In [108]:

```
import numpy as np
import pandas as pd
from keras.models import Sequential
from keras.layers import Dense
from sklearn.model_selection import train_test_split, cross_val_score, KFold
from sklearn.metrics import plot_confusion_matrix, confusion_matrix, accuracy_score
from keras.utils import np_utils
from sklearn.preprocessing import LabelEncoder,StandardScaler
from sklearn.tree import DecisionTreeClassifier
from sklearn.linear_model import LogisticRegressionCV
import seaborn as sns
from scipy import stats
from sklearn.svm import SVC
from sklearn.naive_bayes import GaussianNB
```

In [28]:

```
df = pd.read_csv('lab4.csv')
df.drop(['ID', 'Unnamed: 0'], axis='columns', inplace=True)
df_new = df.copy()
df.shape
```

Out[28]:

```
(10868, 259)
```

In [29]:

```
z = np.abs(stats.zscore(df))
df = df_new[(z < 3).all(axis=1)]
df.shape
```

Out[29]:

```
(8061, 259)
```

In [30]:

```
y = df['Class']
y.shape
```

Out[30]:

```
(8061,)
```

In [31]:

```
# encode class values as integers
encoder = LabelEncoder()
encoder.fit(y)
encoded_Y = encoder.transform(y)
# convert integers to dummy variables (i.e. one hot encoded)
y = np_utils.to_categorical(encoded_Y)
y
```

Out[31]:

```
array([[1., 0., 0., ..., 0., 0., 0.],
       [0., 0., 0., ..., 0., 1., 0.],
       [0., 0., 0., ..., 0., 0., 0.],
       ...,
       [0., 0., 0., ..., 0., 0., 0.],
       [0., 0., 0., ..., 0., 0., 0.],
       [0., 0., 0., ..., 0., 0., 0.]], dtype=float32)
```

In [32]:

```
X = df.drop(['Class'], axis='columns')
Y = df['Class']
X.head()
```

Out[32]:

	0	1	2	3	4	5	6	7	8	9	...	f8	f9	fa	f
3	21091	1213	726	817	1257	625	550	523	1078	473	...	873	485	462	5
4	19764	710	302	433	559	410	262	249	422	223	...	947	350	209	23
5	85090	414	340	331	350	324	303	299	327	364	...	305	295	333	34
8	33141	430	311	410	411	330	385	863	345	378	...	333	312	272	27
11	12369	2317	2111	2210	2087	2120	2106	2186	2424	1971	...	2001	2056	1977	208

5 rows × 258 columns

In [33]:

```
scaler = StandardScaler().fit(X)
X = scaler.transform(X)
```

In [34]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.20, random
_state=42, stratify=y)
```

Applying Keras Model

In [35]:

```
# define the keras model
model = Sequential()
model.add(Dense(350, input_dim=258, activation='relu'))
model.add(Dense(250, activation='relu'))
model.add(Dense(150, activation='relu'))
model.add(Dense(100, activation='relu'))
model.add(Dense(9, activation='softmax'))
```

In [36]:

```
# compile the keras model
model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])
```

In [37]:

```
# fit the keras model on the dataset
model.fit(X_train, y_train, epochs=150, batch_size=250, verbose=0, validation_split=0.2)
```

Out[37]:

```
<tensorflow.python.keras.callbacks.History at 0x7f97aebcd350>
```

In [38]:

```
# evaluate the keras model on train set
_, accuracy = model.evaluate(X_train, y_train)
print('Accuracy: %.2f' % (accuracy*100))
```

```
202/202 [==============================] - 0s 1ms/step - loss: 0.039
1 - accuracy: 0.9941
Accuracy: 99.41
```

In [95]:

```
# evaluate the keras model on test set
_, accuracy_keras = model.evaluate(X_test, y_test)
print('Accuracy: %.2f' % (accuracy_keras*100))
```

```
51/51 [==============================] - 0s 2ms/step - loss: 0.2001
- accuracy: 0.9783
Accuracy: 97.83
```

In [40]:

```
predictions = model.predict_classes(X)
```

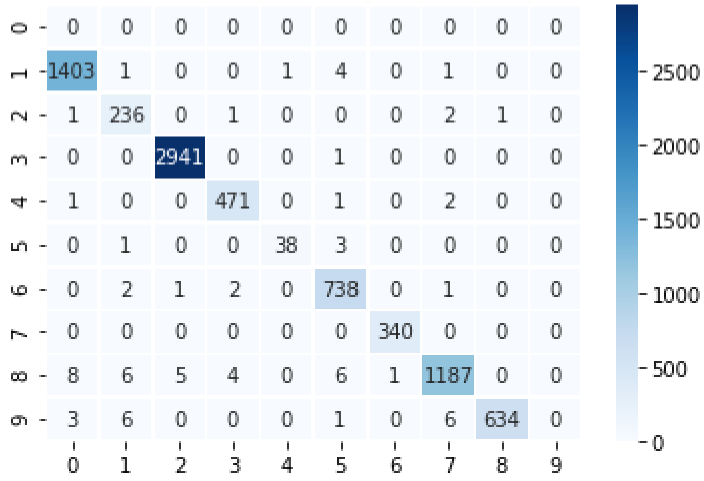
Confusion Matrix

In [113]:

```
cm = confusion_matrix(y_true=Y, y_pred=predictions)
sns.heatmap(cm, annot=True, fmt="d", linewidths=.5, cmap='Blues')
```

Out[113]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f979c1c4590>
```



	0	1	2	3	4	5	6	7	8	9
0	0	0	0	0	0	0	0	0	0	0
1	1403	1	0	0	1	4	0	1	0	0
2	1	236	0	1	0	0	0	2	1	0
3	0	0	2941	0	0	1	0	0	0	0
4	1	0	0	471	0	1	0	2	0	0
5	0	1	0	0	38	3	0	0	0	0
6	0	2	1	2	0	738	0	1	0	0
7	0	0	0	0	0	0	340	0	0	0
8	8	6	5	4	0	6	1	1187	0	0
9	3	6	0	0	0	1	0	6	634	0

In [42]:

```
pred = model.predict(X_test)
pred.argmax(axis=-1)
```

Out[42]:

```
array([2, 7, 5, ..., 3, 2, 2])
```

Decision Tree Classifier

In [43]:

```
X_train_dt, X_test_dt, y_train_dt, y_test_dt = train_test_split(X, Y, test_size=
0.20, random_state=42, stratify=Y)
```

In [44]:

```
dtree_model = DecisionTreeClassifier(max_depth=15).fit(X_train_dt, y_train_dt)
```

In [45]:

```
dtree_model.score(X_train_dt,y_train_dt)
```

Out[45]:

```
0.9984491315136477
```

In [46]:

```
dtree_predictions = dtree_model.predict(X_test_dt)
dtree_predictions
```

Out[46]:

```
array([1, 9, 1, ..., 9, 3, 4])
```

In [96]:

```
accuracy_DecisionTree = dtree_model.score(X_test_dt,y_test_dt)
accuracy_DecisionTree
```

Out[96]:

```
0.9454432734035958
```

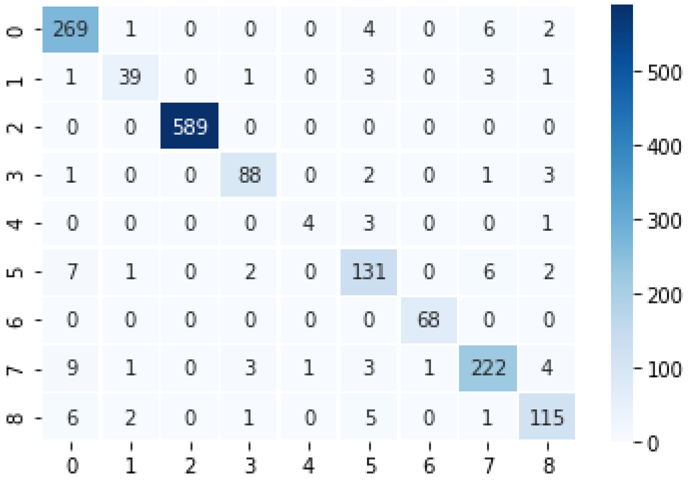
Confusion Matrix

In [112]:

```
cm = confusion_matrix(y_test_dt, dtree_predictions)
sns.heatmap(cm, annot=True, fmt="d", linewidths=.5, cmap='Blues')
```

Out[112]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f9794d75fd0>
```



	0	1	2	3	4	5	6	7	8
0	269	1	0	0	0	4	0	6	2
1	1	39	0	1	0	3	0	3	1
2	0	0	589	0	0	0	0	0	0
3	1	0	0	88	0	2	0	1	3
4	0	0	0	0	4	3	0	0	1
5	7	1	0	2	0	131	0	6	2
6	0	0	0	0	0	0	68	0	0
7	9	1	0	3	1	3	1	222	4
8	6	2	0	1	0	5	0	1	115

In [ ]:

```

```

SVM (Support vector machine) classifier –

In [49]:

```
X_train_svm, X_test_svm, y_train_svm, y_test_svm = train_test_split(X, Y, test_s
ize=0.20, random_state=42, stratify=Y)
```

In [71]:

```
# training a linear SVM classifier
svm_model_linear = SVC(kernel = 'linear', C = 1).fit(X_train_svm, y_train_svm)
```

In [72]:

```
# model accuracy for X_test
train_accuracy = svm_model_linear.score(X_train_svm, y_train_svm)
train_accuracy
```

Out[72]:

```
0.9928660049627791
```

In [73]:

```
svm_predictions = svm_model_linear.predict(X_test_svm)
svm_predictions
```

Out[73]:

```
array([1, 9, 1, ..., 6, 3, 4])
```

In [97]:

```
# model accuracy for X_test
accuracy_svc = svm_model_linear.score(X_test_svm, y_test_svm)
accuracy_svc
```

Out[97]:

```
0.9646621202727836
```

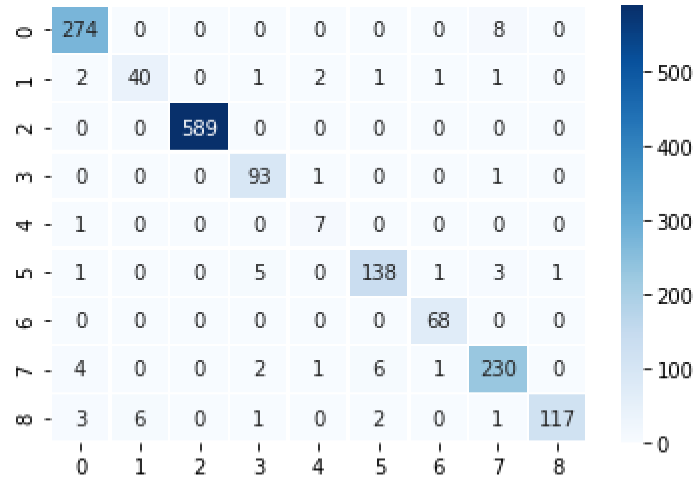
Confusion Matrix

In [111]:

```
# creating a confusion matrix
cm = confusion_matrix(y_test_svm, svm_predictions)
sns.heatmap(cm, annot=True, fmt="d", linewidths=.5, cmap='Blues')
```

Out[111]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f9794274810>
```



Naive Bayes classifier –

In [82]:

```
X_train_gnb, X_test_gnb, y_train_gnb, y_test_gnb = train_test_split(X, Y, test_s
ize=0.20, random_state=42, stratify=Y)
```

In [83]:

```
# training a Naive Bayes classifier
gnb = GaussianNB().fit(X_train_gnb, y_train_gnb)
```

In [86]:

```
# accuracy on Train
train_accuracy = gnb.score(X_train_gnb, y_train_gnb)
train_accuracy
```

Out[86]:

```
0.7194478908188585
```

In [87]:

```
gnb_predictions = gnb.predict(X_test)
```

In [98]:

```
# accuracy on X_test
accuracy_gnb = gnb.score(X_test_gnb, y_test_gnb)
accuracy_gnb
```

Out[98]:

```
0.7253564786112833
```

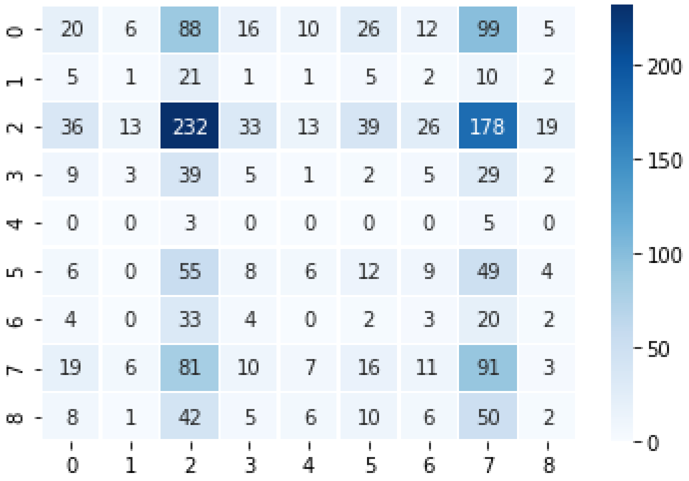
Confusion Matrix

In [110]:

```
# creating a confusion matrix
cm = confusion_matrix(y_test_gnb, gnb_predictions)
sns.heatmap(cm, annot=True, fmt="d", linewidths=.5, cmap='Blues')
```

Out[110]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f97a4ca7a10>
```



In [ ]:

```
```

Result

In [114]:

```
result = np.array([['KerasClassifier: Accuracy-', round(accuracy_keras,2)],
                   ['DecisionTreeClassifier: Accuracy-', round(accuracy_Decision
Tree,2)],
                   ['SVC Classifier: Accuracy-', round(accuracy_svc,2)],
                   ['GaussianNBClassifier: Accuracy-', round(accuracy_gnb,2)],
                  ])
print(result)
```

```
[['KerasClassifier: Accuracy-' '0.98']
 ['DecisionTreeClassifier: Accuracy-' '0.95']
 ['SVC Classifier: Accuracy-' '0.96']
 ['GaussianNBClassifier: Accuracy-' '0.73']]
```

In [ ]: