02PreProcessing

November 4, 2018

1 前處理-資料清理

1. missing data
   - 平均值、標準差、屆在平均值與標準差之間的亂數
2. range 差異過大的資料
   - 偵測 (identity): PCA
   - 處理: 取 log e.g. 10^1 => 1, 10^6 => 6
3. 資料不一致的問題
   - domain knowledge e.g. 年紀為負的
4. 正規化 (Normalize)
   - L1 Norm(穩定: 水平調整較少):
     - $|||_1 = \sum||$
   - L2 Norm(強健: 較能對抗 outlier):
     - $|||_2 = \frac{}{\sqrt{(\sum^2)}}$
5. 類別型資料的處理
   - 自然語言 (NLP): 先轉成類別型資料
   - onehot encoding

0	1	2
[1,0,0]	[0,1,0]	[0,0,1]

7. Feature 產生工具
   - PolynomialFeatures: (_1, _2)=> (1, _1, _2, _1^2, _1 _2, _2^2)
8. 議題:
   - 請問取 log 與 normalize 有什麼差別?

2 IMPORT & DATA

In [1]:
```
import pandas as pd
import numpy as np
from collections import Counter
import re
import numpy as np

from sklearn import preprocessing

import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
from sklearn.decomposition import PCA

import os
import random
import math
```

In [2]:
```
df = pd.read_csv('train.csv')

# 請查看 df.info()
# 並找出共有幾種型別，以及哪一些欄位有 null 值
#=============your works starts===============#
df_info =
#==============your works ends================#
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 891 entries, 0 to 890
Data columns (total 12 columns):
PassengerId    891 non-null int64
Survived       891 non-null int64
Pclass         891 non-null int64
Name           891 non-null object
Sex            891 non-null object
Age            714 non-null float64
SibSp          891 non-null int64
Parch          891 non-null int64
Ticket         891 non-null object
Fare           891 non-null float64
Cabin          204 non-null object
Embarked       889 non-null object
dtypes: float64(2), int64(5), object(5)
memory usage: 83.6+ KB
```

In [3]:
```
# 請查看 df.describe()
# 請透過 mean 關注每一個變數的 scale
#=============your works starts===============#
df_describe =
```

```
#==============your works ends================#
df_describe
```

Out[3]:

	PassengerId	Survived	Pclass	Age	SibSp	Parch	Fare
count	891.000000	891.000000	891.000000	714.000000	891.000000	891.000000	891.000000
mean	446.000000	0.383838	2.308642	29.699118	0.523008	0.381594	32.204208
std	257.353842	0.486592	0.836071	14.526497	1.102743	0.806057	49.693429
min	1.000000	0.000000	1.000000	0.420000	0.000000	0.000000	0.000000
25%	223.500000	0.000000	2.000000	20.125000	0.000000	0.000000	7.910400
50%	446.000000	0.000000	3.000000	28.000000	0.000000	0.000000	14.454200
75%	668.500000	1.000000	3.000000	38.000000	1.000000	0.000000	31.000000
max	891.000000	1.000000	3.000000	80.000000	8.000000	6.000000	512.329200

In [4]:
```
# 請透過 head() 查看 df 的頭 5 行
#==============your works starts===============#
df_head =
#==============your works ends================#

df_head
```

Out[4]:

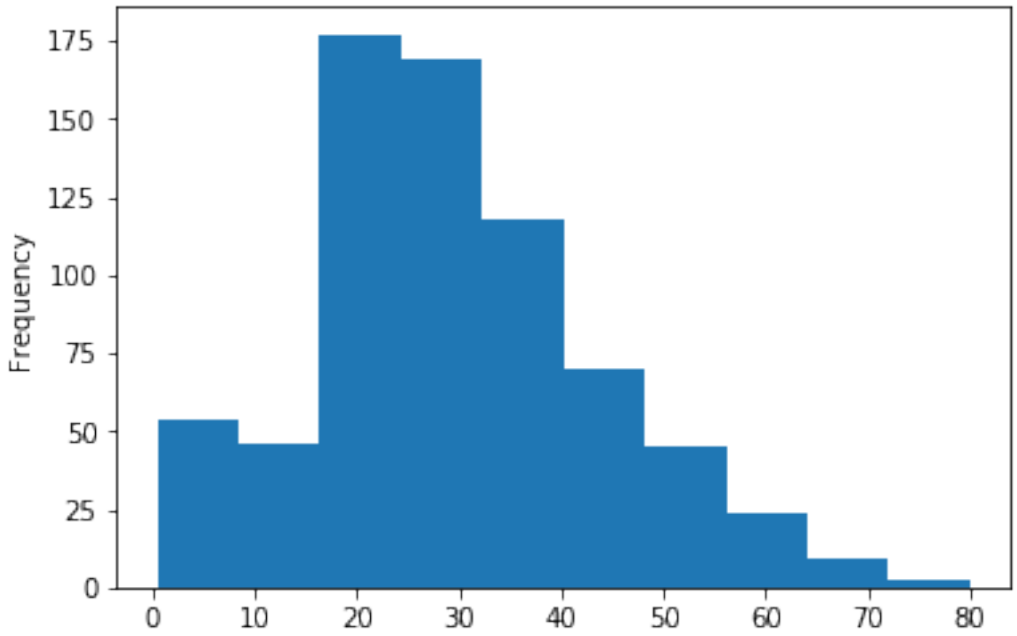
	PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cabin	Embarked
0	1	0	3	Braund, Mr. Owen Harris	male	22.0	1	0	A/5 21171	7.2500	NaN	S
1	2	1	1	Cumings, Mrs. John Bradley (Florence Briggs Th...	female	38.0	1	0	PC 17599	71.2833	C85	C
2	3	1	3	Heikkinen, Miss. Laina	female	26.0	0	0	STON/O2. 3101282	7.9250	NaN	S
3	4	1	1	Futrelle, Mrs. Jacques Heath (Lily May Peel)	female	35.0	1					
4	5	0	3	Allen, Mr. William Henry	male	35.0	0					

```
3      0            113803  53.1000  C123        S
4      0            373450   8.0500   NaN        S
```

3 PREPROCESSING

3.1 Age - Fill in missing values

```
In [5]: # 查看 Age 的分布狀況 (hint: df['Age'].plot('hist'))
        #=============your works starts===============#
        age_ax =
        #==============your works ends================#

        plt.show()
```




```
In [6]: # 作法一: 取平均值
        #=============your works starts===============#
        avg_age =
        #==============your works ends================#


        print("avg_age", avg_age)
        # avg_age 29.69911764705882
```

```
avg_age 29.69911764705882
```

```
In [7]: # 作法二: 取中位數
        #=============your works starts===============#
        median_age =
        #==============your works ends================#


        print("median_age", median_age)
        # median_age 28.0
```

```
median_age 28.0
```

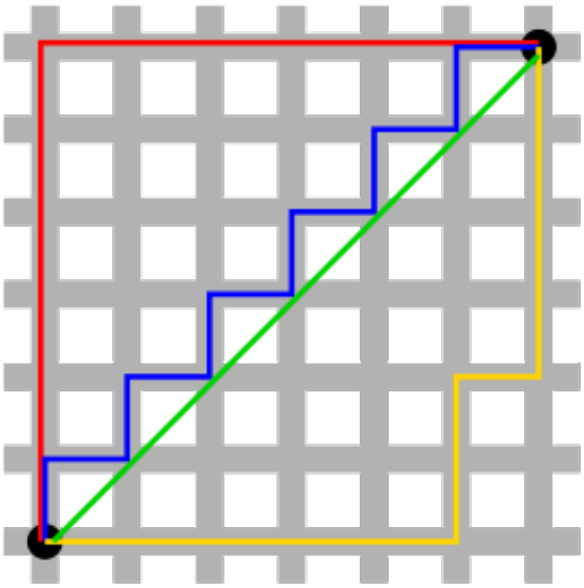
```
In [8]: # 作法三: 用相同的分布產生亂數塞入 (hint: 使用 np.random.randint)
        std = df['Age'].std()
        mean = df['Age'].mean()
        size = len(df[pd.isnull(df['Age'])])
        np.random.seed(1212)
        #=============your works starts===============#
        random_age =
        #==============your works ends================#


        print("random_age", random_age)
        print("len(random_age)", len(random_age))
        # random_age [23 41 37 17 31 20 28 24 16 42 33 19 22 20 29 15 32 16 35 40 35 34 26 27
        # len(random_age) 177
```

```
random_age [23 41 37 17 31 20 28 24 16 42 33 19 22 20 29 15 32 16 35 40 35 34 26 27
 37 28 30 23 31 33 42 30 25 21 29 15 21 16 39 39 21 31 31 37 31 30 23 41
 30 35 33 21 31 28 39 37 31 29 29 40 16 43 20 29 36 22 27 41 32 24 35 23
 29 43 33 43 31 34 34 28 27 40 29 35 27 20 40 37 16 29 29 39 20 17 20 35
 24 42 34 33 26 38 42 31 30 40 34 16 35 16 34 24 43 29 22 29 20 43 29 38
 37 39 35 42 40 19 32 17 25 36 15 26 31 23 19 24 34 39 39 19 17 28 16 35
 20 16 29 18 34 43 16 28 30 42 27 25 36 19 22 43 37 38 30 15 32 38 41 21
 26 33 20 19 21 29 40 30 28]
len(random_age) 177
```

```
In [9]: df['avg_age'] = df['Age']
        df.loc[pd.isnull(df['Age']), 'avg_age'] = avg_age
        df['median_age'] = df['Age']
        df.loc[pd.isnull(df['Age']), 'median_age'] = median_age
        df['random_age'] = df['Age']
        df.loc[pd.isnull(df['Age']), 'random_age'] = random_age

        df.loc[pd.isnull(df['Age']), ['avg_age', 'median_age', 'random_age']].head()
```

Out[9]:

	avg_age	median_age	random_age
5	29.699118	28.0	23.0



l1_l2_norm

```
17  29.699118       28.0        41.0
19  29.699118       28.0        37.0
26  29.699118       28.0        17.0
28  29.699118       28.0        31.0
```

3.2 Age - Normalize

- L1 Normalization: $||x||_2 = \sqrt{(\sum_i x_i^2)} = \sqrt{x_1^2 + x_2^2 + \ldots + x_i^2}$
- L2 Normalization: $||x||_1 = \sum_i |x_i| = |x_1| + |x_2| + \ldots + |x_i|$
- difference

```
In [10]: # 請寫出 L1 Normaliaze 的 function
         def normalize_l1(X):
             """if type(X) == np.array, and X has two dimensiions"""
             #=============your works starts===============#
             l1_x =
             X =
             #==============your works ends================#
             return X

         X = [[ 1., -1.,  2.],
              [ 2.,  0.,  0.],
              [ 0.,  1., -1.]]
         X_normalized = normalize_l1(X)
         print(X_normalized)
         # [[ 0.25 -0.25  0.5 ]
```

```
        #  [ 0.5   0.    0.  ]
        #  [ 0.    0.25 -0.25]]
```

```
[[ 0.25 -0.25  0.5 ]
 [ 0.5   0.    0.  ]
 [ 0.    0.25 -0.25]]
```

```
In [11]: # 請寫出 L2 Normaliaze 的 function
         def normalize_l2(X):
             """if type(X) == np.array, and X has two dimensiions"""
             #=============your works starts===============#
             l2_x =
             X =
             #==============your works ends================#
             return X

         X_normalized = normalize_l2(X)
         print(X_normalized)
         # [[ 0.28867513 -0.28867513  0.57735027]
         #  [ 0.57735027  0.          0.        ]
         #  [ 0.          0.28867513 -0.28867513]]
```

```
[[ 0.28867513 -0.28867513  0.57735027]
 [ 0.57735027  0.          0.        ]
 [ 0.          0.28867513 -0.28867513]]
```

```
In [12]: X = [[ 1., -1.,  2.],
              [ 2.,  0.,  0.],
              [ 0.,  1., -1.]]

         # 請使用 preprocessing.normalize(X, norm='l1') 比較，與我們自己寫的 normalize function
         #=============your works starts===============#
         X_normalized =
         #==============your works ends================#

         print(X_normalized)
         # sklearn l1_norm
         # [[ 0.25 -0.25  0.5 ]
         #  [ 1.    0.    0.  ]
         #  [ 0.    0.5  -0.5 ]]
```

```
[[ 0.25 -0.25  0.5 ]
 [ 1.    0.    0.  ]
 [ 0.    0.5  -0.5 ]]
```

```
In [13]: avg_age_l1 = normalize_l1(df['avg_age'].values)
         avg_age_l2 = normalize_l2(df['avg_age'].values)
```

```
df['avg_age_l1'] = avg_age_l1
df['avg_age_l2'] = avg_age_l2

df[['avg_age', 'avg_age_l1', 'avg_age_l2']].head()
```

Out[13]:

	avg_age	avg_age_l1	avg_age_l2
0	22.0	0.000831	0.022735
1	38.0	0.001436	0.039270
2	26.0	0.000983	0.026869
3	35.0	0.001323	0.036170
4	35.0	0.001323	0.036170

3.3 Cabin - NLP category

In [14]:
```
# 整理出每一個 Cabin 的個數並排序 (hint:Counter(), sorted())
#=============your works starts===============#
sorted_cabin_counter =
#==============your works ends================#


print(sorted_cabin_counter[:10])
# [('A10', 1), ('A14', 1), ('A16', 1), ('A19', 1), ('A20', 1), ('A23', 1), ('A24', 1)
```

```
[('A10', 1), ('A14', 1), ('A16', 1), ('A19', 1), ('A20', 1), ('A23', 1), ('A24', 1), ('A26', 1
```

In [15]:
```
# 抓出第一個 char 出來分類，並轉成 int 類別 (hint:Counter(), sorted())
#=============your works starts===============#
new_Cabin =
mapping_dict =
new_Cabin_int =
#==============your works ends================#


print(new_Cabin.values[:10])
print(mapping_dict)
print(new_Cabin_int[:10])
# ['n' 'C' 'n' 'C' 'n' 'n' 'E' 'n' 'n' 'n']
# {'n': 0, 'B': 1, 'T': 2, 'E': 3, 'C': 4, 'F': 5, 'G': 6, 'D': 7, 'A': 8}
# [0, 4, 0, 4, 0, 0, 3, 0, 0, 0]
```

```
['n' 'C' 'n' 'C' 'n' 'n' 'E' 'n' 'n' 'n']
{'T': 0, 'A': 1, 'F': 2, 'G': 3, 'n': 4, 'C': 5, 'E': 6, 'D': 7, 'B': 8}
[4, 5, 4, 5, 4, 4, 6, 4, 4, 4]
```

In [16]:
```
df['cabin_cat'] = new_Cabin_int
df[['Cabin', 'cabin_cat']].head()
```

```
Out[16]:   Cabin  cabin_cat
         0   NaN          4
         1   C85          5
         2   NaN          4
         3  C123          5
         4   NaN          4
```

3.4 Sex - Category

```
In [17]: # 請算出 Sex 共有幾個類別，每一個類別共出現幾次 (hint:Counter)
         #=============your works starts===============#
         counter =
         #==============your works ends================#


         print(counter)
         #Counter({'male': 577, 'female': 314})
```

```
Counter({'male': 577, 'female': 314})
```

```
In [18]: # 創造出一個與 df['Sex'] 等長的 array，並將 df['Sex'] 中的 male 換成 1，female 換成 0
         #=============your works starts===============#
         sex_mapping =
         sex_cat =
         #==============your works ends================#


         print("Counter(sex_cat)", Counter(sex_cat))
         #Counter(sex_cat) Counter({1: 577, 0: 314})
```

```
Counter(sex_cat) Counter({1: 577, 0: 314})
```

```
In [19]: df['sex_cat'] = sex_cat
         Counter(df['sex_cat'])
```

```
Out[19]: Counter({1: 577, 0: 314})
```

3.5 Ticket - Category

```
In [20]: # 整理出每一個 Ticket 的個數並排序 (hint:Counter(), sorted())
         #=============your works starts===============#
         sorted_ticket_counter =
         #==============your works ends================#

         print(sorted_ticket_counter)
         # [('110152', 3), ('110413', 3), ('110465', 2), ('110564', 1), ('110813', 1), ('11124
```

```
[('110152', 3), ('110413', 3), ('110465', 2), ('110564', 1), ('110813', 1), ('111240', 1), ('11
```

```
In [21]: # ticket
         ticket_cat = {}
         for ticket in df['Ticket']:
             if ticket.isdigit():
                 ticket_cat[ticket] = 1
             elif ticket.startswith('A'):
                 ticket_cat[ticket] = 2
             elif ticket.startswith('C'):
                 ticket_cat[ticket] = 3
             elif ticket.startswith('F'):
                 ticket_cat[ticket] = 4
             elif ticket.startswith('P'):
                 ticket_cat[ticket] = 5
             elif ticket.startswith('SOTON'):
                 ticket_cat[ticket] = 6
             elif ticket.startswith('STON'):
                 ticket_cat[ticket] = 7
             elif ticket.startswith('S'):
                 ticket_cat[ticket] = 8
             elif ticket.startswith('W'):
                 ticket_cat[ticket] = 9
             else:
                 ticket_cat[ticket] = 0
         df['ticket_cat'] = df['Ticket'].apply(ticket_cat.get)
         print(Counter(df['ticket_cat']))
```

```
Counter({1: 661, 5: 65, 3: 47, 8: 30, 2: 29, 7: 18, 6: 17, 9: 13, 4: 7, 0: 4})
```

3.6 Embarked - Category

```
In [22]: # 整理出每一個 Embarked 的個數並排序 (hint:Counter(), sorted())
         #=============your works starts===============#
         sorted_embarked_counter =
         #==============your works ends================#

         print(sorted_embarked_counter)
         # [('C', 168), ('Q', 77), ('S', 644), ('nan', 2)]
```

```
[('C', 168), ('Q', 77), ('S', 644), ('nan', 2)]
```

```
In [23]: # 創造 embarked 的類別對應 dict
         #=============your works starts===============#
         embarked_cat =
         #==============your works ends================#
```

```
        print(embarked_cat)
        #{nan: 0, 'S': 1, 'Q': 2, 'C': 3}
```

```
{nan: 0, 'C': 1, 'S': 2, 'Q': 3}
```

```
In [24]: # 轉換 embarked 為數字類別
         #=============your works starts===============#
         df['embarked_cat'] =
         #==============your works ends================#

         print(Counter(df['embarked_cat']))
         #Counter({1: 644, 3: 168, 2: 77, 0: 2})
```

```
Counter({2: 644, 1: 168, 3: 77, 0: 2})
```

3.7 Title - NLP category

```
In [25]: # 請找到位在"," 以及"." 的所有字並將" ", ".", "," 去掉 (hint: re.findall(), str.replace
         def find_call(name):
             #=============your works starts===============#
             name =
             #==============your works ends================#
             return name

         title_cat_series = df['Name'].apply(find_call)
         print(title_cat_series.values[:10])
         #['Mr' 'Mrs' 'Miss' 'Mrs' 'Mr' 'Mr' 'Mr' 'Master' 'Mrs' 'Mrs']
```

```
['Mr' 'Mrs' 'Miss' 'Mrs' 'Mr' 'Mr' 'Mr' 'Master' 'Mrs' 'Mrs']
```

```
In [26]: title_mapping= {
             'Ms':"Miss",
             'Mlle':"Miss",
             'Miss':"Miss",
             'Mrs':"Mrs",
             'Mme':"Mrs",
             'MrsMartin(ElizabethL':"Mrs",
             'Mr':"Mr"
             }

         title_cat = {"Mr": 1, "Miss": 2, "Mrs": 3, "Master": 4, "Rare": 5}

         def process_title(call):
             if title_cat.get(call):
```

```
            return title_cat.get(call)
        else:
            return title_cat.get(title_mapping.get(call, "Rare"))

    df['title_cat'] = title_cat_series.apply(process_title)
    print(Counter(df['title_cat']))
```

```
Counter({1: 517, 2: 185, 3: 126, 4: 40, 5: 23})
```

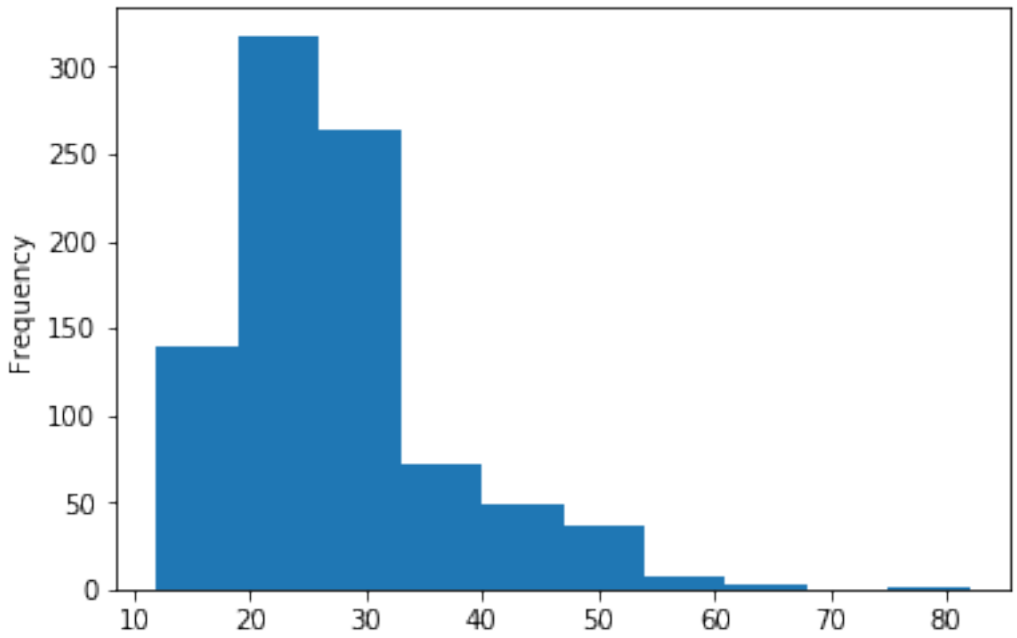
3.8 Title - Length

```
In [27]: # 算出 df['Name'] 中每一個名字的長度並放進一個 array
         #=============your works starts===============#
         name_length =
         #==============your works ends================#


         print(Counter(pd.cut(name_length, bins=10, labels=range(10))))
         # Counter({1: 303, 2: 237, 0: 204, 3: 57, 4: 53, 5: 26, 6: 8, 7: 2, 9: 1})
```

```
Counter({1: 303, 2: 237, 0: 204, 3: 57, 4: 53, 5: 26, 6: 8, 7: 2, 9: 1})
```

```
In [28]: df['name_length'] = name_length
```

```
In [29]: # 劃出每一長度區間次數的長條分布圖 (如長度界在 10~20 之間的有出現約 150 次)(hint: df[col
         #=============your works starts===============#
         df['name_length'].plot('hist')
         #==============your works ends================#


         plt.show()
```



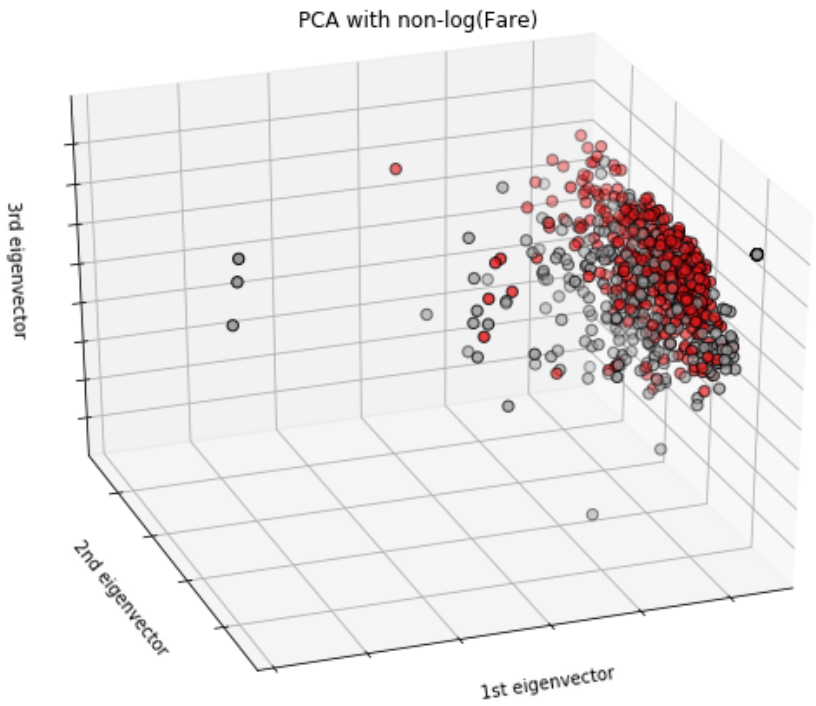
3.9 Fare - PCA, smooth noisy data, feature generation

```
In [30]: # 請找出 dtype 是 np.int64 或 np.float64 且名稱不以'_cat' 結尾的欄位。
         #=============your works starts===============#
         number_cols =
         #==============your works ends================#


         print(number_cols)
         # ['PassengerId', 'Survived', 'Pclass', 'Age', 'SibSp', 'Parch', 'Fare', 'avg_age', '
```

```
['PassengerId', 'Survived', 'Pclass', 'Age', 'SibSp', 'Parch', 'Fare', 'avg_age', 'median_age'
```

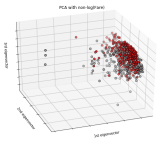
請參照這個連結，劃出以下這張 PCA 圖

```
In [31]: X = df[['Pclass', 'Parch', 'SibSp', 'Fare', 'avg_age', 'name_length']].values
         Y = np.array(df['Survived'])

         #!=============your works starts==============!#
```



PCA_chart

```
    #!==============your works ends================!#

    plt.show()
```



In [32]:
```
# 請找出標準差最大的欄位 ['Pclass', 'Parch', 'SibSp', 'Fare', 'avg_age', 'name_length'
#!==============your works starts===============!#

#!==============your works ends================!#
```

Out[32]:

	Pclass	Parch	SibSp	Fare	avg_age	name_length
count	891.000000	891.000000	891.000000	891.000000	891.000000	891.000000
mean	2.308642	0.381594	0.523008	32.204208	29.699118	26.965208
std	0.836071	0.806057	1.102743	49.693429	13.002015	9.281607
min	1.000000	0.000000	0.000000	0.000000	0.420000	12.000000
25%	2.000000	0.000000	0.000000	7.910400	22.000000	20.000000
50%	3.000000	0.000000	0.000000	14.454200	29.699118	25.000000
75%	3.000000	0.000000	1.000000	31.000000	35.000000	30.000000
max	3.000000	6.000000	8.000000	512.329200	80.000000	82.000000

In [33]:
```
# 請找出 Fare 的平均值 (mean)，並填入 df['Fare'] 中
#=============your works starts===============#
avg_fare =
df[pd.isnull(df['Fare'])] =
#==============your works ends================#
# df['Fare'].fillna(avg_fare)


print("avg_fare", avg_fare)
# 32.204207968574636
print("number of null of Fare:", len(df[pd.isnull(df['Fare'])]))
# number of null of Fare: 0
```

```
avg_fare 32.204207968574636
number of null of Fare: 0
```

In [34]:
```
df['Fare'].describe()
```

Out[34]:
```
count    891.000000
mean      32.204208
std       49.693429
min        0.000000
25%        7.910400
50%       14.454200
75%       31.000000
max      512.329200
Name: Fare, dtype: float64
```

In [35]:
```
# 找出 Fare==0 的 row，補上 Fare=1
#=============your works starts===============#
df[df['Fare']=
#==============your works ends================#

print("number of Fare equals zero:", len(df[df['Fare']==0]))
# number of Fare equals zero: 0
```

```
number of Fare equals zero: 0
```

In [36]:
```
# 請算出 Fare 以 10 為底的 log 值
#==============your works starts===============#
fare_log10 =
#==============your works ends================#


print(fare_log10[:5])
# [0.86033801 1.8529878  0.89899927 1.72509452 0.90579588]
```

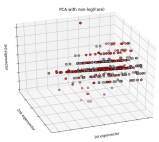
```
[0.86033801 1.8529878  0.89899927 1.72509452 0.90579588]
```

In [37]:
```
df['fare_log10'] = fare_log10
df[['Fare', 'fare_log10']].head()
```

Out[37]:

	Fare	fare_log10
0	7.2500	0.860338
1	71.2833	1.852988
2	7.9250	0.898999
3	53.1000	1.725095
4	8.0500	0.905796

In [38]:
```
X = np.matrix(df[['Parch', 'SibSp', 'avg_age', 'fare_log10']])
Y = np.array(df['Survived'])

fig = plt.figure(1, figsize=(8, 6))
ax = Axes3D(fig, elev=-150, azim=110)

X_reduced = PCA(n_components=3).fit_transform(X)
ax.scatter(X_reduced[:, 0], X_reduced[:, 1], X_reduced[:, 2], c=Y,
           cmap=plt.cm.Set1, edgecolor='k', s=40)
ax.set_title("PCA with non-log(Fare)")
ax.set_xlabel("1st eigenvector")
ax.w_xaxis.set_ticklabels([])
ax.set_ylabel("2nd eigenvector")
ax.w_yaxis.set_ticklabels([])
ax.set_zlabel("3rd eigenvector")
ax.w_zaxis.set_ticklabels([])

plt.show()
```



4 類別型變數 onehot encode

```
In [39]: enc = preprocessing.OneHotEncoder()
         # 請使用 enc.fit_transform 兩個步驟，onehot encode title_cat
         #=============your works starts===============#
         title_cat_onehot =
         #=============your works ends================#


         print(title_cat_onehot[:3])
         # [[1. 0. 0. 0. 0.]
         #  [0. 0. 1. 0. 0.]
         #  [0. 1. 0. 0. 0.]]
```

```
[[1. 0. 0. 0. 0.]
 [0. 0. 1. 0. 0.]
 [0. 1. 0. 0. 0.]]


If you want the future behaviour and silence this warning, you can specify "categories='auto'"
In case you used a LabelEncoder before this OneHotEncoder to convert the categories to integers
  warnings.warn(msg, FutureWarning)
```

```
In [40]: enc = preprocessing.OneHotEncoder()
         # 請使用 enc.fit_transform 兩個步驟，onehot encode embarked_cat
         #=============your works starts===============#
         embarked_cat_onehot =
         #=============your works ends================#

         embarked_cat_onehot[:3]
         # array([[0., 0., 1., 0.],
         #        [0., 1., 0., 0.],
         #        [0., 0., 1., 0.]])
```

```
If you want the future behaviour and silence this warning, you can specify "categories='auto'"
In case you used a LabelEncoder before this OneHotEncoder to convert the categories to integers
  warnings.warn(msg, FutureWarning)
```

```
Out[40]: array([[0., 0., 1., 0.],
                [0., 1., 0., 0.],
                [0., 0., 1., 0.]])
```

5 PolynomialFeatures

```
In [41]: poly = preprocessing.PolynomialFeatures(degree=2)
         # 請利用 poly.fit_transform 製造出 fare_log10 的 0 次項、1 次項、2 次項，並把 0 次項拿掉
```

```
        #=============your works starts===============#
        fare_log10_poly =
        #==============your works ends================#

        print(fare_log10_poly[:2])
        # [[1.         0.86033801 0.74018149]
        #  [1.         1.8529878  3.43356378]]
```

```
[[0.86033801 0.74018149]
 [1.8529878  3.43356378]]
```

```
In [42]: # 請利用 poly.fit_transform 製造出'fare_log10', 'random_age' 的二項次及其一次交成項
         #=============your works starts===============#
         age_fare_ploy =
         #==============your works ends================#

         print(age_fare_ploy[:2])
         # [[8.60338007e-01 8.31383556e-04 7.40181486e-01 7.15270871e-04 6.91198616e-07]
         #  [1.85298780e+00 1.43602614e-03 3.43356378e+00 2.66093892e-03 2.06217108e-06]]
```

```
[[8.60338007e-01 8.31383556e-04 7.40181486e-01 7.15270871e-04
  6.91198616e-07]
 [1.85298780e+00 1.43602614e-03 3.43356378e+00 2.66093892e-03
  2.06217108e-06]]
```

5.1 Preprocessing Conclude

```
In [43]: df.columns
```

```
Out[43]: Index(['PassengerId', 'Survived', 'Pclass', 'Name', 'Sex', 'Age', 'SibSp',
                'Parch', 'Ticket', 'Fare', 'Cabin', 'Embarked', 'avg_age', 'median_age',
                'random_age', 'avg_age_l1', 'avg_age_l2', 'cabin_cat', 'sex_cat',
                'ticket_cat', 'embarked_cat', 'title_cat', 'name_length', 'fare_log10'],
               dtype='object')
```

```
In [44]: X = df[['SibSp', 'Parch', 'avg_age_l2', 'sex_cat', 'name_length', 'fare_log10']].valu
         X = np.concatenate([X, title_cat_onehot, embarked_cat_onehot, age_fare_ploy], axis=1)
         Y = df[['Survived']].values

         print(X.shape)
         print(Y.shape)
```

```
(891, 20)
(891, 1)
```

```
In [45]: from sklearn import linear_model
         from  sklearn.model_selection import train_test_split


         X_train, X_test, Y_train, Y_test = train_test_split(X, Y, random_state=1212)

         reg = linear_model.LinearRegression()
         reg.fit(X_train, Y_train)
         predict_prob = reg.predict(X_test)

         Y_predict = predict_prob > 0.5
         Y_test = Y_test == 1
         acc = np.sum(Y_predict == Y_test)/ len(Y_test)
         print("Accuracy:", acc)

Accuracy: 0.8026905829596412
```