



ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

DIPARTIMENTO DI
SCIENZE STATISTICHE "PAOLO FORTUNATI"



Deep Learning and Large Language Models

From Neural Network to ChatGPT

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Seminar Overview

Introduction to Neural Networks

- Neural Networks: The Foundation of Deep Learning
- Explains basic concepts, neurons, activation functions, and the role of layers in neural networks.

Recurrent Neural Networks (RNNs)

- Sequencing Data with RNNs
- Introduces RNNs for handling sequential data, such as time series and text data.

Gated Recurrent Unit (GRU) Networks

- Enhancing RNNs with GRUs
- Describes the GRU architecture, emphasizing its ability to capture long-range dependencies.

Long Short-Term Memory (LSTM) Networks

- Memory and Learning: LSTMs Unveiled
- Explores LSTM networks and their capacity to maintain long-term memory for sequential data.

Introduction to Sequence-to-Sequence Models

- Transforming Sequences with Seq2Seq Models
- Introduces sequence-to-sequence models, used for tasks like machine translation and chatbots.

Word Embedding

- Mapping Words to Vectors
- Explains how word embeddings like Word2Vec and GloVe convert words into vector representations.

LLM and Transformers Architecture

- The Revolution: Large Language Models and Transformers
- Discusses the breakthrough role of Transformers in natural language understanding.

Pretrained Language Models

- The Power of Pretrained Models
- Covers the idea of pretrained language models and their capabilities in various NLP tasks.

OpenAI API and GPT

- Unlocking AI Magic: OpenAI's GPT Models
- Introduces OpenAI's GPT (Generative Pre-trained Transformer) models and their applications.

Hugging Face and Transformers Library

- Transformers for Everyone: Hugging Face's Contribution
- Showcases the Hugging Face Transformers library and its prebuilt models.

Examples and Applications

- Putting Knowledge into Practice
- Provides real-world examples and applications, like chatbots, sentiment analysis, and language translation.

Learning Tools

Anaconda

- To set up your python environment, you'll first need to have a python on your machine.
- There are various python distributions available and we have chosen one that works very well for data science.
- Anaconda comes with its own Python distribution which will be installed along with it.



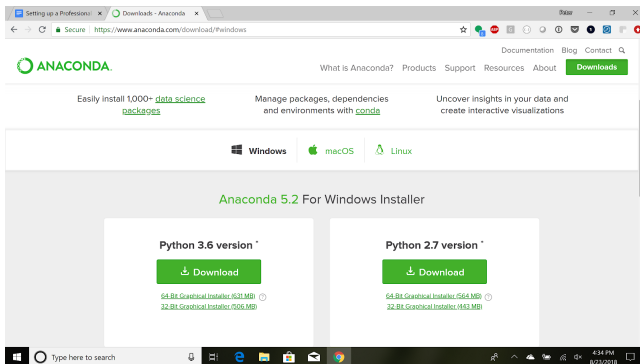
Anaconda

- Data Science often requires you to work with a lot of scientific packages like scipy and numpy, data manipulation packages like pandas and IDEs and interactive Jupyter Notebook.
- Now, you don't need to worry about any python package most of them come pre-installed and if you want to install a new package, you can do that simply by using conda or pip.



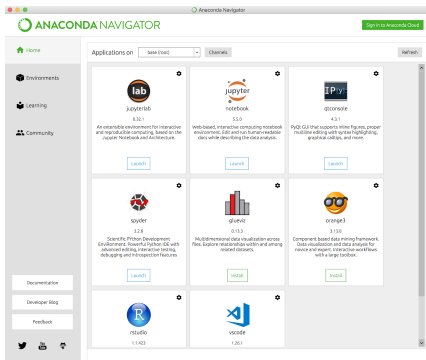
Installing Python and Anaconda

- To download an Anaconda distribution, you can use the official download page:
<https://www.anaconda.com/download/>
- Here, you can select your platform and then choose the installer. For this, you can choose which version you want and whether 32-bit or 64-bit.



Testing Your Installation

To test your installation, on Windows, click on Start and then Anaconda Navigator in the program list (or search for Anaconda in the search bar and select Anaconda Navigator). On a Mac, open up the finder, and in the Applications folder, double click on Anaconda-Navigator.



Package Managers

- Anaconda will give you two package managers- pip and conda.
- When some packages aren't available with conda, you can use pip to install them.
- Note that using pip to install packages also available to conda may cause an installation error.

Teaching tools: Jupyter Notebook

- The Python world developed the IPython notebook system.
- Notebooks allow you to write text, but you insert code blocks as "cells" into the notebook.
- A notebook is interactive, so you can execute the code in the cell directly!
- Recently the Notebook idea took a much enhanced vision and scope, to explicitly allow languages other than Python to run inside the cells.
- Thus the Jupyter Notebook was born, a project initially aimed at Julia, Python and R (Ju-Pyt-e-R). But in reality many other languages are supported in Jupyter.

Teaching tools: Jupyter Notebook

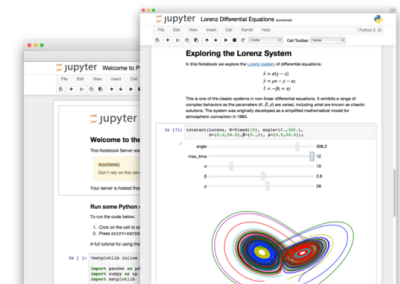


Jupyter Notebook

The Jupyter Notebook is a web application that allows you to create and share documents that contain live code, equations, visualizations and explanatory text. Uses include: data cleaning and transformation, numerical simulation, statistical modeling, machine learning and much more.

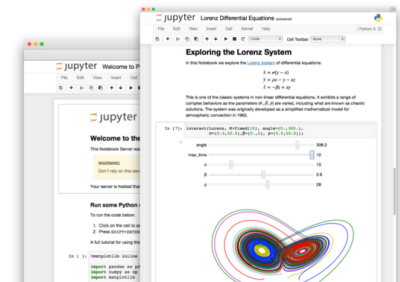
Teaching tools: Jupyter Notebook

- Jupyter was designed to enable sharing of notebooks with other people.
- The idea is that you can write some code, mix some text with the code, and publish this as a notebook.
- In the notebook they can see the code as well as the actual results of running the code.



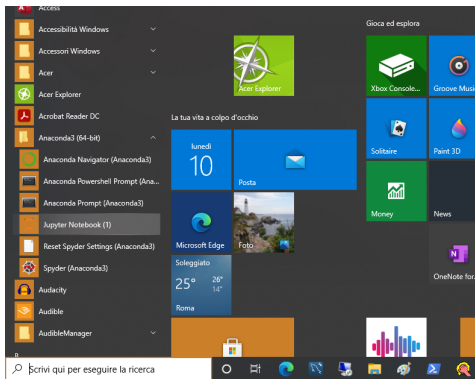
Teaching tools: Jupyter Notebook

- This is a nice way of sharing little experimental snippets, but also to publish more detailed reports with explanations and full code sets.
- Of course, a variety of web services allows you to post just code snippets (e.g. gist).
- What makes Jupyter different is that the service will actually render the code output.



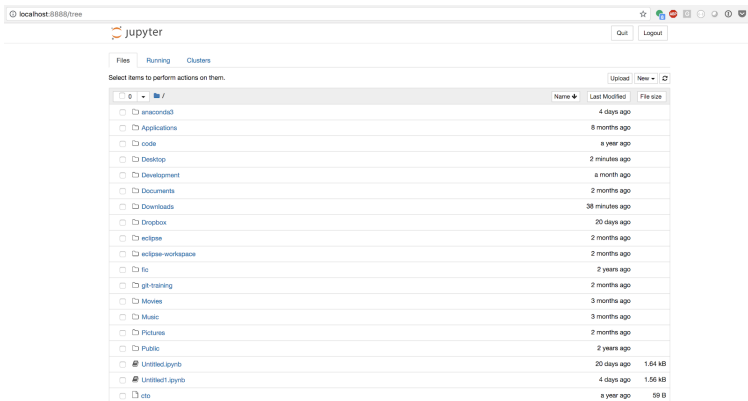
Teaching tools: Jupyter Notebook

- As we saw earlier, the Jupyter Notebook ships with Anaconda. To run it, you can get in your virtual environment and type the following command: **jupyter notebook**;
- Or directly from the Windows Menu...



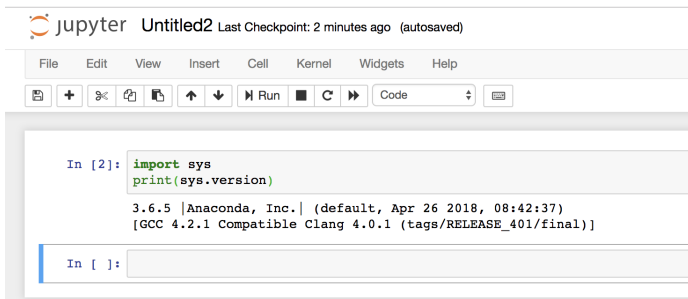
Teaching tools: Jupyter Notebook

- You can find this at **<http://localhost:8888/tree>**
- Now to run Python here, you can create a new file.



Teaching tools: Jupyter Notebook

To make sure it's working, click in the cell and type the following:



The screenshot shows a Jupyter Notebook window titled "Untitled2" with a status bar indicating "Last Checkpoint: 2 minutes ago (autosaved)". The interface includes a menu bar with options: File, Edit, View, Insert, Cell, Kernel, Widgets, and Help. Below the menu is a toolbar with icons for saving, adding, deleting, and running code. The main area contains a code cell with the following content:

```
In [2]: import sys
        print(sys.version)

3.6.5 |Anaconda, Inc.| (default, Apr 26 2018, 08:42:37)
[GCC 4.2.1 Compatible Clang 4.0.1 (tags/RELEASE_401/final)]
```

Below the code cell is an empty input cell labeled "In []:".

Teaching tools: Google Colab



- Colaboratory, or "Colab" for short, is a product from Google Research.
- Colab allows anybody to write and execute arbitrary python code through the browser, and is especially well suited to machine learning, data analysis and education.

<https://colab.research.google.com/notebooks/intro.ipynb?hl=en>

Teaching tools: Google Colab



- More technically, Colab is a hosted Jupyter notebook service that requires no setup to use, while providing free access to computing resources including GPUs.
- Colab notebooks are stored in *Google Drive*, or can be loaded from *GitHub*. Colab notebooks can be shared just as you would with Google Docs or Sheets.

<https://colab.research.google.com/notebooks/intro.ipynb?hl=en>

GitHub Repository for this Course

- GitHub is a provider of Internet hosting for software development and version control using Git. It offers the distributed version control and source code management (SCM) functionality of Git, plus its own features.
- It provides access control and several collaboration features such as bug tracking, feature requests, task management, continuous integration for every project.
- You can find all the teaching materials (notebook, slides, code, etc...) at this address <https://github.com/polyhedron-gdl> in the repository [halloween-seminar-2023](#).

A final word for students: don't try to bend the spoon...

- ... that's impossible!
- Don't worry if you don't understand all the topics we are going to talk about in these days!
- The aim of the seminar is to give an overview of the main techniques used in a field that is having a growing application interest
- In order to obtain the credits you will have to pass correctly answering at least 3 out of 6 questions of a very simple questionnaire with predefined answers on the main topics addressed
- so don't worry, just relax and enjoy the ride ...

