Class 03: models

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Machine Learning

- **Everything Old Is New Again**
  - Computer capacity
  - Amount of data available
- **You Are Already Reaping the Benefits of Machine Learning**
  - Netflix account
  - Amazon
- **It's All About the Data**

DZone

https://dzone.com/articles/how-will-deep-learning-change-the-way-we-design-ou

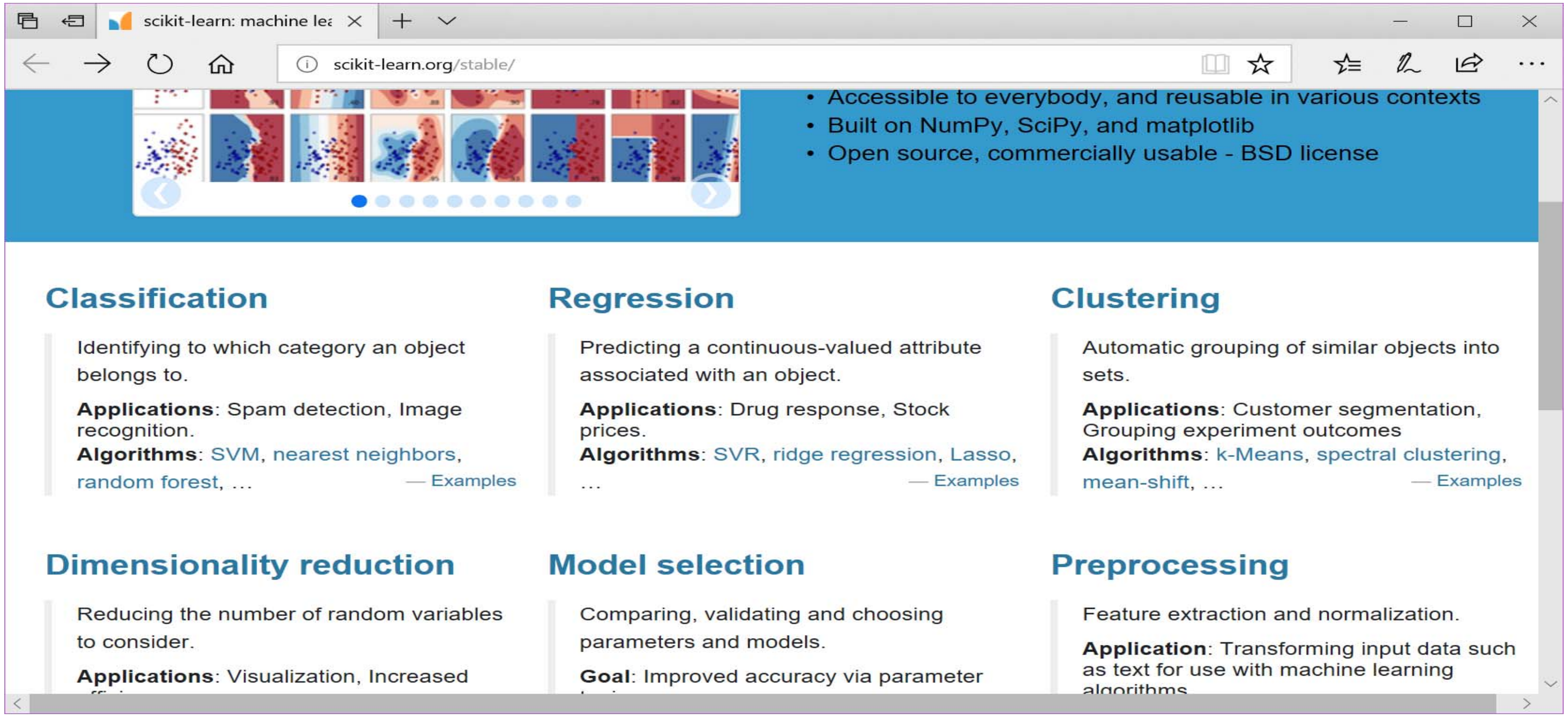
It’s All About the Data

- Given the importance of the data to the success of any machine learning implementation.
  - Data Quality
  - Data Volume
  - Data Timeliness
  - Data Pedigree

https://dzone.com/articles/how-will-deep-learning-change-the-way-we-design-ou
Software

Machine Learning

- Scikit-Learn



- Accessible to everybody, and reusable in various contexts
- Built on NumPy, SciPy, and matplotlib
- Open source, commercially usable - BSD license

Classification

Identifying to which category an object belongs to.

Applications: Spam detection, Image recognition.
Algorithms: SVM, nearest neighbors, random forest, ... — Examples

Regression

Predicting a continuous-valued attribute associated with an object.

Applications: Drug response, Stock prices.
Algorithms: SVR, ridge regression, Lasso, ... — Examples

Clustering

Automatic grouping of similar objects into sets.

Applications: Customer segmentation, Grouping experiment outcomes
Algorithms: k-Means, spectral clustering, mean-shift, ... — Examples

Dimensionality reduction

Reducing the number of random variables to consider.

Applications: Visualization, Increased

Model selection

Comparing, validating and choosing parameters and models.

Goal: Improved accuracy via parameter

Preprocessing

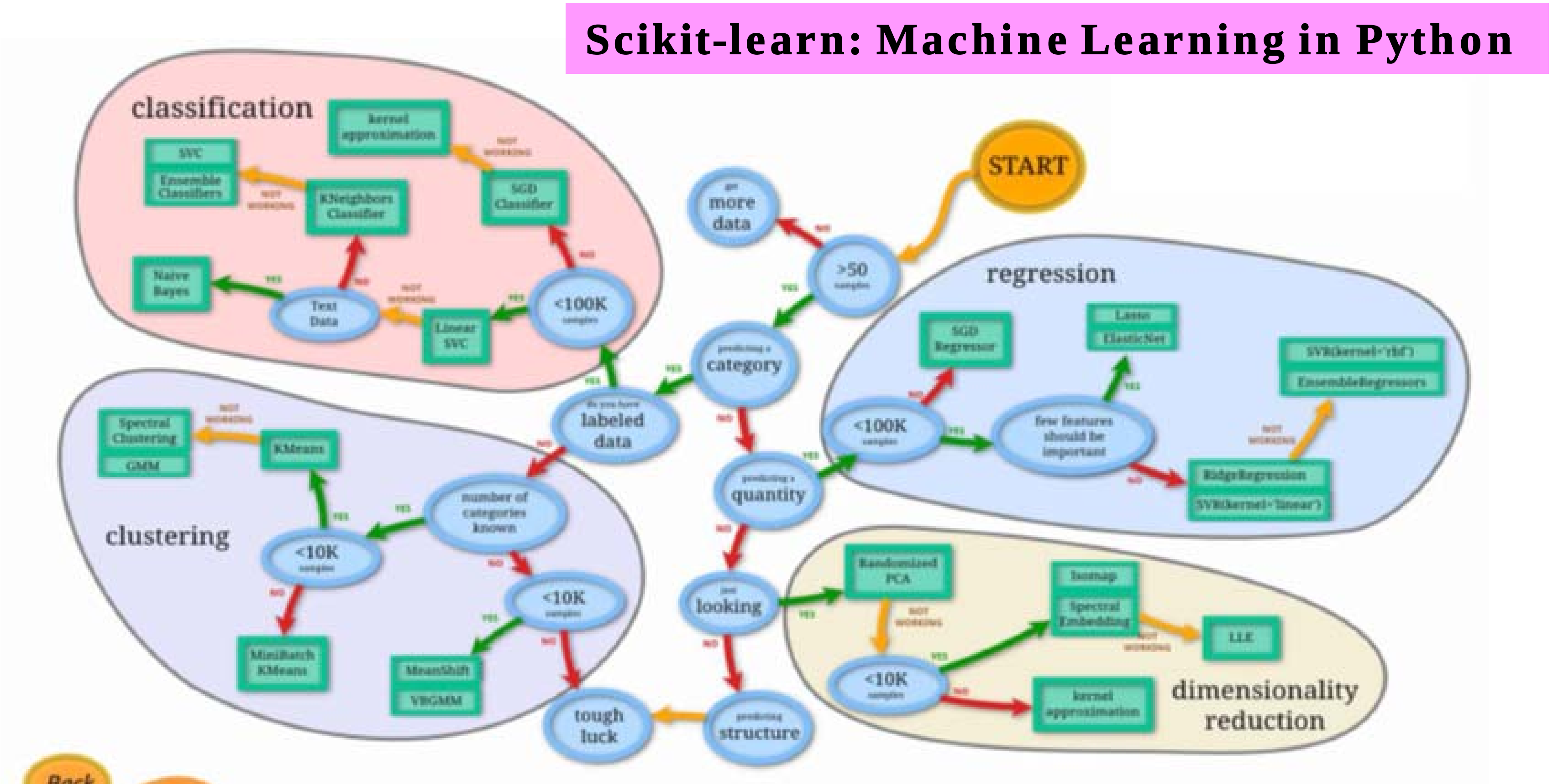
Feature extraction and normalization.

Application: Transforming input data such as text for use with machine learning

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

Scikit-Learn Packages

Scikit-learn: Machine Learning in Python



Back

http://scikit-learn.org/dev/tutorial/machine_learning_map/index.html

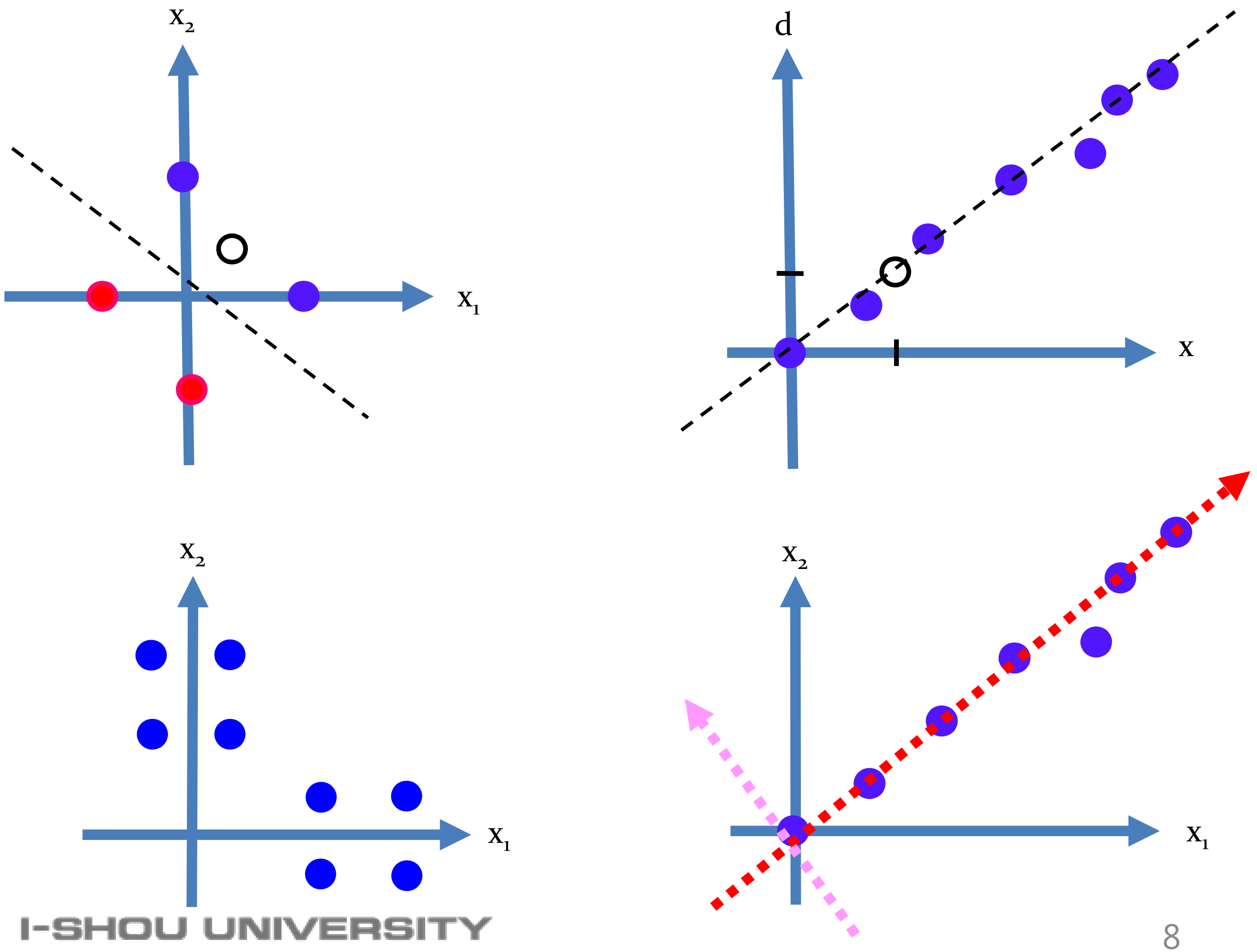
Supervised Learning

- Model-based learning
  - Linear regression
  - Regression with regularization
  - Logistic regression
  - Support vector machine
  - Decision Tree
  - Random Forests
- Instance-based learning
  - Naive Bayesian model
  - K-nearest neighbor(KNN)

Unsupervised Learning

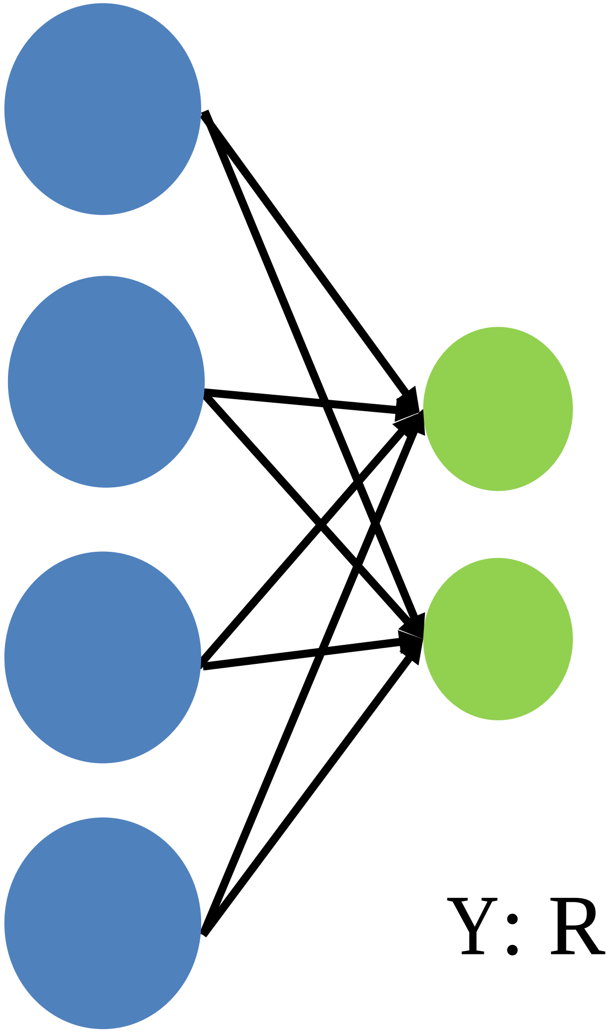
- Principal Component Analysis
- K-mean

Model Diagnostic



Mapping

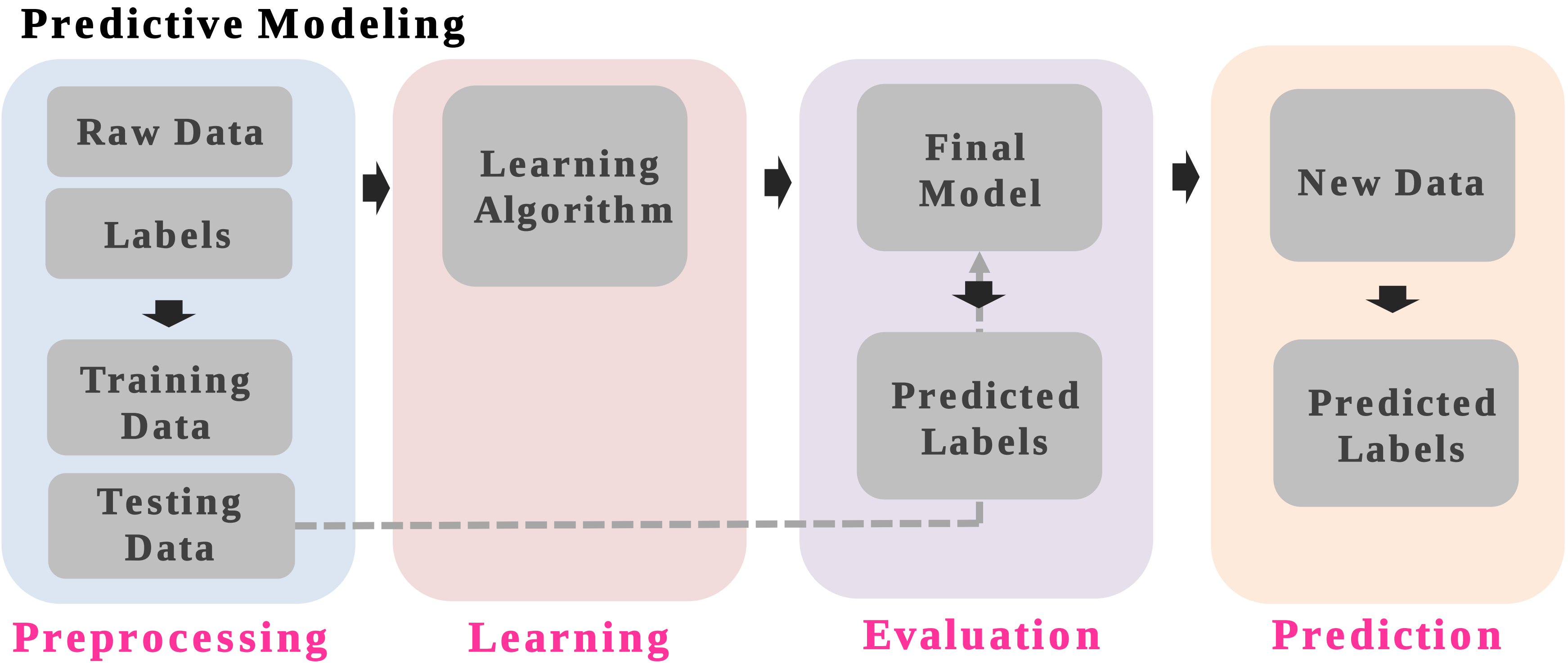
$Y = AX$



X: R^4

Y: R^2

Supervised Learning

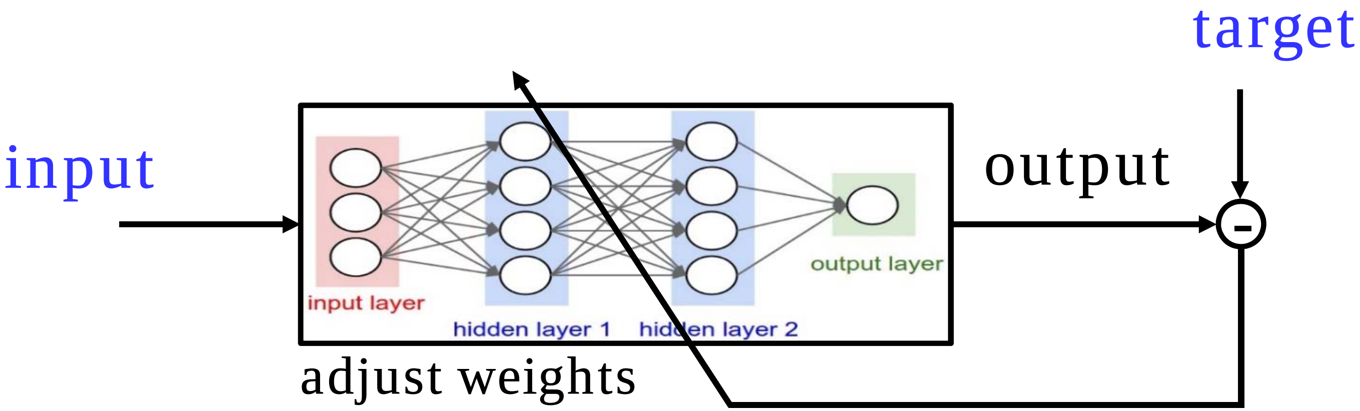


- Feature extraction -normalization
- Feature selection
- Dimension reduction
- Sampling

- Model selection
- Cross-validation
- Metric
- Hyperparameter optimization

Supervised Learning

- Supervised Learning
  - Model Selection
    - Parameters of Model
    - Parameters of Learning
    - Learning Algorithm
    - Object Function



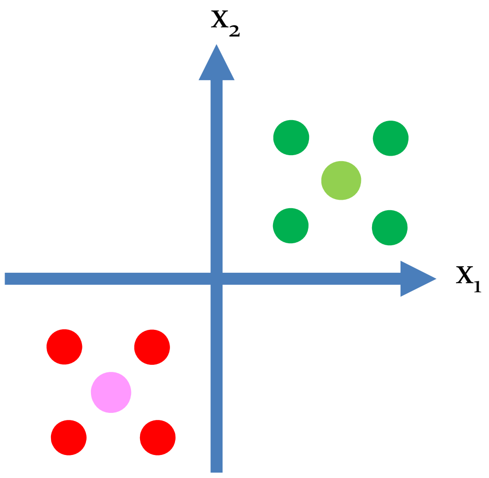
Toy dataset

- Clustering (data reduction/compression)
- Density estimation

input (x1)	input (x2)
-1	-1
-2	-1
-1	-2
-2	-2
1	1
2	1
1	2
2	2

input (x1)	input (x2)
-1	-1
-2	-1
-1	-2
-2	-2
1	1
2	1
1	2
2	2

input (x1)	input (x2)
-1.5	-1.5
1.5	1.5



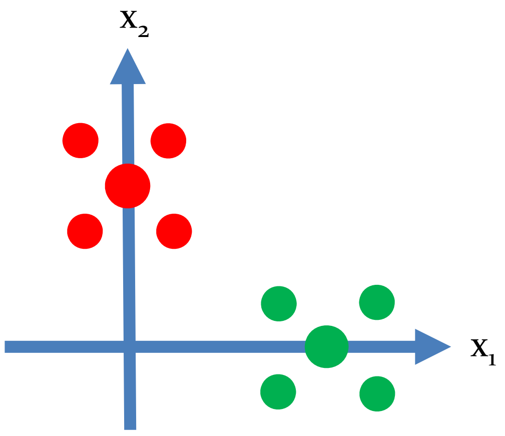
Toy dataset

- Data mining

input (x1)	input (x2)
3	1
3	-1
5	-1
5	1
1	1
1	3
-1	1
-1	3

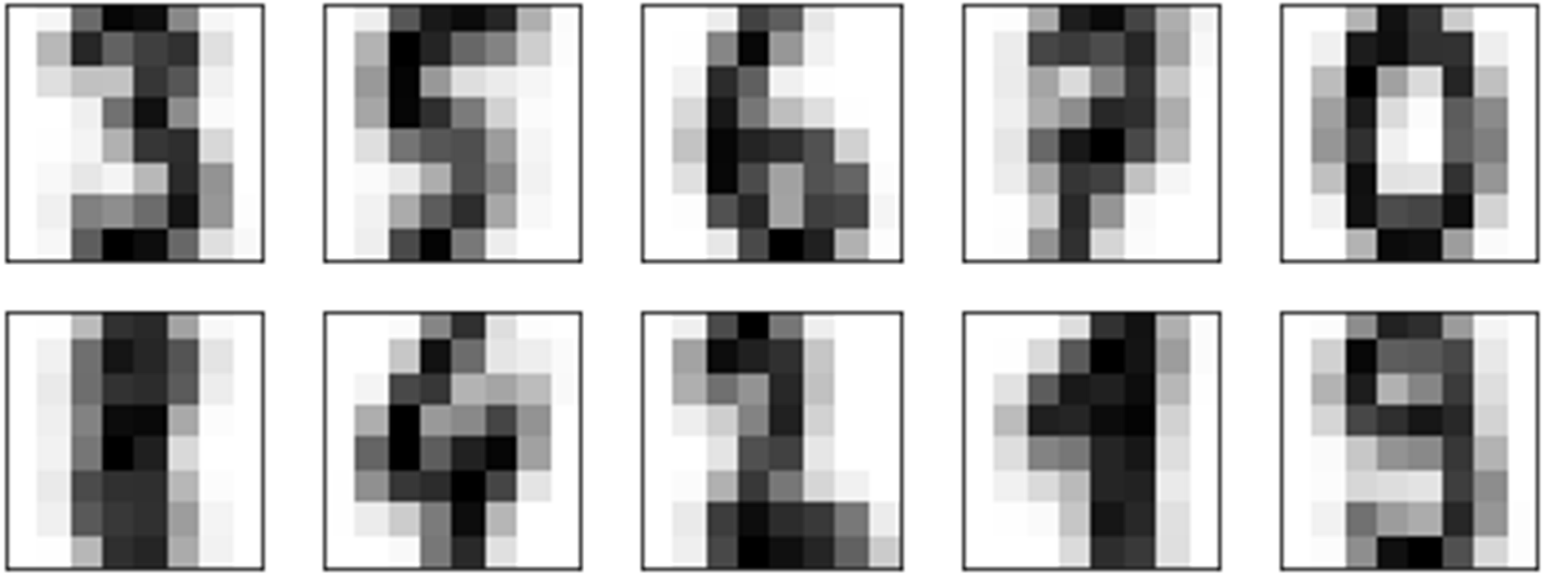
input (x1)	input (x2)
3	1
3	-1
5	-1
5	1
1	1
1	3
-1	1
-1	3

input (x1)	input (x2)
4	~~0~~
~~0~~	4



Unsupervised Learning

- K-means clustering for data compression



digits.images.shape = (1797, 8, 8)

http://scikit-learn.org/stable/modules/generated/sklearn.cluster.KMeans.html

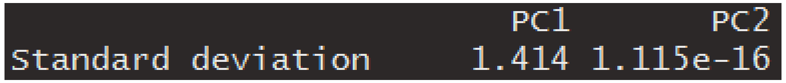
06_kmeans_clustering.ipynb

PCA

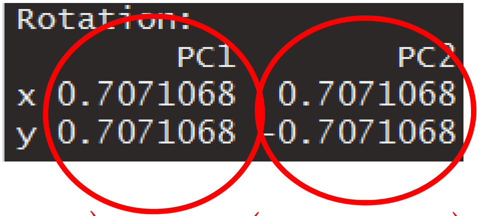
- Dimensionality reduction
- Data mining

x1	x2
1	3
2	5
3	7
4	9
5	11
6	13
7	15
8	17

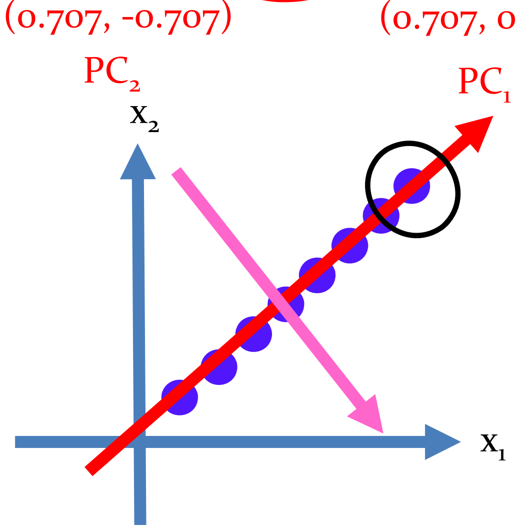
PC$_1$	PC$_2$
-2.02	0.00
-1.44	0.00
-0.86	0.00
-0.28	0.00
0.28	0.00
0.86	0.00
1.44	0.00
2.02	0.00



```
                          PC1       PC2
Standard deviation      1.414 1.115e-16
```



```
Rotation:
        PC1        PC2
x 0.7071068  0.7071068
y 0.7071068 -0.7071068
```

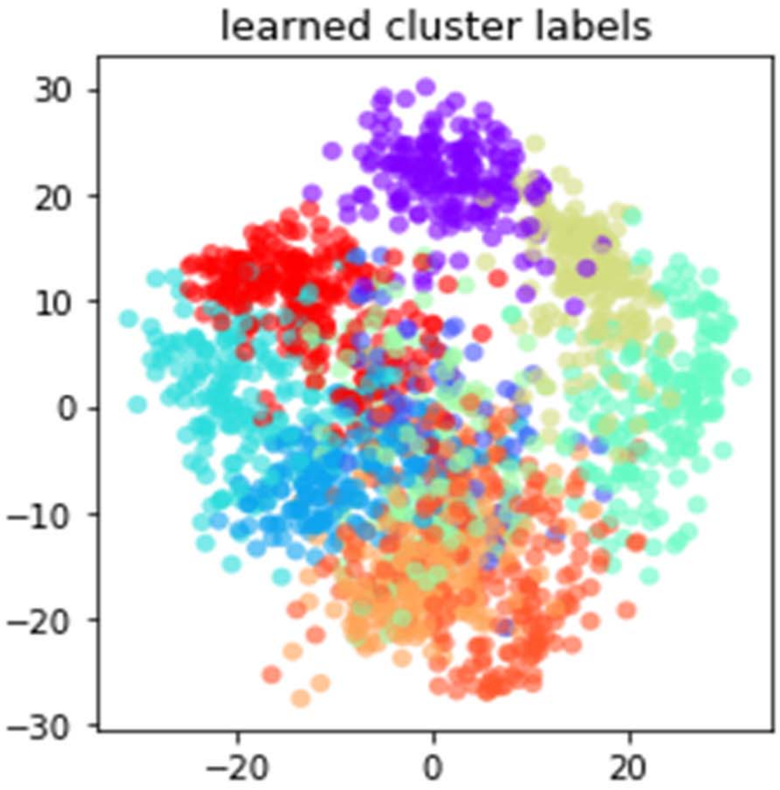


(0.707, -0.707)

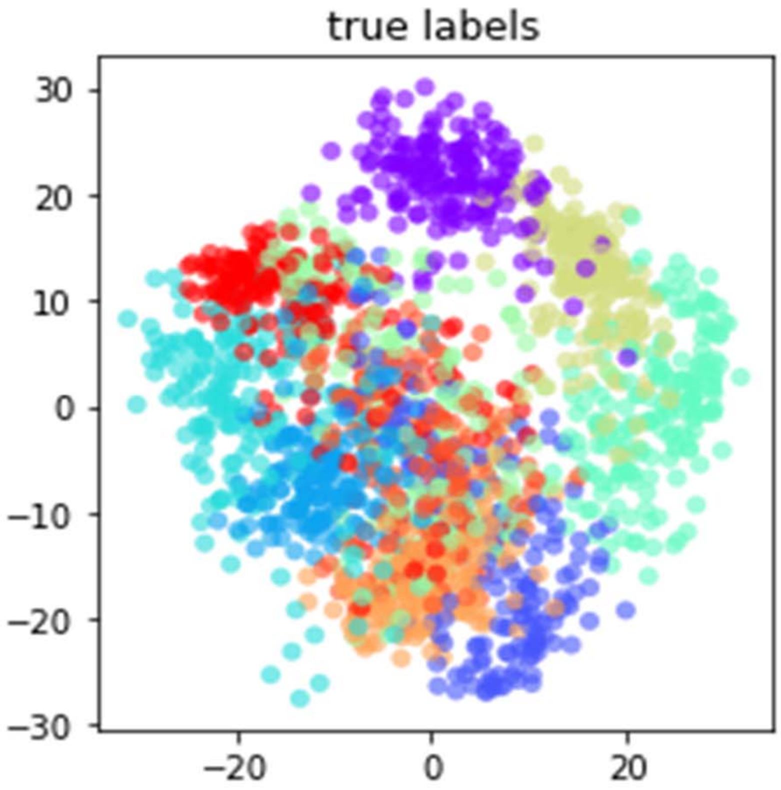
(0.707, 0.707)

Unsupervised Learning

- PCA Visualization

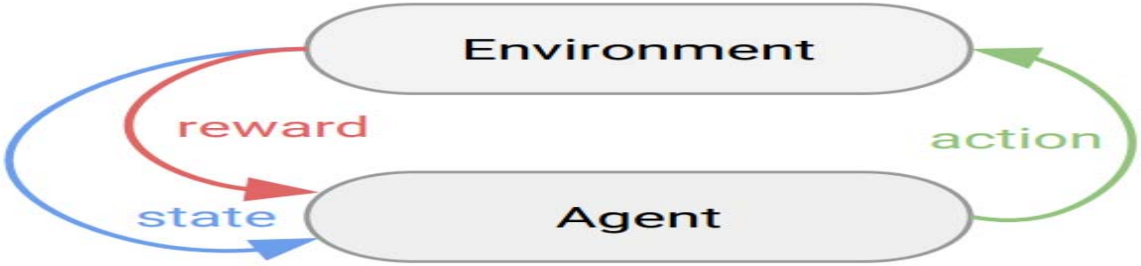


digits.images.shape = (1797, 2)

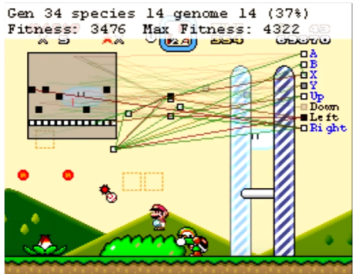


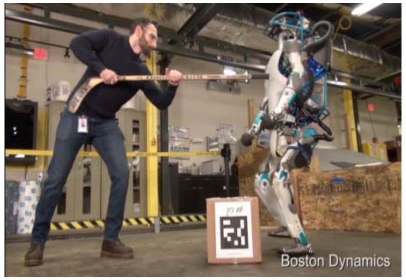
digits.images.shape = (1797, 2)

Reinforcement Learning



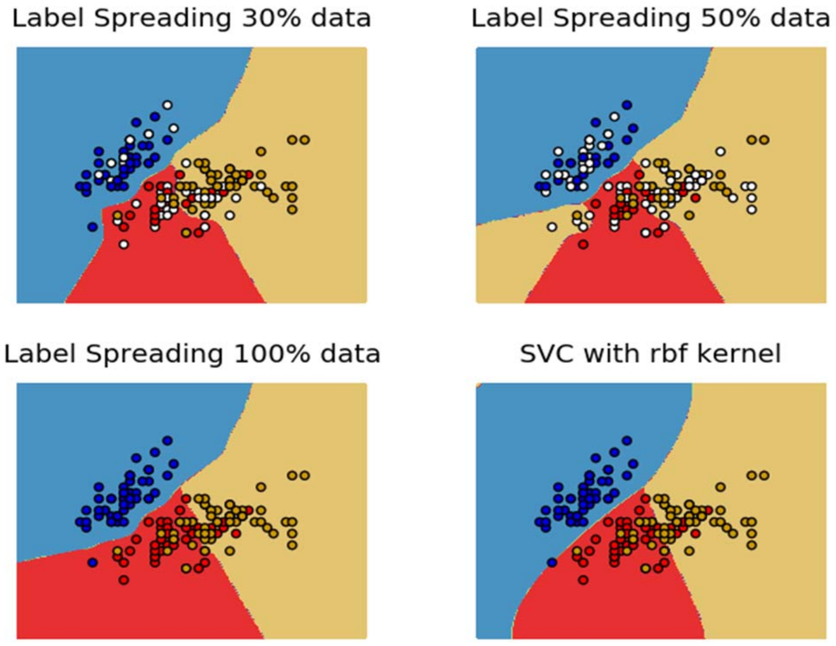
- Training data: (S, A, R). (State-Action-Reward)
- Goal: Develop an optimal policy (sequence of decision rules) for the learner so as to **maximize its long-term reward**.

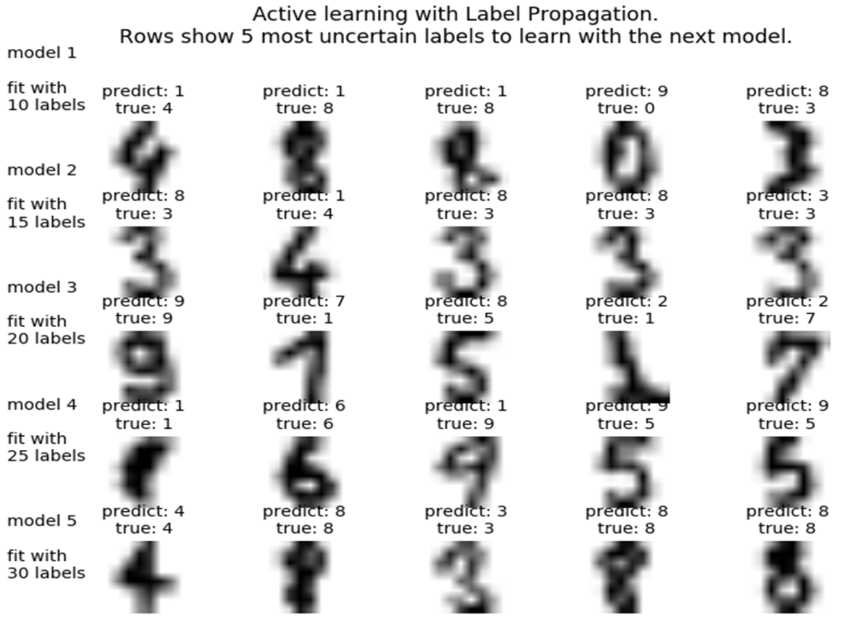

Gen 34 species 14 genome 14 (37%)
Fitness: 3476 Max Fitness: 4322
A
B
X
Y
Up
Down
Left
Right



Semi-supervised Learning

- Semi-supervised learning is about using these unlabeled examples to improve supervised learning methods, which generally require labeled examples for training.





Machine Learning

- **Supervised learning**
- **Unsupervised learning**
- Reinforcement learning
- Semi-supervised learning

Scikit-learn's Estimator

- Available in **all estimators**
  - **model.fit()**: fit training data, X: data, Y: label
  - Supervised: **model.fit(X,Y)** ⟺ Unsupervised:**model.fit(X)**
- Available in **supervised estimators**
  - **model.predict()** : predict the label of a new set of data by model
  - **model.predict_proba()** : for classification problems, some estimators provides this method to return probability of each class
- Available in **unsupervised estimators**
  - **model.transform()** : transform new data into new basis by model
  - **model.fit_transform() :** some estimators implement this method to efficiently perform a fit and transform on the same input data

Supervised Learning

- In supervised learning, we have a dataset consisting of both **features** (input variables) and **labels** (output variables)
- The task is to construct an **estimator**(model) which enables to predict the labels of an instance given the set of features
- Two categories: **Classification** and **Regression**
  - Classification: the label is **discrete**
  - Regression: the label is **continuous**
- Split into **training** and **testing** datasets

Supervised Learning

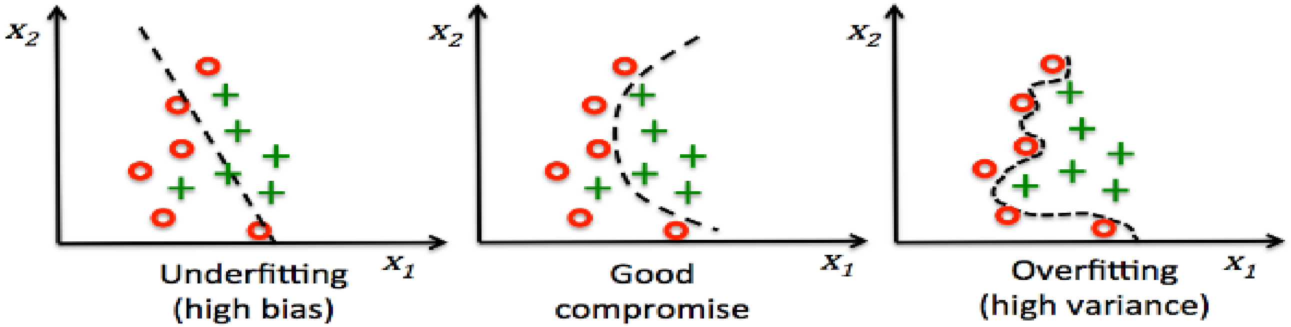
- Model-based learning
  - Linear regression
  - Regression with regularization
  - Logistic regression
  - Support vector machine
  - Decision Tree
  - Random Forests
  - Neural Networks
- Instance-based learning
  - Naive Bayesian model
  - K-nearest neighbor(KNN)

Training and Testing Dataset

- To validate the generalization of a trained model, splitting a whole dataset into **training** and **testing** datasets
- We fit and optimize predictive models using the training dataset
- Use testing datasets to evaluate the performance of trained models to ensure the model **generalization**

Generalization

- We hope that a model trained on the basis of a training dataset can seamlessly apply to **unseen testing** dataset
- If the model over fits the training dataset, its performance on testing dataset will be worse
- Higher model complexity, easier to overfitting



Hyperparameters

- Learning the parameters of a prediction function and testing it on **the same data** is a methodological mistake
- There are **Hyperparameters**: choices about the algorithm that we **set** rather than learn

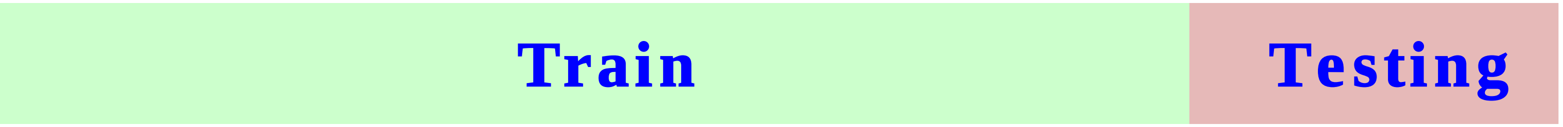
Your Dataset: Images / Corpus

Hyperparameters

- **idea 1:** Choose **hyperparameters** that work best on the data Your Dataset

Your Dataset

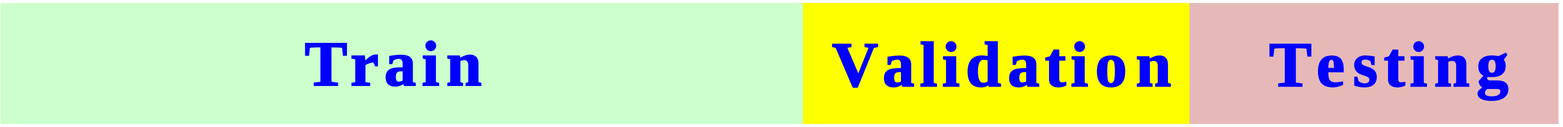
- **idea 2:** Split data into train and test, choose **hyperparameters** that work best on test data



Train

Testing

- **idea 3:** Split data into train, val., and test; choose **hyperparameters** on val. and evaluate on test



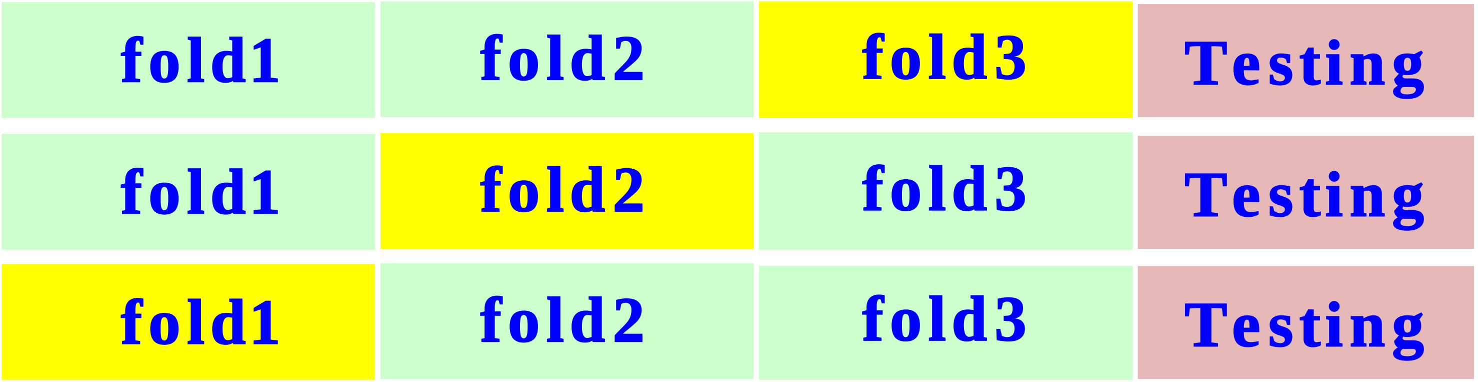
Train

Validation

Testing

Hyperparameters

- **idea 4: Cross-Validation**: Split data into folds, try each fold as validation and **average** the results

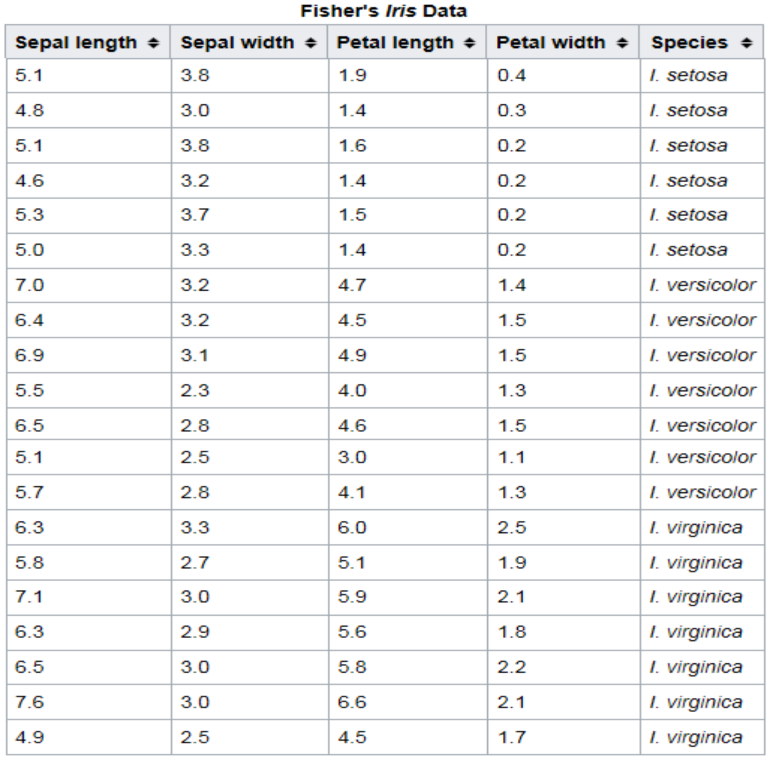


fold1	**fold2**	**fold3**	**Testing**
fold1	**fold2**	**fold3**	**Testing**
fold1	**fold2**	**fold3**	**Testing**

Useful for small datasets, but not used too frequently in deep learning

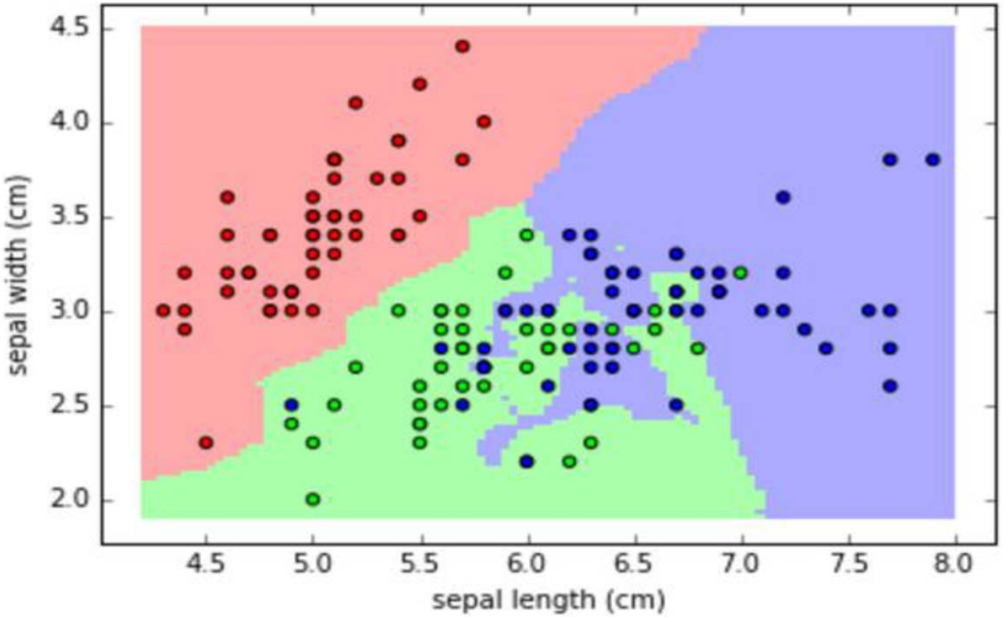
Classification

- **k-Nearest Neighbor** for iris



Fisher's *Iris* Data

Sepal length ⬍	Sepal width ⬍	Petal length ⬍	Petal width ⬍	Species ⬍
5.1	3.8	1.9	0.4	*I. setosa*
4.8	3.0	1.4	0.3	*I. setosa*
5.1	3.8	1.6	0.2	*I. setosa*
4.6	3.2	1.4	0.2	*I. setosa*
5.3	3.7	1.5	0.2	*I. setosa*
5.0	3.3	1.4	0.2	*I. setosa*
7.0	3.2	4.7	1.4	*I. versicolor*
6.4	3.2	4.5	1.5	*I. versicolor*
6.9	3.1	4.9	1.5	*I. versicolor*
5.5	2.3	4.0	1.3	*I. versicolor*
6.5	2.8	4.6	1.5	*I. versicolor*
5.1	2.5	3.0	1.1	*I. versicolor*
5.7	2.8	4.1	1.3	*I. versicolor*
6.3	3.3	6.0	2.5	*I. virginica*
5.8	2.7	5.1	1.9	*I. virginica*
7.1	3.0	5.9	2.1	*I. virginica*
6.3	2.9	5.6	1.8	*I. virginica*
6.5	3.0	5.8	2.2	*I. virginica*
7.6	3.0	6.6	2.1	*I. virginica*
4.9	2.5	4.5	1.7	*I. virginica*



http://scikit-learn.org/stable/modules/generated/sklearn.neighbors.NearestNeighbors.html#sklearn.neighbors.NearestNeighbors

Confusion matrix

	Predicted 0	Predicted 1
Actual 0	True Negative (TN)	False Positive (FP)
Actual 1	False Negative (FN)	True Positive (TP)

Recall = TP/ (FN+TP)

Precision = TP / (FP+TP)

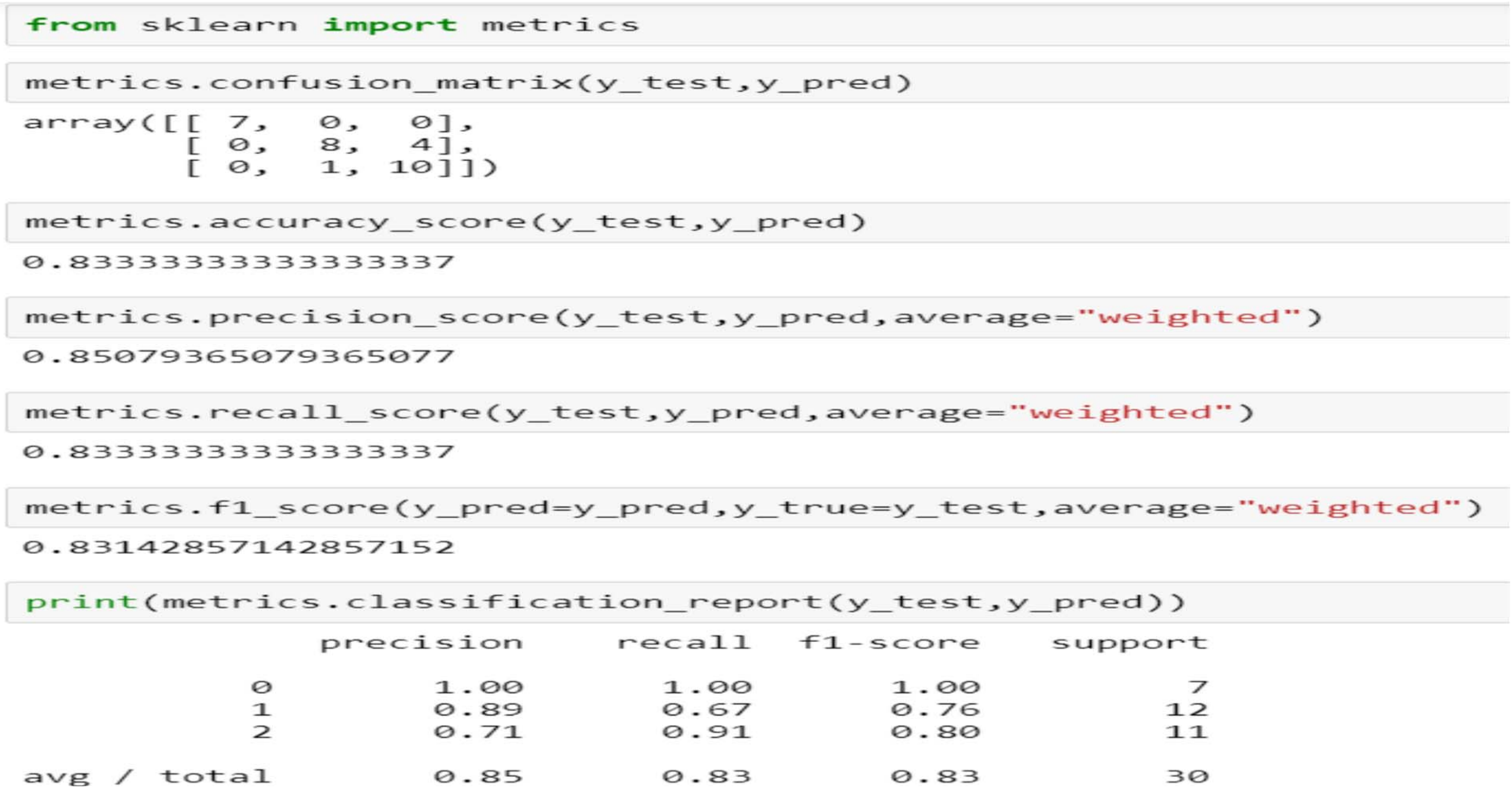
F1 score = 2*(Recall∗Precision)/(Recall+Precision)

Confusion matrix

	Predicted 0	Predicted 1
Actual 0	True Negative (TN)	False Positive (FP)
Actual 1	False Negative (FN)	True Positive (TP)

Accuracy = (TN+TP)/ (TN+FP+FN+TP)

Metrics in Classification



```
from sklearn import metrics
```

```
metrics.confusion_matrix(y_test,y_pred)
```

```
array([[ 7,  0,  0],
       [ 0,  8,  4],
       [ 0,  1, 10]])
```

```
metrics.accuracy_score(y_test,y_pred)
```

```
0.8333333333333337
```

```
metrics.precision_score(y_test,y_pred,average="weighted")
```

```
0.8507936507936507
```

```
metrics.recall_score(y_test,y_pred,average="weighted")
```

```
0.8333333333333337
```

```
metrics.f1_score(y_pred=y_pred,y_true=y_test,average="weighted")
```

```
0.8314285714285714
```

```
print(metrics.classification_report(y_test,y_pred))
```

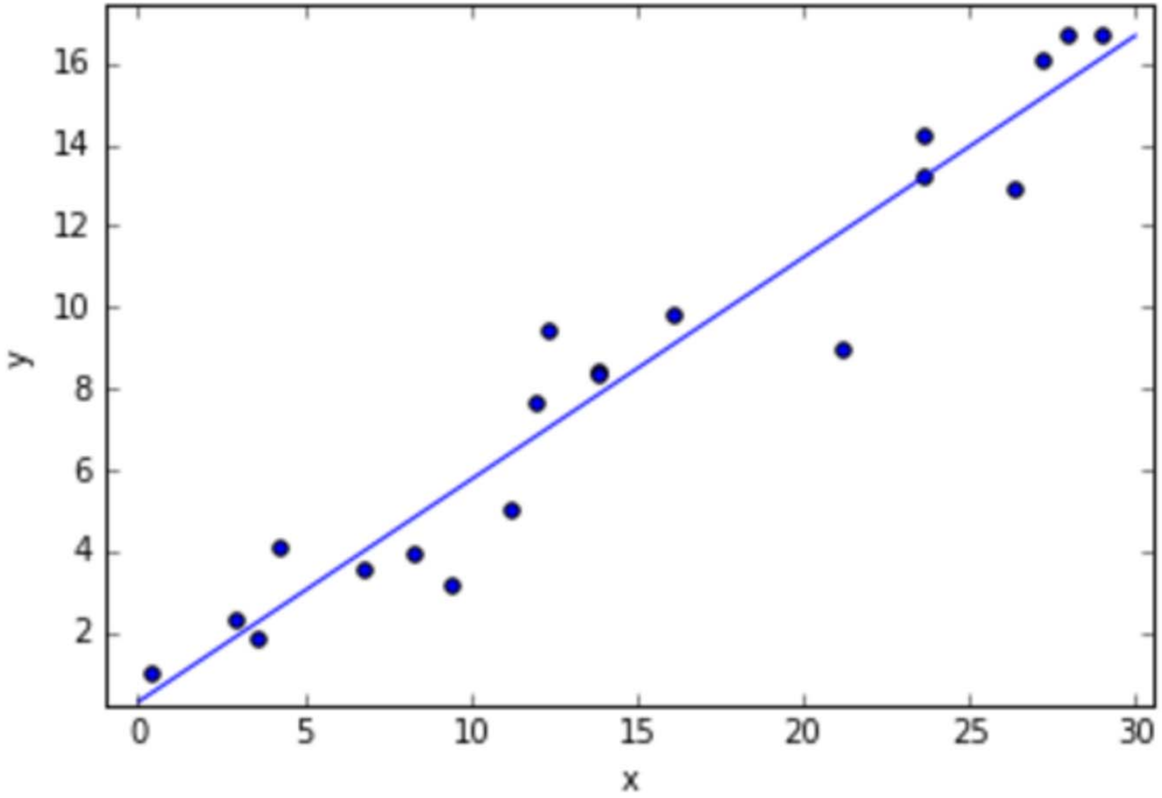
```
             precision    recall  f1-score   support

          0       1.00      1.00      1.00         7
          1       0.89      0.67      0.76        12
          2       0.71      0.91      0.80        11

avg / total       0.85      0.83      0.83        30
```

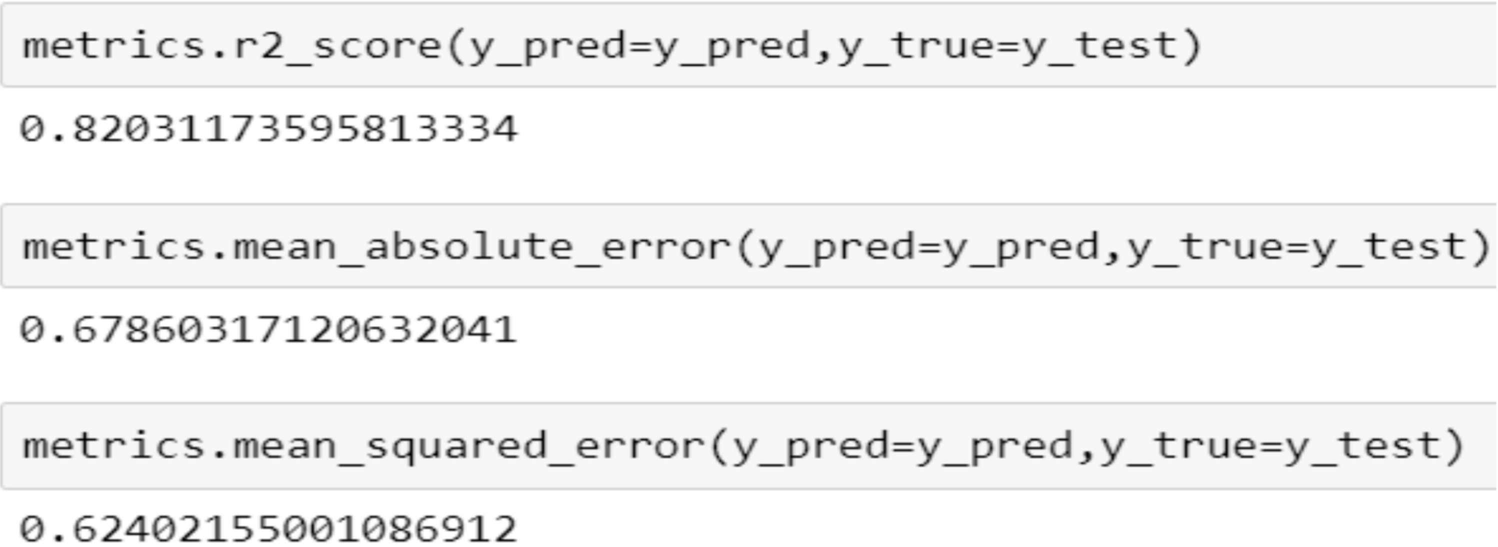
Regression

- Fit a line to the data



Metrics in Regression

- Mean Absolute Error (MAE)
- Mean Square Error (MSE)
- R Squared
- **Peak Signal to Noise Ratio (PNSR)**
- **Structural Similarity Index Measure (SSIM)**



```
metrics.r2_score(y_pred=y_pred,y_true=y_test)
```

```
0.8203173595813334
```

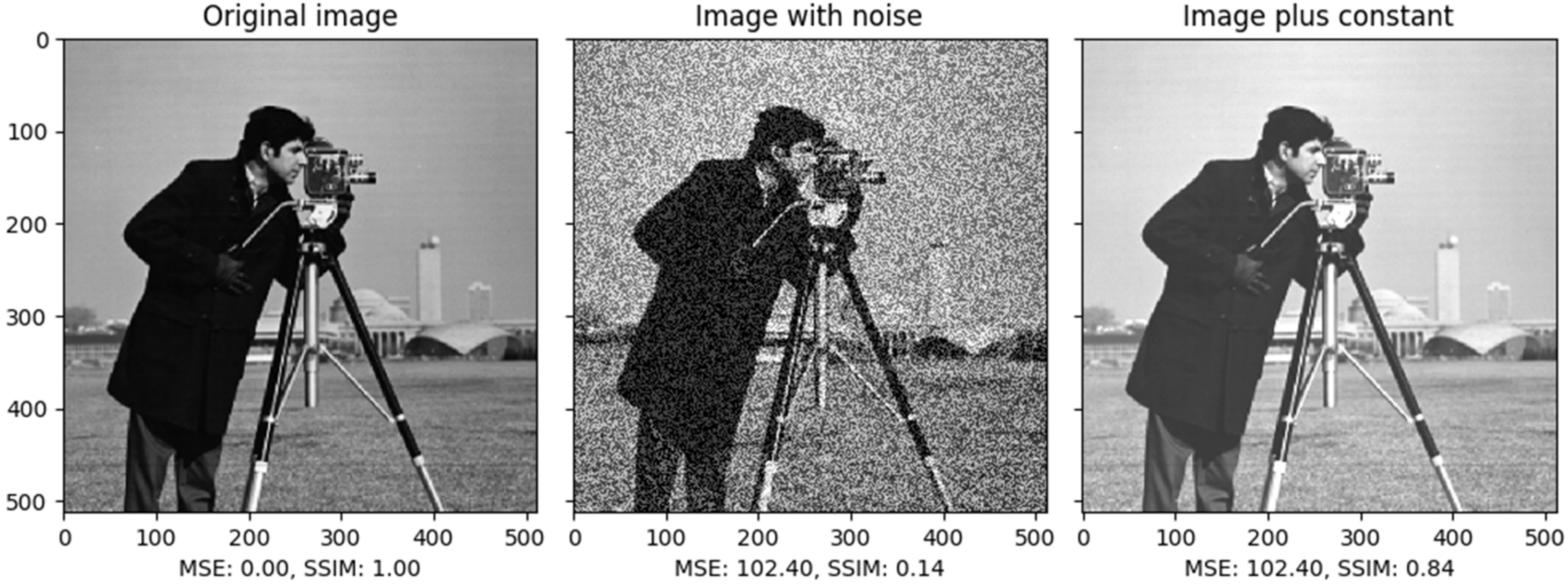
```
metrics.mean_absolute_error(y_pred=y_pred,y_true=y_test)
```

```
0.6786031712063204
```

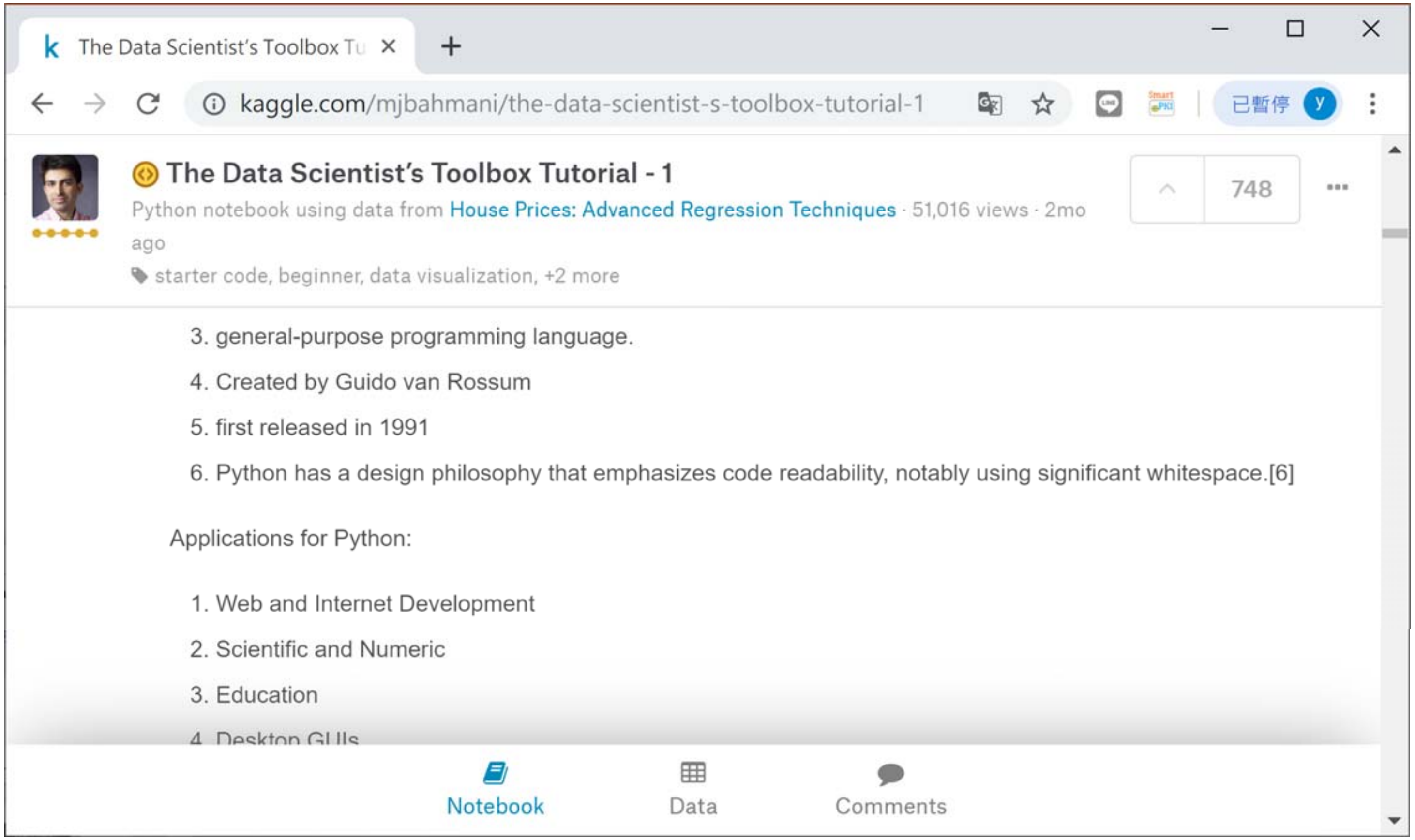
```
metrics.mean_squared_error(y_pred=y_pred,y_true=y_test)
```

```
0.6240215500108691
```

SSIM


Original image
Image with noise
Image plus constant
0
100
200
300
400
500
MSE: 0.00, SSIM: 1.00
MSE: 102.40, SSIM: 0.14
MSE: 102.40, SSIM: 0.84

Data Scientist's Toolbox


The Data Scientist's Toolbox Tu
kaggle.com/mjbahmani/the-data-scientist-s-toolbox-tutorial-1
已暫停
748
Notebook
Data
Comments

The Data Scientist's Toolbox Tutorial - 1

Python notebook using data from House Prices: Advanced Regression Techniques · 51,016 views · 2mo ago

starter code, beginner, data visualization, +2 more

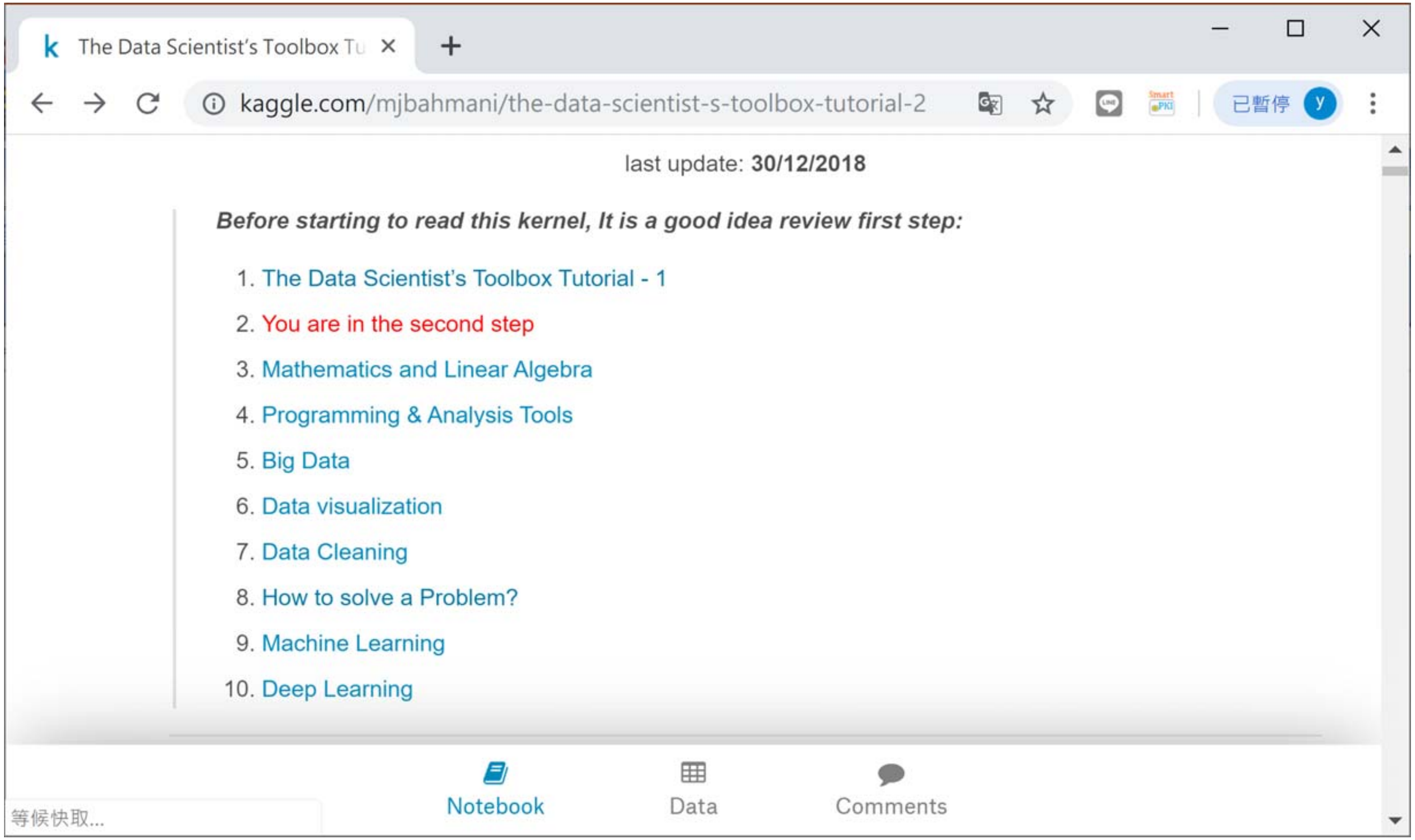
3. general-purpose programming language.
4. Created by Guido van Rossum
5. first released in 1991
6. Python has a design philosophy that emphasizes code readability, notably using significant whitespace.[6]

Applications for Python:

1. Web and Internet Development
2. Scientific and Numeric
3. Education
4. Desktop GUIs

https://www.kaggle.com/mjbahmani/the-data-scientist-s-toolbox-tutorial-1

Data Scientist's Toolbox



The Data Scientist's Toolbox Tu ×
kaggle.com/mjbahmani/the-data-scientist-s-toolbox-tutorial-2
已暫停

last update: **30/12/2018**

Before starting to read this kernel, It is a good idea review first step:

1. The Data Scientist's Toolbox Tutorial - 1
2. You are in the second step
3. Mathematics and Linear Algebra
4. Programming & Analysis Tools
5. Big Data
6. Data visualization
7. Data Cleaning
8. How to solve a Problem?
9. Machine Learning
10. Deep Learning

Notebook
Data
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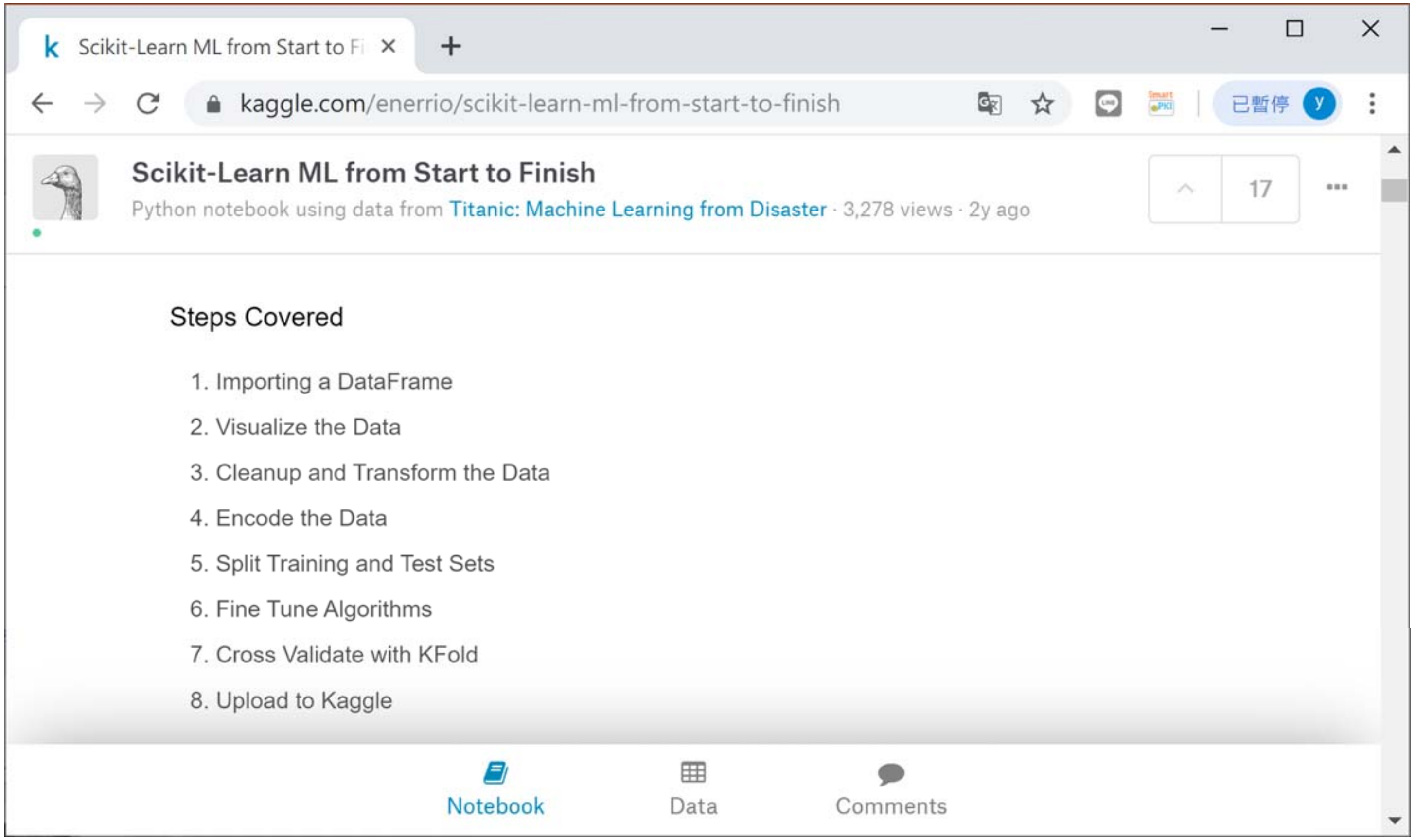
等候快取...

https://www.kaggle.com/mjbahmani/the-data-scientist-s-toolbox-tutorial-2

Scikit-Learn ML



Scikit-Learn ML from Start to Fi
kaggle.com/enerrio/scikit-learn-ml-from-start-to-finish
已暫停
17
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Scikit-Learn ML from Start to Finish

Python notebook using data from Titanic: Machine Learning from Disaster · 3,278 views · 2y ago

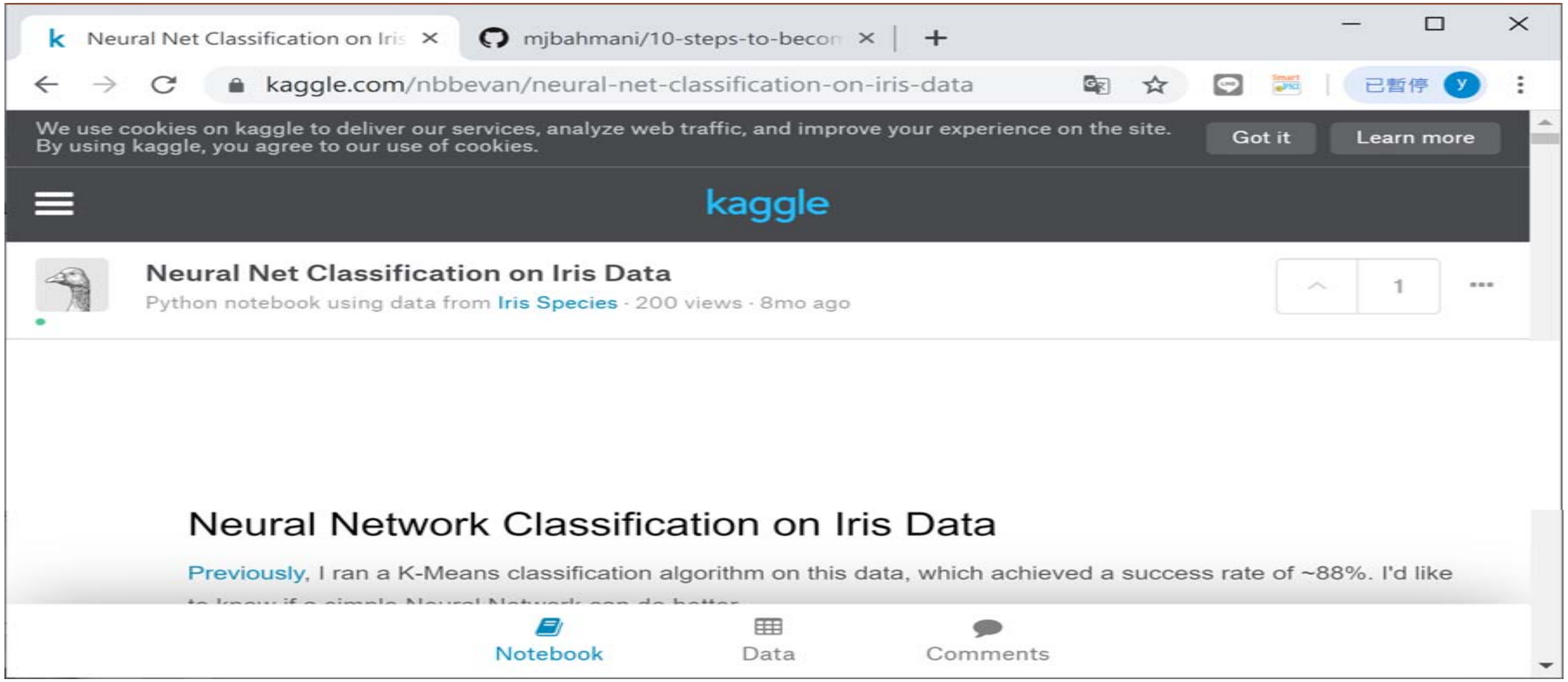
Steps Covered

1. Importing a DataFrame
2. Visualize the Data
3. Cleanup and Transform the Data
4. Encode the Data
5. Split Training and Test Sets
6. Fine Tune Algorithms
7. Cross Validate with KFold
8. Upload to Kaggle

https://www.kaggle.com/enerrio/scikit-learn-ml-from-start-to-finish

IRIS Classification

- **Neural Network**


Neural Net Classification on Iris
mjbahmani/10-steps-to-becon
kaggle.com/nbbevan/neural-net-classification-on-iris-data
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Neural Net Classification on Iris Data

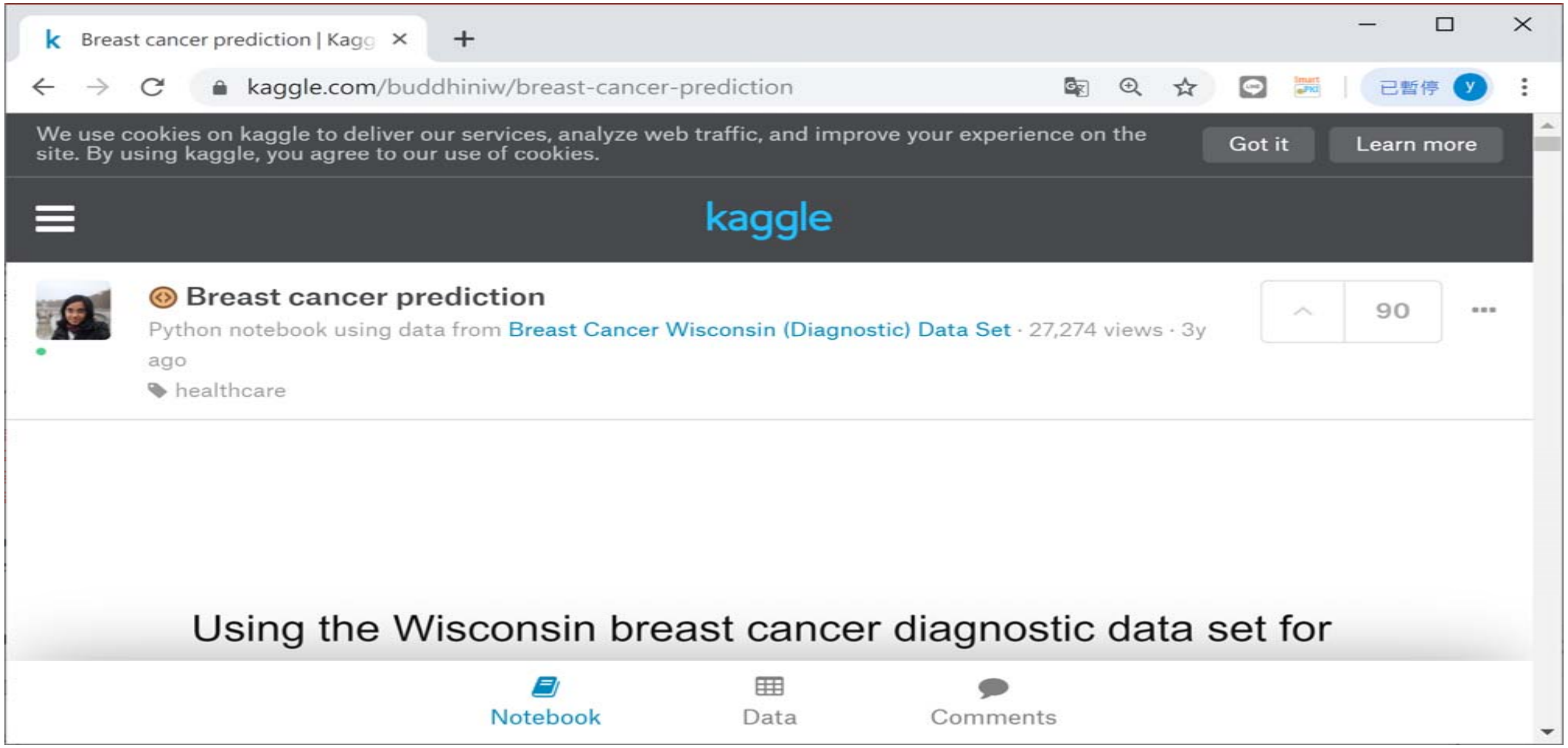
Python notebook using data from Iris Species · 200 views · 8mo ago

Neural Network Classification on Iris Data

Previously, I ran a K-Means classification algorithm on this data, which achieved a success rate of ~88%. I'd like to know if a simple Neural Network can do better

https://www.kaggle.com/anthonyhills/classifying-species-of-iris-flowers
https://www.kaggle.com/mjbahmani/20-ml-algorithms-15-plot-for-beginners
https://www.kaggle.com/nbbevan/neural-net-classification-on-iris-data

Breast Cancer Dataset



Breast cancer prediction | Kagg
kaggle.com/buddhiniw/breast-cancer-prediction
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Breast cancer prediction

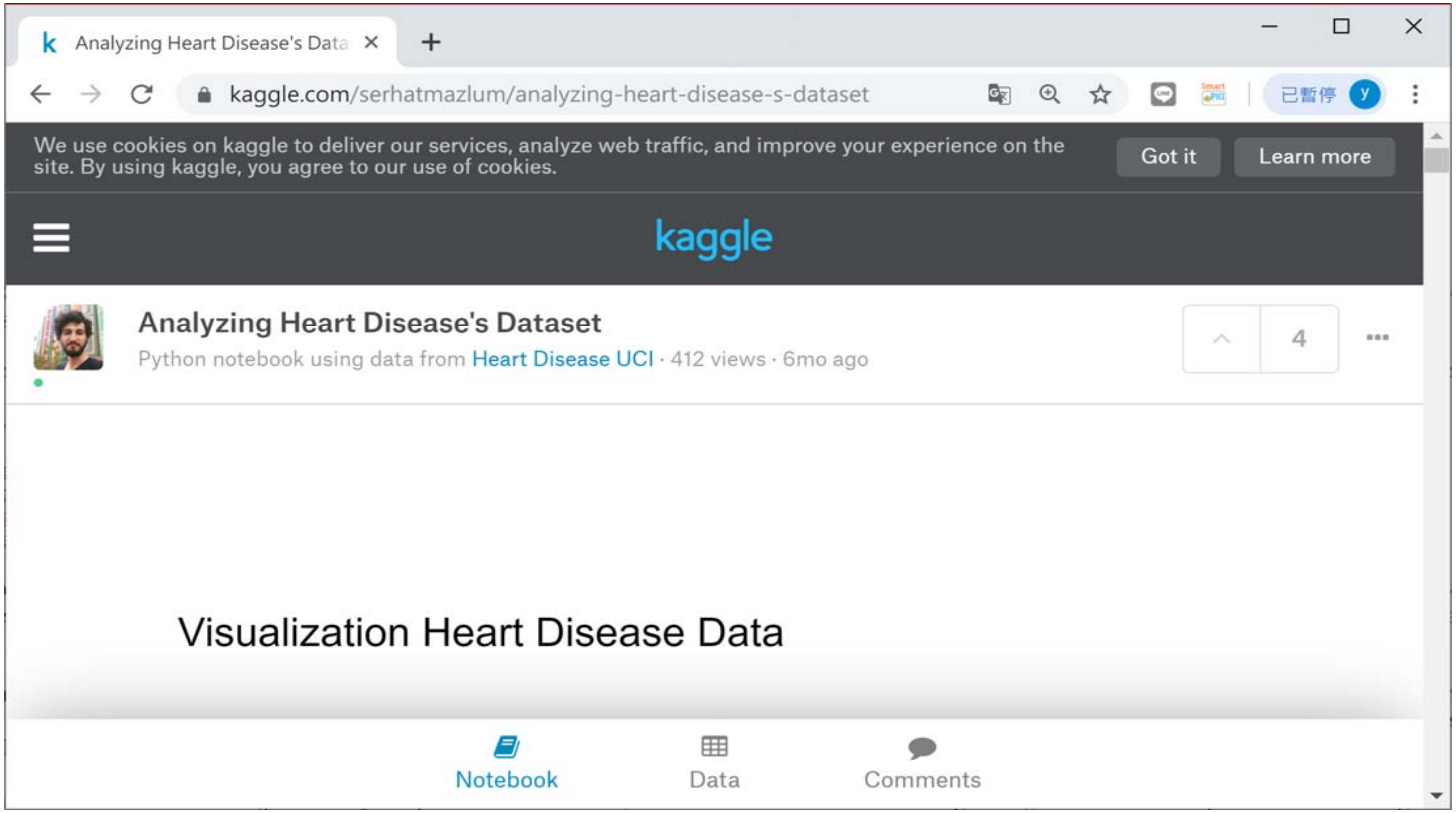
Python notebook using data from Breast Cancer Wisconsin (Diagnostic) Data Set · 27,274 views · 3y ago

healthcare

Using the Wisconsin breast cancer diagnostic data set for

https://www.kaggle.com/buddhiniw/breast-cancer-prediction

Heart Disease Dataset



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Analyzing Heart Disease's Dataset

Python notebook using data from Heart Disease UCI · 412 views · 6mo ago

Visualization Heart Disease Data

Analyzing Heart Disease's Data
kaggle.com/serhatmazlum/analyzing-heart-disease-s-dataset
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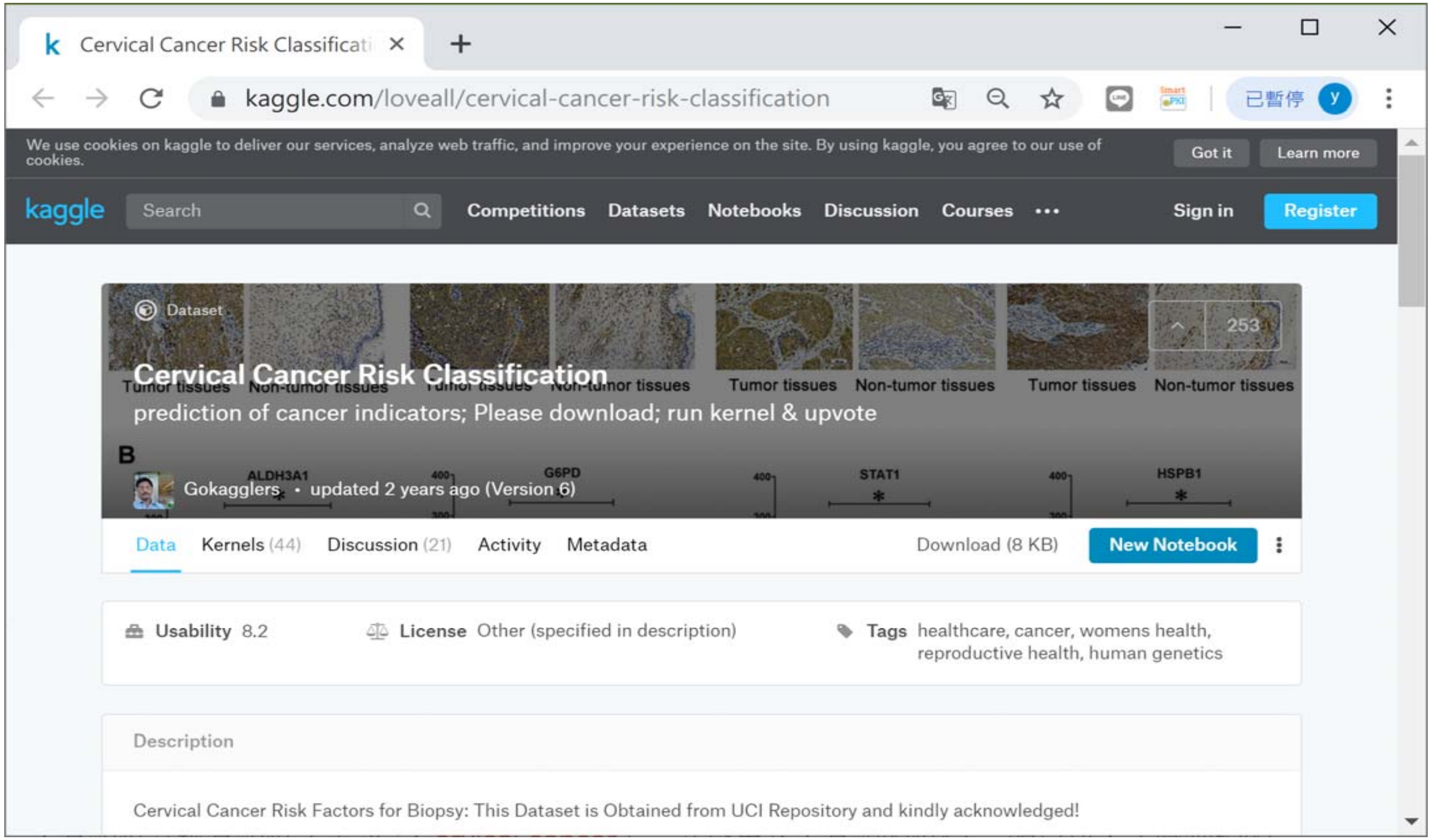
https://www.kaggle.com/serhatmazlum/analyzing-heart-disease-s-dataset

Cervical Cancer Risk Dataset



Cervical Cancer Risk Classificati
kaggle.com/loveall/cervical-cancer-risk-classification
已暫停

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Cervical Cancer Risk Classification

prediction of cancer indicators; Please download; run kernel & upvote

Gokagglers • updated 2 years ago (Version 6)

Usability 8.2

License Other (specified in description)

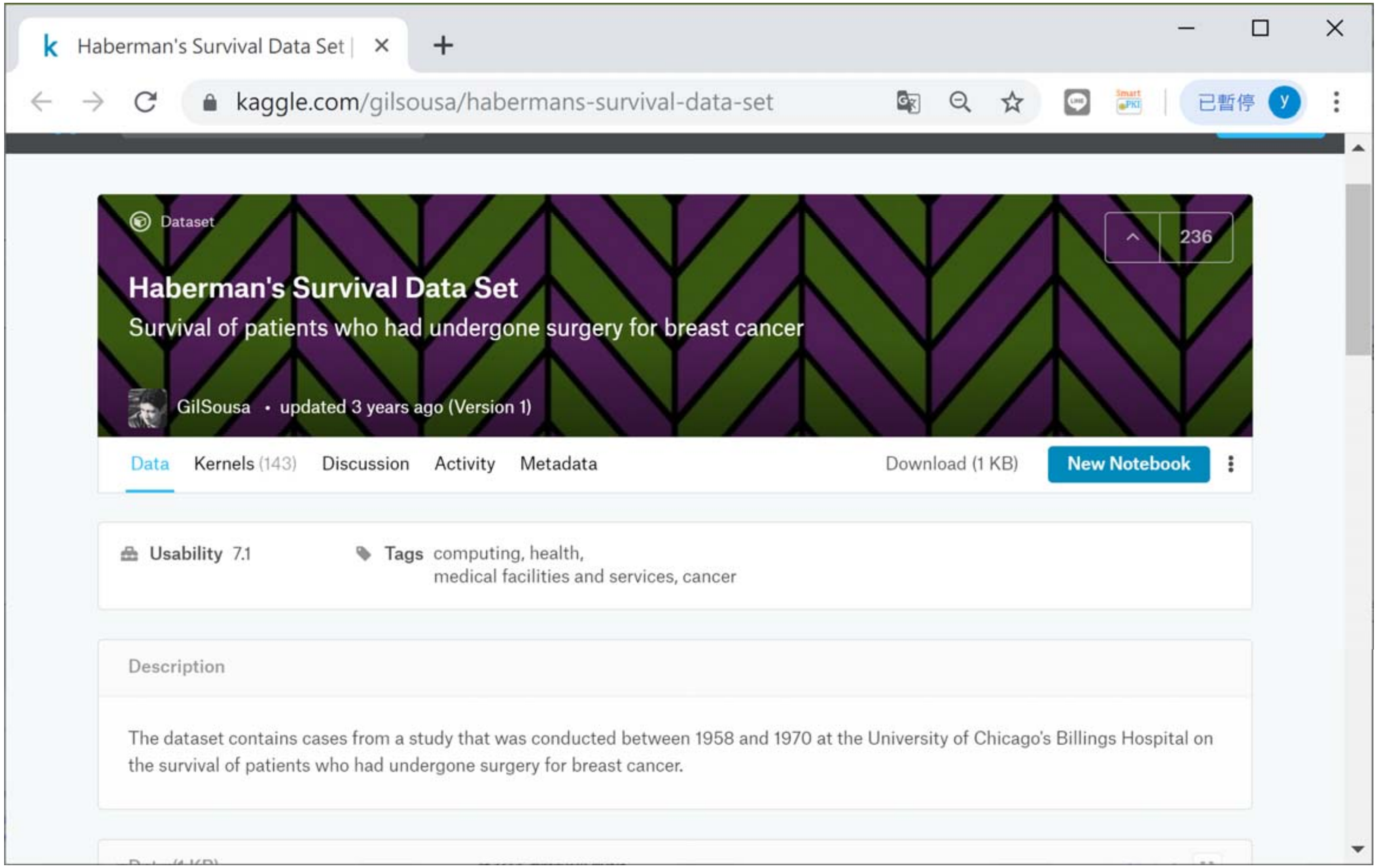
Tags healthcare, cancer, womens health, reproductive health, human genetics

Description

Cervical Cancer Risk Factors for Biopsy: This Dataset is Obtained from UCI Repository and kindly acknowledged!

https://www.kaggle.com/loveall/cervical-cancer-risk-classification

Survival Dataset


Haberman's Survival Data Set |
kaggle.com/gilsousa/habermans-survival-data-set
已暫停
Dataset
236

Haberman's Survival Data Set

Survival of patients who had undergone surgery for breast cancer

GilSousa • updated 3 years ago (Version 1)

Usability 7.1

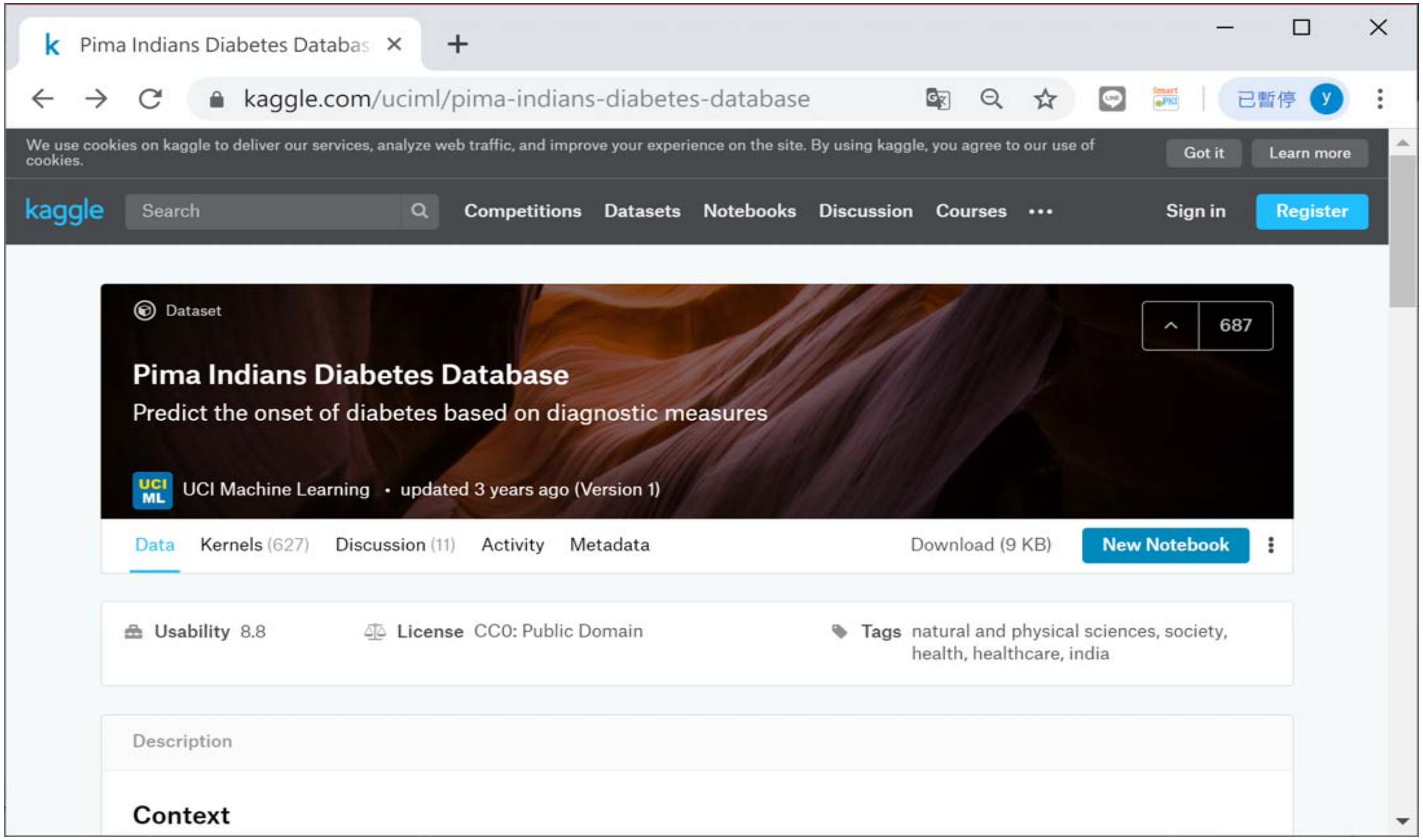
Tags computing, health, medical facilities and services, cancer

Description

The dataset contains cases from a study that was conducted between 1958 and 1970 at the University of Chicago's Billings Hospital on the survival of patients who had undergone surgery for breast cancer.

https://www.kaggle.com/gilsousa/habermans-survival-data-set

Diabetes Database



Pima Indians Diabetes Databas
kaggle.com/uciml/pima-indians-diabetes-database
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Pima Indians Diabetes Database

Predict the onset of diabetes based on diagnostic measures

UCI Machine Learning • updated 3 years ago (Version 1)

Usability 8.8

License CC0: Public Domain

Tags natural and physical sciences, society, health, healthcare, india

Description

Context

https://www.kaggle.com/buddhiniw/breast-cancer-prediction

課後練習

- **IRIS Classification**
  - 微調模型與優化

作業二

- 使用 Breast Cancer Dataset 或 自行檢索的資料庫，實現Neural Networks。