Microsoft

Using Machine Learning Models

数据科学 –
机器学习模型入门

人类活动预测

Random Forest with Classification & Clustering

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Microsoft Reactor | Ryan Chung

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Reactor

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手机感测器数据 => 当前行为动作

- Accelerometer 加速度计
- Gyroscope 陀螺仪

1. Walking 行走
2. Walking Upstairs 上楼
3. Walking Downstairs 下楼
4. Sitting 坐
5. Standing 站立
6. Laying 躺着

分析步骤

分析步骤


```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import StratifiedShuffleSplit
from sklearn.linear_model import LogisticRegression, LogisticRegressionCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.preprocessing import LabelEncoder
from sklearn.model_selection import train_test_split
from sklearn.metrics import precision_recall_fscore_support as error_metric
from sklearn.metrics import confusion_matrix, accuracy_score, precision_score, f1_score,
recall_score
from sklearn.feature_selection import VarianceThreshold
```

分析步骤

前置作业
- 汇入所需模组

数据取得
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数据分析
- 关联性

数据切割
- 训练/测试

预测
- 模型选择
- 结果评估

```
train = pd.read_csv("Data/train.csv")
test = pd.read_csv("Data/test.csv")
```

```
train.head()
```

	tBodyAcc-mean()-X	tBodyAcc-mean()-Y	tBodyAcc-mean()-Z	tBodyAcc-std()-X	tBodyAcc-std()-Y	tBodyAcc-std()-Z	tBodyAcc-mad()-X	tBodyAcc-mad()-Y	tBodyAcc-mad()-Z	tBodyAcc-max()-X	...
0	0.288585	-0.020294	-0.132905	-0.995279	-0.983111	-0.913526	-0.995112	-0.983185	-0.923527	-0.934724	...
1	0.278419	-0.016411	-0.123520	-0.998245	-0.975300	-0.960322	-0.998807	-0.974914	-0.957686	-0.943068	...
2	0.279653	-0.019467	-0.113462	-0.995380	-0.967187	-0.978944	-0.996520	-0.963668	-0.977469	-0.938692	...
3	0.279174	-0.026201	-0.123283	-0.996091	-0.983403	-0.990675	-0.997099	-0.982750	-0.989302	-0.938692	...
4	0.276629	-0.016570	-0.115362	-0.998139	-0.980817	-0.990482	-0.998321	-0.979672	-0.990441	-0.942469	...

5 rows × 563 columns

angle(X,gravityMean)	angle(Y,gravityMean)	angle(Z,gravityMean)	subject	Activity
-0.841247	0.179941	-0.058627	1	STANDING
-0.844788	0.180289	-0.054317	1	STANDING
-0.848933	0.180637	-0.049118	1	STANDING
-0.848649	0.181935	-0.047663	1	STANDING
-0.847865	0.185151	-0.043892	1	STANDING

遗漏值确认

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```
train.isnull().sum()
test.isnull().sum()
train.isnull().values.any()
test.isnull().values.any()
```

```
[26] train.isnull().sum()

tBodyAcc-mean()-X       0
tBodyAcc-mean()-Y       0
tBodyAcc-mean()-Z       0
tBodyAcc-std()-X        0
tBodyAcc-std()-Y        0
                       ..
angle(X,gravityMean)    0
angle(Y,gravityMean)    0
angle(Z,gravityMean)    0
subject                 0
Activity                0
Length: 563, dtype: int64
```

```
[27] test.isnull().sum()

tBodyAcc-mean()-X       0
tBodyAcc-mean()-Y       0
tBodyAcc-mean()-Z       0
tBodyAcc-std()-X        0
tBodyAcc-std()-Y        0
                       ..
angle(X,gravityMean)    0
angle(Y,gravityMean)    0
angle(Z,gravityMean)    0
subject                 0
Activity                0
Length: 563, dtype: int64
```

```
[28] train.isnull().values.any()

False
```

```
[29] test.isnull().values.any()

False
```

整体观察

train.info()
test.info()

```
[30]  train.info()

      <class 'pandas.core.frame.DataFrame'>
      RangeIndex: 7352 entries, 0 to 7351
      Columns: 563 entries, tBodyAcc-mean()-X to Activity
      dtypes: float64(561), int64(1), object(1)
      memory usage: 31.6+ MB

[31]  test.info()

      <class 'pandas.core.frame.DataFrame'>
      RangeIndex: 2947 entries, 0 to 2946
      Columns: 563 entries, tBodyAcc-mean()-X to Activity
      dtypes: float64(561), int64(1), object(1)
      memory usage: 12.7+ MB
```

数据分析 – 移除可能不相关的栏位

- subject：区分受测者的id

```
train.drop('subject',axis=1, inplace=True)
test.drop('subject',axis=1, inplace=True)
```

```
[36]  train.head()
```

oJerkMean,gravityMean)	angle(X,gravityMean)	angle(Y,gravityMean)	angle(Z,gravityMean)	Activity
-0.018446	-0.841247	0.179941	-0.058627	STANDING
0.703511	-0.844788	0.180289	-0.054317	STANDING
0.808529	-0.848933	0.180637	-0.049118	STANDING
-0.485366	-0.848649	0.181935	-0.047663	STANDING
-0.615971	-0.847865	0.185151	-0.043892	STANDING

数据分析 – 分析所有栏位

- 将栏位名称另存一个List

```
rem_cols2 = train.columns.tolist()
```

```
[45]  len(rem_cols2)

      562
```

```
[42]  rem_cols2

      ['tBodyAcc-mean()-X',
       'tBodyAcc-mean()-Y',
       'tBodyAcc-mean()-Z',
       'tBodyAcc-std()-X',
       'tBodyAcc-std()-Y',
       'tBodyAcc-std()-Z',
       'tBodyAcc-mad()-X',
       'tBodyAcc-mad()-Y',
       'tBodyAcc-mad()-Z',
       'tBodyAcc-max()-X',
       'tBodyAcc-max()-Y',
       'tBodyAcc-max()-Z',
       'tBodyAcc-min()-X',
       'tBodyAcc-min()-Y',
```

数据分析 – 分析所有栏位

- 观察目前各栏位的资料型态

```
[46]  train.info()

      <class 'pandas.core.frame.DataFrame'>
      RangeIndex: 7352 entries, 0 to 7351
      Columns: 562 entries, tBodyAcc-mean()-X to Activity
      dtypes: float64(561), object(1)
      memory usage: 31.5+ MB
```

- 唯一的 object 就是目标值

```
[47]  train['Activity'][0]

      'STANDING'
```

```
[48]  type(train['Activity'][0])

      str
```

数据分析 – 分析所有栏位

- 另一个找到object的方式

```
is_object_type_feature = train.dtypes == np.object
train.columns[is_object_type_feature]
```

```
[67] is_object_type_feature

tBodyAcc-mean()-X                          False
tBodyAcc-mean()-Y                          False
tBodyAcc-mean()-Z                          False
tBodyAcc-std()-X                           False
tBodyAcc-std()-Y                           False
                                           ...
angle(tBodyGyroJerkMean,gravityMean)       False
angle(X,gravityMean)                       False
angle(Y,gravityMean)                       False
angle(Z,gravityMean)                       False
Activity                                    True
Length: 562, dtype: bool
```

```
[68] train.columns

Index(['tBodyAcc-mean()-X', 'tBodyAcc-mean()-Y', 'tBodyAcc-mean()-Z',
       'tBodyAcc-std()-X', 'tBodyAcc-std()-Y', 'tBodyAcc-std()-Z',
       'tBodyAcc-mad()-X', 'tBodyAcc-mad()-Y', 'tBodyAcc-mad()-Z',
       'tBodyAcc-max()-X',
       ...
       'fBodyBodyGyroJerkMag-skewness()', 'fBodyBodyGyroJerkMag-kurtosis()',
       'angle(tBodyAccMean,gravity)', 'angle(tBodyAccJerkMean),gravityMean)',
       'angle(tBodyGyroMean,gravityMean)',
       'angle(tBodyGyroJerkMean,gravityMean)', 'angle(X,gravityMean)',
       'angle(Y,gravityMean)', 'angle(Z,gravityMean)', 'Activity'],
      dtype='object', length=562)
```

```
[69] train.columns[is_object_type_feature]

Index(['Activity'], dtype='object')
```

数据分析 – 分析所有栏位

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- Activity的数值分布

```
train['Activity'].value_counts()
```

- 也可以写成

```
train.Activity.value_counts()
```

```
[72] train['Activity'].value_counts()

LAYING                1407
STANDING              1374
SITTING               1286
WALKING               1226
WALKING_UPSTAIRS      1073
WALKING_DOWNSTAIRS     986
Name: Activity, dtype: int64
```

```
[73] train.Activity.value_counts()

LAYING                1407
STANDING              1374
SITTING               1286
WALKING               1226
WALKING_UPSTAIRS      1073
WALKING_DOWNSTAIRS     986
Name: Activity, dtype: int64
```

数据分析 – 分析所有栏位

- 将Activity转换成数值型式

```
le = LabelEncoder()
for x in [train, test]:
    x['Activity'] = le.fit_transform(x['Activity'])
```

```
[77] train['Activity'].value_counts()

0    1407
2    1374
1    1286
3    1226
5    1073
4     986
Name: Activity, dtype: int64
```

数据分析 – 分析所有栏位

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- 关联性观察

```
corr_val = train.corr()
corr_val_activity_abs = corr_val['Activity'].abs()
corr_val_activity_abs_sort = corr_val_activity_abs.sort_values(ascending=False)
corr_val_activity_abs_sort[corr_val_activity_abs_sort>0.84]
```

```
[109] corr_val_activity_abs_sort[corr_val_activity_abs_sort>0.83]

Activity                        1.000000
fBodyAccJerk-entropy()-X        0.845190
tBodyGyroJerk-entropy()-Z       0.844754
tBodyAccJerk-entropy()-Y        0.837034
tBodyAcc-sma()                  0.835621
tBodyAccJerkMag-entropy()       0.835376
tGravityAccMag-sma()            0.833126
tBodyAccMag-sma()               0.833126
tBodyAccMag-mean()              0.833126
tGravityAccMag-mean()           0.833126
fBodyAccJerk-entropy()-Y        0.832284
fBodyAccMag-entropy()           0.831222
fBodyAcc-entropy()-Y            0.831114
fBodyAcc-std()-Y                0.830052
Name: Activity, dtype: float64
```

```
[110] corr_val_activity_abs_sort[corr_val_activity_abs_sort>0.84]

Activity                        1.000000
fBodyAccJerk-entropy()-X        0.845190
tBodyGyroJerk-entropy()-Z       0.844754
Name: Activity, dtype: float64
```

数据分析 – 基本整理原则

- 无遗漏值
- 剔除明显不相关栏位
- 全面数值化
- 观察数值分布情况，必要时进行转换
  - Normalization：往常态分布迈进
  - Standardization：使用相同的尺规
- 关联性分析

分析步骤

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```
feature_cols = train.columns[:-1]
split_data = StratifiedShuffleSplit(n_splits=3, test_size=0.3, random_state=42)
train_idx, val_idx = next(split_data.split(train[feature_cols],train.Activity))

X_train = train.loc[train_idx, feature_cols]
y_train = train.loc[train_idx, 'Activity']

X_val = train.loc[val_idx, feature_cols]
y_val = train.loc[val_idx, 'Activity']
```

分析步骤


```
feature_cols = train.columns[:-1]
split_data = StratifiedShuffleSplit(n_splits=3, test_size=0.3, random_state=42)
train_idx, val_idx = next(split_data.split(train[feature_cols],train.Activity))

X_train = train.loc[train_idx, feature_cols]
y_train = train.loc[train_idx, 'Activity']

X_val = train.loc[val_idx, feature_cols]
y_val = train.loc[val_idx, 'Activity']

y_train.value_counts()
y_train.value_counts(normalize=True)
y_val.value_counts(normalize=True)
```

```
[122] y_train.value_counts()

0    985
2    962
1    900
3    858
5    751
4    690
Name: Activity, dtype: int64
```

```
[126] y_val.value_counts(normalize=True)

0    0.191296
2    0.186763
1    0.174977
3    0.166818
5    0.145966
4    0.134180
Name: Activity, dtype: float64
```

```
[123] y_train.value_counts(normalize=True)

0    0.191411
2    0.186941
1    0.174893
3    0.166731
5    0.145939
4    0.134085
Name: Activity, dtype: float64
```

分析步骤

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```
lr = LogisticRegression()
lr_l2 = LogisticRegressionCV()
rf = RandomForestClassifier()

lr_model = lr.fit(X_train, y_train)
lr_l2_model = lr_l2.fit(X_train, y_train)
rf_model = rf.fit(X_train, y_train)

lr_model_predict = lr_model.predict(X_val)
lr_l2_model_predict = lr_l2_model.predict(X_val)
rf_model_predict = rf_model.predict(X_val)

three_model_predict_df = pd.DataFrame({'lr':lr_model_predict,
'lr_l2':lr_l2_model_predict,'rf':rf_model_predict})
```

	lr	lr_l2	rf
0	0	0	0
1	5	5	5
2	1	1	1
3	0	0	0
4	3	3	3
...	...	...	...
2201	1	1	1
2202	5	5	5
2203	2	2	2
2204	1	1	1
2205	3	3	3

2206 rows × 3 columns

分析步骤

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- 三个模型的信心指数也可输出进行观察

```
lr_model_proba = lr_model.predict_proba(X_val).max(axis=1)
lr_l2_model_proba = lr_l2_model.predict_proba(X_val).max(axis=1)
rf_model_proba = rf_model.predict_proba(X_val).max(axis=1)

three_model_proba_df = pd.DataFrame({'lr':lr_model_proba,
'lr_l2':lr_l2_model_proba,'rf':rf_model_proba})
```

	lr	lr_l2	rf
0	0.982767	0.999938	1.0
1	0.977773	0.999258	1.0
2	0.995116	0.998465	0.8
3	0.999999	1.000000	0.9
4	0.962265	0.998696	0.9
...	...	...	...
2201	0.998039	0.999863	1.0
2202	0.997980	0.999993	0.9
2203	0.992126	0.999752	1.0
2204	0.978954	0.989888	0.9
2205	0.991474	0.999875	1.0

2206 rows × 3 columns

分析步骤

- 三个模型的评量综整

```
accurcy_lr = accuracy_score(y_val, lr_model_predict)
accurcy_lr_l2 = accuracy_score(y_val, lr_l2_model_predict)
accurcy_rf = accuracy_score(y_val, rf_model_predict)

three_model_report = pd.DataFrame(data={'Accuracy':[accurcy_lr,
accurcy_lr_l2,accurcy_rf]},index=['lr','lr_l2','rf'])
```

	Accuracy
lr	0.982774
lr_l2	0.986401
rf	0.966002

分析步骤

- 加上其他指标 - Precision

```
precision_lr = precision_score(y_val, lr_model_predict, average='weighted')
precision_lr_l2 = precision_score(y_val, lr_l2_model_predict, average='weighted')
precision_rf = precision_score(y_val, rf_model_predict, average='weighted')

three_model_report['Precision'] = [precision_lr,precision_lr_l2,precision_rf]
```

	Accuracy	Precision
lr	0.982774	0.982787
lr_l2	0.986401	0.986408
rf	0.966002	0.966252

分析步骤

- 加上其他指标 - Recall

```
recall_lr = recall_score(y_val, lr_model_predict, average='weighted')
recall_lr_l2 = recall_score(y_val, lr_l2_model_predict, average='weighted')
recall_rf = recall_score(y_val, rf_model_predict, average='weighted')

three_model_report['Recall'] = [recall_lr,recall_lr_l2,recall_rf]
```

	Accuracy	Precision	Recall
lr	0.982774	0.982787	0.982774
lr_l2	0.986401	0.986408	0.986401
rf	0.966002	0.966252	0.966002

分析步骤

- 加上其他指标 – F1 Score

```
f1score_lr = f1_score(y_val, lr_model_predict, average='weighted')
f1score_lr_l2 = f1_score(y_val, lr_l2_model_predict, average='weighted')
f1score_rf = f1_score(y_val, rf_model_predict, average='weighted')

three_model_report['F1 Score'] = [f1score_lr,f1score_lr_l2,f1score_rf]
```

	Accuracy	Precision	Recall	F1 Score
lr	0.982774	0.982787	0.982774	0.982771
lr_l2	0.986401	0.986408	0.986401	0.986399
rf	0.966002	0.966252	0.966002	0.966006

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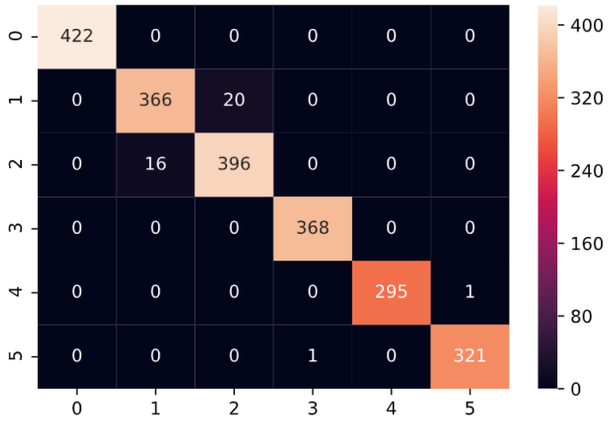
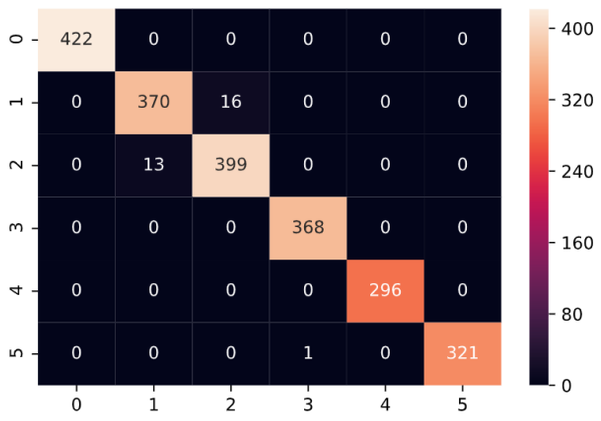
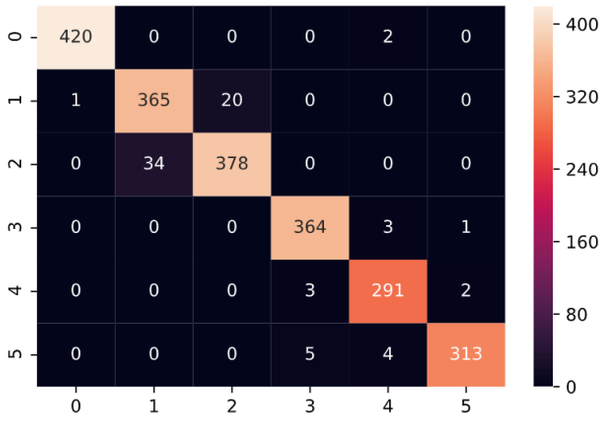
- 加上其他指标 – Confusion Matrix

```
cm_lr = confusion_matrix(y_val, lr_model_predict)
cm_lr_l2 = confusion_matrix(y_val, lr_l2_model_predict)
cm_rf = confusion_matrix(y_val, rf_model_predict)
sns.heatmap(cm_lr, annot=True, fmt="d")
sns.heatmap(cm_lr_l2, annot=True, fmt="d")
sns.heatmap(cm_rf, annot=True, fmt="d")
```

annot 是否标示数值
fmt 数值标示格式(d为整数)

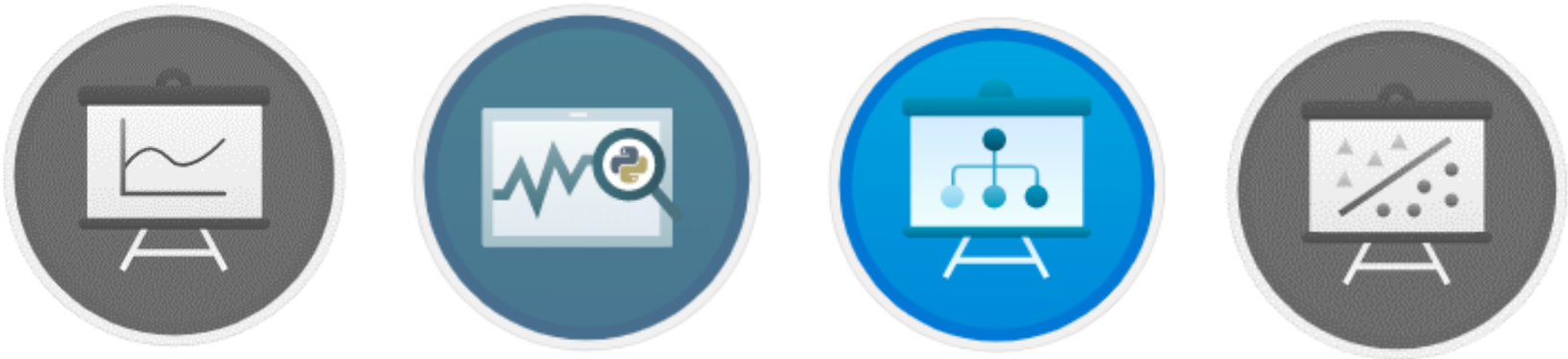






小结

- 依数据的分布情形与范围，考量是否需要Normalization与Standardization
- 数据集的训练与测试切割，须同时考量目标分类的平均取样
- 综合比较各种评量指标的结果，了解不同模型的表现



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https://aka.ms/Reactor/Survey