Introduction to Scikit-Learn: Machine Learning with Python

Machine Learning Intro

郭耀仁

About Scikit-Learn

Scikit-Learn (http://scikit-learn.org/stable/) is a Python package designed to give access to **well-known** machine learning algorithms within Python code, through a **clean, well-thought-out API**. It has been built by hundreds of contributors from around the world, and is used across industry and academia.

Scikit-Learn is built upon Python's NumPy (Numerical Python) (http://numpy.org) and SciPy (Scientific Python) (http://scipy.org) libraries, which enable efficient in-core numerical and scientific computation within Python.

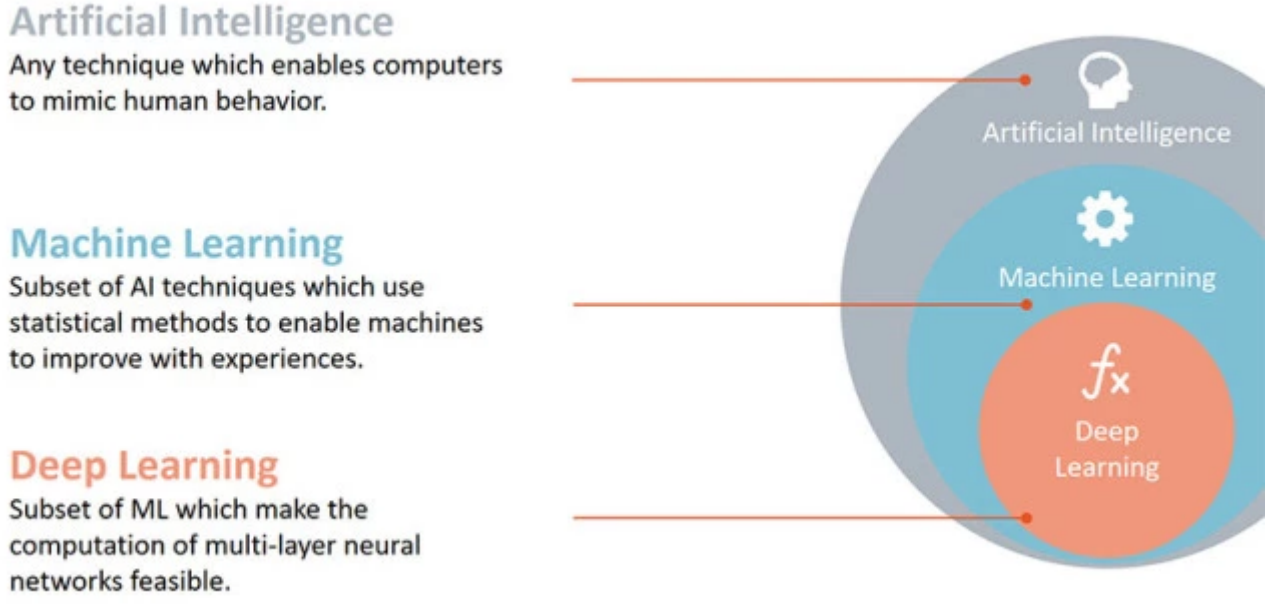
What is Machine Learning?

Machine Learning is about building programs with **tunable parameters** (typically an array of floating point values) that are adjusted automatically so as to improve their behavior by **adapting to previously seen data.**

Tom Mitchell (http://www.cs.cmu.edu/~tom/)

> *A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E.*

Machine Learning can be considered a subfield of **Artificial Intelligence** since those algorithms can be seen as building blocks to make computers learn to behave more intelligently by somehow **generalizing** rather that just storing and retrieving data items like a database system would do.



Source: [rapidminer (https://rapidminer.com/artificial-intelligence-machine-learning-deep-learning/)](https://rapidminer.com/artificial-intelligence-machine-learning-deep-learning/)

Machine Learning is

- Constructing/using algorithms that learn from data
- Performing better with more information
- Learning from previous solutions as experience

Formulating Machine Learning

- input -> Function(f) -> output
- input -> Estimated Function($\hat{f}$) -> predicted output

Machine Learning Topics

- Supervised Learning
    - Classification
    - Regression
- Unsupervised Learning
    - Dimensionality Reduction
    - Clustering

Machine Learning Topics in Depth

- Supervised Learning: Finding function $\hat{f}$ which can be used to assign a class or value to unseen observations given a set of labeled observations.
- Unsupervised Learning: Finding groups observation that are similar or using less vairiables to achieve similar predictability.

Machine Learning Topics in Depth

- Supervised Learning: Finding function $\hat{f}$ which can be used to assign a class or value to unseen observations given a set of labeled observations.
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Measuring performance

- Supervised Learning: Comparing real labels with predicted labels, great performance means predictions should be similar to real labels
- Unsupervised Learning: No real labels to compare

Representation of Data in Scikit-learn

Machine learning is about

- Creating models from data
- How data can be represented in order to be understood by the computer?

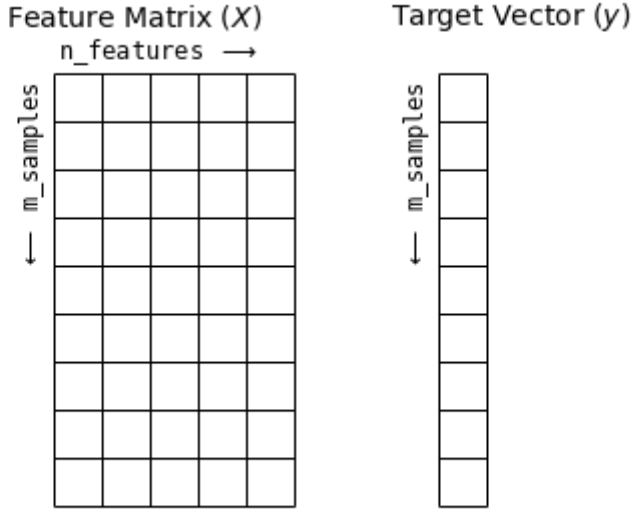
Two-dimensional array or matrix

Most machine learning algorithms implemented in scikit-learn expect data to be stored in a **two-dimensional array or matrix**. The size of the array is expected to be `[m_samples, n_features]`

m x n in general

- **m_samples:** The number of samples: each sample is an item to process (e.g. classify). A sample can be a document, a picture, a sound, a video, an astronomical object, a row in database or CSV file, or whatever you can describe with a fixed set of quantitative traits.
- **n_features:** The number of features or distinct traits that can be used to describe each item in a quantitative manner. Features are generally real-valued, but may be boolean or discrete-valued in some cases.

In [1]:
```
plt.show()
```


Feature Matrix (X)
n_features ⟶
m_samples ⟵
Target Vector (y)
m_samples ⟵

Simple Examples: Getting Started with Kaggle

We're going to take a look at the data hosted by Kaggle. Try extracting feature matrix and target vector from the following datasets:

- House Prices: Advanced Regression Techniques
- Titanic: Machine Learning from Disaster
- Digit Recognizer

Installing Kaggle Module

In [2]:
```
!pip install kaggle
```

```
Requirement already satisfied: kaggle in /Users/kuoyaojen/anaconda3/lib/python
3.7/site-packages (1.5.3)
Requirement already satisfied: requests in /Users/kuoyaojen/anaconda3/lib/pyth
on3.7/site-packages (from kaggle) (2.21.0)
Requirement already satisfied: certifi in /Users/kuoyaojen/anaconda3/lib/pytho
n3.7/site-packages (from kaggle) (2018.11.29)
Requirement already satisfied: six>=1.10 in /Users/kuoyaojen/anaconda3/lib/pyt
hon3.7/site-packages (from kaggle) (1.12.0)
Requirement already satisfied: python-dateutil in /Users/kuoyaojen/anaconda3/l
ib/python3.7/site-packages (from kaggle) (2.7.5)
Requirement already satisfied: urllib3<1.25,>=1.21.1 in /Users/kuoyaojen/anaco
nda3/lib/python3.7/site-packages (from kaggle) (1.24.1)
Requirement already satisfied: tqdm in /Users/kuoyaojen/anaconda3/lib/python3.
7/site-packages (from kaggle) (4.28.1)
Requirement already satisfied: python-slugify in /Users/kuoyaojen/anaconda3/li
b/python3.7/site-packages (from kaggle) (3.0.2)
Requirement already satisfied: idna<2.9,>=2.5 in /Users/kuoyaojen/anaconda3/li
b/python3.7/site-packages (from requests->kaggle) (2.8)
Requirement already satisfied: chardet<3.1.0,>=3.0.2 in /Users/kuoyaojen/anaco
nda3/lib/python3.7/site-packages (from requests->kaggle) (3.0.4)
Requirement already satisfied: text-unidecode==1.2 in /Users/kuoyaojen/anacond
a3/lib/python3.7/site-packages (from python-slugify->kaggle) (1.2)
```

Creating New API Token

- Register / Log in Kaggle
- My Account
- Create New API Token

Using Kaggle API on Google Colab

```
!mkdir /root/.kaggle
import json
token = {"username": "YOUR-USERNAME", "key": "YOUR-KEY"}
with open('/root/.kaggle/kaggle.json', 'w') as file:
    json.dump(token, file)
!chmod 600 /root/.kaggle/kaggle.json
```

In [3]:
```
!kaggle datasets list
```

```
ref                                                            title
size  lastUpdated          downloadCount
-------------------------------------------------------------  -----------------
--------------------------------  -----  -------------------  -------------
ronitf/heart-disease-uci                                       Heart Disease UCI
3KB  2018-06-25 11:33:56          27773
karangadiya/fifa19                                             FIFA 19 complete
player dataset                     2MB  2018-12-21 03:52:59          21716
iarunava/cell-images-for-detecting-malaria                     Malaria Cell Imag
es Dataset                       337MB  2018-12-05 05:40:21           4379
bigquery/crypto-ethereum-classic                               Ethereum Classic
Blockchain                        70GB  2019-03-20 23:21:25              0
jutrera/stanford-car-dataset-by-classes-folder                 Stanford Car Data
set by classes folder              2GB  2018-07-02 07:35:45           2769
vjchoudhary7/customer-segmentation-tutorial-in-python          Mall Customer Seg
mentation Data                     2KB  2018-08-11 07:23:02           6845
russellyates88/suicide-rates-overview-1985-to-2016             Suicide Rates Ove
rview 1985 to 2016               396KB  2018-12-01 19:18:25          20324
rmisra/news-headlines-dataset-for-sarcasm-detection            News Headlines Da
taset For Sarcasm Detection        2MB  2018-06-09 22:14:56           2556
lava18/google-play-store-apps                                  Google Play Store
Apps                               2MB  2019-02-03 13:55:47          48807
mohansacharya/graduate-admissions                              Graduate Admissio
ns                                 9KB  2018-12-28 10:07:14          18344
jessicali9530/stanford-dogs-dataset                            Stanford Dogs Dat
aset                             735MB  2019-02-13 05:45:25           2480
anokas/kuzushiji                                               Kuzushiji-MNIST
318MB  2018-12-17 01:19:31            798
cityofLA/los-angeles-parking-citations                         Los Angeles Parki
ng Citations                     257MB  2019-04-13 22:17:45           3032
noriuk/us-education-datasets-unification-project               U.S. Education Da
tasets: Unification Project       85MB  2019-03-02 18:41:52           3308
safegraph/visit-patterns-by-census-block-group                 Consumer & Visito
r Insights For Neighborhoods      66MB  2018-12-19 21:31:50           1303
```

```
safegraph/census-block-group-american-community-survey-data  Census Block Grou
p American Community Survey Data     2GB  2018-12-22 00:29:56            707
jessicali9530/celeba-dataset                                 CelebFaces Attrib
utes (CelebA) Dataset                1GB  2018-06-01 20:08:48           6412
pavansanagapati/urban-sound-classification                   Urban Sound Class
ification                            6GB  2018-06-16 13:44:36           2271
fivethirtyeight/fivethirtyeight-comic-characters-dataset     FiveThirtyEight C
omic Characters Dataset            577KB  2019-03-26 15:01:15           2297
xvivancos/barcelona-data-sets                                Barcelona data se
ts                                   1MB  2018-12-13 14:16:53           3669
```

In [4]:
```
!kaggle datasets list -s MNIST
```

```
ref                                 title                          size  lastUpd
ated          downloadCount
----------------------------------  -----------------------------  -----  -------
------------  -------------
daavoo/3d-mnist                     3D MNIST                       154MB  2016-11
-09 18:53:12           2471
datamunge/sign-language-mnist       Sign Language MNIST             31MB  2017-10
-20 15:09:18           5690
kmader/skin-cancer-mnist-ham10000   Skin Cancer MNIST: HAM10000      3GB  2018-09
-20 20:36:13           7400
zalando-research/fashionmnist       Fashion MNIST                   69MB  2017-12
-07 00:54:20          28597
kmader/colorectal-histology-mnist   Colorectal Histology MNIST     991MB  2018-09
-19 14:20:49            927
vikramtiwari/mnist-numpy            mnist.npz                       11MB  2018-06
-29 01:59:44            445
oddrationale/mnist-in-csv           MNIST in CSV                    15MB  2018-05
-19 02:24:20           4936
pablotab/mnistpklgz                 mnist.pkl.gz                    15MB  2017-11
-20 15:02:57            298
miningjerry/mnist-for-tf            mnist for tf                    15MB  2017-05
-16 09:50:29             63
joewkim/mnist-data                  mnist data                      11MB  2017-11
-07 19:39:08             66
backalla/words-mnist                Words MNIST                     47MB  2018-06
-06 09:34:28            114
mustafaali96/mnist                  mnist.                          11MB  2018-05
-10 22:18:24             44
crawford/emnist                     EMNIST (Extended MNIST)          1GB  2017-12
-20 17:42:58           5887
ashishguptajiit/handwritten-az      Handwritten A-Z                 92MB  2018-01
-26 15:44:12            527
kevinv/mnist1                       mnist1                          15MB  2017-11
-30 16:55:58              4
```

```
jwjohnson314/notmnist                notMNIST                      226MB  2018-02
-14 19:52:14            607
anokas/kuzushiji                     Kuzushiji-MNIST               318MB  2018-12
-17 01:19:31            798
farhanhubble/multimnistm2nist        Multidigit MNIST(M2NIST)       17MB  2018-07
-16 12:05:34            161
lianglirong/mnistnpz                 mnist.npz                      11MB  2018-09
-16 12:44:43              6
zsx242030/mnistplk                   mnist.plk                      11MB  2018-10
-06 03:59:01              0
```

House Prices: Advanced Regression Techniques

https://www.kaggle.com/c/house-prices-advanced-regression-techniques (https://www.kaggle.com/c/house-prices-advanced-regression-techniques)

In [5]:

```
# Target Vector: SalePrice

train_url = "https://storage.googleapis.com/kaggle_datasets/House-Prices-Advanced-Regression-Techniques/train.csv"
```

In [6]:
```
# Or using Kaggle-API
!kaggle competitions download -c house-prices-advanced-regression-techniques --for
ce
```

```
Downloading sample_submission.csv to /Users/kuoyaojen/python-sklearn-cht
  0%|                                                | 0.00/31.2k [00:00<?, ?B/
s]
100%|████████████████████████████████████████████████| 31.2k/
31.2k [00:00<00:00, 639kB/s]
Downloading test.csv to /Users/kuoyaojen/python-sklearn-cht
100%|████████████████████████████████████████████████| 441
k/441k [00:00<00:00, 1.16MB/s]

Downloading train.csv to /Users/kuoyaojen/python-sklearn-cht
100%|████████████████████████████████████████████████| 450
k/450k [00:00<00:00, 2.46MB/s]

Downloading data_description.txt to /Users/kuoyaojen/python-sklearn-cht
  0%|                                                | 0.00/13.1k [00:00<?, ?B/
s]
100%|████████████████████████████████████████████████| 13.1k/1
3.1k [00:00<00:00, 6.88MB/s]
```

Titanic: Machine Learning from Disaster

https://www.kaggle.com/c/titanic (https://www.kaggle.com/c/titanic)

In [7]:
```
# Target Vector: Survived

train_url = "https://storage.googleapis.com/kaggle_datasets/Titanic-Machine-Learning-from-Disaster/train.csv"
```

In [8]:
```
# Or using Kaggle-API
!kaggle competitions download -c titanic --force
```

```
Downloading train.csv to /Users/kuoyaojen/python-sklearn-cht
100%|████████████████████████████████████████| 59.8k/59.8k [00:00<00:00, 494kB/s]

Downloading test.csv to /Users/kuoyaojen/python-sklearn-cht
  0%|                                               | 0.00/28.0k [00:00<?, ?B/s]
100%|████████████████████████████████████████| 28.0k/28.0k [00:00<00:00, 10.9MB/s]
Downloading gender_submission.csv to /Users/kuoyaojen/python-sklearn-cht
  0%|                                               | 0.00/3.18k [00:00<?, ?B/s]
100%|████████████████████████████████████████| 3.18k/3.18k [00:00<00:00, 2.58MB/s]
```

Digit Recognizer

https://www.kaggle.com/c/digit-recognizer (https://www.kaggle.com/c/digit-recognizer)

In [9]:
```
# Target Vector: label

train_url = "https://storage.googleapis.com/kaggle_datasets/Digit-Recognizer/train.csv"
```

In [10]:
```
# Or using Kaggle-API
!kaggle competitions download -c digit-recognizer --force
```

```
Downloading train.csv to /Users/kuoyaojen/python-sklearn-cht
100%|████████████████████████████████████████████████████| 73.0M/73.2M [00:40<00:00, 2.48MB/s]
100%|████████████████████████████████████████████████████| 73.2M/73.2M [00:40<00:00, 1.88MB/s]
Downloading test.csv to /Users/kuoyaojen/python-sklearn-cht
100%|████████████████████████████████████████████████████| 48.8M/48.8M [00:13<00:00, 4.17MB/s]

Downloading sample_submission.csv to /Users/kuoyaojen/python-sklearn-cht
  0%|                                                      | 0.00/235k [00:00<?, ?B/s]
100%|████████████████████████████████████████████████████| 235k/235k [00:00<00:00, 4.25MB/s]
```

The Scikit-learn Estimator Object

Every algorithm is exposed in scikit-learn via an ''Estimator'' object.

In [11]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

Estimator parameters: All the parameters of an estimator can be set when it is instantiated, and have suitable default values:

In [12]:
```
from sklearn.linear_model import LinearRegression

model = LinearRegression()
print(model)
```

```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None,
         normalize=False)
```

Estimated Model parameters: When data is fit with an estimator, parameters are estimated from the data at hand. All the estimated parameters are attributes of the estimator object ending by an underscore:

In [13]:
```
train_url = "https://storage.googleapis.com/kaggle_datasets/House-Prices-Advanced-Regression-Techniques/train.csv"
train_df = pd.read_csv(train_url)
X_train = train_df["GrLivArea"].values.reshape(-1, 1)
y_train = train_df["SalePrice"].values.reshape(-1, 1)
reg = LinearRegression()
reg.fit(X_train, y_train)
print(reg.intercept_)
print(reg.coef_)
```

```
[18569.02585649]
[[107.13035897]]
```

In [ ]:

```
xfit = np.linspace(X_train.min() - 10, X_train.max() + 10, 100).reshape(-1, 1)
yfit = reg.predict(xfit)
plt.scatter(train_df["GrLivArea"], train_df["SalePrice"], label='train', s=3, colo
r="#4286f4")
plt.plot(xfit, yfit, color="#f4a041", linewidth=2, label='thetas')
plt.legend()
```

In [14]:
```
plt.show()
```