数据分析与机器学习案例

本案例基于泰坦尼克号事件数据，介绍如何使用Matlab对相关数据进行分析与处理，建立泰坦尼克号乘客是否幸存的预测模型。

内容仅涉及对数据的讨论，不就事件本身性质以及影响等做任何研究。

愿灾难不再发生

正文

0.相关内容

- Matlab对象
- table变量
- cell变量
- nan系列数学运算函数
- statistics and machine learning toolbox

1.数据导入与展示

```
data = readtable('train.csv');
[row,col] = size(data);
head(data)
```

```
ans = 8×12 table
```

	PassengerId	Survived	Pclass	Name	Sex	Age
1	1	0	3	'Braund, Mr...	'male'	22
2	2	1	1	'Cumings, M...	'female'	38
3	3	1	3	'Heikkinen,...	'female'	26
4	4	1	1	'Futrelle, ...	'female'	35
5	5	0	3	'Allen, Mr....	'male'	35
6	6	0	3	'Moran, Mr....	'male'	NaN
7	7	0	1	'McCarthy, ...	'male'	54
8	8	0	3	'Palsson, M...	'male'	2

```
varnames = data.Properties.VariableNames
```

```
varnames = 1×12 cell 数组
    {'PassengerId'}    {'Survived'}    {'Pclass'}    {'Name'}    {'Sex'}    {'Age'}    {'SibSp'}    {'Parch'}    {'
```

各个特征的中文名

PassengerId 乘客编号

Survived 存活情况

Pclass 客舱等级

Name 乘客姓名

Sex 性别

Age 年龄

SibSp 同乘的兄弟姐妹/配偶数

Parch 同乘的父母/小孩数

Ticket 船票编号

Fare 船票价格

Cabin 客舱号

Embarked 登船港口

2.补全缺失值

```
for name = varnames
    tempdata = data(:,name).Variables;
    %若为数值类型数据缺失，则以该列众数进行填补
    if isnumeric(tempdata)
        nanindex = isnan(tempdata);
        if sum(nanindex)
            com = tsnanmode(tempdata);
            tempdata(nanindex) = com;
        end
        data(:,name).Variables = tempdata;
    %若为字符串类型数据缺失，则以该列出现次数最多的字符串进行填补
    else
        nanindex = cellfun(@(x) isempty(x),tempdata);
        if sum(nanindex)
            index = find(nanindex);
            %tabulate函数对单组数据的模式进行统计
            sat = tabulate(tempdata);
            count_arr = [sat{:,2}];
            [~,max_freq_index] = max(count_arr);
            mode_ = tempdata{max_freq_index};
            for i = 1:length(index)
                tempdata{index(i)} = mode_;
            end
        end
        data(:,name).Variables = tempdata;
    end
```

```
end
```

3.特征工程

3.1 清除明显的无关特征

明显的无关特征包括Name,PassengerId,Ticket,Cabin

删除Cabin的原因是该列缺失数据过多，达到687个，超过77%。

```
remove_set = {'PassengerId','Name','Ticket','Cabin'};
result_set = setdiff(varnames,remove_set);
data = data(:,result_set);
```

3.2 特征选择

3.2.1 对性别数据与登船港口号数据进行编码

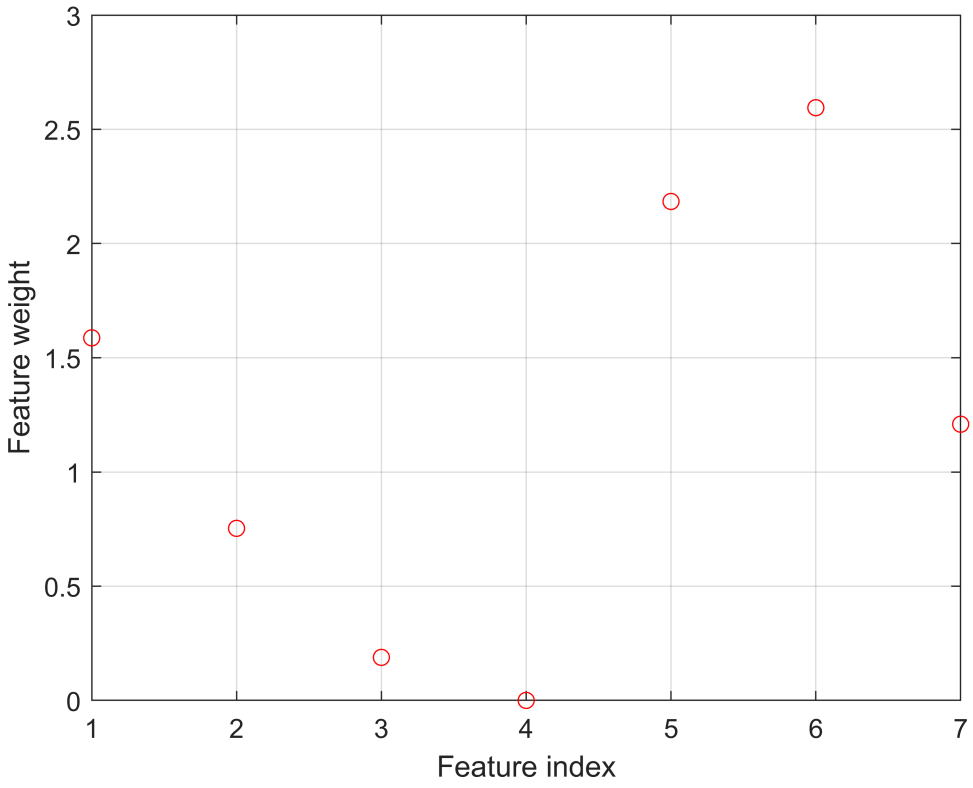
```
%对性别进行编码
m_index = cellfun(@(x) isequal(x,'male'),data(:,'Sex').Variables);
f_index = cellfun(@(x) isequal(x,'female'),data(:,'Sex').Variables);
data(m_index,'Sex').Variables = repmat({1},sum(m_index),1);
data(f_index,'Sex').Variables = repmat({2},sum(f_index),1);
%对登船港口进行编码
C_index = cellfun(@(x) isequal(x,'C'),data(:,'Embarked').Variables);
Q_index = cellfun(@(x) isequal(x,'Q'),data(:,'Embarked').Variables);
S_index = cellfun(@(x) isequal(x,'S'),data(:,'Embarked').Variables);

data(C_index,'Embarked').Variables = repmat({1},sum(C_index),1);
data(Q_index,'Embarked').Variables = repmat({2},sum(Q_index),1);
data(S_index,'Embarked').Variables = repmat({3},sum(S_index),1);

Embarked = cell2mat(data(:,'Embarked').Variables);
Sex = cell2mat(data(:,'Sex').Variables);
%由于table变量各列数据类型不好变化，因此选择删除后重新建立的方法
data.Embarked = [];
data.Sex = [];
data = addvars(data,Embarked,'Before','Survived');
data = addvars(data,Sex,'Before','Survived');
```

3.2.2 对剩余数据进行特征选择

```
rng(0);
Y = data(:,'Survived').Variables;
X = data(:,setdiff(result_set,'Survived')).Variables;
%近邻成分分析——Neighbourhood Component Analysis(NCA)
%fscnca——feature selection using neighborhood component analysis for classification
mdl = fscnca(X,Y);
```

近邻成分分析理论部分参考链接

```
figure()
plot(mdl.FeatureWeights,'ro');
grid on
xlabel('Feature index');
ylabel('Feature weight');
```



根据上图权重值，取较好的第1，5，6，7个特征

此处也可选取阈值为0.5或者1，尝试使用不同的特征选择结果来训练模型

```
feature_selection_index = [1,5,6,7];
feature_selection = {data.Properties.VariableNames{feature_selection_index}};
```

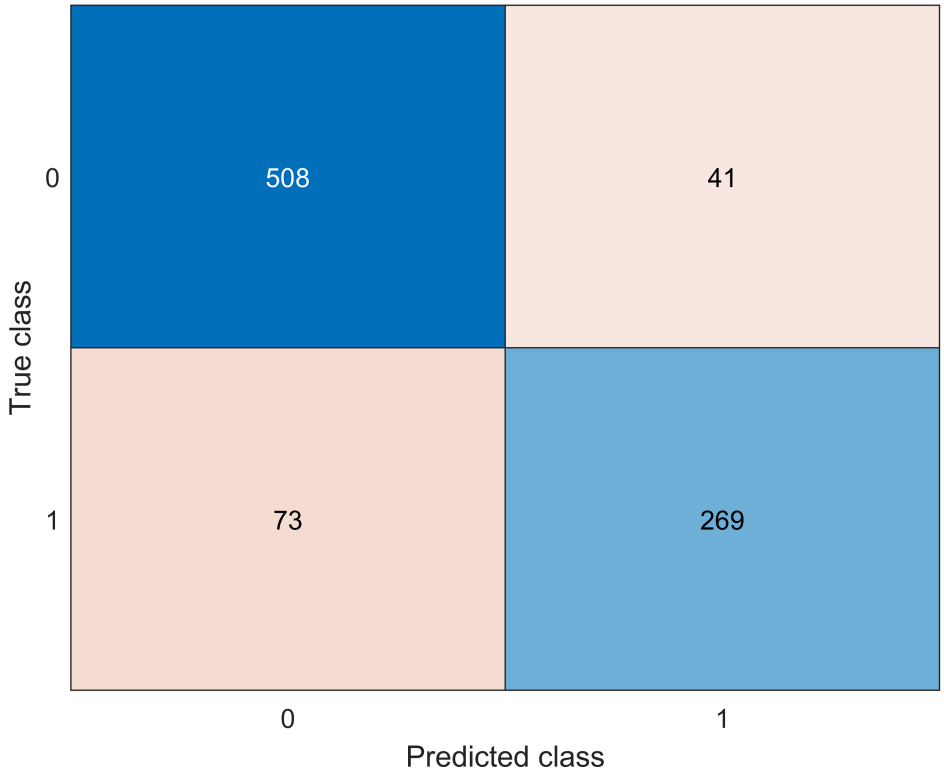
4.预测模型建立及其在训练集上的表现

4.1 支持向量机分类

```
inp = data(:,feature_selection).Variables;
labels = data(:,'Survived').Variables;
model = fitcsvm(inp,labels,'KernelFunction','RBF');
cvmodel = crossval(model,'kfold',10);
cvloss = kfoldLoss(cvmodel)
```

```
cvloss = 0.2480
```

```
data_prediction = predict(model,inp);
res = confusionchart(labels,data_prediction);
```




```
resdata = res.NormalizedValues;
TP = resdata(2,2);
TN = resdata(1,1);
FP = resdata(1,2);
FN = resdata(2,1);
precision = TP/(TP+FP)
```

```
precision = 0.8677
```

```
recall = TP/(TP+FN)
```

```
recall = 0.7865
```

```
F1 = 2*precision*recall/(precision+recall)
```

```
F1 = 0.8252
```

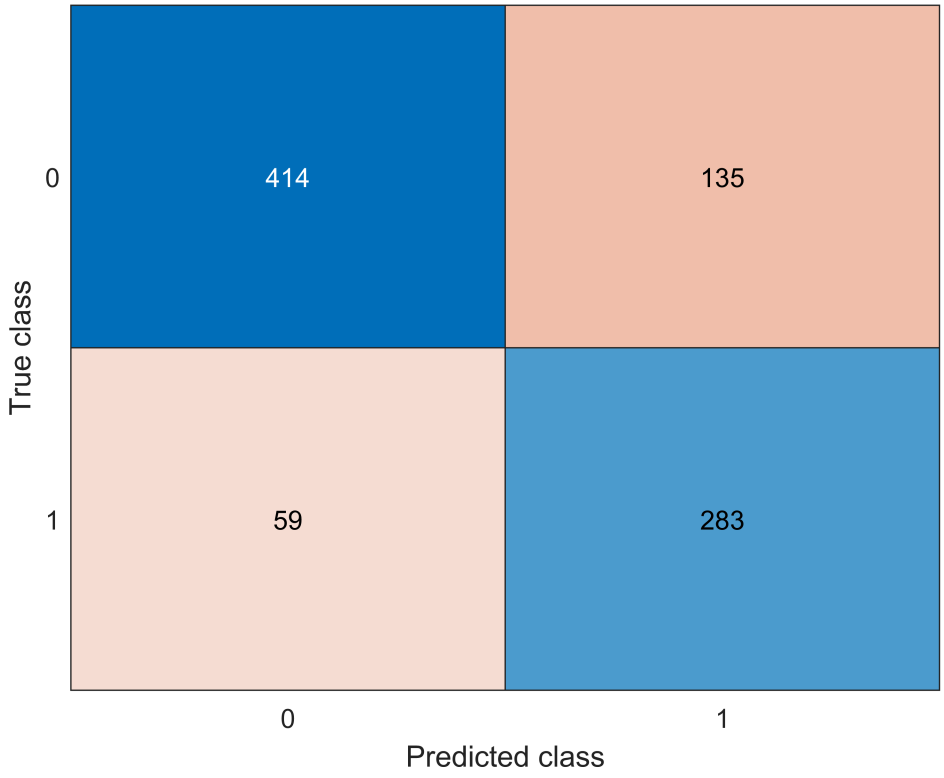
4.2 最近邻分类

```
model_ = fitcknn(inp,labels);
cvmodel_ = crossval(model_,'kfold',10);
```

```
cvloss_ = kfoldLoss(cvmodel_)
```

```
cvloss_ = 0.3513
```

```
data_prediction_ = predict(model_,inp);
res_ = confusionchart(labels,data_prediction_);
```




```
resdata_ = res_.NormalizedValues;
TP_ = resdata_(2,2);
TN_ = resdata_(1,1);
FP_ = resdata_(1,2);
FN_ = resdata_(2,1);
precision_ = TP_/(TP_+FP_)
```

```
precision_ = 0.6770
```

```
recall_ = TP_/(TP_+FN_)
```

```
recall_ = 0.8275
```

```
F1_ = 2*precision_*recall_/(precision_+recall_)
```

```
F1_ = 0.7447
```

5.预测模型建立及其在测试集上的表现(仅svm)

5.1 测试集的预处理

```
data_ = readtable('test.csv');%测试集样本数据
labels_ = readtable('gender_submission.csv');%测试集标签数据
[row_,col_] = size(data_);
head(data_)
```

ans = 8×11 table

...

	PassengerId	Pclass	Name	Sex	Age	SibSp
1	892	3	'Kelly, Mr....	'male'	34.5000	0
2	893	3	'Wilkes, Mr...	'female'	47.0000	1
3	894	2	'Myles, Mr....	'male'	62.0000	0
4	895	3	'Wirz, Mr. ...	'male'	27.0000	0
5	896	3	'Hirvonen, ...	'female'	22.0000	1
6	897	3	'Svensson, ...	'male'	14.0000	0
7	898	3	'Connolly, ...	'female'	30.0000	0
8	899	2	'Caldwell, ...	'male'	26.0000	1

```
head(labels_)
```

ans = 8×2 table

	PassengerId	Survived
1	892	0
2	893	1
3	894	0
4	895	0
5	896	1
6	897	0
7	898	1
8	899	0

5.1.1 补全所选特征的缺失值

```
for name = feature_selection
    tempdata = data_(:,name).Variables;
    %若为数值类型数据缺失，则以该列众数进行填补
    if isnumeric(tempdata)
        nanindex = isnan(tempdata);
        if sum(nanindex)
            com = tsnanmode(tempdata);
            tempdata(nanindex) = com;
```

```
        end
        data_(:,name).Variables = tempdata;
    %若为字符串类型数据缺失，则以该列出现次数最多的字符串进行填补
    else
        nanindex = cellfun(@(x) isempty(x),tempdata);
        if sum(nanindex)
            index = find(nanindex);
            sat = tabulate(tempdata);
            count_arr = [sat{:,2}];
            [~,max_freq_index] = max(count_arr);
            mode_ = tempdata{max_freq_index};
            for i = 1:length(index)
                tempdata{index(i)} = mode_;
            end
        end
        data_(:,name).Variables = tempdata;
    end
end
```

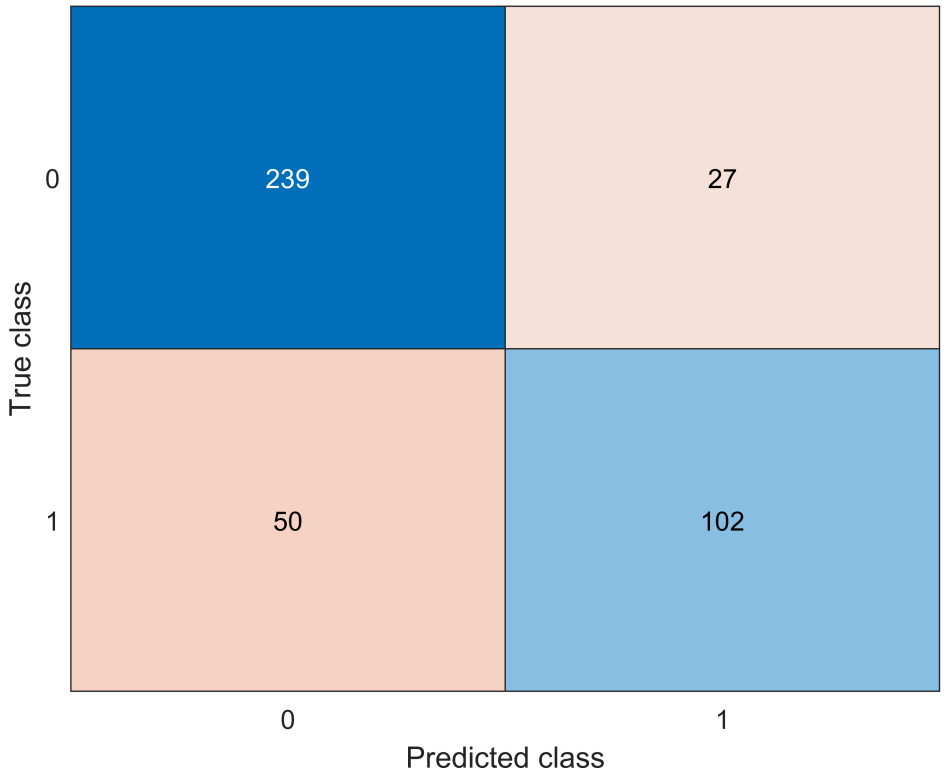
5.1.2 数据编码

```
%对性别进行编码
m_index = cellfun(@(x) isequal(x,'male'),data_(:,'Sex').Variables);
f_index = cellfun(@(x) isequal(x,'female'),data_(:,'Sex').Variables);
data_(m_index,'Sex').Variables = repmat({1},sum(m_index),1);
data_(f_index,'Sex').Variables = repmat({2},sum(f_index),1);
%对登船港口进行编码
C_index = cellfun(@(x) isequal(x,'C'),data_(:,'Embarked').Variables);
Q_index = cellfun(@(x) isequal(x,'Q'),data_(:,'Embarked').Variables);
S_index = cellfun(@(x) isequal(x,'S'),data_(:,'Embarked').Variables);

data_(C_index,'Embarked').Variables = repmat({1},sum(C_index),1);
data_(Q_index,'Embarked').Variables = repmat({2},sum(Q_index),1);
data_(S_index,'Embarked').Variables = repmat({3},sum(S_index),1);

Embarked = cell2mat(data_(:,'Embarked').Variables);
Sex = cell2mat(data_(:,'Sex').Variables);
%由于table变量各列数据类型不好变化，直接赋值为double数据会报错（can not cell2double），因此选择删除后重新
data_.Embarked = [];
data_.Sex = [];
data_ = addvars(data_,Embarked);
data_ = addvars(data_,Sex);
```

5.2 模型测试

```
inp_test = data_(:,feature_selection).Variables;
labels_test = labels_(:,'Survived').Variables;
data_prediction_test = predict(model,inp_test);
```

```
res_test = confusionchart(labels_test,data_prediction_test);
```




```
resdata_test = res_test.NormalizedValues;
TP_test = resdata_test(2,2);
TN_test = resdata_test(1,1);
FP_test = resdata_test(1,2);
FN_test = resdata_test(2,1);
precision_test = TP_test/(TP_test+FP_test)
```

```
precision_test = 0.7907
```

```
recall_test = TP_test/(TP_test+FN_test)
```

```
recall_test = 0.6711
```

```
F1_test = 2*precision_test*recall_test/(precision_test+recall_test)
```

```
F1_test = 0.7260
```