Linear Algebra

TA session #1

Fall 2021

Introduction to NumPy

Provided by:

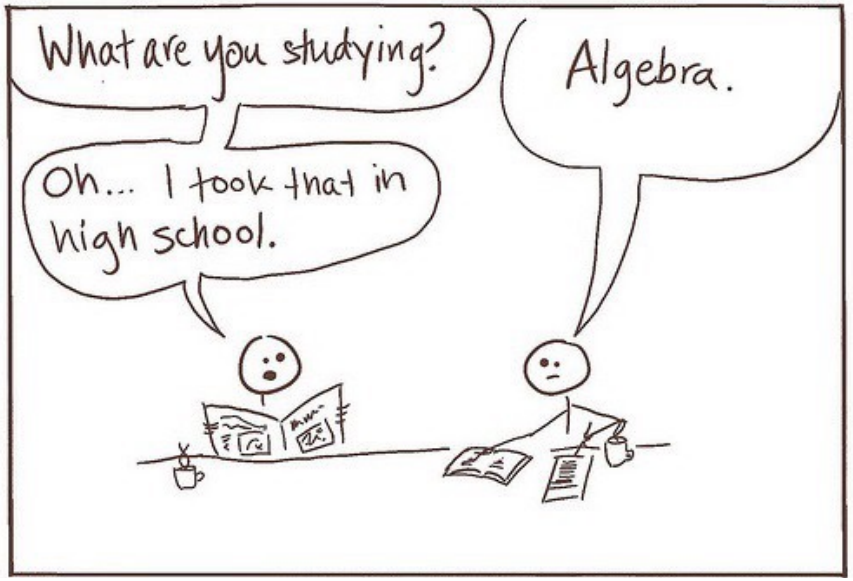
Mohammad Hashemi – Hanieh Mahdavi – Narges Ghasemi – Peyman Alavi

Outline

1. Motivations for learning Linear Algebra
2. Introduction to Jupyter Notebook
3. An introduction to NumPy

Motivation

Why should I learn Linear Algebra?!



Motivation

Fields of CE as graduate studies:

Computer Hardware	Computer Software	Artificial Intelligence

Motivation

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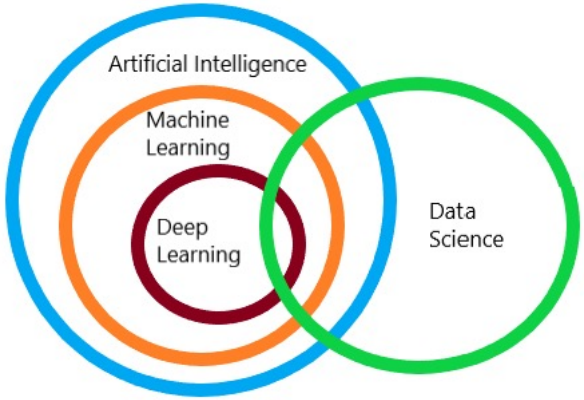
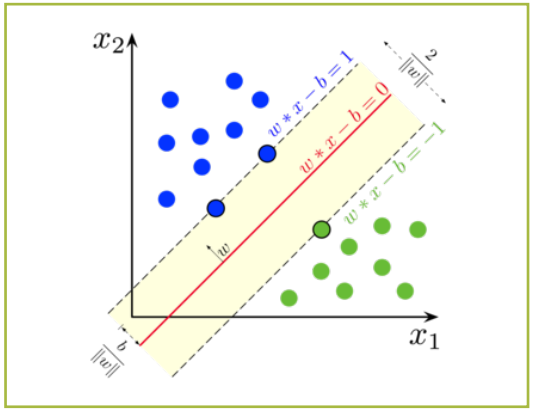
Computer Hardware	Computer Software	**Artificial Intelligence**

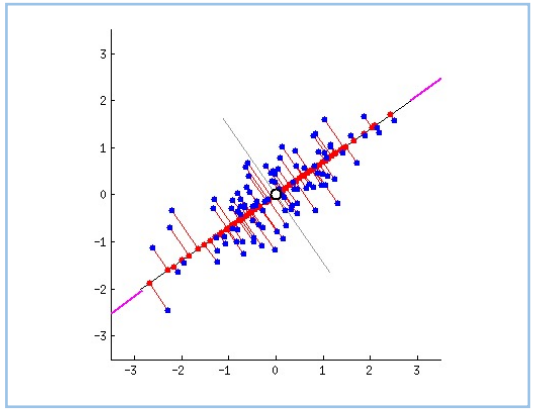


Motivation

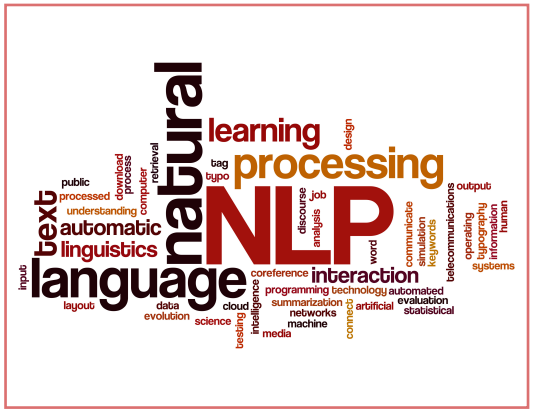
'If Data Science was Batman, Linear Algebra would be Robin.'



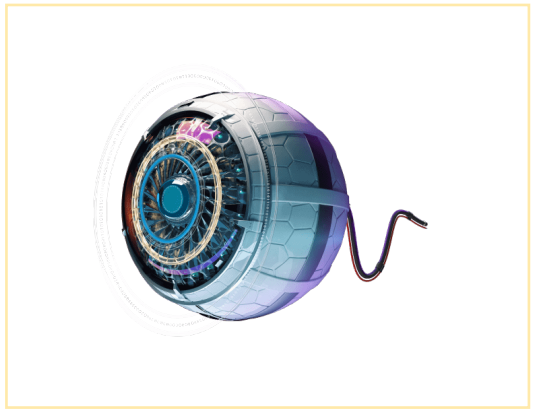
Machine Learning



Dimensionality Reduction



Natural Language Processing



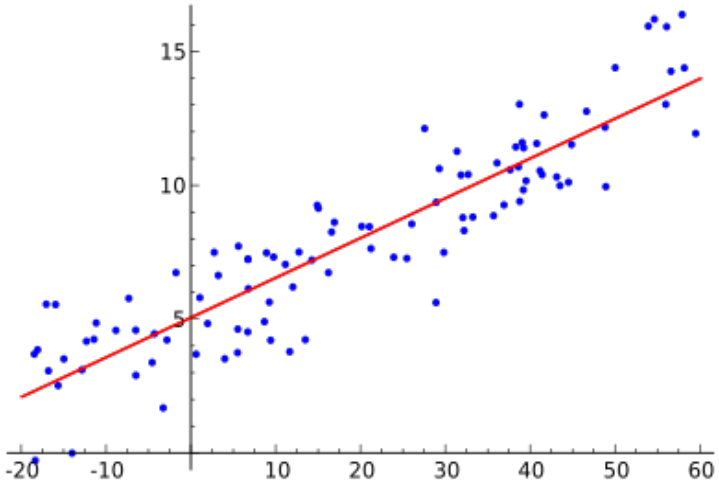
Computer Vision

Motivation

Linear Algebra in Machine Learning

1. Loss Functions

- Start with some arbitrary function (i.e. A linear function).
- Calculate how far-off the predicted output is from the actual output. *How?!*
- Use GD optimize your prediction function.



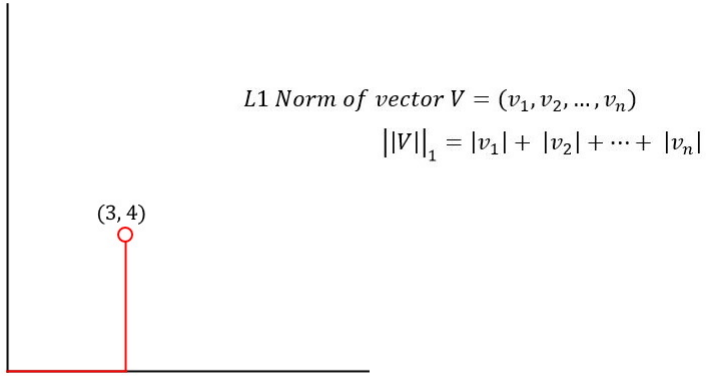
Linear Regression

Motivation

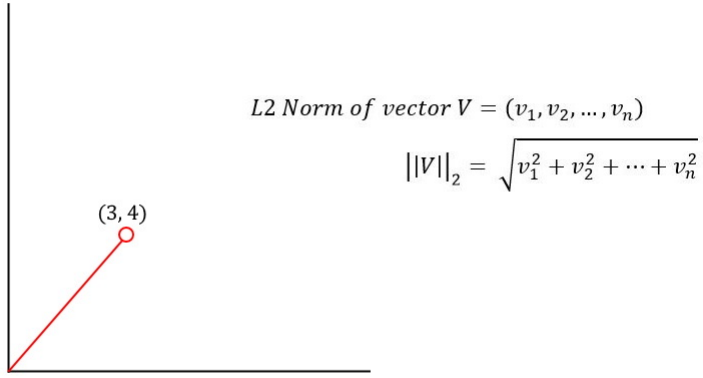
Linear Algebra in Machine Learning

1. Loss Functions

Manhattan Distance or L1 Norm



Euclidean Distance or L2 Norm



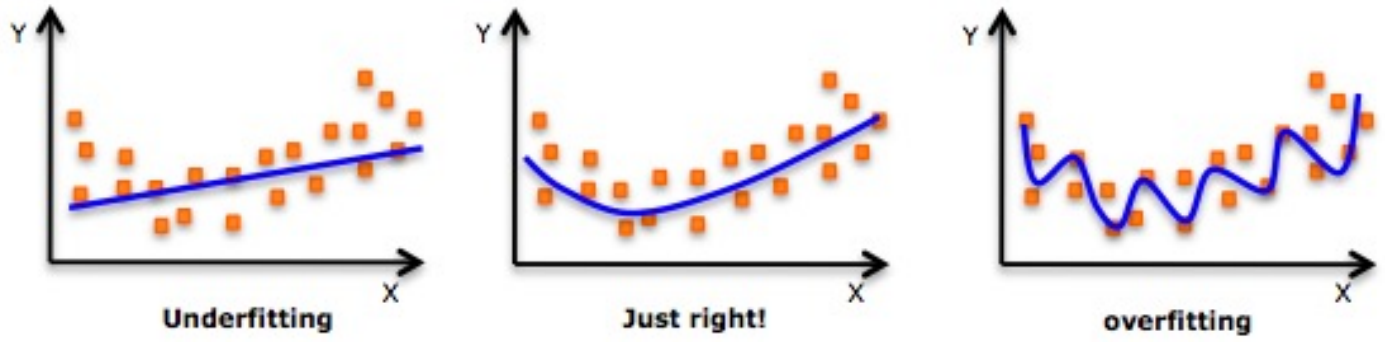
Motivation

Linear Algebra in Machine Learning

2. Regularization

Regularization is a very important concept in data science. It's a technique we use to prevent models from **overfitting**. Regularization is actually another application of the ***Norm***.

- L1 regularization used with **Lasso Regression**.
- L2 regularization used with **Ridge Regression**.

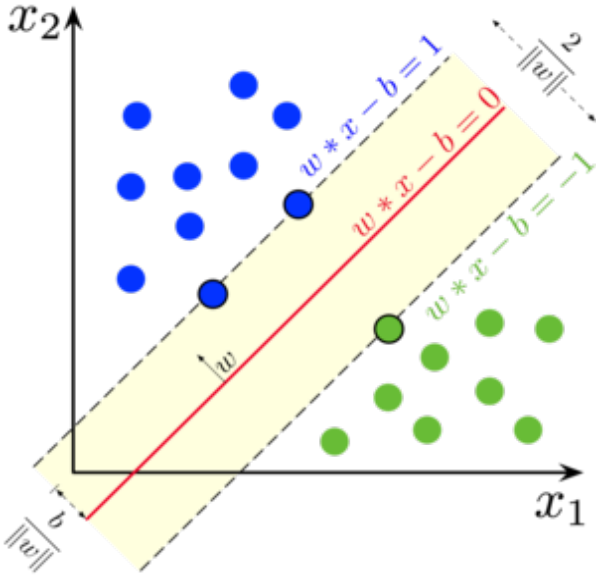


Motivation

Linear Algebra in Machine Learning

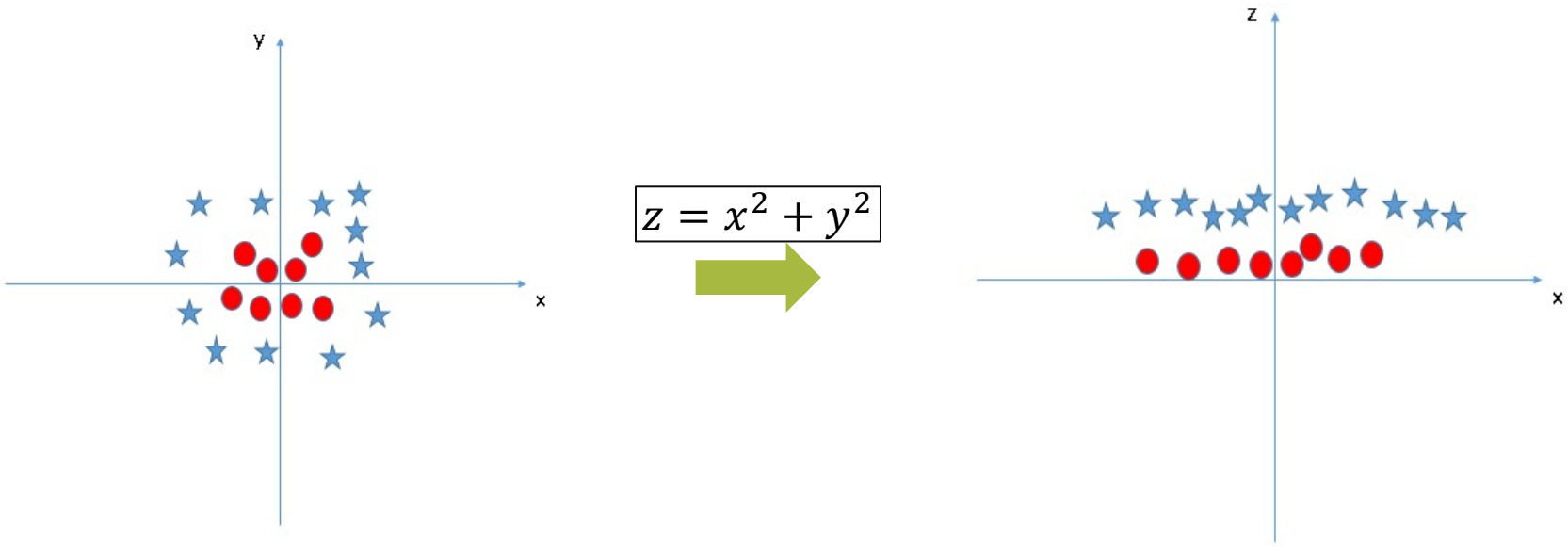
3. Support Vector Machines (SVM)

One of the most common classification algorithms that regularly produces impressive results. It is an application of the concept of **Vector Spaces** in Linear Algebra.



Motivation

Kernel Transformations



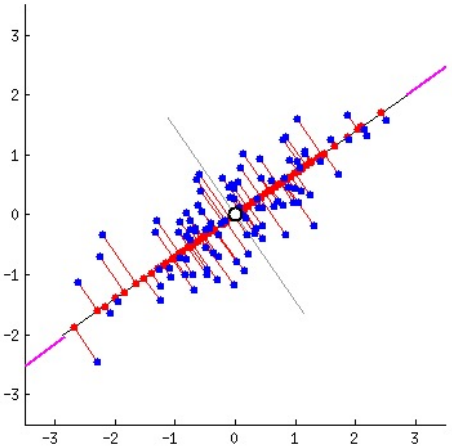
Motivation

Linear Algebra in Dimensionality Reduction

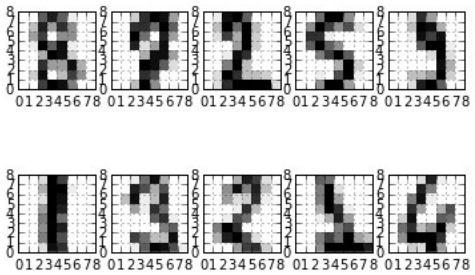
1. Principal Component Analysis (PCA)

PCA finds the **directions of maximum variance** and projects the data along them to reduce the dimensions.

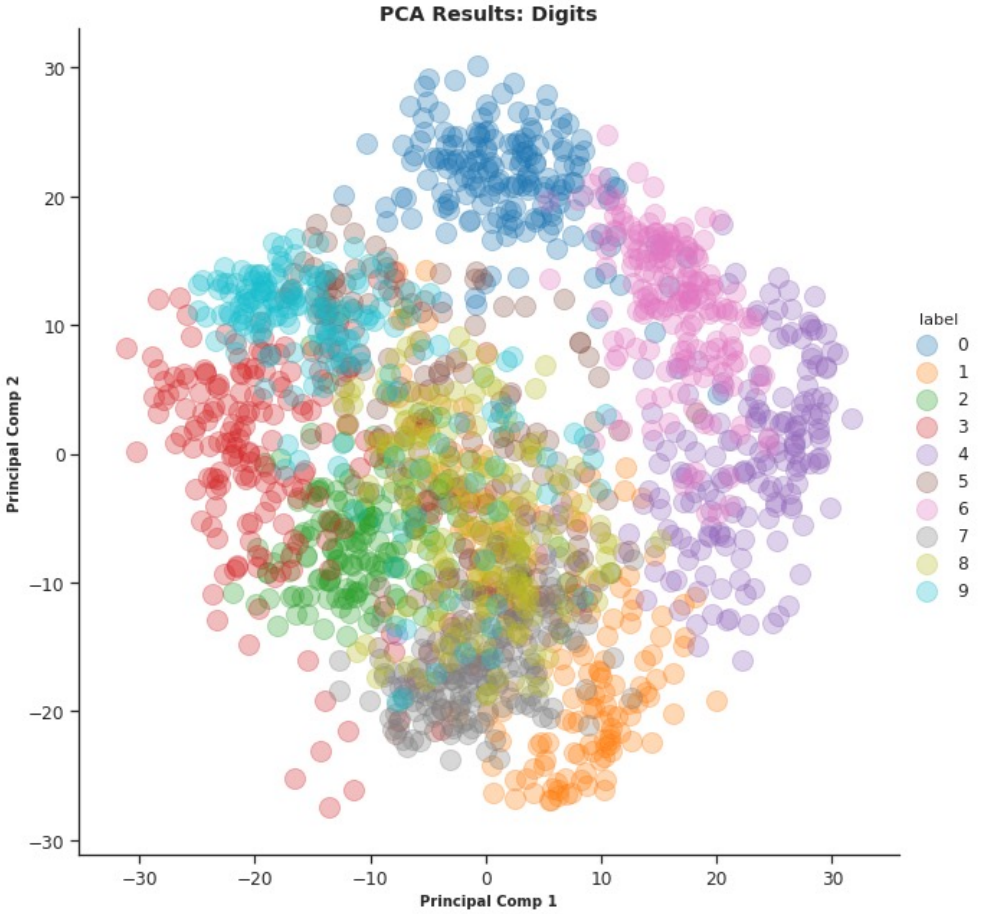
Without going into the math, these directions are the eigenvectors **of the covariance** matrix of the data.



Motivation



Digit Dataset



Motivation

Linear Algebra in Dimensionality Reduction

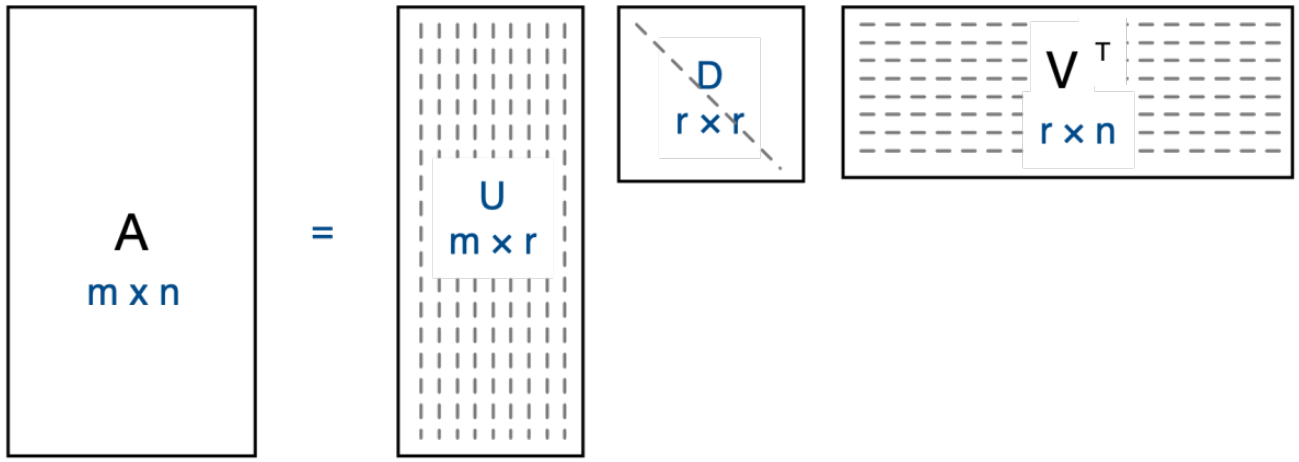
2. Singular Value Decomposition (SVD)

$$A = U D V^T$$

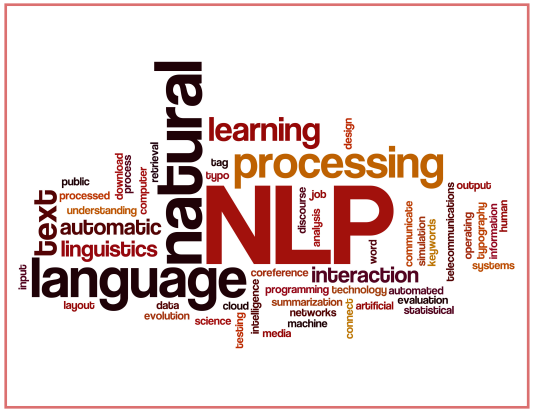
Left singular vectors

Singular values

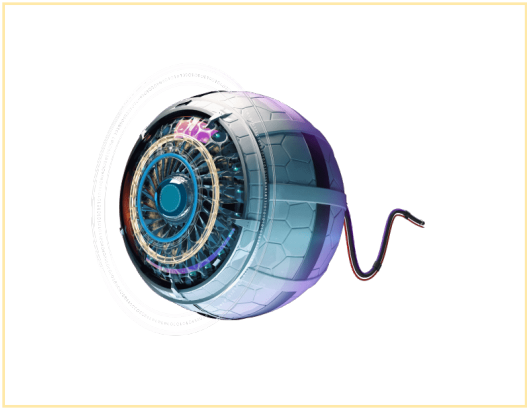
Right singular vectors



Motivation



Natural Language Processing



Natural Language Processing

Word Embeddings

Latent Semantic Analysis (LSA)

...

Image Representation as Tensors

Convolution & Image Processing

...

https://www.analyticsvidhya.com/blog/2019/07/10-applications-linear-algebra-data-science

Notebook

Jupyter Notebook

What is Jupyter Notebook ?!

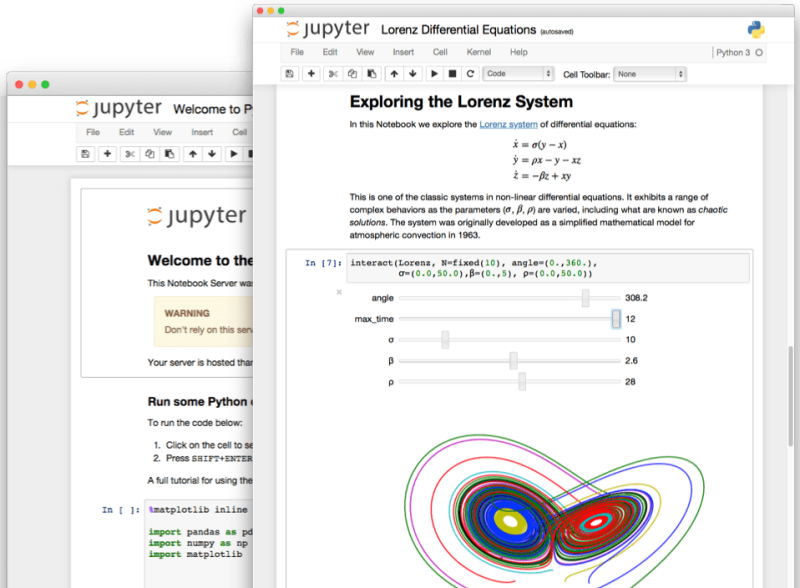
The Jupyter Notebook is an open-source web application that allows you to create and share documents that contain live code, equations, visualizations and narrative text.

Install with **Conda**:

```
conda install -c conda-forge notebook
```

Or install with **Pip**:

```
pip install notebook
```



https://www.anaconda.com/blog/understanding-conda-and-pip

An introduction to NumPy

NumPy

What is NumPy ?!

1. An open-source numerical **Python** library.
2. Contains a multi-dimensional array and **matrix** data structures.
3. Can be utilized to perform a number of mathematical operations on arrays. Therefore, the library contains a large number of mathematical, **algebraic**, and **transformation functions**.
4. It is a wrapper around library implemented in **C**.

NumPy

How to install NumPy?

If you already have Python, NumPy can be installed with:

If not, you might want to consider using **Anaconda**. It is the easiest way for getting started and has all the major packages pre-installed.

NumPy

Let’s Do Some Code! 👨🏻‍💻

Thanks.

Mohammad Hashemi
mohammad99hashemi@gmail.com

Hanieh Mahdavi
haniehmahdavi@yahoo.com

Narges Ghasemi
ghasemi.narges2000@gmail.com

Peyman Alavi
peymanalavy@gmail.com