UROP 1100 - Victoria A. Junaedi

Code from https://github.com/BenjiKCF/Neural-Network-with-Financial-Time-Series-Data (https://github.com/BenjiKCF/Neural-Network-with-Financial-Time-Series-Data)

In [2]:

```
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.pyplot as plt2
import pandas as pd
from pandas import datetime
import math, time
from sklearn import preprocessing
import datetime
from sklearn.metrics import mean_squared_error
from math import sqrt
from keras.models import Sequential
from keras.layers.core import Dense, Dropout, Activation
from keras.layers.recurrent import LSTM
from keras.models import load_model
import keras
import pandas_datareader.data as web
import h5py
from keras import backend as K
import quandl
```

```
Using TensorFlow backend.
```

Getting the data from Quandl

and determining other parameters

In [49]:

```
quandl.ApiConfig.api_key = 'ETPyWitxJn3wiSRvxUjk'
seq_len = 22
shape = [seq_len, 9, 1]
neurons = [256, 256, 32, 1]
dropout = 0.3
decay = 0.5
epochs = 300
stock_name = 'CathayPacific'
```

Pulling the data from Quandl

In [50]:

```
def get_stock_data(stock_name, normalize=True, ma=[]):
    """
    Return a dataframe of that stock and normalize all the values.
    (Optional: create moving average)
    """
#     df = quandl.get_table('HKEX', ticker = stock_name)
# Date,Nominal Price,Net Change,Change (%),Bid,Ask,P/E(x),High,Low,Previous Close,Share
 Volume ('000),Turnover ('000),Lot Size

    df = quandl.get("HKEX/00293", authtoken="ETPyWitxJn3wiSRvxUjk")
    df.drop(['Net Change','P/E(x)', 'Bid', 'Ask', 'Lot Size', 'Turnover (\'000)'], 1, i
nplace=True)
#     df.set_index('Date', inplace=True)

    # Renaming all the columns so that we can use the old version code
    df.rename(columns={'Nominal Price': 'Open','Share Volume (\'000)': 'Volume', 'Previ
ous Close': 'Adj Close', 'Change (%)': 'Pct'}, inplace=True)

#     # Percentage change
#     df['Pct'] = df['Adj Close'].pct_change()
    df.dropna(inplace=True)

    # Moving Average
    if ma != []:
        for moving in ma:
            df['{}ma'.format(moving)] = df['Adj Close'].rolling(window=moving).mean()
    df.dropna(inplace=True)

    if normalize:
        min_max_scaler = preprocessing.MinMaxScaler()
        df['Open'] = min_max_scaler.fit_transform(df.Open.values.reshape(-1,1))
        df['High'] = min_max_scaler.fit_transform(df.High.values.reshape(-1,1))
        df['Low'] = min_max_scaler.fit_transform(df.Low.values.reshape(-1,1))
        df['Volume'] = min_max_scaler.fit_transform(df.Volume.values.reshape(-1,1))
        df['Adj Close'] = min_max_scaler.fit_transform(df['Adj
Close'].values.reshape(-1,1))
        df['Pct'] = min_max_scaler.fit_transform(df['Pct'].values.reshape(-1,1))
        if ma != []:
            for moving in ma:
                df['{}ma'.format(moving)] = min_max_scaler.fit_transform(df['{}ma'.form
at(moving)].values.reshape(-1,1))

    # Move Adj Close to the rightmost for the ease of training
    adj_close = df['Adj Close']
    df.drop(labels=['Adj Close'], axis=1, inplace=True)
    df = pd.concat([df, adj_close], axis=1)

    return df
```

In [51]:

```
df = get_stock_data(stock_name, ma=[50, 100, 200]) # putting 50 days, 100 days, and 200
 days moving average
```

Visualizing the data

In [52]:

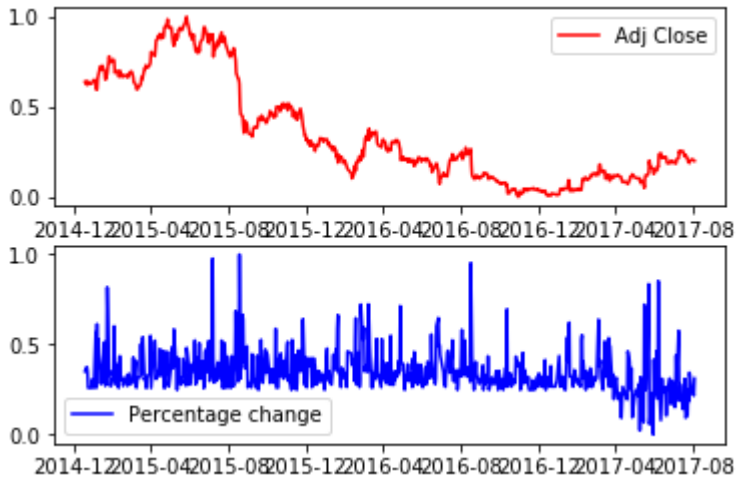
```
def plot_stock(df):
    print(df.head())
    plt.subplot(211)
    plt.plot(df['Adj Close'], color='red', label='Adj Close')
    plt.legend(loc='best')
    plt.subplot(212)
    plt.plot(df['Pct'], color='blue', label='Percentage change')
    plt.legend(loc='best')
    plt.show()
```

In [53]:

```
plot_stock(df)
```

```
                Open       Pct      High       Low    Volume      50ma  \
Date
2014-12-19  0.628352  0.350632  0.623352  0.629412  0.062676  0.560608
2014-12-22  0.649425  0.375036  0.629002  0.649020  0.018500  0.564995
2014-12-23  0.632184  0.350439  0.627119  0.643137  0.020874  0.570337
2014-12-24  0.634100  0.258898  0.623352  0.643137  0.009915  0.575722
2014-12-29  0.636015  0.258898  0.629002  0.654902  0.017850  0.581759

               100ma     200ma  Adj Close
Date
2014-12-19  0.525715  0.569391   0.639469
2014-12-22  0.527974  0.570507   0.622391
2014-12-23  0.530558  0.571352   0.643264
2014-12-24  0.533049  0.572354   0.626186
2014-12-29  0.535634  0.573413   0.628083
```



Split training and testing

In [54]:

```
def load_data(stock, seq_len):
    amount_of_features = len(stock.columns)
    print ("Amount of features = {}".format(amount_of_features))
    data = stock.as_matrix()
    sequence_length = seq_len + 1 # index starting from 0
    result = []

    for index in range(len(data) - sequence_length): # maxmimum date = lastest date - s
equence length
        result.append(data[index: index + sequence_length]) # index : index + 22days

    result = np.array(result)
    row = round(0.8 * result.shape[0]) # 80% split
    print ("Amount of training data = {}".format(round(0.9 * result.shape[0])))
    print ("Amount of testing data = {}".format(round(0.1 * result.shape[0])))

    train = result[:int(row), :] # 90% date
    X_train = train[:, :-1] # all data until day m
    y_train = train[:, -1][:,-1] # day m + 1 adjusted close price

    X_test = result[int(row):, :-1]
    y_test = result[int(row):, -1][:,-1]

    X_train = np.reshape(X_train, (X_train.shape[0], X_train.shape[1], amount_of_featur
es))
    X_test = np.reshape(X_test, (X_test.shape[0], X_test.shape[1], amount_of_features))

    return [X_train, y_train, X_test, y_test]
```

In [55]:

```
X_train, y_train, X_test, y_test = load_data(df, seq_len)
```

```
Amount of features = 9
Amount of training data = 558
Amount of testing data = 62
```

In [56]:

```
def build_model(shape, neurons, dropout, decay):
    model = Sequential()

    model.add(LSTM(neurons[0], input_shape=(shape[0], shape[1]),
return_sequences=True))
    model.add(Dropout(dropout))

    model.add(LSTM(neurons[1], input_shape=(shape[0], shape[1]),
return_sequences=False))
    model.add(Dropout(dropout))

    model.add(Dense(neurons[2],kernel_initializer="uniform",activation='relu'))
    model.add(Dense(neurons[3],kernel_initializer="uniform",activation='linear'))
    # model = load_model('my_LSTM_stock_model1000.h5')
    adam = keras.optimizers.Adam(decay=decay)
    model.compile(loss='mse',optimizer='adam', metrics=['accuracy'])
    model.summary()
    return model
```

In [59]:

```
model = build_model(shape, neurons, dropout, decay)
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
lstm_7 (LSTM)                (None, 22, 256)           272384
_________________________________________________________________
dropout_7 (Dropout)          (None, 22, 256)           0
_________________________________________________________________
lstm_8 (LSTM)                (None, 256)               525312
_________________________________________________________________
dropout_8 (Dropout)          (None, 256)               0
_________________________________________________________________
dense_7 (Dense)              (None, 32)                8224
_________________________________________________________________
dense_8 (Dense)              (None, 1)                 33
=================================================================
Total params: 805,953
Trainable params: 805,953
Non-trainable params: 0
_________________________________________________________________
```

In [67]:

```
model.fit(
    X_train,
    y_train,
    batch_size=512,
    epochs=epochs,
    validation_split=0.33,
    verbose=1)
```

```
Train on 332 samples, validate on 164 samples
Epoch 1/300
332/332 [==============================] - 6s - loss: 0.0079 - acc: 0.0030
- val_loss: 0.0348 - val_acc: 0.0061
Epoch 2/300
332/332 [==============================] - 3s - loss: 0.0105 - acc: 0.0030
- val_loss: 0.0340 - val_acc: 0.0061
Epoch 3/300
332/332 [==============================] - 2s - loss: 0.0071 - acc: 0.0030
- val_loss: 0.0327 - val_acc: 0.0061
Epoch 4/300
332/332 [==============================] - 2s - loss: 0.0079 - acc: 0.0030
- val_loss: 0.0326 - val_acc: 0.0061
Epoch 5/300
332/332 [==============================] - 2s - loss: 0.0086 - acc: 0.0030
- val_loss: 0.0342 - val_acc: 0.0061
Epoch 6/300
332/332 [==============================] - 2s - loss: 0.0058 - acc: 0.0030
- val_loss: 0.0362 - val_acc: 0.0061
Epoch 7/300
332/332 [==============================] - 2s - loss: 0.0072 - acc: 0.0030
- val_loss: 0.0371 - val_acc: 0.0061
Epoch 8/300
332/332 [==============================] - 2s - loss: 0.0072 - acc: 0.0030
- val_loss: 0.0366 - val_acc: 0.0061
Epoch 9/300
332/332 [==============================] - 2s - loss: 0.0058 - acc: 0.0030
- val_loss: 0.0367 - val_acc: 0.0061
Epoch 10/300
332/332 [==============================] - 3s - loss: 0.0067 - acc: 0.0030
- val_loss: 0.0379 - val_acc: 0.0061
Epoch 11/300
332/332 [==============================] - 3s - loss: 0.0056 - acc: 0.0030
- val_loss: 0.0381 - val_acc: 0.0061
Epoch 12/300
332/332 [==============================] - 2s - loss: 0.0068 - acc: 0.0030
- val_loss: 0.0367 - val_acc: 0.0061
Epoch 13/300
332/332 [==============================] - 2s - loss: 0.0054 - acc: 0.0030
- val_loss: 0.0367 - val_acc: 0.0061
Epoch 14/300
332/332 [==============================] - 2s - loss: 0.0055 - acc: 0.0030
- val_loss: 0.0377 - val_acc: 0.0061
Epoch 15/300
332/332 [==============================] - 2s - loss: 0.0061 - acc: 0.0030
- val_loss: 0.0373 - val_acc: 0.0061
Epoch 16/300
332/332 [==============================] - 2s - loss: 0.0052 - acc: 0.0030
- val_loss: 0.0362 - val_acc: 0.0061
Epoch 17/300
332/332 [==============================] - 2s - loss: 0.0069 - acc: 0.0030
- val_loss: 0.0371 - val_acc: 0.0061
Epoch 18/300
332/332 [==============================] - 2s - loss: 0.0054 - acc: 0.0030
- val_loss: 0.0365 - val_acc: 0.0061
Epoch 19/300
332/332 [==============================] - 2s - loss: 0.0053 - acc: 0.0030
- val_loss: 0.0347 - val_acc: 0.0061
Epoch 20/300
332/332 [==============================] - 2s - loss: 0.0073 - acc: 0.0030
- val_loss: 0.0351 - val_acc: 0.0061
```

```
Epoch 21/300
332/332 [==============================] - 2s - loss: 0.0051 - acc: 0.0030
- val_loss: 0.0346 - val_acc: 0.0061
Epoch 22/300
332/332 [==============================] - 2s - loss: 0.0048 - acc: 0.0030
- val_loss: 0.0330 - val_acc: 0.0061
Epoch 23/300
332/332 [==============================] - 2s - loss: 0.0046 - acc: 0.0030
- val_loss: 0.0330 - val_acc: 0.0061
Epoch 24/300
332/332 [==============================] - 2s - loss: 0.0046 - acc: 0.0030
- val_loss: 0.0335 - val_acc: 0.0061
Epoch 25/300
332/332 [==============================] - 2s - loss: 0.0045 - acc: 0.0030
- val_loss: 0.0329 - val_acc: 0.0061
Epoch 26/300
332/332 [==============================] - 2s - loss: 0.0039 - acc: 0.0030
- val_loss: 0.0324 - val_acc: 0.0061
Epoch 27/300
332/332 [==============================] - 2s - loss: 0.0049 - acc: 0.0030
- val_loss: 0.0333 - val_acc: 0.0061
Epoch 28/300
332/332 [==============================] - 2s - loss: 0.0042 - acc: 0.0030
- val_loss: 0.0332 - val_acc: 0.0061
Epoch 29/300
332/332 [==============================] - 2s - loss: 0.0042 - acc: 0.0030
- val_loss: 0.0323 - val_acc: 0.0061
Epoch 30/300
332/332 [==============================] - 2s - loss: 0.0045 - acc: 0.0030
- val_loss: 0.0325 - val_acc: 0.0061
Epoch 31/300
332/332 [==============================] - 2s - loss: 0.0035 - acc: 0.0030
- val_loss: 0.0330 - val_acc: 0.0061
Epoch 32/300
332/332 [==============================] - 2s - loss: 0.0051 - acc: 0.0030
- val_loss: 0.0323 - val_acc: 0.0061
Epoch 33/300
332/332 [==============================] - 2s - loss: 0.0041 - acc: 0.0030
- val_loss: 0.0324 - val_acc: 0.0061
Epoch 34/300
332/332 [==============================] - 2s - loss: 0.0036 - acc: 0.0030
- val_loss: 0.0328 - val_acc: 0.0061
Epoch 35/300
332/332 [==============================] - 2s - loss: 0.0041 - acc: 0.0030
- val_loss: 0.0325 - val_acc: 0.0061
Epoch 36/300
332/332 [==============================] - 2s - loss: 0.0040 - acc: 0.0030
- val_loss: 0.0321 - val_acc: 0.0061
Epoch 37/300
332/332 [==============================] - 2s - loss: 0.0042 - acc: 0.0030
- val_loss: 0.0330 - val_acc: 0.0061
Epoch 38/300
332/332 [==============================] - 3s - loss: 0.0040 - acc: 0.0030
- val_loss: 0.0328 - val_acc: 0.0061
Epoch 39/300
332/332 [==============================] - 3s - loss: 0.0037 - acc: 0.0030
- val_loss: 0.0318 - val_acc: 0.0061
Epoch 40/300
332/332 [==============================] - 2s - loss: 0.0054 - acc: 0.0030
- val_loss: 0.0334 - val_acc: 0.0061
Epoch 41/300
```

```
332/332 [==============================] - 2s - loss: 0.0051 - acc: 0.0030
- val_loss: 0.0332 - val_acc: 0.0061
Epoch 42/300
332/332 [==============================] - 2s - loss: 0.0047 - acc: 0.0030
- val_loss: 0.0318 - val_acc: 0.0061
Epoch 43/300
332/332 [==============================] - 2s - loss: 0.0045 - acc: 0.0030
- val_loss: 0.0322 - val_acc: 0.0061
Epoch 44/300
332/332 [==============================] - 2s - loss: 0.0035 - acc: 0.0030
- val_loss: 0.0331 - val_acc: 0.0061
Epoch 45/300
332/332 [==============================] - 2s - loss: 0.0044 - acc: 0.0030
- val_loss: 0.0328 - val_acc: 0.0061
Epoch 46/300
332/332 [==============================] - 2s - loss: 0.0040 - acc: 0.0030
- val_loss: 0.0318 - val_acc: 0.0061
Epoch 47/300
332/332 [==============================] - 2s - loss: 0.0038 - acc: 0.0030
- val_loss: 0.0319 - val_acc: 0.0061
Epoch 48/300
332/332 [==============================] - 2s - loss: 0.0034 - acc: 0.0030
- val_loss: 0.0323 - val_acc: 0.0061
Epoch 49/300
332/332 [==============================] - 2s - loss: 0.0045 - acc: 0.0030
- val_loss: 0.0316 - val_acc: 0.0061
Epoch 50/300
332/332 [==============================] - 2s - loss: 0.0037 - acc: 0.0030
- val_loss: 0.0304 - val_acc: 0.0061
Epoch 51/300
332/332 [==============================] - 2s - loss: 0.0042 - acc: 0.0030
- val_loss: 0.0305 - val_acc: 0.0061
Epoch 52/300
332/332 [==============================] - 2s - loss: 0.0034 - acc: 0.0030
- val_loss: 0.0309 - val_acc: 0.0061
Epoch 53/300
332/332 [==============================] - 2s - loss: 0.0038 - acc: 0.0030
- val_loss: 0.0308 - val_acc: 0.0061
Epoch 54/300
332/332 [==============================] - 2s - loss: 0.0035 - acc: 0.0030
- val_loss: 0.0305 - val_acc: 0.0061
Epoch 55/300
332/332 [==============================] - 2s - loss: 0.0041 - acc: 0.0030
- val_loss: 0.0316 - val_acc: 0.0061
Epoch 56/300
332/332 [==============================] - 2s - loss: 0.0039 - acc: 0.0030
- val_loss: 0.0309 - val_acc: 0.0061
Epoch 57/300
332/332 [==============================] - 2s - loss: 0.0036 - acc: 0.0030
- val_loss: 0.0297 - val_acc: 0.0061
Epoch 58/300
332/332 [==============================] - 2s - loss: 0.0042 - acc: 0.0030
- val_loss: 0.0306 - val_acc: 0.0061
Epoch 59/300
332/332 [==============================] - 2s - loss: 0.0034 - acc: 0.0030
- val_loss: 0.0311 - val_acc: 0.0061
Epoch 60/300
332/332 [==============================] - 2s - loss: 0.0039 - acc: 0.0030
- val_loss: 0.0307 - val_acc: 0.0061
Epoch 61/300
332/332 [==============================] - 2s - loss: 0.0031 - acc: 0.0030
```

```
- val_loss: 0.0308 - val_acc: 0.0061
Epoch 62/300
332/332 [==============================] - 2s - loss: 0.0038 - acc: 0.0030
- val_loss: 0.0312 - val_acc: 0.0061
Epoch 63/300
332/332 [==============================] - 2s - loss: 0.0037 - acc: 0.0030
- val_loss: 0.0306 - val_acc: 0.0061
Epoch 64/300
332/332 [==============================] - 2s - loss: 0.0034 - acc: 0.0030
- val_loss: 0.0296 - val_acc: 0.0061
Epoch 65/300
332/332 [==============================] - 2s - loss: 0.0030 - acc: 0.0030
- val_loss: 0.0296 - val_acc: 0.0061
Epoch 66/300
332/332 [==============================] - 2s - loss: 0.0033 - acc: 0.0030
- val_loss: 0.0305 - val_acc: 0.0061
Epoch 67/300
332/332 [==============================] - 2s - loss: 0.0030 - acc: 0.0030
- val_loss: 0.0305 - val_acc: 0.0061
Epoch 68/300
332/332 [==============================] - 2s - loss: 0.0035 - acc: 0.0030
- val_loss: 0.0291 - val_acc: 0.0061
Epoch 69/300
332/332 [==============================] - 2s - loss: 0.0030 - acc: 0.0030
- val_loss: 0.0285 - val_acc: 0.0061
Epoch 70/300
332/332 [==============================] - 2s - loss: 0.0035 - acc: 0.0030
- val_loss: 0.0295 - val_acc: 0.0061
Epoch 71/300
332/332 [==============================] - 2s - loss: 0.0033 - acc: 0.0030
- val_loss: 0.0296 - val_acc: 0.0061
Epoch 72/300
332/332 [==============================] - 2s - loss: 0.0035 - acc: 0.0030
- val_loss: 0.0289 - val_acc: 0.0061
Epoch 73/300
332/332 [==============================] - 2s - loss: 0.0032 - acc: 0.0030
- val_loss: 0.0286 - val_acc: 0.0061
Epoch 74/300
332/332 [==============================] - 2s - loss: 0.0031 - acc: 0.0030
- val_loss: 0.0284 - val_acc: 0.0061
Epoch 75/300
332/332 [==============================] - 2s - loss: 0.0033 - acc: 0.0030
- val_loss: 0.0281 - val_acc: 0.0061
Epoch 76/300
332/332 [==============================] - 2s - loss: 0.0032 - acc: 0.0030
- val_loss: 0.0281 - val_acc: 0.0061
Epoch 77/300
332/332 [==============================] - 2s - loss: 0.0031 - acc: 0.0030
- val_loss: 0.0292 - val_acc: 0.0061
Epoch 78/300
332/332 [==============================] - 2s - loss: 0.0034 - acc: 0.0030
- val_loss: 0.0289 - val_acc: 0.0061
Epoch 79/300
332/332 [==============================] - 2s - loss: 0.0030 - acc: 0.0030
- val_loss: 0.0276 - val_acc: 0.0061
Epoch 80/300
332/332 [==============================] - 2s - loss: 0.0032 - acc: 0.0030
- val_loss: 0.0273 - val_acc: 0.0061
Epoch 81/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0279 - val_acc: 0.0061
```

```
Epoch 82/300
332/332 [==============================] - 3s - loss: 0.0028 - acc: 0.0030
- val_loss: 0.0286 - val_acc: 0.0061
Epoch 83/300
332/332 [==============================] - 3s - loss: 0.0034 - acc: 0.0030
- val_loss: 0.0283 - val_acc: 0.0061
Epoch 84/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0284 - val_acc: 0.0061
Epoch 85/300
332/332 [==============================] - 2s - loss: 0.0030 - acc: 0.0030
- val_loss: 0.0289 - val_acc: 0.0061
Epoch 86/300
332/332 [==============================] - 2s - loss: 0.0032 - acc: 0.0030
- val_loss: 0.0277 - val_acc: 0.0061
Epoch 87/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0262 - val_acc: 0.0061
Epoch 88/300
332/332 [==============================] - 2s - loss: 0.0028 - acc: 0.0030
- val_loss: 0.0263 - val_acc: 0.0061
Epoch 89/300
332/332 [==============================] - 2s - loss: 0.0031 - acc: 0.0030
- val_loss: 0.0266 - val_acc: 0.0061
Epoch 90/300
332/332 [==============================] - 2s - loss: 0.0028 - acc: 0.0030
- val_loss: 0.0264 - val_acc: 0.0061
Epoch 91/300
332/332 [==============================] - 2s - loss: 0.0034 - acc: 0.0030
- val_loss: 0.0274 - val_acc: 0.0061
Epoch 92/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0275 - val_acc: 0.0061
Epoch 93/300
332/332 [==============================] - 2s - loss: 0.0030 - acc: 0.0030
- val_loss: 0.0261 - val_acc: 0.0061
Epoch 94/300
332/332 [==============================] - 2s - loss: 0.0034 - acc: 0.0030
- val_loss: 0.0271 - val_acc: 0.0061
Epoch 95/300
332/332 [==============================] - 2s - loss: 0.0030 - acc: 0.0030
- val_loss: 0.0293 - val_acc: 0.0061
Epoch 96/300
332/332 [==============================] - 2s - loss: 0.0030 - acc: 0.0030
- val_loss: 0.0291 - val_acc: 0.0061
Epoch 97/300
332/332 [==============================] - 2s - loss: 0.0031 - acc: 0.0030
- val_loss: 0.0276 - val_acc: 0.0061
Epoch 98/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0279 - val_acc: 0.0061
Epoch 99/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0277 - val_acc: 0.0061
Epoch 100/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0262 - val_acc: 0.0061
Epoch 101/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0260 - val_acc: 0.0061
Epoch 102/300
```

```
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0262 - val_acc: 0.0061
Epoch 103/300
332/332 [==============================] - 2s - loss: 0.0031 - acc: 0.0030
- val_loss: 0.0250 - val_acc: 0.0061
Epoch 104/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0243 - val_acc: 0.0061
Epoch 105/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0253 - val_acc: 0.0061
Epoch 106/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0271 - val_acc: 0.0061
Epoch 107/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0268 - val_acc: 0.0061
Epoch 108/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0259 - val_acc: 0.0061
Epoch 109/300
332/332 [==============================] - 2s - loss: 0.0028 - acc: 0.0030
- val_loss: 0.0267 - val_acc: 0.0061
Epoch 110/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0265 - val_acc: 0.0061
Epoch 111/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0258 - val_acc: 0.0061
Epoch 112/300
332/332 [==============================] - 2s - loss: 0.0028 - acc: 0.0030
- val_loss: 0.0256 - val_acc: 0.0061
Epoch 113/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0255 - val_acc: 0.0061
Epoch 114/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0255 - val_acc: 0.0061
Epoch 115/300
332/332 [==============================] - 2s - loss: 0.0030 - acc: 0.0030
- val_loss: 0.0278 - val_acc: 0.0061
Epoch 116/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0275 - val_acc: 0.0061
Epoch 117/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0240 - val_acc: 0.0061
Epoch 118/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0229 - val_acc: 0.0061
Epoch 119/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0237 - val_acc: 0.0061
Epoch 120/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0252 - val_acc: 0.0061
Epoch 121/300
332/332 [==============================] - 2s - loss: 0.0028 - acc: 0.0030
- val_loss: 0.0255 - val_acc: 0.0061
Epoch 122/300
332/332 [==============================] - 2s - loss: 0.0028 - acc: 0.0030
```

```
- val_loss: 0.0266 - val_acc: 0.0061
Epoch 123/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0257 - val_acc: 0.0061
Epoch 124/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0253 - val_acc: 0.0061
Epoch 125/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0255 - val_acc: 0.0061
Epoch 126/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0248 - val_acc: 0.0061
Epoch 127/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0234 - val_acc: 0.0061
Epoch 128/300
332/332 [==============================] - 2s - loss: 0.0030 - acc: 0.0030
- val_loss: 0.0227 - val_acc: 0.0061
Epoch 129/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0251 - val_acc: 0.0061
Epoch 130/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0262 - val_acc: 0.0061
Epoch 131/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0257 - val_acc: 0.0061
Epoch 132/300
332/332 [==============================] - 2s - loss: 0.0031 - acc: 0.0030
- val_loss: 0.0271 - val_acc: 0.0061
Epoch 133/300
332/332 [==============================] - 2s - loss: 0.0028 - acc: 0.0030
- val_loss: 0.0254 - val_acc: 0.0061
Epoch 134/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0220 - val_acc: 0.0061
Epoch 135/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0231 - val_acc: 0.0061
Epoch 136/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0267 - val_acc: 0.0061
Epoch 137/300
332/332 [==============================] - 2s - loss: 0.0032 - acc: 0.0030
- val_loss: 0.0250 - val_acc: 0.0061
Epoch 138/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0218 - val_acc: 0.0061
Epoch 139/300
332/332 [==============================] - 2s - loss: 0.0028 - acc: 0.0030
- val_loss: 0.0230 - val_acc: 0.0061
Epoch 140/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0262 - val_acc: 0.0061
Epoch 141/300
332/332 [==============================] - 2s - loss: 0.0030 - acc: 0.0030
- val_loss: 0.0254 - val_acc: 0.0061
Epoch 142/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0218 - val_acc: 0.0061
```

```
Epoch 143/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0216 - val_acc: 0.0061
Epoch 144/300
332/332 [==============================] - 2s - loss: 0.0028 - acc: 0.0030
- val_loss: 0.0243 - val_acc: 0.0061
Epoch 145/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0244 - val_acc: 0.0061
Epoch 146/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0225 - val_acc: 0.0061
Epoch 147/300
332/332 [==============================] - 2s - loss: 0.0032 - acc: 0.0030
- val_loss: 0.0231 - val_acc: 0.0061
Epoch 148/300
332/332 [==============================] - 2s - loss: 0.0034 - acc: 0.0030
- val_loss: 0.0228 - val_acc: 0.0061
Epoch 149/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0222 - val_acc: 0.0061
Epoch 150/300
332/332 [==============================] - 2s - loss: 0.0030 - acc: 0.0030
- val_loss: 0.0239 - val_acc: 0.0061
Epoch 151/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0250 - val_acc: 0.0061
Epoch 152/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0235 - val_acc: 0.0061
Epoch 153/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0217 - val_acc: 0.0061
Epoch 154/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0216 - val_acc: 0.0061
Epoch 155/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0228 - val_acc: 0.0061
Epoch 156/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0238 - val_acc: 0.0061
Epoch 157/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0241 - val_acc: 0.0061
Epoch 158/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0227 - val_acc: 0.0061
Epoch 159/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0212 - val_acc: 0.0061
Epoch 160/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0216 - val_acc: 0.0061
Epoch 161/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0233 - val_acc: 0.0061
Epoch 162/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0228 - val_acc: 0.0061
Epoch 163/300
```

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332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0219 - val_acc: 0.0061
Epoch 164/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0221 - val_acc: 0.0061
Epoch 165/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0223 - val_acc: 0.0061
Epoch 166/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0227 - val_acc: 0.0061
Epoch 167/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0230 - val_acc: 0.0061
Epoch 168/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0226 - val_acc: 0.0061
Epoch 169/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0205 - val_acc: 0.0061
Epoch 170/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0201 - val_acc: 0.0061
Epoch 171/300
332/332 [==============================] - 2s - loss: 0.0028 - acc: 0.0030
- val_loss: 0.0226 - val_acc: 0.0061
Epoch 172/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0232 - val_acc: 0.0061
Epoch 173/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0227 - val_acc: 0.0061
Epoch 174/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0242 - val_acc: 0.0061
Epoch 175/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0254 - val_acc: 0.0061
Epoch 176/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0234 - val_acc: 0.0061
Epoch 177/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0206 - val_acc: 0.0061
Epoch 178/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0194 - val_acc: 0.0061
Epoch 179/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0195 - val_acc: 0.0061
Epoch 180/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0213 - val_acc: 0.0061
Epoch 181/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0218 - val_acc: 0.0061
Epoch 182/300
332/332 [==============================] - 2s - loss: 0.0020 - acc: 0.0030
- val_loss: 0.0213 - val_acc: 0.0061
Epoch 183/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
```

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- val_loss: 0.0208 - val_acc: 0.0061
Epoch 184/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0222 - val_acc: 0.0061
Epoch 185/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0232 - val_acc: 0.0061
Epoch 186/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0220 - val_acc: 0.0061
Epoch 187/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0223 - val_acc: 0.0061
Epoch 188/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0225 - val_acc: 0.0061
Epoch 189/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0220 - val_acc: 0.0061
Epoch 190/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0215 - val_acc: 0.0061
Epoch 191/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0221 - val_acc: 0.0061
Epoch 192/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0216 - val_acc: 0.0061
Epoch 193/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0197 - val_acc: 0.0061
Epoch 194/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0205 - val_acc: 0.0061
Epoch 195/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0210 - val_acc: 0.0061
Epoch 196/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0195 - val_acc: 0.0061
Epoch 197/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0203 - val_acc: 0.0061
Epoch 198/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0221 - val_acc: 0.0061
Epoch 199/300
332/332 [==============================] - 2s - loss: 0.0028 - acc: 0.0030
- val_loss: 0.0209 - val_acc: 0.0061
Epoch 200/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0206 - val_acc: 0.0061
Epoch 201/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0229 - val_acc: 0.0061
Epoch 202/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0224 - val_acc: 0.0061
Epoch 203/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0202 - val_acc: 0.0061
```

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Epoch 204/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0204 - val_acc: 0.0061
Epoch 205/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0210 - val_acc: 0.0061
Epoch 206/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0191 - val_acc: 0.0061
Epoch 207/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0182 - val_acc: 0.0061
Epoch 208/300
332/332 [==============================] - 2s - loss: 0.0028 - acc: 0.0030
- val_loss: 0.0209 - val_acc: 0.0061
Epoch 209/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0231 - val_acc: 0.0061
Epoch 210/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0210 - val_acc: 0.0061
Epoch 211/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0203 - val_acc: 0.0061
Epoch 212/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0223 - val_acc: 0.0061
Epoch 213/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0225 - val_acc: 0.0061
Epoch 214/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0210 - val_acc: 0.0061
Epoch 215/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0199 - val_acc: 0.0061
Epoch 216/300
332/332 [==============================] - 2s - loss: 0.0029 - acc: 0.0030
- val_loss: 0.0210 - val_acc: 0.0061
Epoch 217/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0201 - val_acc: 0.0061
Epoch 218/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0187 - val_acc: 0.0061
Epoch 219/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0215 - val_acc: 0.0061
Epoch 220/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0235 - val_acc: 0.0061
Epoch 221/300
332/332 [==============================] - 2s - loss: 0.0032 - acc: 0.0030
- val_loss: 0.0210 - val_acc: 0.0061
Epoch 222/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0190 - val_acc: 0.0061
Epoch 223/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0200 - val_acc: 0.0061
Epoch 224/300
```

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332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0220 - val_acc: 0.0061
Epoch 225/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0219 - val_acc: 0.0061
Epoch 226/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0202 - val_acc: 0.0061
Epoch 227/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0208 - val_acc: 0.0061
Epoch 228/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0217 - val_acc: 0.0061
Epoch 229/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0214 - val_acc: 0.0061
Epoch 230/300
332/332 [==============================] - 3s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0202 - val_acc: 0.0061
Epoch 231/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0190 - val_acc: 0.0061
Epoch 232/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0174 - val_acc: 0.0061
Epoch 233/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0174 - val_acc: 0.0061
Epoch 234/300
332/332 [==============================] - 2s - loss: 0.0019 - acc: 0.0030
- val_loss: 0.0198 - val_acc: 0.0061
Epoch 235/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0232 - val_acc: 0.0061
Epoch 236/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0222 - val_acc: 0.0061
Epoch 237/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0197 - val_acc: 0.0061
Epoch 238/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0202 - val_acc: 0.0061
Epoch 239/300
332/332 [==============================] - 2s - loss: 0.0020 - acc: 0.0030
- val_loss: 0.0222 - val_acc: 0.0061
Epoch 240/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0222 - val_acc: 0.0061
Epoch 241/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0198 - val_acc: 0.0061
Epoch 242/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0187 - val_acc: 0.0061
Epoch 243/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0190 - val_acc: 0.0061
Epoch 244/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
```

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- val_loss: 0.0200 - val_acc: 0.0061
Epoch 245/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0209 - val_acc: 0.0061
Epoch 246/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0208 - val_acc: 0.0061
Epoch 247/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0188 - val_acc: 0.0061
Epoch 248/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0184 - val_acc: 0.0061
Epoch 249/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0202 - val_acc: 0.0061
Epoch 250/300
332/332 [==============================] - 2s - loss: 0.0018 - acc: 0.0030
- val_loss: 0.0210 - val_acc: 0.0061
Epoch 251/300
332/332 [==============================] - 2s - loss: 0.0019 - acc: 0.0030
- val_loss: 0.0206 - val_acc: 0.0061
Epoch 252/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0206 - val_acc: 0.0061
Epoch 253/300
332/332 [==============================] - 2s - loss: 0.0020 - acc: 0.0030
- val_loss: 0.0211 - val_acc: 0.0061
Epoch 254/300
332/332 [==============================] - 2s - loss: 0.0019 - acc: 0.0030
- val_loss: 0.0211 - val_acc: 0.0061
Epoch 255/300
332/332 [==============================] - 3s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0214 - val_acc: 0.0061
Epoch 256/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0208 - val_acc: 0.0061
Epoch 257/300
332/332 [==============================] - 2s - loss: 0.0018 - acc: 0.0030
- val_loss: 0.0203 - val_acc: 0.0061
Epoch 258/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0200 - val_acc: 0.0061
Epoch 259/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0209 - val_acc: 0.0061
Epoch 260/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0218 - val_acc: 0.0061
Epoch 261/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0208 - val_acc: 0.0061
Epoch 262/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0198 - val_acc: 0.0061
Epoch 263/300
332/332 [==============================] - 2s - loss: 0.0020 - acc: 0.0030
- val_loss: 0.0207 - val_acc: 0.0061
Epoch 264/300
332/332 [==============================] - 2s - loss: 0.0020 - acc: 0.0030
- val_loss: 0.0212 - val_acc: 0.0061
```

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Epoch 265/300
332/332 [==============================] - 2s - loss: 0.0019 - acc: 0.0030
- val_loss: 0.0207 - val_acc: 0.0061
Epoch 266/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0185 - val_acc: 0.0061
Epoch 267/300
332/332 [==============================] - 2s - loss: 0.0019 - acc: 0.0030
- val_loss: 0.0185 - val_acc: 0.0061
Epoch 268/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0200 - val_acc: 0.0061
Epoch 269/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0212 - val_acc: 0.0061
Epoch 270/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0211 - val_acc: 0.0061
Epoch 271/300
332/332 [==============================] - 2s - loss: 0.0020 - acc: 0.0030
- val_loss: 0.0203 - val_acc: 0.0061
Epoch 272/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0195 - val_acc: 0.0061
Epoch 273/300
332/332 [==============================] - 2s - loss: 0.0017 - acc: 0.0030
- val_loss: 0.0199 - val_acc: 0.0061
Epoch 274/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0204 - val_acc: 0.0061
Epoch 275/300
332/332 [==============================] - 2s - loss: 0.0020 - acc: 0.0030
- val_loss: 0.0206 - val_acc: 0.0061
Epoch 276/300
332/332 [==============================] - 2s - loss: 0.0020 - acc: 0.0030
- val_loss: 0.0199 - val_acc: 0.0061
Epoch 277/300
332/332 [==============================] - 2s - loss: 0.0022 - acc: 0.0030
- val_loss: 0.0192 - val_acc: 0.0061
Epoch 278/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0216 - val_acc: 0.0061
Epoch 279/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0229 - val_acc: 0.0061
Epoch 280/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0211 - val_acc: 0.0061
Epoch 281/300
332/332 [==============================] - 2s - loss: 0.0019 - acc: 0.0030
- val_loss: 0.0185 - val_acc: 0.0061
Epoch 282/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0191 - val_acc: 0.0061
Epoch 283/300
332/332 [==============================] - 2s - loss: 0.0031 - acc: 0.0030
- val_loss: 0.0181 - val_acc: 0.0061
Epoch 284/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0180 - val_acc: 0.0061
Epoch 285/300
```

```
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0222 - val_acc: 0.0061
Epoch 286/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0274 - val_acc: 0.0061
Epoch 287/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0242 - val_acc: 0.0061
Epoch 288/300
332/332 [==============================] - 2s - loss: 0.0027 - acc: 0.0030
- val_loss: 0.0192 - val_acc: 0.0061
Epoch 289/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0191 - val_acc: 0.0061
Epoch 290/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0227 - val_acc: 0.0061
Epoch 291/300
332/332 [==============================] - 2s - loss: 0.0023 - acc: 0.0030
- val_loss: 0.0236 - val_acc: 0.0061
Epoch 292/300
332/332 [==============================] - 2s - loss: 0.0026 - acc: 0.0030
- val_loss: 0.0197 - val_acc: 0.0061
Epoch 293/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0181 - val_acc: 0.0061
Epoch 294/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0196 - val_acc: 0.0061
Epoch 295/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0202 - val_acc: 0.0061
Epoch 296/300
332/332 [==============================] - 2s - loss: 0.0025 - acc: 0.0030
- val_loss: 0.0188 - val_acc: 0.0061
Epoch 297/300
332/332 [==============================] - 2s - loss: 0.0019 - acc: 0.0030
- val_loss: 0.0176 - val_acc: 0.0061
Epoch 298/300
332/332 [==============================] - 2s - loss: 0.0024 - acc: 0.0030
- val_loss: 0.0183 - val_acc: 0.0061
Epoch 299/300
332/332 [==============================] - 2s - loss: 0.0019 - acc: 0.0030
- val_loss: 0.0194 - val_acc: 0.0061
Epoch 300/300
332/332 [==============================] - 2s - loss: 0.0021 - acc: 0.0030
- val_loss: 0.0201 - val_acc: 0.0061
```

Out[67]:

```
<keras.callbacks.History at 0xe99f4fa518>
```

Result

In [68]:

```
def model_score(model, X_train, y_train, X_test, y_test):
    trainScore = model.evaluate(X_train, y_train, verbose=0)
    print('Train Score: %.5f MSE (%.2f RMSE)' % (trainScore[0],
math.sqrt(trainScore[0])))

    testScore = model.evaluate(X_test, y_test, verbose=0)
    print('Test Score: %.5f MSE (%.2f RMSE)' % (testScore[0], math.sqrt(testScore[0])))
    return trainScore[0], testScore[0]

model_score(model, X_train, y_train, X_test, y_test)
```

```
Train Score: 0.00735 MSE (0.09 RMSE)
Test Score: 0.01370 MSE (0.12 RMSE)
```

Out[68]:

```
(0.0073529773301655244, 0.013702700447831903)
```

Prediction vs Real Results

In [69]:

```
def percentage_difference(model, X_test, y_test):
    percentage_diff=[]

    p = model.predict(X_test)
    for u in range(len(y_test)): # for each data index in test data
        pr = p[u][0] # pr = prediction on day u

        percentage_diff.append((pr-y_test[u]/pr)*100)
    return p
```

In [70]:

```
p = percentage_difference(model, X_test, y_test)
```

In [71]:

```
def denormalize(normalized_value):
    """
    Return a dataframe of that stock and normalize all the values.
    (Optional: create moving average)
    """
    df = quandl.get("HKEX/00293", authtoken="ETPyWitxJn3wiSRvxUjk")
    df.drop(['Net Change','P/E(x)', 'Bid', 'Ask', 'Lot Size', 'Turnover (\'000)'], 1, i
nplace=True)
#     df.set_index('Date', inplace=True)

    # Renaming all the columns so that we can use the old version code
    df.rename(columns={'Nominal Price': 'Open','Share Volume (\'000)': 'Volume', 'Previ
ous Close': 'Adj Close', 'Change (%)': 'Pct'}, inplace=True)

    df.dropna(inplace=True)
    df = df['Adj Close'].values.reshape(-1,1)
    normalized_value = normalized_value.reshape(-1,1)

    #return df.shape, p.shape
    min_max_scaler = preprocessing.MinMaxScaler()
    a = min_max_scaler.fit_transform(df)
    new = min_max_scaler.inverse_transform(normalized_value)

    return new
```

In [73]:

```
def plot_result(stock_name, normalized_value_p, normalized_value_y_test):
    newp = denormalize(normalized_value_p)
    newy_test = denormalize(normalized_value_y_test)
    plt2.plot(newp, color='red', label='Prediction')
    plt2.plot(newy_test,color='blue', label='Actual')
    plt2.legend(loc='best')
    plt2.title('The test result for {}'.format(stock_name))
    plt2.xlabel('Days')
    plt2.ylabel('Adjusted Close')
    plt2.show()
```