DE MONTFORT UNIVERSITY LEICESTER

CSIP5403 – Research Methods and AI Applications

Python for AI

Dr. Nathanael Baisa
Lecturer in Artificial Intelligence
Institute of Artificial Intelligence
Email: nathanael.baisa@dmu.ac.uk

May, 2024

DE MONTFORT UNIVERSITY LEICESTER

Python

- **Why using Python:**
  - **Easy to learn**
  - **Fast prototyping and code development and management**
  - **Interpreted language and Object Oriented:** With Python you can write code in the form of a script which can be loaded to run from a command line. There is no need to do first compilation of the code. Additionally, Python is Object Oriented programming language which makes easy to reuse code you have previously written and extend it, you can create objects, and APIs and Libraries.
  - **Open source libraries**: Python has an extended programming community and forums where you can find reusable code from previous projects, load into your program a new library or use functions from an API.
  - https://www.w3schools.com/python/

DE MONTFORT UNIVERSITY LEICESTER

Python and AI

- Variety and plethora of libraries for developing advanced AI programs
  - NumPy
  - SciPy
  - Matplotlib and Seaborn
  - Pandas
  - Scikit-learn
  - PyTorch
  - Keras and Tensorflow
  - OpenCV
  - NLTK
  - CPLEX
  - Open3D
  - ROS

Python and AI: NumPy

- **NumPy is one of the most important libraries for data science and AI. You can use NumPy and its functions and APIs to develop advanced ML and AI algorithms.**
  - https://numpy.org/
- **NumPy multidimensional arrays**: One of the most important strengths of NumPy is it offers the creation and handling of multidimensional array objects, called ndarrays
  - A multidimensional array is a matrix but that has **more than 2 dimensions**

    i.e. [m x n]
  - ndarrays can be used for solving advanced linear algebra and matrix calculations as well as allow complex operations on image data.

DE MONTFORT UNIVERSITY LEICESTER

Python and AI: NumPy

❑ TIP – Matrix operations with NumPy

- **A vector is similar to a matrix but it has only one row and several columns. Vectors are represented in Python as type list.**
- **The usual linear algebra rules apply for matrices and vectors in Python i.e. the allowed operations are:**
  - **Addition**
  - **Subtraction**
  - **Scalar multiplication**

  N/B: The following rules hold:

  1. **Required condition for addition and subtraction are the matrices to be of the same size.**
  2. **The result of the addition and subtraction of two matrices is another matrix whose elements are the result of the sum or subtraction of corresponding elements in row and column order.**
  3. **The product of two matrices or two vectors does not follow the commutative property.**
  4. numpy library **provides the** dot() **function to calculate the product of two matrices.**

DE MONTFORT UNIVERSITY LEICESTER

Python and Robotics: SciPy

- **SciPy** (pronounced /ˈsaɪpaɪ/ "sigh pie") is a free and open-source Python library used for scientific computing and technical computing.
- **SciPy** provides algorithms for optimization, integration, interpolation, eigenvalue problems, algebraic equations, differential equations, statistics, special functions, FFT, signal and image processing, and many others.
  - https://scipy.org/
- The SciPy package is at the core of Python's scientific computing capabilities.

DE MONTFORT UNIVERSITY LEICESTER

Python and AI: Matplotlib and Seaborn

- **Both libraries are used for data visualization, and graphical representation and plotting. By graphical representation we can perform an exploratory data analysis (EDA) which assists us in the selection of more accurate predictive models.**
- matplotlib **is a data plotting tool.**
- **Seaborn is an extension of** matplotlib **and uses features of** scikit-learn **for providing with various visualization tools.**

- https://matplotlib.org/
- https://seaborn.pydata.org

Python and AI: Pandas

- pandas package **enables the data cleaning for proceeding with the data analysis phase. That step is very important for the correct analysis to be achieved when applying afterwards an ML algorithm on the data.**

- **https://pandas.pydata.org/**

Python and AI: Scikit-learn

- scikit-learn library **consists of a series of models and algorithms in ML that can be re-used for developing advanced predictive applications such as:**
  - Classification
  - Regression
  - Dimensionality reduction
  - Clustering
  - Data preprocessing
  - Feature extraction
  - Hyperparameter optimization
  - Model evaluation

- https://scikit-learn.org/stable/

DE MONTFORT UNIVERSITY LEICESTER

Python and AI: OpenCV

- OpenCV (Open Source Computer Vision Library) is a library of programming functions mainly aimed at real-time computer vision. It is cross-platform and free for use under the open-source Apache 2 License. OpenCV features GPU acceleration for real-time operations.

- **https://opencv.org/**
- **To install:**
  - **sudo apt-get install python3-opencv**

DE MONTFORT UNIVERSITY LEICESTER

Python and AI: NLTK

- NLTK (Natural Language Toolkit) is a leading platform for building Python programs to work with human language data. It provides easy-to-use interfaces to **over 50 corpora and lexical resources** such as WordNet, along with a suite of text processing libraries for classification, tokenization, stemming, tagging, parsing, and semantic reasoning, wrappers for industrial-strength NLP libraries, and an active discussion forum.

- **https://www.nltk.org/**
- **To install:**
  - **pip install nltk**

DE MONTFORT UNIVERSITY LEICESTER

Python and AI: CPLEX

- CPLEX is an example of an optimization/AI engine to explore. CPLEX Optimizer provides flexible, high-performance mathematical programming solvers for linear programming, mixed integer programming, quadratic programming and quadratically constrained programming problems. These solvers include a distributed parallel algorithm for mixed integer programming to leverage multiple computers to solve difficult problems.
-
- **https://www.ibm.com/uk-en/analytics/cplex-optimizer**
- **https://www.ibm.com/docs/en/SSSA5P_12.8.0/ilog.odms.studio.help/pdf/gscplex.pdf**
- **To install:**
  - **pip install cplex**

DE MONTFORT UNIVERSITY LEICESTER

Python and AI: Open3D

- Open3D is an open-source library that supports rapid development of software that deals with 3D data.
- The Open3D frontend exposes a set of carefully selected data structures and algorithms in both C++ and Python.
- It can be set up on different platforms and compiled from source with minimal effort.

- **http://www.open3d.org/**
- **To install:**
  - **sudo pip install open3d**

DE MONTFORT UNIVERSITY LEICESTER

Python and AI: OpenAI Gym

- Gym is an open source Python library for developing and comparing reinforcement learning algorithms by providing a standard API to communicate between learning algorithms and environments, as well as a standard set of environments compliant with that API.
- Since its release, Gym's API has become the field standard for doing this.

➢ https://github.com/openai/gym

➢ **To install:**

- **sudo pip install gym**

DE MONTFORT UNIVERSITY LEICESTER

Python and AI: ROS

- The Robot Operating System (ROS) is a set of software libraries and tools that help you build robot applications.
- From drivers to state-of-the-art algorithms, and with powerful developer tools, ROS has what you need for your next robotics project. And it's all open source.

- **https://www.ros.org/**
- **To install:**
  - **https://www.ros.org/blog/getting-started/**

DE MONTFORT UNIVERSITY LEICESTER

Tools for Labs

Anaconda 1of4

- Anaconda is a collection of over 700 packages developed in Python containing amongst other ML and data analysis libraries:
  - NumPy
  - SciPy
  - Scikit-learn
  - Pandas
  - Matplotlib, etc.
- https://www.anaconda.com/products/individual
- Latest version 3.10; Recommended >= 3.7
- Anaconda allows you to configure custom environments within which you can select the Python libraries you want to install.

Anaconda 2of4

- **Conda utility is used for installing or updating existing packages and libraries.**
- To access the help menu:

```
conda -h
```

- To install a new package:

```
conda install
```

- To create and activate a custom environment where we want to install, e.g. version Python 3.7:

```
conda create –n py37 python=3.7
activate py37
```

Anaconda 3of4

- **Useful** conda **commands:**
  - activate py37
  - conda install –n py37 PACKAGE-NAME

  e.g. conda install –n py37 seaborn
  - conda list –n py37
  - conda update conda

    conda update -all

- **Jupyter Notebook is a development environment which allows in a single document the integration of both the Python code and the result of its execution such as images or graphics. It assists the developer with the debugging of his code and its testing.**
- **Jupyter Notebook is a web-based utility. It comes pre-installed with Anaconda. So, it is not necessary to install it separately since it comes readily available. To run it:**

```
jupyter notebook
```

For specifying the listening port e.g. 9000 of the service:

```
jupyter notebook  --port 9000
```

Once Jupyter has started to open an existing notebook inside the root directory:

http://localhost:8888/tree

Anaconda
Deep Learning 1of3

- **Deep Learning Libraries:**
  - **PyTorch**
  - **TensorFlow**
  - **Keras**
- **PyTorch has been developed by Facebook for performing large-scale image analysis.**
  - **To install:**

```
conda install –n py37 –c peterjc123 pytorch
```

  - https://pytorch.org/

- Common applications for using the PyTorch:
  - Large-scale image processing (computer vision) – TorchVision.
  - Natural Language Processing (NLP) – TorchText.
  - Social media analysis
  - Deep Reinforcement Learning – TorchRL.

Anaconda
Deep Learning 2of3

- **TensorFlow has been specifically developed to program deep neural networks (DNNs). To install and test with Anaconda:**

  1. **Install TensorFlow with conda:**

     conda install –n py37 –c conda-forge tensorflow

  2. **Install a specific version of TensorFlow by using the following command:**

     conda install –n py37 –c conda-forge tensorflow=2.0.0

  3. **Test the installation of TensorFlow by the following test lines:**

     activate py37

     python

     >>> import tensorflow as tf

     >>> hello = tf.constant('Hello, TensorFlow!')

     >>> sess = tf.Session()

     >> print(sess.run(hello))

- https://www.tensorflow.org/

Anaconda
Deep Learning 3of3

- **Keras can be installed on top of TensorFlow as a high-level interface for NNs development.**
  - **To install:**

```
conda install –n py37 –c conda-forge keras
```

  - https://keras.io/

DE MONTFORT UNIVERSITY LEICESTER

Google Colab

- Colab, or ‘Colaboratory’, allows you to write and execute Python in your browser, with
  - Zero configuration required
  - Access to GPUs free of charge
  - Easy sharing
- You can also use Google Colab to do your labs.
  - To use it, you need to have google account and log in. Follow the following link for more information.
    - https://colab.research.google.com/notebooks/welcome.ipynb#scrollTo=gJr_9dXGpJ05

DE MONTFORT UNIVERSITY LEICESTER

IDE for Python

- PyCharm is the widely used Python Integrated Development Environment (IDE).
- PyCharm provides code analysis, a graphical debugger, an integrated unit tester, integration with version control systems, and supports web development with Django.
- It is cross-platform, working on Microsoft Windows, macOS and Linux. PyCharm has a Professional Edition, released under a proprietary license and a Community Edition released under the Apache License. PyCharm Community Edition is less extensive than the Professional Edition.
- https://www.jetbrains.com/pycharm/

DE MONTFORT UNIVERSITY LEICESTER

Questions ?

Dr. Nathanael Baisa

Lecturer in Artificial Intelligence

Email: nathanael.baisa@dmu.ac.uk