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       "15      0.265336  2247.77  2248.38  2154.28  2293.46  13701.698603   \n",

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       "23      0.436437  2248.35  2248.69  2154.28  2293.46  13742.110913   \n",

       "\n",

       "             created\_at           updated\_at  \n",

       "3   2017-05-31 14:59:36  2017-05-31 14:59:36  \n",

       "4   2017-05-31 14:59:36  2017-05-31 14:59:36  \n",

       "15  2017-05-31 15:00:36  2017-05-31 15:00:36  \n",

       "16  2017-05-31 15:00:36  2017-05-31 15:00:36  \n",

       "23  2017-05-31 15:01:36  2017-05-31 15:01:36  "

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     "output\_type": "execute\_result"

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   ],

   "source": [

    "df.head()"

   ]

  },

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    "### Convert datetime\_id to data type and filter dates greater than  2017-06-28 00:00:00"

   ]

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   "execution\_count": 7,

   "metadata": {

    "collapsed": true

   },

   "outputs": [],

   "source": [

    "df = df.reset\_index(drop=True)\n",

    "df['datetime'] = pd.to\_datetime(df['datetime\_id'])\n",

    "df = df.loc[df['datetime'] > pd.to\_datetime('2017-06-28 00:00:00')]"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 8,

   "metadata": {

    "collapsed": true

   },

   "outputs": [],

   "source": [

    "df = df[['datetime', 'last', 'diff\_24h', 'diff\_per\_24h', 'bid', 'ask', 'low', 'high', 'volume']]"

   ]

  },

  {

   "cell\_type": "code",

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   "metadata": {

    "scrolled": true

   },

   "outputs": [

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       "    }\n",

       "\n",

       "    .dataframe thead th {\n",

       "        text-align: left;\n",

       "    }\n",

       "\n",

       "    .dataframe tbody tr th {\n",

       "        vertical-align: top;\n",

       "    }\n",

       "</style>\n",

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       "      <th>datetime</th>\n",

       "      <th>last</th>\n",

       "      <th>diff\_24h</th>\n",

       "      <th>diff\_per\_24h</th>\n",

       "      <th>bid</th>\n",

       "      <th>ask</th>\n",

       "      <th>low</th>\n",

       "      <th>high</th>\n",

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       "      <td>2344.00</td>\n",

       "      <td>2491.98</td>\n",

       "      <td>-5.938250</td>\n",

       "      <td>2335.01</td>\n",

       "      <td>2343.89</td>\n",

       "      <td>2307.0</td>\n",

       "      <td>2473.19</td>\n",

       "      <td>20719.583592</td>\n",

       "    </tr>\n",

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       "      <td>2682.25</td>\n",

       "      <td>-6.817411</td>\n",

       "      <td>2495.00</td>\n",

       "      <td>2499.33</td>\n",

       "      <td>2444.0</td>\n",

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       "      <td>-6.211928</td>\n",

       "      <td>2337.18</td>\n",

       "      <td>2340.00</td>\n",

       "      <td>2307.0</td>\n",

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       "    <tr>\n",

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       "      <td>2492.76</td>\n",

       "      <td>2682.25</td>\n",

       "      <td>-7.064591</td>\n",

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       "      <th>77766</th>\n",

       "      <td>2017-06-28 00:03:00</td>\n",

       "      <td>2335.02</td>\n",

       "      <td>2491.98</td>\n",

       "      <td>-6.298606</td>\n",

       "      <td>2335.01</td>\n",

       "      <td>2335.02</td>\n",

       "      <td>2307.0</td>\n",

       "      <td>2473.19</td>\n",

       "      <td>20665.357191</td>\n",

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       "</div>"

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       "77763 2017-06-28 00:01:00  2499.39   2682.25     -6.817411  2495.00  2499.33   \n",

       "77764 2017-06-28 00:02:00  2337.18   2491.98     -6.211928  2337.18  2340.00   \n",

       "77765 2017-06-28 00:02:00  2492.76   2682.25     -7.064591  2492.76  2495.00   \n",

       "77766 2017-06-28 00:03:00  2335.02   2491.98     -6.298606  2335.01  2335.02   \n",

       "\n",

       "          low     high        volume  \n",

       "77762  2307.0  2473.19  20719.583592  \n",

       "77763  2444.0  2780.62   2265.557866  \n",

       "77764  2307.0  2473.19  20732.082581  \n",

       "77765  2444.0  2780.62   2262.618866  \n",

       "77766  2307.0  2473.19  20665.357191  "

      ]

     },

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     "output\_type": "execute\_result"

    }

   ],

   "source": [

    "df.head()"

   ]

  },

  {

   "cell\_type": "markdown",

   "metadata": {},

   "source": [

    "### we require only the last value, so we subset that and convert it to numpy array"

   ]

  },

  {

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   "execution\_count": 10,

   "metadata": {

    "collapsed": true

   },

   "outputs": [],

   "source": [

    "df = df[['last']]"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 11,

   "metadata": {

    "collapsed": true

   },

   "outputs": [],

   "source": [

    "dataset = df.values\n",

    "dataset = dataset.astype('float32')"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 12,

   "metadata": {},

   "outputs": [

    {

     "data": {

      "text/plain": [

       "array([[ 2344.        ],\n",

       "       [ 2499.38989258],\n",

       "       [ 2337.17993164],\n",

       "       ..., \n",

       "       [ 2394.0300293 ],\n",

       "       [ 2320.4699707 ],\n",

       "       [ 2394.0300293 ]], dtype=float32)"

      ]

     },

     "execution\_count": 12,

     "metadata": {},

     "output\_type": "execute\_result"

    }

   ],

   "source": [

    "dataset"

   ]

  },

  {

   "cell\_type": "markdown",

   "metadata": {},

   "source": [

    "Neural networks are sensitive to input data, especiallly when we are using activation functions like sigmoid or tanh activation functions are used. ISo we rescale our data to the range of 0-to-1, using MinMaxScaler"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 13,

   "metadata": {

    "collapsed": true

   },

   "outputs": [],

   "source": [

    "scaler = MinMaxScaler(feature\_range=(0, 1))\n",

    "dataset = scaler.fit\_transform(dataset)"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 14,

   "metadata": {},

   "outputs": [

    {

     "data": {

      "text/plain": [

       "array([[ 0.1997695 ],\n",

       "       [ 0.49828053],\n",

       "       [ 0.18666792],\n",

       "       ..., \n",

       "       [ 0.29587936],\n",

       "       [ 0.15456724],\n",

       "       [ 0.29587936]], dtype=float32)"

      ]

     },

     "execution\_count": 14,

     "metadata": {},

     "output\_type": "execute\_result"

    }

   ],

   "source": [

    "dataset"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 15,

   "metadata": {},

   "outputs": [

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     "output\_type": "stream",

     "text": [

      "(31942, 15734)\n"

     ]

    }

   ],

   "source": [

    "train\_size = int(len(dataset) \* 0.67)\n",

    "test\_size = len(dataset) - train\_size\n",

    "train, test = dataset[0:train\_size, :], dataset[train\_size:len(dataset), :]\n",

    "print(len(train), len(test))"

   ]

  },

  {

   "cell\_type": "markdown",

   "metadata": {},

   "source": [

    "Now let us define the function called create\_dataset, which take two inputs, \n",

    "\n",

    "1. Dataset - numpy array that we want to convert into a dataset\n",

    "2. look\_back - number of previous time steps to use as input variables to predict the next time period\n"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 16,

   "metadata": {

    "collapsed": true

   },

   "outputs": [],

   "source": [

    "# convert an array of values into a dataset matrix\n",

    "def create\_dataset(dataset, look\_back=1):\n",

    "  dataX, dataY = [], []\n",

    "  for i in range(len(dataset)-look\_back-1):\n",

    "    a = dataset[i:(i+look\_back), 0]\n",

    "    dataX.append(a)\n",

    "    dataY.append(dataset[i + look\_back, 0])\n",

    "  return np.array(dataX), np.array(dataY)"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 17,

   "metadata": {

    "collapsed": true

   },

   "outputs": [],

   "source": [

    "look\_back = 10\n",

    "trainX, trainY = create\_dataset(train, look\_back=look\_back)\n",

    "testX, testY = create\_dataset(test, look\_back=look\_back)"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 18,

   "metadata": {},

   "outputs": [

    {

     "data": {

      "text/plain": [

       "array([[ 0.1997695 ,  0.49828053,  0.18666792, ...,  0.49753141,\n",

       "         0.19973087,  0.48600531],\n",

       "       [ 0.49828053,  0.18666792,  0.4855442 , ...,  0.19973087,\n",

       "         0.48600531,  0.18442059],\n",

       "       [ 0.18666792,  0.4855442 ,  0.18251848, ...,  0.48600531,\n",

       "         0.18442059,  0.48598576],\n",

       "       ..., \n",

       "       [ 0.53376245,  0.69436169,  0.53105354, ...,  0.70821238,\n",

       "         0.52058411,  0.70815468],\n",

       "       [ 0.69436169,  0.53105354,  0.70823145, ...,  0.52058411,\n",

       "         0.70815468,  0.52665424],\n",

       "       [ 0.53105354,  0.70823145,  0.53320551, ...,  0.70815468,\n",

       "         0.52665424,  0.70815468]], dtype=float32)"

      ]

     },

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    }

   ],

   "source": [

    "trainX"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 19,

   "metadata": {},

   "outputs": [

    {

     "data": {

      "text/plain": [

       "array([ 0.18442059,  0.48598576,  0.19208527, ...,  0.52665424,\n",

       "        0.70815468,  0.5206418 ], dtype=float32)"

      ]

     },

     "execution\_count": 19,

     "metadata": {},

     "output\_type": "execute\_result"

    }

   ],

   "source": [

    "trainY"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 20,

   "metadata": {

    "collapsed": true

   },

   "outputs": [],

   "source": [

    "# reshape input to be [samples, time steps, features]\n",

    "trainX = np.reshape(trainX, (trainX.shape[0], 1, trainX.shape[1]))\n",

    "testX = np.reshape(testX, (testX.shape[0], 1, testX.shape[1]))"

   ]

  },

  {

   "cell\_type": "markdown",

   "metadata": {},

   "source": [

    "## Build our Model"

   ]

  },

  {

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   "execution\_count": null,

   "metadata": {

    "scrolled": true

   },

   "outputs": [],

   "source": [

    "model = Sequential()\n",

    "model.add(LSTM(4, input\_shape=(1, look\_back)))\n",

    "model.add(Dense(1))\n",

    "model.compile(loss='mean\_squared\_error', optimizer='adam')\n",

    "model.fit(trainX, trainY, epochs=100, batch\_size=256, verbose=2)"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 22,

   "metadata": {

    "collapsed": true

   },

   "outputs": [],

   "source": [

    "trainPredict = model.predict(trainX)\n",

    "testPredict = model.predict(testX)"

   ]

  },

  {

   "cell\_type": "markdown",

   "metadata": {},

   "source": [

    "We have to invert the predictions before calculating error to so that reports will be in same units as our original data"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 23,

   "metadata": {

    "collapsed": true

   },

   "outputs": [],

   "source": [

    "trainPredict = scaler.inverse\_transform(trainPredict)\n",

    "trainY = scaler.inverse\_transform([trainY])\n",

    "testPredict = scaler.inverse\_transform(testPredict)\n",

    "testY = scaler.inverse\_transform([testY])"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 24,

   "metadata": {},

   "outputs": [

    {

     "name": "stdout",

     "output\_type": "stream",

     "text": [

      "Train Score: 4.77 RMSE\n",

      "Test Score: 5.57 RMSE\n"

     ]

    }

   ],

   "source": [

    "\n",

    "trainScore = math.sqrt(mean\_squared\_error(trainY[0], trainPredict[:, 0]))\n",

    "print('Train Score: %.2f RMSE' % (trainScore))\n",

    "testScore = math.sqrt(mean\_squared\_error(testY[0], testPredict[:, 0]))\n",

    "print('Test Score: %.2f RMSE' % (testScore))\n"

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 25,

   "metadata": {

    "collapsed": true

   },

   "outputs": [],

   "source": [

    "# shift train predictions for plotting\n",

    "trainPredictPlot = np.empty\_like(dataset)\n",

    "trainPredictPlot[:, :] = np.nan\n",

    "trainPredictPlot[look\_back:len(trainPredict) + look\_back, :] = trainPredict\n",

    " "

   ]

  },

  {

   "cell\_type": "code",

   "execution\_count": 39,

   "metadata": {

    "collapsed": true

   },

   "outputs": [],

   "source": [

    " # shift test predictions for plotting\n",

    "testPredictPlot = np.empty\_like(dataset)\n",

    "testPredictPlot[:, :] = np.nan\n",

    "testPredictPlot[len(trainPredict) + (look\_back \* 2) + 1:len(dataset) - 1, :] = testPredict\n",

    " \n"

   ]

  },

  {

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   "metadata": {},

   "outputs": [

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   "pygments\_lexer": "ipython2",

   "version": "2.7.11"

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