Hands on Machine Learning

2019 AI summer program in Asia University

Yueh-Lin Tsai
2019 / 07

About me

- Yueh-Lin Tsai

- Education
  - National Cheng Kung University, M.S., Psychology (2013-2015)
  - National Cheng Kung University, B.S., Psychology (2009-2013)

- Present
  - AI Engineer in Taiwan AI Academy

What is Artificial Intelligence ?

Artificial Intelligence

- Definition : Intelligence demonstrated by machine

- How ?

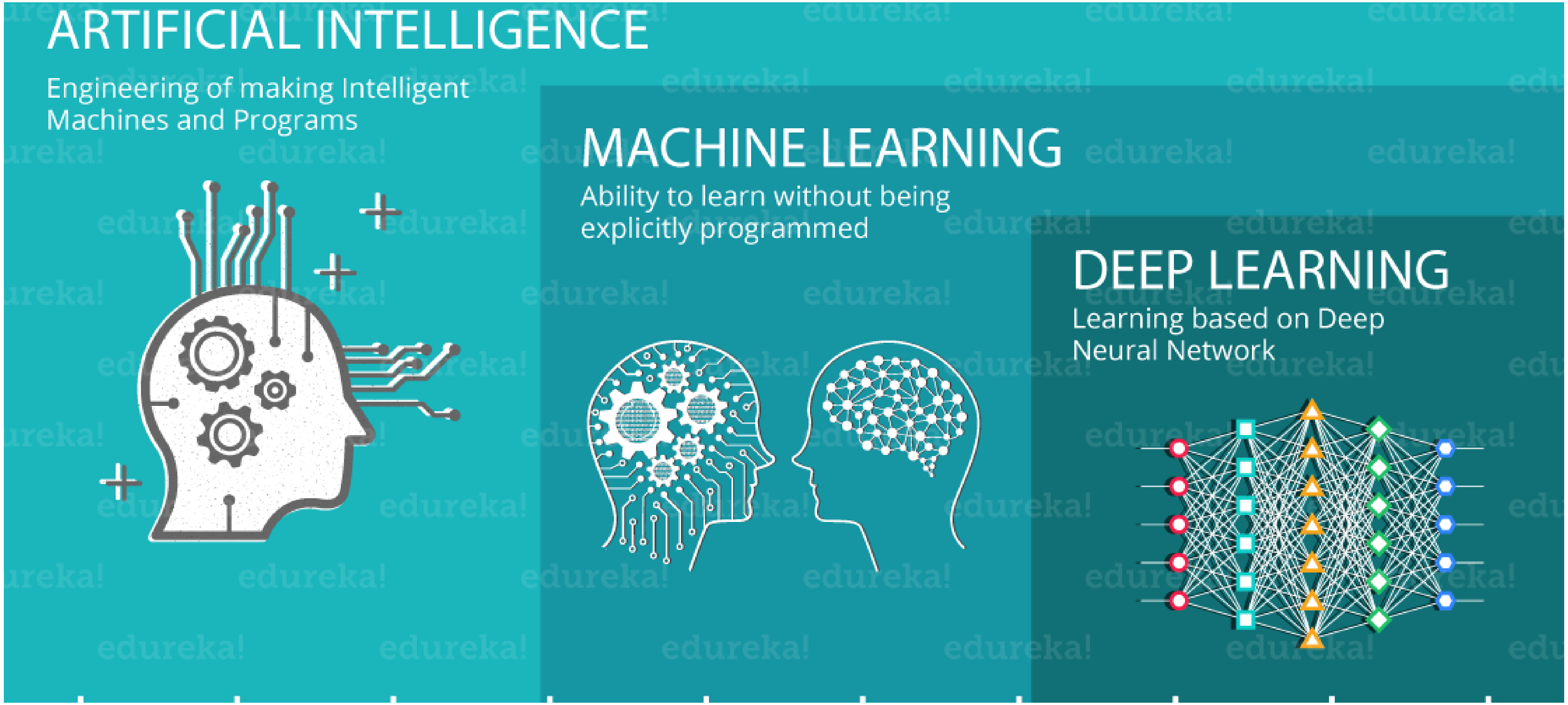
Expertise system

Explicit rule from human

Machine learning

Get knowledge from data

Modern Artificial Intelligence



ARTIFICIAL INTELLIGENCE

Engineering of making Intelligent Machines and Programs

MACHINE LEARNING

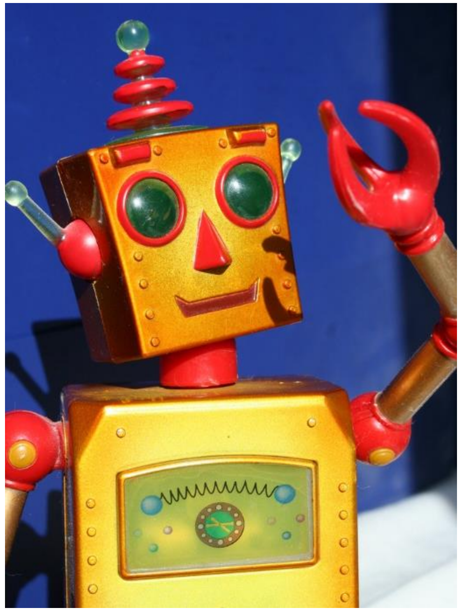
Ability to learn without being explicitly programmed

DEEP LEARNING

Learning based on Deep Neural Network

Machine learning

- Extract relations/patterns from data automatically
- Apply those rules to unseen data



$$f(x) = y$$

Type of machine learning

- Supervised learning
  - Regression
  - Classification

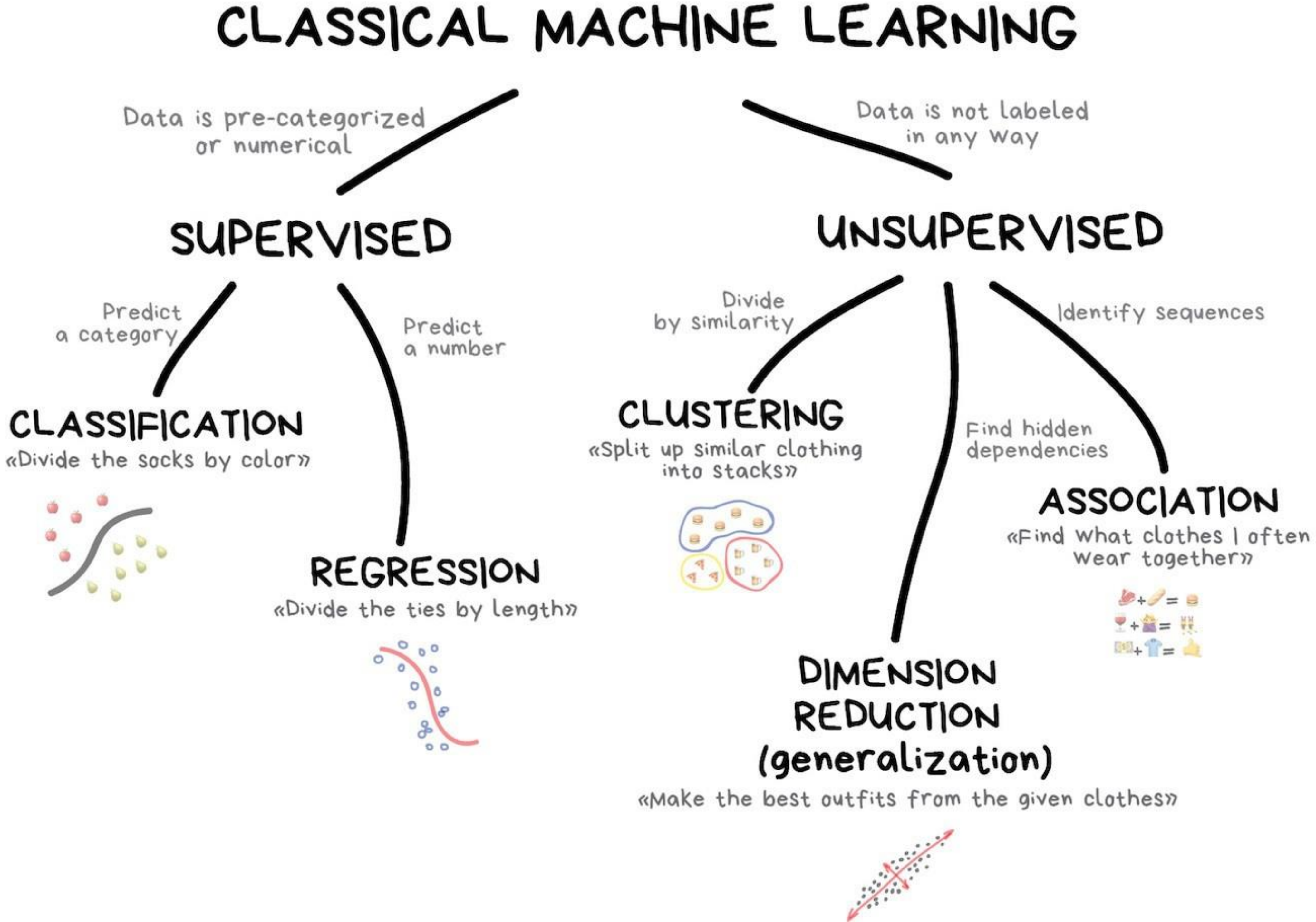
Problems with answer

- Unsupervised learning
  - Cluster
  - Dimension reduction

Problems without answer

- Reinforcement learning

Problems with fuzzy metric



CLASSICAL MACHINE LEARNING

Data is pre-categorized or numerical

Data is not labeled in any way

SUPERVISED

Predict a category

Predict a number

CLASSIFICATION

«Divide the socks by color»

REGRESSION

«Divide the ties by length»

UNSUPERVISED

Divide by similarity

Find hidden dependencies

Identify sequences

CLUSTERING

«Split up similar clothing into stacks»

ASSOCIATION

«Find what clothes I often wear together»

DIMENSION REDUCTION (generalization)

«Make the best outfits from the given clothes»

Machine learning workflow

1. Problem definition
2. Data collection
3. Data exploration / preprocessing
4. Build model
5. Model evaluation

Cheat sheet – scikit learn

python™

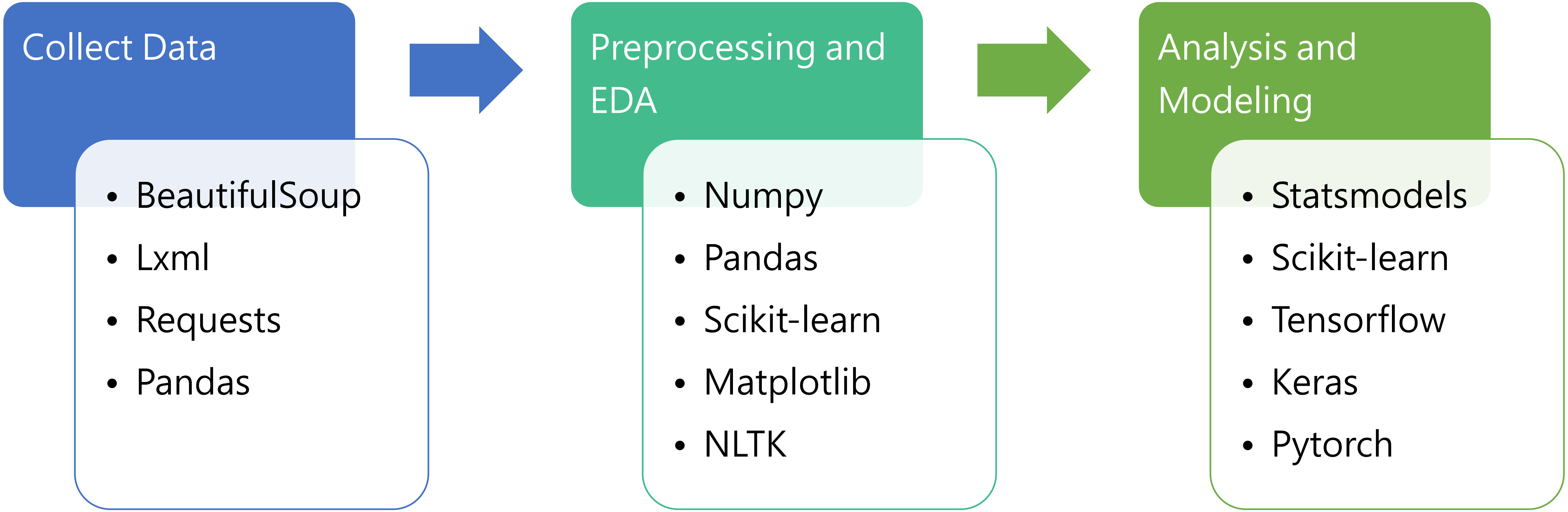
+

CO

Time for practice

Familiar with colab and python

Machine Learning with Python



Collect Data

- BeautifulSoup
- Lxml
- Requests
- Pandas

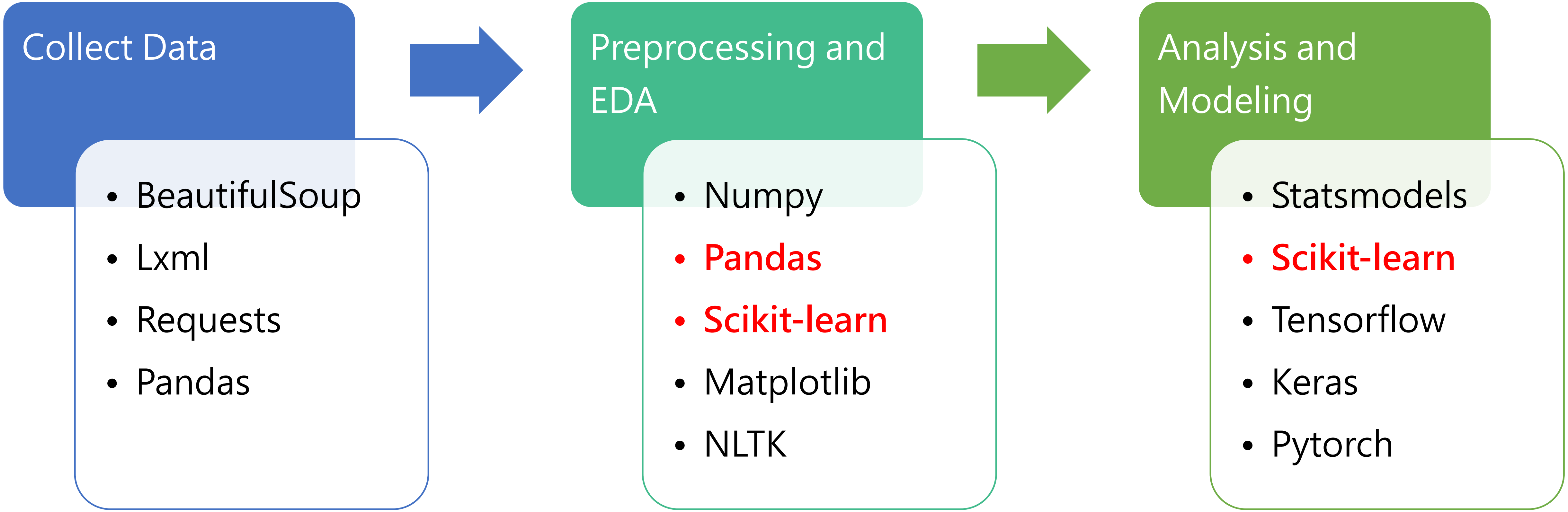
Preprocessing and EDA

- Numpy
- Pandas
- Scikit-learn
- Matplotlib
- NLTK

Analysis and Modeling

- Statsmodels
- Scikit-learn
- Tensorflow
- Keras
- Pytorch

Machine Learning with Python



Collect Data

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- Numpy
- **Pandas**
- **Scikit-learn**
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Analysis and Modeling

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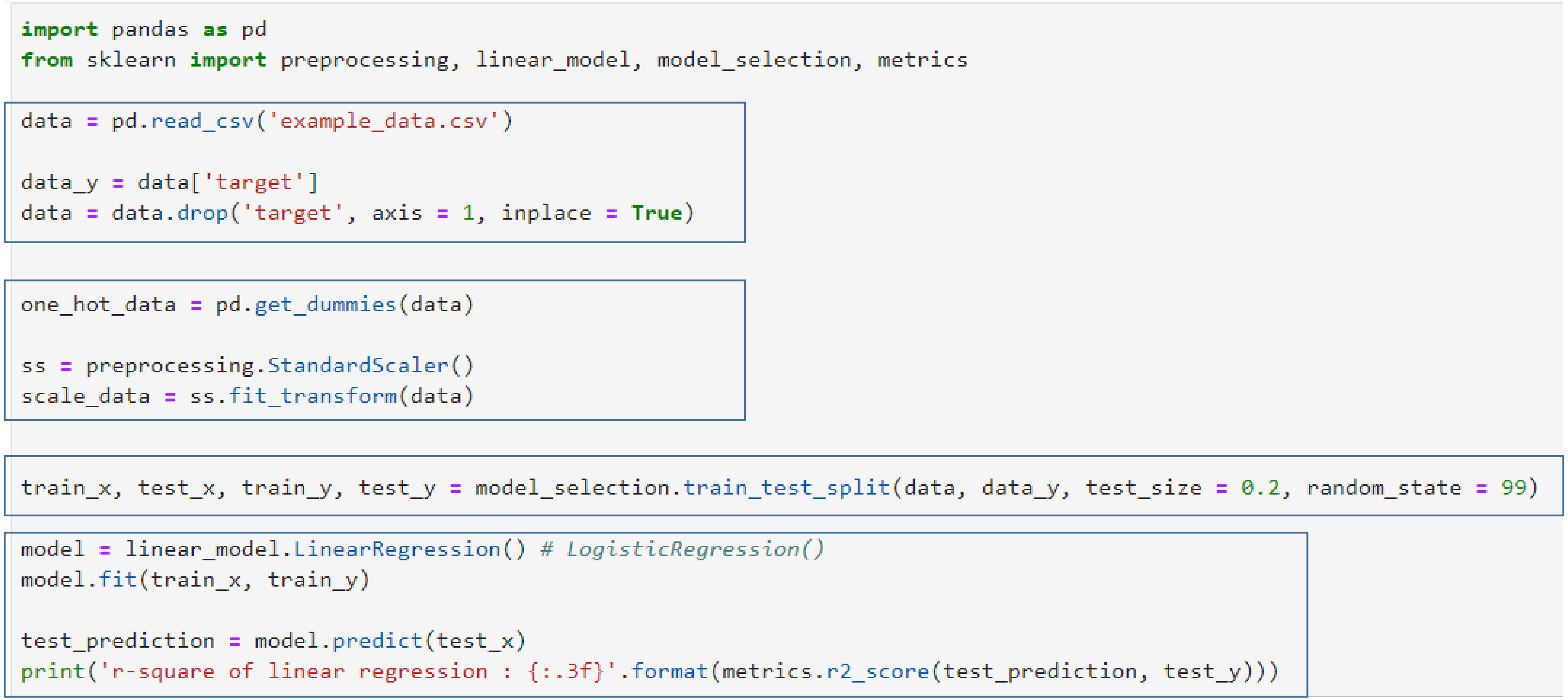
Build up your ML model in one slide



```
import pandas as pd
from sklearn import preprocessing, linear_model, model_selection, metrics

data = pd.read_csv('example_data.csv')

data_y = data['target']
data = data.drop('target', axis = 1, inplace = True)

one_hot_data = pd.get_dummies(data)

ss = preprocessing.StandardScaler()
scale_data = ss.fit_transform(data)

train_x, test_x, train_y, test_y = model_selection.train_test_split(data, data_y, test_size = 0.2, random_state = 99)

model = linear_model.LinearRegression() # LogisticRegression()
model.fit(train_x, train_y)

test_prediction = model.predict(test_x)
print('r-square of linear regression : {:.3f}'.format(metrics.r2_score(test_prediction, test_y)))
```

Exploration and preprocessing

Data exploration

- Get to know your dataset
  - How many data do I have ?
  - Which column/feature do I have ?
  - Statistics and relations between columns ?
  - Outlier or missing data ?

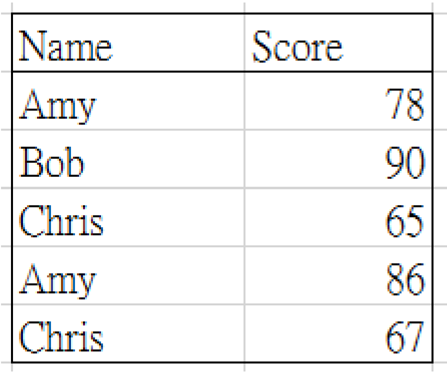
Data preprocessing

- Handle missing data
  - Delete data which have missing values (row or column)
  - Missing imputation
- Handle outliers
  - Distribution transformation
  - Replace outliers

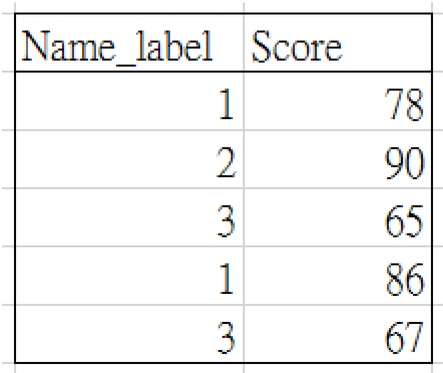
Data preprocessing

```
from sklearn.preprocessing import LabelEncoder, OneHotEncoder
```

- Convert categorical data to numerical data
  - Label encoding
  - One-hot encoding

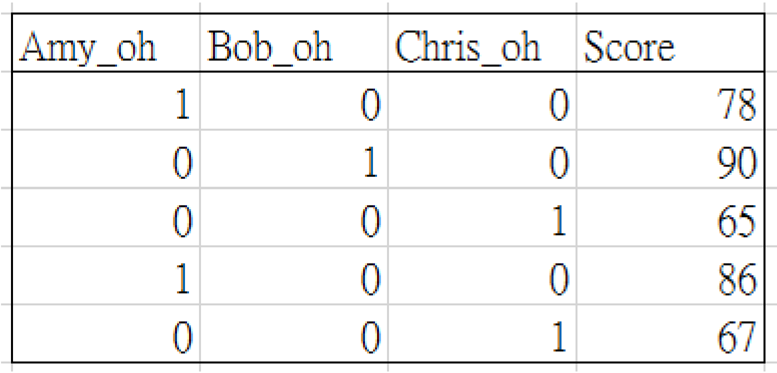


Name	Score
Amy	78
Bob	90
Chris	65
Amy	86
Chris	67



Name_label	Score
1	78
2	90
3	65
1	86
3	67

Label encoding



Amy_oh	Bob_oh	Chris_oh	Score
1	0	0	78
0	1	0	90
0	0	1	65
1	0	0	86
0	0	1	67

One-hot encoding

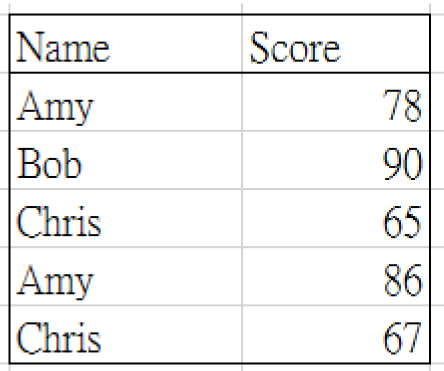
Data preprocessing

```
from sklearn.preprocessing import StandardScaler, MinMaxScaler
```

- Normalize data
  - Standard scale
  - Min-max scale

$$x_{standard} = \frac{x - \mu}{\sigma}$$

$$x_{minmax} = \frac{x - Min(x)}{Max(x) - Min(x)}$$



Name	Score
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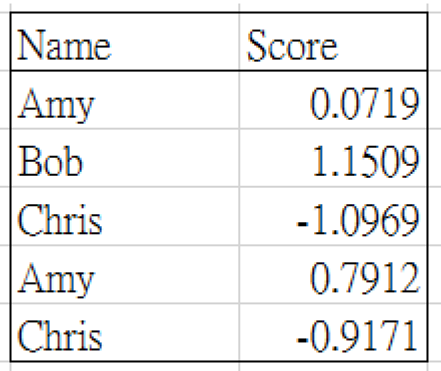
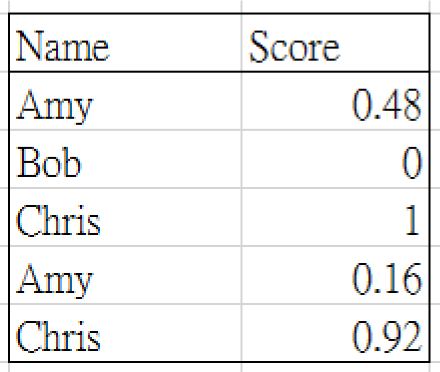


Name	Score
Amy	0.0719
Bob	1.1509
Chris	-1.0969
Amy	0.7912
Chris	-0.9171

Standard scale



Name	Score
Amy	0.48
Bob	0
Chris	1
Amy	0.16
Chris	0.92

Min-max scale

Data preprocessing

```
from sklearn.preprocess import train_test_split
```

- Data splitting
  - Training set
  - Validation set
  - Testing set

- Cross validation

Time for practice

Data exploration and preprocessing

Build model

Model selection

- Model comparison
  - Linear model
    - Focus on global information
    - Have data hypothesis

    Encoding matters

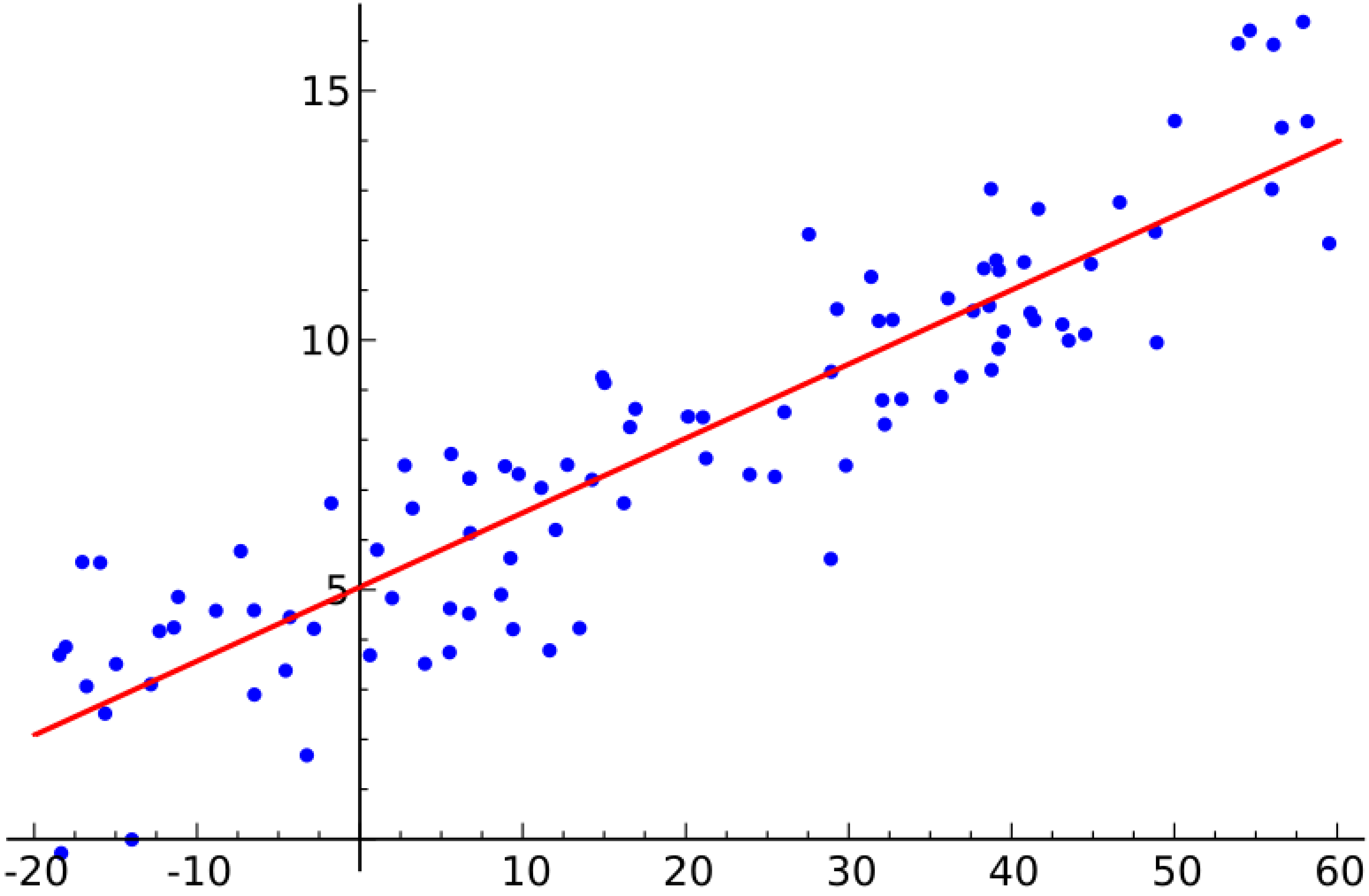
    Normalization is needed

  - Tree-based model
    - Clear rules provided by model
    - Focus on local information

    No need to normalize data

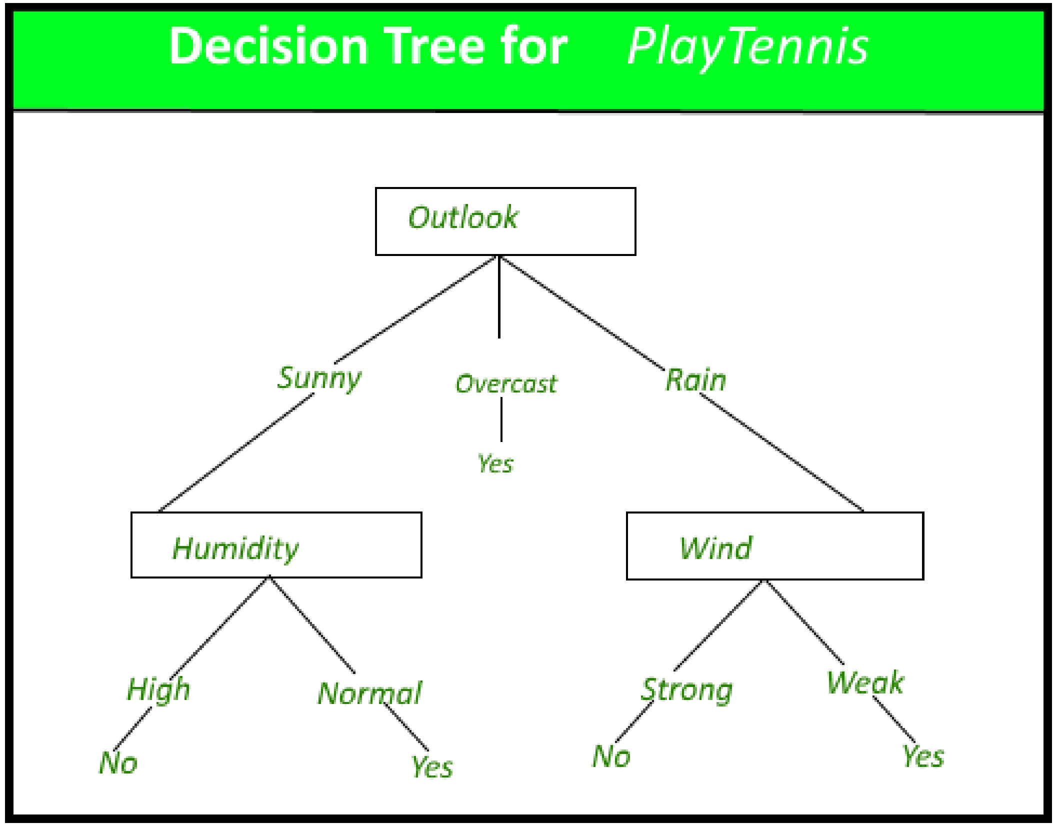
Model selection

- Linear model
    - Linear regression
    - Logistic regression



Model selection

- Tree based model
  - Decision tree



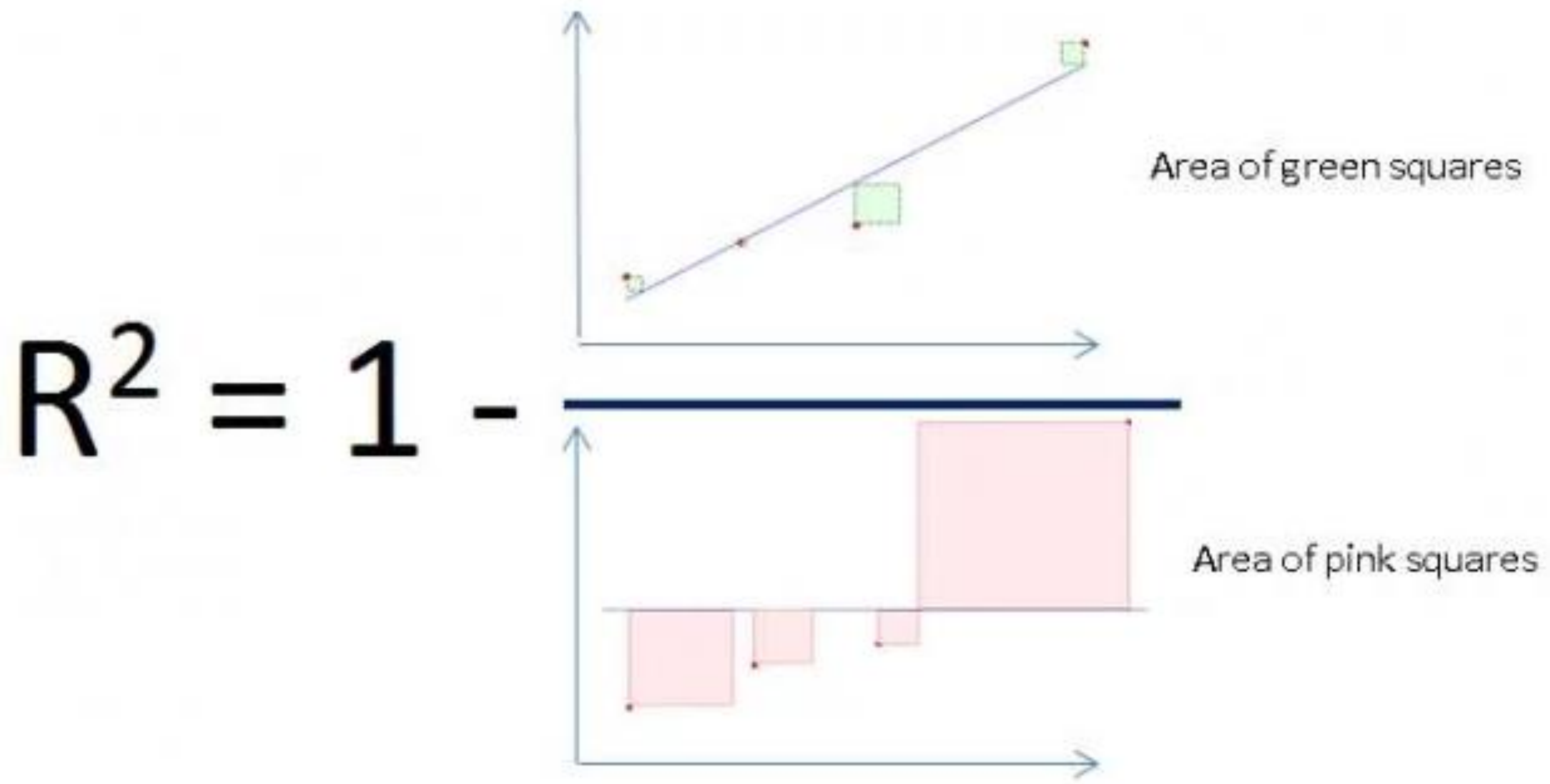
Model evaluation

Model evaluation

```
from sklearn.metrics import r2_score, mean_squared_error,
mean_absolute_error
```

- Regression problem
  - R – square, R^2
  - Mean Squared Error, MSE
  - Mean Absolute Error, MAE

Model evaluation



Source

Model evaluation

$$MSE = \frac{1}{n}\Sigma\underbrace{\left(y - \widehat{y}\right)^{2}}_{\text{The square of the difference between actual and predicted}}$$

$$MAE = \overset{\text{Divide by the total number of data points}}{\boxed{\frac{1}{n}}}\ \underset{\text{Sum of}}{\Sigma}\ \underbrace{\left|\overset{\text{Actual output value}}{\boxed{y}} - \overset{\text{Predicted output value}}{\boxed{\widehat{y}}}\right|}_{\text{The absolute value of the residual}}$$

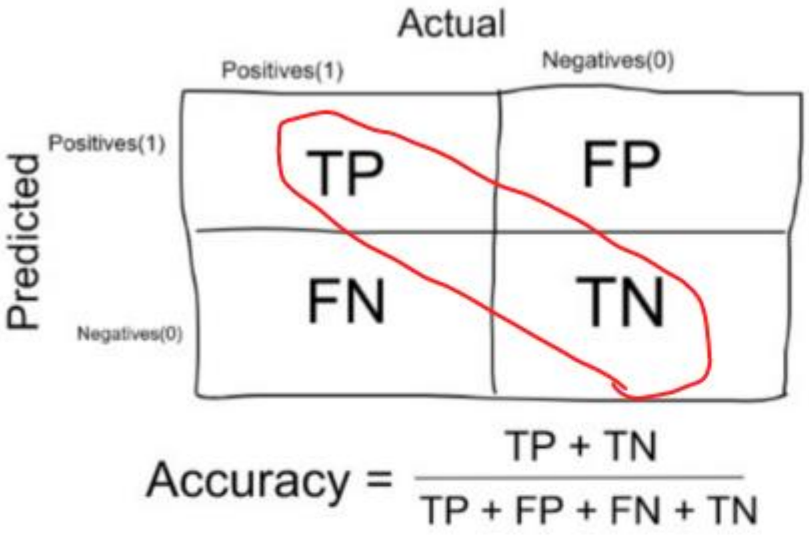
Source

Model evaluation

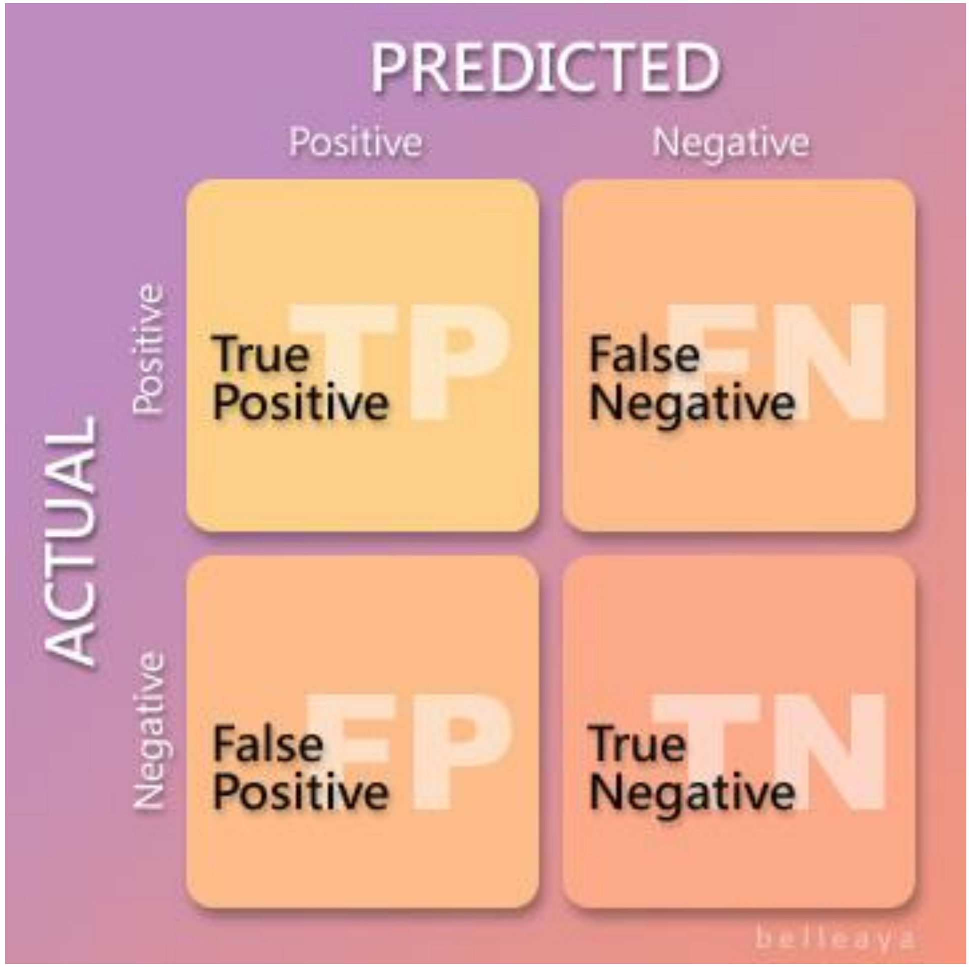
```
from sklearn.metrics import confusion_matrix, accuracy_score,
precision_score, recall_score
```

- Classification problem
  - Confusion matrix
  - Accuracy
  - Precision, recall
  - Area under curve (AUC), f1 score

Model evaluation



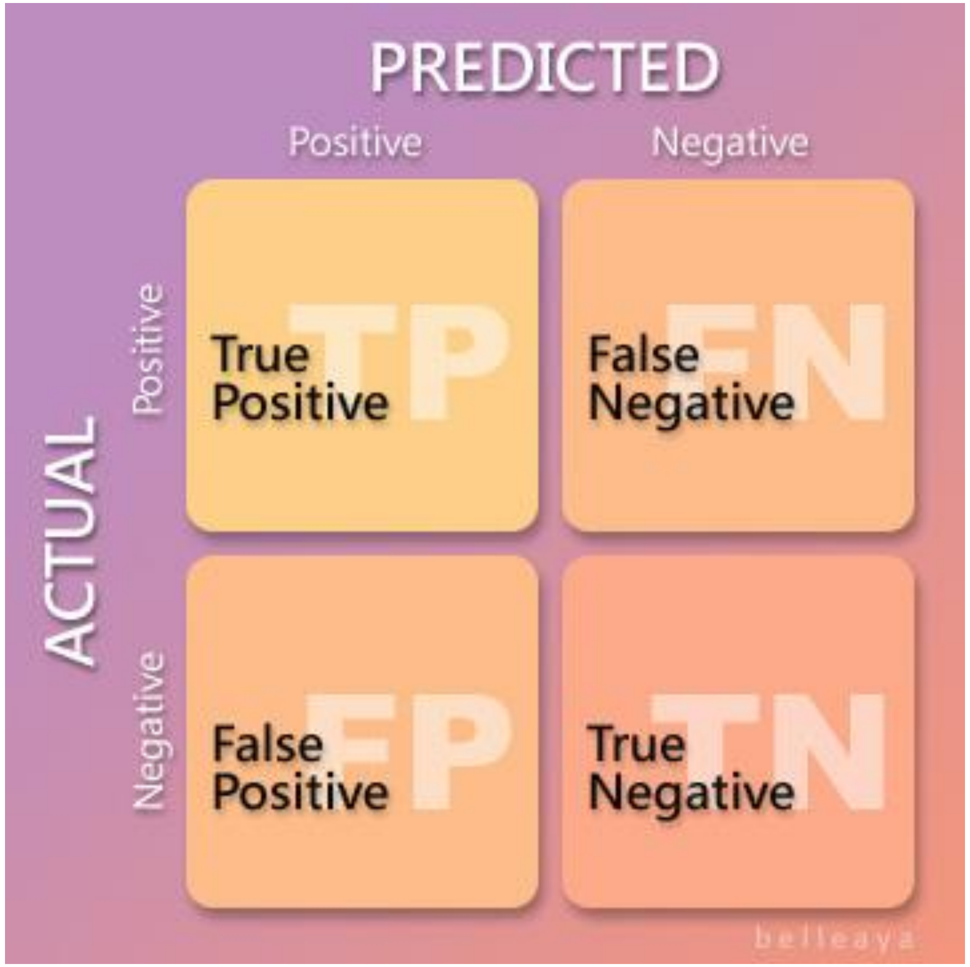
$$\text{Accuracy} = \frac{TP + TN}{TP + FP + FN + TN}$$



Source

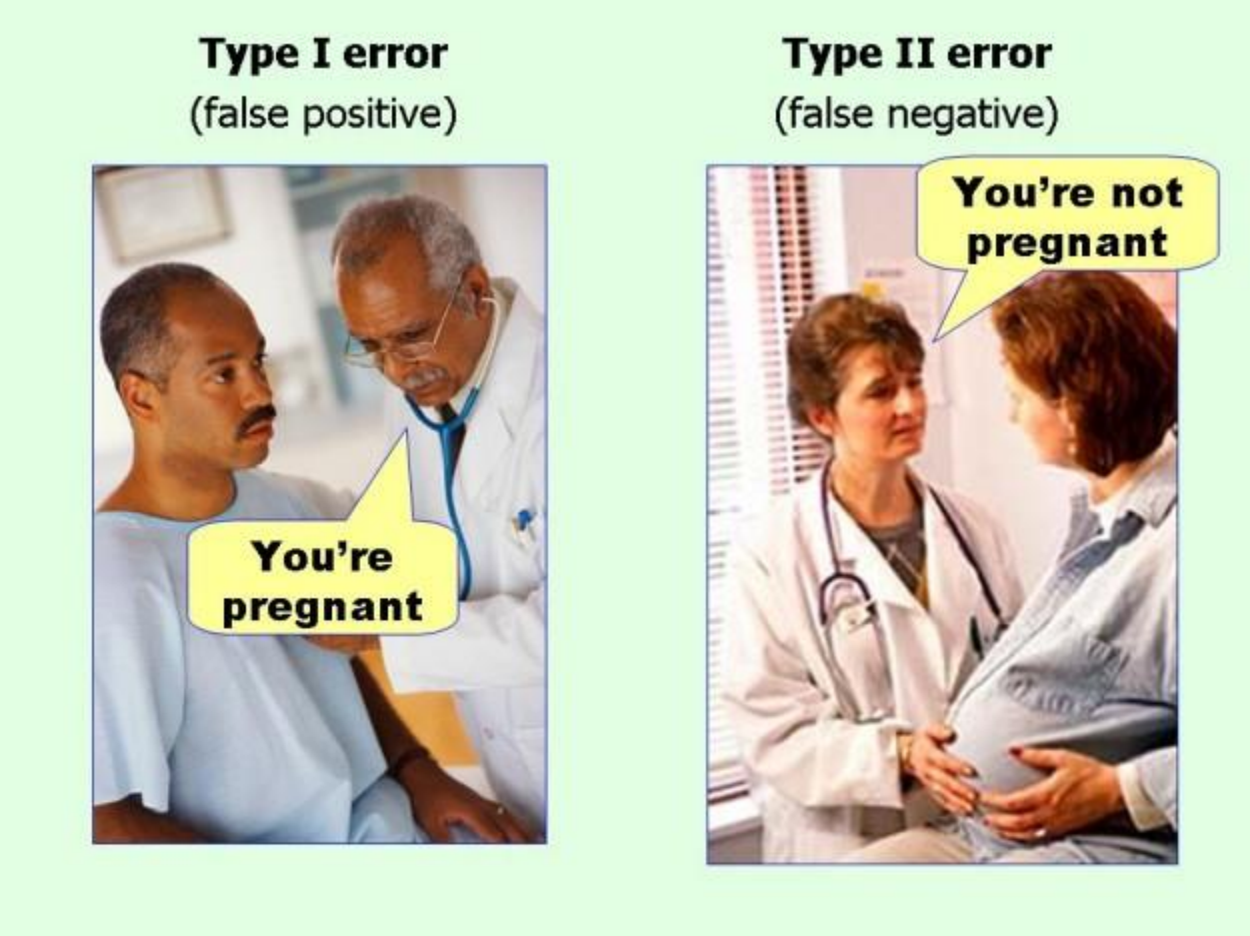
Source

Model evaluation



		PREDICTED	
		Positive	Negative
ACTUAL	Positive	True Positive TP	False Negative FN
	Negative	False Positive FP	True Negative TN

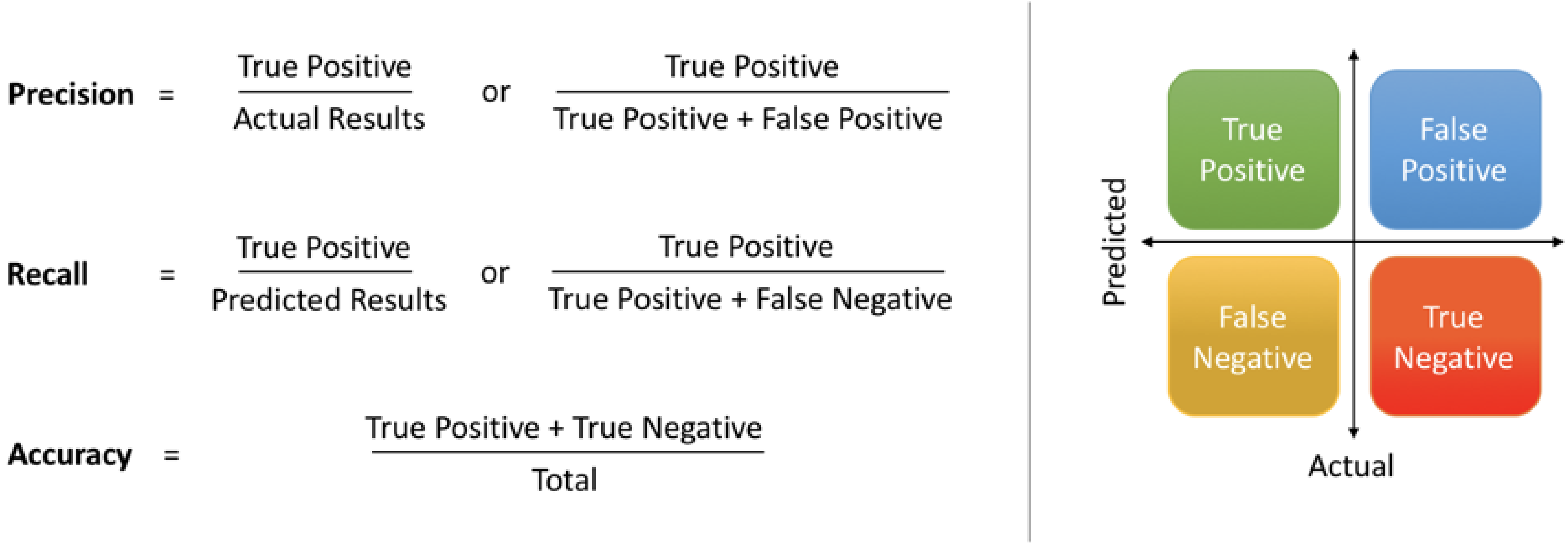
belleaya



Source

Model evaluation

- Precision & recall



$$\textbf{Precision} = \frac{\text{True Positive}}{\text{Actual Results}} \quad \text{or} \quad \frac{\text{True Positive}}{\text{True Positive + False Positive}}$$

$$\textbf{Recall} = \frac{\text{True Positive}}{\text{Predicted Results}} \quad \text{or} \quad \frac{\text{True Positive}}{\text{True Positive + False Negative}}$$

$$\textbf{Accuracy} = \frac{\text{True Positive + True Negative}}{\text{Total}}$$

Time for practice

Build your first machine learning model with python

Advanced topics about ML

Feature engineering / Feature selection

- Generate new feature
  - Domain knowhow
  - Data exploration
- Feature selection
  - Correlation
  - Lasso, Ridge regression
  - Index of feature importance

Other ML models

- Other machine learning models
  - Support Vector Machine
  - K-Nearest Neighbor
  - Naïve-bayes
  - Neural network

Other ML models

- Ml models that usually showed on ml competitions
  - Bagging : Random Forest
  - Boosting : XGBoost, LightGBM, CatBoost
  - Neural Network
  - Stacking model