Statistical Techniques for Monitoring Industrial Processes

Lecture : Python Installation & Development Environment

Module : Python Installation and Basics

Course TOC

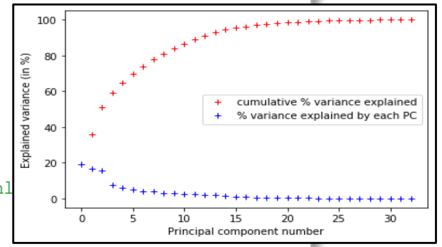
- ❑ Introduction to Statistical Process Monitoring (SPM)
- ❑ Python Installation and basics (optional)
  - ➢ Development environment; Scientific computing packages
- ❑ Univariate SPM & Control Charts
  - ➢ Shewhart Charts
  - ➢ CUSUM Charts
  - ➢ EWMA Charts
- ❑ Multivariate SPM
  - ➢ Fault detection using Principal Component Analysis (PCA)
  - ➢ Fault detection using Partial Least Squares (PLS) regression
  - ➢ Fault diagnosis using PCA/PLS contribution charts
  - ➢ Strategies for handling nonlinear, dynamic, multimode systems
- ❑ Deploying SPM solutions

Implemented using Python

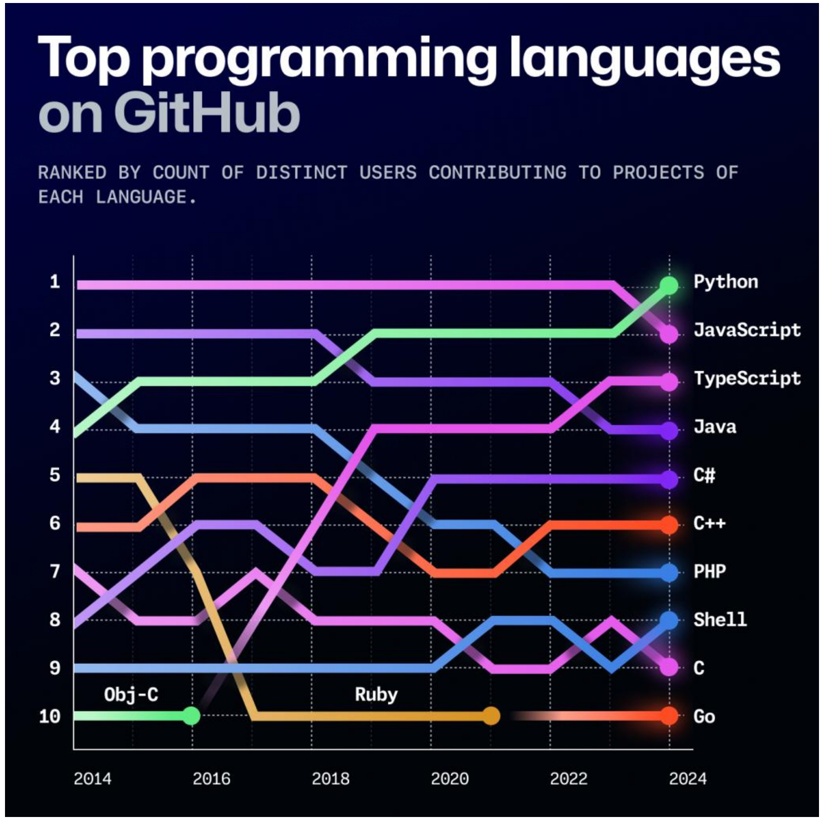
What is Python?

High-level modern programming language

```python
#%% import required packages
import numpy as np
import pandas as pd
from sklearn.preprocessing import StandardScaler
from sklearn.decomposition import PCA

#%% fetch data
data = pd.read_excel('proc1a.xls', skiprows = 1,usecols = 'C:AI')

#%% separate train data
data_train = data.iloc[0:69,]

#%% scale data
scaler = StandardScaler()
data_train_normal = scaler.fit_transform(data_train)

#%% PCA
pca = PCA()
score_train = pca.fit_transform(data_train_normal)

#%% confirm no correlation
corr_coef = np.corrcoef(score_train,rowvar = False)
print('Correlation matrix: \n', corr_coef[0:3,0:3]) # printing onl

#%% visualize explained variance
import matplotlib.pyplot as plt

explained_variance = 100*pca.explained_variance_ratio_ # in percentage
cum_explained_variance = np.cumsum(explained_variance) # cumulative % variance explained

plt.figure()
plt.plot(cum_explained_variance, 'r+', label = 'cumulative % variance explained')
plt.plot(explained_variance, 'b+' , label = '% variance explained by each PC')
plt.ylabel('Explained variance (in %)'), plt.xlabel('Principal component number'), plt.legend()
```



De-facto language of choice for data science



*https://github.blog/news-insights/octoverse/octoverse-2024/

Why Python is so Popular?

Easy & Simple
- Gentle learning curve
- Easy to read; Low maintenance

Versatile
- ML, DL, scientific computing
- Web development
- GUI programming

Extensive Libraries
- Large standard library set for common tasks
- Ever-growing collection from Python community

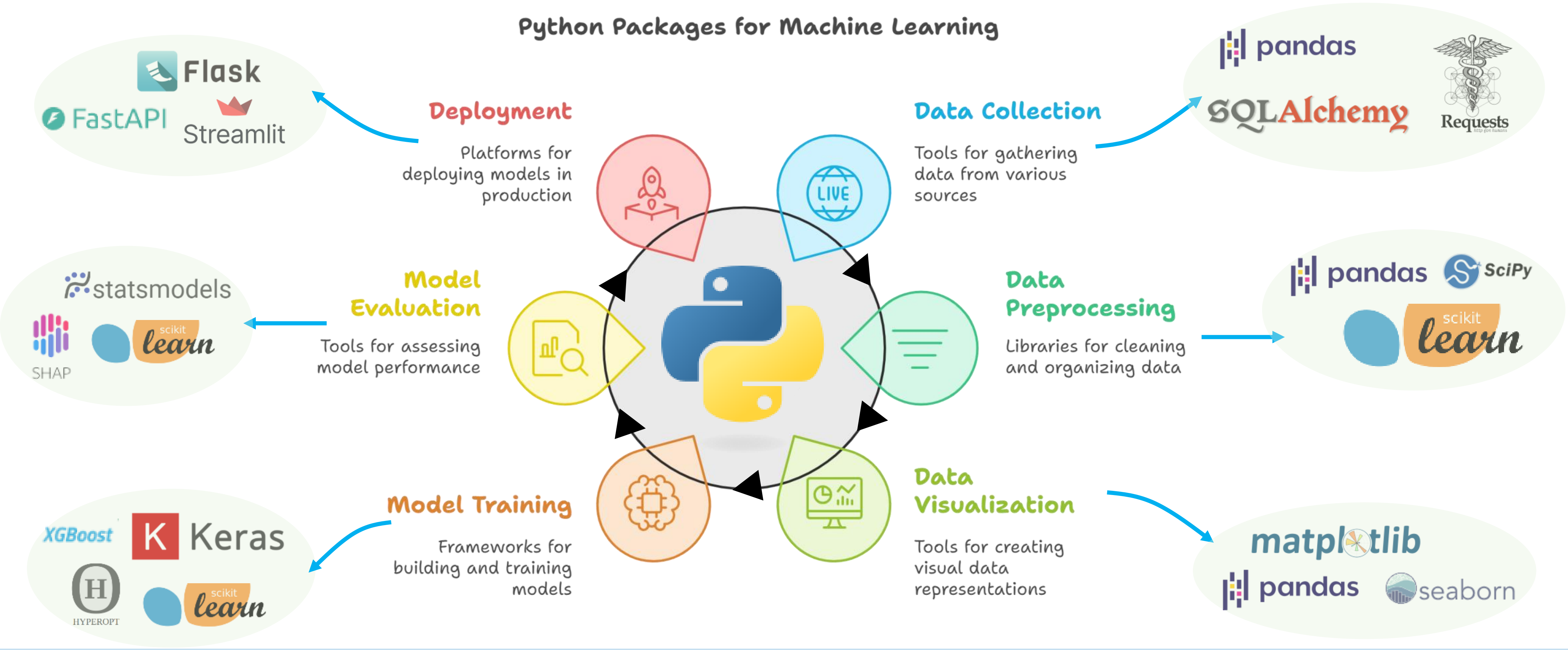
Community Support
- Vast community contributes to open-source knowledgebase
- Easy to find timely support

Documentation
- Well-written documentation
- Plenty of resources (guides, tutorials) for all level (beginner, expert)

Portable / Platform-independent
- Code written on Windows PC can be easily executed on a Linux/Mac/UNIX machine

Why Python is so Popular?

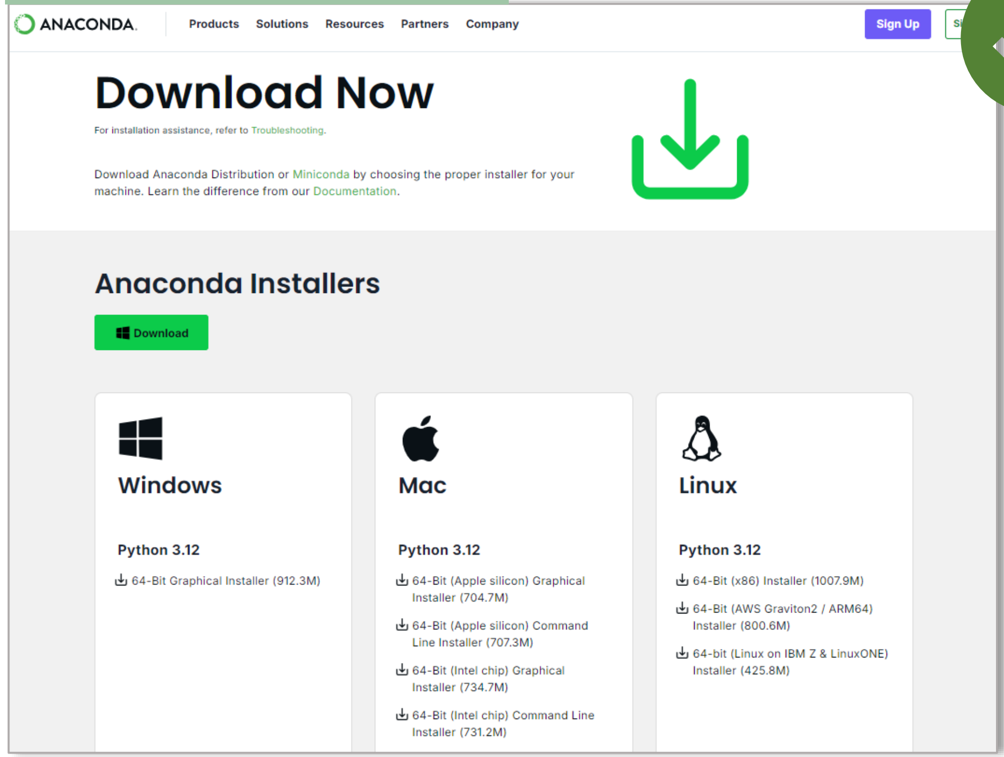
Python provides several tools to conveniently perform all steps of a data science project



Python Installation

Popular and convenient way

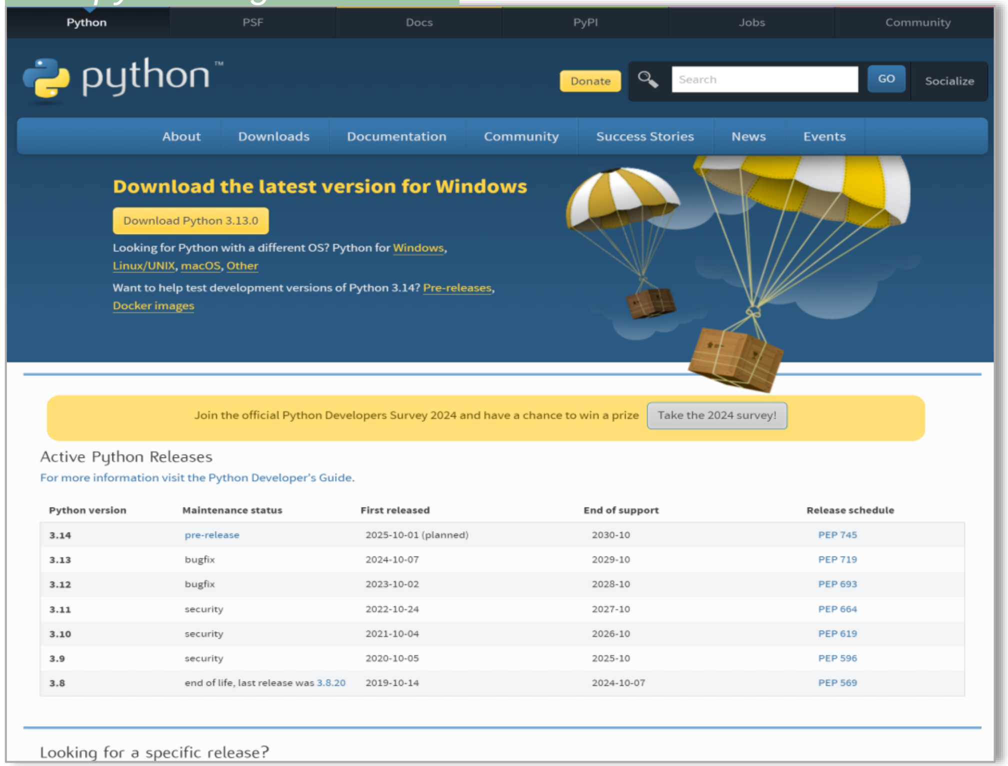
www.anaconda.com/download



➢ When you install Anaconda, several commonly used packages are installed along with Python

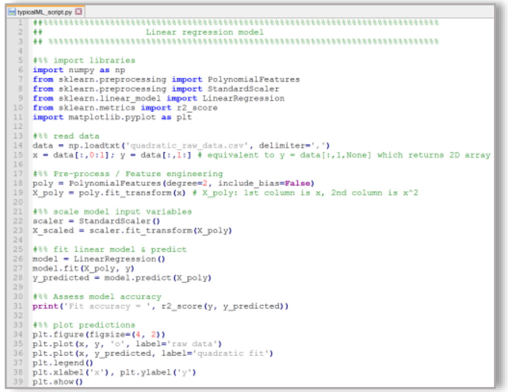
Using base Python installer

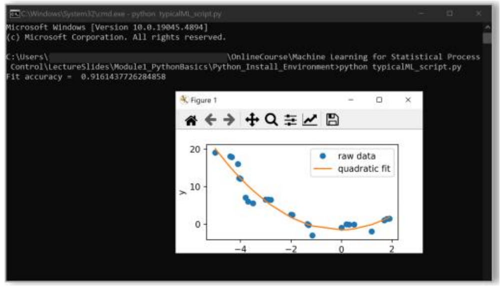
www.python.org/downloads



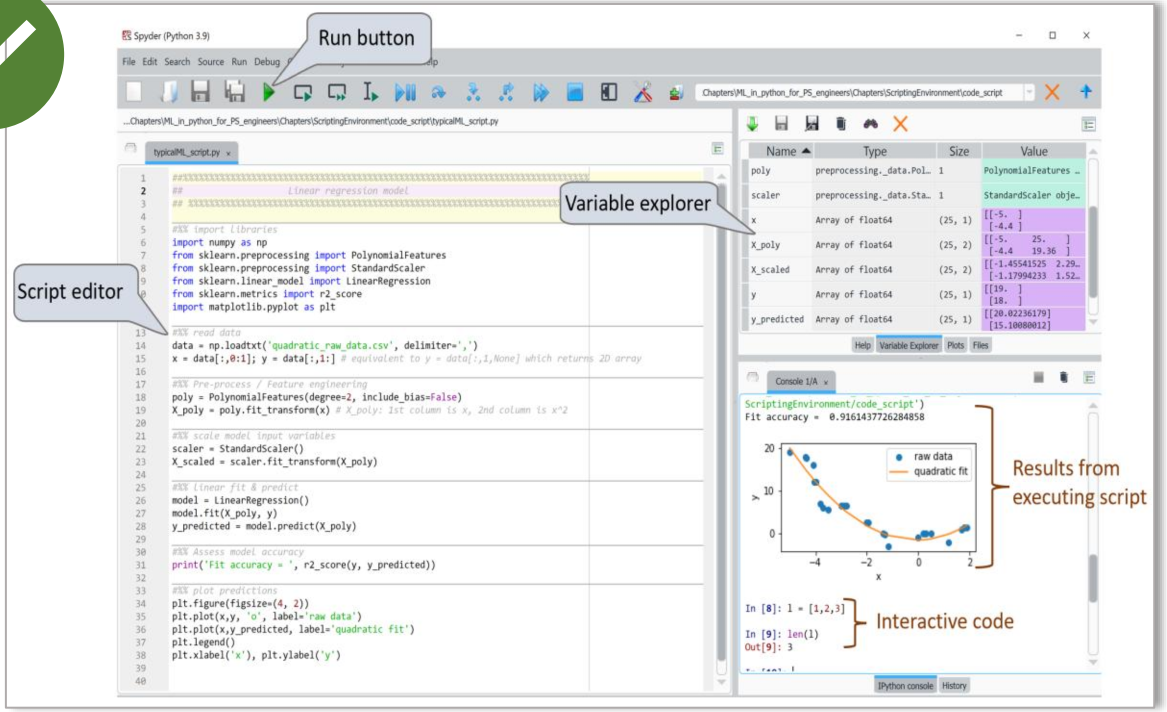
Where to Write Python Code?

Any text editor + command terminal execution





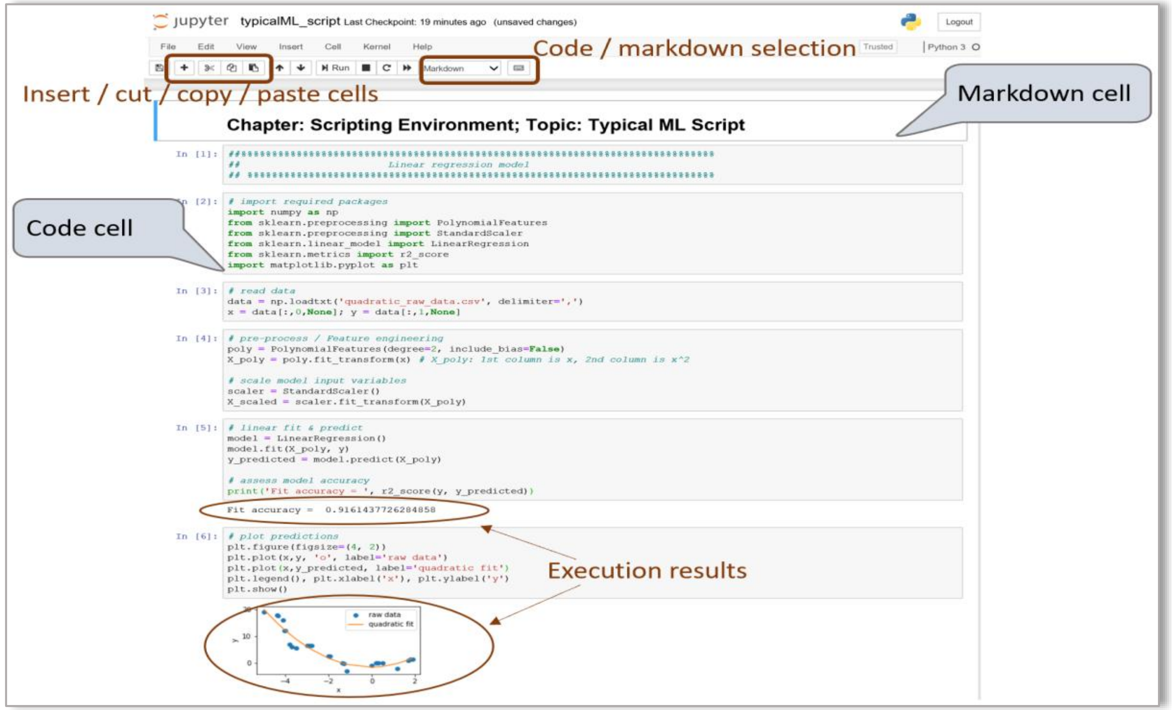
Using IDE (Integrated Development Environment)



- Allows you to write and execute your scripts, and see the results in the same environment
- Popular choices: PyCharm, Spyder, Visual Studio Code

Where to Write Python Code?

Using Jupyter Notebook



- ➢ Allows you to put code, results, plots, formatted text in the same document

Very popular among data scientists for interactive data exploration and modeling experimentations

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Next Lecture : Python Language Basics

Module : Python Installation and Basics