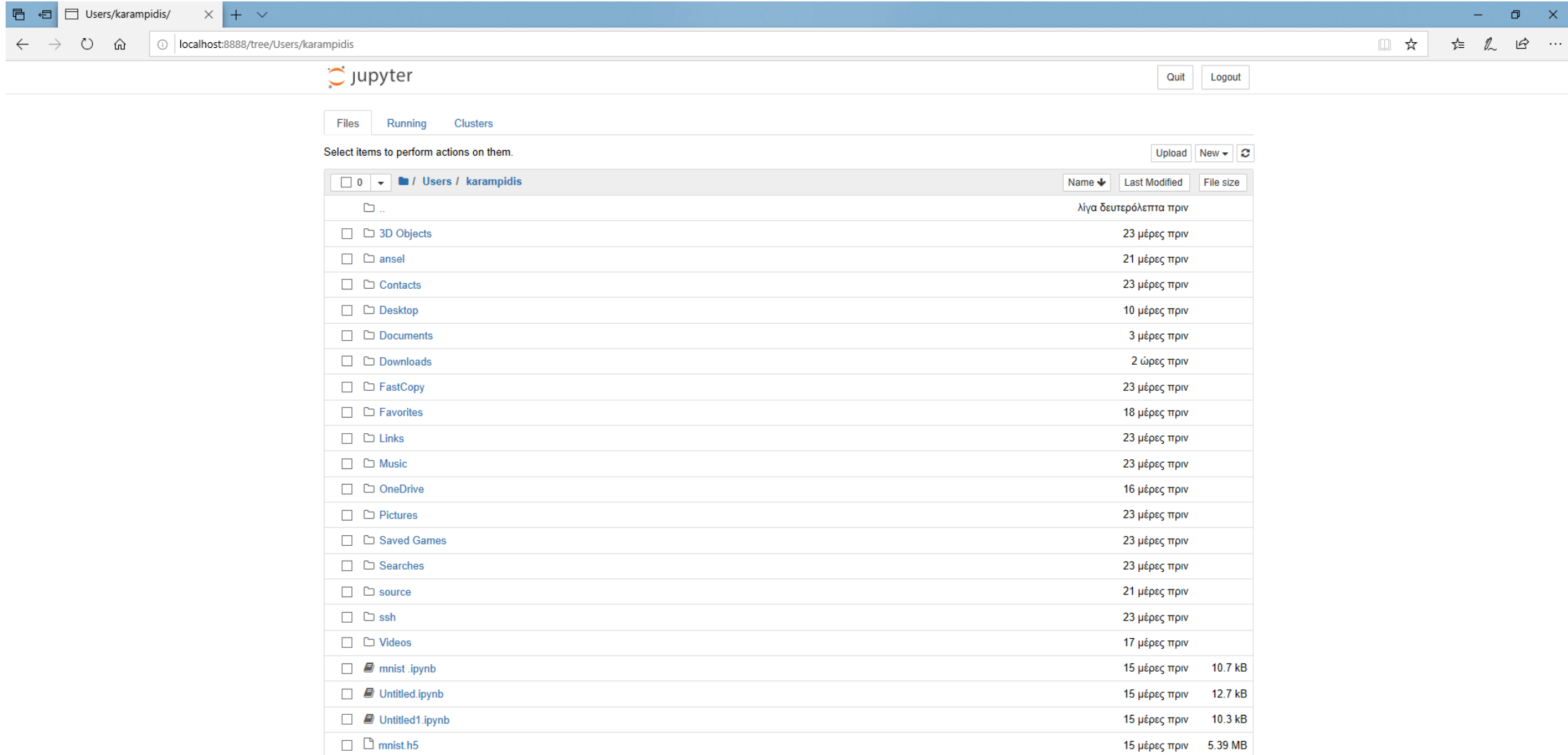


```
Anaconda Prompt (anaconda3)
(base) C:\>jupyter notebook
```



Jupyter Notebook

You must see a page similar to this



The screenshot shows a web browser window displaying the Jupyter Notebook interface. The browser's address bar shows the URL `localhost:8888/tree/Users/karampidis`. The Jupyter logo is visible in the top left, and there are "Quit" and "Logout" buttons in the top right. Below the header, there are tabs for "Files", "Running", and "Clusters". A message says "Select items to perform actions on them." with "Upload", "New", and refresh icons. The main area is a file browser showing the directory structure of `/Users/karampidis`. The browser lists various system folders and files, including `mnist.ipynb`, `Untitled.ipynb`, `Untitled1.ipynb`, and `mnist.h5`.

| | Name | Last Modified | File size |
|--------------------------|-----------------|------------------------|-----------|
| <input type="checkbox"/> | .. | λίγα δευτερόλεπτα πριν | |
| <input type="checkbox"/> | 3D Objects | 23 μέρες πριν | |
| <input type="checkbox"/> | ansel | 21 μέρες πριν | |
| <input type="checkbox"/> | Contacts | 23 μέρες πριν | |
| <input type="checkbox"/> | Desktop | 10 μέρες πριν | |
| <input type="checkbox"/> | Documents | 3 μέρες πριν | |
| <input type="checkbox"/> | Downloads | 2 ώρες πριν | |
| <input type="checkbox"/> | FastCopy | 23 μέρες πριν | |
| <input type="checkbox"/> | Favorites | 18 μέρες πριν | |
| <input type="checkbox"/> | Links | 23 μέρες πριν | |
| <input type="checkbox"/> | Music | 23 μέρες πριν | |
| <input type="checkbox"/> | OneDrive | 16 μέρες πριν | |
| <input type="checkbox"/> | Pictures | 23 μέρες πριν | |
| <input type="checkbox"/> | Saved Games | 23 μέρες πριν | |
| <input type="checkbox"/> | Searches | 23 μέρες πριν | |
| <input type="checkbox"/> | source | 21 μέρες πριν | |
| <input type="checkbox"/> | ssh | 23 μέρες πριν | |
| <input type="checkbox"/> | Videos | 17 μέρες πριν | |
| <input type="checkbox"/> | mnist.ipynb | 15 μέρες πριν | 10.7 kB |
| <input type="checkbox"/> | Untitled.ipynb | 15 μέρες πριν | 12.7 kB |
| <input type="checkbox"/> | Untitled1.ipynb | 15 μέρες πριν | 10.3 kB |
| <input type="checkbox"/> | mnist.h5 | 15 μέρες πριν | 5.39 MB |

Jupyter Notebook

- Navigate through your folders until you get to the directory you want to save your notebooks.
- Open a new Notebook file by clicking on the “New” menu on the upper right



Quit

Logout

Files

Running

Clusters

Select items to perform actions on them.

Upload

New



| <input type="checkbox"/> 0 | Name | |
|----------------------------|----------------------|---------------|
| <input type="checkbox"/> | / Users / karampidis | |
| <input type="checkbox"/> | .. | |
| <input type="checkbox"/> | 3D Objects | |
| <input type="checkbox"/> | ansel | |
| <input type="checkbox"/> | Contacts | |
| <input type="checkbox"/> | Desktop | 10 μέρες πριν |
| <input type="checkbox"/> | Documents | 3 μέρες πριν |

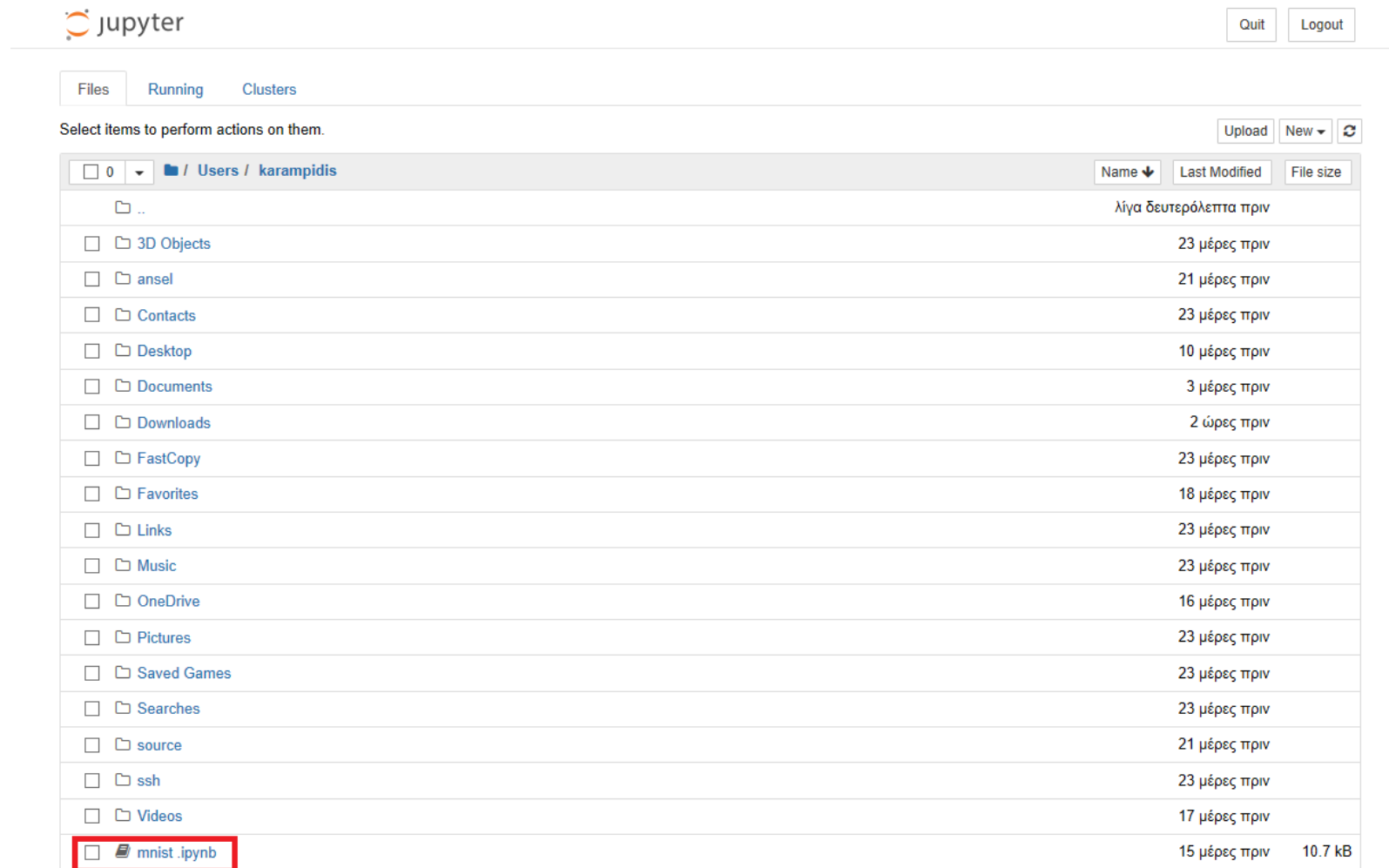
Notebook:
Python 3

Other:
Text File
Folder
Terminal

Jupyter Notebook

Open a previously saved Notebook file by clicking on the name of the file.

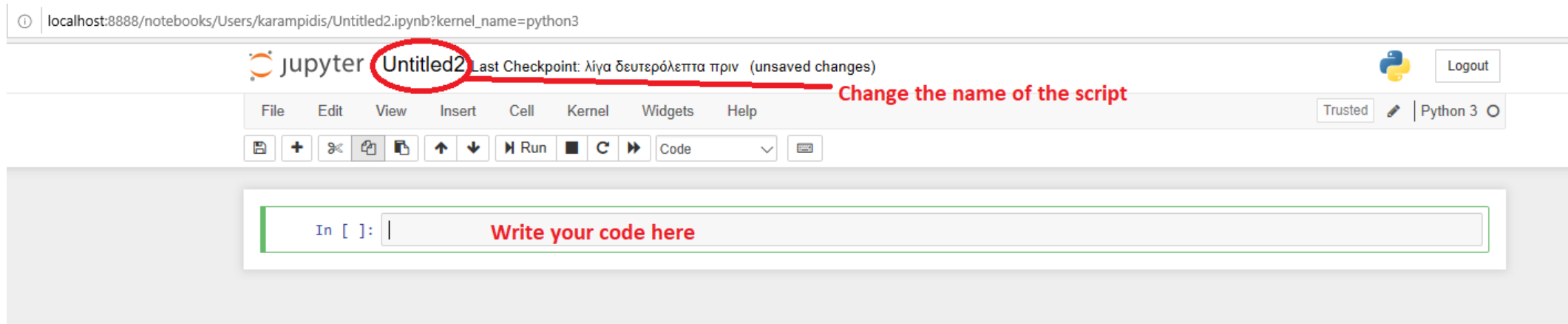
The extension for a Jupyter Notebook file is “.ipynb”, which is short for “interactive python notebook”



The screenshot shows the Jupyter Notebook interface. At the top left is the Jupyter logo. On the top right are 'Quit' and 'Logout' buttons. Below the logo are tabs for 'Files', 'Running', and 'Clusters'. A message says 'Select items to perform actions on them.' with 'Upload', 'New', and a refresh icon. The main area shows a file browser for the user 'karampidis'. A table lists files and folders with columns for Name, Last Modified, and File size. The file 'mnist.ipynb' is highlighted with a red box.

| | Name | Last Modified | File size |
|--------------------------|-------------|------------------------|-----------|
| <input type="checkbox"/> | .. | λίγα δευτερόλεπτα πριν | |
| <input type="checkbox"/> | 3D Objects | 23 μέρες πριν | |
| <input type="checkbox"/> | ansel | 21 μέρες πριν | |
| <input type="checkbox"/> | Contacts | 23 μέρες πριν | |
| <input type="checkbox"/> | Desktop | 10 μέρες πριν | |
| <input type="checkbox"/> | Documents | 3 μέρες πριν | |
| <input type="checkbox"/> | Downloads | 2 ώρες πριν | |
| <input type="checkbox"/> | FastCopy | 23 μέρες πριν | |
| <input type="checkbox"/> | Favorites | 18 μέρες πριν | |
| <input type="checkbox"/> | Links | 23 μέρες πριν | |
| <input type="checkbox"/> | Music | 23 μέρες πριν | |
| <input type="checkbox"/> | OneDrive | 16 μέρες πριν | |
| <input type="checkbox"/> | Pictures | 23 μέρες πριν | |
| <input type="checkbox"/> | Saved Games | 23 μέρες πριν | |
| <input type="checkbox"/> | Searches | 23 μέρες πριν | |
| <input type="checkbox"/> | source | 21 μέρες πριν | |
| <input type="checkbox"/> | ssh | 23 μέρες πριν | |
| <input type="checkbox"/> | Videos | 17 μέρες πριν | |
| <input type="checkbox"/> | mnist.ipynb | 15 μέρες πριν | 10.7 kB |

Jupyter Notebook



The screenshot displays the Jupyter Notebook interface. At the top, the browser address bar shows the URL: `localhost:8888/notebooks/Users/karampidis/Untitled2.ipynb?kernel_name=python3`. Below the address bar, the Jupyter logo is followed by the notebook title **Untitled2**, which is circled in red. To the right of the title, it says "Last Checkpoint: λίγα δευτερόλεπτα πριν (unsaved changes)". A red arrow points from the text "Change the name of the script" to the circled title. On the far right, there is a "Logout" button and the Python logo. Below the title bar is a menu bar with options: File, Edit, View, Insert, Cell, Kernel, Widgets, and Help. To the right of the menu bar, it says "Trusted" and "Python 3". Below the menu bar is a toolbar with icons for saving, adding, deleting, copying, pasting, undo, redo, and running. Below the toolbar is a code cell with the prompt "In []:" and a text input field containing the red text "Write your code here".

In a jupyter notebook you can have equations, text , code , plots etc.

Jupyter Notebook

jupyter spectrogram (autosaved)



File Edit View Insert Cell Kernel Help

Python 3



Simple spectral analysis

An illustration of the [Discrete Fourier Transform](#)

$$X_k = \sum_{n=0}^{N-1} x_n \exp^{-\frac{j2\pi}{N}kn} \quad k = 0, \dots, N-1$$

Equations

```
In [2]: from scipy.io import wavfile
rate, x = wavfile.read('test_mono.wav')
```

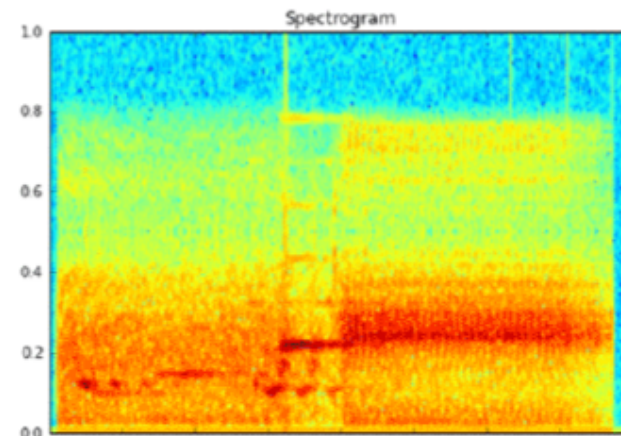
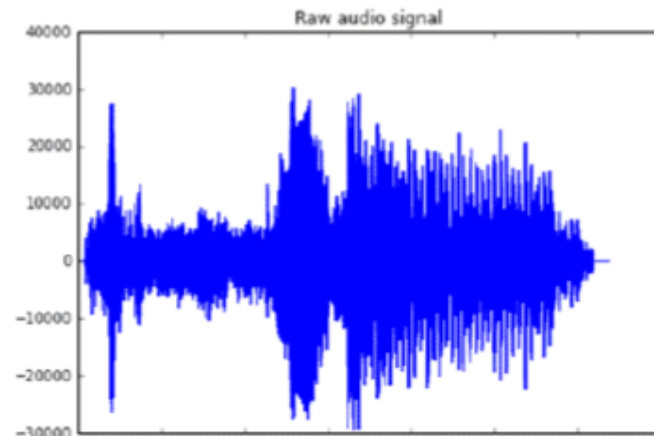
Code

And we can easily view it's spectral structure using matplotlib's builtin specgram routine:

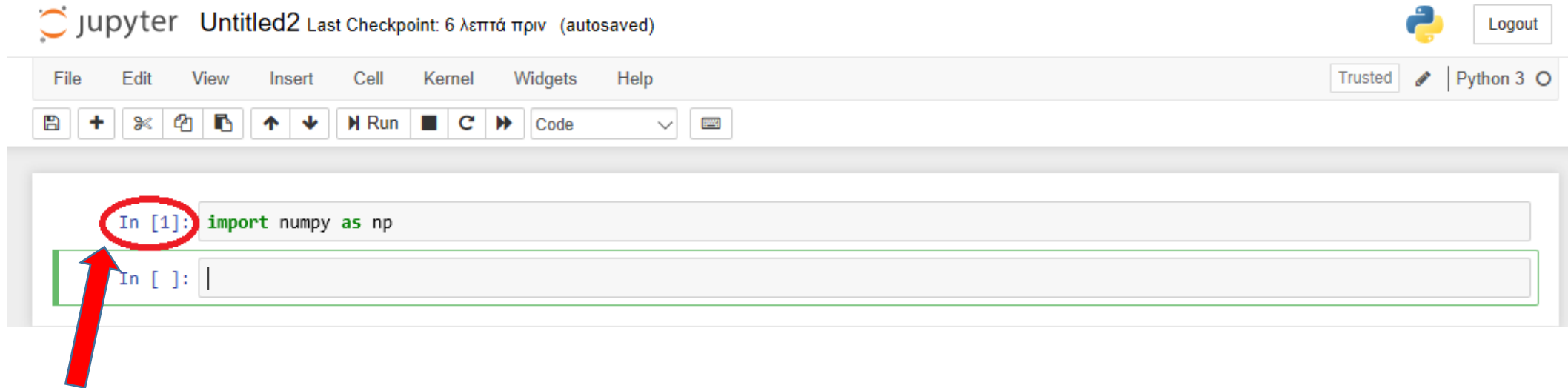
```
In [5]: fig, (ax1, ax2) = plt.subplots(1,2,figsize(16,5))
ax1.plot(x); ax1.set_title('Raw audio signal')
ax2.specgram(x); ax2.set_title('Spectrogram');
```

Text

Plots



Jupyter Notebook



The screenshot shows the Jupyter Notebook interface. At the top, the text "jupyter Untitled2 Last Checkpoint: 6 λεπτά πριν (autosaved)" is visible. To the right, there is a Python logo and a "Logout" button. Below this is a menu bar with "File", "Edit", "View", "Insert", "Cell", "Kernel", "Widgets", and "Help". On the right side of the menu bar, it says "Trusted" and "Python 3". Below the menu bar is a toolbar with icons for saving, adding, deleting, copying, pasting, undo, redo, and running. The main area contains two code cells. The first cell is highlighted with a red circle around the text "In [1]:" and a red arrow pointing to it. The code in this cell is `import numpy as np`. The second cell is empty and has the text "In []:".

If there is a number , then the cell has been evaluated! This means that the code written in that cell has been run. A cell is evaluated by either clicking “Run” or by typing Shift+Return.

Environment Setup

In order to work flawlessly this semester you need to:

- Create a new environment
- Select the new environment and install these packages:
 - numpy
 - scikit-learn
 - matplotlib
 - pandas
 - seaborn

Open Anaconda prompt as administrator and issue the command:

```
activate <your_environment_name>
```

```
pip install neurolab yellowbrick
```

Environment Setup

Environment setup through Anaconda prompt

Open Anaconda prompt and issue the following commands:

```
conda create --name neural
```

```
conda activate neural
```

```
conda install numpy scikit-learn matplotlib pandas seaborn keras
```

```
pip install neurolab yellowbrick
```

```
conda install jupyter
```

Load data

In order to load data into a jupyter notebook you can use the `.read_csv()` method* from pandas

Example:

```
import pandas as pd
```

```
mydata = pd.read_csv("path_to_file/your_data.csv")
```

```
print(mydata)
```

Alternatively, you can see the header of the file along with the first five patterns

```
df = pd.DataFrame(mydata)
```

```
df.head()
```

* with this method you can also import `.data` files

Load data

To load txt files you can use the following

```
import numpy as np
```

```
from urllib.request import urlopen
```

```
data = np.loadtxt(urlopen("url_to_txt_file"),delimiter=",")
```

or convert the txt file to csv and use the previous method