



What is Numerical Calculation?

By: Iman Khani Jazani

- *AI and Data Specialist, Business Developer | AiHum*
- *Adjunct Professor | Sharif University of Technology*
- *Senior Data Scientist, Community builder | Adin*



Last Lecture

- Short Presentations
- Review the last lecture
- Data story telling
- Visualization in Python!
- **Application of Programming in the Digital Age!**



Today

- Short Presentations
- Random number generation
- Sampling from distribution
- Introduction to linear algebra with Numpy
- Introduction to SciPy
- **Application of Programming in the Digital Age!**



Together

Send your feedback about the
class whenever you want!



Contact me

- Gmail: ImanKhaniJazani@gmail.com
- LinkedIn: <https://www.linkedin.com/in/ImanKhaniJazani/>
- Telegram: [@IKJ1992](https://t.me/IkJ1992)



Short Presentations

Review the Last Lecture




DST Procedure












Let's go to matplotlib.org!

 [Plot types](#) [Examples](#) [Tutorials](#) [Reference](#) [User guide](#) [Develop](#) [Releases](#)

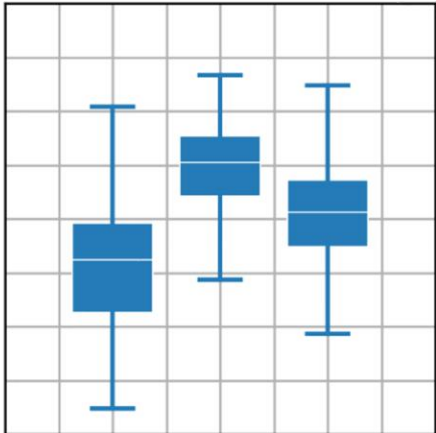
    

Matplotlib: Visualization with Python


Matplotlib is a comprehensive library for creating static, animated, and interactive visualizations in Python. Matplotlib makes easy things easy and hard things possible.

- Create publication quality plots.
- Make interactive figures that can zoom, pan, update.
- Customize visual style and layout.
- Export to many file formats.
- Embed in JupyterLab and Graphical User Interfaces.
- Use a rich array of third-party packages built on Matplotlib.

Try Matplotlib (on Binder) →



boxplot(X)






DST Procedure












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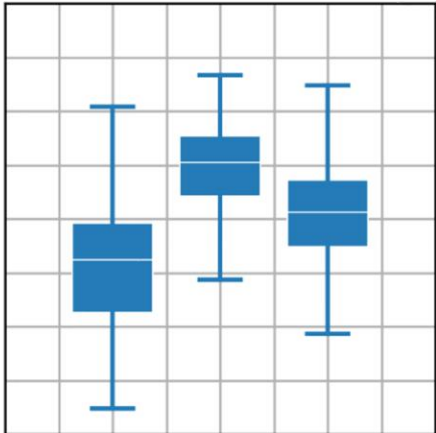
    

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boxplot(X)





PyLab

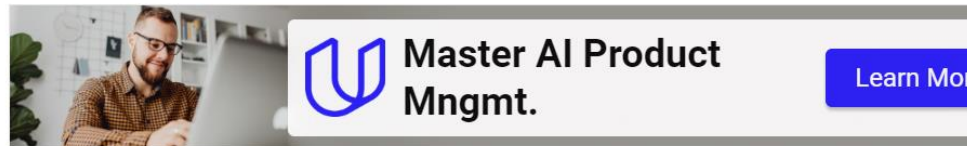


LEARN MATPLOTLIB
absolute beginners

Matplotlib Tutorial

- Matplotlib - Home
- Matplotlib - Introduction
- Matplotlib - Environment Setup
- Matplotlib - Anaconda distribution
- Matplotlib - Jupyter Notebook
- Matplotlib - Pyplot API
- Matplotlib - Simple Plot
- Matplotlib - PyLab module

Matplotlib - PyLab module



Previous Page

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PyLab is a procedural interface to the Matplotlib object-oriented plotting library. Matplotlib is the whole package; matplotlib.pyplot is a module in Matplotlib; and PyLab is a module that gets installed alongside Matplotlib.

PyLab is a convenience module that bulk imports matplotlib.pyplot (for plotting) and NumPy (for Mathematics and working with arrays) in a single name space. Although many examples use PyLab, it is no longer recommended.

Basic Plotting

Plotting curves is done with the plot command. It takes a pair of same-length arrays (or sequences) –

```
from numpy import *
```

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Thanks to Prof. Shahshahani for his talk in the meeting about Math!



Random Number Generation



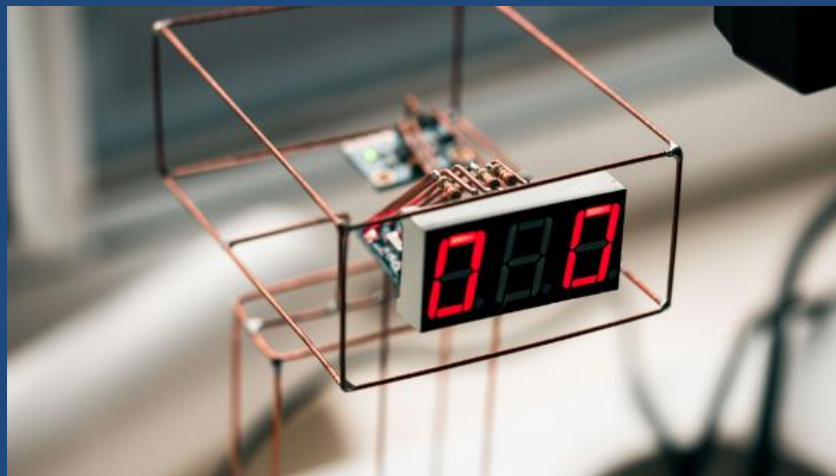
History!

- People have been using **random numbers** for millennia, so the concept isn't new. From the lottery in ancient Babylon, to roulette tables in Monte Carlo, to dice games in Vegas, the goal is to leave the end result up to random chance.
- Generating large quantities of random numbers requires great deal of time and work. Thanks to human ingenuity, we have more powerful tools and methods at our disposal.



True Random Number Generator

- A true random number generator (TRNG), also known as a hardware random number generator (HRNG), does not use a computer algorithm. Instead, it uses an external unpredictable physical variable such as radioactive decay of isotopes or airwave static to generate random numbers.





Pseudo-Random Number

- As an alternative to "true" random numbers, the **second method** of generating random numbers involves computational algorithms that can produce apparently random results.
- Why apparently random? Because the end results obtained are in fact completely determined by an initial value also known as the **seed** value or **key**. Therefore, if you knew the key value and how the algorithm works, you could reproduce these seemingly random results.



Pseudo-Random number generator algorithm

- 1.**Accept** some initial input number, that is a seed or key.
- 2.**Apply** that seed in a sequence of mathematical operations to generate the result. That result is the random number.
- 3.**Use** that resulting random number as the seed for the next iteration.
- 4.**Repeat** the process to emulate randomness.



Let's go to Python!

Courses ▾ Tutorials ▾ Jobs ▾ Practice ▾ Contests ▾

⏪ Data Types Control Flow Functions List String Set Tuple Dictionary Oops Exception Handling Python Programs Python Projects Python Interview Questions Python MCQ NumPy Pandas ⏩

Generating random number list in Python

Python | random.sample() function

Python | Pandas Dataframe.sample()

How to randomly select rows from Pandas DataFrame

Python program to find number of days between two given dates

Python | Difference between two dates (in minutes) using datetime.timedelta() method

Python | datetime.timedelta() function

Comparing dates in Python

Convert string to DateTime and vice-versa in Python




Random Numbers in Python

Read

Discuss

Courses

Practice



Python defines a set of functions that are used to generate or manipulate random numbers through the random module.

Functions in the [random module](#) rely on a pseudo-random number generator function random(), which generates a random float number between 0.0 and 1.0. These particular type of functions is used in a lot of games, lotteries, or any application requiring a random number generation.

Let us see an example of generating a random number in Python using the [random\(\) function](#).

Python3

```
import random
num = random.random()
print(num)
```

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Sampling from Distribution



What is distribution?

A **probability distribution** is a mathematical function that describes the probability of different possible values of a variable. Probability distributions are often depicted using graphs or probability tables.

Example: Probability distribution

We can describe the probability distribution of one coin flip using a probability table:

Outcome	Probability
Heads	Tails
.5	.5



Different types of distribution

- Bernoulli Distribution
- Uniform Distribution
- Binomial Distribution
- Normal or Gaussian Distribution
- Exponential Distribution
- Poisson Distribution



What is sampling?

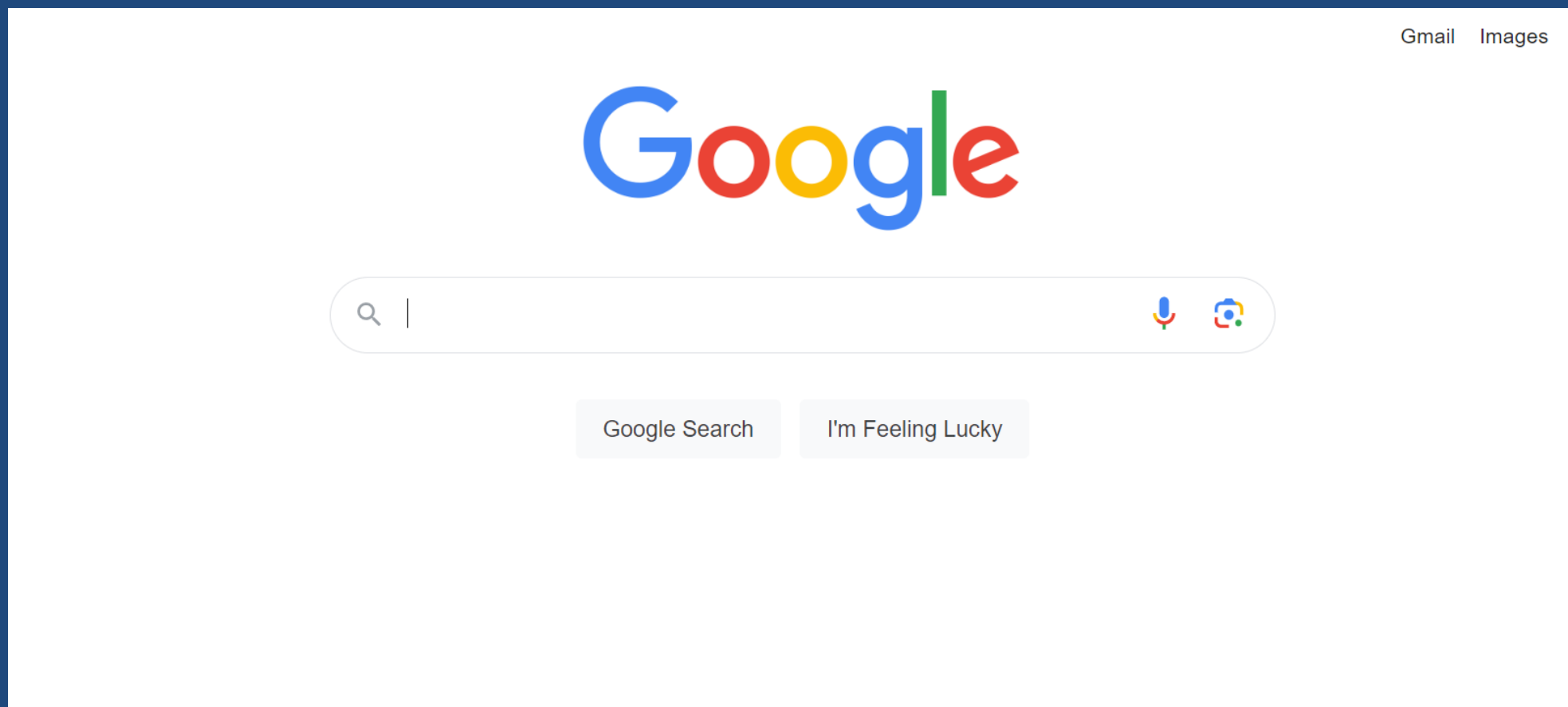
- A **sample** is a subset of individuals from a larger population. Sampling means selecting the group that you will actually collect data from in your research. For example, if you are researching the opinions of students in your university, you could survey a sample of 100 students.



What is a sample in Bernoulli distribution?



Sampling with Python? Let's go!



Introduction to linear algebra with Numpy



What is vector? matrix? tensor?

(11)

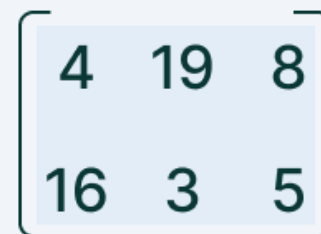


Scalar

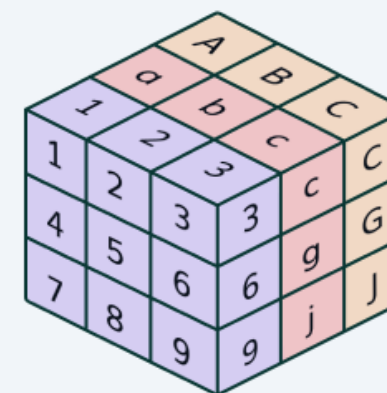
Row Vector
(shape 1×3)



Column Vector
(shape 3×1)



Matrix



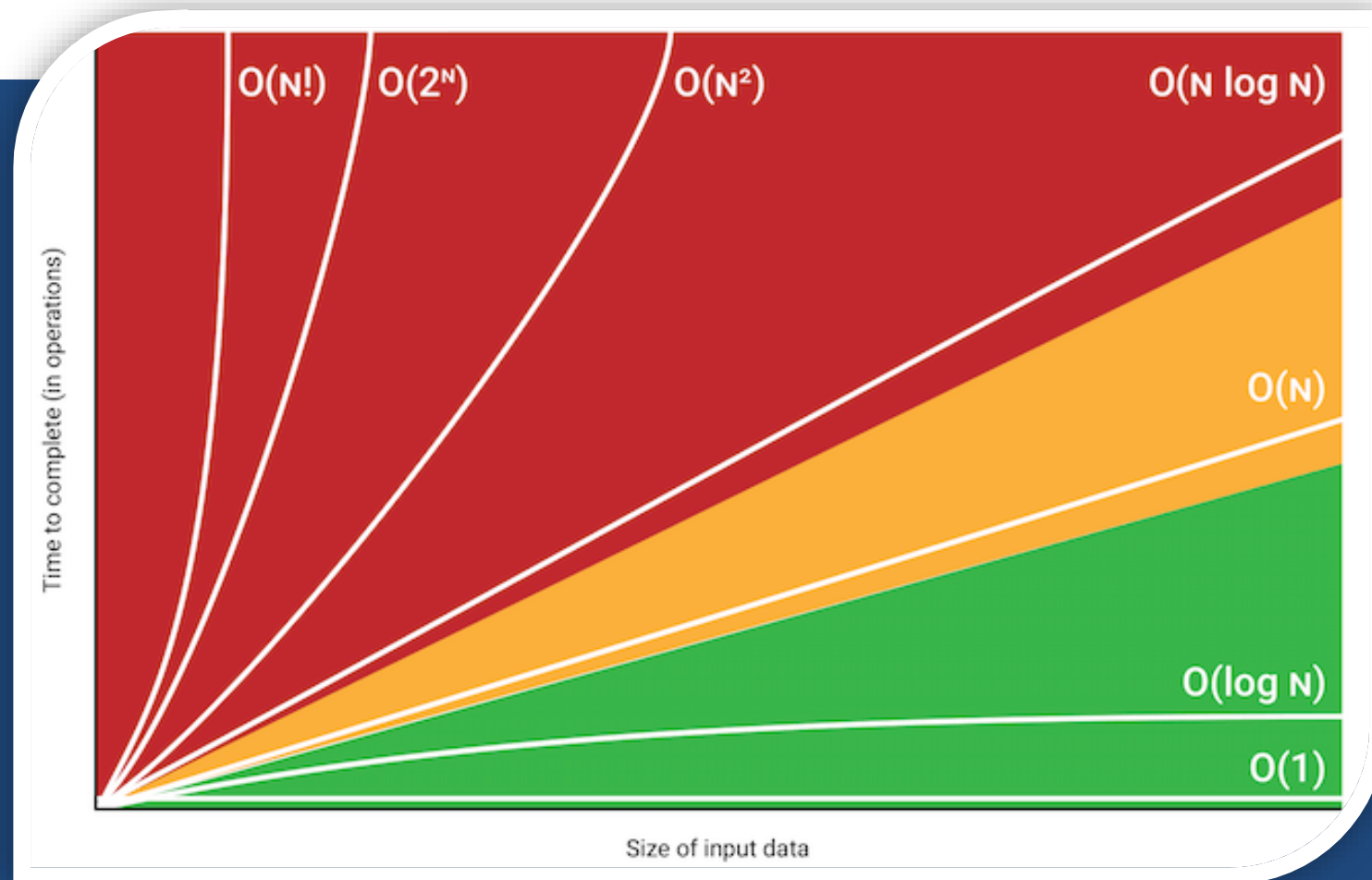
Tensor

V7 Labs



Let's go to implement in python and time complexity!

- scalar * vector
- vector + vector
- matrix + matrix
- matrix * matrix





Let's go to Numpy

[Home](#) [HTML](#) [CSS](#) [JAVASCRIPT](#) [SQL](#) [PYTHON](#) [JAVA](#) [PHP](#) [BOOTSTRAP](#) [HOW TO](#) [W3.CSS](#) [C](#)

NumPy Tutorial

NumPy HOME

NumPy Intro

NumPy Getting Started

NumPy Creating Arrays

NumPy Array Indexing

NumPy Array Slicing

NumPy Data Types

NumPy Copy vs View

NumPy Array Shape

NumPy Array Reshape

NumPy Array Iterating

NumPy Array Join

NumPy Array Split

NumPy Array Search

NumPy Array Sort

NumPy Array Filter

NumPy Random

Learning by Reading

We have created 43 tutorial pages for you to learn more about NumPy.

Starting with a basic introduction and ends up with creating and plotting random data sets, and working with NumPy functions:

Basic

Introduction

Getting Started

Creating Arrays

Array Indexing

Array Slicing

Random

Random Intro

Data Distribution

Random Permutation

Seaborn Module

Normal Dist.

ufunc

ufunc Intro


Create Function

Simple Arithmetic

Rounding Decimals

Logs

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<https://www.w3schools.com/default.asp>

Introduction to SciPy



Let's go!

The screenshot shows a Google search interface with the query "introduction to scipy". The search results page displays "About 13,100,000 results (0.40 seconds)" and a featured snippet from W3Schools. The snippet states: "SciPy is a scientific computation library that uses NumPy underneath. SciPy stands for Scientific Python. It provides more utility functions for optimization, stats and signal processing. Like NumPy, SciPy is open source so we can use it freely." Below the snippet, the W3Schools link is shown with the URL "https://www.w3schools.com › python › scipy › scipy_intro". At the bottom of the snippet, the link "Introduction to SciPy - W3Schools" is visible. To the right of the search results, there is a button that says "Ask ChatGPT for this query". At the bottom of the search results, there are links for "About featured snippets" and "Feedback". Below the search results, the SciPy logo and the URL "https://docs.scipy.org › doc › scipy › tutorial › general" are shown, along with the link "Introduction — SciPy v1.10.1 Manual".



Solve linear equation

```
import numpy as np
from scipy import linalg

# The linear algebra system which is given as

#  $3x + 2y = 2$ 

#  $x - y = 4$ 

#  $5y + z = -1$ 

# We need to find values of x,y and z for which all these equations are zero

# Creating the input array
a = np.array([[3, 2, 0], [1, -1, 0], [0, 5, 1]])

# Providing the solution Array
b = np.array([[2], [4], [-1]])

# Solve the linear algebra
x = linalg.solve(a, b)

# Printing the result
print(x)

# Checking the result
np.dot(a, x) == b
```

Edit & Run



What is interpolation?

Google search results for "interpolation in python".

Search results include:

- Linear
- Trilinear
- Bicubic
- Natural neighbor
- Kriging
- Multivariate
- IDW

« Add Grepper Answer (a)

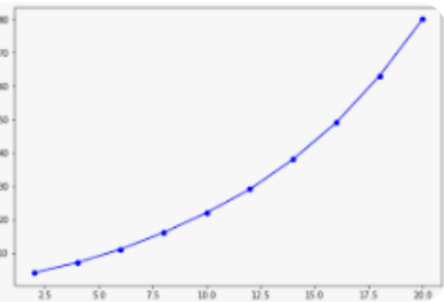
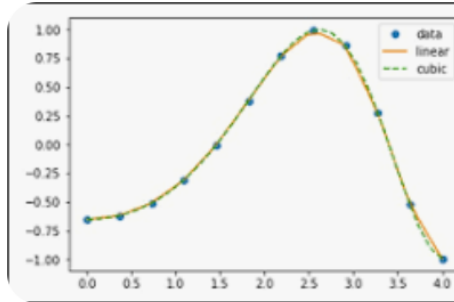
Interpolation in Python is a technique used to estimate unknown data points between two known data points. In Python, Interpolation is a technique mostly used to impute missing values in the data frame or series while preprocessing data.

Khordad 11, 1400 AP

Analytics Vidhya
<https://www.analyticsvidhya.com> › blog › 2021/06 › po...

[Interpolation Techniques Guide & Benefits | Data Analysis](#)

Two line plots are shown:



Footer: ? About featured snippets • Feedback



Interpolation with SciPy

```
from scipy.interpolate import interp1d
import numpy as np

xs = np.arange(10)
ys = 2*xs + 1

interp_func = interp1d(xs, ys)

newarr = interp_func(np.arange(2.1, 3, 0.1))

print(newarr)
```

Application of Programming in the Digital Age!



Is it ethical!?

Monitoring





Lecture Resources

- <https://www.guru99.com/scipy-tutorial.html>
- <https://www.geeksforgeeks.org/numpy-tutorial/>
- <https://www.w3schools.com/python/numpy/default.asp>