Tensorflow Project

Let's take a look at the effectiveness of Neural Nets.

We'll use the Bank Authentication Data Set from the UCI repository.

The data consists of 5 columns:

- variance of Wavelet Transformed image (continuous)
- skewness of Wavelet Transformed image (continuous)
- curtosis of Wavelet Transformed image (continuous)
- entropy of image (continuous)
- class (integer)

Where class indicates whether or not a Bank Note was authentic.

In [1]:
```
import pandas as pd
```

In [21]:
```
data = pd.read_csv('bank_note_data.csv')
data.head()
```

Out[21]:

	Image.Var	Image.Skew	Image.Curt	Entropy	Class
0	3.62160	8.6661	-2.8073	-0.44699	0
1	4.54590	8.1674	-2.4586	-1.46210	0
2	3.86600	-2.6383	1.9242	0.10645	0
3	3.45660	9.5228	-4.0112	-3.59440	0
4	0.32924	-4.4552	4.5718	-0.98880	0

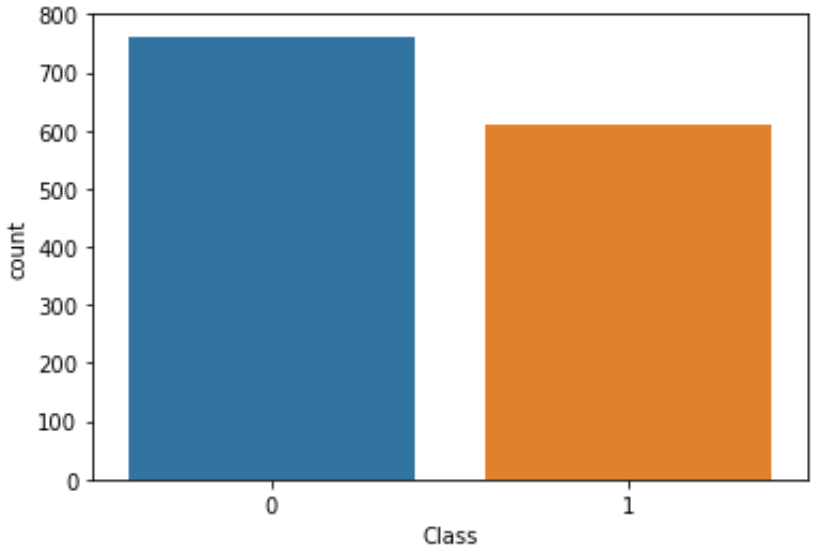
Exploratory Data Analysis

In [35]:
```
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
```

Create a Countplot of the Classes (Authentic 1 vs Fake 0)

In [36]:
```
1 sns.countplot(x = 'Class', data = data)
```

Out[36]: <matplotlib.axes._subplots.AxesSubplot at 0x1a25d57588>

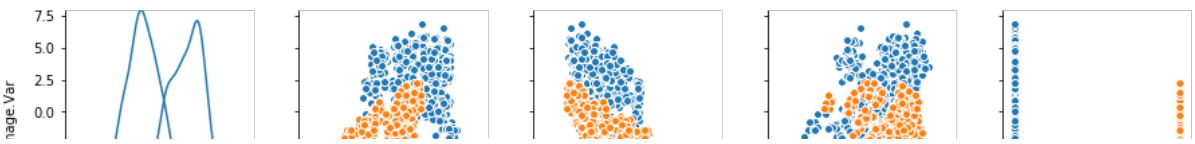


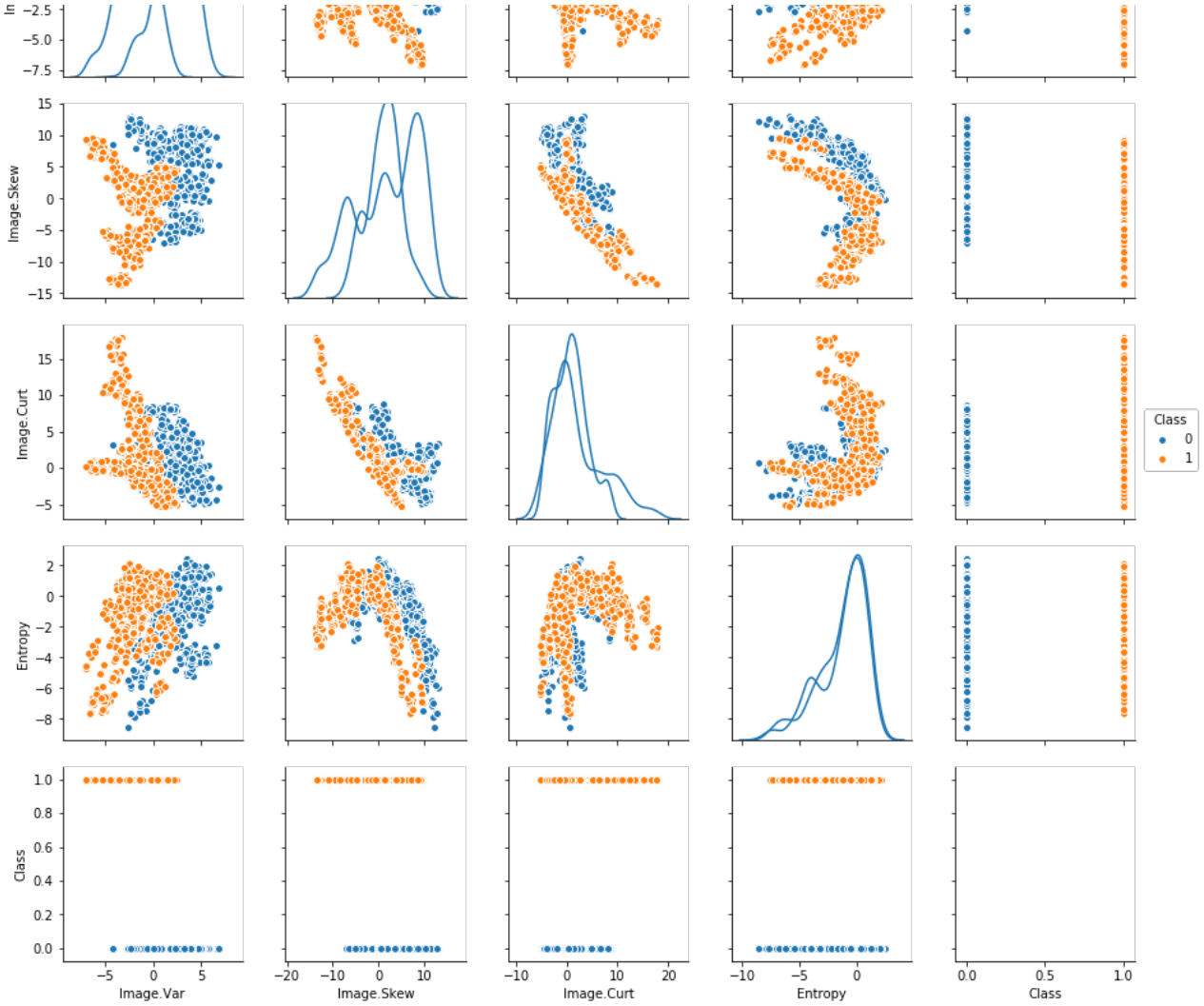
Create a PairPlot of the Data with Seaborn, set Hue to Class

In [37]:
```
1 sns.pairplot(data = data, hue ="Class", diag_kind="kde")
```

```
/Users/Jayashri/anaconda/lib/python3.6/site-packages/scipy/stats/stats
.py:1713: FutureWarning: Using a non-tuple sequence for multidimension
al indexing is deprecated; use `arr[tuple(seq)]` instead of `arr[seq]`
. In the future this will be interpreted as an array index, `arr[np.ar
ray(seq)]`, which will result either in an error or a different result
.
  return np.add.reduce(sorted[indexer] * weights, axis=axis) / sumval
/Users/Jayashri/anaconda/lib/python3.6/site-packages/statsmodels/nonpa
rametric/kde.py:494: RuntimeWarning: invalid value encountered in true
_divide
  binned = fast_linbin(X,a,b,gridsize)/(delta*nobs)
/Users/Jayashri/anaconda/lib/python3.6/site-packages/statsmodels/nonpa
rametric/kdetools.py:34: RuntimeWarning: invalid value encountered in
double_scalars
  FAC1 = 2*(np.pi*bw/RANGE)**2
/Users/Jayashri/anaconda/lib/python3.6/site-packages/numpy/core/fromnu
meric.py:83: RuntimeWarning: invalid value encountered in reduce
  return ufunc.reduce(obj, axis, dtype, out, **passkwargs)
```

Out[37]: <seaborn.axisgrid.PairGrid at 0x1a27909160>





Data Preparation

When using Neural Network and Deep Learning based systems, it is a good practice to Standardize the data.

Standard Scaling

In [38]:
```
from sklearn.preprocessing import StandardScaler
```

Create a StandardScaler() object called scaler.

In [39]:
```
scaler = StandardScaler()
```

Fit scaler to the features.

In [40]:
```
scaler.fit(X=data.drop("Class", axis = 1))
```

Out[40]:
```
StandardScaler(copy=True, with_mean=True, with_std=True)
```

Use the .transform() method to transform the features to a scaled version.

In [43]:
```
scaled_features = scaler.transform(X=data.drop("Class",
                                               axis = 1))
scaled_features
```

Out[43]:
```
array([[ 1.12180565,  1.14945512, -0.97597007,  0.35456135],
       [ 1.44706568,  1.06445293, -0.89503626, -0.12876744],
       [ 1.20780971, -0.77735215,  0.12221838,  0.61807317],
       ...,
       [-1.47235682, -2.62164576,  3.75901744, -0.75488418],
       [-1.40669251, -1.75647104,  2.552043  , -0.04315848],
       [-1.04712236, -0.43982168,  0.29861555,  1.1364645 ]])
```

Convert the scaled features to a dataframe and check the head of this dataframe to make sure the scaling worked.

In [51]:
```
df_feat = pd.DataFrame(data = scaled_features,
                       columns = data.columns[:-1])
df_feat.head()
```

Out[51]:

	Image.Var	Image.Skew	Image.Curt	Entropy
0	1.121806	1.149455	-0.975970	0.354561
1	1.447066	1.064453	-0.895036	-0.128767
2	1.207810	-0.777352	0.122218	0.618073
3	1.063742	1.295478	-1.255397	-1.144029
4	-0.036772	-1.087038	0.736730	0.096587

Train Test Split

Create two objects X and y which are the scaled feature values and labels respectively.

In [56]:
```
X = df_feat
y = data["Class"]
```

Use SciKit Learn to create training and testing sets of the data, using test_size = 30%

In [57]:
```
from sklearn.model_selection import train_test_split
```

In [58]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y,
                                                    test_size=0.3)
```

Tensorflow

Create a list of feature column objects using tf.feature.numeric_column()

In [61]:
```
import tensorflow as tf
X.columns
```

Out[61]:
```
Index(['Image.Var', 'Image.Skew', 'Image.Curt', 'Entropy'], dtype='obj
ect')
```

In [70]:
```
df_feat.columns
```

Out[70]:
```
Index(['Image.Var', 'Image.Skew', 'Image.Curt', 'Entropy'], dtype='obj
ect')
```

In [71]:
```
image_var = tf.feature_column.numeric_column("Image.Var")
image_skew = tf.feature_column.numeric_column("Image.Skew")
image_curt = tf.feature_column.numeric_column("Image.Curt")
entropy = tf.feature_column.numeric_column("Entropy")
```

In [73]:
```
feat_cols=[image_var, image_skew, image_curt, entropy]
```

Create an object called classifier which is a DNNClassifier from learn. Set it to have 2 classes and a [10,20,10] hidden unit layer structure:

In [74]:
```
classifier = tf.estimator.DNNClassifier(hidden_units = [10,20,10],
                                        n_classes= 2,
                                        feature_columns = feat_cols)
```

```
INFO:tensorflow:Using default config.
WARNING:tensorflow:Using temporary folder as model directory: /var/fol
ders/lw/sc_sdzmj67jcw7r58sdqrt2r0000gq/T/tmpkq1_q9ob
INFO:tensorflow:Using config: {'_model_dir': '/var/folders/lw/sc_sdzmj
67jcw7r58sdqrt2r0000gq/T/tmpkq1_q9ob', '_tf_random_seed': None, '_save
_summary_steps': 100, '_save_checkpoints_steps': None, '_save_checkpoi
nts_secs': 600, '_session_config': None, '_keep_checkpoint_max': 5, '_
keep_checkpoint_every_n_hours': 10000, '_log_step_count_steps': 100, '
_train_distribute': None, '_device_fn': None, '_service': None, '_clus
ter_spec': <tensorflow.python.training.server_lib.ClusterSpec object a
t 0x1a3f7d7fd0>, '_task_type': 'worker', '_task_id': 0, '_global_id_in
_cluster': 0, '_master': '', '_evaluation_master': '', '_is_chief': Tr
ue, '_num_ps_replicas': 0, '_num_worker_replicas': 1}
```

```
** Now create a tf.estimator.pandas_input_fn that takes in
X_train, y_train, batch_size and set shuffle=True. Set batch_size
parameter to 20. **
```

In [75]:
```
input_func = tf.estimator.inputs.pandas_input_fn(x = X_train,
                                                 y = y_train,
                                                 batch_size = 20,
                                                 shuffle = True)
```

Now train classifier to the input function. Use steps=500.

In [76]:
```
classifier.train(input_fn=input_func,steps = 500)
```

```
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Create CheckpointSaverHook.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
INFO:tensorflow:Saving checkpoints for 0 into /var/folders/lw/sc_sdzmj
67jcw7r58sdqrt2r0000gq/T/tmpkq1_q9ob/model.ckpt.
INFO:tensorflow:loss = 14.076602, step = 1
INFO:tensorflow:Saving checkpoints for 48 into /var/folders/lw/sc_sdzm
j67jcw7r58sdqrt2r0000gq/T/tmpkq1_q9ob/model.ckpt.
INFO:tensorflow:Loss for final step: 0.38162005.
```

Out[76]:
```
<tensorflow.python.estimator.canned.dnn.DNNClassifier at 0x1a3f7d71d0>
```

Model Evaluation

Create another pandas_input_fn that takes in the X_test data for x. This one won't need any y_test info since we will be using this for the network to create its own predictions. Set shuffle=False since we don't need to shuffle for predictions.

In [77]:
```
pred_fn = tf.estimator.inputs.pandas_input_fn(x=X_test,
                                              batch_size = len(X_test),
                                              shuffle = False)
```

Use the predict method from the classifier model to create predictions from X_test

In [78]:
```
predictions = list(classifier.predict(input_fn = pred_fn))
```

```
INFO:tensorflow:Calling model_fn.
INFO:tensorflow:Done calling model_fn.
INFO:tensorflow:Graph was finalized.
INFO:tensorflow:Restoring parameters from /var/folders/lw/sc_sdzmj67jc
w7r58sdqrt2r0000gq/T/tmpkq1_q9ob/model.ckpt-48
INFO:tensorflow:Running local_init_op.
INFO:tensorflow:Done running local_init_op.
```

In [79]:
```
#Let us look at predictions
predictions
```

Out[79]:
```
[{'class_ids': array([1]),
  'classes': array([b'1'], dtype=object),
  'logistic': array([0.9935614], dtype=float32),
  'logits': array([5.038985], dtype=float32),
  'probabilities': array([0.0064386, 0.9935614], dtype=float32)},
 {'class_ids': array([1]),
  'classes': array([b'1'], dtype=object),
  'logistic': array([0.997971], dtype=float32),
  'logits': array([6.198182], dtype=float32),
  'probabilities': array([0.002029, 0.997971], dtype=float32)},
 {'class_ids': array([0]),
  'classes': array([b'0'], dtype=object),
  'logistic': array([0.00843123], dtype=float32),
  'logits': array([-4.7673454], dtype=float32),
  'probabilities': array([0.99156874, 0.00843123], dtype=float32)},
 {'class_ids': array([0]),
  'classes': array([b'0'], dtype=object),
  'logistic': array([0.00111933], dtype=float32),
  'logits': array([-6.793903], dtype=float32),
```

It is a dictionay with key 'class_ids' and we want to get the first value i.e. array[1] or array[0]

array[0]

In [82]:
```
final_preds = []
for pred in predictions:
    final_preds.append(pred['class_ids'][0])

```

Now create a classification report and a Confusion Matrix.

In [83]:
```
from sklearn.metrics import classification_report, confusion_matrix
```

In [84]:
```
print(confusion_matrix(y_test, final_preds))
```

```
[[224   7]
 [  0 181]]
```

In [85]:
```
print(classification_report(y_test, final_preds))
```

```
             precision    recall  f1-score   support

          0       1.00      0.97      0.98       231
          1       0.96      1.00      0.98       181

avg / total       0.98      0.98      0.98       412
```

Comparison with Random Forest Classifier

The results from the DNN model seem to be accurate. Let's compare this to a Random Forest Classifier for a reality check!

Use SciKit Learn to Create a Random Forest Classifier and compare the confusion matrix and classification report to the DNN model

In [86]:
```
from sklearn.ensemble import RandomForestClassifier
```

In [94]:
```
rfc = RandomForestClassifier(n_estimators=200)
rfc
```

Out[94]:
```
RandomForestClassifier(bootstrap=True, class_weight=None, criterion='g
ini',
            max_depth=None, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=200, n_jobs=1,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False)
```

In [95]:
```
rfc.fit(X_train, y_train)
```

Out[95]:
```
RandomForestClassifier(bootstrap=True, class_weight=None, criterion='g
ini',
            max_depth=None, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=200, n_jobs=1,
            oob_score=False, random_state=None, verbose=0,
            warm_start=False)
```

In [96]:
```
rfc_pred = rfc.predict(X_test)
```

In [97]:
```
print(classification_report(y_test, rfc_pred))
```

```
             precision    recall  f1-score   support

          0       1.00      0.99      0.99       231
          1       0.99      0.99      0.99       181

avg / total       0.99      0.99      0.99       412
```

In [98]:
```
print(confusion_matrix(y_test, rfc_pred))
```

```
[[229   2]
 [  1 180]]
```

It looks like Random Forest Classifier does a very good job too and it is comparable to Deep Neural Networks.

In [ ]:
```

```