In [1]:
```
#meta 1/25/2021 Poker Example 1
#src https://medium.com/@virgoady7/poker-hand-prediction-7a801e254acd
#Claim: Keras nn models predicts much higher than LogR, CART or SVM

#history
#1/25/202 ORIGINAL EXAMPLE + MY CODE DELTA
#       Original code errored out in Keras NN section: problem is with your lab
el-data shape
#       Fixed with $mycodedelta

#here 1/25/202 MANAGE DATA DOWNLOAD
#       Check if data already exists and downloaded if it doesn't
```

In [2]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import os
from os import path
import warnings
warnings.filterwarnings('ignore')

#modeling
from sklearn.linear_model import LogisticRegression
from sklearn.tree import DecisionTreeClassifier
from sklearn import svm
from sklearn.metrics import accuracy_score
from sklearn.metrics import confusion_matrix

#from joblib import load, dump
```

Poker Example with Keras

0. Load Data

In [3]:
```
#$mycodedelta #was
#!wget http://archive.ics.uci.edu/ml/machine-learning-databases/poker/poker-ha
nd-testing.data
#!wget http://archive.ics.uci.edu/ml/machine-learning-databases/poker/poker-ha
nd-training-true.data
#!wget http://archive.ics.uci.edu/ml/machine-learning-databases/poker/poker-ha
nd.names
```

In [4]:
```
#$mycodedelta
#check if data already downloaded
if path.exists('data/poker-hand.names'):
    print('Poker data already exists')
else:
    !wget http://archive.ics.uci.edu/ml/machine-learning-databases/poker/poker
-hand-testing.data -O 'data/poker-hand-testing.data'
    !wget http://archive.ics.uci.edu/ml/machine-learning-databases/poker/poker
-hand-training-true.data -O 'data/poker-hand-training-true.data'
    !wget http://archive.ics.uci.edu/ml/machine-learning-databases/poker/poker
-hand.names -O 'data/poker-hand.names'
```

```
Poker data already exists
```

1. Prep Data

note: When switch between train and test. SVM runs way longer. NN results are slightly better.
In reality need `train` , `valid` and `test` datsets.

In [5]:
```
data_train=pd.read_csv("data/poker-hand-training-true.data",header=None)
data_test = pd.read_csv("data/poker-hand-testing.data",header=None)
#data_test=pd.read_csv("data/poker-hand-training-true.data",header=None)
#data_train = pd.read_csv("data/poker-hand-testing.data",header=None)
col=['Suit of card #1','Rank of card #1','Suit of card #2','Rank of card #2',
'Suit of card #3','Rank of card #3','Suit of card #4','Rank of card #4','Suit
 of card #5','Rank of card 5','Poker Hand']
col
```

Out[5]:
```
['Suit of card #1',
 'Rank of card #1',
 'Suit of card #2',
 'Rank of card #2',
 'Suit of card #3',
 'Rank of card #3',
 'Suit of card #4',
 'Rank of card #4',
 'Suit of card #5',
 'Rank of card 5',
 'Poker Hand']
```

In [6]:
```
data_train.columns=col
data_test.columns=col
```

In [7]:
```
y_train=data_train['Poker Hand']
y_test=data_test['Poker Hand']
y_train=pd.get_dummies(y_train)
y_test=pd.get_dummies(y_test)
```

In [8]:
```
x_train=data_train.drop('Poker Hand',axis=1)
x_test=data_test.drop('Poker Hand',axis=1)
```

In [9]:
```
print('Shape of Training Set:',x_train.shape)
print('Shape of Testing Set:',x_test.shape)
```

```
Shape of Training Set: (25010, 10)
Shape of Testing Set: (1000000, 10)
```

In [10]:
```
x_train.head()
```

Out[10]:

	Suit of card #1	Rank of card #1	Suit of card #2	Rank of card #2	Suit of card #3	Rank of card #3	Suit of card #4	Rank of card #4	Suit of card #5	Rank of card 5
0	1	10	1	11	1	13	1	12	1	1
1	2	11	2	13	2	10	2	12	2	1
2	3	12	3	11	3	13	3	10	3	1
3	4	10	4	11	4	1	4	13	4	12
4	4	1	4	13	4	12	4	11	4	10

In [11]:
```
from sklearn import preprocessing
le = preprocessing.LabelEncoder()
y_train=le.fit_transform(data_train['Poker Hand'])
y_test=le.transform(data_test['Poker Hand'])
```

In [12]:
```
y_train.shape, y_test.shape
```

Out[12]:
```
((25010,), (1000000,))
```

2. Model

Logistic Regression

In [13]:
```
clf = LogisticRegression(random_state=0, solver='lbfgs',max_iter=100,multi_cla
ss='ovr').fit(x_train, y_train)

#predict
y_hat=clf.predict(x_test)
accuracy_score(y_hat,y_test)
```

Out[13]:
```
0.501209
```

In [14]:
```
unique, counts = np.unique(y_hat, return_counts=True)
print (np.asarray((unique, counts)).T)
```

```
[[      0 1000000]]
```

In [15]:
```
cm = confusion_matrix(y_test, y_hat)
print("Confusion matrix:\n{}".format(cm))
```

```
Confusion matrix:
[[501209      0      0      0      0      0      0      0      0      0]
 [422498      0      0      0      0      0      0      0      0      0]
 [ 47622      0      0      0      0      0      0      0      0      0]
 [ 21121      0      0      0      0      0      0      0      0      0]
 [  3885      0      0      0      0      0      0      0      0      0]
 [  1996      0      0      0      0      0      0      0      0      0]
 [  1424      0      0      0      0      0      0      0      0      0]
 [   230      0      0      0      0      0      0      0      0      0]
 [    12      0      0      0      0      0      0      0      0      0]
 [     3      0      0      0      0      0      0      0      0      0]]
```

CART

Classification and Regression Trees or CART for short

In [16]:
```
decision_tree = DecisionTreeClassifier(random_state=0,max_depth = 3) #max_dept
h =2
decision_tree = decision_tree.fit(x_train,y_train)

#predict
y_hat = decision_tree.predict(x_test)
accuracy_score(y_hat,y_test)
```

Out[16]:
```
0.501209
```

In [17]:
```
unique, counts = np.unique(y_hat, return_counts=True)
print (np.asarray((unique, counts)).T)
```

```
[[      0 1000000]]
```

In [18]:
```
cm = confusion_matrix(y_test, y_hat)
print("Confusion matrix:\n{}".format(cm))
```

```
Confusion matrix:
[[501209      0      0      0      0      0      0      0      0      0]
 [422498      0      0      0      0      0      0      0      0      0]
 [ 47622      0      0      0      0      0      0      0      0      0]
 [ 21121      0      0      0      0      0      0      0      0      0]
 [  3885      0      0      0      0      0      0      0      0      0]
 [  1996      0      0      0      0      0      0      0      0      0]
 [  1424      0      0      0      0      0      0      0      0      0]
 [   230      0      0      0      0      0      0      0      0      0]
 [    12      0      0      0      0      0      0      0      0      0]
 [     3      0      0      0      0      0      0      0      0      0]]
```

SVM

We plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate

In [19]:
```
clf = svm.LinearSVC()
clf.fit(x_train,y_train)

#predict
y_hat = clf.predict(x_test)
accuracy_score(y_hat,y_test)
```

Out[19]:
```
0.43198
```

In [20]:
```
unique, counts = np.unique(y_hat, return_counts=True)
print (np.asarray((unique, counts)).T)
```

```
[[     0 703526]
 [     1 169147]
 [     2 127327]]
```

In [21]:
```
cm = confusion_matrix(y_test, y_hat)
print("Confusion matrix:\n{}".format(cm))
```

```
Confusion matrix:
[[355655  90209  55345      0      0      0      0      0      0      0]
 [295348  68529  58621      0      0      0      0      0      0      0]
 [ 32960   6866   7796      0      0      0      0      0      0      0]
 [ 14304   2838   3979      0      0      0      0      0      0      0]
 [  2752    158    975      0      0      0      0      0      0      0]
 [  1408    365    223      0      0      0      0      0      0      0]
 [   935    154    335      0      0      0      0      0      0      0]
 [   155     28     47      0      0      0      0      0      0      0]
 [     8      0      4      0      0      0      0      0      0      0]
 [     1      0      2      0      0      0      0      0      0      0]]
```

Neural Net with Keras

A neural network is a progression of algorithms that attempts to perceive fundamental connections in a lot of information through a procedure that copies the manner in which the human brain works. Neural network can adjust to changing input; so the network produces the most ideal outcome without expecting to redesign the output criteria. To create NN we used Keras library which is a high-level API wrapper for the low-level API, capable of running on top of TensorFlow, CNTK, or Theano. My neural network architecture comprised of 3 dense layers with respectively 15,10 and 10 nodes in each layer.

In [22]:
```
#$mycodedelta
#code below errors out: ValueError: Error when checking target: expected dense
_3 to have shape (10,) but got array with shape (1,)
#src https://stackoverflow.com/questions/49392972/error-when-checking-target-e
xpected-dense-3-to-have-shape-3-but-got-array-wi/55992428
#issue: problem is with label-data shape
#      Keras expects y-data in (N, 10) shape, not (N,)
#      was: y_train.shape, y_test.shape
#      was: ((25010,), (1000000,))
#fix: Recode labels using to_categorical to get the correct shape of inputs
from keras.utils import to_categorical
y_train_nn = to_categorical(y_train)
y_test_nn = to_categorical(y_test)

y_train_nn.shape, y_test_nn.shape
```

```
Using TensorFlow backend.
```

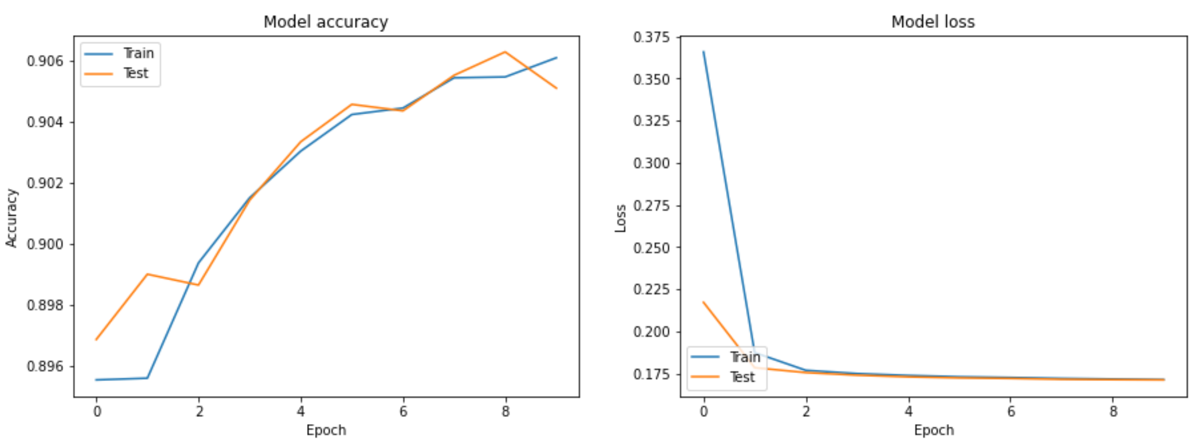
Out[22]:
```
((25010, 10), (1000000, 10))
```

In [35]:
```
import keras
from keras.models import Sequential
from keras.layers import Dense, Dropout, Activation
from keras.optimizers import SGD
from keras import regularizers


model = Sequential()
model.add(Dense(15, activation='relu', input_dim=10))
model.add(Dense(10, activation='relu'))
model.add(Dense(10, activation='softmax'))
model.compile(loss='binary_crossentropy',
              optimizer='adam',
              metrics=['accuracy'])

history = model.fit(x_train, y_train_nn, epochs = 10, batch_size = 256, verbos
e=1,validation_data=(x_test,y_test_nn),shuffle=True) #$mycodedelta


score = model.evaluate(x_test, y_test_nn, batch_size=256) #$mycodedelta
```

```
Train on 25010 samples, validate on 1000000 samples
Epoch 1/10
25010/25010 [==============================] - 4s 140us/step - loss: 0.3658 -
accuracy: 0.8956 - val_loss: 0.2173 - val_accuracy: 0.8969
Epoch 2/10
25010/25010 [==============================] - 3s 132us/step - loss: 0.1875 -
accuracy: 0.8956 - val_loss: 0.1786 - val_accuracy: 0.8990
Epoch 3/10
25010/25010 [==============================] - 3s 131us/step - loss: 0.1770 -
accuracy: 0.8994 - val_loss: 0.1757 - val_accuracy: 0.8987
Epoch 4/10
25010/25010 [==============================] - 3s 132us/step - loss: 0.1751 -
accuracy: 0.9015 - val_loss: 0.1741 - val_accuracy: 0.9014
Epoch 5/10
25010/25010 [==============================] - 3s 132us/step - loss: 0.1740 -
accuracy: 0.9031 - val_loss: 0.1731 - val_accuracy: 0.9034
Epoch 6/10
25010/25010 [==============================] - 3s 133us/step - loss: 0.1732 -
accuracy: 0.9043 - val_loss: 0.1725 - val_accuracy: 0.9046
Epoch 7/10
25010/25010 [==============================] - 3s 133us/step - loss: 0.1727 -
accuracy: 0.9045 - val_loss: 0.1722 - val_accuracy: 0.9044
Epoch 8/10
25010/25010 [==============================] - 3s 133us/step - loss: 0.1722 -
accuracy: 0.9055 - val_loss: 0.1717 - val_accuracy: 0.9055
Epoch 9/10
25010/25010 [==============================] - 3s 133us/step - loss: 0.1719 -
accuracy: 0.9055 - val_loss: 0.1715 - val_accuracy: 0.9063
Epoch 10/10
25010/25010 [==============================] - 3s 131us/step - loss: 0.1715 -
accuracy: 0.9061 - val_loss: 0.1713 - val_accuracy: 0.9051
1000000/1000000 [==============================] - 2s 2us/step
```

In [36]:
```
plt.figure(figsize=(15, 5))
plt.subplot(1,2,1)
plt.plot(history.history['accuracy']) #$mycodedelta
plt.plot(history.history['val_accuracy'])#$mycodedelta
plt.title('Model accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='upper left')
plt.subplot(1,2,2)
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('Model loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='lower left')
```

Out[36]:
```
<matplotlib.legend.Legend at 0x25a62b27d88>
```



Evaluate NN model

by predicting on the given test set (which unfortunately has been used for validation, too).

In [37]:
```
#predict
y_hat = model.predict(x_test) #numpy.ndarray
y_hat_class = y_hat.argmax(axis=1)
print(y_hat.shape, y_hat_class.shape)
accuracy_score(y_hat_class, y_test)
```

```
(1000000, 10) (1000000,)
```

Out[37]:
```
0.520584
```

In [38]:
```
unique, counts = np.unique(y_hat_class, return_counts=True)
print (np.asarray((unique, counts)).T)
```

```
[[     0 660649]
 [     1 339332]
 [     2     19]]
```

In [39]:
```
cm = confusion_matrix(y_test, y_hat_class)
print("Confusion matrix:\n{}".format(cm))
```

```
Confusion matrix:
[[360781 140428      0      0      0      0      0      0      0      0]
 [262701 159796      1      0      0      0      0      0      0      0]
 [ 24701  22914      7      0      0      0      0      0      0      0]
 [  9714  11398      9      0      0      0      0      0      0      0]
 [   700   3185      0      0      0      0      0      0      0      0]
 [  1500    496      0      0      0      0      0      0      0      0]
 [   502    922      0      0      0      0      0      0      0      0]
 [    48    180      2      0      0      0      0      0      0      0]
 [     0     12      0      0      0      0      0      0      0      0]
 [     2      1      0      0      0      0      0      0      0      0]]
```

Summary

The author claims that the Neural Network using Keras Library enables us to produce the most accurate results above all. I further evaluated the model results by predicting on the `test` ds and found that NN predictions didn't perform anywhere close to 90% and more like other models ~ 50%.

In ML, using the same `test` ds for validation and testing is not a valid technique. Next step should be to truly have `train` , `validation` and `test` sets and see how all the models fair with a holdout dataset.

Src: [https://keras.io/guides/training_with_built_in_methods/ (https://keras.io/guides/training_with_built_in_methods/)](https://keras.io/guides/training_with_built_in_methods/) Here's what the typical end-to-end workflow looks like, consisting of:

- Training
- Validation on a holdout set generated from the original training data
- Evaluation on the test data

In [40]:
```
mystop
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-40-255d8eb4da7e> in <module>
----> 1 mystop

NameError: name 'mystop' is not defined
```

Xtra

In [ ]:
```
#$xtra my export data for reuse
dump(data_train, 'data/poker_ex1_data_train.pkl')
dump(data_test, 'data/poker_ex1_data_test.pkl')
```