In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from statistics import mean

pd.set_option('display.max_columns', None)
```

In [2]:
```
# Import Data
data_df = pd.read_csv('sf_data.csv', header = None)
```

1 Data Cleaning

1.1 Feature Space

Each data set contains the following Features (in order):

- House ID #
- Price (deflated to year 2000 dollars)
- county ID # (see below)
- Year Built
- Square Footage
- # Bathrooms
- # Bedrooms
- # Total Rooms
- # Stories
- Violent Crime Rate (Cases per 100,000)
- Property Crime Rate (Cases Per 100,000)
- Year of Sale (1993-2008)

In [3]:
```
# Rename the columns
data_df.rename(columns={0: 'House_ID', 1: 'Price', 2: 'County_ID',
                        3: 'Year_Built', 4: 'Square_Footage', 5: 'Bathrooms',
                        6: 'Bedrooms', 7: 'Rooms', 8: 'Stories',
                        9: 'VC', 10: 'PC', 11: 'Year_of_Sale'}, inplace=True)
```

1.2 Construct Dummies for Counties

- 1 Alameda
- 13 Contra costa
- 75 San Francisco
- 81 San Mateo
- 85 Santa Clara

For San Francisco, I include dummies for counties 13, 75, 81, and 85. Alameda is the baseline.

In [4]:
```
for label, county in enumerate(set(data_df.iloc[:]['County_ID'])):
    for i in range(len(data_df.index)):
        if data_df.iloc[i]['County_ID'] == county:
            data_df.at[i,str(county)] = 1
```

In [5]:
```
data_df = data_df.fillna(0)
```

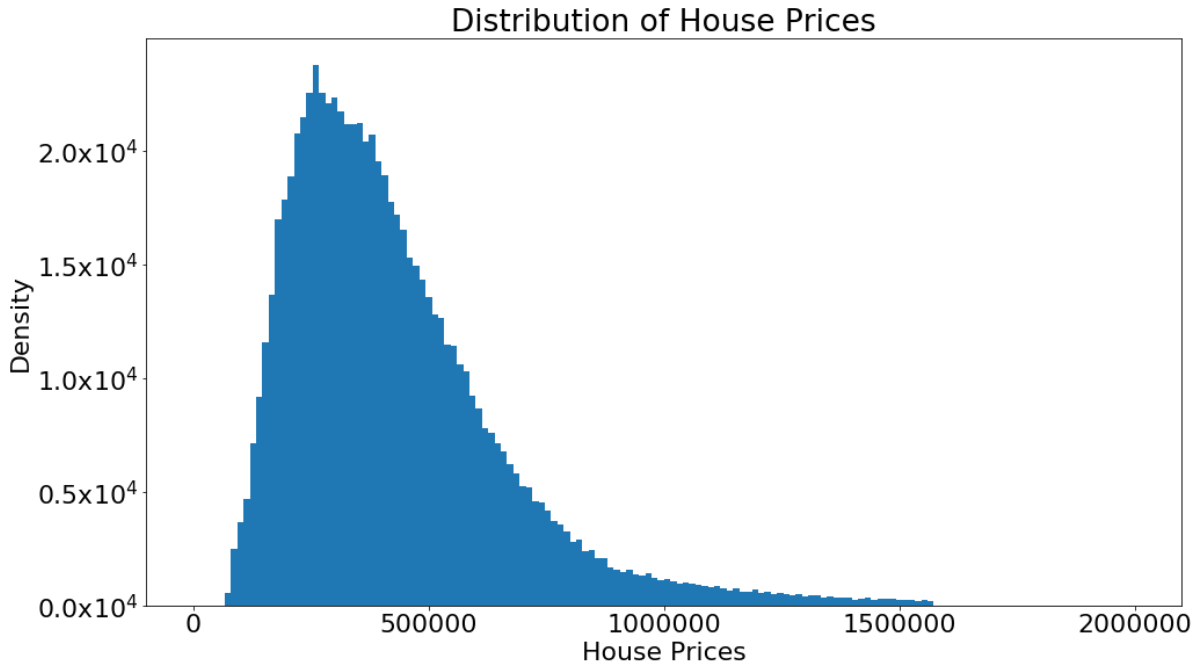
In [6]:
```
data_df.to_csv('data_modified.csv')
```

1.3 Discriptive Statistic

In [7]:
```
from scipy.stats import norm
from sklearn.neighbors import KernelDensity
from matplotlib.pyplot import MultipleLocator
from pylab import rcParams
from matplotlib.ticker import FuncFormatter
rcParams['figure.figsize'] = 16, 9
plt.rcParams.update({'font.size': 22})
```

In [12]:
```
plt.hist(y, bins=150, range = (1,2000000), density = True,
         label = 'Price')
plt.ylabel('Density')
plt.xlabel('House Prices')
plt.title('Distribution of House Prices')

x_major_locator=MultipleLocator(500000)
ax=plt.gca()
ax.xaxis.set_major_locator(x_major_locator)
def formatnum(x, pos):
    return '$%.1f$x$10^{4}$' % (x*1000000)
def formatnum_x(x, pos):
    return '$%.2f \pi$' % (x)
formatter1 = FuncFormatter(formatnum)
formatter2 = FuncFormatter(formatnum_x)
ax.yaxis.set_major_formatter(formatter1)
plt.savefig('Distribution of House Prices.png')
plt.show()
```



2 Models

The model assumption and economic theoretical base for the model is given in the write-up.

2.1 Linear Regression

2.1.1 Construct Variables for Regression

The linear regression model

- Constant
- # Bathrooms
- # Bedrooms
- # Stories
- Property Crime Rate
- (Property Crime Rate) ^{2}
- Year Built
- (Year Built) ^{2}
- Square Footage
- (Square Footage) ^{2}
- # Total Rooms
- (# Total Rooms) ^{2}
- Violent Crime Rate
- (Violent Crime Rate) ^{2}
- Vector of Year Dummies (omit 1999)
- Vector of Dummies for Certain Counties ^{2}

2.1.2 Conduct Linear Regression on Training Set

The first two parts are written in my Fortran code. They following python code aim to read the regression result and make prediction on testing set.

2.1.3 Make Prediction on Testing Set

In [9]:
```
# Read dataset
X_df = pd.read_csv('X_SF.csv')
y_df = pd.read_csv('y_SF.csv', header = None)
y_df.rename(columns={0: 'Price'}, inplace=True)
```

In [10]:
```
# Read regression results
reg_result = pd.read_csv('Hedonic_Price_Function_Regression_Results_SF.csv')
```

In [11]:
```
X = X_df.to_numpy()
y = y_df.to_numpy()
beta = reg_result.to_numpy()[0][:]

# Construct Testing Set (10% of the all samples)
X_test = X[340426:][:]
y_test = y[340426:][:]
```

In [14]:
```
# Make predictions
y_pred = np.matmul(X_test, beta.T)
```

2.2 Keras Regressions

2.2.1 Seperate Dataset

In [64]:
```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Activation
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.wrappers.scikit_learn import KerasClassifier
from sklearn.model_selection import GridSearchCV
from sklearn import preprocessing
from sklearn.model_selection import KFold
```

In [59]:
```
# Nomalized the features

X = preprocessing.scale(X)
```

In [55]:
```
X_test = X[340426:][:]
y_test = y[340426:]
X_train = X[:340426][:]
y_train = y[:340426]
```

2.2.2 Train the Neural Network Model with Cross Validation

I cross validate the number of epochs times.

In [ ]:
```
def creat_model(layer = 5):
    clt_nn = Sequential()
    for i in range(layer):
        clt_nn.add(Dense(33,activation='relu'))
    clt_nn.add(Dense(1))
    clt_nn.compile(optimizer='Adam',loss='mse')
    return clt_nn
```

In [104]:
```
X_train_df = pd.DataFrame(data=X_train)
y_train_df = pd.DataFrame(data=y_train)
```

In [106]:
```
EPOCH_MAX = 100
epochs = list(range(1,EPOCH_MAX+1))
val_loss = []
val_loss_mean = []

for train_index, test_index in kf.split(X_train):
    X_train_cross, X_test_cross = X_train_df.loc[train_index], X_train_df.loc[
test_index]
    y_train_cross, y_test_cross = y_train_df.loc[train_index], y_train_df.loc[
test_index]
    clt_nn = creat_model(5)
    history = clt_nn.fit(x=X_train_cross,y=y_train_cross,
          validation_data=(X_test_cross,y_test_cross),
          batch_size=256,epochs=EPOCH_MAX)
    val_loss.append(history.history['val_loss'])
val_loss_mean.append(np.mean(val_loss, axis=0))
```

```
Epoch 1/100
WARNING:tensorflow:Layer dense_195 is casting an input tensor from dtype floa
t64 to the layer's dtype of float32, which is new behavior in TensorFlow 2.
The layer has dtype float32 because its dtype defaults to floatx.

If you intended to run this layer in float32, you can safely ignore this warn
ing. If in doubt, this warning is likely only an issue if you are porting a T
ensorFlow 1.X model to TensorFlow 2.

To change all layers to have dtype float64 by default, call `tf.keras.backen
d.set_floatx('float64')`. To change just this layer, pass dtype='float64' to
the layer constructor. If you are the author of this layer, you can disable a
utocasting by passing autocast=False to the base Layer constructor.

1064/1064 [==============================] - 1s 1ms/step - loss: 61263572992.
0000 - val_loss: 68190650368.0000
Epoch 2/100
1064/1064 [==============================] - 1s 934us/step - loss: 1634299596
8.0000 - val_loss: 64050769920.0000
Epoch 3/100
1064/1064 [==============================] - 1s 937us/step - loss: 1533058048
0.0000 - val_loss: 52238340096.0000
Epoch 4/100
1064/1064 [==============================] - 1s 933us/step - loss: 1465024102
4.0000 - val_loss: 36747956224.0000
Epoch 5/100
1064/1064 [==============================] - 1s 935us/step - loss: 1417506918
4.0000 - val_loss: 26531129344.0000
Epoch 6/100
1064/1064 [==============================] - 1s 912us/step - loss: 1385683660
8.0000 - val_loss: 19664203776.0000
Epoch 7/100
1064/1064 [==============================] - 1s 951us/step - loss: 1357751603
2.0000 - val_loss: 16738002944.0000
Epoch 8/100
1064/1064 [==============================] - 1s 935us/step - loss: 1334510796
8.0000 - val_loss: 15927662592.0000
Epoch 9/100
1064/1064 [==============================] - 1s 927us/step - loss: 1315805798
4.0000 - val_loss: 16780314624.0000
Epoch 10/100
1064/1064 [==============================] - 1s 959us/step - loss: 1298764902
4.0000 - val_loss: 18297030656.0000
Epoch 11/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12839964672.
0000 - val_loss: 20837089280.0000
Epoch 12/100
1064/1064 [==============================] - 1s 922us/step - loss: 1269977702
4.0000 - val_loss: 23985649664.0000
Epoch 13/100
1064/1064 [==============================] - 1s 929us/step - loss: 1257812582
4.0000 - val_loss: 30214993920.0000
Epoch 14/100
1064/1064 [==============================] - 1s 984us/step - loss: 1246960844
8.0000 - val_loss: 32907278336.0000
Epoch 15/100
1064/1064 [==============================] - 1s 985us/step - loss: 1237562163
```

```
2.0000 - val_loss: 38302056448.0000
Epoch 16/100
1064/1064 [==============================] - 1s 936us/step - loss: 1230851788
8.0000 - val_loss: 46019731456.0000
Epoch 17/100
1064/1064 [==============================] - 1s 958us/step - loss: 1222913024
0.0000 - val_loss: 50010103808.0000
Epoch 18/100
1064/1064 [==============================] - 1s 937us/step - loss: 1216188518
4.0000 - val_loss: 59369287680.0000
Epoch 19/100
1064/1064 [==============================] - 1s 957us/step - loss: 1210091417
6.0000 - val_loss: 61903675392.0000
Epoch 20/100
1064/1064 [==============================] - 1s 912us/step - loss: 1204882944
0.0000 - val_loss: 68002013184.0000
Epoch 21/100
1064/1064 [==============================] - 1s 915us/step - loss: 1199496704
0.0000 - val_loss: 73518505984.0000
Epoch 22/100
1064/1064 [==============================] - 1s 915us/step - loss: 1195647488
0.0000 - val_loss: 76439609344.0000
Epoch 23/100
1064/1064 [==============================] - 1s 921us/step - loss: 1190723481
6.0000 - val_loss: 81414242304.0000
Epoch 24/100
1064/1064 [==============================] - 1s 914us/step - loss: 1185820057
6.0000 - val_loss: 90551394304.0000
Epoch 25/100
1064/1064 [==============================] - 1s 931us/step - loss: 1182389145
6.0000 - val_loss: 95207858176.0000
Epoch 26/100
1064/1064 [==============================] - 1s 922us/step - loss: 1178048000
0.0000 - val_loss: 94252490752.0000
Epoch 27/100
1064/1064 [==============================] - 1s 916us/step - loss: 1175012044
8.0000 - val_loss: 100071931904.0000
Epoch 28/100
1064/1064 [==============================] - 1s 927us/step - loss: 1170868531
2.0000 - val_loss: 103588855808.0000
Epoch 29/100
1064/1064 [==============================] - 1s 911us/step - loss: 1167751680
0.0000 - val_loss: 114145607680.0000
Epoch 30/100
1064/1064 [==============================] - 1s 925us/step - loss: 1164465971
2.0000 - val_loss: 114028797952.0000
Epoch 31/100
1064/1064 [==============================] - 1s 926us/step - loss: 1162503577
6.0000 - val_loss: 116933025792.0000
Epoch 32/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11605429248.
0000 - val_loss: 121678831616.0000
Epoch 33/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11583286272.
0000 - val_loss: 122603520000.0000
Epoch 34/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11559271424.
```

```
0000 - val_loss: 121354805248.0000
Epoch 35/100
1064/1064 [==============================] - 2s 2ms/step - loss: 11537476608.
0000 - val_loss: 124140240896.0000
Epoch 36/100
1064/1064 [==============================] - 2s 1ms/step - loss: 11524714496.
0000 - val_loss: 130942484480.0000
Epoch 37/100
1064/1064 [==============================] - 2s 1ms/step - loss: 11499382784.
0000 - val_loss: 136130707456.0000
Epoch 38/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11479267328.
0000 - val_loss: 136366014464.0000
Epoch 39/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11464581120.
0000 - val_loss: 146776080384.0000
Epoch 40/100
1064/1064 [==============================] - 2s 2ms/step - loss: 11438174208.
0000 - val_loss: 141004587008.0000
Epoch 41/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11432287232.
0000 - val_loss: 137711648768.0000
Epoch 42/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11415011328.
0000 - val_loss: 143306686464.0000
Epoch 43/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11394386944.
0000 - val_loss: 135824949248.0000
Epoch 44/100
1064/1064 [==============================] - 2s 2ms/step - loss: 11375207424.
0000 - val_loss: 140317605888.0000
Epoch 45/100
1064/1064 [==============================] - 3s 2ms/step - loss: 11353631744.
0000 - val_loss: 142990786560.0000
Epoch 46/100
1064/1064 [==============================] - 2s 1ms/step - loss: 11337247744.
0000 - val_loss: 143451865088.0000
Epoch 47/100
1064/1064 [==============================] - 2s 2ms/step - loss: 11314747392.
0000 - val_loss: 151173169152.0000
Epoch 48/100
1064/1064 [==============================] - 2s 2ms/step - loss: 11299586048.
0000 - val_loss: 145731878912.0000
Epoch 49/100
1064/1064 [==============================] - 2s 2ms/step - loss: 11284261888.
0000 - val_loss: 157875273728.0000
Epoch 50/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11266202624.
0000 - val_loss: 153581731840.0000
Epoch 51/100
1064/1064 [==============================] - 2s 2ms/step - loss: 11259620352.
0000 - val_loss: 141104414720.0000
Epoch 52/100
1064/1064 [==============================] - 2s 1ms/step - loss: 11241334784.
0000 - val_loss: 142481817600.0000
Epoch 53/100
1064/1064 [==============================] - 2s 2ms/step - loss: 11229539328.
```

```
0000 - val_loss: 147683917824.0000
Epoch 54/100
1064/1064 [==============================] - 2s 1ms/step - loss: 11210594304.
0000 - val_loss: 138389061632.0000
Epoch 55/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11199271936.
0000 - val_loss: 152848826368.0000
Epoch 56/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11192562688.
0000 - val_loss: 143901605888.0000
Epoch 57/100
1064/1064 [==============================] - 1s 995us/step - loss: 1117840691
2.0000 - val_loss: 143765798912.0000
Epoch 58/100
1064/1064 [==============================] - 1s 933us/step - loss: 1117481369
6.0000 - val_loss: 153442205696.0000
Epoch 59/100
1064/1064 [==============================] - 1s 940us/step - loss: 1115451494
4.0000 - val_loss: 152867012608.0000
Epoch 60/100
1064/1064 [==============================] - 1s 909us/step - loss: 1115556147
2.0000 - val_loss: 150288384000.0000
Epoch 61/100
1064/1064 [==============================] - 1s 974us/step - loss: 1113211801
6.0000 - val_loss: 157044146176.0000
Epoch 62/100
1064/1064 [==============================] - 1s 957us/step - loss: 1112732057
6.0000 - val_loss: 157934616576.0000
Epoch 63/100
1064/1064 [==============================] - 1s 945us/step - loss: 1110690611
2.0000 - val_loss: 161147076608.0000
Epoch 64/100
1064/1064 [==============================] - 1s 982us/step - loss: 1110895001
6.0000 - val_loss: 163586179072.0000
Epoch 65/100
1064/1064 [==============================] - 1s 916us/step - loss: 1108645171
2.0000 - val_loss: 167602110464.0000
Epoch 66/100
1064/1064 [==============================] - 1s 915us/step - loss: 1108934860
8.0000 - val_loss: 157278093312.0000
Epoch 67/100
1064/1064 [==============================] - 1s 913us/step - loss: 1107793203
2.0000 - val_loss: 165541396480.0000
Epoch 68/100
1064/1064 [==============================] - 1s 999us/step - loss: 1106707148
8.0000 - val_loss: 156567846912.0000
Epoch 69/100
1064/1064 [==============================] - 1s 955us/step - loss: 1106243686
4.0000 - val_loss: 165919375360.0000
Epoch 70/100
1064/1064 [==============================] - 1s 999us/step - loss: 1104818483
2.0000 - val_loss: 167612366848.0000
Epoch 71/100
1064/1064 [==============================] - 1s 957us/step - loss: 1104126259
2.0000 - val_loss: 168193392640.0000
Epoch 72/100
1064/1064 [==============================] - 1s 951us/step - loss: 1103529369
```

```
6.0000 - val_loss: 166323830784.0000
Epoch 73/100
1064/1064 [==============================] - 1s 933us/step - loss: 1102580019
2.0000 - val_loss: 158965432320.0000
Epoch 74/100
1064/1064 [==============================] - 1s 941us/step - loss: 1102952243
2.0000 - val_loss: 186493321216.0000
Epoch 75/100
1064/1064 [==============================] - 1s 925us/step - loss: 1101570969
6.0000 - val_loss: 172662030336.0000
Epoch 76/100
1064/1064 [==============================] - 1s 944us/step - loss: 1100594585
6.0000 - val_loss: 169081503744.0000
Epoch 77/100
1064/1064 [==============================] - 1s 931us/step - loss: 1100408422
4.0000 - val_loss: 167957479424.0000
Epoch 78/100
1064/1064 [==============================] - 1s 998us/step - loss: 1098998681
6.0000 - val_loss: 170661019648.0000
Epoch 79/100
1064/1064 [==============================] - 1s 929us/step - loss: 1099627520
0.0000 - val_loss: 177441898496.0000
Epoch 80/100
1064/1064 [==============================] - 1s 961us/step - loss: 1098454937
6.0000 - val_loss: 170818420736.0000
Epoch 81/100
1064/1064 [==============================] - 1s 934us/step - loss: 1096620236
8.0000 - val_loss: 177505812480.0000
Epoch 82/100
1064/1064 [==============================] - 1s 937us/step - loss: 1096130252
8.0000 - val_loss: 180724482048.0000
Epoch 83/100
1064/1064 [==============================] - 1s 930us/step - loss: 1096347340
8.0000 - val_loss: 171737088000.0000
Epoch 84/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10963958784.
0000 - val_loss: 176354263040.0000
Epoch 85/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10943742976.
0000 - val_loss: 172222676992.0000
Epoch 86/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10945781760.
0000 - val_loss: 172448399360.0000
Epoch 87/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10952307712.
0000 - val_loss: 171793039360.0000
Epoch 88/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10936190976.
0000 - val_loss: 171370692608.0000
Epoch 89/100
1064/1064 [==============================] - 1s 988us/step - loss: 1093161984
0.0000 - val_loss: 178570379264.0000
Epoch 90/100
1064/1064 [==============================] - 1s 943us/step - loss: 1093070131
2.0000 - val_loss: 180039188480.0000
Epoch 91/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10923831296.
```

```
0000 - val_loss: 173050904576.0000
Epoch 92/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10921221120.
0000 - val_loss: 173433815040.0000
Epoch 93/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10912937984.
0000 - val_loss: 182240755712.0000
Epoch 94/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10911477760.
0000 - val_loss: 160751190016.0000
Epoch 95/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10908975104.
0000 - val_loss: 179574128640.0000
Epoch 96/100
1064/1064 [==============================] - 1s 951us/step - loss: 1089822105
6.0000 - val_loss: 171635769344.0000
Epoch 97/100
1064/1064 [==============================] - 1s 986us/step - loss: 1090994380
8.0000 - val_loss: 179873071104.0000
Epoch 98/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10891727872.
0000 - val_loss: 175017295872.0000
Epoch 99/100
1064/1064 [==============================] - 1s 979us/step - loss: 1088365670
4.0000 - val_loss: 184626118656.0000
Epoch 100/100
1064/1064 [==============================] - 1s 920us/step - loss: 1087673548
8.0000 - val_loss: 181681242112.0000
Epoch 1/100
WARNING:tensorflow:Layer dense_201 is casting an input tensor from dtype floa
t64 to the layer's dtype of float32, which is new behavior in TensorFlow 2.
The layer has dtype float32 because its dtype defaults to floatx.

If you intended to run this layer in float32, you can safely ignore this warn
ing. If in doubt, this warning is likely only an issue if you are porting a T
ensorFlow 1.X model to TensorFlow 2.

To change all layers to have dtype float64 by default, call `tf.keras.backen
d.set_floatx('float64')`. To change just this layer, pass dtype='float64' to
the layer constructor. If you are the author of this layer, you can disable a
utocasting by passing autocast=False to the base Layer constructor.

1064/1064 [==============================] - 1s 1ms/step - loss: 62289788928.
0000 - val_loss: 70376579072.0000
Epoch 2/100
1064/1064 [==============================] - 1s 950us/step - loss: 1588780851
2.0000 - val_loss: 63667720192.0000
Epoch 3/100
1064/1064 [==============================] - 1s 1ms/step - loss: 14864551936.
0000 - val_loss: 49012969472.0000
Epoch 4/100
1064/1064 [==============================] - 1s 998us/step - loss: 1427249254
4.0000 - val_loss: 34828546048.0000
Epoch 5/100
1064/1064 [==============================] - 1s 946us/step - loss: 1387959091
2.0000 - val_loss: 25561982976.0000
Epoch 6/100
```

```
1064/1064 [==============================] - 1s 935us/step - loss: 1361306931
2.0000 - val_loss: 21620369408.0000
Epoch 7/100
1064/1064 [==============================] - 1s 981us/step - loss: 1340487680
0.0000 - val_loss: 19665973248.0000
Epoch 8/100
1064/1064 [==============================] - 1s 1ms/step - loss: 13255555072.
0000 - val_loss: 18210119680.0000
Epoch 9/100
1064/1064 [==============================] - 1s 1ms/step - loss: 13125841920.
0000 - val_loss: 16936879104.0000
Epoch 10/100
1064/1064 [==============================] - 1s 1ms/step - loss: 13011860480.
0000 - val_loss: 16012668928.0000
Epoch 11/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12909043712.
0000 - val_loss: 15375980544.0000
Epoch 12/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12827793408.
0000 - val_loss: 14999399424.0000
Epoch 13/100
1064/1064 [==============================] - 1s 996us/step - loss: 1272953241
6.0000 - val_loss: 15115657216.0000
Epoch 14/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12637230080.
0000 - val_loss: 15646139392.0000
Epoch 15/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12551930880.
0000 - val_loss: 16112450560.0000
Epoch 16/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12464005120.
0000 - val_loss: 17920747520.0000
Epoch 17/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12383760384.
0000 - val_loss: 17918416896.0000
Epoch 18/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12298292224.
0000 - val_loss: 19615791104.0000
Epoch 19/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12216274944.
0000 - val_loss: 20605872128.0000
Epoch 20/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12145609728.
0000 - val_loss: 23383119872.0000
Epoch 21/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12084891648.
0000 - val_loss: 26588641280.0000
Epoch 22/100
1064/1064 [==============================] - 1s 962us/step - loss: 1203093913
6.0000 - val_loss: 27163555840.0000
Epoch 23/100
1064/1064 [==============================] - 1s 969us/step - loss: 1197582848
0.0000 - val_loss: 30977994752.0000
Epoch 24/100
1064/1064 [==============================] - 1s 962us/step - loss: 1192024166
4.0000 - val_loss: 36875550720.0000
Epoch 25/100
```

```
1064/1064 [==============================] - 1s 986us/step - loss: 1187618304
0.0000 - val_loss: 39620284416.0000
Epoch 26/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11831590912.
0000 - val_loss: 42758918144.0000
Epoch 27/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11790742528.
0000 - val_loss: 47127789568.0000
Epoch 28/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11761858560.
0000 - val_loss: 48710787072.0000
Epoch 29/100
1064/1064 [==============================] - 1s 977us/step - loss: 1171698176
0.0000 - val_loss: 53284634624.0000
Epoch 30/100
1064/1064 [==============================] - 1s 937us/step - loss: 1169048780
8.0000 - val_loss: 59507449856.0000
Epoch 31/100
1064/1064 [==============================] - 1s 932us/step - loss: 1166957568
0.0000 - val_loss: 58791800832.0000
Epoch 32/100
1064/1064 [==============================] - 1s 916us/step - loss: 1163470540
8.0000 - val_loss: 62678032384.0000
Epoch 33/100
1064/1064 [==============================] - 1s 934us/step - loss: 1160460697
6.0000 - val_loss: 68381536256.0000
Epoch 34/100
1064/1064 [==============================] - 1s 940us/step - loss: 1158588518
4.0000 - val_loss: 68115058688.0000
Epoch 35/100
1064/1064 [==============================] - 1s 927us/step - loss: 1155269324
8.0000 - val_loss: 73336070144.0000
Epoch 36/100
1064/1064 [==============================] - 1s 907us/step - loss: 1153847808
0.0000 - val_loss: 76034949120.0000
Epoch 37/100
1064/1064 [==============================] - 1s 940us/step - loss: 1149833728
0.0000 - val_loss: 78107484160.0000
Epoch 38/100
1064/1064 [==============================] - 1s 923us/step - loss: 1148630835
2.0000 - val_loss: 84761452544.0000
Epoch 39/100
1064/1064 [==============================] - 1s 951us/step - loss: 1146600140
8.0000 - val_loss: 88288272384.0000
Epoch 40/100
1064/1064 [==============================] - 1s 948us/step - loss: 1144697548
8.0000 - val_loss: 89444974592.0000
Epoch 41/100
1064/1064 [==============================] - 1s 996us/step - loss: 1144165785
6.0000 - val_loss: 91242807296.0000
Epoch 42/100
1064/1064 [==============================] - 1s 944us/step - loss: 1141024153
6.0000 - val_loss: 96964050944.0000
Epoch 43/100
1064/1064 [==============================] - 1s 952us/step - loss: 1139181363
2.0000 - val_loss: 93910564864.0000
Epoch 44/100
```

```
1064/1064 [==============================] - 1s 952us/step - loss: 1137949081
6.0000 - val_loss: 97082728448.0000
Epoch 45/100
1064/1064 [==============================] - 1s 945us/step - loss: 1135540531
2.0000 - val_loss: 100840284160.0000
Epoch 46/100
1064/1064 [==============================] - 1s 941us/step - loss: 1133770547
2.0000 - val_loss: 103938809856.0000
Epoch 47/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11316634624.
0000 - val_loss: 102421127168.0000
Epoch 48/100
1064/1064 [==============================] - 1s 952us/step - loss: 1130193920
0.0000 - val_loss: 106512318464.0000
Epoch 49/100
1064/1064 [==============================] - 1s 944us/step - loss: 1128605388
8.0000 - val_loss: 111275081728.0000
Epoch 50/100
1064/1064 [==============================] - 1s 997us/step - loss: 1126355251
2.0000 - val_loss: 114010644480.0000
Epoch 51/100
1064/1064 [==============================] - 1s 950us/step - loss: 1124563558
4.0000 - val_loss: 113851392000.0000
Epoch 52/100
1064/1064 [==============================] - 1s 935us/step - loss: 1124086374
4.0000 - val_loss: 118151053312.0000
Epoch 53/100
1064/1064 [==============================] - 1s 925us/step - loss: 1121390592
0.0000 - val_loss: 117811118080.0000
Epoch 54/100
1064/1064 [==============================] - 1s 945us/step - loss: 1120821555
2.0000 - val_loss: 118854893568.0000
Epoch 55/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11181431808.
0000 - val_loss: 120079597568.0000
Epoch 56/100
1064/1064 [==============================] - 1s 989us/step - loss: 1118628864
0.0000 - val_loss: 119371964416.0000
Epoch 57/100
1064/1064 [==============================] - 1s 962us/step - loss: 1116357324
8.0000 - val_loss: 125009559552.0000
Epoch 58/100
1064/1064 [==============================] - 1s 925us/step - loss: 1115893657
6.0000 - val_loss: 124012789760.0000
Epoch 59/100
1064/1064 [==============================] - 1s 948us/step - loss: 1114005913
6.0000 - val_loss: 129136336896.0000
Epoch 60/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11137038336.
0000 - val_loss: 132154474496.0000
Epoch 61/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11115403264.
0000 - val_loss: 135619674112.0000
Epoch 62/100
1064/1064 [==============================] - 1s 976us/step - loss: 1111416422
4.0000 - val_loss: 140033310720.0000
Epoch 63/100
```

```
1064/1064 [==============================] - 1s 961us/step - loss: 1110684364
8.0000 - val_loss: 141754810368.0000
Epoch 64/100
1064/1064 [==============================] - 1s 938us/step - loss: 1108994867
2.0000 - val_loss: 143704735744.0000
Epoch 65/100
1064/1064 [==============================] - 1s 960us/step - loss: 1109361664
0.0000 - val_loss: 140287180800.0000
Epoch 66/100
1064/1064 [==============================] - 1s 931us/step - loss: 1106485145
6.0000 - val_loss: 146666225664.0000
Epoch 67/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11068278784.
0000 - val_loss: 149697495040.0000
Epoch 68/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11046841344.
0000 - val_loss: 153727385600.0000
Epoch 69/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11038736384.
0000 - val_loss: 151820877824.0000
Epoch 70/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11023304704.
0000 - val_loss: 157767761920.0000
Epoch 71/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11015998464.
0000 - val_loss: 160357859328.0000
Epoch 72/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10998503424.
0000 - val_loss: 167721992192.0000
Epoch 73/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10987281408.
0000 - val_loss: 160360202240.0000
Epoch 74/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10978409472.
0000 - val_loss: 168090550272.0000
Epoch 75/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10974670848.
0000 - val_loss: 166236422144.0000
Epoch 76/100
1064/1064 [==============================] - 1s 980us/step - loss: 1095244800
0.0000 - val_loss: 163370565632.0000
Epoch 77/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10940542976.
0000 - val_loss: 172763398144.0000
Epoch 78/100
1064/1064 [==============================] - 2s 1ms/step - loss: 10940640256.
0000 - val_loss: 180715274240.0000
Epoch 79/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10919339008.
0000 - val_loss: 169765257216.0000
Epoch 80/100
1064/1064 [==============================] - 2s 1ms/step - loss: 10915709952.
0000 - val_loss: 175688482816.0000
Epoch 81/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10901163008.
0000 - val_loss: 179552190464.0000
Epoch 82/100
```

```
1064/1064 [==============================] - 1s 1ms/step - loss: 10895591424.
0000 - val_loss: 186911113216.0000
Epoch 83/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10880135168.
0000 - val_loss: 192470384640.0000
Epoch 84/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10883444736.
0000 - val_loss: 191337168896.0000
Epoch 85/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10856797184.
0000 - val_loss: 204123865088.0000
Epoch 86/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10850757632.
0000 - val_loss: 196913774592.0000
Epoch 87/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10842009600.
0000 - val_loss: 202463756288.0000
Epoch 88/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10830552064.
0000 - val_loss: 213009416192.0000
Epoch 89/100
1064/1064 [==============================] - 1s 941us/step - loss: 1082110771
2.0000 - val_loss: 203969691648.0000
Epoch 90/100
1064/1064 [==============================] - 1s 844us/step - loss: 1080504832
0.0000 - val_loss: 213747204096.0000
Epoch 91/100
1064/1064 [==============================] - 1s 848us/step - loss: 1079242547
2.0000 - val_loss: 213800255488.0000
Epoch 92/100
1064/1064 [==============================] - 1s 839us/step - loss: 1078567833
6.0000 - val_loss: 225413234688.0000
Epoch 93/100
1064/1064 [==============================] - 1s 839us/step - loss: 1077664870
4.0000 - val_loss: 223108726784.0000
Epoch 94/100
1064/1064 [==============================] - 1s 841us/step - loss: 1077223526
4.0000 - val_loss: 229779619840.0000
Epoch 95/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10770356224.
0000 - val_loss: 218869268480.0000
Epoch 96/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10746604544.
0000 - val_loss: 221626253312.0000
Epoch 97/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10746406912.
0000 - val_loss: 239213133824.0000
Epoch 98/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10729841664.
0000 - val_loss: 234513940480.0000
Epoch 99/100
1064/1064 [==============================] - 1s 967us/step - loss: 1073040486
4.0000 - val_loss: 228751310848.0000
Epoch 100/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10720730112.
0000 - val_loss: 233431433216.0000
Epoch 1/100
```

```
WARNING:tensorflow:Layer dense_207 is casting an input tensor from dtype floa
t64 to the layer's dtype of float32, which is new behavior in TensorFlow 2.
The layer has dtype float32 because its dtype defaults to floatx.

If you intended to run this layer in float32, you can safely ignore this warn
ing. If in doubt, this warning is likely only an issue if you are porting a T
ensorFlow 1.X model to TensorFlow 2.

To change all layers to have dtype float64 by default, call `tf.keras.backen
d.set_floatx('float64')`. To change just this layer, pass dtype='float64' to
the layer constructor. If you are the author of this layer, you can disable a
utocasting by passing autocast=False to the base Layer constructor.

1064/1064 [==============================] - 1s 1ms/step - loss: 51177070592.
0000 - val_loss: 74177011712.0000
Epoch 2/100
1064/1064 [==============================] - 1s 853us/step - loss: 1428323737
6.0000 - val_loss: 69672042496.0000
Epoch 3/100
1064/1064 [==============================] - 1s 926us/step - loss: 1336940851
2.0000 - val_loss: 56467451904.0000
Epoch 4/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12861970432.
0000 - val_loss: 45665423360.0000
Epoch 5/100
1064/1064 [==============================] - 1s 948us/step - loss: 1256782131
2.0000 - val_loss: 37454061568.0000
Epoch 6/100
1064/1064 [==============================] - 1s 995us/step - loss: 1236547686
4.0000 - val_loss: 30380525568.0000
Epoch 7/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12212695040.
0000 - val_loss: 25432745984.0000
Epoch 8/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12074799104.
0000 - val_loss: 23045345280.0000
Epoch 9/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11970360320.
0000 - val_loss: 20920295424.0000
Epoch 10/100
1064/1064 [==============================] - 1s 844us/step - loss: 1187515596
8.0000 - val_loss: 20664121344.0000
Epoch 11/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11783093248.
0000 - val_loss: 20590376960.0000
Epoch 12/100
1064/1064 [==============================] - 1s 962us/step - loss: 1169670451
2.0000 - val_loss: 21067079680.0000
Epoch 13/100
1064/1064 [==============================] - 1s 946us/step - loss: 1161231462
4.0000 - val_loss: 22508414976.0000
Epoch 14/100
1064/1064 [==============================] - 1s 849us/step - loss: 1154938163
2.0000 - val_loss: 24114589696.0000
Epoch 15/100
1064/1064 [==============================] - 1s 886us/step - loss: 1148316467
2.0000 - val_loss: 26227580928.0000
```

```
Epoch 16/100
1064/1064 [==============================] - 1s 957us/step - loss: 1139927449
6.0000 - val_loss: 29860100096.0000
Epoch 17/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11319311360.
0000 - val_loss: 32793307136.0000
Epoch 18/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11254252544.
0000 - val_loss: 37080408064.0000
Epoch 19/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11187047424.
0000 - val_loss: 38107807744.0000
Epoch 20/100
1064/1064 [==============================] - 1s 862us/step - loss: 1113721241
6.0000 - val_loss: 46034055168.0000
Epoch 21/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11091007488.
0000 - val_loss: 48878137344.0000
Epoch 22/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11050268672.
0000 - val_loss: 52279418880.0000
Epoch 23/100
1064/1064 [==============================] - 1s 860us/step - loss: 1101799321
6.0000 - val_loss: 55378542592.0000
Epoch 24/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10971959296.
0000 - val_loss: 61234270208.0000
Epoch 25/100
1064/1064 [==============================] - 1s 995us/step - loss: 1095362048
0.0000 - val_loss: 63527272448.0000
Epoch 26/100
1064/1064 [==============================] - 1s 909us/step - loss: 1092612812
8.0000 - val_loss: 71169925120.0000
Epoch 27/100
1064/1064 [==============================] - 1s 906us/step - loss: 1089973862
4.0000 - val_loss: 75630854144.0000
Epoch 28/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10876169216.
0000 - val_loss: 80060014592.0000
Epoch 29/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10857957376.
0000 - val_loss: 85873623040.0000
Epoch 30/100
1064/1064 [==============================] - 2s 1ms/step - loss: 10832067584.
0000 - val_loss: 87251386368.0000
Epoch 31/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10822371328.
0000 - val_loss: 96902537216.0000
Epoch 32/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10801880064.
0000 - val_loss: 95837995008.0000
Epoch 33/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10776414208.
0000 - val_loss: 100437368832.0000
Epoch 34/100
1064/1064 [==============================] - 2s 1ms/step - loss: 10772210688.
0000 - val_loss: 109712334848.0000
```

```
Epoch 35/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10749969408.
0000 - val_loss: 111488122880.0000
Epoch 36/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10736436224.
0000 - val_loss: 119324205056.0000
Epoch 37/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10716187648.
0000 - val_loss: 121201262592.0000
Epoch 38/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10701928448.
0000 - val_loss: 123157323776.0000
Epoch 39/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10695813120.
0000 - val_loss: 134809722880.0000
Epoch 40/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10679128064.
0000 - val_loss: 134714564608.0000
Epoch 41/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10670359552.
0000 - val_loss: 145471258624.0000
Epoch 42/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10655372288.
0000 - val_loss: 150742614016.0000
Epoch 43/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10648139776.
0000 - val_loss: 151595450368.0000
Epoch 44/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10641873920.
0000 - val_loss: 152461410304.0000
Epoch 45/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10627785728.
0000 - val_loss: 163240198144.0000
Epoch 46/100
1064/1064 [==============================] - 1s 964us/step - loss: 1060611686
4.0000 - val_loss: 174074019840.0000
Epoch 47/100
1064/1064 [==============================] - 1s 983us/step - loss: 1059535974
4.0000 - val_loss: 176755507200.0000
Epoch 48/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10585776128.
0000 - val_loss: 191276630016.0000
Epoch 49/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10580020224.
0000 - val_loss: 191630737408.0000
Epoch 50/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10564880384.
0000 - val_loss: 194448293888.0000
Epoch 51/100
1064/1064 [==============================] - 1s 949us/step - loss: 1055251865
6.0000 - val_loss: 208655187968.0000
Epoch 52/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10548687872.
0000 - val_loss: 219872837632.0000
Epoch 53/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10537368576.
0000 - val_loss: 218038435840.0000
```

```
Epoch 54/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10531240960.
0000 - val_loss: 235487805440.0000
Epoch 55/100
1064/1064 [==============================] - 2s 2ms/step - loss: 10508110848.
0000 - val_loss: 237037699072.0000
Epoch 56/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10509708288.
0000 - val_loss: 250843250688.0000
Epoch 57/100
1064/1064 [==============================] - 2s 2ms/step - loss: 10500177920.
0000 - val_loss: 248111071232.0000
Epoch 58/100
1064/1064 [==============================] - 2s 2ms/step - loss: 10491874304.
0000 - val_loss: 267607752704.0000
Epoch 59/100
1064/1064 [==============================] - 2s 2ms/step - loss: 10480156672.
0000 - val_loss: 270016233472.0000
Epoch 60/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10468754432.
0000 - val_loss: 280760483840.0000
Epoch 61/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10471188480.
0000 - val_loss: 271767945216.0000
Epoch 62/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10456879104.
0000 - val_loss: 282641825792.0000
Epoch 63/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10450588672.
0000 - val_loss: 296037154816.0000
Epoch 64/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10433973248.
0000 - val_loss: 302672707584.0000
Epoch 65/100
1064/1064 [==============================] - 2s 1ms/step - loss: 10436939776.
0000 - val_loss: 306326011904.0000
Epoch 66/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10429043712.
0000 - val_loss: 334498037760.0000
Epoch 67/100
1064/1064 [==============================] - 1s 976us/step - loss: 1043011174
4.0000 - val_loss: 320677642240.0000
Epoch 68/100
1064/1064 [==============================] - 1s 930us/step - loss: 1041325977
6.0000 - val_loss: 344276893696.0000
Epoch 69/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10398188544.
0000 - val_loss: 343738777600.0000
Epoch 70/100
1064/1064 [==============================] - 2s 2ms/step - loss: 10396769280.
0000 - val_loss: 355572023296.0000
Epoch 71/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10388610048.
0000 - val_loss: 349689118720.0000
Epoch 72/100
1064/1064 [==============================] - 2s 2ms/step - loss: 10392200192.
0000 - val_loss: 364222644224.0000
```

```
Epoch 73/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10372092928.
0000 - val_loss: 367567372288.0000
Epoch 74/100
1064/1064 [==============================] - 2s 1ms/step - loss: 10371229696.
0000 - val_loss: 391460028416.0000
Epoch 75/100
1064/1064 [==============================] - 2s 1ms/step - loss: 10356147200.
0000 - val_loss: 405893808128.0000
Epoch 76/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10355487744.
0000 - val_loss: 405934768128.0000
Epoch 77/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10349068288.
0000 - val_loss: 389220925440.0000
Epoch 78/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10337674240.
0000 - val_loss: 411902279680.0000
Epoch 79/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10343550976.
0000 - val_loss: 417799143424.0000
Epoch 80/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10325937152.
0000 - val_loss: 439828054016.0000
Epoch 81/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10312760320.
0000 - val_loss: 446411833344.0000
Epoch 82/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10325401600.
0000 - val_loss: 465100570624.0000
Epoch 83/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10315737088.
0000 - val_loss: 479901089792.0000
Epoch 84/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10296687616.
0000 - val_loss: 475261796352.0000
Epoch 85/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10294617088.
0000 - val_loss: 485032919040.0000
Epoch 86/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10292023296.
0000 - val_loss: 497918214144.0000
Epoch 87/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10278509568.
0000 - val_loss: 486608961536.0000
Epoch 88/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10271782912.
0000 - val_loss: 504391368704.0000
Epoch 89/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10269554688.
0000 - val_loss: 537477021696.0000
Epoch 90/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10253815808.
0000 - val_loss: 525106872320.0000
Epoch 91/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10255426560.
0000 - val_loss: 540535750656.0000
```

```
Epoch 92/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10252565504.
0000 - val_loss: 550126747648.0000
Epoch 93/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10244366336.
0000 - val_loss: 561820663808.0000
Epoch 94/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10227173376.
0000 - val_loss: 570232733696.0000
Epoch 95/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10221932544.
0000 - val_loss: 558144356352.0000
Epoch 96/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10214896640.
0000 - val_loss: 578575925248.0000
Epoch 97/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10212174848.
0000 - val_loss: 591160672256.0000
Epoch 98/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10195898368.
0000 - val_loss: 558976794624.0000
Epoch 99/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10201959424.
0000 - val_loss: 596358791168.0000
Epoch 100/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10187860992.
0000 - val_loss: 608555827200.0000
Epoch 1/100
WARNING:tensorflow:Layer dense_213 is casting an input tensor from dtype floa
t64 to the layer's dtype of float32, which is new behavior in TensorFlow 2.
The layer has dtype float32 because its dtype defaults to floatx.

If you intended to run this layer in float32, you can safely ignore this warn
ing. If in doubt, this warning is likely only an issue if you are porting a T
ensorFlow 1.X model to TensorFlow 2.

To change all layers to have dtype float64 by default, call `tf.keras.backen
d.set_floatx('float64')`. To change just this layer, pass dtype='float64' to
the layer constructor. If you are the author of this layer, you can disable a
utocasting by passing autocast=False to the base Layer constructor.

1064/1064 [==============================] - 1s 1ms/step - loss: 52804882432.
0000 - val_loss: 78227824640.0000
Epoch 2/100
1064/1064 [==============================] - 1s 1ms/step - loss: 14510166016.
0000 - val_loss: 64559190016.0000
Epoch 3/100
1064/1064 [==============================] - 1s 1ms/step - loss: 13600645120.
0000 - val_loss: 53285236736.0000
Epoch 4/100
1064/1064 [==============================] - 1s 1ms/step - loss: 13153610752.
0000 - val_loss: 42483580928.0000
Epoch 5/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12875628544.
0000 - val_loss: 34546982912.0000
Epoch 6/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12669473792.
```

```
0000 - val_loss: 27512301568.0000
Epoch 7/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12496987136.
0000 - val_loss: 23906695168.0000
Epoch 8/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12335073280.
0000 - val_loss: 20943790080.0000
Epoch 9/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12188302336.
0000 - val_loss: 18758705152.0000
Epoch 10/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12049709056.
0000 - val_loss: 18043191296.0000
Epoch 11/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11925315584.
0000 - val_loss: 18317592576.0000
Epoch 12/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11811689472.
0000 - val_loss: 20543193088.0000
Epoch 13/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11692709888.
0000 - val_loss: 24080963584.0000
Epoch 14/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11600818176.
0000 - val_loss: 27910600704.0000
Epoch 15/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11523555328.
0000 - val_loss: 31870795776.0000
Epoch 16/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11435475968.
0000 - val_loss: 35923501056.0000
Epoch 17/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11361034240.
0000 - val_loss: 41416781824.0000
Epoch 18/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11297926144.
0000 - val_loss: 47593484288.0000
Epoch 19/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11243005952.
0000 - val_loss: 50451181568.0000
Epoch 20/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11199517696.
0000 - val_loss: 52829917184.0000
Epoch 21/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11164800000.
0000 - val_loss: 58309754880.0000
Epoch 22/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11129650176.
0000 - val_loss: 66700656640.0000
Epoch 23/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11099537408.
0000 - val_loss: 68690198528.0000
Epoch 24/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11064796160.
0000 - val_loss: 79303761920.0000
Epoch 25/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11053713408.
```

```
0000 - val_loss: 82046369792.0000
Epoch 26/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11017798656.
0000 - val_loss: 95121457152.0000
Epoch 27/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11005619200.
0000 - val_loss: 101813297152.0000
Epoch 28/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10980543488.
0000 - val_loss: 103951319040.0000
Epoch 29/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10958560256.
0000 - val_loss: 106857046016.0000
Epoch 30/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10939749376.
0000 - val_loss: 112634019840.0000
Epoch 31/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10930465792.
0000 - val_loss: 124102344704.0000
Epoch 32/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10908359680.
0000 - val_loss: 131497459712.0000
Epoch 33/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10896149504.
0000 - val_loss: 133493981184.0000
Epoch 34/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10880374784.
0000 - val_loss: 138806689792.0000
Epoch 35/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10862115840.
0000 - val_loss: 150109536256.0000
Epoch 36/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10842673152.
0000 - val_loss: 147896745984.0000
Epoch 37/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10842678272.
0000 - val_loss: 168894808064.0000
Epoch 38/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10820288512.
0000 - val_loss: 163860660224.0000
Epoch 39/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10814566400.
0000 - val_loss: 187093663744.0000
Epoch 40/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10802660352.
0000 - val_loss: 190387912704.0000
Epoch 41/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10781261824.
0000 - val_loss: 194609299456.0000
Epoch 42/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10783112192.
0000 - val_loss: 208867344384.0000
Epoch 43/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10767872000.
0000 - val_loss: 199786266624.0000
Epoch 44/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10756458496.
```

```
0000 - val_loss: 216561614848.0000
Epoch 45/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10743486464.
0000 - val_loss: 222908153856.0000
Epoch 46/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10730969088.
0000 - val_loss: 233610313728.0000
Epoch 47/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10721347584.
0000 - val_loss: 230189760512.0000
Epoch 48/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10709120000.
0000 - val_loss: 244833222656.0000
Epoch 49/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10703865856.
0000 - val_loss: 250251788288.0000
Epoch 50/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10684904448.
0000 - val_loss: 250107740160.0000
Epoch 51/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10679472128.
0000 - val_loss: 268708134912.0000
Epoch 52/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10669154304.
0000 - val_loss: 277947383808.0000
Epoch 53/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10662703104.
0000 - val_loss: 278993338368.0000
Epoch 54/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10651210752.
0000 - val_loss: 292859150336.0000
Epoch 55/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10650940416.
0000 - val_loss: 288661962752.0000
Epoch 56/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10635681792.
0000 - val_loss: 302665367552.0000
Epoch 57/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10621601792.
0000 - val_loss: 315465105408.0000
Epoch 58/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10619498496.
0000 - val_loss: 316597108736.0000
Epoch 59/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10613467136.
0000 - val_loss: 311726407680.0000
Epoch 60/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10610979840.
0000 - val_loss: 321982562304.0000
Epoch 61/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10594644992.
0000 - val_loss: 317920215040.0000
Epoch 62/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10588823552.
0000 - val_loss: 345081774080.0000
Epoch 63/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10578646016.
```

```
0000 - val_loss: 339735117824.0000
Epoch 64/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10575413248.
0000 - val_loss: 338721439744.0000
Epoch 65/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10570108928.
0000 - val_loss: 335460728832.0000
Epoch 66/100
1064/1064 [==============================] - 2s 1ms/step - loss: 10562922496.
0000 - val_loss: 350186504192.0000
Epoch 67/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10548627456.
0000 - val_loss: 348144140288.0000
Epoch 68/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10546382848.
0000 - val_loss: 356937859072.0000
Epoch 69/100
1064/1064 [==============================] - 2s 2ms/step - loss: 10543796224.
0000 - val_loss: 367783411712.0000
Epoch 70/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10546099200.
0000 - val_loss: 359778123776.0000
Epoch 71/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10529487872.
0000 - val_loss: 383588007936.0000
Epoch 72/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10531622912.
0000 - val_loss: 382507515904.0000
Epoch 73/100
1064/1064 [==============================] - 2s 2ms/step - loss: 10518223872.
0000 - val_loss: 376541970432.0000
Epoch 74/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10508196864.
0000 - val_loss: 368833298432.0000
Epoch 75/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10500313088.
0000 - val_loss: 387877732352.0000
Epoch 76/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10492165120.
0000 - val_loss: 379077427200.0000
Epoch 77/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10490233856.
0000 - val_loss: 381414473728.0000
Epoch 78/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10485906432.
0000 - val_loss: 413450305536.0000
Epoch 79/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10486837248.
0000 - val_loss: 410498170880.0000
Epoch 80/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10481931264.
0000 - val_loss: 406376284160.0000
Epoch 81/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10468699136.
0000 - val_loss: 408836276224.0000
Epoch 82/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10469178368.
```

```
0000 - val_loss: 399053783040.0000
Epoch 83/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10462958592.
0000 - val_loss: 413000892416.0000
Epoch 84/100
1064/1064 [==============================] - 1s 1000us/step - loss: 104485099
52.0000 - val_loss: 395185520640.0000
Epoch 85/100
1064/1064 [==============================] - 1s 995us/step - loss: 1044077875
2.0000 - val_loss: 425550610432.0000
Epoch 86/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10439435264.
0000 - val_loss: 409554780160.0000
Epoch 87/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10436589568.
0000 - val_loss: 415841157120.0000
Epoch 88/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10423269376.
0000 - val_loss: 425639706624.0000
Epoch 89/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10413133824.
0000 - val_loss: 424974254080.0000
Epoch 90/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10409527296.
0000 - val_loss: 439467311104.0000
Epoch 91/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10399724544.
0000 - val_loss: 444355215360.0000
Epoch 92/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10399563776.
0000 - val_loss: 453504335872.0000
Epoch 93/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10389937152.
0000 - val_loss: 457974054912.0000
Epoch 94/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10395654144.
0000 - val_loss: 447729303552.0000
Epoch 95/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10375875584.
0000 - val_loss: 448078151680.0000
Epoch 96/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10379679744.
0000 - val_loss: 460679512064.0000
Epoch 97/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10364184576.
0000 - val_loss: 458027794432.0000
Epoch 98/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10366939136.
0000 - val_loss: 450805596160.0000
Epoch 99/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10357605376.
0000 - val_loss: 452688248832.0000
Epoch 100/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10350799872.
0000 - val_loss: 458947657728.0000
Epoch 1/100
WARNING:tensorflow:Layer dense_219 is casting an input tensor from dtype floa
```

```
t64 to the layer's dtype of float32, which is new behavior in TensorFlow 2.
The layer has dtype float32 because its dtype defaults to floatx.

If you intended to run this layer in float32, you can safely ignore this warn
ing. If in doubt, this warning is likely only an issue if you are porting a T
ensorFlow 1.X model to TensorFlow 2.

To change all layers to have dtype float64 by default, call `tf.keras.backen
d.set_floatx('float64')`. To change just this layer, pass dtype='float64' to
the layer constructor. If you are the author of this layer, you can disable a
utocasting by passing autocast=False to the base Layer constructor.

1064/1064 [==============================] - 1s 1ms/step - loss: 44107509760.
0000 - val_loss: 246558523392.0000
Epoch 2/100
1064/1064 [==============================] - 1s 1ms/step - loss: 13675321344.
0000 - val_loss: 231608909824.0000
Epoch 3/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12934937600.
0000 - val_loss: 206993113088.0000
Epoch 4/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12494206976.
0000 - val_loss: 176956964864.0000
Epoch 5/100
1064/1064 [==============================] - 1s 1ms/step - loss: 12199048192.
0000 - val_loss: 152394317824.0000
Epoch 6/100
1064/1064 [==============================] - 1s 999us/step - loss: 1200727040
0.0000 - val_loss: 128626999296.0000
Epoch 7/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11865816064.
0000 - val_loss: 113516535808.0000
Epoch 8/100
1064/1064 [==============================] - 1s 987us/step - loss: 1173864038
4.0000 - val_loss: 95351996416.0000
Epoch 9/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11633352704.
0000 - val_loss: 80817594368.0000
Epoch 10/100
1064/1064 [==============================] - 1s 980us/step - loss: 1154465792
0.0000 - val_loss: 69388959744.0000
Epoch 11/100
1064/1064 [==============================] - 1s 997us/step - loss: 1144883814
4.0000 - val_loss: 58748506112.0000
Epoch 12/100
1064/1064 [==============================] - 1s 998us/step - loss: 1137875968
0.0000 - val_loss: 52869431296.0000
Epoch 13/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11302802432.
0000 - val_loss: 46003269632.0000
Epoch 14/100
1064/1064 [==============================] - 1s 977us/step - loss: 1124678144
0.0000 - val_loss: 40639119360.0000
Epoch 15/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11179579392.
0000 - val_loss: 37125955584.0000
Epoch 16/100
```

```
1064/1064 [==============================] - 1s 1ms/step - loss: 11115315200.
0000 - val_loss: 35525783552.0000
Epoch 17/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11068755968.
0000 - val_loss: 36414758912.0000
Epoch 18/100
1064/1064 [==============================] - 1s 1ms/step - loss: 11030546432.
0000 - val_loss: 38967074816.0000
Epoch 19/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10979784704.
0000 - val_loss: 42079363072.0000
Epoch 20/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10944314368.
0000 - val_loss: 50060660736.0000
Epoch 21/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10906512384.
0000 - val_loss: 57213681664.0000
Epoch 22/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10873812992.
0000 - val_loss: 64026595328.0000
Epoch 23/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10830812160.
0000 - val_loss: 76335153152.0000
Epoch 24/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10802151424.
0000 - val_loss: 92551323648.0000
Epoch 25/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10771620864.
0000 - val_loss: 111146680320.0000
Epoch 26/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10733763584.
0000 - val_loss: 130468995072.0000
Epoch 27/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10705502208.
0000 - val_loss: 145163632640.0000
Epoch 28/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10688517120.
0000 - val_loss: 169115697152.0000
Epoch 29/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10659399680.
0000 - val_loss: 193496825856.0000
Epoch 30/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10628162560.
0000 - val_loss: 208679436288.0000
Epoch 31/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10608310272.
0000 - val_loss: 227669786624.0000
Epoch 32/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10596584448.
0000 - val_loss: 254970298368.0000
Epoch 33/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10578138112.
0000 - val_loss: 260336943104.0000
Epoch 34/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10564956160.
0000 - val_loss: 290684010496.0000
Epoch 35/100
```

```
1064/1064 [==============================] - 1s 1ms/step - loss: 10538618880.
0000 - val_loss: 298213736448.0000
Epoch 36/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10525900800.
0000 - val_loss: 324050812928.0000
Epoch 37/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10503877632.
0000 - val_loss: 355600334848.0000
Epoch 38/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10488233984.
0000 - val_loss: 372204503040.0000
Epoch 39/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10472787968.
0000 - val_loss: 421584666624.0000
Epoch 40/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10454843392.
0000 - val_loss: 432481533952.0000
Epoch 41/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10433422336.
0000 - val_loss: 457991323648.0000
Epoch 42/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10429256704.
0000 - val_loss: 479438864384.0000
Epoch 43/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10402810880.
0000 - val_loss: 504081973248.0000
Epoch 44/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10399455232.
0000 - val_loss: 535234117632.0000
Epoch 45/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10381101056.
0000 - val_loss: 581636718592.0000
Epoch 46/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10377578496.
0000 - val_loss: 599722557440.0000
Epoch 47/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10355472384.
0000 - val_loss: 624986423296.0000
Epoch 48/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10355671040.
0000 - val_loss: 639670812672.0000
Epoch 49/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10334982144.
0000 - val_loss: 680566259712.0000
Epoch 50/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10327247872.
0000 - val_loss: 680477065216.0000
Epoch 51/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10316622848.
0000 - val_loss: 744223080448.0000
Epoch 52/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10296300544.
0000 - val_loss: 766195138560.0000
Epoch 53/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10280664064.
0000 - val_loss: 789168390144.0000
Epoch 54/100
```

```
1064/1064 [==============================] - 1s 1ms/step - loss: 10274975744.
0000 - val_loss: 802609364992.0000
Epoch 55/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10261122048.
0000 - val_loss: 858181861376.0000
Epoch 56/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10241506304.
0000 - val_loss: 925615718400.0000
Epoch 57/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10236267520.
0000 - val_loss: 957708042240.0000
Epoch 58/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10230801408.
0000 - val_loss: 973874266112.0000
Epoch 59/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10219513856.
0000 - val_loss: 963026944000.0000
Epoch 60/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10203011072.
0000 - val_loss: 1027118596096.0000
Epoch 61/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10190880768.
0000 - val_loss: 1071344189440.0000
Epoch 62/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10185322496.
0000 - val_loss: 1091426582528.0000
Epoch 63/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10166539264.
0000 - val_loss: 1092574052352.0000
Epoch 64/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10168039424.
0000 - val_loss: 1157490671616.0000
Epoch 65/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10144572416.
0000 - val_loss: 1227085316096.0000
Epoch 66/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10135577600.
0000 - val_loss: 1267857489920.0000
Epoch 67/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10128685056.
0000 - val_loss: 1263626878976.0000
Epoch 68/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10116226048.
0000 - val_loss: 1323217846272.0000
Epoch 69/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10104707072.
0000 - val_loss: 1343295979520.0000
Epoch 70/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10080723968.
0000 - val_loss: 1369166184448.0000
Epoch 71/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10083406848.
0000 - val_loss: 1350920437760.0000
Epoch 72/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10070154240.
0000 - val_loss: 1387816943616.0000
Epoch 73/100
```

```
1064/1064 [==============================] - 1s 1ms/step - loss: 10063761408.
0000 - val_loss: 1491531202560.0000
Epoch 74/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10059343872.
0000 - val_loss: 1523394936832.0000
Epoch 75/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10038334464.
0000 - val_loss: 1519782068224.0000
Epoch 76/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10034588672.
0000 - val_loss: 1550830665728.0000
Epoch 77/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10022955008.
0000 - val_loss: 1564958392320.0000
Epoch 78/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10005516288.
0000 - val_loss: 1637659443200.0000
Epoch 79/100
1064/1064 [==============================] - 1s 1ms/step - loss: 10000785408.
0000 - val_loss: 1684872364032.0000
Epoch 80/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9999033344.0
000 - val_loss: 1666253455360.0000
Epoch 81/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9984743424.0
000 - val_loss: 1682183159808.0000
Epoch 82/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9978121216.0
000 - val_loss: 1676613779456.0000
Epoch 83/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9973076992.0
000 - val_loss: 1712729489408.0000
Epoch 84/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9956719616.0
000 - val_loss: 1747380076544.0000
Epoch 85/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9947816960.0
000 - val_loss: 1768065073152.0000
Epoch 86/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9945443328.0
000 - val_loss: 1752163549184.0000
Epoch 87/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9931223040.0
000 - val_loss: 1860119035904.0000
Epoch 88/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9934592000.0
000 - val_loss: 1811474808832.0000
Epoch 89/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9925043200.0
000 - val_loss: 1792547356672.0000
Epoch 90/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9924937728.0
000 - val_loss: 1804008947712.0000
Epoch 91/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9909208064.0
000 - val_loss: 1927947747328.0000
Epoch 92/100
```

```
1064/1064 [==============================] - 1s 1ms/step - loss: 9910005760.0
000 - val_loss: 1943749918720.0000
Epoch 93/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9895170048.0
000 - val_loss: 1927978549248.0000
Epoch 94/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9890558976.0
000 - val_loss: 1884746153984.0000
Epoch 95/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9894507520.0
000 - val_loss: 1958110560256.0000
Epoch 96/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9892077568.0
000 - val_loss: 1945645481984.0000
Epoch 97/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9874844672.0
000 - val_loss: 1927074807808.0000
Epoch 98/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9866102784.0
000 - val_loss: 1998697267200.0000
Epoch 99/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9879014400.0
000 - val_loss: 1949909647360.0000
Epoch 100/100
1064/1064 [==============================] - 1s 1ms/step - loss: 9858245632.0
000 - val_loss: 1957814468608.0000
```

In [107]:
```
val_loss_mean
```

Out[107]:
```
[array([1.07506118e+11, 9.87117265e+10, 8.35994223e+10, 6.73364943e+10,
        5.52976949e+10, 4.55608799e+10, 3.98519906e+10, 3.46957828e+10,
        3.08427577e+10, 2.84811944e+10, 2.67739091e+10, 2.66929506e+10,
        2.75846599e+10, 2.82435455e+10, 2.99277679e+10, 3.30499727e+10,
        3.57106737e+10, 4.05252092e+10, 4.26295800e+10, 4.80619532e+10,
        5.29017442e+10, 5.73219672e+10, 6.25592263e+10, 7.21032602e+10,
        7.83096930e+10, 8.67543572e+10, 9.39615011e+10, 1.01085335e+11,
        1.10731547e+11, 1.16420218e+11, 1.24879899e+11, 1.33332523e+11,
        1.37050670e+11, 1.45734580e+11, 1.51457541e+11, 1.59649840e+11,
        1.71986919e+11, 1.76069991e+11, 1.95710481e+11, 1.97606715e+11,
        2.05405268e+11, 2.15863912e+11, 2.17039841e+11, 2.28331495e+11,
        2.42323228e+11, 2.50959513e+11, 2.57105197e+11, 2.65604973e+11,
        2.78319828e+11, 2.78525095e+11, 2.95308442e+11, 3.04929646e+11,
        3.10339040e+11, 3.17640055e+11, 3.31361989e+11, 3.48479581e+11,
        3.58011915e+11, 3.67106825e+11, 3.65354587e+11, 3.82460900e+11,
        3.90739234e+11, 4.03423622e+11, 4.06249642e+11, 4.21235147e+11,
        4.35352270e+11, 4.51297270e+11, 4.49537511e+11, 4.66945566e+11,
        4.74511684e+11, 4.81979292e+11, 4.82549763e+11, 4.93718585e+11,
        5.10993236e+11, 5.27654427e+11, 5.30490412e+11, 5.33658986e+11,
        5.35262934e+11, 5.62877664e+11, 5.72075367e+11, 5.71792939e+11,
        5.78897854e+11, 5.81680746e+11, 5.93967789e+11, 5.97103765e+11,
        6.10999029e+11, 6.05799743e+11, 6.27365190e+11, 6.25177199e+11,
        6.27507741e+11, 6.32473905e+11, 6.59937975e+11, 6.69245610e+11,
        6.70624550e+11, 6.58647800e+11, 6.72555293e+11, 6.75632588e+11,
        6.79069896e+11, 6.83602179e+11, 6.82466823e+11, 6.88086126e+11])]
```

In [115]:
```
# find the best epoch
best_epoch = np.argmin(val_loss_mean[0])+1
best_epoch
```

Out[115]: 12

In [117]:
```
# Train the model again on the entire testing set with the best parameters.
clt_nn = creat_model(5)
clt_nn.fit(x=X_train,y=y_train,
          validation_data=(X_test,y_test),
          batch_size=256,epochs=best_epoch)
```

```
Epoch 1/12
1330/1330 [==============================] - 1s 931us/step - loss: 4859992473
6.0000 - val_loss: 215038197760.0000
Epoch 2/12
1330/1330 [==============================] - 1s 868us/step - loss: 1478702284
8.0000 - val_loss: 204508037120.0000
Epoch 3/12
1330/1330 [==============================] - 1s 869us/step - loss: 1387418419
2.0000 - val_loss: 178344050688.0000
Epoch 4/12
1330/1330 [==============================] - 1s 861us/step - loss: 1338677760
0.0000 - val_loss: 145075879936.0000
Epoch 5/12
1330/1330 [==============================] - 1s 849us/step - loss: 1309770035
2.0000 - val_loss: 115701194752.0000
Epoch 6/12
1330/1330 [==============================] - 1s 849us/step - loss: 1288504320
0.0000 - val_loss: 89730818048.0000
Epoch 7/12
1330/1330 [==============================] - 1s 863us/step - loss: 1272692940
8.0000 - val_loss: 66775109632.0000
Epoch 8/12
1330/1330 [==============================] - 1s 845us/step - loss: 1259812454
4.0000 - val_loss: 50425892864.0000
Epoch 9/12
1330/1330 [==============================] - 1s 844us/step - loss: 1249677721
6.0000 - val_loss: 40979849216.0000
Epoch 10/12
1330/1330 [==============================] - 1s 859us/step - loss: 1241415577
6.0000 - val_loss: 36094009344.0000
Epoch 11/12
1330/1330 [==============================] - 1s 850us/step - loss: 1233134592
0.0000 - val_loss: 34952568832.0000
Epoch 12/12
1330/1330 [==============================] - 1s 850us/step - loss: 1227023257
6.0000 - val_loss: 40774336512.0000
```

Out[117]: <tensorflow.python.keras.callbacks.History at 0x1c867126a08>

2.2.3 Make Prediction on Testing Set

In [118]:
```
y_pred_nn = clt_nn.predict(X_test)
```

2.3 Decision Trees

2.3.1 Seperate Dataset

In [119]:
```
from sklearn.model_selection import GridSearchCV
from sklearn.tree import DecisionTreeRegressor
```

2.3.2 Train Model

In [120]:
```
params_grid = [{'max_depth':[5,10,15,20,25]}]

clf_dt_grid = GridSearchCV(DecisionTreeRegressor(), params_grid, cv=5)
clf_dt_grid.fit(X_train, y_train)
```

Out[120]:
```
GridSearchCV(cv=5, error_score=nan,
             estimator=DecisionTreeRegressor(ccp_alpha=0.0, criterion='mse',
                                             max_depth=None, max_features=Non
e,
                                             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,
                                             presort='deprecated',
                                             random_state=None,
                                             splitter='best'),
             iid='deprecated', n_jobs=None,
             param_grid=[{'max_depth': [5, 10, 15, 20, 25]}],
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring=None, verbose=0)
```

In [121]:
```
clf_dt = clf_dt_grid.best_estimator_
print('Best max_depth:',clf_dt_grid.best_estimator_.max_depth,"\n")
```

```
Best max_depth: 10
```

2.3.3 Make Prediction on Testing Set

In [122]:
```
y_pred_dt = clf_dt.predict(X_test)
```

2.4 Random Forests

In [123]:
```
from sklearn.model_selection import GridSearchCV
from sklearn.ensemble import RandomForestRegressor
```

2.3.2 Train Model

In [124]:
```
params_grid = [{'max_depth':[5,10,15,20,25]}]

clf_rf_grid = GridSearchCV(RandomForestRegressor(), params_grid, cv=5)
clf_rf_grid.fit(X_train, y_train)
```

```
C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
n.py:515: DataConversionWarning: A column-vector y was passed when a 1d array
was expected. Please change the shape of y to (n_samples,), for example using
ravel().
  estimator.fit(X_train, y_train, **fit_params)
C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
n.py:515: DataConversionWarning: A column-vector y was passed when a 1d array
was expected. Please change the shape of y to (n_samples,), for example using
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
n.py:515: DataConversionWarning: A column-vector y was passed when a 1d array
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ravel().
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
n.py:515: DataConversionWarning: A column-vector y was passed when a 1d array
was expected. Please change the shape of y to (n_samples,), for example using
ravel().
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
n.py:515: DataConversionWarning: A column-vector y was passed when a 1d array
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
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was expected. Please change the shape of y to (n_samples,), for example using
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  estimator.fit(X_train, y_train, **fit_params)
C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
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was expected. Please change the shape of y to (n_samples,), for example using
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  estimator.fit(X_train, y_train, **fit_params)
C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
n.py:515: DataConversionWarning: A column-vector y was passed when a 1d array
```

```
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
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  estimator.fit(X_train, y_train, **fit_params)
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
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ravel().
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
n.py:515: DataConversionWarning: A column-vector y was passed when a 1d array
was expected. Please change the shape of y to (n_samples,), for example using
ravel().
```

```
  estimator.fit(X_train, y_train, **fit_params)
C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
n.py:515: DataConversionWarning: A column-vector y was passed when a 1d array
was expected. Please change the shape of y to (n_samples,), for example using
ravel().
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C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_validatio
n.py:515: DataConversionWarning: A column-vector y was passed when a 1d array
was expected. Please change the shape of y to (n_samples,), for example using
ravel().
  estimator.fit(X_train, y_train, **fit_params)
C:\Users\kaike\anaconda3\lib\site-packages\sklearn\model_selection\_search.p
y:739: DataConversionWarning: A column-vector y was passed when a 1d array wa
s expected. Please change the shape of y to (n_samples,), for example using r
avel().
  self.best_estimator_.fit(X, y, **fit_params)
```

Out[124]:
```
GridSearchCV(cv=5, error_score=nan,
             estimator=RandomForestRegressor(bootstrap=True, ccp_alpha=0.0,
                                             criterion='mse', max_depth=None,
                                             max_features='auto',
                                             max_leaf_nodes=None,
                                             max_samples=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=100, n_jobs=None,
                                             oob_score=False, random_state=No
ne,
                                             verbose=0, warm_start=False),
             iid='deprecated', n_jobs=None,
             param_grid=[{'max_depth': [5, 10, 15, 20, 25]}],
             pre_dispatch='2*n_jobs', refit=True, return_train_score=False,
             scoring=None, verbose=0)
```

In [125]:
```
clf_rf = clf_rf_grid.best_estimator_
print('Best max_depth:',clf_rf_grid.best_estimator_.max_depth,"\n")
```

```
Best max_depth: 25
```

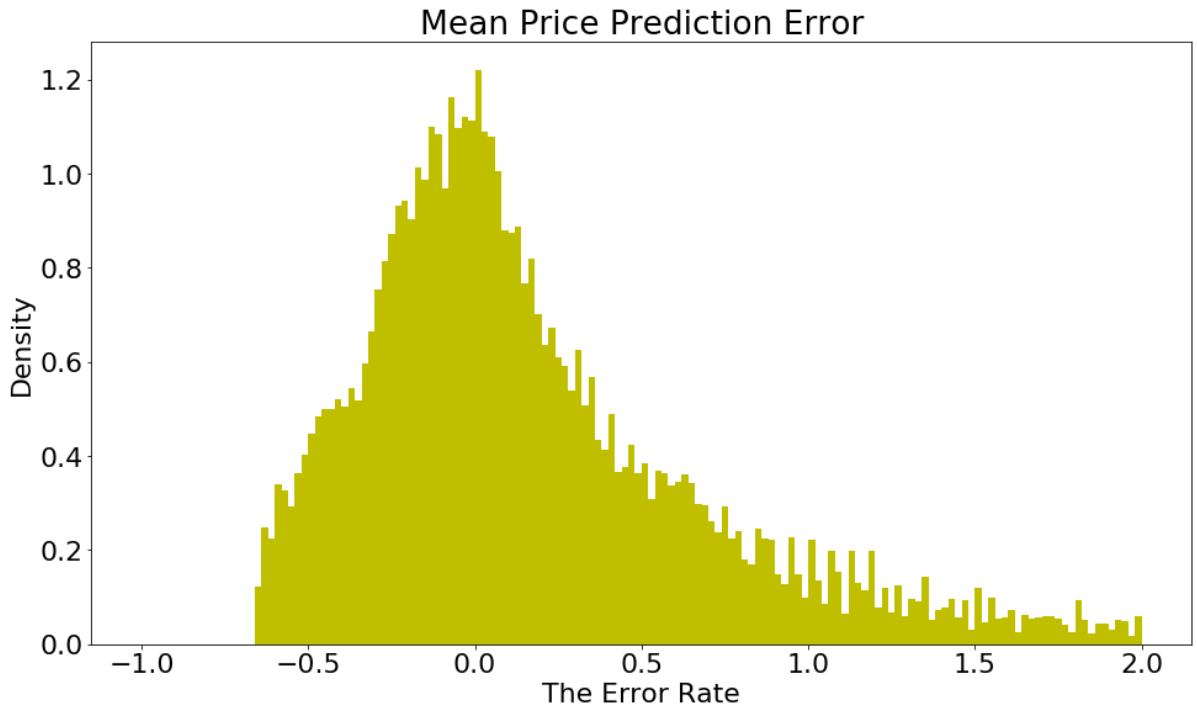
2.3.3 Make Prediction on Testing Set

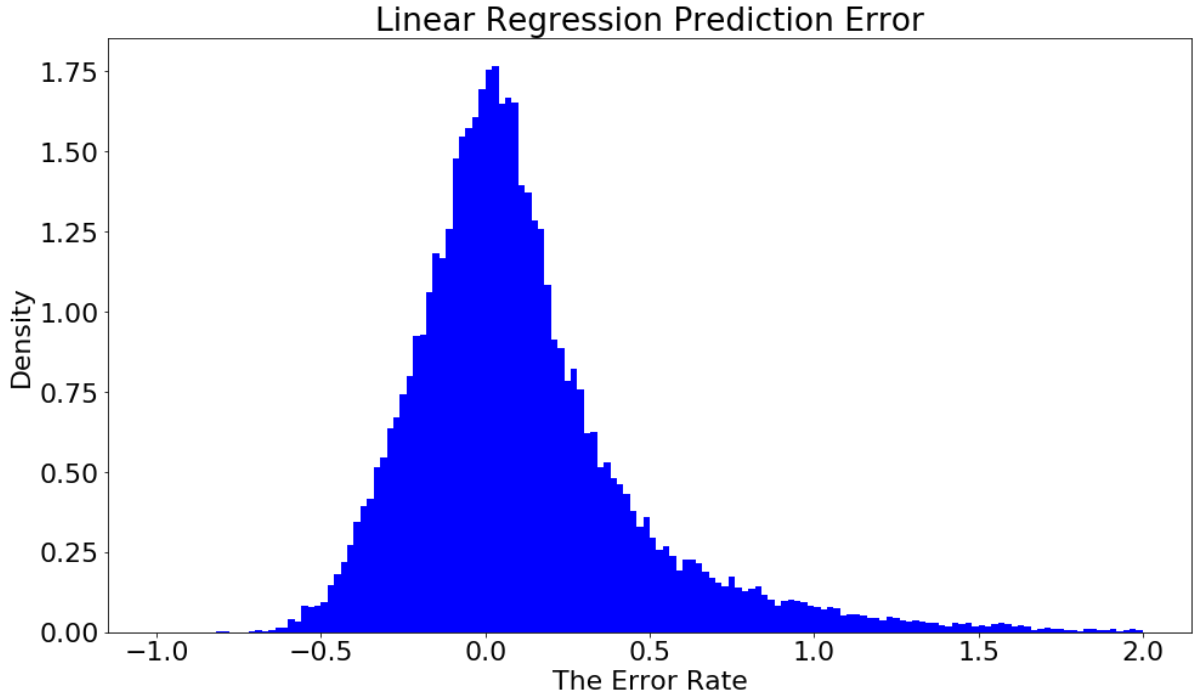
In [126]:
```
y_pred_rf = clf_rf.predict(X_test)
```

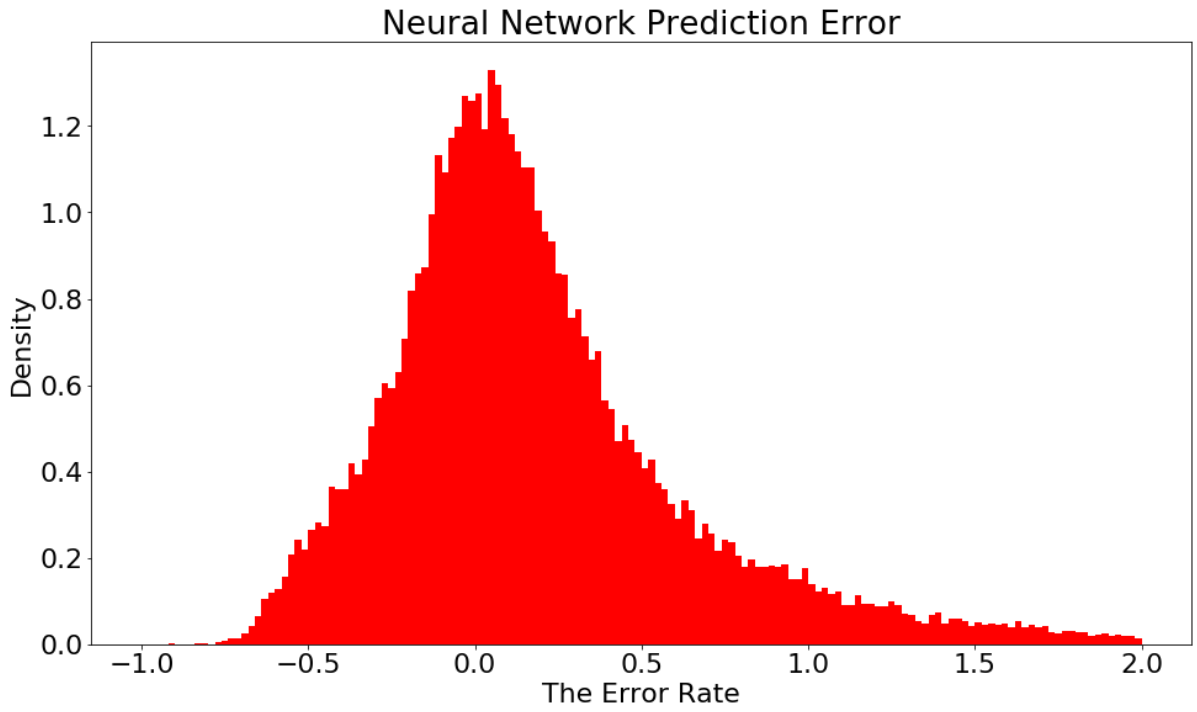
3 Evaluation

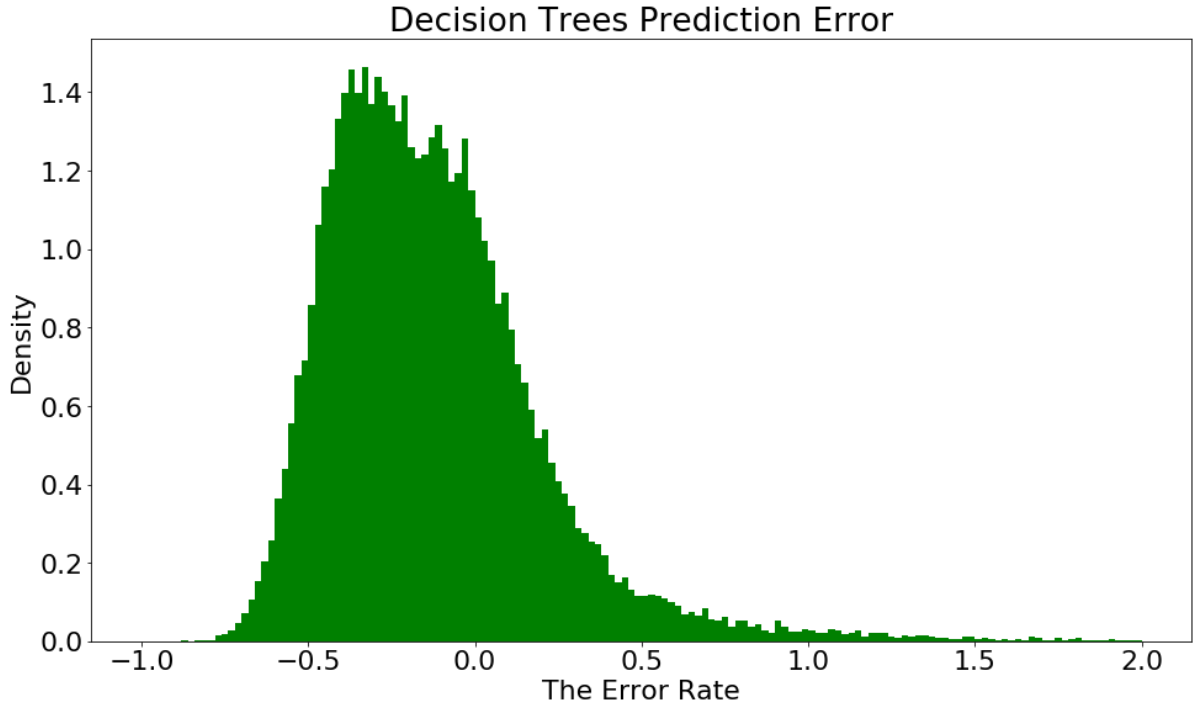
In [127]:
```
# Number of Algorithms (Prediction using the mean price is included)
ALGORITM_NUMBER = 5
# Name of Algorithms
ALGORITHM = ['Mean Price', 'Linear Regression', 'Neural Network', 'Decision Tr
ees', 'Random Forest']
# Color of Plot
COLOR_OF_PLOT = ['y','b','r', 'g','m']

# Calculate the differences between true values of prices and our predictions.
y_result = np.zeros((len(y_pred), 4 + ALGORITM_NUMBER))

# Calculate the mean price
sum = 0
for i in range(len(y_pred)):
    sum = sum + y_test[i]
y_mean = sum/len(y_pred)

# Calculate the results of predictions from different methods
for i in range(len(y_pred)):
    y_result[i][0] = y_test[i]
    y_result[i][1] = y_pred[i]
    y_result[i][2] = y_pred_nn[i]
    y_result[i][3] = (y_mean - y_test[i]) / y_test[i]
    y_result[i][4] = (y_pred[i] - y_test[i]) / y_test[i]
    y_result[i][5] = (y_pred_nn[i] - y_test[i]) / y_test[i]
    y_result[i][6] = (y_pred_dt[i] - y_test[i]) / y_test[i]
    y_result[i][7] = (y_pred_rf[i] - y_test[i]) / y_test[i]

y_result_df = pd.DataFrame(y_result)
```

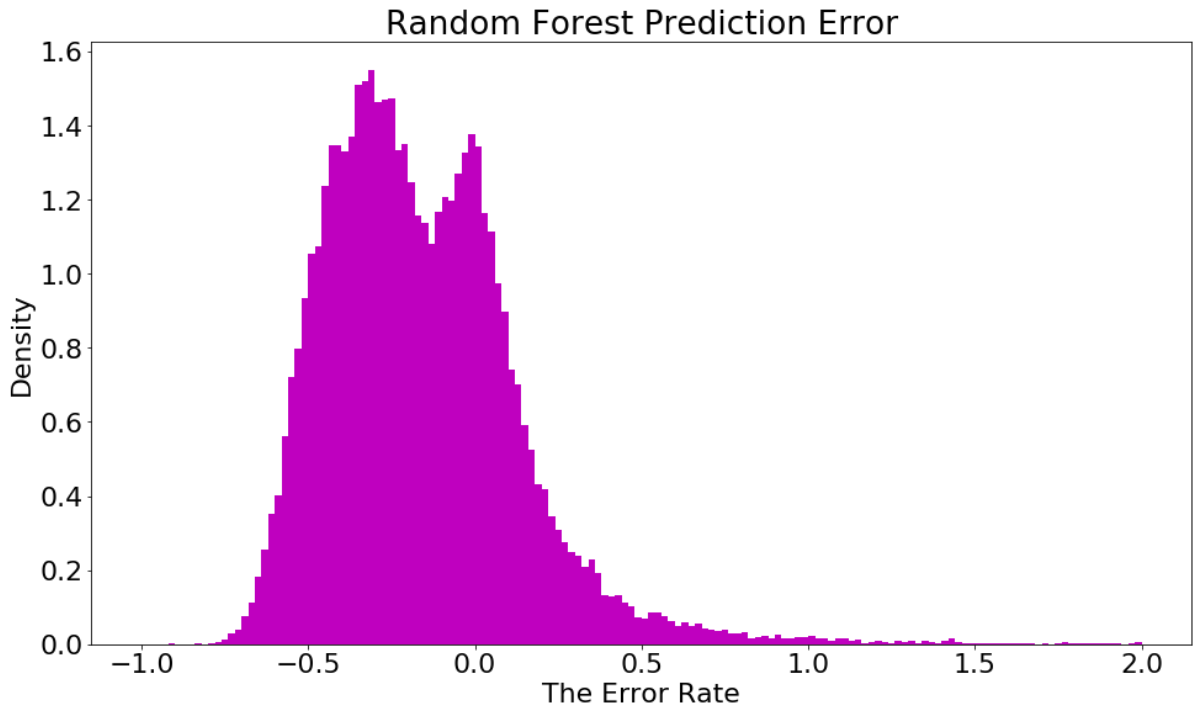
In [131]:
```
# Plot the distribution of error

for alg in range(ALGORITM_NUMBER):
    label_plt = ALGORITHM[alg]
    color_plt = COLOR_OF_PLOT[alg]
    plt.hist(y_result_df.iloc[:][alg + 3], bins=150, range = (-1,2), density =
True,
             label = label_plt, color = color_plt)
    plt.ylabel('Density')
    plt.xlabel('The Error Rate')
    plt.title(str(label_plt) + ' Prediction Error')
    plt.show()

for alg in range(ALGORITM_NUMBER):
    label_plt = ALGORITHM[alg]
    color_plt = COLOR_OF_PLOT[alg]
    if alg == 0:
        plt.hist(y_result_df.iloc[:][alg + 3], bins=150, range = (-1,2), densi
ty = True,
                 label = label_plt, color = color_plt)
    else:
        plt.hist(y_result_df.iloc[:][alg + 3], bins=150, range = (-1,2), densi
ty = True,
                 alpha=0.7, label = label_plt, color = color_plt)
plt.ylabel('Density')
plt.legend()
plt.title('Camparison of The Error Rate')
plt.show()
```

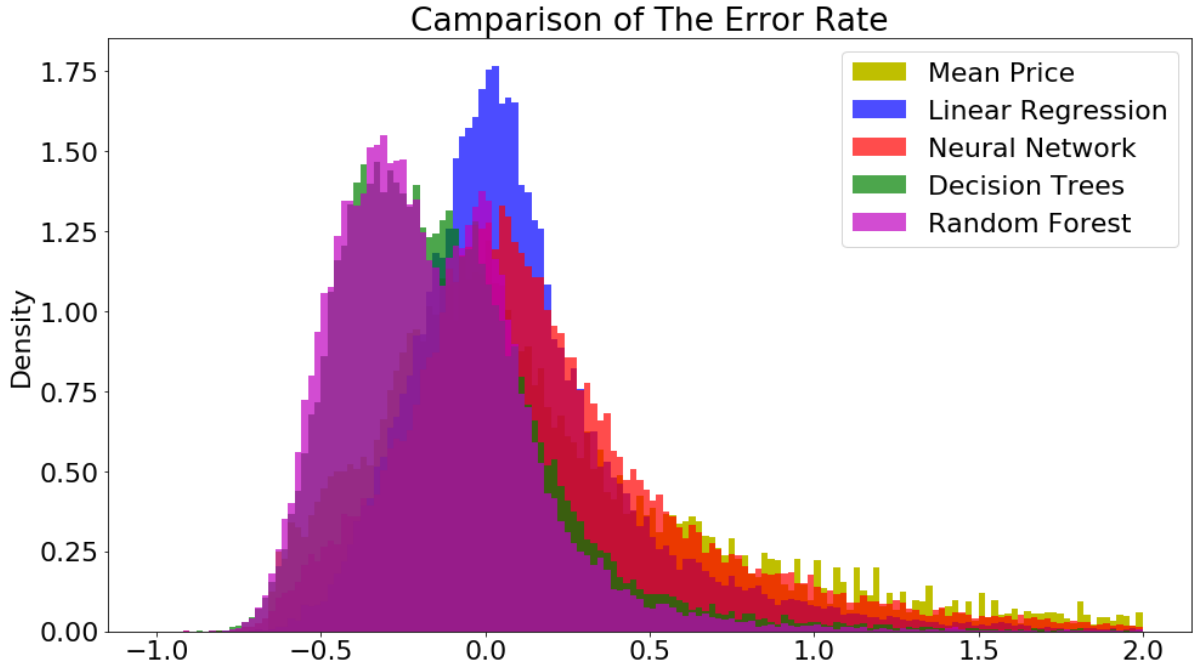

Mean Price Prediction Error
Density
The Error Rate
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0


Linear Regression Prediction Error
Density
The Error Rate
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0


Neural Network Prediction Error
Density
The Error Rate
0.0
0.2
0.4
0.6
0.8
1.0
1.2
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0

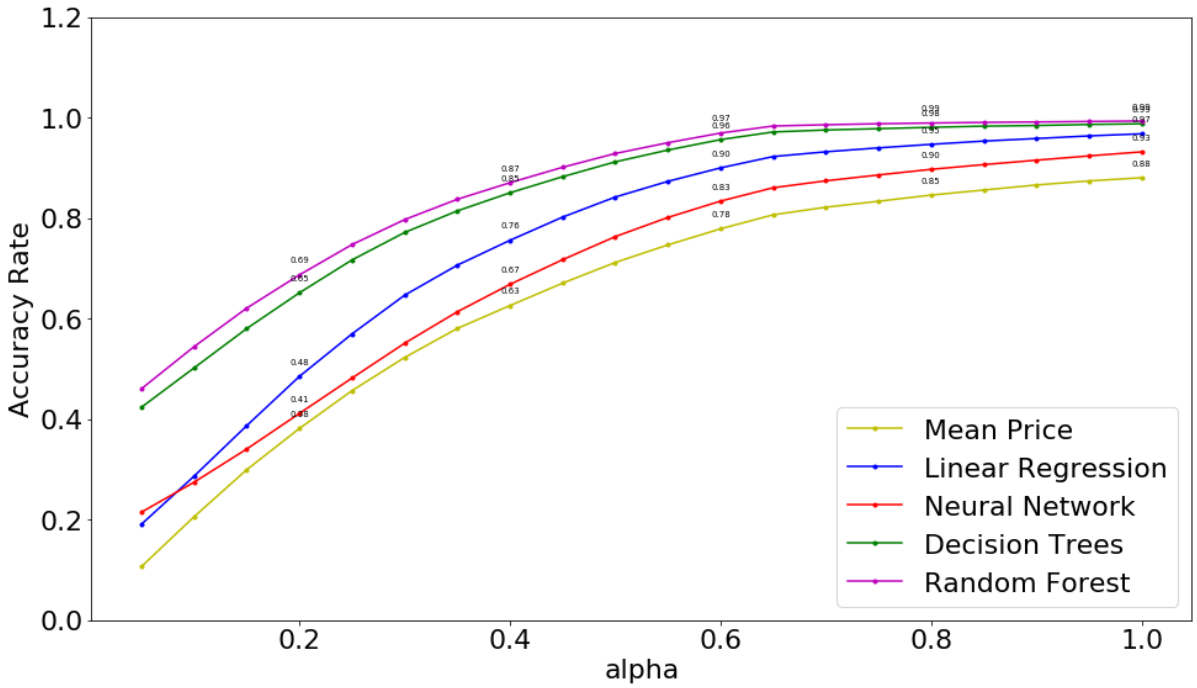

Decision Trees Prediction Error
Density
The Error Rate
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0


Random Forest Prediction Error
Density
The Error Rate
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0


Camparison of The Error Rate
Density
Mean Price
Linear Regression
Neural Network
Decision Trees
Random Forest
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0

In [129]:
```
# Calcualte and plot the accuracy rate

critiria = []
accuracy = []*(ALGORITM_NUMBER)
for i in range(1,21):
    critiria.append(i*0.05)


for alg in range(ALGORITM_NUMBER):
    accuracy_temp = []
    for cri in critiria:
        correct_count = 0
        for i in range(len(y_result_df.index)):
            if y_result[i][alg+3] < cri and y_result[i][3] > -cri:
                correct_count = correct_count + 1
        accuracy_temp.append(correct_count/len(y_result_df.index))
    accuracy.append(accuracy_temp)
```

In [132]:
```
for alg in range(ALGORITM_NUMBER):
    color_plt = COLOR_OF_PLOT[alg]
    label_plt = ALGORITHM[alg]
    plt.plot(critiria,accuracy[alg][:],color_plt,label=label_plt, marker='.')

plt.ylim(top=1.2)
plt.ylim(bottom=0)


for alg in range(ALGORITM_NUMBER):
    counter = 0
    for x,y in zip(critiria,accuracy[alg][:]):
        label = "{:.2f}".format(y)
        if counter % 4 == 3:
            plt.annotate(label, (x,y), textcoords="offset points", xytext=(0,1
0), ha='center', fontsize=7)
        counter = counter + 1

plt.legend()
plt.xlabel('alpha')
plt.ylabel('Accuracy Rate')
plt.show()
```



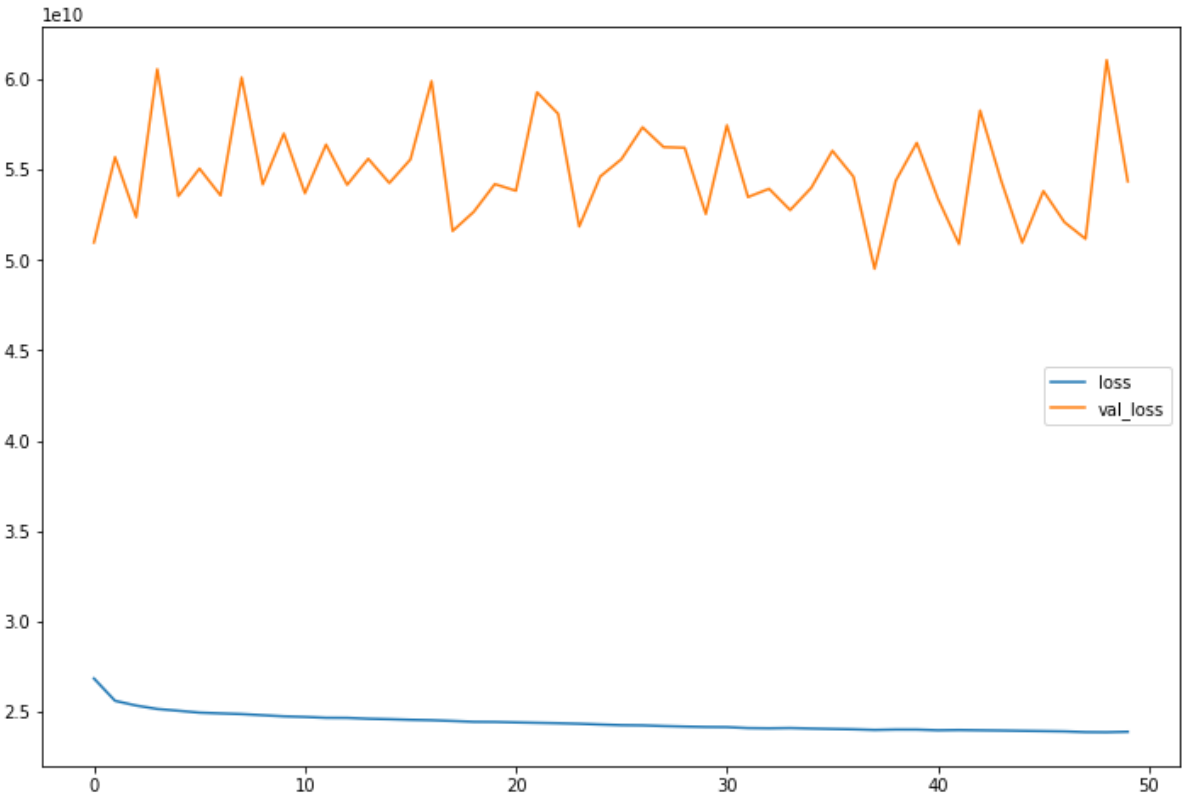
In [45]:
```
ALGORITM_NUMBER = 2

critiria = []
accuracy = []*(ALGORITM_NUMBER+1)
```

In [49]:
```
accuracy[0][:]
```

Out[49]:
```
[0.10677840638714112,
 0.2060223126949717,
 0.2995294242055729,
 0.38143076190979747,
 0.4567228890181357,
 0.5227356844498493,
 0.580368000845979,
 0.6259186802728283,
 0.6704647596891027,
 0.711653360122667,
 0.7465764289113308,
 0.7785650081954212,
 0.8064823137524454,
 0.8215513139110665,
 0.8333421456141279,
 0.8456881510072437,
 0.8557341511129911,
 0.8657537143763548,
 0.8738433881457198,
 0.8801882303177708]
```

In [27]:
```
loss_df = pd.DataFrame(model.history.history)
loss_df.plot(figsize=(12,8))
```

Out[27]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x2228b2984c8>
```



In [36]:
```
y_result
```

Out[36]:
```
array([[ 5.36117720e+05,  7.46004646e+05,  2.09886926e+05,
         3.91494103e-01],
       [ 6.52555790e+05,  6.43142427e+05, -9.41336297e+03,
        -1.44253765e-02],
       [ 9.20142140e+05,  8.20128927e+05, -1.00013213e+05,
        -1.08693221e-01],
       ...,
       [ 6.04949930e+05,  5.79699337e+05, -2.52505930e+04,
        -4.17399718e-02],
       [ 5.08836390e+05,  6.06320886e+05,  9.74844964e+04,
         1.91583185e-01],
       [ 2.24229540e+05,  5.22371962e+05,  2.98142422e+05,
         1.32963044e+00]])
```

In [ ]:
```

```