Data Analysis, A tutorial

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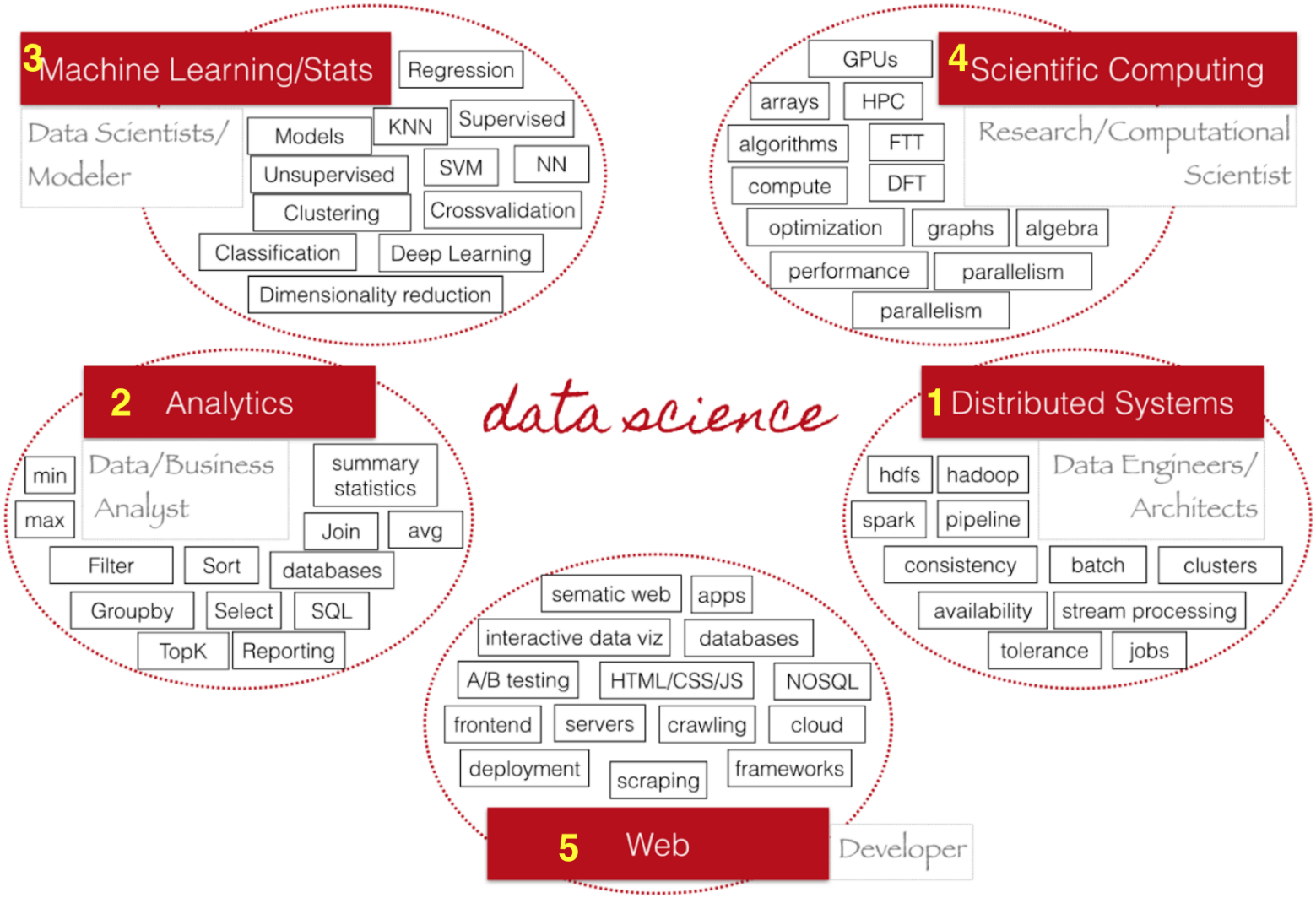
Overview

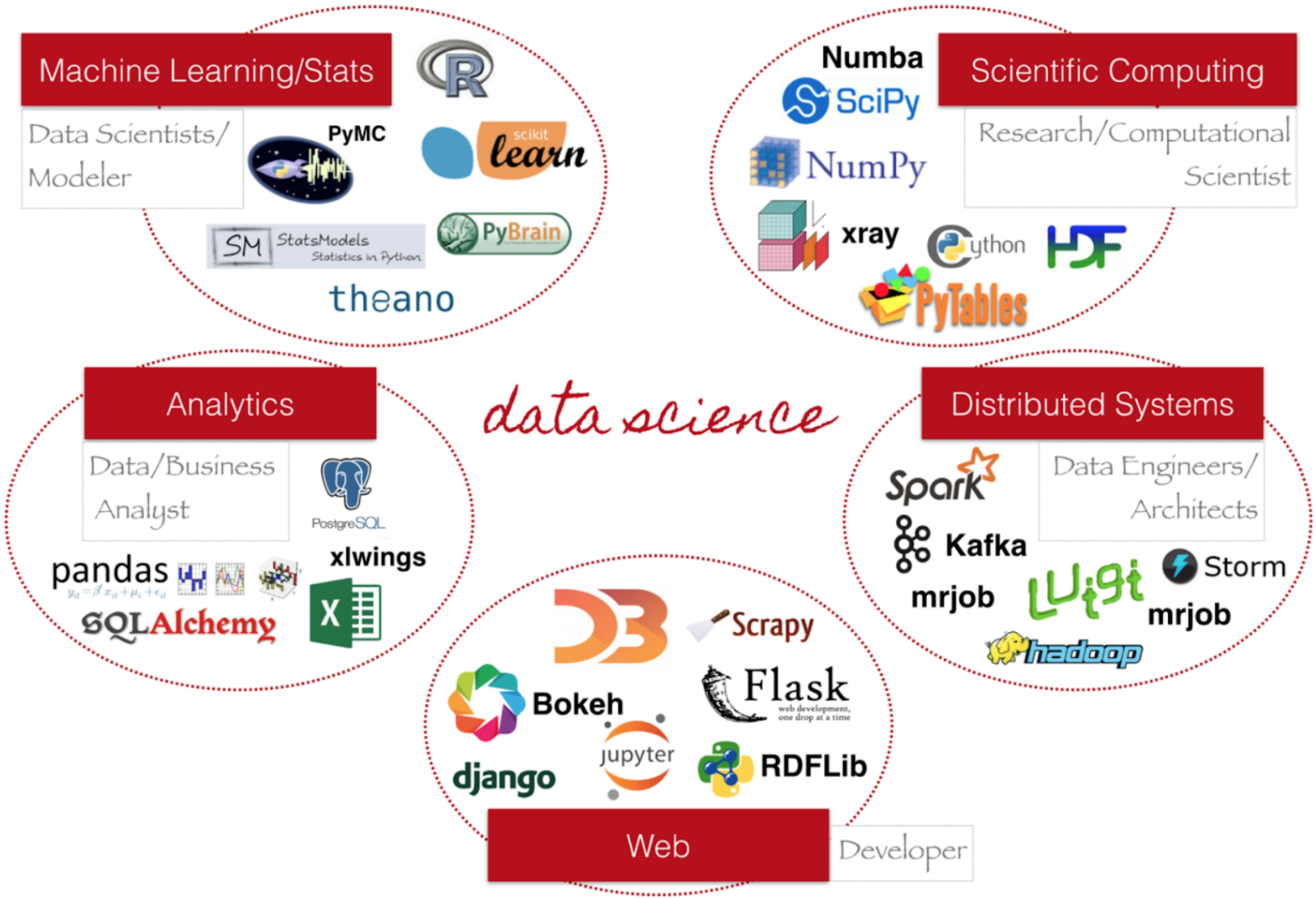
1. Introduction
    - 介紹資料分析相關套件
2. Implementation
    - 一些套件的用法
3. Case

Introduction

介紹資料分析相關套件



Ref: http://chdoig.github.io/ep2015-blaze/#/ (http://chdoig.github.io/ep2015-blaze/#/)



Ref: http://chdoig.github.io/ep2015-blaze/#/ (http://chdoig.github.io/ep2015-blaze/#/)

Python 資料分析相關套件

Library	Type	Commits	Contributors	Releases	Watch	Star	Fork	Commits / Contributors	Commits / Releases	Star/ Contributors
NumPy	Data wrangling	15980	522	125	280	4286	2012	31	128	8
SciPy	Data wrangling	17213	489	91	244	3043	1775	35	189	6
Pandas	Data wrangling	15089	762	76	626	9394	3709	20	199	12
Matplotlib	Visualization	21754	588	60	413	5190	2517	37	363	9
Seaborn	Visualization	1699	71	11	176	3878	580	24	154	55
Bokeh	Visualization	15724	223	40	322	5720	1401	71	393	26
Plotly	Visualization	2486	33	7	149	2044	512	75	355	62
SciKit-Learn	Machine learning	21793	842	80	1650	18246	9997	26	272	22
Keras	Machine learning	3519	428	28	1025	15043	5227	8	126	35
TensorFlow	Machine learning	16785	795	29	5002	55486	26433	21	579	70
Theano	Machine learning	25870	300	23	520	6171	2116	86	1125	21
Scrapy	Data scraping	6325	243	78	1427	20124	5353	26	81	83
NLTK	NLP	12449	196	20	376	4649	1358	64	622	24
Gensim	NLP	2878	179	43	300	4182	1595	16	67	23
Statsmodels	Statistics	8960	119	19	194	2019	977	75	472	17

ActiveWizards.com
28.04.2017

Ref: https://activewizards.com/blog/top-15-libraries-for-data-science-in-python/ (https://activewizards.com/blog/top-15-libraries-for-data-science-in-python/)

Implementation

一些套件的用法

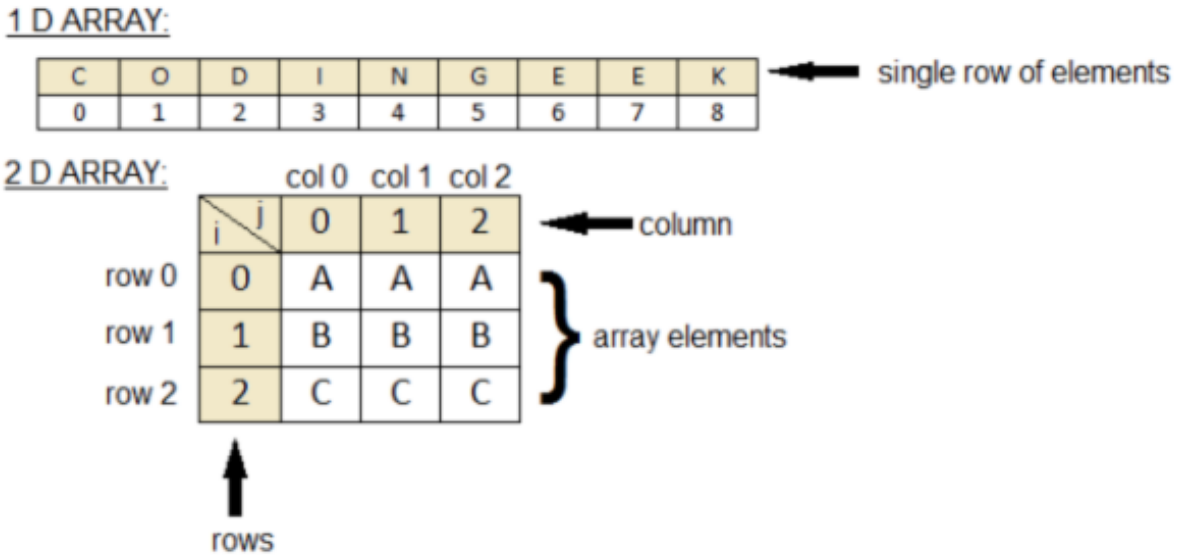
Numpy

支援高階大量的維度陣列與矩陣運算，此外也針對陣列運算提供大量的數學函式函式庫。

Numpy 屬性

ndarray (N-dimensional array)

- `ndim`: 維度
- `shape`: 行數和列數
- `size`: 元素個數



Numpy屬性

In [1]:
```
# 引入 numpy 模組
import numpy as np
np1 = np.array([[1,2,3],[2,3,4]]) # list轉成矩陣
print(np1)

# 顯示相關訊息
print('np1 number of dim:', np1.ndim)  # 維度
print('np1 shape :', np1.shape) # 行數和列數
print('np1 size:', np1.size) # 元素個數
```

```
[[1 2 3]
 [2 3 4]]
np1 number of dim: 2
np1 shape : (2, 3)
np1 size: 6
```

Numpy 基本運算(1)

In [2]:
```
import numpy as np
a = np.array([10,20,30,40])
b = np.arange(4)

print('a= ', a)
print('b= ', b)

print('a+b= ', a+b)
print('a-b= ', a-b)
print('a*b= ', a*b)
print('b**2= ', b**2)
print('10*np.sin(a)= ', 10*np.sin(a))
```

```
a=  [10 20 30 40]
b=  [0 1 2 3]
a+b=  [10 21 32 43]
a-b=  [10 19 28 37]
a*b=  [  0  20  60 120]
b**2=  [0 1 4 9]
10*np.sin(a)=  [-5.44021111  9.12945251 -9.88031624  7.4511316 ]
```

Ref: http://www.numpy.org/ (http://www.numpy.org/)

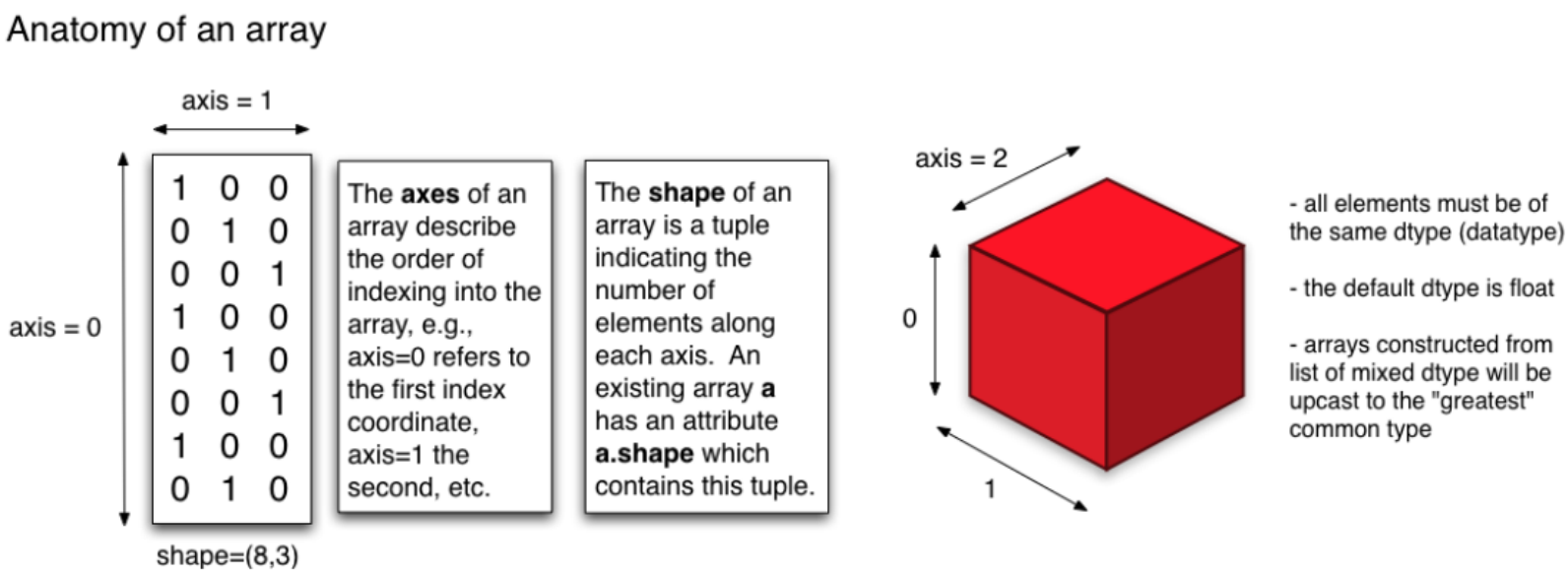
Numpy 基本運算(2)

In [3]:
```
import numpy as np
A = np.arange(3,14)
print('A=', A)
```

```
A= [ 3  4  5  6  7  8  9 10 11 12 13]
```

In [4]:
```
A = np.arange(3,15).reshape((3,4))
print('A=', A)
print('A[1][1]= ', A[1][1])
print(A.sum(axis=1))
```

```
A= [[ 3  4  5  6]
 [ 7  8  9 10]
 [11 12 13 14]]
A[1][1]=  8
[18 34 50]
```



Ref:
http://pages.physics.cornell.edu/~myers/teaching/ComputationalMethods/python/arrays.htr
(http://pages.physics.cornell.edu/~myers/teaching/ComputationalMethods/python/arrays.ht

Pandas

基於Numpy的一個套件，不論在讀取或處理資料都很簡單且方便

Pandas基本介紹

- Numpy 和 Pandas有什麼不同？
  - Numpy 是array形式的，沒有欄位名稱或標籤
  - Pandas 基於Numpy構建的，有列表的標籤
- 主要有兩個資料結構
  - Series
  - DataFrame

Series

In [5]:
```
import pandas as pd
import numpy as np
a = pd.Series([1,2,4,np.nan,1])
print(a)
```

```
0    1.0
1    2.0
2    4.0
3    NaN
4    1.0
dtype: float64
```

Series的表現形式為：左邊索引，右邊為值
因為我們沒指定索引，所以它會自己建立0到N-1(N為長度)的整數型索引

DataFrame

In [6]:
```
import pandas as pd
import numpy as np

dates = pd.date_range('20160101',periods=6)
df = pd.DataFrame(np.random.randn(6,4),index=dates,columns=['a','b','c','d'])

print(df)
```

```
                   a         b         c         d
2016-01-01  0.626148  0.276924 -0.057152 -1.231409
2016-01-02  1.199111  1.725236  0.456273  2.350759
2016-01-03  0.993157 -2.108354 -1.401421  1.305804
2016-01-04 -1.411956  0.876656 -3.858380 -0.304684
2016-01-05  0.974309  0.075325 -1.426059 -1.336222
2016-01-06  0.831480 -0.776678  1.880107  1.693091
```

Dataframe為一個表格型的資料結構，既有行索引也有列索引，可被看成由Series組成的大集合
https://www.jianshu.com/p/214798dd8f93 (https://www.jianshu.com/p/214798dd8f93)

In [7]:
```
import pandas as pd
import numpy as np

df2 = pd.DataFrame({'A' : np.random.rand(4),
                    'B' : pd.Timestamp('20130102'),
                    'C' : pd.Series(1,index=list(range(4)),dtype='float32'),
                    'D' : np.array([3] * 4,dtype='int32'),
                    'E' : pd.Categorical(["test","train","test","train"]),
                    'F' : 'foo'})

print(df2)
# print(df2.dtypes) # 資料類型
# print(df2.columns) # 資料名稱
# print(df2.describe()) # 資料的總結
# print(df2.T) # transpose
# print(df2.sort_values(by='A'))
```

```
          A          B    C  D      E    F
0  0.683989 2013-01-02  1.0  3   test  foo
1  0.684026 2013-01-02  1.0  3  train  foo
2  0.023853 2013-01-02  1.0  3   test  foo
3  0.642294 2013-01-02  1.0  3  train  foo
```

Dataframe的loc(根據標籤)

Dataframe的iloc(根據序列)

In [9]:
```
dates = pd.date_range('20130101', periods=6)
df = pd.DataFrame(np.arange(24).reshape((6,4)),index=dates, columns=['A','B','C',
'D'])

print(df)
print(df.iloc[3,1])
print(df.iloc[3:5,1:3])
print(df.iloc[[1,3,5],1:3])
```

```
             A   B   C   D
2013-01-01   0   1   2   3
2013-01-02   4   5   6   7
2013-01-03   8   9  10  11
2013-01-04  12  13  14  15
2013-01-05  16  17  18  19
2013-01-06  20  21  22  23
13
             B   C
2013-01-04  13  14
2013-01-05  17  18
             B   C
2013-01-02   5   6
2013-01-04  13  14
2013-01-06  21  22
```

Dataframe的Boolean indexing

In [10]:
```
dates = pd.date_range('20130101', periods=6)
df = pd.DataFrame(np.arange(24).reshape((6,4)),index=dates, columns=['A','B','C',
'D'])

print(df)
print(df[df.A>8])
```

```
             A   B   C   D
2013-01-01   0   1   2   3
2013-01-02   4   5   6   7
2013-01-03   8   9  10  11
2013-01-04  12  13  14  15
2013-01-05  16  17  18  19
2013-01-06  20  21  22  23
             A   B   C   D
2013-01-04  12  13  14  15
2013-01-05  16  17  18  19
2013-01-06  20  21  22  23
```

Pandas I/O

Format Type	Data Description	Reader	Writer
text	CSV	read_csv	to_csv
text	JSON	read_json	to_json
text	HTML	read_html	to_html
text	Local clipboard	read_clipboard	to_clipboard
binary	MS Excel	read_excel	to_excel
binary	HDF5 Format	read_hdf	to_hdf
binary	Feather Format	read_feather	to_feather
binary	Parquet Format	read_parquet	to_parquet
binary	Msgpack	read_msgpack	to_msgpack
binary	Stata	read_stata	to_stata
binary	SAS	read_sas	
binary	Python Pickle Format	read_pickle	to_pickle
SQL	SQL	read_sql	to_sql
SQL	Google Big Query	read_gbq	to_gbq

Ref: https://pandas.pydata.org/pandas-docs/stable/io.html (https://pandas.pydata.org/pandas-docs/stable/io.html)

Pandas load csv

In [11]:
```
import pandas as pd

data = pd.read_csv('student.csv')
print(data)

data.to_pickle('student.pickle')
```

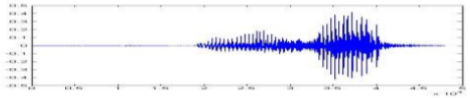
```
    Student ID  name   age  gender
0         1100  Kelly   22  Female
1         1101    Clo   21  Female
2         1102  Tilly   22  Female
3         1103   Tony   24    Male
4         1104  David   20    Male
5         1105  Catty   22  Female
6         1106      M    3  Female
7         1107      N   43    Male
8         1108      A   13    Male
9         1109      S   12    Male
10        1110  David   33    Male
11        1111     Dw    3  Female
12        1112      Q   23    Male
13        1113      W   21  Female
```

Scikit-learn

適合想要使用Python實作機器學習的初學者，提供許多演算法，包含監督式、非監督式...等

Machine Learning ≈ Looking for a Function

- Speech Recognition

$f($  $)=$ “How are you”

- Image Recognition

$f($  $)=$ “Cat”

- Playing Go

$f($  $)=$ “5-5” (next move)

- Dialogue System

$f($ “Hi” $)=$ “Hello”

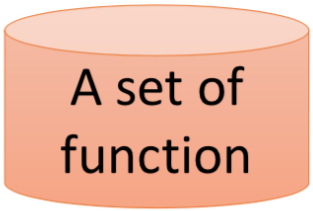
(what the user said) (system response)

Ref: http://speech.ee.ntu.edu.tw/~tlkagk/courses/ML_2017_2/Lecture/policy.pdf (http://speech.ee.ntu.edu.tw/~tlkagk/courses/ML_2017_2/Lecture/policy.pdf)

Framework

Image Recognition:

$f($  $)=$ "cat"



Model

$f_1, f_2 \cdots$

$f_1($  $)=$ "cat"

$f_2($  $)=$ "money"

Better!

$f_1($  $)=$ "dog"

$f_2($  $)=$ "snake"

function input:   

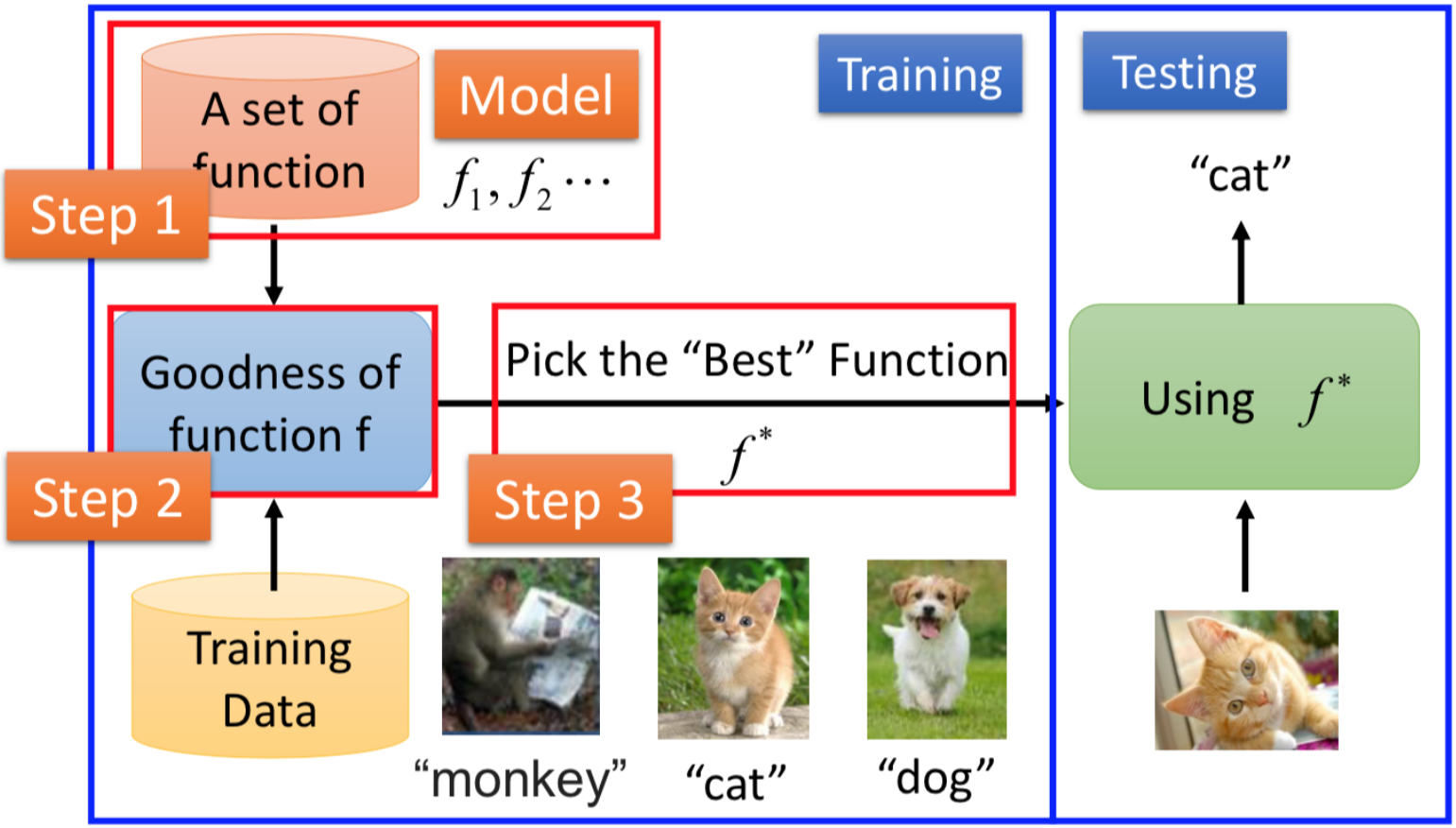
function output: "monkey" "cat" "dog"

Ref: http://speech.ee.ntu.edu.tw/~tlkagk/courses/ML_2017_2/Lecture/policy.pdf (http://speech.ee.ntu.edu.tw/~tlkagk/courses/ML_2017_2/Lecture/policy.pdf)

Framework

Image Recognition:

$f($  $) =$ "cat"



Ref: http://speech.ee.ntu.edu.tw/~tlkagk/courses/ML_2017_2/Lecture/policy.pdf (http://speech.ee.ntu.edu.tw/~tlkagk/courses/ML_2017_2/Lecture/policy.pdf)

範例：The digits dataset

- http://scikit-learn.org/stable/auto_examples/datasets/plot_digits_last_image.html (http://scikit-learn.org/stable/auto_examples/datasets/plot_digits_last_image.html)

1. 載入手寫數字資料

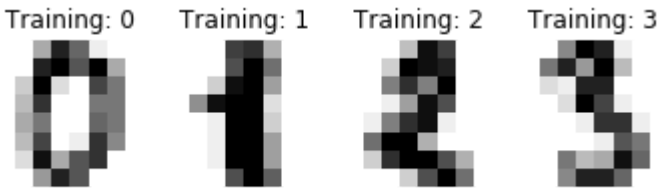
In [12]:
```
# 這行是在ipython notebook的介面裏專用，如果在其他介面則可以拿掉
%matplotlib inline
from sklearn import datasets, svm, metrics

import matplotlib.pyplot as plt

# 載入數字資料集
digits = datasets.load_digits()

for key, value in digits.items():
    try:
        print(key, value.shape)
    except:
        print(key)
```

```
data (1797, 64)
target (1797,)
target_names (10,)
images (1797, 8, 8)
DESCR
```

顯示	說明
('images', (1797L, 8L, 8L))	共有 1797 張影像，影像大小為 8x8
('data', (1797L, 64L))	data 則是將8x8的矩陣攤平成64個元素之一維向量
('target_names', (10L,))	說明10種分類之對應 [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
DESCR	資料之描述
('target', (1797L,))	記錄1797張影像各自代表那一個數字

每張影像所對照的實際數字存在digits.target變數中

In [13]:
```
images_and_labels = list(zip(digits.images, digits.target))
for index, (image, label) in enumerate(images_and_labels[:4]):
    plt.subplot(2, 4, index + 1)
    plt.axis('off')
    plt.imshow(image, cmap=plt.cm.gray_r, interpolation='nearest')
    plt.title('Training: %i' % label)
```



2. 訓練以及分類

In [14]:
```
n_samples = len(digits.images)

# 資料攤平:1797 x 8 x 8 -> 1797 x 64
# 這裏的-1代表自動計算，相當於 (n_samples, 64)
data = digits.images.reshape((n_samples, -1))

# 產生SVC分類器
classifier = svm.SVC(gamma=0.001)

# 用前半部份的資料來訓練
classifier.fit(data[:n_samples // 2], digits.target[:n_samples // 2])

expected = digits.target[n_samples // 2:]

#利用後半部份的資料來測試分類器，共 899筆資料
predicted = classifier.predict(data[n_samples // 2:])

print("expected前10個值＝ ", expected[:10])
print("predicted前10個值＝ ", predicted[:10])
```

```
expected前10個值＝  [8 8 4 9 0 8 9 8 1 2]
predicted前10個值＝  [8 8 4 9 0 8 9 8 1 2]
```

3. 分類準確度統計

- 使用Confusion matrix(混淆矩陣)來統計
- `metrics.confusion_matrix(真實資料:899, 預測資料:899)`

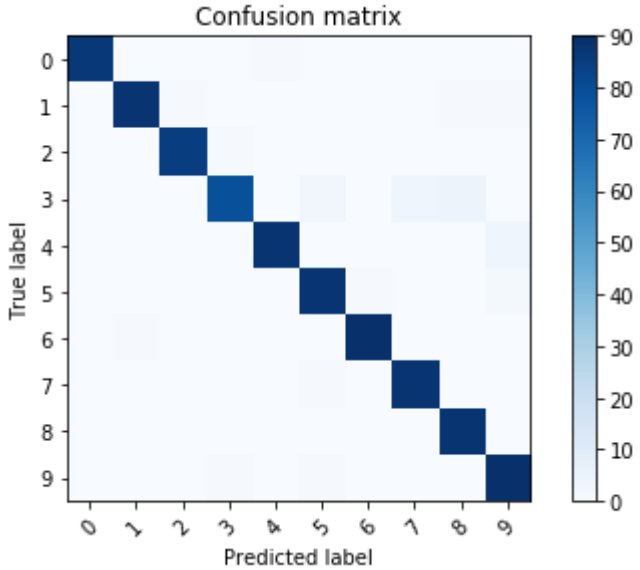
In [15]:
```
print("Confusion matrix:\n%s"
    % metrics.confusion_matrix(expected, predicted))
```

```
Confusion matrix:
[[87  0  0  0  1  0  0  0  0  0]
 [ 0 88  1  0  0  0  0  0  1  1]
 [ 0  0 85  1  0  0  0  0  0  0]
 [ 0  0  0 79  0  3  0  4  5  0]
 [ 0  0  0  0 88  0  0  0  0  4]
 [ 0  0  0  0  0 88  1  0  0  2]
 [ 0  1  0  0  0  0 90  0  0  0]
 [ 0  0  0  0  0  1  0 88  0  0]
 [ 0  0  0  0  0  0  0  0 88  0]
 [ 0  0  0  1  0  1  0  0  0 90]]
```

由矩陣可以看出，實際為3時，有數次誤判為5,7,8。

Confusion matrix (圖示)

In [16]:
```
def plot_confusion_matrix(cm, title='Confusion matrix', cmap=plt.cm.Blues):
    import numpy as np
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(digits.target_names))
    plt.xticks(tick_marks, digits.target_names, rotation=45)
    plt.yticks(tick_marks, digits.target_names)
    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')

plt.figure()
plot_confusion_matrix(metrics.confusion_matrix(expected, predicted))
```



Confusion matrix (以手寫3為例)

	True Positive	True Negative
Predicted Positive	79	2
Predicted Negative	12	806

Measure	Value	Derivations
Sensitivity	0.8681	TPR = TP / (TP + FN)
Specificity	0.9975	SPC = TN / (FP + TN)
Precision	0.9753	PPV = TP / (TP + FP)
Negative Predictive Value	0.9853	NPV = TN / (TN + FN)
False Positive Rate	0.0025	FPR = FP / (FP + TN)
False Discovery Rate	0.0247	FDR = FP / (FP + TP)
False Negative Rate	0.1319	FNR = FN / (FN + TP)
Accuracy	0.9844	ACC = (TP + TN) / (P + N)
F1 Score	0.9186	F1 = 2TP / (2TP + FP + FN)
Matthews Correlation Coefficient	0.9119	TP*TN - FP*FN / sqrt((TP+FP)*(TP+FN)*(TN+FP)*(TN+FN))

Confusion Matrix 統計數據

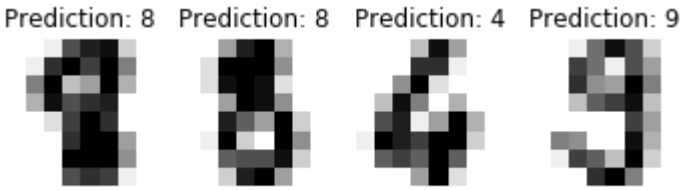
- metrics.classification_report(expected, predicted)

In [17]:
```
print("Classification report for classifier %s:\n%s\n"
    % (classifier, metrics.classification_report(expected, predicted)))
```

```
Classification report for classifier SVC(C=1.0, cache_size=200, class_weight=N
one, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=0.001, kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False):
             precision    recall  f1-score   support

          0       1.00      0.99      0.99        88
          1       0.99      0.97      0.98        91
          2       0.99      0.99      0.99        86
          3       0.98      0.87      0.92        91
          4       0.99      0.96      0.97        92
          5       0.95      0.97      0.96        91
          6       0.99      0.99      0.99        91
          7       0.96      0.99      0.97        89
          8       0.94      1.00      0.97        88
          9       0.93      0.98      0.95        92

avg / total       0.97      0.97      0.97       899
```

觀察測試影像以及預測(分類)結果得對應關係

In [18]:
```
images_and_predictions = list(
                         zip(digits.images[n_samples // 2:], predicted))
for index, (image, prediction) in enumerate(images_and_predictions[:4]):
    plt.subplot(2, 4, index + 5)
    plt.axis('off')
    plt.imshow(image, cmap=plt.cm.gray_r, interpolation='nearest')
    plt.title('Prediction: %i' % prediction)
```



手寫字辨識完整程式碼：http://scikit-learn.org/stable/_downloads/plot_digits_classification.py (http://scikit-learn.org/stable/_downloads/plot_digits_classification.py)

學習推薦：

- 莫須Python: https://morvanzhou.github.io/ (https://morvanzhou.github.io/)
- 李宏毅教授: https://www.youtube.com/channel/UC2ggjtuuWvxrHHHiaDH1dlQ/playlists (https://www.youtube.com/channel/UC2ggjtuuWvxrHHHiaDH1dlQ/playlists)

Thanks for listening!