Procesamiento Digital de Señales

Introducción a Python

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4 de diciembre de 2019

Contenido

Próxima sección

1. Why Python
2. Tools
3. Let's code

Outline

$_1 43 ents[currentsection, currentsubsection, hideothersubsections, sectionsty$
$show/shaded,]$

Why Python

https://twitter.com/i/status/1121452279289135104

Why Python

Guido Van Rossum

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Why Python

Recuperar las palabras de un documento en ABC

```
HOW TO RETURN words document:
    PUT {} IN collection
    FOR line IN document:
        FOR word IN split line:
            IF word not.in collection:
                INSERT word IN collection
    RETURN collection
```

Recuperar las palabras de un documento en Python

```
def words(document):
    collection = set()
    for line in document:
        for word in line.split():
            if word not in collection:
                collection.add(word)
    return collection
```

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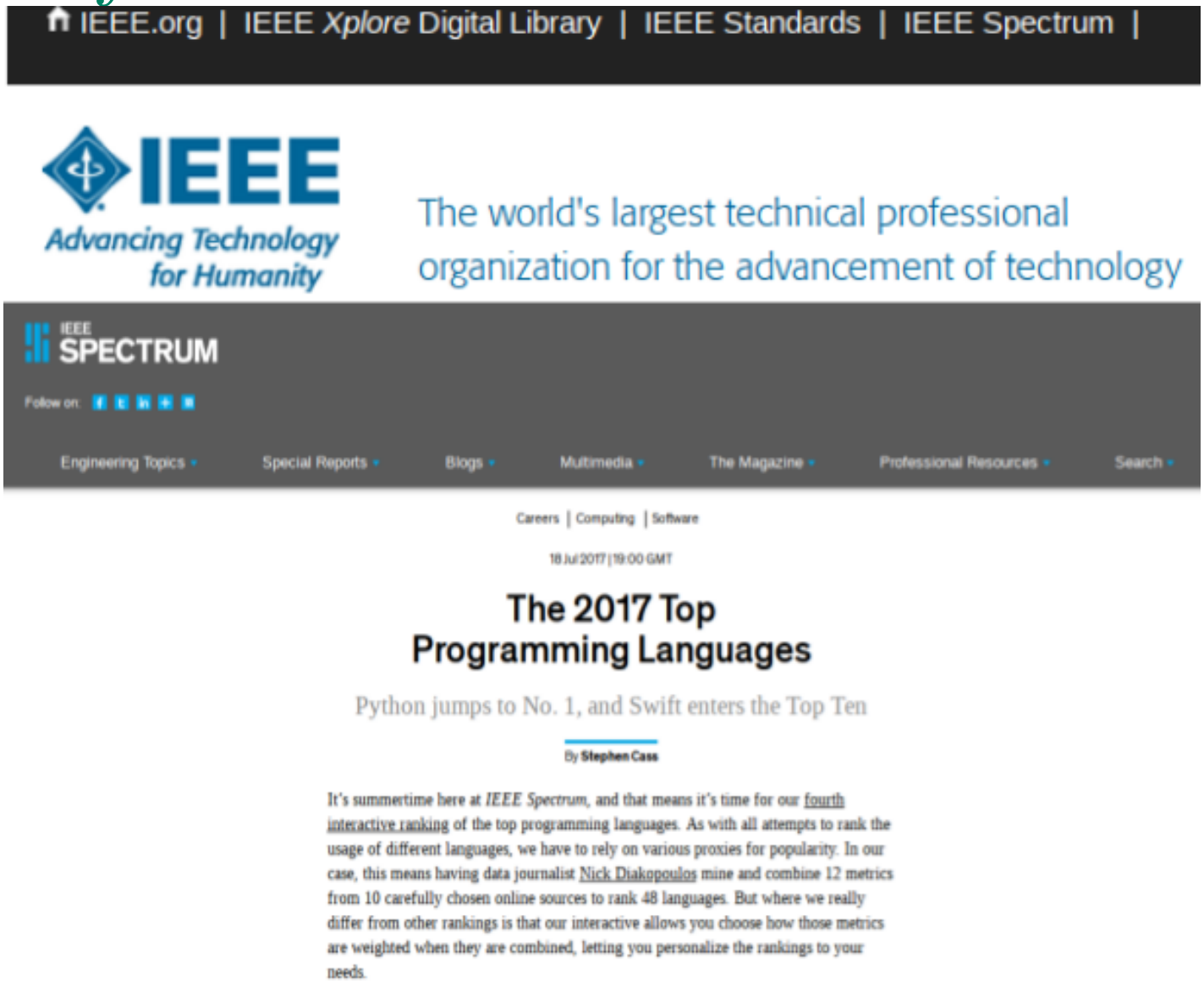
Why Python



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18 Jul 2017 | 19:00 GMT

The 2017 Top Programming Languages

Python jumps to No. 1, and Swift enters the Top Ten

By **Stephen Cass**

It's summertime here at *IEEE Spectrum*, and that means it's time for our fourth interactive ranking of the top programming languages. As with all attempts to rank the usage of different languages, we have to rely on various proxies for popularity. In our case, this means having data journalist Nick Diakopoulos mine and combine 12 metrics from 10 carefully chosen online sources to rank 48 languages. But where we really differ from other rankings is that our interactive allows you choose how those metrics are weighted when they are combined, letting you personalize the rankings to your needs.

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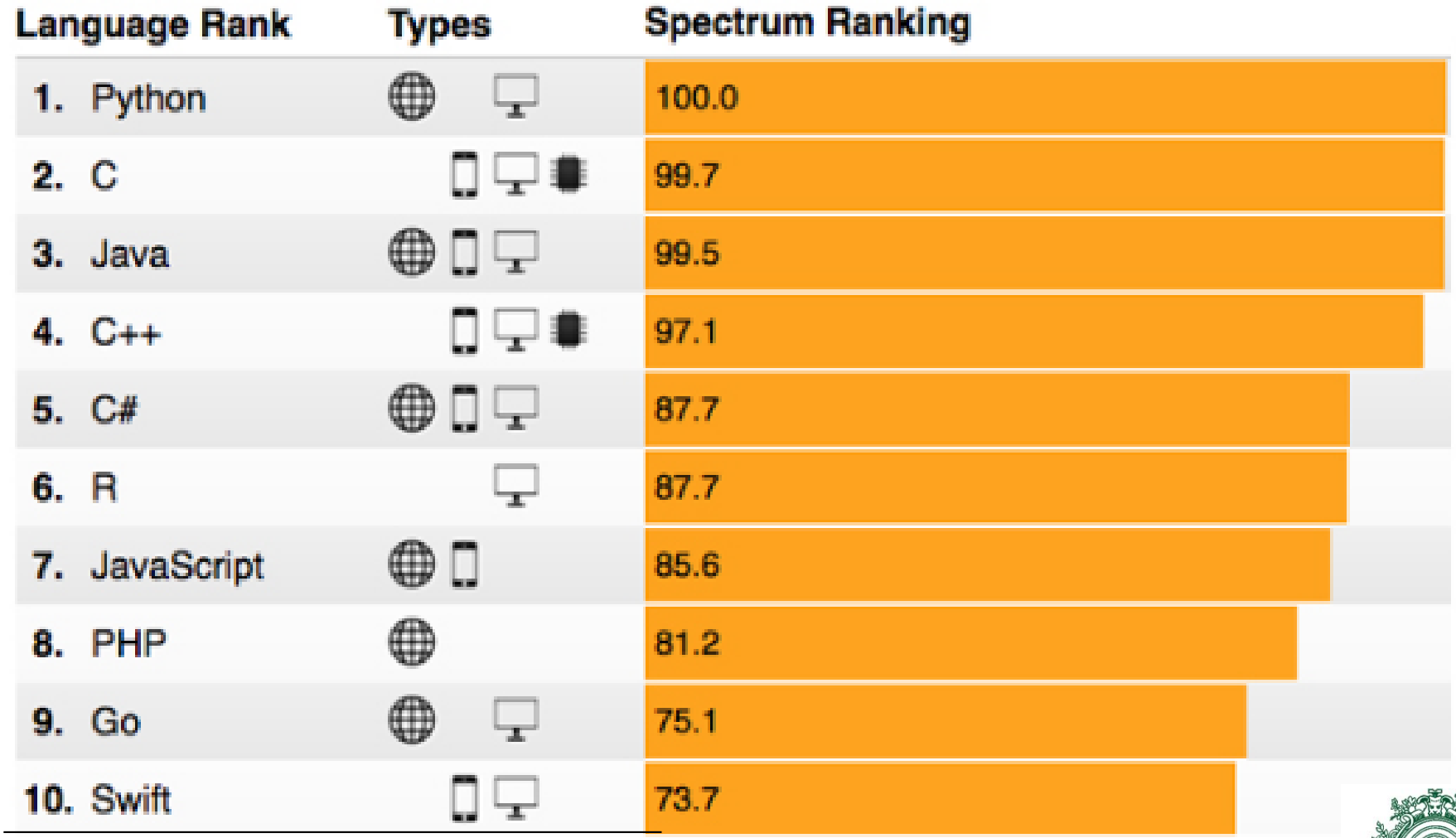
Why Python



[1]Source: IEEE Spectrum 2017: http://spectrum.ieee.org/computing/software/the-2017-top-programming-

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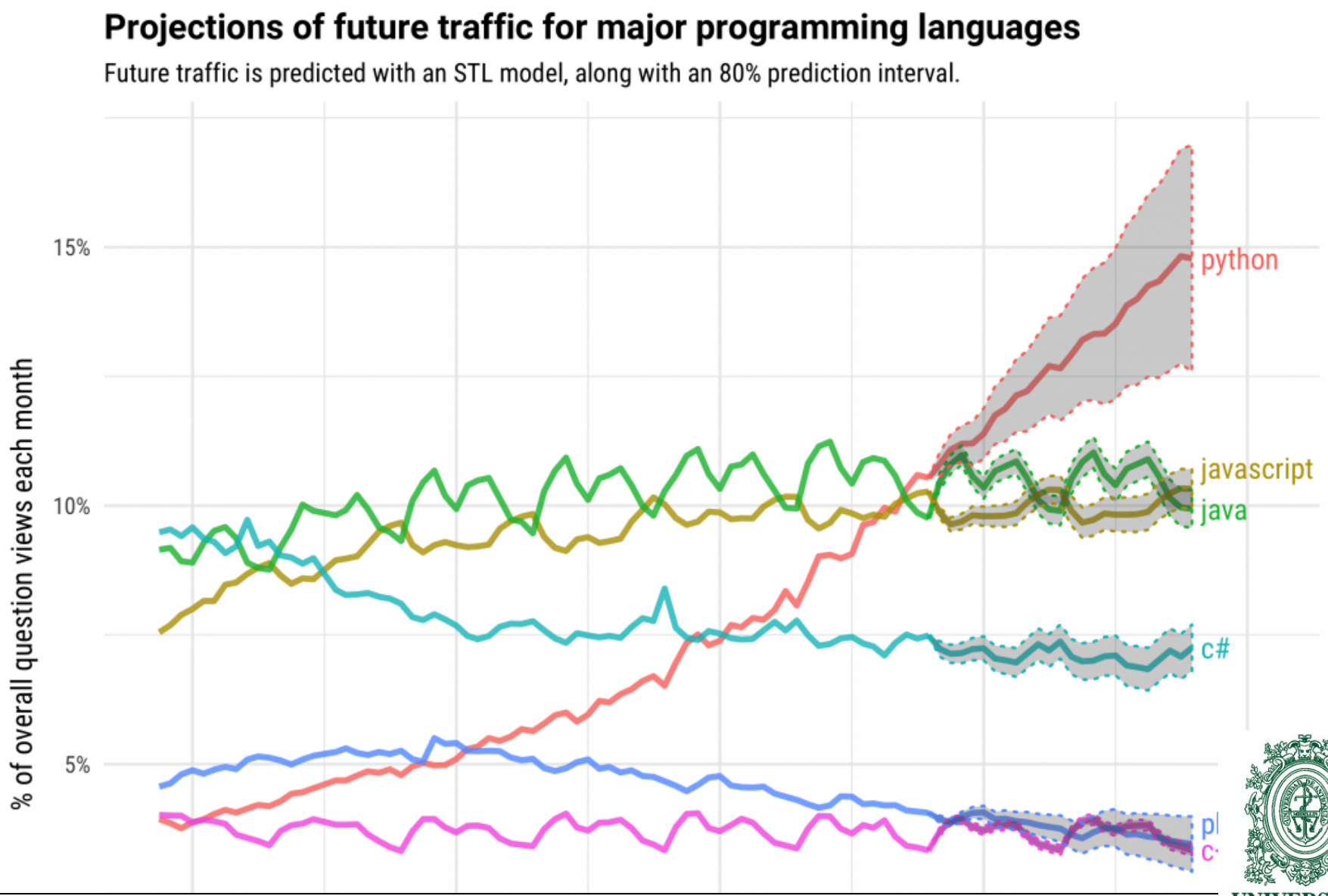
Why python


Projections of future traffic for major programming languages
Future traffic is predicted with an STL model, along with an 80% prediction interval.
% of overall question views each month
15%
10%
5%
python
javascript
java
c#

Why python

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Python3

A (very incomplete) list of properties Python

- Multi-paradigm programming language (e.g. object-oriented)
- Garbage collection for memory management
- The intention is to have highly readable code
- Indentation instead of (curly) braces
- Dynamic typing
- Data types / structures

Lists	`a = []`	Tuple	`b = ()`
Dictionaries	`d = {'one':1, 'two':2}`	Strings	`str = "hi"`
Integer	`i = 3`	Float	`j = 1.5`

  Type verification: `type(i)`

- Due to Python's popularity there are numerous libraries available for everything one can think of.

Why python

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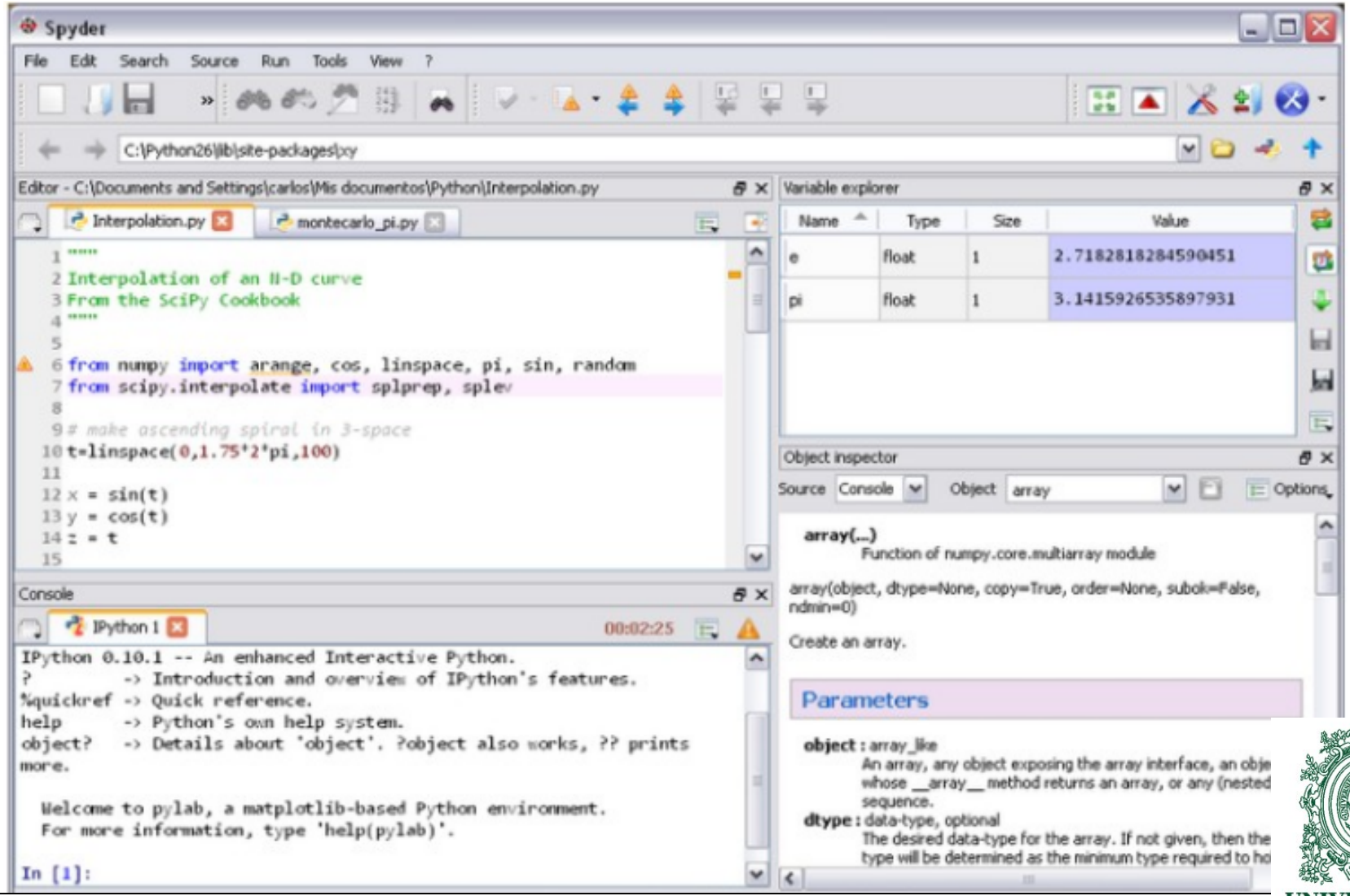
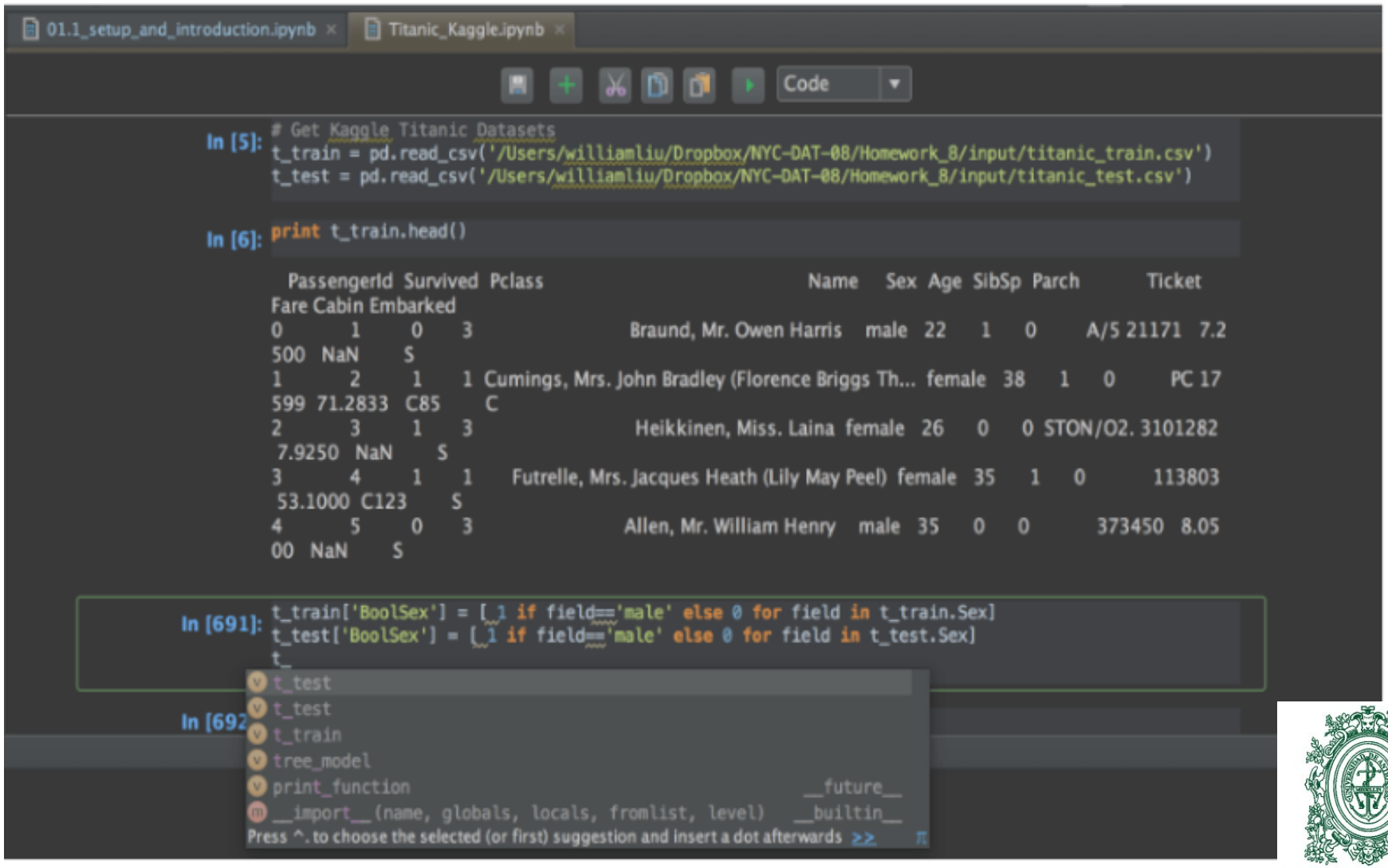
Why python

Spyder



Why python

Pycharm



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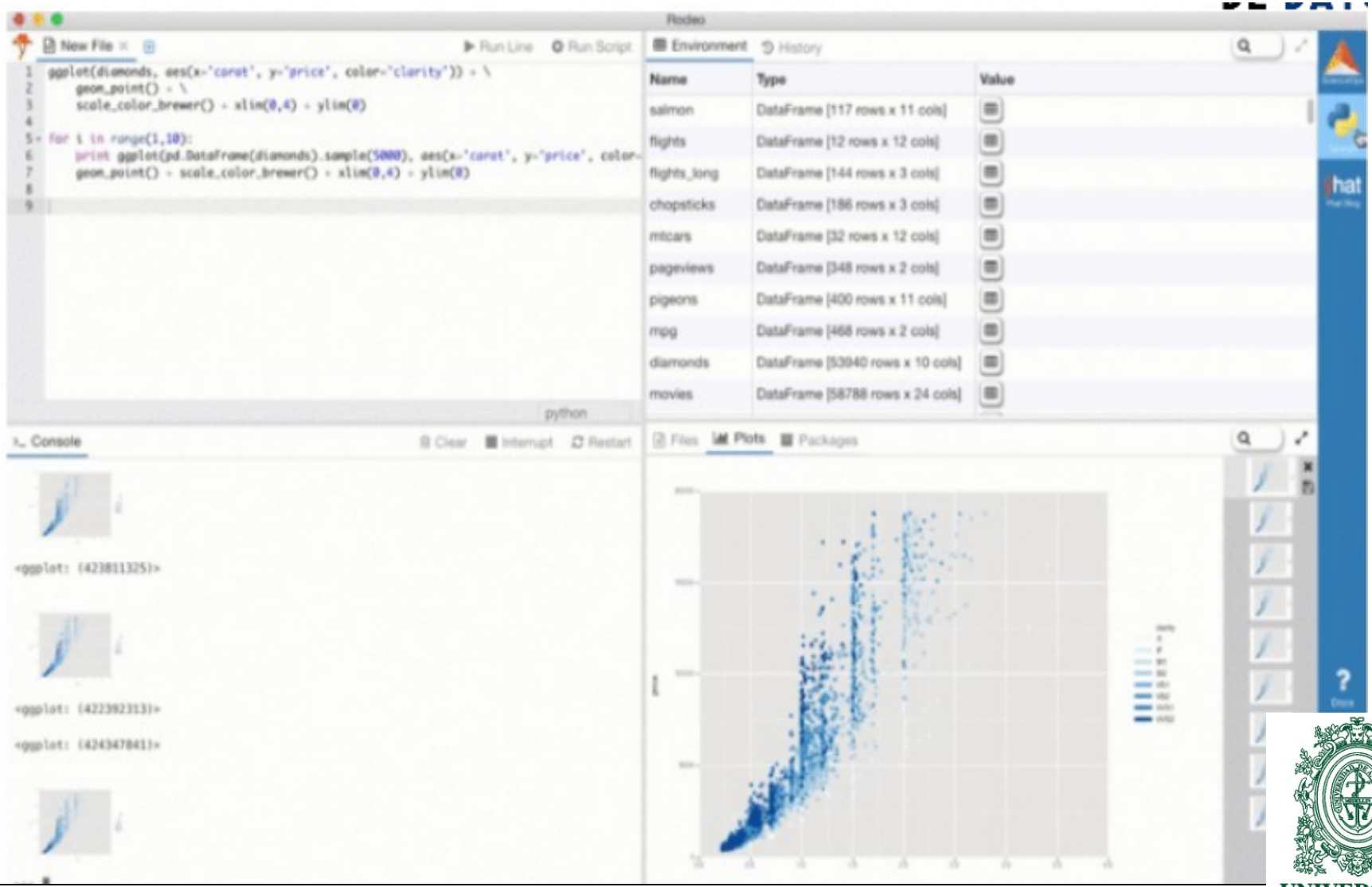
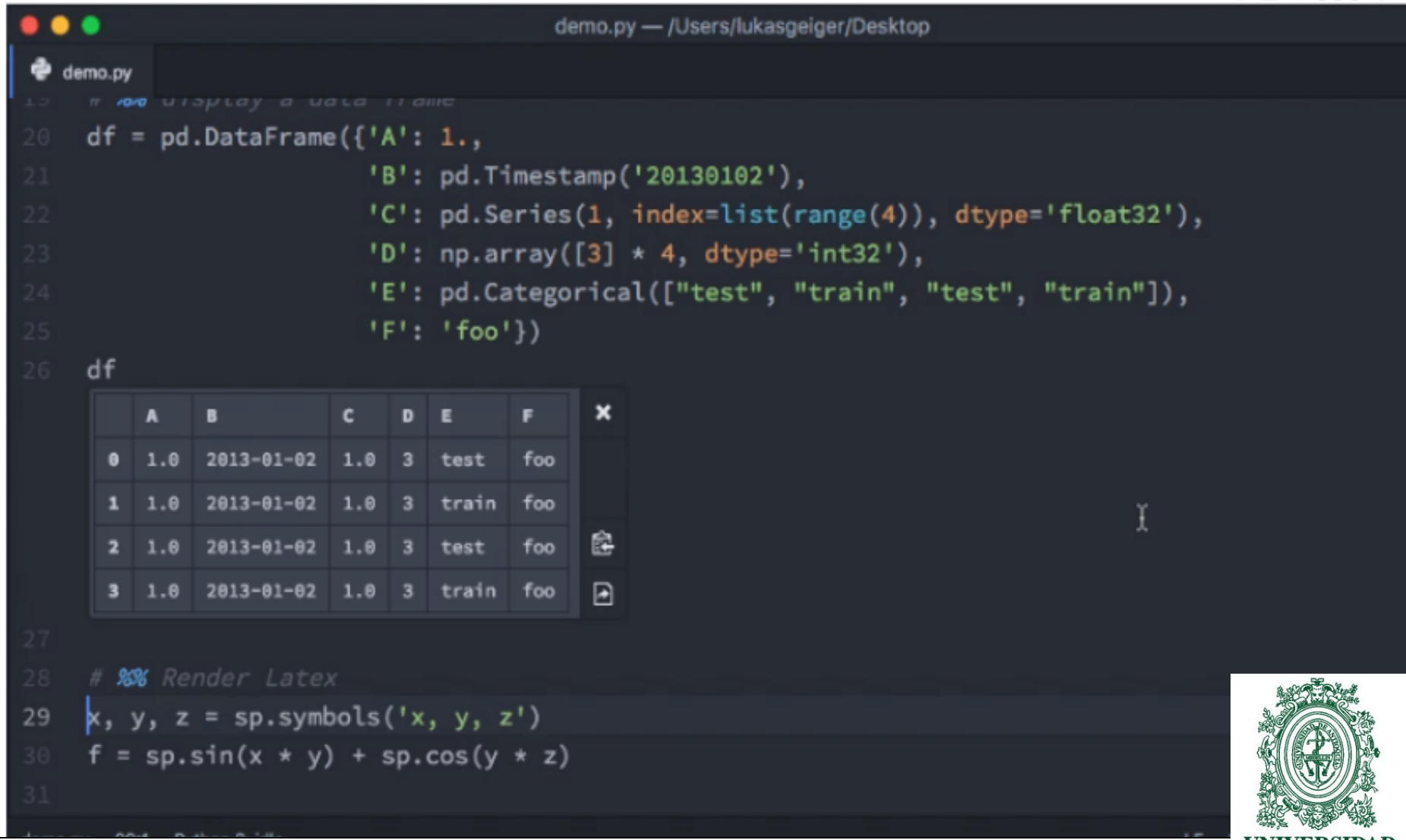
Why python

Rodeo



Why python

Atom



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Why python

IP[y]: Notebook spectrogram Last Checkpoint: a few seconds ago (autosaved)

IPython (Python 3)

File Edit View Insert Cell Kernel Help

Code Cell Toolbar: None

Simple spectral analysis

An illustration of the Discrete Fourier Transform using windowing, to reveal the frequency content of a sound signal.

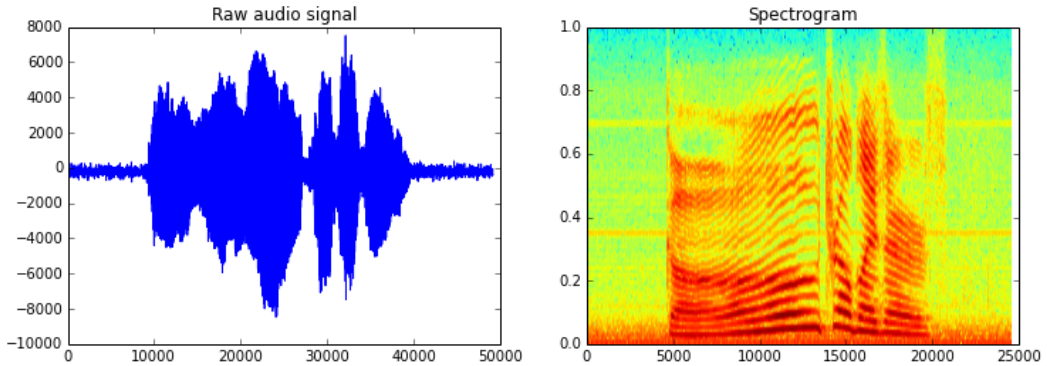
$$X_k = \sum_{n=0}^{N-1} x_n e^{-\frac{2\pi i}{N} kn} \qquad k = 0, \ldots, N-1$$

We begin by loading a datafile using SciPy's audio file support:

In [1]:
```
from scipy.io import wavfile
rate, x = wavfile.read('test_mono.wav')
```

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

In [2]:
```
%matplotlib inline
from matplotlib import pyplot as plt
fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(12, 4))
ax1.plot(x); ax1.set_title('Raw audio signal')
ax2.specgram(x); ax2.set_title('Spectrogram');
```



Jupyter

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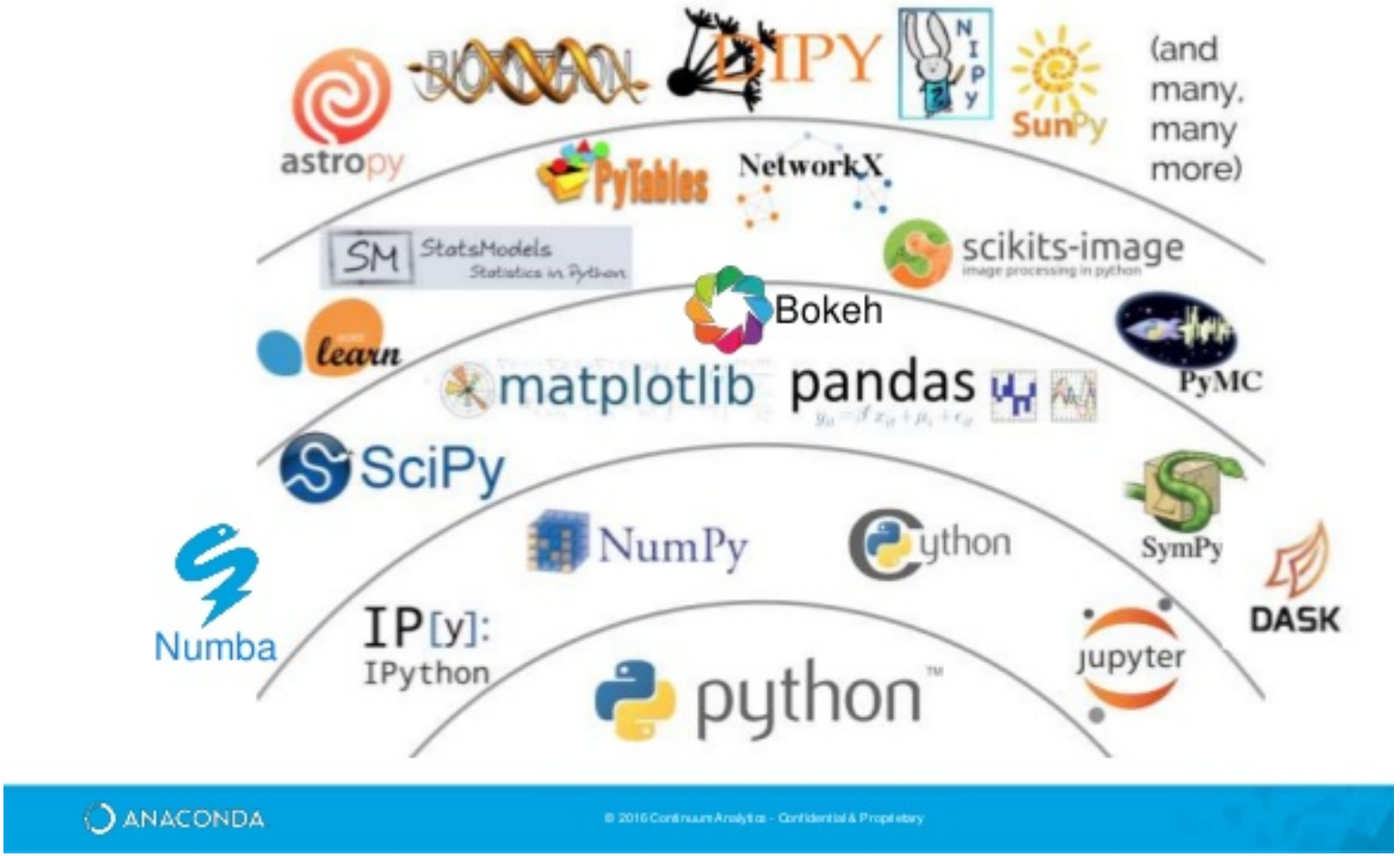
Próxima sección

Tools



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Tools

- Jupyter
- Numpy
- Pandas
- Matplotlib
- Scipy

Tools: Jupyter

Interactive environment to create documents, code, interactive widgets, graphs, texts and equations.

[2]

[2] http://jupyter.org/

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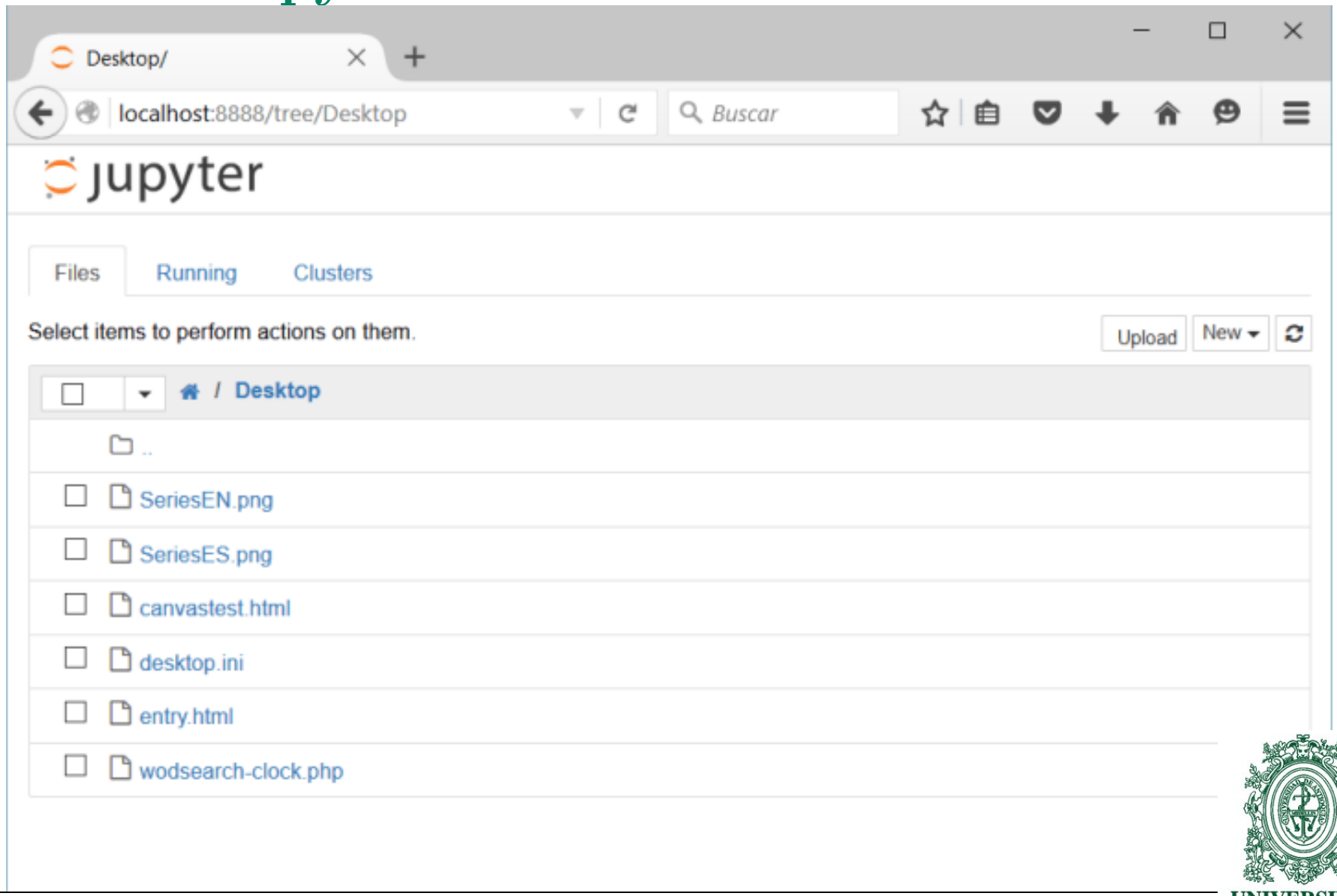
Tools: Jupyter



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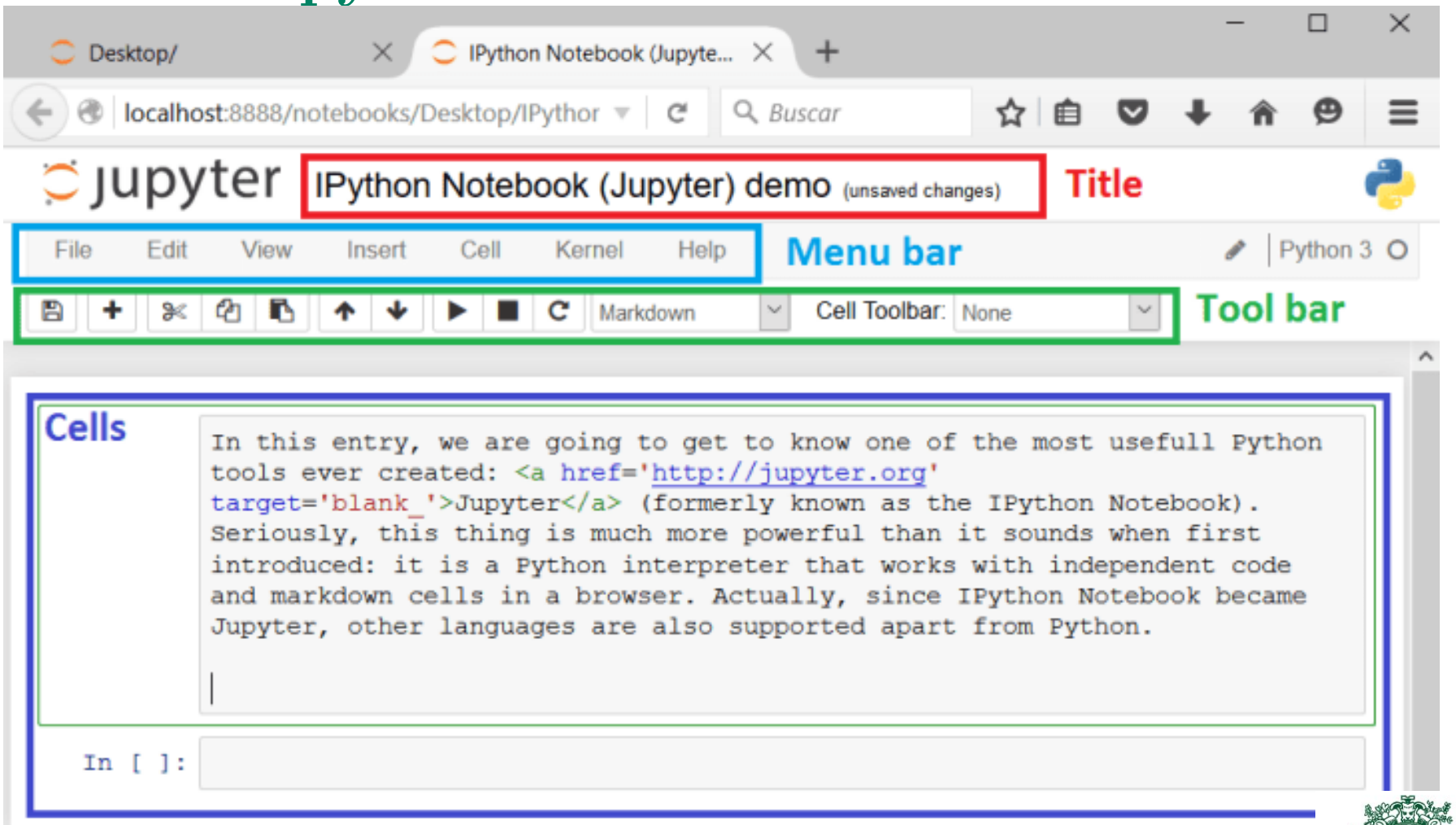
Tools: Jupyter



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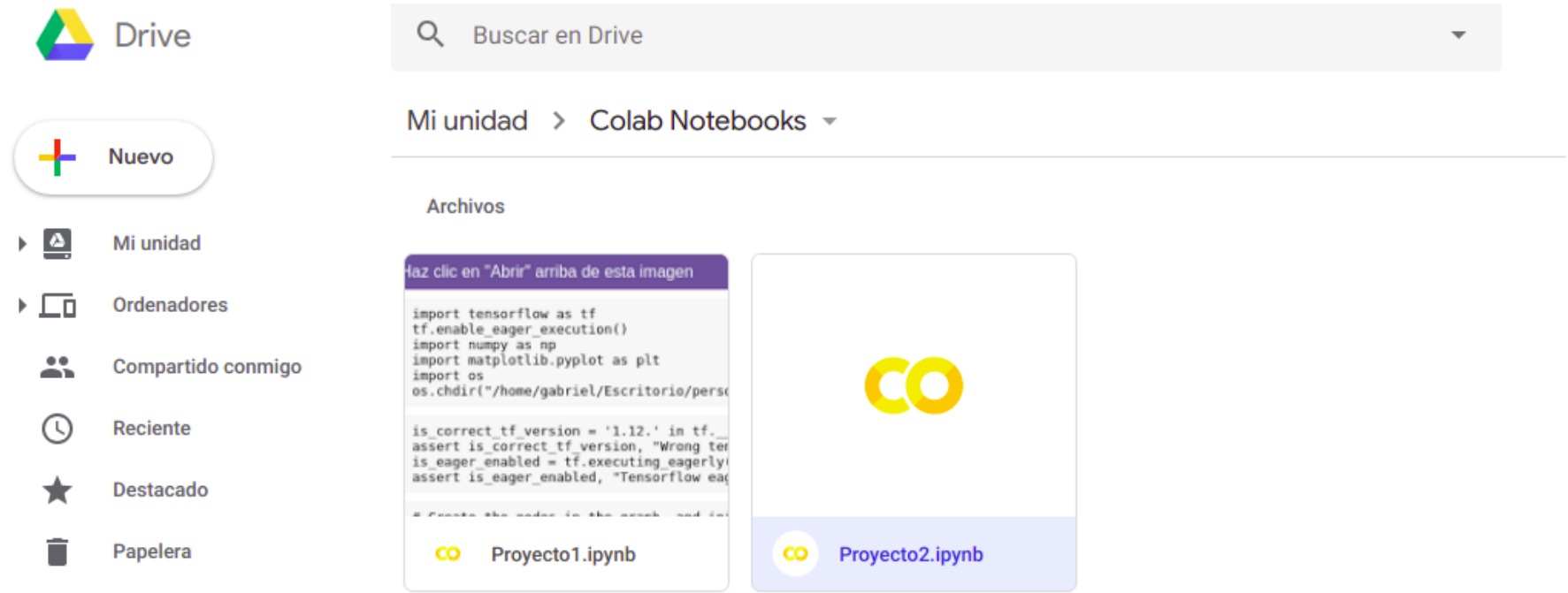
Tools: Google Colab



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[5] https://colab.research.google.com/notebooks/welcome.ipynb

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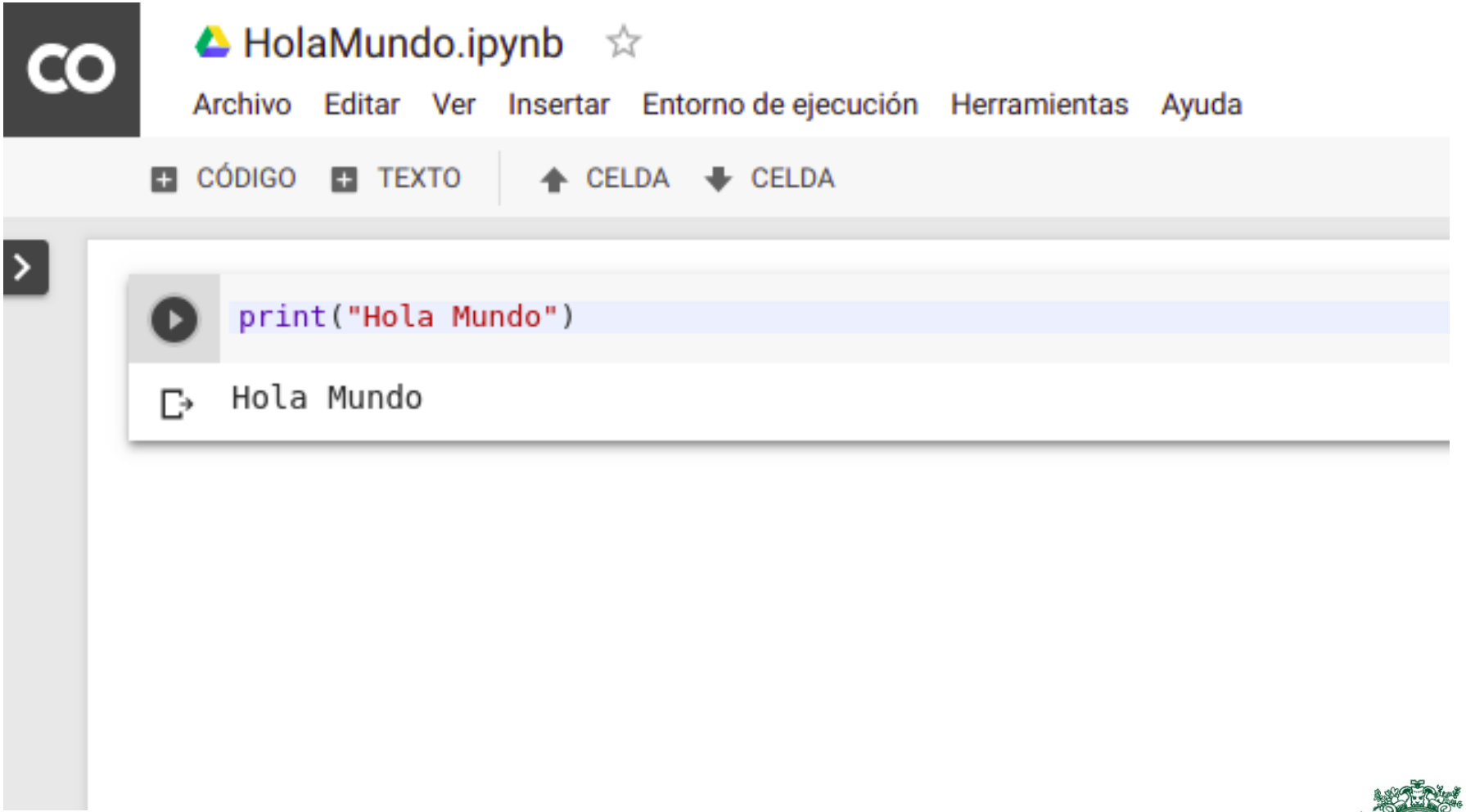
Tools: Google Colab



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[6] https://colab.research.google.com/notebooks/welcome.ipynb

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Tools: List processing

- Lists are just like the arrays, declared in other languages.
- Lists need not be homogeneous always which makes it a most powerful tool in Python.
- A single list may contain DataTypes like Integers, Strings, as well as Objects.
- Lists are also very useful for implementing stacks and queues.

Tools: List processing

```
1  # Creating a List
2  List = []
3  print("Intial blank List: ")
4  print(List)
5
6  # Creating a List with
7  # the use of a String
8  List = ['GeeksForGeeks']
9  print("\nList with the use of String: ")
10 print(List)
11
12 # Creating a List with
13 # the use of multiple values
14 List = ["Geeks", "For", "Geeks"]
15 print("\nList containing multiple values: ")
16 print(List[0])
17 print(List[2])
```

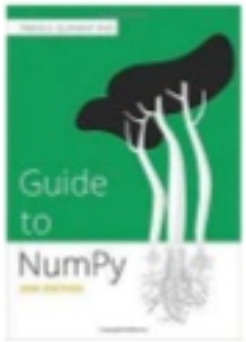
Tools: List processing

```
1  # Creating a List with
2  # the use of Numbers
3  # (Having duplicate values)
4  List = [1, 2, 4, 4, 3, 3, 3, 6, 5]
5  print("\nList with the use of Numbers: ")
6  print(List)
7
8  # Creating a List with
9  # mixed type of values
10 # (Having numbers and strings)
11 List = [1, 2, 'Geeks', 4, 'For', 6, 'Geeks']
12 print("\nList with the use of Mixed Values: ")
13 print(List)
```

Tools: Numpy

NumPy: an Array Extension of Python

- Data: the array object
  - slicing and shaping
  - data-type map to Bytes



- Fast Math (ufuncs):
  - vectorization
  - broadcasting
  - aggregations

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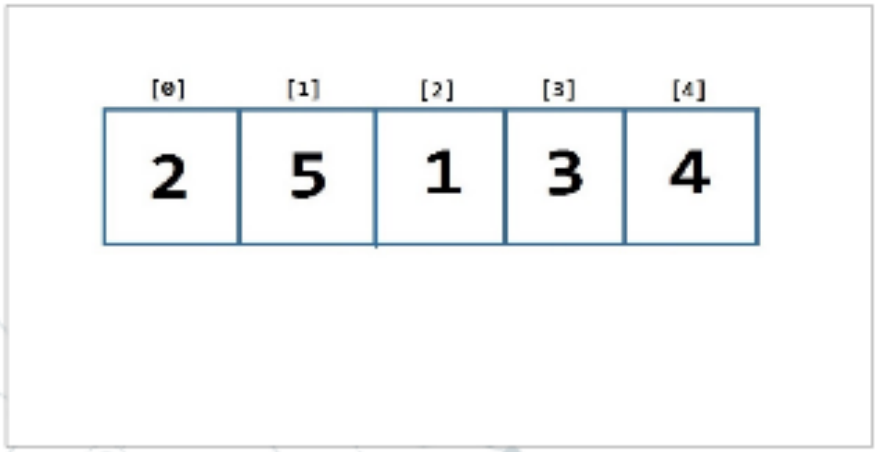
Tools: Numpy

- Array, matrix, vectorial operations.
- Import numpy as np



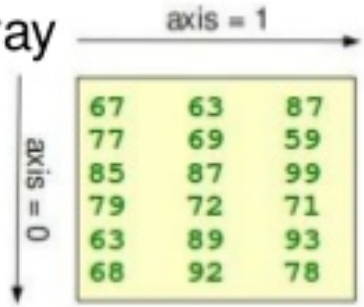
[7]

[7] http://www.numpy.org/

Tools: Numpy

NumPy Examples

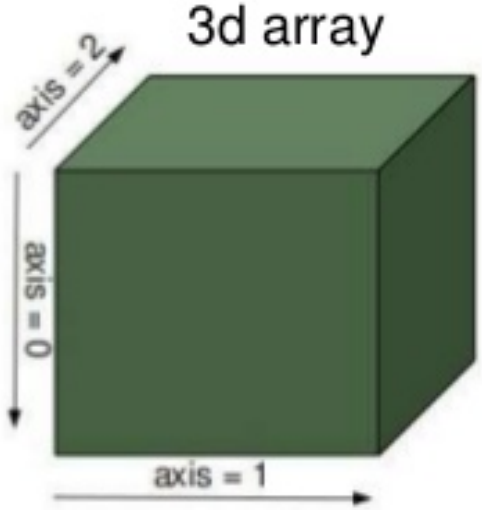
2d array




```
1  import numpy as np
2
3  x = np.array([[67, 63, 87],
4                [77, 69, 59],
5                [85, 87, 89],
6                [79, 72, 71],
7                [63, 89, 93],
8                [68, 92, 78]])
9  print x.sum(axis=0), x.sum(axis=1)
```

```
[439 472 477]
[217 205 261 222 245 238]
```

3d array




```
12  y = 3*np.random.randn(10,20,30)+10
13  print y.mean(), y.std()
```

```
9.98330639789 2.96677717122
```

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Tools: Numpy

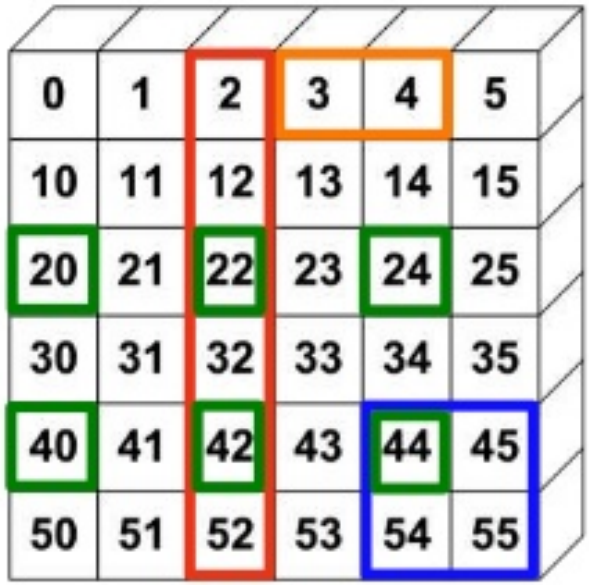
NumPy Slicing (Selection)

```
>>> a[0,3:5]
array([3, 4])

>>> a[4:,4:]
array([[44, 45],
       [54, 55]])

>>> a[:,2]
array([2,12,22,32,42,52])

>>> a[2::2,::2]
array([[20, 22, 24],
       [40, 42, 44]])
```



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Tools: Numpy

```
1  # manejo de arreglos
2
3  import numpy as np #libreria estandar para manejo de datos y senales en Python
4
5  a = np.zeros((2,2))   # Crea un arreglo tipo matriz de ceros
6  print(a)               # Prints "[[ 0.  0.]
7                         #          [ 0.  0.]]"
8  b = np.ones((1,2))    # Crea un arreglo tipo vector fila de unos
9  print(b)              # Prints "[[ 1.  1.]]"
10
11 c = np.full((2,2), 7) # Crea un arreglo tipo matriz de un valor constante
12 print(c)               # Prints "[[ 7.  7.]
13                        #          [ 7.  7.]]"
14 c = 7*np.ones((2,2)) # Otra forma
15 print (c)
16
17 d = np.eye(2)         # Crea un arreglo con la matriz
```

Tools: Numpy

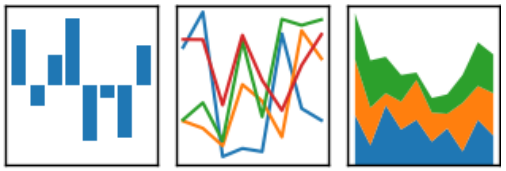
```
1  e = np.random.random((2,2)) # Crea un arreglo tipo matriz de numeros aleatorios entre 0 y 1
2  print (e)          # print "[[ 0.91940167  0.08143941]
3                     #        [ 0.68744134  0.87236687]]"
4  print (e[0,1])                  # Seleccionar un elemento
5  print (e[0,:])                 # Seleccionar la primera fila
6  print (e[:,1])                  # Seleccionar la segunda columna
7
8  xrang=np.arange(20) # Crea un arreglo de numeros consecutivos entre 0 y 19
9  print (xrang)            # print "[0 1 2 3 4 5... 19]"
10 # Para seleccionar partes del arreglo use los siguientes comandos
11 print (xrang[0:5])      # print "[0 1 2 3 4]"
12 print (xrang[10])       # print [10]
13
14 A=np.random.random(100)
15 media=np.mean(A) # calcula la media de un arreglo A
16 maxA=np.max(A) # calcula el maximo valor de un arreglo
```

Tools: Pandas

Python has long been great for data munging and preparation, but less so for data analysis and modeling. pandas helps fill this gap, enabling you to carry out your entire data analysis workflow in Python

pandas

$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$



8

[8] https://pandas.pydata.org/

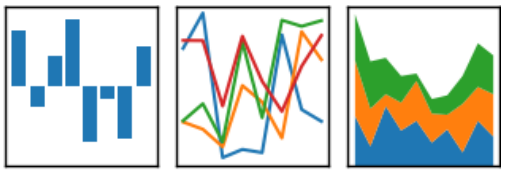
Tools: Pandas

Data structure and tools for data analysis.

- DataFrames
- GroupBy, merge, join
- Data reading and writing
- Import pandas as pd

pandas

$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$



[9]

[9] https://pandas.pydata.org/

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Tools: Pandas

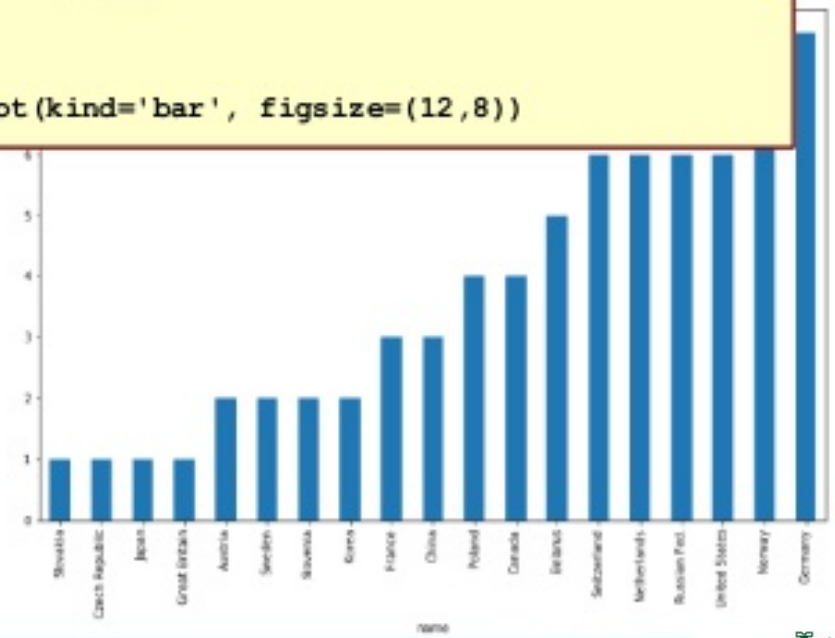
pandas

$y_{it} = \beta' x_{it} + \mu_i + \epsilon_{it}$

Easy Data Wrangling

```
medals = pd.read_csv('data/medals.csv', index_col='name')
medals.head()
gold = medals['medal'] == 'gold'
won = medals['count'] > 0
medals.loc[gold & won, 'count'].sort_values().plot(kind='bar', figsize=(12,8))
```

	count	medal	country
name			
Australia	1	bronze	AUS
Australia	2	silver	AUS
Australia	0	gold	AUS
Austria	1	bronze	AUT
Austria	6	silver	AUT



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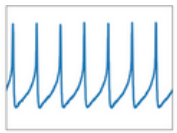
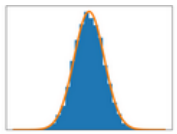
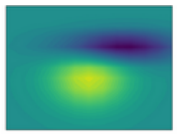
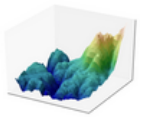
Tools: Matplotlib

Graphics in Python

- Frequency diagram
- Histograms
- Scatter-plots
- 3D graphics
- Surface

Import matplotlib

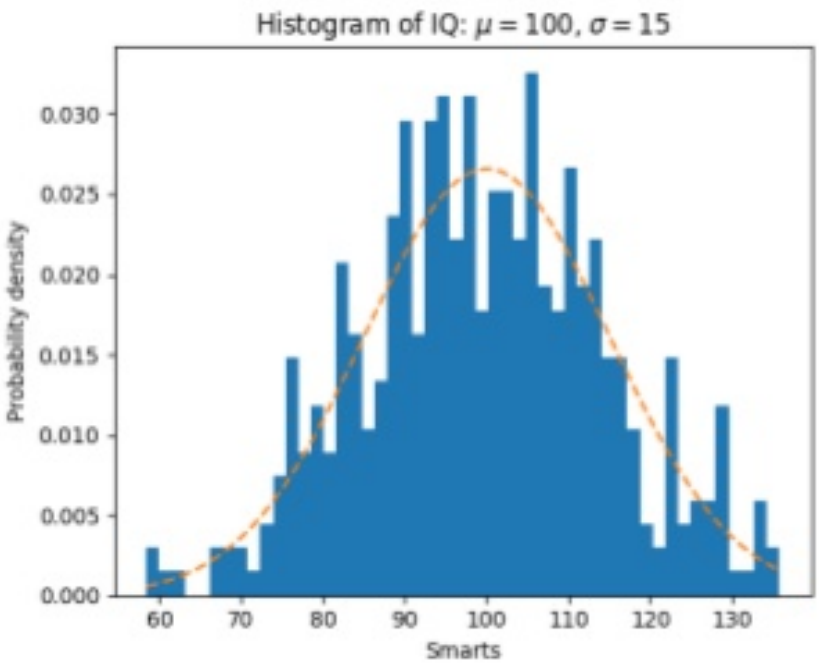
10

[10] https://matplotlib.org/

Tools: Matplotlib

matplotlib a powerful plotting engine

```
import numpy as np
import matplotlib.mlab as mlab
import matplotlib.pyplot as plt

np.random.seed(0)

# example data
mu = 100  # mean of distribution
sigma = 15  # standard deviation of distribution
x = mu + sigma * np.random.randn(437)

num_bins = 50

fig, ax = plt.subplots()

# the histogram of the data
n, bins, patches = ax.hist(x, num_bins, normed=1)

# add a 'best fit' line
y = mlab.normpdf(bins, mu, sigma)
ax.plot(bins, y, '--')
ax.set_xlabel('Smarts')
ax.set_ylabel('Probability density')
ax.set_title(r'Histogram of IQ: $\mu=100$,
$\sigma=15$')

# Tweak spacing to prevent clipping of ylabel
fig.tight_layout()
plt.show()
```



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Tools: Matplotlib

matplotlib a powerful plotting engine

```
import matplotlib.pyplot as plt
import numpy as np

with plt.xkcd():
    fig = plt.figure()
    ax = fig.add_axes((0.1, 0.2, 0.8, 0.7))
    ax.spines['right'].set_color('none')
    ax.spines['top'].set_color('none')
    plt.xticks([])
    plt.yticks([])
    ax.set_ylim([-30, 10])
    data = np.ones(100)
    data[70:] -= np.arange(30)

    plt.annotate('THE DAY I REALIZED\nI COULD
COOK BACON\nWHENEVER I WANTED',
        xy=(70, 1),
        arrowprops=dict(arrowstyle='->'),
        xytext=(15, -10))

    plt.plot(data)

    plt.xlabel('time')
    plt.ylabel('my overall health')
    fig.text(0.5, 0.05, '"Stove Ownership" from
xkcd by Randall Monroe',
        ha='center')
```

"STOVE OWNERSHIP" FROM XKCD BY RANDALL MONROE

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Tools: Matplotlib

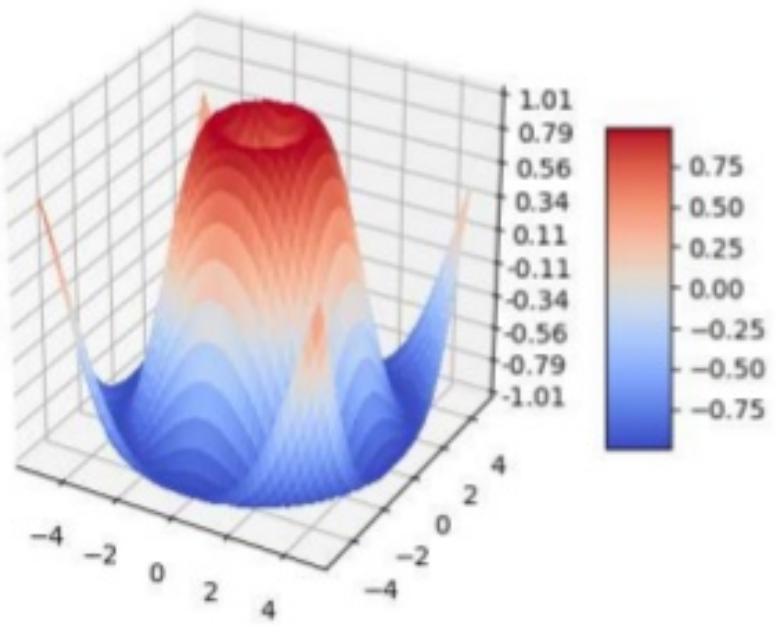
matplotlib a powerful plotting engine

```
from mpl_toolkits.mplot3d import Axes3D
import matplotlib.pyplot as plt
from matplotlib import cm
from matplotlib.ticker import LinearLocator,
FormatStrFormatter
import numpy as np

fig = plt.figure()
ax = fig.gca(projection='3d')
# Make data.
X = np.arange(-5, 5, 0.25)
Y = np.arange(-5, 5, 0.25)
X, Y = np.meshgrid(X, Y)
R = np.sqrt(X**2 + Y**2)
Z = np.sin(R)
# Plot the surface.
surf = ax.plot_surface(X, Y, Z, cmap=cm.coolwarm,
linewidth=0, antialiased=False)

# Customize the z axis.
ax.set_zlim(-1.01, 1.01)
ax.zaxis.set_major_locator(LinearLocator(10))
ax.zaxis.set_major_formatter(FormatStrFormatter('%
.02f'))

# Add a color bar which maps values to colors.
fig.colorbar(surf, shrink=0.5, aspect=5)
plt.show()
```



ANACONDA

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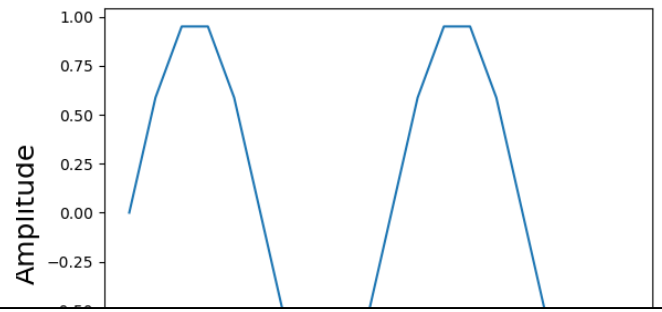
Tools: Matplotlib

```
1  import numpy as np
2  import matplotlib.pyplot as plt
3  %matplotlib inline
4  f=1.0 # Signal frequency
5  fs=10.0 # Sampling frequency
6  t=np.arange(0, 2.0, 1.0/fs) # Vector de tiempo
7  x = np.sin(2*np.pi*f*t)
8  plt.plot(t,x)
9  plt.xlabel('Time',fontsize=18)
10 plt.ylabel('Amplitude',fontsize=18)
11 plt.show()
```



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File managment

Load Text files containing vector or matrices data.

```
1 import numpy as np
2 data=np.loadtxt("file.txt")
```

Write a Text file with vector or matrices data.

```
1 Data=np.random.rand((100,20))
2 np.savetxt("file.txt", Data)
```

File managment

Loading and plotting a Text file that contains a signal.

```
1    data=np.loadtxt("PrecioDolar.txt")
2    signal=data[:,3]
3    t=np.arange(len(signal))
4    plt.plot(t,signal)
5    plt.xlabel("samples")
6    plt.ylabel("TRM COP -US")
7    plt.show()
```

```
1    Ts=1.0/365
2    t=np.arange(1992, 2016+244*Ts+5*Ts, Ts)
3    plt.plot(t,signal)
4    plt.xlabel("Fecha")
5    plt.ylabel("TRM COP-US")
6    plt.show()
```

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File managment

Load data from excel files (.csv)

```
1    import pandas as pd
2    import matplotlib.pyplot as plt
3    data=pd.read_csv("DataSiata.csv")
4    signal=data["pm10"]
5    t=data["index"]
6    plt.plot(t,signal)
7    plt.xlabel("samples")
8    plt.ylabel("Concentracion particulas PM10")
9    plt.show()
```

File managment

Load audio signals (.wav)

```
1    from scipy.io.wavfile import read
2    import matplotlib.pyplot as plt
3    fs,signal=read("098_readtext_PCGITA.wav")
4    t=np.arange(0,len(signal)/fs, 1./fs)
5    plt.plot(t,signal)
6    plt.xlabel("Time [s]")
7    plt.ylabel("Amplitude")
8    plt.show()
```

File managment

Write signal into .wav filee

```
1  from scipy.io.wavfile import write
2  import numpy as np
3
4  fs=44100
5  t=np.arange(0,10,1.0/fs)
6  signal=np.sin(2*np.pi*fs*(t**3))
7
8  signal2=np.asarray(signal*2**15, dtype=np.int16)
9  write("signal.wav", fs, signal2)
```

Functions

If a sequence of commands is used more often, a function is helpful:

```
1    def say_hello():
2        print("hello")
```

```
1    def say_hello_to(name):
2        print("hello " + name)
```

Call the function like this:

```
1    say_hello()
2    say_hello_to("Donald")
```

Functions

```
1    def energy(signal):
2        s2=signal**2
3        energy=sum(s2)
4        return(energy)
```

Call the function like this:

```
1    signal=[2,4,6,0,0,1,2,4,0]
2    E=energy(signal)
3    print("Energy="+str(E))
```

Important: Make sure you get the indentation right, especially when you do cut and paste (so your code works).

Próxima sección

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Let's code

Terminal: **jupyter notebook**

Preguntas

Thanks!

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