Linear Discriminant Analysis: Titanic

Kaggle

Maria Aquino
Alexander Montenegro
Cris Navarijo
Arin Parsanian

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What is LDA?

LDA can be used as a dimensional reduction technique similar to PCA or for classification tasks by making three crucial assumptions:

- Data is normally distributed
- Features are statistically independent
- Has identical covariance matrices for each class

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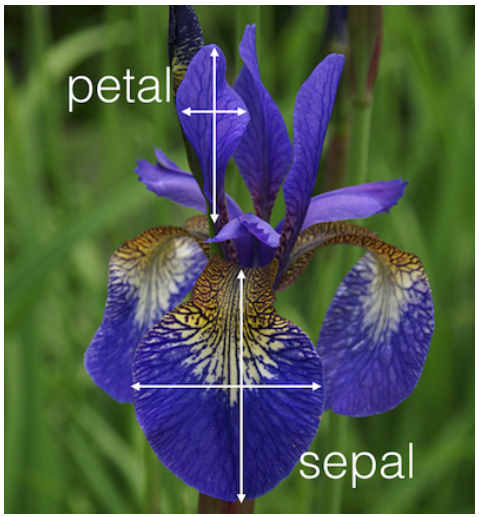
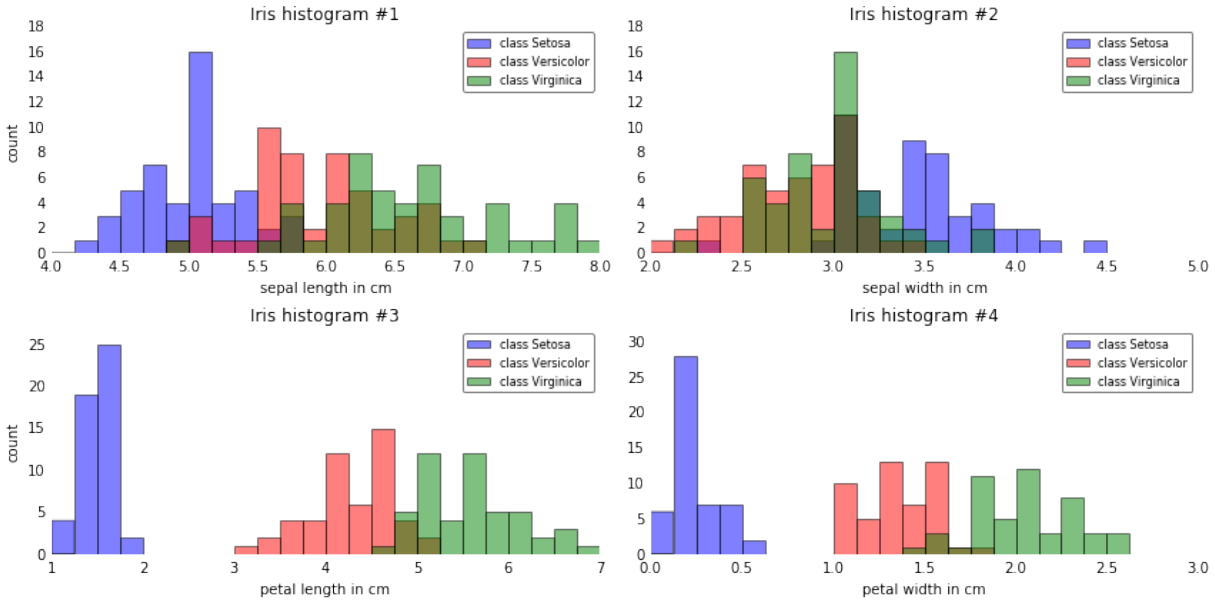
What does LDA do for classification?

Example of ideal/non-ideal distributions for LDA:





What does that mean?

The model is limited in 2 major ways

- Data is assumed normally distributed
- Data must contain at least 1 continuous random variables to fit the model (IE, cannot use categorical data exclusively)

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In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline
```

In [2]:
```
DF = pd.read_csv("train.csv")
print(DF.shape)
DF[:10]
```

```
(891, 12)
```

Out[2]:

	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	0	113803	53.1000	C123	S
4	5	0	3	Allen, Mr. William Henry	male	35.0	0	0	373450	8.0500	NaN	S
5	6	0	3	Moran, Mr. James	male	NaN	0	0	330877	8.4583	NaN	Q
6	7	0	1	McCarthy, Mr. Timothy J	male	54.0	0	0	17463	51.8625	E46	S
7	8	0	3	Palsson, Master. Gosta Leonard	male	2.0	3	1	349909	21.0750	NaN	S
8	9	1	3	Johnson, Mrs. Oscar W (Elisabeth Vilhelmina Berg)	female	27.0	0	2	347742	11.1333	NaN	S
9	10	1	2	Nasser, Mrs. Nicholas (Adele Achem)	female	14.0	1	0	237736	30.0708	NaN	C

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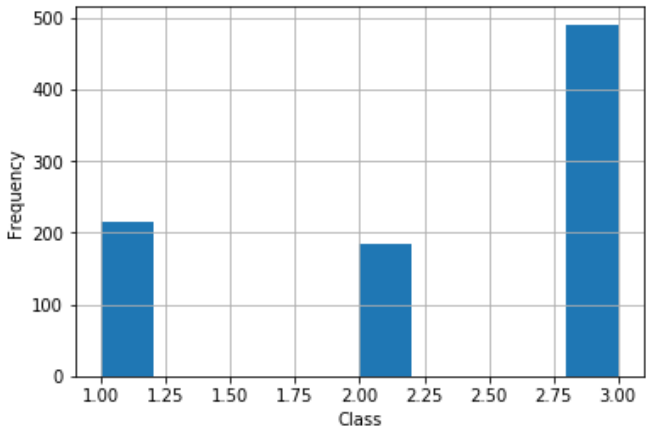
In [3]:
```
Y = np.array(DF["Survived"])
X = pd.DataFrame([DF["Sex"], DF["Age"], DF["Fare"]]).T
```

In [4]:
```
plt.hist(DF["Pclass"])
plt.xlabel("Class")
plt.ylabel("Frequency")
plt.grid();
```



In [5]:
```
plt.scatter(DF["Pclass"], DF["Fare"])
plt.grid()
```

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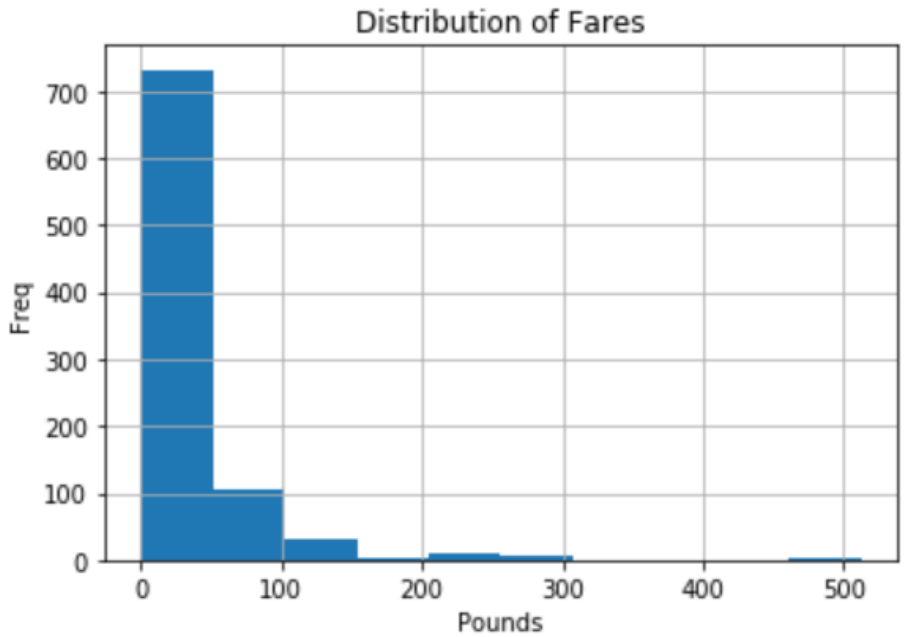
In [24]:

```
plt.hist(DF['Fare'])
plt.title("Distribution of Fares")
plt.xlabel('Pounds')
plt.ylabel('Freq')
plt.grid();
```



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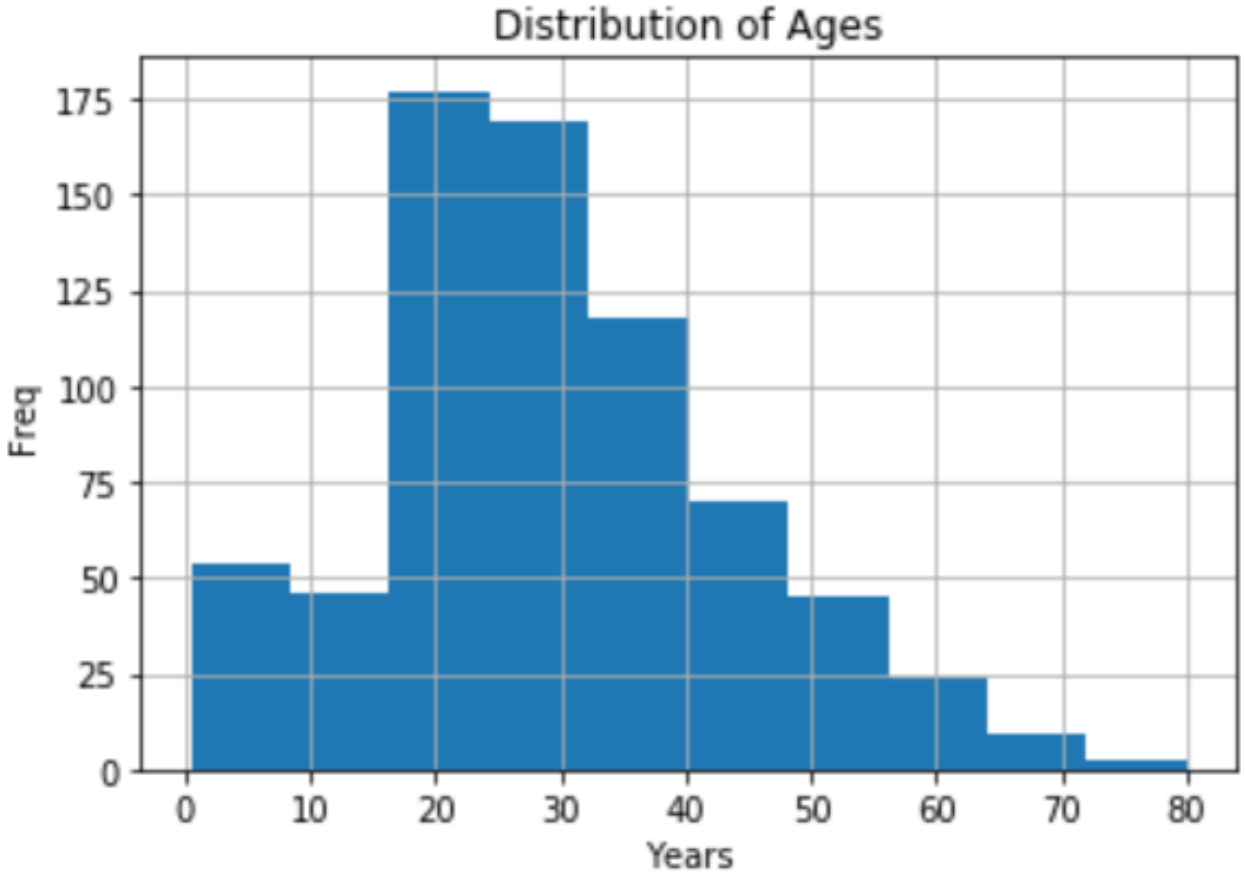

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In [7]:
```
namedata
```

Out[7]:

	Surname/title	First/Middle
0	Braund, Mr	Owen Harris
1	Cumings, Mrs	John Bradley (Florence Briggs Thayer)
2	Heikkinen, Miss	Laina
3	Futrelle, Mrs	Jacques Heath (Lily May Peel)
4	Allen, Mr	William Henry
5	Moran, Mr	James
6	McCarthy, Mr	Timothy J
7	Palsson, Master	Gosta Leonard
8	Johnson, Mrs	Oscar W (Elisabeth Vilhelmina Berg)
9	Nasser, Mrs	Nicholas (Adele Achem)
10	Sandstrom, Miss	Marguerite Rut
11	Bonnell, Miss	Elizabeth

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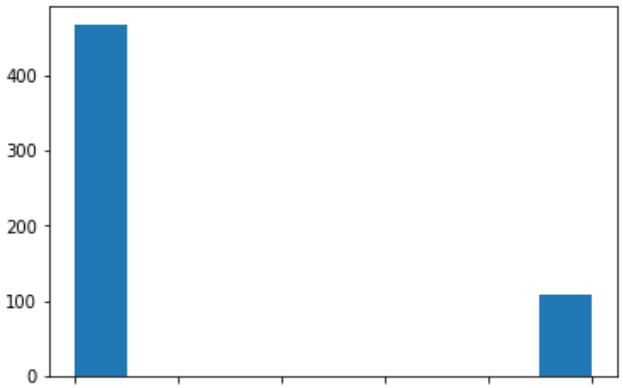
Some broad data visualization

In [10]:
```
ismale = DF["Sex"]=="male"
males = DF[ismale]
females = DF[ismale == False]
```

In [11]:
```
plt.hist(males["Survived"]);
print("Male survival rate: ", (len(males[males["Survived"] == 1])/len(males))*100, "%")
```

```
Male survival rate:  18.890814558058924 %
```



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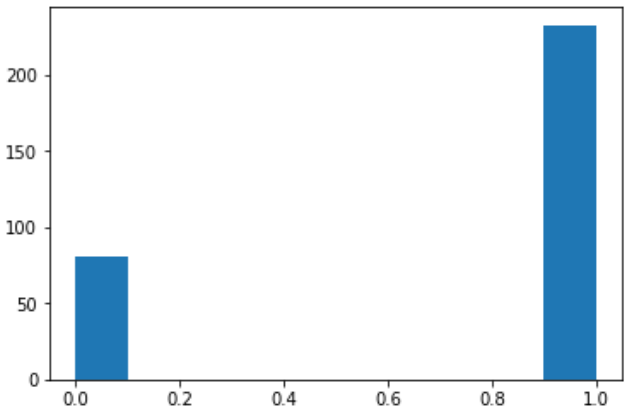
In [12]:
```
plt.hist(females["Survived"]);
print("Female Survival rate: ",len(females[females["Survived"] == 1])/len(DF)*100, "%" )
```

```
Female Survival rate:  26.15039281705948 %
```



In [13]:
```
plt.hist(DF[DF["Title"]=="Master"]["Survived"])
plt.title("Survival of Young Men (< 12yo)")
plt.xlabel("Survived")
plt.ylabel("Frequency")
plt.grid();
```

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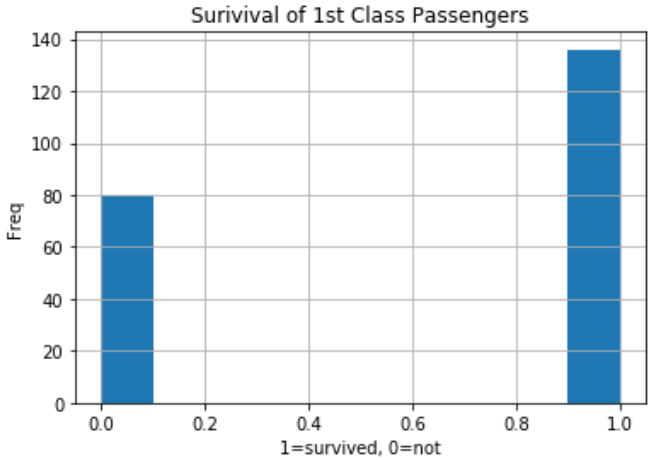

In [22]:
```
plt.hist(secondclass['Survived'])
plt.title("Surivival of 2nd Class Passengers")
plt.xlabel('1=survived, 0=not')
plt.ylabel('Freq')
plt.grid();
```

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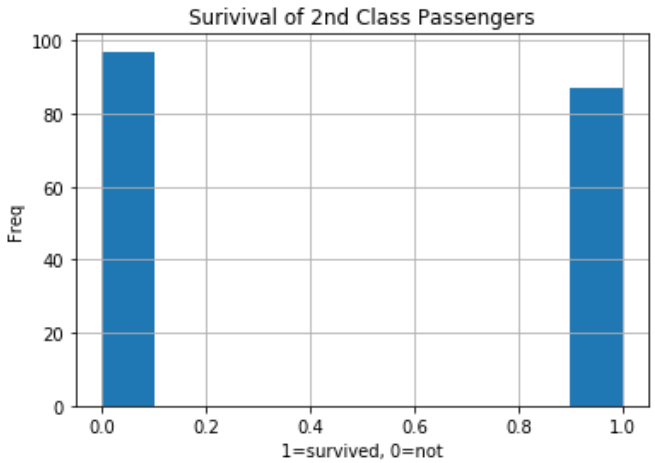

In [23]:
```
plt.hist(thirdclass['Survived'])
plt.title("Surivival of 3rd Class Passengers")
plt.xlabel('1=survived, 0=not')
plt.ylabel('Freq')
plt.grid();
```

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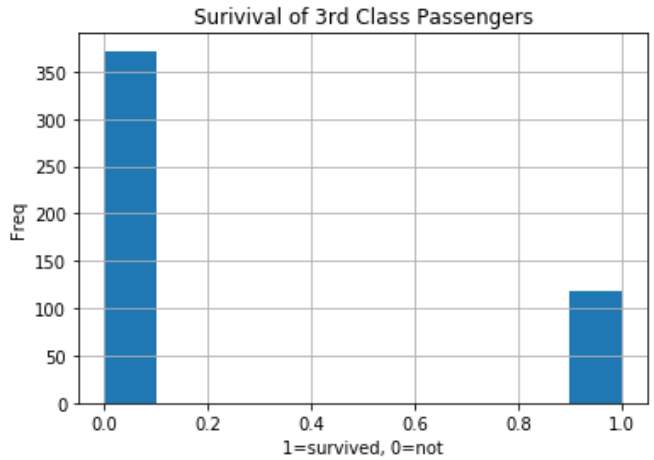

In [24]:
```
for x in np.unique(DF["Title"]):
    tokenDF = pd.DataFrame(DF[DF["Title"]==x])
    averageage = np.mean(tokenDF["Age"])
    empties = tokenDF[tokenDF["Age"].isnull()]
    DF[(DF["Title"]==x) & (DF["Age"].isnull())] = DF[(DF["Title"]==x) & (DF["Age"].isnull())].fillna(value = averageage)
```

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Training the model

In [25]:
```
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score,confusion_matrix
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis
import warnings
warnings.filterwarnings("error")
```

In [26]:
```
errs=[]
nsplits=100
skipped=0
X = pd.DataFrame([DF["Sex"], DF["Age"], DF["Pclass"]]).T

# Casting categorical data to numerical categories
X['Sex']= X['Sex'].astype('category')
X['Sex'] = X['Sex'].cat.codes


Y= np.array(DF["Survived"])
for j in range(nsplits):
  try:
    XTRAIN, XTEST, YTRAIN, YTEST=train_test_split(X,Y, test_size = .2)
    LDA = LinearDiscriminantAnalysis(solver = "lsqr", shrinkage = "auto")
    LDA.fit(XTRAIN,YTRAIN)
    YP=LDA.predict(XTEST)
    errs.append(1-accuracy_score(YTEST,YP))
  except UserWarning:
    skipped+=1
```

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```
print("LDA mean error=%7.5f std=%7.5f" %(np.mean(errs),np.std(errs)))
print(skipped,"train/test splits had to be skipped because of Normalization Errors")
```

```
LDA mean error=0.21318 std=0.03139
0 train/test splits had to be skipped because of Normalization Errors
```

In [27]:
```
X
```

Out[27]:

	Sex	Age	Pclass
0	1	22	3
1	0	38	1
2	0	26	3
3	0	35	1
4	1	35	3
5	1	32.3681	3
6	1	54	1
7	1	2	3
8	0	27	3
9	0	14	2
10	0	4	3
11	0	58	1

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Prediction to upload

In [28]:
```
testDF = pd.read_csv("test.csv")
```

Cleaning test data

In [29]:
```
testnames = []
for x in np.array(testDF["Name"]):
    tokens = x.split('. ', maxsplit = 1)
    testnames.append(tokens)
testnamedata = pd.DataFrame(testnames, columns = ["Surname/title", "First/Middle"])

testsurnamesandtitles = pd.DataFrame(testnamedata["Surname/title"])
testnames2 = []
for x in np.array(testsurnamesandtitles["Surname/title"]):
    tokens = x.split(', ', maxsplit = 1)
    testnames2.append(tokens)
testnames2 = pd.DataFrame(testnames2, columns = ["Surname", "Title"])
np.unique(testnames2["Title"])
testDF = pd.concat([testDF, testnames2], axis = 1)
```

In [30]:
```
testDF
```

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Out[30]:

	PassengerId	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cabin	Embarked	Surname	Title
0	892	3	Kelly, Mr. James	male	34.5	0	0	330911	7.8292	NaN	Q	Kelly	Mr
1	893	3	Wilkes, Mrs. James (Ellen Needs)	female	47.0	1	0	363272	7.0000	NaN	S	Wilkes	Mrs
2	894	2	Myles, Mr. Thomas Francis	male	62.0	0	0	240276	9.6875	NaN	Q	Myles	Mr
3	895	3	Wirz, Mr. Albert	male	27.0	0	0	315154	8.6625	NaN	S	Wirz	Mr
4	896	3	Hirvonen, Mrs. Alexander (Helga E Lindqvist)	female	22.0	1	1	3101298	12.2875	NaN	S	Hirvonen	Mrs
5	897	3	Svensson, Mr. Johan Cervin	male	14.0	0	0	7538	9.2250	NaN	S	Svensson	Mr
6	898	3	Connolly, Miss. Kate	female	30.0	0	0	330972	7.6292	NaN	Q	Connolly	Miss
7	899	2	Caldwell, Mr. Albert Francis	male	26.0	1	1	248738	29.0000	NaN	S	Caldwell	Mr
8	900	3	Abrahim, Mrs. Joseph (Sophie Halaut Easu)	female	18.0	0	0	2657	7.2292	NaN	C	Abrahim	Mrs
9	901	3	Davies, Mr. John Samuel	male	21.0	2	0	A/4 48871	24.1500	NaN	S	Davies	Mr

In [31]:
```
for x in np.unique(testDF["Title"]):
    tokenDF = pd.DataFrame(testDF[testDF["Title"]==x])
    averageage = np.mean(tokenDF["Age"])
    empties = tokenDF[tokenDF["Age"].isnull()]
    testDF[(testDF["Title"]==x) & (testDF["Age"].isnull())] = testDF[(testDF["Title"]==x) & (testDF["Age"].isnull())].fillna(val
```

In [32]:
```
testDF[(testDF["Title"]=="Ms") & (testDF["Age"].isnull())] = testDF[(testDF["Title"]=="Ms") & (testDF["Age"].isnull())].fillna(v
testDF
```

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Out[32]:

	PassengerId	Pclass	Name	Sex	Age	SibSp	Parch	Ticket	Fare	Cabin	Embarked	Surname	Title
0	892	3	Kelly, Mr. James	male	34.500000	0	0	330911	7.8292	NaN	Q	Kelly	Mr
1	893	3	Wilkes, Mrs. James (Ellen Needs)	female	47.000000	1	0	363272	7.0000	NaN	S	Wilkes	Mrs
2	894	2	Myles, Mr. Thomas Francis	male	62.000000	0	0	240276	9.6875	NaN	Q	Myles	Mr
3	895	3	Wirz, Mr. Albert	male	27.000000	0	0	315154	8.6625	NaN	S	Wirz	Mr
4	896	3	Hirvonen, Mrs. Alexander (Helga E Lindqvist)	female	22.000000	1	1	3101298	12.2875	NaN	S	Hirvonen	Mrs
5	897	3	Svensson, Mr. Johan Cervin	male	14.000000	0	0	7538	9.2250	NaN	S	Svensson	Mr
6	898	3	Connolly, Miss. Kate	female	30.000000	0	0	330972	7.6292	NaN	Q	Connolly	Miss
7	899	2	Caldwell, Mr. Albert Francis	male	26.000000	1	1	248738	29.0000	NaN	S	Caldwell	Mr
8	900	3	Abrahim, Mrs. Joseph (Sophie Halaut Easu)	female	18.000000	0	0	2657	7.2292	NaN	C	Abrahim	Mrs

In [33]:
```
XT = pd.DataFrame([testDF["Sex"], testDF["Age"], testDF["Pclass"]]).T
XT['Sex']= XT['Sex'].astype('category')
XT['Sex'] = XT['Sex'].cat.codes

XT
```

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Out[33]:

	Sex	Age	Pclass
0	1	34.5	3
1	0	47	3
2	1	62	2
3	1	27	3
4	0	22	3
5	1	14	3
6	0	30	3
7	1	26	2
8	0	18	3
9	1	21	3
10	1	32	3
11	1	46	1

Prediction

In [34]:
```
YT = LDA.predict(XT)
```

In [35]:
```
pass_id = testDF["PassengerId"]
output = pd.DataFrame({"PassengerId":np.array(pass_id),
                       "Survived": YT})
output.to_csv("result.csv", sep =",",index = False)
```

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In [36]:
```
output
```

Out[36]:

	PassengerId	Survived
0	892	0
1	893	0
2	894	0
3	895	0
4	896	1
5	897	0
6	898	1
7	899	0
8	900	1
9	901	0
10	902	0
11	903	0

In [ ]:

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```
In [36]: output
```

Out[36]:

	PassengerId	Survived
0	892	0
1	893	0
2	894	0
3	895	0
4	896	1
5	897	0
6	898	1
7	899	0
8	900	1
9	901	0
10	902	0
11	903	0

```
In [ ]:
```

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Submission and Description	Public Score	Use for Final Score
result.csv 20 hours ago by Bungles Linear Determinants: Sex, Pclass, Age(normalized)	0.78947	☐

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