

# bikeshare\_neural\_net\_exercise-nates\_solution

February 13, 2018

- 1 We will be using Keras, pretty much the highest-level neural network API. It can use tensorflow, CNTK, or theano as a backend. If tensorflow is using a GPU, then it is using the NVIDIA CUDA code-base (another API), which then is calling nearly direct commands on the GPU. So we could have 3 levels of APIs if we are using Keras on a GPU.

data from here: <https://archive.ics.uci.edu/ml/datasets/bike+sharing+dataset>

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

```
In [2]: filename = '/home/nate/Dropbox/MSDS/MSDS680_ncg_S8W1_18/week5/hour.csv'
        # parse dates will convert those columns (labels in the list) to dates
```

```
        # infer datetime format will try to figure out the datetime format of the dates column.
        # and keep using that for the column, so can speed up loading by a lot sometimes
bike_df = pd.read_csv(filename, parse_dates=['dteday'], infer_datetime_format=True)
bike_df.head()
```

```
Out[2]:
```

	instant	dteday	season	yr	mnth	hr	holiday	weekday	workingday	\
0	1	2011-01-01	1	0	1	0	0	6	0	
1	2	2011-01-01	1	0	1	1	0	6	0	
2	3	2011-01-01	1	0	1	2	0	6	0	
3	4	2011-01-01	1	0	1	3	0	6	0	
4	5	2011-01-01	1	0	1	4	0	6	0	

	weathersit	temp	atemp	hum	windspeed	casual	registered	cnt
0	1	0.24	0.2879	0.81	0.0	3	13	16
1	1	0.22	0.2727	0.80	0.0	8	32	40
2	1	0.22	0.2727	0.80	0.0	5	27	32
3	1	0.24	0.2879	0.75	0.0	3	10	13
4	1	0.24	0.2879	0.75	0.0	0	1	1

```
In [3]: # drops the record index 'instant' and date
        # also drop casual and registered, because cnt = casual + registered
drop_cols = ['instant', 'dteday', 'casual', 'registered']
bike_df.drop(drop_cols, axis=1, inplace=True)
        # if you want, you could engineer more features by getting the day of the month or oth
```

```
In [4]: bike_df.describe()
```

```
Out [4]:
```

	season	yr	mnth	hr	holiday \
count	17379.000000	17379.000000	17379.000000	17379.000000	17379.000000
mean	2.501640	0.502561	6.537775	11.546752	0.028770
std	1.106918	0.500008	3.438776	6.914405	0.167165
min	1.000000	0.000000	1.000000	0.000000	0.000000
25%	2.000000	0.000000	4.000000	6.000000	0.000000
50%	3.000000	1.000000	7.000000	12.000000	0.000000
75%	3.000000	1.000000	10.000000	18.000000	0.000000
max	4.000000	1.000000	12.000000	23.000000	1.000000

	weekday	workingday	weathersit	temp	atemp \
count	17379.000000	17379.000000	17379.000000	17379.000000	17379.000000
mean	3.003683	0.682721	1.425283	0.496987	0.475775
std	2.005771	0.465431	0.639357	0.192556	0.171850
min	0.000000	0.000000	1.000000	0.020000	0.000000
25%	1.000000	0.000000	1.000000	0.340000	0.333300
50%	3.000000	1.000000	1.000000	0.500000	0.484800
75%	5.000000	1.000000	2.000000	0.660000	0.621200
max	6.000000	1.000000	4.000000	1.000000	1.000000

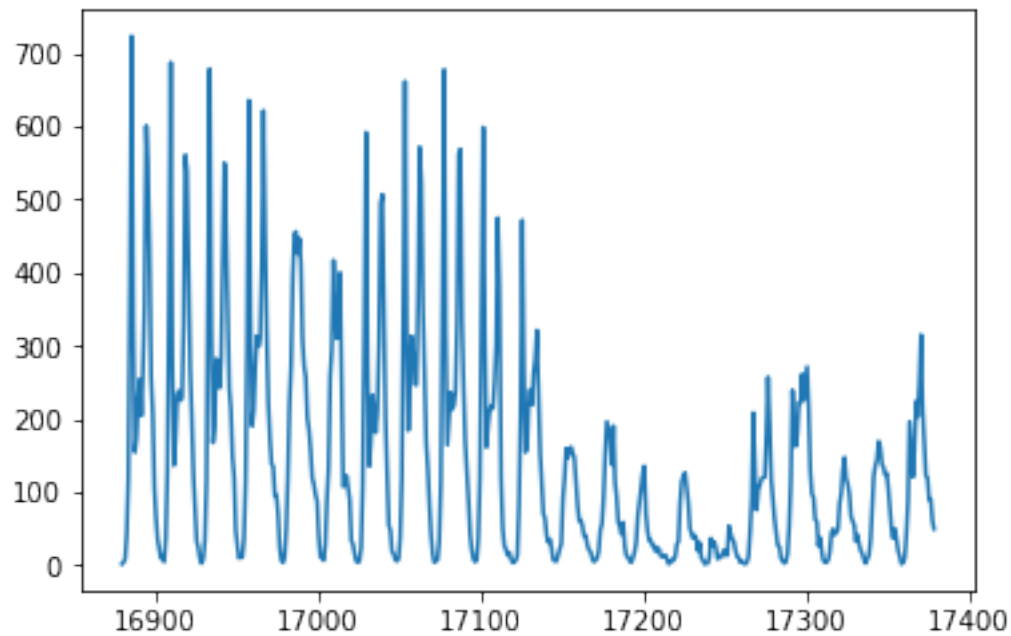
	hum	windspeed	cnt
count	17379.000000	17379.000000	17379.000000
mean	0.627229	0.190098	189.463088
std	0.192930	0.122340	181.387599
min	0.000000	0.000000	1.000000
25%	0.480000	0.104500	40.000000
50%	0.630000	0.194000	142.000000
75%	0.780000	0.253700	281.000000
max	1.000000	0.850700	977.000000

```
In [5]: bike_df.info()
```

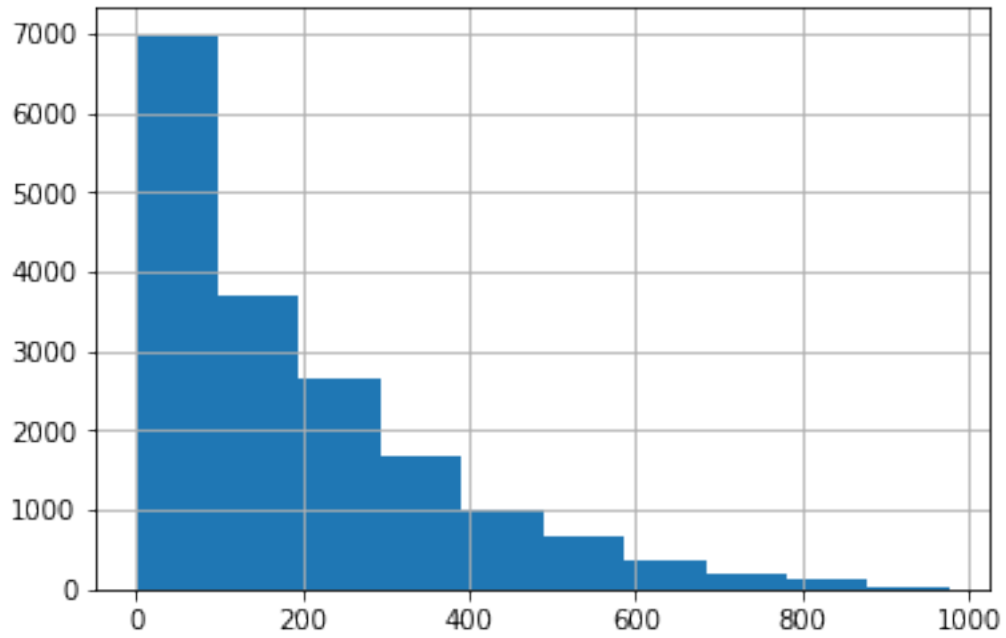
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 17379 entries, 0 to 17378
Data columns (total 13 columns):
season      17379 non-null int64
yr          17379 non-null int64
mnth        17379 non-null int64
hr          17379 non-null int64
holiday     17379 non-null int64
weekday     17379 non-null int64
workingday  17379 non-null int64
weathersit   17379 non-null int64
temp        17379 non-null float64
atemp       17379 non-null float64
hum         17379 non-null float64
```

```
windspeed      17379 non-null float64  
cnt            17379 non-null int64  
dtypes: float64(4), int64(9)  
memory usage: 1.7 MB
```

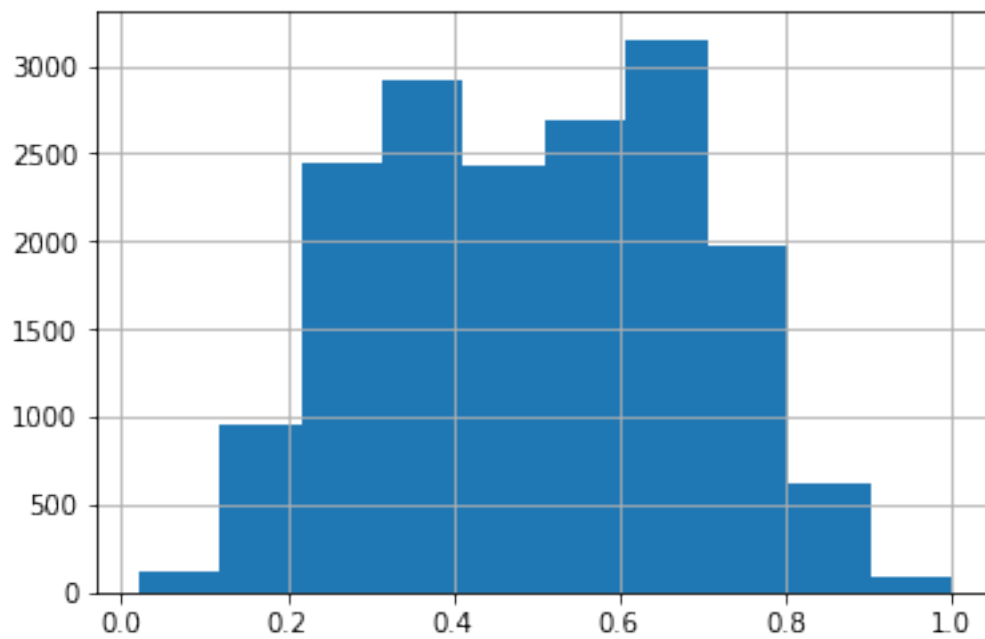
```
In [6]: import matplotlib.pyplot as plt  
        %matplotlib inline  
        _ = bike_df['cnt'].iloc[-500:].plot()
```



```
In [7]: _ = bike_df['cnt'].hist()
```



```
In [8]: _ = bike_df['temp'].hist()
```



## 2 'cnt' is what we are trying to predict. This is the number of people who rented bikes during that hour.

```
In [9]: bike_df.shape
```

```
Out[9]: (17379, 13)
```

```
In [10]: cols = bike_df.columns
         feat_cols = [c for c in cols if c != 'cnt']
         features = bike_df[feat_cols].values
         targets = bike_df['cnt'].values

         # for time series we typically want to save the last bit as the testing instead of mi
         trainsize = round(0.8 * features.shape[0])
         train_features = features[:trainsize]
         test_features = features[trainsize:]
         train_targets = targets[:trainsize]
         test_targets = targets[trainsize:]
         print(train_targets.shape)
         print(test_targets.shape)
```

```
(13903,)
```

```
(3476,)
```

```
In [11]: # force to use CPU for testing
         # import os
         # os.environ["CUDA_DEVICE_ORDER"] = "PCI_BUS_ID"   # see issue #152
         # os.environ["CUDA_VISIBLE_DEVICES"] = ""
```

## 3 I ended up using my GPU so it would run much faster

```
In [12]: from keras.layers import Input, Dense, Dropout, BatchNormalization
         from keras.models import Model, load_model
         import keras.backend as K
         from keras.callbacks import ModelCheckpoint, EarlyStopping
```

Using TensorFlow backend.

```
In [13]: features.shape[1]
```

```
Out[13]: 12
```

```
In [14]: # creates the model
```

```
         # restart keras session (clear weights), sometimes this will clear up errors
         K.clear_session()
```

```

# functional API
inputs = Input(shape=(features.shape[1], ))
x1 = Dense(10, activation='elu')(inputs)
x2 = BatchNormalization()(x1)
x3 = Dropout(0.5)(x2)
x = Dense(1, activation='linear')(x3)

```

```

In [15]: # this saves the best model (lowest validation loss)
checkpoint = ModelCheckpoint('3_layer_dense.h5', monitor='val_loss', save_best_only=True)
# this stops training if the validation loss is not improving for 50 epochs in a row
es = EarlyStopping(patience=50)
cb = [checkpoint, es]

# this compiles our model so it is ready to fit
model = Model(inputs, x)
model.compile(optimizer='adam', loss='mse')

```

```

In [16]: model.summary()

```

```

-----
Layer (type)                 Output Shape              Param #
=====
input_1 (InputLayer)         (None, 12)                0
-----
dense_1 (Dense)              (None, 10)               130
-----
batch_normalization_1 (Batch Normalization) (None, 10)               40
-----
dropout_1 (Dropout)          (None, 10)                0
-----
dense_2 (Dense)              (None, 1)                 11
=====
Total params: 181
Trainable params: 161
Non-trainable params: 20
-----

```

```

In [17]: train_features.shape

```

```

Out[17]: (13903, 12)

```

```

In [18]: subset_size = trainsize
train_feature_subset = train_features[:subset_size]
train_target_subset = train_targets[:subset_size]
# we actually fit the model here
history = model.fit(train_feature_subset,
                    train_target_subset,

```

```
epochs=500,  
validation_split=0.15,  
callbacks=cb,  
batch_size=3000)
```

Train on 11817 samples, validate on 2086 samples

```
Epoch 1/500  
11817/11817 [=====] - 0s - loss: 46888.4853 - val_loss: 122681.0703  
Epoch 2/500  
11817/11817 [=====] - 0s - loss: 46872.0337 - val_loss: 122608.2812  
Epoch 3/500  
11817/11817 [=====] - 0s - loss: 46861.8252 - val_loss: 122535.3125  
Epoch 4/500  
11817/11817 [=====] - 0s - loss: 46842.1859 - val_loss: 122463.2344  
Epoch 5/500  
11817/11817 [=====] - 0s - loss: 46827.7098 - val_loss: 122395.5156  
Epoch 6/500  
11817/11817 [=====] - 0s - loss: 46806.2726 - val_loss: 122330.0156  
Epoch 7/500  
11817/11817 [=====] - 0s - loss: 46791.0079 - val_loss: 122267.0000  
Epoch 8/500  
11817/11817 [=====] - 0s - loss: 46768.3556 - val_loss: 122206.0156  
Epoch 9/500  
11817/11817 [=====] - 0s - loss: 46754.2355 - val_loss: 122147.9062  
Epoch 10/500  
11817/11817 [=====] - 0s - loss: 46738.3481 - val_loss: 122092.4766  
Epoch 11/500  
11817/11817 [=====] - 0s - loss: 46719.8956 - val_loss: 122040.2109  
Epoch 12/500  
11817/11817 [=====] - 0s - loss: 46704.8937 - val_loss: 121990.2266  
Epoch 13/500  
11817/11817 [=====] - 0s - loss: 46685.9169 - val_loss: 121941.9062  
Epoch 14/500  
11817/11817 [=====] - 0s - loss: 46671.9577 - val_loss: 121895.7500  
Epoch 15/500  
11817/11817 [=====] - 0s - loss: 46651.8973 - val_loss: 121852.2109  
Epoch 16/500  
11817/11817 [=====] - 0s - loss: 46643.6937 - val_loss: 121811.0391  
Epoch 17/500  
11817/11817 [=====] - 0s - loss: 46623.2826 - val_loss: 121771.4453  
Epoch 18/500  
11817/11817 [=====] - 0s - loss: 46604.1492 - val_loss: 121734.1172  
Epoch 19/500  
11817/11817 [=====] - 0s - loss: 46588.8342 - val_loss: 121697.9297  
Epoch 20/500  
11817/11817 [=====] - 0s - loss: 46575.9394 - val_loss: 121662.7266  
Epoch 21/500  
11817/11817 [=====] - 0s - loss: 46549.1530 - val_loss: 121628.1328
```

Epoch 22/500  
11817/11817 [=====] - 0s - loss: 46537.8179 - val\_loss: 121594.5234  
Epoch 23/500  
11817/11817 [=====] - 0s - loss: 46518.2371 - val\_loss: 121562.8359  
Epoch 24/500  
11817/11817 [=====] - 0s - loss: 46505.3815 - val\_loss: 121532.0000  
Epoch 25/500  
11817/11817 [=====] - 0s - loss: 46483.8189 - val\_loss: 121502.3672  
Epoch 26/500  
11817/11817 [=====] - 0s - loss: 46466.8105 - val\_loss: 121472.1328  
Epoch 27/500  
11817/11817 [=====] - 0s - loss: 46449.2881 - val\_loss: 121443.1328  
Epoch 28/500  
11817/11817 [=====] - 0s - loss: 46431.2177 - val\_loss: 121414.9688  
Epoch 29/500  
11817/11817 [=====] - 0s - loss: 46412.5444 - val\_loss: 121385.5703  
Epoch 30/500  
11817/11817 [=====] - 0s - loss: 46391.6201 - val\_loss: 121355.6172  
Epoch 31/500  
11817/11817 [=====] - 0s - loss: 46372.7205 - val\_loss: 121325.3203  
Epoch 32/500  
11817/11817 [=====] - 0s - loss: 46353.0065 - val\_loss: 121294.1406  
Epoch 33/500  
11817/11817 [=====] - 0s - loss: 46334.2217 - val\_loss: 121261.3594  
Epoch 34/500  
11817/11817 [=====] - 0s - loss: 46314.5005 - val\_loss: 121227.3516  
Epoch 35/500  
11817/11817 [=====] - 0s - loss: 46290.7544 - val\_loss: 121193.4219  
Epoch 36/500  
11817/11817 [=====] - 0s - loss: 46280.2718 - val\_loss: 121158.7969  
Epoch 37/500  
11817/11817 [=====] - 0s - loss: 46263.8621 - val\_loss: 121123.5625  
Epoch 38/500  
11817/11817 [=====] - 0s - loss: 46236.6341 - val\_loss: 121086.8828  
Epoch 39/500  
11817/11817 [=====] - 0s - loss: 46225.6197 - val\_loss: 121050.1562  
Epoch 40/500  
11817/11817 [=====] - 0s - loss: 46198.0396 - val\_loss: 121013.9844  
Epoch 41/500  
11817/11817 [=====] - 0s - loss: 46166.0450 - val\_loss: 120978.2578  
Epoch 42/500  
11817/11817 [=====] - 0s - loss: 46155.6127 - val\_loss: 120942.0859  
Epoch 43/500  
11817/11817 [=====] - 0s - loss: 46137.4218 - val\_loss: 120901.9453  
Epoch 44/500  
11817/11817 [=====] - 0s - loss: 46113.3448 - val\_loss: 120859.9766  
Epoch 45/500  
11817/11817 [=====] - 0s - loss: 46089.8366 - val\_loss: 120818.9375



Epoch 46/500  
11817/11817 [=====] - 0s - loss: 46066.1076 - val\_loss: 120777.0234  
Epoch 47/500  
11817/11817 [=====] - 0s - loss: 46038.2071 - val\_loss: 120735.0781  
Epoch 48/500  
11817/11817 [=====] - 0s - loss: 46032.2732 - val\_loss: 120692.2656  
Epoch 49/500  
11817/11817 [=====] - 0s - loss: 45992.3934 - val\_loss: 120649.5234  
Epoch 50/500  
11817/11817 [=====] - 0s - loss: 45970.3711 - val\_loss: 120605.0391  
Epoch 51/500  
11817/11817 [=====] - 0s - loss: 45945.9545 - val\_loss: 120559.0938  
Epoch 52/500  
11817/11817 [=====] - 0s - loss: 45912.9137 - val\_loss: 120513.8984  
Epoch 53/500  
11817/11817 [=====] - 0s - loss: 45907.2502 - val\_loss: 120469.3828  
Epoch 54/500  
11817/11817 [=====] - 0s - loss: 45883.5278 - val\_loss: 120425.7891  
Epoch 55/500  
11817/11817 [=====] - 0s - loss: 45851.8191 - val\_loss: 120384.5625  
Epoch 56/500  
11817/11817 [=====] - 0s - loss: 45821.5118 - val\_loss: 120346.7812  
Epoch 57/500  
11817/11817 [=====] - 0s - loss: 45787.7250 - val\_loss: 120311.6797  
Epoch 58/500  
11817/11817 [=====] - 0s - loss: 45773.3797 - val\_loss: 120279.7266  
Epoch 59/500  
11817/11817 [=====] - 0s - loss: 45737.5765 - val\_loss: 120250.2734  
Epoch 60/500  
11817/11817 [=====] - 0s - loss: 45724.0994 - val\_loss: 120222.1406  
Epoch 61/500  
11817/11817 [=====] - 0s - loss: 45687.4754 - val\_loss: 120193.9453  
Epoch 62/500  
11817/11817 [=====] - 0s - loss: 45667.9386 - val\_loss: 120169.5625  
Epoch 63/500  
11817/11817 [=====] - 0s - loss: 45634.1587 - val\_loss: 120148.0859  
Epoch 64/500  
11817/11817 [=====] - 0s - loss: 45599.5670 - val\_loss: 120131.5703  
Epoch 65/500  
11817/11817 [=====] - 0s - loss: 45579.1178 - val\_loss: 120115.4062  
Epoch 66/500  
11817/11817 [=====] - 0s - loss: 45548.3496 - val\_loss: 120110.5156  
Epoch 67/500  
11817/11817 [=====] - 0s - loss: 45520.1771 - val\_loss: 120117.1094  
Epoch 68/500  
11817/11817 [=====] - 0s - loss: 45485.4750 - val\_loss: 120139.7422  
Epoch 69/500  
11817/11817 [=====] - 0s - loss: 45467.0870 - val\_loss: 120169.8984

Epoch 70/500  
11817/11817 [=====] - 0s - loss: 45413.9706 - val\_loss: 120215.5312  
Epoch 71/500  
11817/11817 [=====] - 0s - loss: 45384.1092 - val\_loss: 120287.0703  
Epoch 72/500  
11817/11817 [=====] - 0s - loss: 45328.2117 - val\_loss: 120396.8516  
Epoch 73/500  
11817/11817 [=====] - 0s - loss: 45308.7370 - val\_loss: 120552.0078  
Epoch 74/500  
11817/11817 [=====] - 0s - loss: 45278.7330 - val\_loss: 120740.0234  
Epoch 75/500  
11817/11817 [=====] - 0s - loss: 45228.4405 - val\_loss: 120819.2812  
Epoch 76/500  
11817/11817 [=====] - 0s - loss: 45179.8497 - val\_loss: 120708.8359  
Epoch 77/500  
11817/11817 [=====] - 0s - loss: 45158.7355 - val\_loss: 120572.5391  
Epoch 78/500  
11817/11817 [=====] - 0s - loss: 45099.0454 - val\_loss: 120516.6094  
Epoch 79/500  
11817/11817 [=====] - 0s - loss: 45104.0419 - val\_loss: 120520.5859  
Epoch 80/500  
11817/11817 [=====] - 0s - loss: 45040.8899 - val\_loss: 120598.3516  
Epoch 81/500  
11817/11817 [=====] - 0s - loss: 44969.6555 - val\_loss: 120631.5469  
Epoch 82/500  
11817/11817 [=====] - 0s - loss: 44962.3789 - val\_loss: 120587.5859  
Epoch 83/500  
11817/11817 [=====] - 0s - loss: 44927.9806 - val\_loss: 120501.2266  
Epoch 84/500  
11817/11817 [=====] - 0s - loss: 44885.3303 - val\_loss: 120438.1016  
Epoch 85/500  
11817/11817 [=====] - 0s - loss: 44855.4639 - val\_loss: 120413.8516  
Epoch 86/500  
11817/11817 [=====] - 0s - loss: 44819.7522 - val\_loss: 120396.7031  
Epoch 87/500  
11817/11817 [=====] - 0s - loss: 44749.5370 - val\_loss: 120350.4141  
Epoch 88/500  
11817/11817 [=====] - 0s - loss: 44735.1615 - val\_loss: 120305.9766  
Epoch 89/500  
11817/11817 [=====] - 0s - loss: 44685.0811 - val\_loss: 120329.1562  
Epoch 90/500  
11817/11817 [=====] - 0s - loss: 44612.0259 - val\_loss: 120366.6641  
Epoch 91/500  
11817/11817 [=====] - 0s - loss: 44589.3559 - val\_loss: 120348.8438  
Epoch 92/500  
11817/11817 [=====] - 0s - loss: 44548.3476 - val\_loss: 120297.4766  
Epoch 93/500  
11817/11817 [=====] - 0s - loss: 44506.1508 - val\_loss: 120302.2422

Epoch 94/500  
11817/11817 [=====] - 0s - loss: 44451.9579 - val\_loss: 120247.7812  
Epoch 95/500  
11817/11817 [=====] - 0s - loss: 44419.2089 - val\_loss: 120239.8750  
Epoch 96/500  
11817/11817 [=====] - 0s - loss: 44386.4415 - val\_loss: 120221.3672  
Epoch 97/500  
11817/11817 [=====] - 0s - loss: 44335.0748 - val\_loss: 120185.2266  
Epoch 98/500  
11817/11817 [=====] - 0s - loss: 44269.7703 - val\_loss: 120073.9766  
Epoch 99/500  
11817/11817 [=====] - 0s - loss: 44226.4747 - val\_loss: 120023.3984  
Epoch 100/500  
11817/11817 [=====] - 0s - loss: 44178.9917 - val\_loss: 120018.4297  
Epoch 101/500  
11817/11817 [=====] - 0s - loss: 44147.2747 - val\_loss: 119963.0391  
Epoch 102/500  
11817/11817 [=====] - 0s - loss: 44112.2707 - val\_loss: 119873.3047  
Epoch 103/500  
11817/11817 [=====] - 0s - loss: 44051.1109 - val\_loss: 119776.2734  
Epoch 104/500  
11817/11817 [=====] - 0s - loss: 43996.4254 - val\_loss: 119669.5156  
Epoch 105/500  
11817/11817 [=====] - 0s - loss: 43976.6403 - val\_loss: 119668.9375  
Epoch 106/500  
11817/11817 [=====] - 0s - loss: 43940.3762 - val\_loss: 119591.8359  
Epoch 107/500  
11817/11817 [=====] - 0s - loss: 43842.1178 - val\_loss: 119462.5234  
Epoch 108/500  
11817/11817 [=====] - 0s - loss: 43814.8567 - val\_loss: 119277.5547  
Epoch 109/500  
11817/11817 [=====] - 0s - loss: 43803.4946 - val\_loss: 119081.9453  
Epoch 110/500  
11817/11817 [=====] - 0s - loss: 43734.3517 - val\_loss: 118972.2031  
Epoch 111/500  
11817/11817 [=====] - 0s - loss: 43676.4713 - val\_loss: 118878.8594  
Epoch 112/500  
11817/11817 [=====] - 0s - loss: 43639.4528 - val\_loss: 118760.1953  
Epoch 113/500  
11817/11817 [=====] - 0s - loss: 43598.4757 - val\_loss: 118669.8125  
Epoch 114/500  
11817/11817 [=====] - 0s - loss: 43532.6916 - val\_loss: 118442.6562  
Epoch 115/500  
11817/11817 [=====] - 0s - loss: 43441.3646 - val\_loss: 118361.8203  
Epoch 116/500  
11817/11817 [=====] - 0s - loss: 43453.0554 - val\_loss: 118325.1953  
Epoch 117/500  
11817/11817 [=====] - 0s - loss: 43376.6713 - val\_loss: 118125.9688

Epoch 118/500  
11817/11817 [=====] - 0s - loss: 43326.8632 - val\_loss: 117957.8203  
Epoch 119/500  
11817/11817 [=====] - 0s - loss: 43304.0006 - val\_loss: 117772.1250  
Epoch 120/500  
11817/11817 [=====] - 0s - loss: 43217.0938 - val\_loss: 117557.4062  
Epoch 121/500  
11817/11817 [=====] - 0s - loss: 43213.2126 - val\_loss: 117350.8203  
Epoch 122/500  
11817/11817 [=====] - 0s - loss: 43152.2471 - val\_loss: 117277.4219  
Epoch 123/500  
11817/11817 [=====] - 0s - loss: 43094.1712 - val\_loss: 117130.1406  
Epoch 124/500  
11817/11817 [=====] - 0s - loss: 42998.0445 - val\_loss: 117002.8594  
Epoch 125/500  
11817/11817 [=====] - 0s - loss: 42969.1335 - val\_loss: 116794.9922  
Epoch 126/500  
11817/11817 [=====] - 0s - loss: 42916.9313 - val\_loss: 116793.5781  
Epoch 127/500  
11817/11817 [=====] - 0s - loss: 42874.5289 - val\_loss: 116813.1484  
Epoch 128/500  
11817/11817 [=====] - 0s - loss: 42868.0731 - val\_loss: 116579.0938  
Epoch 129/500  
11817/11817 [=====] - 0s - loss: 42785.5813 - val\_loss: 116142.1797  
Epoch 130/500  
11817/11817 [=====] - 0s - loss: 42716.4741 - val\_loss: 115899.8516  
Epoch 131/500  
11817/11817 [=====] - 0s - loss: 42632.6197 - val\_loss: 115887.4141  
Epoch 132/500  
11817/11817 [=====] - 0s - loss: 42639.9605 - val\_loss: 115899.2578  
Epoch 133/500  
11817/11817 [=====] - 0s - loss: 42561.1844 - val\_loss: 115585.9531  
Epoch 134/500  
11817/11817 [=====] - 0s - loss: 42542.3220 - val\_loss: 115235.4062  
Epoch 135/500  
11817/11817 [=====] - 0s - loss: 42441.1795 - val\_loss: 114915.2578  
Epoch 136/500  
11817/11817 [=====] - 0s - loss: 42402.1553 - val\_loss: 114730.8281  
Epoch 137/500  
11817/11817 [=====] - 0s - loss: 42342.1989 - val\_loss: 114652.8438  
Epoch 138/500  
11817/11817 [=====] - 0s - loss: 42278.5332 - val\_loss: 114419.8906  
Epoch 139/500  
11817/11817 [=====] - 0s - loss: 42213.3634 - val\_loss: 114025.9531  
Epoch 140/500  
11817/11817 [=====] - 0s - loss: 42185.6462 - val\_loss: 113936.6562  
Epoch 141/500  
11817/11817 [=====] - 0s - loss: 42160.2440 - val\_loss: 113756.9531

Epoch 142/500  
11817/11817 [=====] - 0s - loss: 42112.6913 - val\_loss: 113451.1328  
Epoch 143/500  
11817/11817 [=====] - 0s - loss: 41994.0407 - val\_loss: 113223.4531  
Epoch 144/500  
11817/11817 [=====] - 0s - loss: 41989.3443 - val\_loss: 112989.3203  
Epoch 145/500  
11817/11817 [=====] - 0s - loss: 41933.2190 - val\_loss: 112993.5859  
Epoch 146/500  
11817/11817 [=====] - 0s - loss: 41857.3993 - val\_loss: 112763.8750  
Epoch 147/500  
11817/11817 [=====] - 0s - loss: 41740.1792 - val\_loss: 112150.1328  
Epoch 148/500  
11817/11817 [=====] - 0s - loss: 41760.2551 - val\_loss: 111818.9141  
Epoch 149/500  
11817/11817 [=====] - 0s - loss: 41643.0539 - val\_loss: 111698.5000  
Epoch 150/500  
11817/11817 [=====] - 0s - loss: 41600.7610 - val\_loss: 111722.5234  
Epoch 151/500  
11817/11817 [=====] - 0s - loss: 41608.8549 - val\_loss: 111610.6953  
Epoch 152/500  
11817/11817 [=====] - 0s - loss: 41553.2449 - val\_loss: 111514.9609  
Epoch 153/500  
11817/11817 [=====] - 0s - loss: 41468.7507 - val\_loss: 111355.5703  
Epoch 154/500  
11817/11817 [=====] - 0s - loss: 41431.2097 - val\_loss: 111007.6641  
Epoch 155/500  
11817/11817 [=====] - 0s - loss: 41350.5552 - val\_loss: 110661.9688  
Epoch 156/500  
11817/11817 [=====] - 0s - loss: 41279.2475 - val\_loss: 110281.8516  
Epoch 157/500  
11817/11817 [=====] - 0s - loss: 41216.5529 - val\_loss: 110026.5156  
Epoch 158/500  
11817/11817 [=====] - 0s - loss: 41127.5467 - val\_loss: 109926.4141  
Epoch 159/500  
11817/11817 [=====] - 0s - loss: 41130.4091 - val\_loss: 109707.9531  
Epoch 160/500  
11817/11817 [=====] - 0s - loss: 41082.4623 - val\_loss: 109582.3281  
Epoch 161/500  
11817/11817 [=====] - 0s - loss: 40972.7362 - val\_loss: 109412.0938  
Epoch 162/500  
11817/11817 [=====] - 0s - loss: 40919.3731 - val\_loss: 109152.8125  
Epoch 163/500  
11817/11817 [=====] - 0s - loss: 40899.7994 - val\_loss: 108859.9531  
Epoch 164/500  
11817/11817 [=====] - 0s - loss: 40856.8856 - val\_loss: 108737.2031  
Epoch 165/500  
11817/11817 [=====] - 0s - loss: 40719.1942 - val\_loss: 108491.3750

Epoch 166/500  
11817/11817 [=====] - 0s - loss: 40657.6683 - val\_loss: 108252.0000  
Epoch 167/500  
11817/11817 [=====] - 0s - loss: 40657.6237 - val\_loss: 107835.2188  
Epoch 168/500  
11817/11817 [=====] - 0s - loss: 40542.4589 - val\_loss: 107503.4141  
Epoch 169/500  
11817/11817 [=====] - 0s - loss: 40422.2263 - val\_loss: 107306.6641  
Epoch 170/500  
11817/11817 [=====] - 0s - loss: 40511.8928 - val\_loss: 106977.1094  
Epoch 171/500  
11817/11817 [=====] - 0s - loss: 40453.6071 - val\_loss: 106771.7578  
Epoch 172/500  
11817/11817 [=====] - 0s - loss: 40333.0195 - val\_loss: 106999.6797  
Epoch 173/500  
11817/11817 [=====] - 0s - loss: 40318.7837 - val\_loss: 106805.2656  
Epoch 174/500  
11817/11817 [=====] - 0s - loss: 40219.7065 - val\_loss: 106281.7891  
Epoch 175/500  
11817/11817 [=====] - 0s - loss: 40117.0938 - val\_loss: 105825.3984  
Epoch 176/500  
11817/11817 [=====] - 0s - loss: 40111.5766 - val\_loss: 105683.8125  
Epoch 177/500  
11817/11817 [=====] - 0s - loss: 40034.4349 - val\_loss: 105474.3125  
Epoch 178/500  
11817/11817 [=====] - 0s - loss: 40010.9878 - val\_loss: 105217.8359  
Epoch 179/500  
11817/11817 [=====] - 0s - loss: 39880.1924 - val\_loss: 105040.3672  
Epoch 180/500  
11817/11817 [=====] - 0s - loss: 39849.1196 - val\_loss: 104816.3984  
Epoch 181/500  
11817/11817 [=====] - 0s - loss: 39755.9697 - val\_loss: 104386.4688  
Epoch 182/500  
11817/11817 [=====] - 0s - loss: 39734.7749 - val\_loss: 103739.6562  
Epoch 183/500  
11817/11817 [=====] - 0s - loss: 39594.3542 - val\_loss: 103585.7734  
Epoch 184/500  
11817/11817 [=====] - 0s - loss: 39557.8696 - val\_loss: 103360.1250  
Epoch 185/500  
11817/11817 [=====] - 0s - loss: 39525.9174 - val\_loss: 103603.3203  
Epoch 186/500  
11817/11817 [=====] - 0s - loss: 39484.0631 - val\_loss: 103554.1016  
Epoch 187/500  
11817/11817 [=====] - 0s - loss: 39432.3108 - val\_loss: 103047.1406  
Epoch 188/500  
11817/11817 [=====] - 0s - loss: 39419.9050 - val\_loss: 102170.4844  
Epoch 189/500  
11817/11817 [=====] - 0s - loss: 39331.0265 - val\_loss: 101668.7578

Epoch 190/500  
11817/11817 [=====] - 0s - loss: 39156.2000 - val\_loss: 101495.0547  
Epoch 191/500  
11817/11817 [=====] - 0s - loss: 39169.7591 - val\_loss: 101711.0859  
Epoch 192/500  
11817/11817 [=====] - 0s - loss: 39084.4898 - val\_loss: 101644.8438  
Epoch 193/500  
11817/11817 [=====] - 0s - loss: 39108.9832 - val\_loss: 101405.3516  
Epoch 194/500  
11817/11817 [=====] - 0s - loss: 39005.5761 - val\_loss: 100702.0469  
Epoch 195/500  
11817/11817 [=====] - 0s - loss: 38825.7357 - val\_loss: 100400.2734  
Epoch 196/500  
11817/11817 [=====] - 0s - loss: 38852.4220 - val\_loss: 100026.9766  
Epoch 197/500  
11817/11817 [=====] - 0s - loss: 38827.2646 - val\_loss: 99828.3125  
Epoch 198/500  
11817/11817 [=====] - 0s - loss: 38697.0965 - val\_loss: 99246.3906  
Epoch 199/500  
11817/11817 [=====] - 0s - loss: 38634.8751 - val\_loss: 99092.6953  
Epoch 200/500  
11817/11817 [=====] - 0s - loss: 38659.8053 - val\_loss: 98894.9375  
Epoch 201/500  
11817/11817 [=====] - 0s - loss: 38530.6520 - val\_loss: 98857.0000  
Epoch 202/500  
11817/11817 [=====] - 0s - loss: 38455.4830 - val\_loss: 98864.0000  
Epoch 203/500  
11817/11817 [=====] - 0s - loss: 38467.1576 - val\_loss: 98441.2422  
Epoch 204/500  
11817/11817 [=====] - 0s - loss: 38381.1260 - val\_loss: 97948.5391  
Epoch 205/500  
11817/11817 [=====] - 0s - loss: 38341.7409 - val\_loss: 97327.3594  
Epoch 206/500  
11817/11817 [=====] - 0s - loss: 38301.5456 - val\_loss: 96912.2734  
Epoch 207/500  
11817/11817 [=====] - 0s - loss: 38116.0688 - val\_loss: 96844.4453  
Epoch 208/500  
11817/11817 [=====] - 0s - loss: 37993.9275 - val\_loss: 96694.5547  
Epoch 209/500  
11817/11817 [=====] - 0s - loss: 38054.3350 - val\_loss: 96660.8281  
Epoch 210/500  
11817/11817 [=====] - 0s - loss: 38020.8847 - val\_loss: 96103.8984  
Epoch 211/500  
11817/11817 [=====] - 0s - loss: 37977.9720 - val\_loss: 95299.5625  
Epoch 212/500  
11817/11817 [=====] - 0s - loss: 37837.6797 - val\_loss: 95160.3438  
Epoch 213/500  
11817/11817 [=====] - 0s - loss: 37771.3099 - val\_loss: 95448.5625

Epoch 214/500  
11817/11817 [=====] - 0s - loss: 37629.1056 - val\_loss: 95325.4609  
Epoch 215/500  
11817/11817 [=====] - 0s - loss: 37656.4030 - val\_loss: 95372.6875  
Epoch 216/500  
11817/11817 [=====] - 0s - loss: 37573.5391 - val\_loss: 95013.1250  
Epoch 217/500  
11817/11817 [=====] - 0s - loss: 37510.9692 - val\_loss: 94140.9297  
Epoch 218/500  
11817/11817 [=====] - 0s - loss: 37442.3593 - val\_loss: 93629.2656  
Epoch 219/500  
11817/11817 [=====] - 0s - loss: 37508.1923 - val\_loss: 93270.3516  
Epoch 220/500  
11817/11817 [=====] - 0s - loss: 37249.3860 - val\_loss: 93171.8281  
Epoch 221/500  
11817/11817 [=====] - 0s - loss: 37217.1063 - val\_loss: 93298.7891  
Epoch 222/500  
11817/11817 [=====] - 0s - loss: 37190.0069 - val\_loss: 93059.5312  
Epoch 223/500  
11817/11817 [=====] - 0s - loss: 37191.2767 - val\_loss: 92737.1797  
Epoch 224/500  
11817/11817 [=====] - 0s - loss: 37087.3683 - val\_loss: 92443.9531  
Epoch 225/500  
11817/11817 [=====] - 0s - loss: 37078.6828 - val\_loss: 91989.2500  
Epoch 226/500  
11817/11817 [=====] - 0s - loss: 36970.9409 - val\_loss: 91613.9688  
Epoch 227/500  
11817/11817 [=====] - 0s - loss: 36910.0346 - val\_loss: 91315.5234  
Epoch 228/500  
11817/11817 [=====] - 0s - loss: 36772.7596 - val\_loss: 91155.1797  
Epoch 229/500  
11817/11817 [=====] - 0s - loss: 36837.4655 - val\_loss: 90585.6953  
Epoch 230/500  
11817/11817 [=====] - 0s - loss: 36841.5156 - val\_loss: 90019.4062  
Epoch 231/500  
11817/11817 [=====] - 0s - loss: 36592.7104 - val\_loss: 89553.2734  
Epoch 232/500  
11817/11817 [=====] - 0s - loss: 36719.0101 - val\_loss: 89515.0078  
Epoch 233/500  
11817/11817 [=====] - 0s - loss: 36446.4922 - val\_loss: 89444.8516  
Epoch 234/500  
11817/11817 [=====] - 0s - loss: 36472.7652 - val\_loss: 89234.6094  
Epoch 235/500  
11817/11817 [=====] - 0s - loss: 36375.5320 - val\_loss: 88704.3438  
Epoch 236/500  
11817/11817 [=====] - 0s - loss: 36264.0382 - val\_loss: 88355.6016  
Epoch 237/500  
11817/11817 [=====] - 0s - loss: 36239.6100 - val\_loss: 88304.6719



Epoch 238/500  
11817/11817 [=====] - 0s - loss: 36171.9662 - val\_loss: 88170.2109  
Epoch 239/500  
11817/11817 [=====] - 0s - loss: 36112.3554 - val\_loss: 87946.9375  
Epoch 240/500  
11817/11817 [=====] - 0s - loss: 36044.7645 - val\_loss: 87386.6016  
Epoch 241/500  
11817/11817 [=====] - 0s - loss: 36046.4425 - val\_loss: 86947.4922  
Epoch 242/500  
11817/11817 [=====] - 0s - loss: 36067.0127 - val\_loss: 86444.4219  
Epoch 243/500  
11817/11817 [=====] - 0s - loss: 35788.6142 - val\_loss: 86721.5312  
Epoch 244/500  
11817/11817 [=====] - 0s - loss: 35734.7697 - val\_loss: 86807.3750  
Epoch 245/500  
11817/11817 [=====] - 0s - loss: 35685.3900 - val\_loss: 86541.6562  
Epoch 246/500  
11817/11817 [=====] - 0s - loss: 35773.4286 - val\_loss: 86161.4375  
Epoch 247/500  
11817/11817 [=====] - 0s - loss: 35561.1951 - val\_loss: 85750.6250  
Epoch 248/500  
11817/11817 [=====] - 0s - loss: 35520.2555 - val\_loss: 85095.2109  
Epoch 249/500  
11817/11817 [=====] - 0s - loss: 35564.6400 - val\_loss: 85038.2578  
Epoch 250/500  
11817/11817 [=====] - 0s - loss: 35480.4540 - val\_loss: 84890.5078  
Epoch 251/500  
11817/11817 [=====] - 0s - loss: 35348.3092 - val\_loss: 84771.7422  
Epoch 252/500  
11817/11817 [=====] - 0s - loss: 35257.3237 - val\_loss: 84537.7969  
Epoch 253/500  
11817/11817 [=====] - 0s - loss: 35227.0824 - val\_loss: 84388.6016  
Epoch 254/500  
11817/11817 [=====] - 0s - loss: 35155.4427 - val\_loss: 84015.6797  
Epoch 255/500  
11817/11817 [=====] - 0s - loss: 35049.8651 - val\_loss: 83441.0078  
Epoch 256/500  
11817/11817 [=====] - 0s - loss: 34948.5120 - val\_loss: 83074.4375  
Epoch 257/500  
11817/11817 [=====] - 0s - loss: 35018.7593 - val\_loss: 83087.1250  
Epoch 258/500  
11817/11817 [=====] - 0s - loss: 34964.3809 - val\_loss: 82831.5234  
Epoch 259/500  
11817/11817 [=====] - 0s - loss: 34870.7691 - val\_loss: 82102.9922  
Epoch 260/500  
11817/11817 [=====] - 0s - loss: 34695.1869 - val\_loss: 81958.2266  
Epoch 261/500  
11817/11817 [=====] - 0s - loss: 34652.5358 - val\_loss: 82044.6250

Epoch 262/500  
11817/11817 [=====] - 0s - loss: 34685.7834 - val\_loss: 81595.9297  
Epoch 263/500  
11817/11817 [=====] - 0s - loss: 34505.4552 - val\_loss: 81233.7578  
Epoch 264/500  
11817/11817 [=====] - 0s - loss: 34671.4797 - val\_loss: 80979.1562  
Epoch 265/500  
11817/11817 [=====] - 0s - loss: 34582.6679 - val\_loss: 81001.2969  
Epoch 266/500  
11817/11817 [=====] - 0s - loss: 34448.8753 - val\_loss: 80745.9531  
Epoch 267/500  
11817/11817 [=====] - 0s - loss: 34366.5396 - val\_loss: 80399.0156  
Epoch 268/500  
11817/11817 [=====] - 0s - loss: 34238.3299 - val\_loss: 79962.1562  
Epoch 269/500  
11817/11817 [=====] - 0s - loss: 34180.3902 - val\_loss: 79885.3438  
Epoch 270/500  
11817/11817 [=====] - 0s - loss: 34171.2502 - val\_loss: 78694.1328  
Epoch 271/500  
11817/11817 [=====] - 0s - loss: 34163.2669 - val\_loss: 78162.0703  
Epoch 272/500  
11817/11817 [=====] - 0s - loss: 33965.8794 - val\_loss: 78247.0859  
Epoch 273/500  
11817/11817 [=====] - 0s - loss: 34028.2966 - val\_loss: 78366.2656  
Epoch 274/500  
11817/11817 [=====] - 0s - loss: 33863.4168 - val\_loss: 78325.0859  
Epoch 275/500  
11817/11817 [=====] - 0s - loss: 33858.0842 - val\_loss: 78185.9219  
Epoch 276/500  
11817/11817 [=====] - 0s - loss: 33868.5107 - val\_loss: 77769.9453  
Epoch 277/500  
11817/11817 [=====] - 0s - loss: 33706.8769 - val\_loss: 77654.6328  
Epoch 278/500  
11817/11817 [=====] - 0s - loss: 33572.5759 - val\_loss: 77302.1953  
Epoch 279/500  
11817/11817 [=====] - 0s - loss: 33697.4709 - val\_loss: 76914.5469  
Epoch 280/500  
11817/11817 [=====] - 0s - loss: 33603.2157 - val\_loss: 76853.2500  
Epoch 281/500  
11817/11817 [=====] - 0s - loss: 33290.4702 - val\_loss: 76534.8750  
Epoch 282/500  
11817/11817 [=====] - 0s - loss: 33323.4768 - val\_loss: 76597.6562  
Epoch 283/500  
11817/11817 [=====] - 0s - loss: 33295.3802 - val\_loss: 76640.6328  
Epoch 284/500  
11817/11817 [=====] - 0s - loss: 33211.3450 - val\_loss: 76556.3438  
Epoch 285/500  
11817/11817 [=====] - 0s - loss: 33132.5712 - val\_loss: 75950.5625

Epoch 286/500  
11817/11817 [=====] - 0s - loss: 32998.5760 - val\_loss: 75342.6406  
Epoch 287/500  
11817/11817 [=====] - 0s - loss: 33088.0506 - val\_loss: 74989.4375  
Epoch 288/500  
11817/11817 [=====] - 0s - loss: 33031.2162 - val\_loss: 74749.8828  
Epoch 289/500  
11817/11817 [=====] - 0s - loss: 33023.1919 - val\_loss: 74720.9141  
Epoch 290/500  
11817/11817 [=====] - 0s - loss: 32824.3471 - val\_loss: 74584.7109  
Epoch 291/500  
11817/11817 [=====] - 0s - loss: 32864.6465 - val\_loss: 74321.1328  
Epoch 292/500  
11817/11817 [=====] - 0s - loss: 32693.2218 - val\_loss: 73945.4375  
Epoch 293/500  
11817/11817 [=====] - 0s - loss: 32733.6332 - val\_loss: 73463.2109  
Epoch 294/500  
11817/11817 [=====] - 0s - loss: 32631.0473 - val\_loss: 73239.8359  
Epoch 295/500  
11817/11817 [=====] - 0s - loss: 32607.2498 - val\_loss: 73575.1875  
Epoch 296/500  
11817/11817 [=====] - 0s - loss: 32534.7508 - val\_loss: 73431.8516  
Epoch 297/500  
11817/11817 [=====] - 0s - loss: 32378.4038 - val\_loss: 72949.5625  
Epoch 298/500  
11817/11817 [=====] - 0s - loss: 32285.2263 - val\_loss: 72867.1562  
Epoch 299/500  
11817/11817 [=====] - 0s - loss: 32266.2846 - val\_loss: 72470.5156  
Epoch 300/500  
11817/11817 [=====] - 0s - loss: 32068.6942 - val\_loss: 71824.6641  
Epoch 301/500  
11817/11817 [=====] - 0s - loss: 32190.9630 - val\_loss: 71849.3672  
Epoch 302/500  
11817/11817 [=====] - 0s - loss: 31975.8604 - val\_loss: 71898.1484  
Epoch 303/500  
11817/11817 [=====] - 0s - loss: 32088.2288 - val\_loss: 71775.1953  
Epoch 304/500  
11817/11817 [=====] - 0s - loss: 31896.9880 - val\_loss: 71426.6641  
Epoch 305/500  
11817/11817 [=====] - 0s - loss: 31980.6012 - val\_loss: 71197.4375  
Epoch 306/500  
11817/11817 [=====] - 0s - loss: 32036.6693 - val\_loss: 70779.0156  
Epoch 307/500  
11817/11817 [=====] - 0s - loss: 31781.2752 - val\_loss: 70165.2344  
Epoch 308/500  
11817/11817 [=====] - 0s - loss: 31725.7520 - val\_loss: 69651.8594  
Epoch 309/500  
11817/11817 [=====] - 0s - loss: 31715.4307 - val\_loss: 69772.8125

Epoch 310/500  
11817/11817 [=====] - 0s - loss: 31573.9483 - val\_loss: 69720.9922  
Epoch 311/500  
11817/11817 [=====] - 0s - loss: 31599.7956 - val\_loss: 70059.1875  
Epoch 312/500  
11817/11817 [=====] - 0s - loss: 31569.5002 - val\_loss: 69807.1875  
Epoch 313/500  
11817/11817 [=====] - 0s - loss: 31445.1213 - val\_loss: 69072.0000  
Epoch 314/500  
11817/11817 [=====] - 0s - loss: 31360.1523 - val\_loss: 68698.9766  
Epoch 315/500  
11817/11817 [=====] - 0s - loss: 31204.8892 - val\_loss: 68352.1797  
Epoch 316/500  
11817/11817 [=====] - 0s - loss: 31177.5050 - val\_loss: 68159.1094  
Epoch 317/500  
11817/11817 [=====] - 0s - loss: 30988.1702 - val\_loss: 68074.6719  
Epoch 318/500  
11817/11817 [=====] - 0s - loss: 31071.9017 - val\_loss: 67694.6953  
Epoch 319/500  
11817/11817 [=====] - 0s - loss: 31051.5894 - val\_loss: 67545.7266  
Epoch 320/500  
11817/11817 [=====] - 0s - loss: 30904.9277 - val\_loss: 67358.6953  
Epoch 321/500  
11817/11817 [=====] - 0s - loss: 30803.2970 - val\_loss: 67534.5156  
Epoch 322/500  
11817/11817 [=====] - 0s - loss: 30638.4004 - val\_loss: 67336.7188  
Epoch 323/500  
11817/11817 [=====] - 0s - loss: 30788.4332 - val\_loss: 67335.0625  
Epoch 324/500  
11817/11817 [=====] - 0s - loss: 30774.6579 - val\_loss: 66783.6719  
Epoch 325/500  
11817/11817 [=====] - 0s - loss: 30729.4372 - val\_loss: 66169.0859  
Epoch 326/500  
11817/11817 [=====] - 0s - loss: 30621.8253 - val\_loss: 65312.2539  
Epoch 327/500  
11817/11817 [=====] - 0s - loss: 30565.3582 - val\_loss: 65284.0195  
Epoch 328/500  
11817/11817 [=====] - 0s - loss: 30449.4281 - val\_loss: 65280.6445  
Epoch 329/500  
11817/11817 [=====] - 0s - loss: 30316.6288 - val\_loss: 65867.6094  
Epoch 330/500  
11817/11817 [=====] - 0s - loss: 30343.7935 - val\_loss: 65700.8438  
Epoch 331/500  
11817/11817 [=====] - 0s - loss: 30204.7873 - val\_loss: 65265.1719  
Epoch 332/500  
11817/11817 [=====] - 0s - loss: 30282.4135 - val\_loss: 65033.4570  
Epoch 333/500  
11817/11817 [=====] - 0s - loss: 30164.1427 - val\_loss: 64734.0195

Epoch 334/500  
11817/11817 [=====] - 0s - loss: 30294.2553 - val\_loss: 63914.8359  
Epoch 335/500  
11817/11817 [=====] - 0s - loss: 30095.7169 - val\_loss: 63928.1328  
Epoch 336/500  
11817/11817 [=====] - 0s - loss: 29926.4317 - val\_loss: 64245.8477  
Epoch 337/500  
11817/11817 [=====] - 0s - loss: 30040.0982 - val\_loss: 64269.2695  
Epoch 338/500  
11817/11817 [=====] - 0s - loss: 29767.6377 - val\_loss: 64118.0469  
Epoch 339/500  
11817/11817 [=====] - 0s - loss: 29699.7219 - val\_loss: 64050.0859  
Epoch 340/500  
11817/11817 [=====] - 0s - loss: 29836.8857 - val\_loss: 63397.3789  
Epoch 341/500  
11817/11817 [=====] - 0s - loss: 29807.2476 - val\_loss: 62452.3555  
Epoch 342/500  
11817/11817 [=====] - 0s - loss: 29645.3071 - val\_loss: 62356.1719  
Epoch 343/500  
11817/11817 [=====] - 0s - loss: 29456.4278 - val\_loss: 62361.3633  
Epoch 344/500  
11817/11817 [=====] - 0s - loss: 29540.2064 - val\_loss: 62137.0547  
Epoch 345/500  
11817/11817 [=====] - 0s - loss: 29544.6705 - val\_loss: 61635.2891  
Epoch 346/500  
11817/11817 [=====] - 0s - loss: 29359.8052 - val\_loss: 61223.8125  
Epoch 347/500  
11817/11817 [=====] - 0s - loss: 29474.2040 - val\_loss: 61463.5820  
Epoch 348/500  
11817/11817 [=====] - 0s - loss: 29180.6569 - val\_loss: 61424.1680  
Epoch 349/500  
11817/11817 [=====] - 0s - loss: 29284.0726 - val\_loss: 61048.6836  
Epoch 350/500  
11817/11817 [=====] - 0s - loss: 29349.5795 - val\_loss: 60259.3984  
Epoch 351/500  
11817/11817 [=====] - 0s - loss: 29074.8149 - val\_loss: 60099.7266  
Epoch 352/500  
11817/11817 [=====] - 0s - loss: 29144.8957 - val\_loss: 60121.6992  
Epoch 353/500  
11817/11817 [=====] - 0s - loss: 29168.9613 - val\_loss: 59883.9609  
Epoch 354/500  
11817/11817 [=====] - 0s - loss: 29039.1793 - val\_loss: 59642.1289  
Epoch 355/500  
11817/11817 [=====] - 0s - loss: 28950.8695 - val\_loss: 59447.4375  
Epoch 356/500  
11817/11817 [=====] - 0s - loss: 28803.6176 - val\_loss: 59536.4531  
Epoch 357/500  
11817/11817 [=====] - 0s - loss: 28695.1695 - val\_loss: 59400.9570

Epoch 358/500  
11817/11817 [=====] - 0s - loss: 28765.8810 - val\_loss: 59727.7539  
Epoch 359/500  
11817/11817 [=====] - 0s - loss: 28581.4540 - val\_loss: 59406.0742  
Epoch 360/500  
11817/11817 [=====] - 0s - loss: 28499.3095 - val\_loss: 58506.0547  
Epoch 361/500  
11817/11817 [=====] - 0s - loss: 28544.5994 - val\_loss: 58299.8477  
Epoch 362/500  
11817/11817 [=====] - 0s - loss: 28497.9423 - val\_loss: 58206.3359  
Epoch 363/500  
11817/11817 [=====] - 0s - loss: 28572.6868 - val\_loss: 58588.4102  
Epoch 364/500  
11817/11817 [=====] - 0s - loss: 28415.6245 - val\_loss: 58788.3750  
Epoch 365/500  
11817/11817 [=====] - 0s - loss: 28293.5716 - val\_loss: 58241.6172  
Epoch 366/500  
11817/11817 [=====] - 0s - loss: 28161.3918 - val\_loss: 57846.0039  
Epoch 367/500  
11817/11817 [=====] - 0s - loss: 28181.6950 - val\_loss: 57608.6719  
Epoch 368/500  
11817/11817 [=====] - 0s - loss: 28175.7681 - val\_loss: 57437.6289  
Epoch 369/500  
11817/11817 [=====] - 0s - loss: 28011.9634 - val\_loss: 57793.0547  
Epoch 370/500  
11817/11817 [=====] - 0s - loss: 27923.6217 - val\_loss: 57278.1289  
Epoch 371/500  
11817/11817 [=====] - 0s - loss: 27854.5800 - val\_loss: 56955.1797  
Epoch 372/500  
11817/11817 [=====] - 0s - loss: 27885.6066 - val\_loss: 56592.8867  
Epoch 373/500  
11817/11817 [=====] - 0s - loss: 27880.7908 - val\_loss: 56150.1367  
Epoch 374/500  
11817/11817 [=====] - 0s - loss: 27790.7220 - val\_loss: 56064.9102  
Epoch 375/500  
11817/11817 [=====] - 0s - loss: 27958.4860 - val\_loss: 56115.3672  
Epoch 376/500  
11817/11817 [=====] - 0s - loss: 27863.4323 - val\_loss: 56027.9414  
Epoch 377/500  
11817/11817 [=====] - 0s - loss: 27740.2357 - val\_loss: 55504.5508  
Epoch 378/500  
11817/11817 [=====] - 0s - loss: 27571.3139 - val\_loss: 54967.5391  
Epoch 379/500  
11817/11817 [=====] - 0s - loss: 27512.8917 - val\_loss: 54916.7891  
Epoch 380/500  
11817/11817 [=====] - 0s - loss: 27434.3411 - val\_loss: 55089.9219  
Epoch 381/500  
11817/11817 [=====] - 0s - loss: 27495.5237 - val\_loss: 55193.3164

Epoch 382/500  
11817/11817 [=====] - 0s - loss: 27482.7563 - val\_loss: 54734.5586  
Epoch 383/500  
11817/11817 [=====] - 0s - loss: 27302.7835 - val\_loss: 54350.4414  
Epoch 384/500  
11817/11817 [=====] - 0s - loss: 27241.3525 - val\_loss: 54540.3320  
Epoch 385/500  
11817/11817 [=====] - 0s - loss: 27084.3845 - val\_loss: 54694.0312  
Epoch 386/500  
11817/11817 [=====] - 0s - loss: 27138.2095 - val\_loss: 54578.8906  
Epoch 387/500  
11817/11817 [=====] - 0s - loss: 27269.0880 - val\_loss: 53998.5352  
Epoch 388/500  
11817/11817 [=====] - 0s - loss: 27181.6258 - val\_loss: 53529.1172  
Epoch 389/500  
11817/11817 [=====] - 0s - loss: 26875.5959 - val\_loss: 53456.9453  
Epoch 390/500  
11817/11817 [=====] - 0s - loss: 26874.4389 - val\_loss: 52933.6172  
Epoch 391/500  
11817/11817 [=====] - 0s - loss: 26968.9117 - val\_loss: 52827.2305  
Epoch 392/500  
11817/11817 [=====] - 0s - loss: 26865.4212 - val\_loss: 52611.6680  
Epoch 393/500  
11817/11817 [=====] - 0s - loss: 26707.5899 - val\_loss: 52731.9180  
Epoch 394/500  
11817/11817 [=====] - 0s - loss: 26443.0769 - val\_loss: 53145.1250  
Epoch 395/500  
11817/11817 [=====] - 0s - loss: 26689.3378 - val\_loss: 53482.8828  
Epoch 396/500  
11817/11817 [=====] - 0s - loss: 26515.6591 - val\_loss: 52891.6797  
Epoch 397/500  
11817/11817 [=====] - 0s - loss: 26653.6716 - val\_loss: 52379.9844  
Epoch 398/500  
11817/11817 [=====] - 0s - loss: 26464.0974 - val\_loss: 51751.4922  
Epoch 399/500  
11817/11817 [=====] - 0s - loss: 26348.5668 - val\_loss: 51208.3906  
Epoch 400/500  
11817/11817 [=====] - 0s - loss: 26272.1293 - val\_loss: 51031.5469  
Epoch 401/500  
11817/11817 [=====] - 0s - loss: 26286.1608 - val\_loss: 51560.0000  
Epoch 402/500  
11817/11817 [=====] - 0s - loss: 26242.6547 - val\_loss: 51765.3164  
Epoch 403/500  
11817/11817 [=====] - 0s - loss: 26290.3918 - val\_loss: 51833.8945  
Epoch 404/500  
11817/11817 [=====] - 0s - loss: 26268.3760 - val\_loss: 51342.8906  
Epoch 405/500  
11817/11817 [=====] - 0s - loss: 26366.3679 - val\_loss: 50859.4922

Epoch 406/500  
11817/11817 [=====] - 0s - loss: 26183.6286 - val\_loss: 50346.1719  
Epoch 407/500  
11817/11817 [=====] - 0s - loss: 25993.1242 - val\_loss: 50299.5312  
Epoch 408/500  
11817/11817 [=====] - 0s - loss: 25940.2893 - val\_loss: 50168.7852  
Epoch 409/500  
11817/11817 [=====] - 0s - loss: 25798.2645 - val\_loss: 50220.5742  
Epoch 410/500  
11817/11817 [=====] - 0s - loss: 25888.7782 - val\_loss: 50076.7539  
Epoch 411/500  
11817/11817 [=====] - 0s - loss: 25930.4257 - val\_loss: 49571.6523  
Epoch 412/500  
11817/11817 [=====] - 0s - loss: 25752.9026 - val\_loss: 49629.1367  
Epoch 413/500  
11817/11817 [=====] - 0s - loss: 25720.9496 - val\_loss: 49461.8164  
Epoch 414/500  
11817/11817 [=====] - 0s - loss: 25597.9266 - val\_loss: 49406.6367  
Epoch 415/500  
11817/11817 [=====] - 0s - loss: 25503.6896 - val\_loss: 49442.6758  
Epoch 416/500  
11817/11817 [=====] - 0s - loss: 25701.0601 - val\_loss: 49429.7305  
Epoch 417/500  
11817/11817 [=====] - 0s - loss: 25435.4317 - val\_loss: 49055.9766  
Epoch 418/500  
11817/11817 [=====] - 0s - loss: 25546.7169 - val\_loss: 48658.8438  
Epoch 419/500  
11817/11817 [=====] - 0s - loss: 25660.4673 - val\_loss: 48533.3750  
Epoch 420/500  
11817/11817 [=====] - 0s - loss: 25574.1487 - val\_loss: 48634.2227  
Epoch 421/500  
11817/11817 [=====] - 0s - loss: 25377.5137 - val\_loss: 48129.3125  
Epoch 422/500  
11817/11817 [=====] - 0s - loss: 25303.4744 - val\_loss: 47923.1133  
Epoch 423/500  
11817/11817 [=====] - 0s - loss: 25349.1722 - val\_loss: 47633.1562  
Epoch 424/500  
11817/11817 [=====] - 0s - loss: 25193.8540 - val\_loss: 47925.6562  
Epoch 425/500  
11817/11817 [=====] - 0s - loss: 25242.5144 - val\_loss: 48090.4336  
Epoch 426/500  
11817/11817 [=====] - 0s - loss: 25139.2349 - val\_loss: 48179.6289  
Epoch 427/500  
11817/11817 [=====] - 0s - loss: 25040.5106 - val\_loss: 47617.2617  
Epoch 428/500  
11817/11817 [=====] - 0s - loss: 25113.2966 - val\_loss: 46833.2734  
Epoch 429/500  
11817/11817 [=====] - 0s - loss: 24898.2548 - val\_loss: 46632.5078

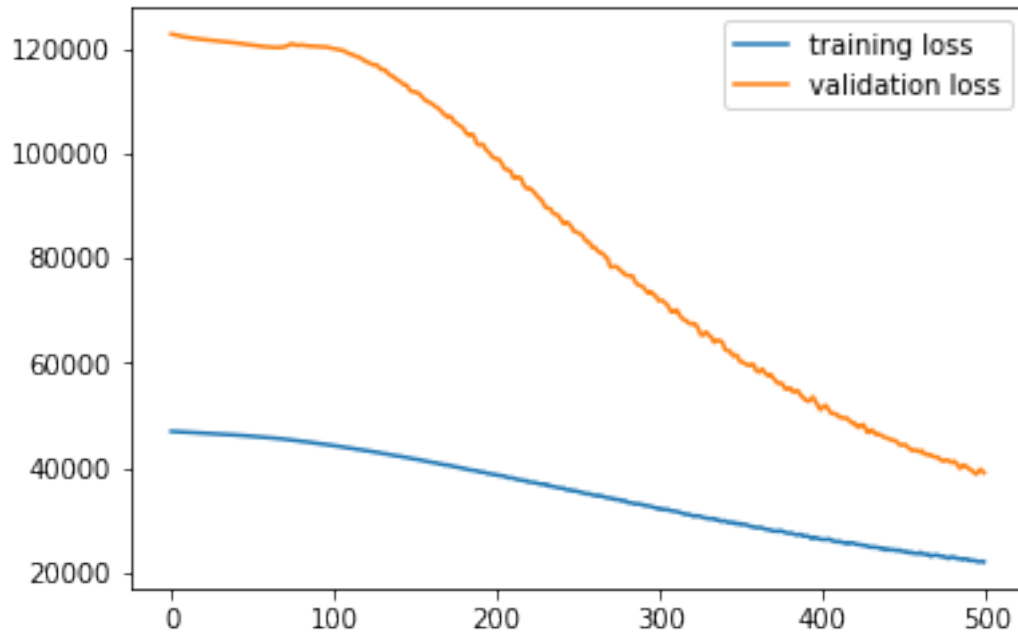


Epoch 430/500  
11817/11817 [=====] - 0s - loss: 24809.5163 - val\_loss: 46976.0859  
Epoch 431/500  
11817/11817 [=====] - 0s - loss: 24753.3695 - val\_loss: 47195.6016  
Epoch 432/500  
11817/11817 [=====] - 0s - loss: 24896.0170 - val\_loss: 46904.9336  
Epoch 433/500  
11817/11817 [=====] - 0s - loss: 24764.6188 - val\_loss: 46528.5508  
Epoch 434/500  
11817/11817 [=====] - 0s - loss: 24766.4726 - val\_loss: 46267.4336  
Epoch 435/500  
11817/11817 [=====] - 0s - loss: 24730.3658 - val\_loss: 46413.9883  
Epoch 436/500  
11817/11817 [=====] - 0s - loss: 24643.0161 - val\_loss: 46230.7422  
Epoch 437/500  
11817/11817 [=====] - 0s - loss: 24422.9231 - val\_loss: 46151.9258  
Epoch 438/500  
11817/11817 [=====] - 0s - loss: 24586.7175 - val\_loss: 45948.0508  
Epoch 439/500  
11817/11817 [=====] - 0s - loss: 24441.4184 - val\_loss: 45697.4727  
Epoch 440/500  
11817/11817 [=====] - 0s - loss: 24206.0067 - val\_loss: 45679.4297  
Epoch 441/500  
11817/11817 [=====] - 0s - loss: 24431.3535 - val\_loss: 45548.5273  
Epoch 442/500  
11817/11817 [=====] - 0s - loss: 24375.2864 - val\_loss: 45470.2500  
Epoch 443/500  
11817/11817 [=====] - 0s - loss: 24237.4546 - val\_loss: 45336.0703  
Epoch 444/500  
11817/11817 [=====] - 0s - loss: 24293.3247 - val\_loss: 45165.4961  
Epoch 445/500  
11817/11817 [=====] - 0s - loss: 24323.5413 - val\_loss: 45218.8008  
Epoch 446/500  
11817/11817 [=====] - 0s - loss: 24137.5808 - val\_loss: 45003.0156  
Epoch 447/500  
11817/11817 [=====] - 0s - loss: 24117.2601 - val\_loss: 44761.6328  
Epoch 448/500  
11817/11817 [=====] - 0s - loss: 24280.7793 - val\_loss: 44415.8086  
Epoch 449/500  
11817/11817 [=====] - 0s - loss: 24101.5920 - val\_loss: 44218.0391  
Epoch 450/500  
11817/11817 [=====] - 0s - loss: 23972.7684 - val\_loss: 44292.2969  
Epoch 451/500  
11817/11817 [=====] - 0s - loss: 23923.7695 - val\_loss: 44367.6445  
Epoch 452/500  
11817/11817 [=====] - 0s - loss: 24004.4470 - val\_loss: 44301.9492  
Epoch 453/500  
11817/11817 [=====] - 0s - loss: 23756.0263 - val\_loss: 43930.7617

Epoch 454/500  
11817/11817 [=====] - 0s - loss: 23834.4241 - val\_loss: 43608.7852  
Epoch 455/500  
11817/11817 [=====] - 0s - loss: 23653.4141 - val\_loss: 43521.8438  
Epoch 456/500  
11817/11817 [=====] - 0s - loss: 23825.4974 - val\_loss: 43178.0195  
Epoch 457/500  
11817/11817 [=====] - 0s - loss: 23626.1946 - val\_loss: 43278.2500  
Epoch 458/500  
11817/11817 [=====] - 0s - loss: 23569.7006 - val\_loss: 43334.2109  
Epoch 459/500  
11817/11817 [=====] - 0s - loss: 23609.9606 - val\_loss: 43277.2305  
Epoch 460/500  
11817/11817 [=====] - 0s - loss: 23546.1960 - val\_loss: 42968.5273  
Epoch 461/500  
11817/11817 [=====] - 0s - loss: 23809.3303 - val\_loss: 43064.5039  
Epoch 462/500  
11817/11817 [=====] - 0s - loss: 23585.2182 - val\_loss: 43197.0234  
Epoch 463/500  
11817/11817 [=====] - 0s - loss: 23440.8261 - val\_loss: 42696.5234  
Epoch 464/500  
11817/11817 [=====] - 0s - loss: 23443.2631 - val\_loss: 42476.8164  
Epoch 465/500  
11817/11817 [=====] - 0s - loss: 23364.4061 - val\_loss: 42555.8008  
Epoch 466/500  
11817/11817 [=====] - 0s - loss: 23464.8952 - val\_loss: 42354.9766  
Epoch 467/500  
11817/11817 [=====] - 0s - loss: 23058.4453 - val\_loss: 42475.5742  
Epoch 468/500  
11817/11817 [=====] - 0s - loss: 23177.7325 - val\_loss: 42213.3867  
Epoch 469/500  
11817/11817 [=====] - 0s - loss: 23206.3388 - val\_loss: 42067.7383  
Epoch 470/500  
11817/11817 [=====] - 0s - loss: 23255.2891 - val\_loss: 41969.9297  
Epoch 471/500  
11817/11817 [=====] - 0s - loss: 23358.7306 - val\_loss: 41990.1367  
Epoch 472/500  
11817/11817 [=====] - 0s - loss: 23163.7581 - val\_loss: 41914.2227  
Epoch 473/500  
11817/11817 [=====] - 0s - loss: 23107.8865 - val\_loss: 41551.0938  
Epoch 474/500  
11817/11817 [=====] - 0s - loss: 23003.6239 - val\_loss: 41390.6758  
Epoch 475/500  
11817/11817 [=====] - 0s - loss: 23058.9437 - val\_loss: 41190.5273  
Epoch 476/500  
11817/11817 [=====] - 0s - loss: 22910.6896 - val\_loss: 41273.9453  
Epoch 477/500  
11817/11817 [=====] - 0s - loss: 22714.6921 - val\_loss: 41463.5977

Epoch 478/500  
11817/11817 [=====] - 0s - loss: 22802.0987 - val\_loss: 41352.6289  
Epoch 479/500  
11817/11817 [=====] - 0s - loss: 22656.1914 - val\_loss: 41145.1133  
Epoch 480/500  
11817/11817 [=====] - 0s - loss: 22914.4654 - val\_loss: 40960.8711  
Epoch 481/500  
11817/11817 [=====] - 0s - loss: 22918.0421 - val\_loss: 41028.1328  
Epoch 482/500  
11817/11817 [=====] - 0s - loss: 22750.8225 - val\_loss: 41182.0859  
Epoch 483/500  
11817/11817 [=====] - 0s - loss: 22777.9906 - val\_loss: 40774.2734  
Epoch 484/500  
11817/11817 [=====] - 0s - loss: 22549.8598 - val\_loss: 40414.6875  
Epoch 485/500  
11817/11817 [=====] - 0s - loss: 22600.5528 - val\_loss: 39848.8555  
Epoch 486/500  
11817/11817 [=====] - 0s - loss: 22546.3527 - val\_loss: 39940.0273  
Epoch 487/500  
11817/11817 [=====] - 0s - loss: 22405.4009 - val\_loss: 40419.4648  
Epoch 488/500  
11817/11817 [=====] - 0s - loss: 22604.1489 - val\_loss: 40452.6172  
Epoch 489/500  
11817/11817 [=====] - 0s - loss: 22521.2372 - val\_loss: 40171.1250  
Epoch 490/500  
11817/11817 [=====] - 0s - loss: 22505.2499 - val\_loss: 40051.2109  
Epoch 491/500  
11817/11817 [=====] - 0s - loss: 22191.3876 - val\_loss: 39642.9531  
Epoch 492/500  
11817/11817 [=====] - 0s - loss: 22270.7518 - val\_loss: 39565.7695  
Epoch 493/500  
11817/11817 [=====] - 0s - loss: 22246.8280 - val\_loss: 39268.5000  
Epoch 494/500  
11817/11817 [=====] - 0s - loss: 22220.9970 - val\_loss: 38949.8594  
Epoch 495/500  
11817/11817 [=====] - 0s - loss: 22210.8478 - val\_loss: 38734.1211  
Epoch 496/500  
11817/11817 [=====] - 0s - loss: 22020.3919 - val\_loss: 38917.8750  
Epoch 497/500  
11817/11817 [=====] - 0s - loss: 21982.1467 - val\_loss: 39452.2188  
Epoch 498/500  
11817/11817 [=====] - 0s - loss: 22040.1864 - val\_loss: 39628.4805  
Epoch 499/500  
11817/11817 [=====] - 0s - loss: 22141.6570 - val\_loss: 39351.9922  
Epoch 500/500  
11817/11817 [=====] - 0s - loss: 21970.0354 - val\_loss: 38980.5039

```
In [19]: # check losses for overfitting and performance
plt.plot(history.history['loss'], label = 'training loss')
plt.plot(history.history['val_loss'], label = 'validation loss')
plt.legend()
plt.show()
```



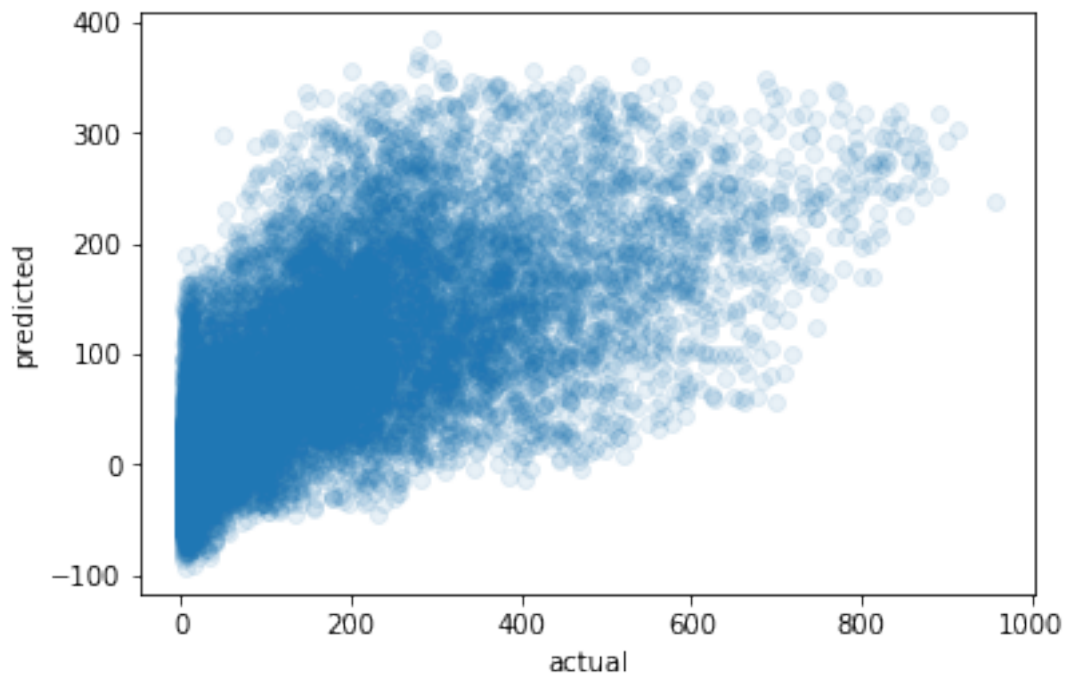
```
In [20]: past_preds = model.predict(train_features)[: , 0]
future_preds = model.predict(test_features)[: , 0]

from sklearn.metrics import r2_score
import numpy as np

# our benchmark is just guessing the average
benchmark = np.mean(train_targets)
print(r2_score(train_targets, [benchmark] * train_targets.shape[0]))

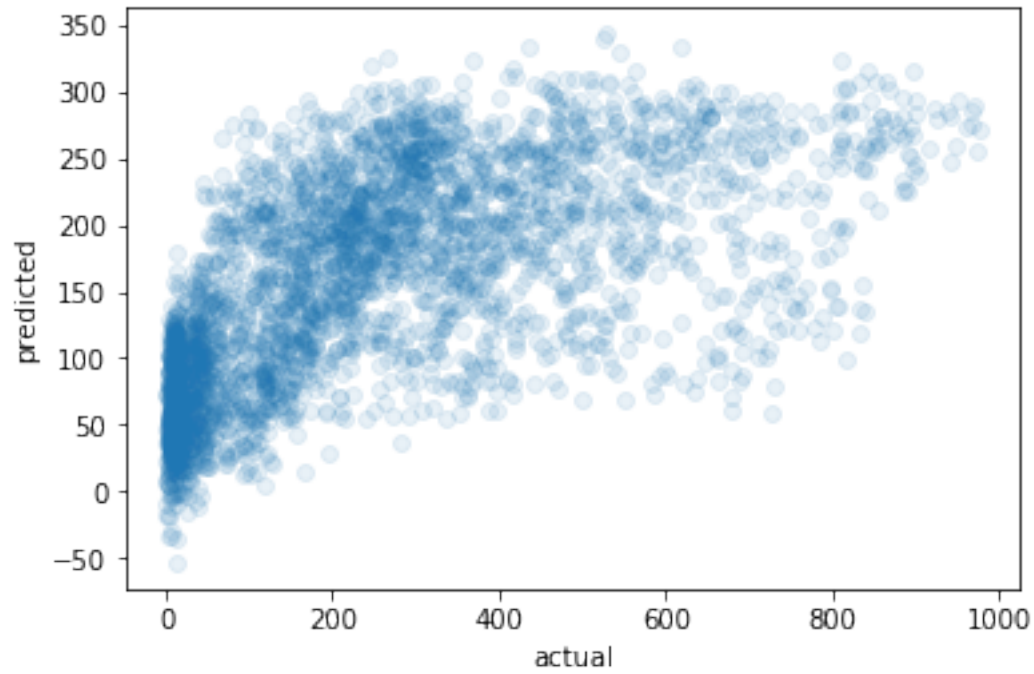
print(r2_score(train_targets, past_preds))
plt.scatter(train_targets, past_preds, alpha=0.1)
plt.xlabel('actual')
plt.ylabel('predicted')
plt.show()
```

```
0.0
0.133775503573
```

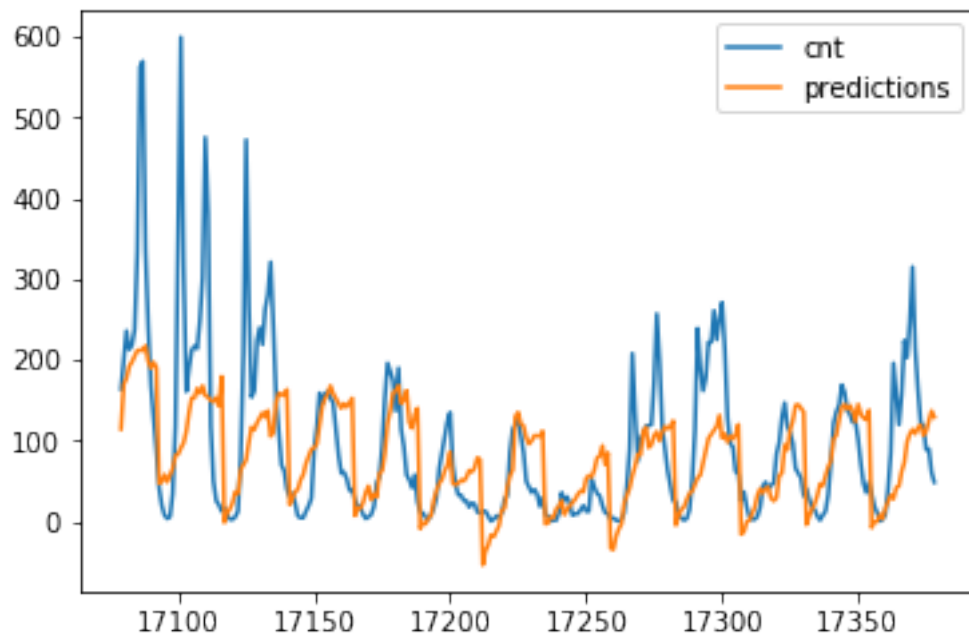


```
In [21]: print(r2_score(test_targets, [benchmark] * test_targets.shape[0]))  
  
         print(r2_score(test_targets, future_preds))  
         plt.scatter(test_targets, future_preds, alpha=0.1)  
         plt.xlabel('actual')  
         plt.ylabel('predicted')  
         plt.show()
```

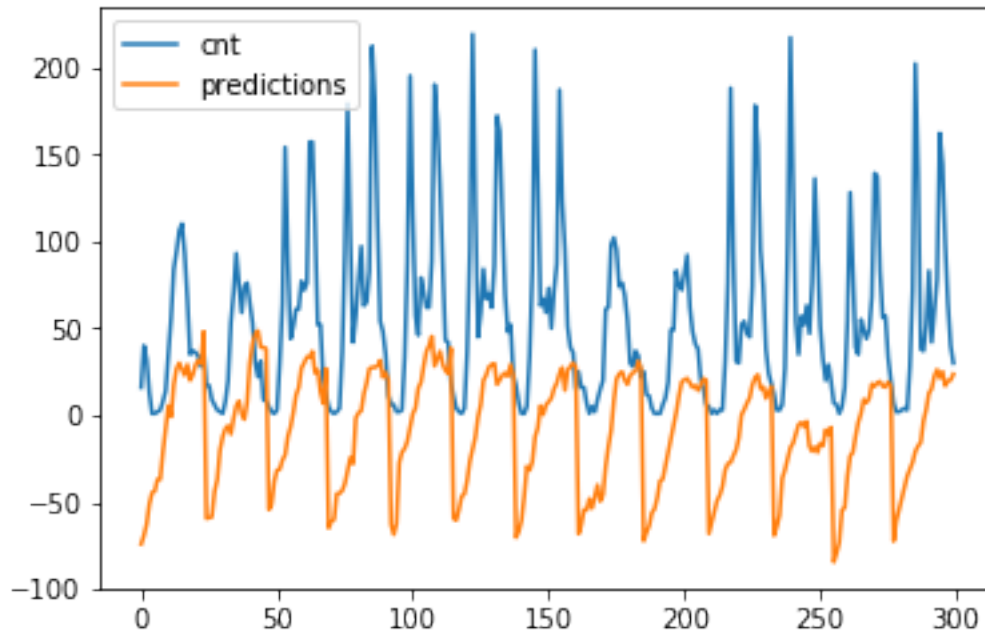
```
-0.112995264662  
0.150761437692
```



```
In [22]: bike_df['cnt'].iloc[-300:].plot()  
plt.plot(bike_df.index[-300:], future_preds[-300:], label='predictions')  
_ = plt.legend()
```



```
In [23]: bike_df['cnt'].iloc[:300].plot()
plt.plot(bike_df.index[:300], past_preds[:300], label='predictions')
_ = plt.legend()
```



#### 4 now your turn: try different network hyperparameter settings and see which is best. Recommendations:

- Change activation functions <https://keras.io/activations/>
- Change layer sizes
- Change number of layers
- Change dropout rate
- loss function <https://keras.io/losses/>

Only do these one at a time. Don't change network size, activation function, dropout rate all at the same time, or you won't know what made your net better or worse.

Advanced things to try: \* regularization (to prevent overfitting) <https://keras.io/regularizers/> \* mess around with optimizers <https://keras.io/optimizers/> \* use sklearn's StandardScaler to z-scale all your features <http://scikit-learn.org/stable/modules/generated/sklearn.preprocessing.StandardScaler.html>

```
In [24]: # try 2 -- make the first layer much larger
```

```
# creates the model
```

```
# restart keras session (clear weights), sometimes this will clear up errors
```

```

K.clear_session()

# functional API
inputs = Input(shape=(features.shape[1], ))
x1 = Dense(1000, activation='elu')(inputs)
x2 = BatchNormalization()(x1)
x3 = Dropout(0.5)(x2)
x = Dense(1, activation='linear')(x3)

# this saves the best model (lowest validation loss)
checkpoint = ModelCheckpoint('3_layer_dense.h5', monitor='val_loss', save_best_only=True)
# this stops training if the validation loss is not improving for 50 epochs in a row
es = EarlyStopping(patience=50)
cb = [checkpoint, es]

# this compiles our model so it is ready to fit
model = Model(inputs, x)
model.compile(optimizer='adam', loss='mse')

subset_size = trainsize
train_feature_subset = train_features[:subset_size]
train_target_subset = train_targets[:subset_size]
# we actually fit the model here
history = model.fit(train_feature_subset,
                    train_target_subset,
                    epochs=500,
                    validation_split=0.15,
                    callbacks=cb,
                    batch_size=3000)

```

Train on 11817 samples, validate on 2086 samples

```

Epoch 1/500
11817/11817 [=====] - 0s - loss: 46644.8879 - val_loss: 121421.8906
Epoch 2/500
11817/11817 [=====] - 0s - loss: 45949.8418 - val_loss: 119146.4531
Epoch 3/500
11817/11817 [=====] - 0s - loss: 45262.4841 - val_loss: 116880.1406
Epoch 4/500
11817/11817 [=====] - 0s - loss: 44649.2050 - val_loss: 114676.4688
Epoch 5/500
11817/11817 [=====] - 0s - loss: 44095.9528 - val_loss: 112558.8984
Epoch 6/500
11817/11817 [=====] - 0s - loss: 43608.7090 - val_loss: 110567.2969
Epoch 7/500
11817/11817 [=====] - 0s - loss: 43150.2623 - val_loss: 108707.9844
Epoch 8/500
11817/11817 [=====] - 0s - loss: 42729.6712 - val_loss: 107007.0938
Epoch 9/500

```



11817/11817 [=====] - 0s - loss: 42345.8143 - val\_loss: 105466.6250  
Epoch 10/500  
11817/11817 [=====] - 0s - loss: 41963.5864 - val\_loss: 104089.1484  
Epoch 11/500  
11817/11817 [=====] - 0s - loss: 41590.9480 - val\_loss: 102918.6875  
Epoch 12/500  
11817/11817 [=====] - 0s - loss: 41230.6380 - val\_loss: 101979.0312  
Epoch 13/500  
11817/11817 [=====] - 0s - loss: 40868.4151 - val\_loss: 101257.1562  
Epoch 14/500  
11817/11817 [=====] - 0s - loss: 40484.5952 - val\_loss: 100730.3203  
Epoch 15/500  
11817/11817 [=====] - 0s - loss: 40078.2901 - val\_loss: 100445.0625  
Epoch 16/500  
11817/11817 [=====] - 0s - loss: 39642.3662 - val\_loss: 100334.8672  
Epoch 17/500  
11817/11817 [=====] - 0s - loss: 39227.5178 - val\_loss: 100301.4375  
Epoch 18/500  
11817/11817 [=====] - 0s - loss: 38756.0906 - val\_loss: 100249.7500  
Epoch 19/500  
11817/11817 [=====] - 0s - loss: 38296.5782 - val\_loss: 100090.6328  
Epoch 20/500  
11817/11817 [=====] - 0s - loss: 37820.8882 - val\_loss: 99906.7422  
Epoch 21/500  
11817/11817 [=====] - 0s - loss: 37326.6422 - val\_loss: 99736.3516  
Epoch 22/500  
11817/11817 [=====] - 0s - loss: 36848.3268 - val\_loss: 99304.1875  
Epoch 23/500  
11817/11817 [=====] - 0s - loss: 36344.4305 - val\_loss: 98668.8359  
Epoch 24/500  
11817/11817 [=====] - 0s - loss: 35833.1751 - val\_loss: 98008.1953  
Epoch 25/500  
11817/11817 [=====] - 0s - loss: 35299.8942 - val\_loss: 97378.8906  
Epoch 26/500  
11817/11817 [=====] - 0s - loss: 34826.3210 - val\_loss: 96261.5938  
Epoch 27/500  
11817/11817 [=====] - 0s - loss: 34366.3817 - val\_loss: 95345.3203  
Epoch 28/500  
11817/11817 [=====] - 0s - loss: 33943.9311 - val\_loss: 94550.3516  
Epoch 29/500  
11817/11817 [=====] - 0s - loss: 33510.0922 - val\_loss: 93212.1016  
Epoch 30/500  
11817/11817 [=====] - 0s - loss: 33080.9844 - val\_loss: 92721.8750  
Epoch 31/500  
11817/11817 [=====] - 0s - loss: 32670.0059 - val\_loss: 92026.6094  
Epoch 32/500  
11817/11817 [=====] - 0s - loss: 32242.2107 - val\_loss: 91058.7812  
Epoch 33/500

11817/11817 [=====] - 0s - loss: 31837.1432 - val\_loss: 90093.9062  
Epoch 34/500  
11817/11817 [=====] - 0s - loss: 31408.8420 - val\_loss: 89848.3750  
Epoch 35/500  
11817/11817 [=====] - 0s - loss: 31071.9208 - val\_loss: 89014.5781  
Epoch 36/500  
11817/11817 [=====] - 0s - loss: 30646.9676 - val\_loss: 87733.6484  
Epoch 37/500  
11817/11817 [=====] - 0s - loss: 30203.5209 - val\_loss: 87069.6484  
Epoch 38/500  
11817/11817 [=====] - 0s - loss: 29772.7884 - val\_loss: 85967.4297  
Epoch 39/500  
11817/11817 [=====] - 0s - loss: 29361.1447 - val\_loss: 85043.6406  
Epoch 40/500  
11817/11817 [=====] - 0s - loss: 28919.2894 - val\_loss: 83828.8047  
Epoch 41/500  
11817/11817 [=====] - 0s - loss: 28476.7676 - val\_loss: 82613.2734  
Epoch 42/500  
11817/11817 [=====] - 0s - loss: 28021.1070 - val\_loss: 81444.3125  
Epoch 43/500  
11817/11817 [=====] - 0s - loss: 27592.5120 - val\_loss: 80394.6953  
Epoch 44/500  
11817/11817 [=====] - 0s - loss: 27117.1541 - val\_loss: 78788.7266  
Epoch 45/500  
11817/11817 [=====] - 0s - loss: 26613.1421 - val\_loss: 78075.2109  
Epoch 46/500  
11817/11817 [=====] - 0s - loss: 26145.3516 - val\_loss: 77104.2344  
Epoch 47/500  
11817/11817 [=====] - 0s - loss: 25634.6403 - val\_loss: 75196.5469  
Epoch 48/500  
11817/11817 [=====] - 0s - loss: 25212.1637 - val\_loss: 73700.9141  
Epoch 49/500  
11817/11817 [=====] - 0s - loss: 24697.6795 - val\_loss: 73064.4141  
Epoch 50/500  
11817/11817 [=====] - 0s - loss: 24196.7207 - val\_loss: 71777.2656  
Epoch 51/500  
11817/11817 [=====] - 0s - loss: 23704.9392 - val\_loss: 70011.7188  
Epoch 52/500  
11817/11817 [=====] - 0s - loss: 23290.8944 - val\_loss: 68503.1797  
Epoch 53/500  
11817/11817 [=====] - 0s - loss: 22731.1067 - val\_loss: 68335.3203  
Epoch 54/500  
11817/11817 [=====] - 0s - loss: 22263.3068 - val\_loss: 67229.7266  
Epoch 55/500  
11817/11817 [=====] - 0s - loss: 21814.5129 - val\_loss: 65566.9375  
Epoch 56/500  
11817/11817 [=====] - 0s - loss: 21337.3556 - val\_loss: 64776.2852  
Epoch 57/500

11817/11817 [=====] - 0s - loss: 20886.2747 - val\_loss: 63952.1875  
Epoch 58/500  
11817/11817 [=====] - 0s - loss: 20416.9602 - val\_loss: 61432.4375  
Epoch 59/500  
11817/11817 [=====] - 0s - loss: 19962.4590 - val\_loss: 61333.5234  
Epoch 60/500  
11817/11817 [=====] - 0s - loss: 19525.8076 - val\_loss: 60099.9102  
Epoch 61/500  
11817/11817 [=====] - 0s - loss: 19121.7568 - val\_loss: 59156.2773  
Epoch 62/500  
11817/11817 [=====] - 0s - loss: 18637.6587 - val\_loss: 57250.5234  
Epoch 63/500  
11817/11817 [=====] - 0s - loss: 18228.2100 - val\_loss: 56384.8125  
Epoch 64/500  
11817/11817 [=====] - 0s - loss: 17854.7992 - val\_loss: 55877.5625  
Epoch 65/500  
11817/11817 [=====] - 0s - loss: 17393.5412 - val\_loss: 54294.3594  
Epoch 66/500  
11817/11817 [=====] - 0s - loss: 17089.0167 - val\_loss: 53339.4961  
Epoch 67/500  
11817/11817 [=====] - 0s - loss: 16682.4039 - val\_loss: 52283.7539  
Epoch 68/500  
11817/11817 [=====] - 0s - loss: 16309.5140 - val\_loss: 51280.8828  
Epoch 69/500  
11817/11817 [=====] - 0s - loss: 16001.3496 - val\_loss: 50267.7422  
Epoch 70/500  
11817/11817 [=====] - 0s - loss: 15606.6110 - val\_loss: 49584.4375  
Epoch 71/500  
11817/11817 [=====] - 0s - loss: 15379.3176 - val\_loss: 48281.3711  
Epoch 72/500  
11817/11817 [=====] - 0s - loss: 15014.6446 - val\_loss: 46814.1289  
Epoch 73/500  
11817/11817 [=====] - 0s - loss: 14732.4236 - val\_loss: 46503.6680  
Epoch 74/500  
11817/11817 [=====] - 0s - loss: 14476.9513 - val\_loss: 45925.6992  
Epoch 75/500  
11817/11817 [=====] - 0s - loss: 14190.1915 - val\_loss: 44567.1641  
Epoch 76/500  
11817/11817 [=====] - 0s - loss: 13959.3940 - val\_loss: 43951.6992  
Epoch 77/500  
11817/11817 [=====] - 0s - loss: 13753.6511 - val\_loss: 42568.0000  
Epoch 78/500  
11817/11817 [=====] - 0s - loss: 13541.1734 - val\_loss: 41956.1094  
Epoch 79/500  
11817/11817 [=====] - 0s - loss: 13365.3657 - val\_loss: 42151.4727  
Epoch 80/500  
11817/11817 [=====] - 0s - loss: 13166.8975 - val\_loss: 40865.7891  
Epoch 81/500

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11817/11817 [=====] - 0s - loss: 12988.2788 - val_loss: 40305.3359
Epoch 82/500
11817/11817 [=====] - 0s - loss: 12822.9105 - val_loss: 39551.7070
Epoch 83/500
11817/11817 [=====] - 0s - loss: 12619.3665 - val_loss: 39179.8867
Epoch 84/500
11817/11817 [=====] - 0s - loss: 12503.3501 - val_loss: 38303.3672
Epoch 85/500
11817/11817 [=====] - 0s - loss: 12420.8059 - val_loss: 37414.8984
Epoch 86/500
11817/11817 [=====] - 0s - loss: 12260.3369 - val_loss: 37339.1836
Epoch 87/500
11817/11817 [=====] - 0s - loss: 12137.0558 - val_loss: 36476.9023
Epoch 88/500
11817/11817 [=====] - 0s - loss: 12082.8755 - val_loss: 36120.1094
Epoch 89/500
11817/11817 [=====] - 0s - loss: 11971.6005 - val_loss: 35490.4219
Epoch 90/500
11817/11817 [=====] - 0s - loss: 11882.4605 - val_loss: 34880.9453
Epoch 91/500
11817/11817 [=====] - 0s - loss: 11771.4555 - val_loss: 34009.8398
Epoch 92/500
11817/11817 [=====] - 0s - loss: 11736.8167 - val_loss: 33900.5586
Epoch 93/500
11817/11817 [=====] - 0s - loss: 11608.6632 - val_loss: 33714.2461
Epoch 94/500
11817/11817 [=====] - 0s - loss: 11622.2906 - val_loss: 33454.5938
Epoch 95/500
11817/11817 [=====] - 0s - loss: 11569.0296 - val_loss: 32722.7461
Epoch 96/500
11817/11817 [=====] - 0s - loss: 11525.3957 - val_loss: 32926.3828
Epoch 97/500
11817/11817 [=====] - 0s - loss: 11473.9225 - val_loss: 31848.4199
Epoch 98/500
11817/11817 [=====] - 0s - loss: 11447.1741 - val_loss: 32244.2949
Epoch 99/500
11817/11817 [=====] - 0s - loss: 11437.7780 - val_loss: 31944.5547
Epoch 100/500
11817/11817 [=====] - 0s - loss: 11357.0765 - val_loss: 30772.8164
Epoch 101/500
11817/11817 [=====] - 0s - loss: 11306.2398 - val_loss: 31170.5059
Epoch 102/500
11817/11817 [=====] - 0s - loss: 11278.4689 - val_loss: 31489.7344
Epoch 103/500
11817/11817 [=====] - 0s - loss: 11268.0776 - val_loss: 30324.1309
Epoch 104/500
11817/11817 [=====] - 0s - loss: 11292.1469 - val_loss: 30165.3535
Epoch 105/500

```

11817/11817 [=====] - 0s - loss: 11201.4843 - val\_loss: 30866.6328  
Epoch 106/500  
11817/11817 [=====] - 0s - loss: 11177.6480 - val\_loss: 29511.5410  
Epoch 107/500  
11817/11817 [=====] - 0s - loss: 11179.9064 - val\_loss: 30003.3145  
Epoch 108/500  
11817/11817 [=====] - 0s - loss: 11153.7829 - val\_loss: 29880.3906  
Epoch 109/500  
11817/11817 [=====] - 0s - loss: 11138.1128 - val\_loss: 29375.4434  
Epoch 110/500  
11817/11817 [=====] - 0s - loss: 11138.4072 - val\_loss: 29441.6758  
Epoch 111/500  
11817/11817 [=====] - 0s - loss: 11140.0210 - val\_loss: 29122.3047  
Epoch 112/500  
11817/11817 [=====] - 0s - loss: 11100.6686 - val\_loss: 29060.1582  
Epoch 113/500  
11817/11817 [=====] - 0s - loss: 11112.3098 - val\_loss: 28560.2188  
Epoch 114/500  
11817/11817 [=====] - 0s - loss: 11117.1044 - val\_loss: 29045.8262  
Epoch 115/500  
11817/11817 [=====] - 0s - loss: 11069.5057 - val\_loss: 28404.8125  
Epoch 116/500  
11817/11817 [=====] - 0s - loss: 11081.9670 - val\_loss: 28930.1172  
Epoch 117/500  
11817/11817 [=====] - 0s - loss: 11068.2458 - val\_loss: 28071.8555  
Epoch 118/500  
11817/11817 [=====] - 0s - loss: 11082.9380 - val\_loss: 28363.5098  
Epoch 119/500  
11817/11817 [=====] - 0s - loss: 11050.9713 - val\_loss: 28442.2207  
Epoch 120/500  
11817/11817 [=====] - 0s - loss: 11050.7432 - val\_loss: 28033.3242  
Epoch 121/500  
11817/11817 [=====] - 0s - loss: 11035.4333 - val\_loss: 27715.7324  
Epoch 122/500  
11817/11817 [=====] - 0s - loss: 11040.6863 - val\_loss: 28044.4941  
Epoch 123/500  
11817/11817 [=====] - 0s - loss: 11003.6593 - val\_loss: 28273.6562  
Epoch 124/500  
11817/11817 [=====] - 0s - loss: 11014.5353 - val\_loss: 27583.2207  
Epoch 125/500  
11817/11817 [=====] - 0s - loss: 10984.4872 - val\_loss: 28047.4629  
Epoch 126/500  
11817/11817 [=====] - 0s - loss: 11008.0775 - val\_loss: 27924.2070  
Epoch 127/500  
11817/11817 [=====] - 0s - loss: 11022.6322 - val\_loss: 27354.0879  
Epoch 128/500  
11817/11817 [=====] - 0s - loss: 10978.5658 - val\_loss: 27724.4375  
Epoch 129/500

11817/11817 [=====] - 0s - loss: 10986.6068 - val\_loss: 27590.2734  
Epoch 130/500  
11817/11817 [=====] - 0s - loss: 10973.2308 - val\_loss: 27287.5938  
Epoch 131/500  
11817/11817 [=====] - 0s - loss: 11002.0604 - val\_loss: 27139.7617  
Epoch 132/500  
11817/11817 [=====] - 0s - loss: 10972.3494 - val\_loss: 27367.4590  
Epoch 133/500  
11817/11817 [=====] - 0s - loss: 10950.4527 - val\_loss: 27517.4629  
Epoch 134/500  
11817/11817 [=====] - 0s - loss: 10995.8063 - val\_loss: 27046.0703  
Epoch 135/500  
11817/11817 [=====] - 0s - loss: 10898.9130 - val\_loss: 27064.2148  
Epoch 136/500  
11817/11817 [=====] - 0s - loss: 10886.2502 - val\_loss: 27085.1172  
Epoch 137/500  
11817/11817 [=====] - 0s - loss: 10939.0394 - val\_loss: 26941.0000  
Epoch 138/500  
11817/11817 [=====] - 0s - loss: 10909.4142 - val\_loss: 26925.9297  
Epoch 139/500  
11817/11817 [=====] - 0s - loss: 10965.0875 - val\_loss: 26979.5234  
Epoch 140/500  
11817/11817 [=====] - 0s - loss: 10925.2214 - val\_loss: 26893.7363  
Epoch 141/500  
11817/11817 [=====] - 0s - loss: 10855.0234 - val\_loss: 26963.4980  
Epoch 142/500  
11817/11817 [=====] - 0s - loss: 10863.1162 - val\_loss: 26904.5371  
Epoch 143/500  
11817/11817 [=====] - 0s - loss: 10921.2678 - val\_loss: 26722.7656  
Epoch 144/500  
11817/11817 [=====] - 0s - loss: 10883.4844 - val\_loss: 26781.2734  
Epoch 145/500  
11817/11817 [=====] - 0s - loss: 10868.6081 - val\_loss: 26712.8672  
Epoch 146/500  
11817/11817 [=====] - 0s - loss: 10891.7958 - val\_loss: 26790.8887  
Epoch 147/500  
11817/11817 [=====] - 0s - loss: 10819.8164 - val\_loss: 26664.1270  
Epoch 148/500  
11817/11817 [=====] - 0s - loss: 10866.2289 - val\_loss: 26619.6035  
Epoch 149/500  
11817/11817 [=====] - 0s - loss: 10884.7889 - val\_loss: 26703.8164  
Epoch 150/500  
11817/11817 [=====] - 0s - loss: 10852.8419 - val\_loss: 26705.5391  
Epoch 151/500  
11817/11817 [=====] - 0s - loss: 10845.8277 - val\_loss: 26577.0352  
Epoch 152/500  
11817/11817 [=====] - 0s - loss: 10865.2941 - val\_loss: 26575.6797  
Epoch 153/500

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11817/11817 [=====] - 0s - loss: 10816.0421 - val_loss: 26617.2891
Epoch 154/500
11817/11817 [=====] - 0s - loss: 10825.6915 - val_loss: 26537.5000
Epoch 155/500
11817/11817 [=====] - 0s - loss: 10837.0006 - val_loss: 26504.0957
Epoch 156/500
11817/11817 [=====] - 0s - loss: 10839.7717 - val_loss: 26540.5000
Epoch 157/500
11817/11817 [=====] - 0s - loss: 10812.9890 - val_loss: 26587.6543
Epoch 158/500
11817/11817 [=====] - 0s - loss: 10796.7555 - val_loss: 26491.5195
Epoch 159/500
11817/11817 [=====] - 0s - loss: 10806.3036 - val_loss: 26442.8418
Epoch 160/500
11817/11817 [=====] - 0s - loss: 10798.2024 - val_loss: 26420.9941
Epoch 161/500
11817/11817 [=====] - 0s - loss: 10801.0308 - val_loss: 26460.9609
Epoch 162/500
11817/11817 [=====] - 0s - loss: 10808.0462 - val_loss: 26412.9492
Epoch 163/500
11817/11817 [=====] - 0s - loss: 10762.1306 - val_loss: 26403.9160
Epoch 164/500
11817/11817 [=====] - 0s - loss: 10770.6848 - val_loss: 26402.0215
Epoch 165/500
11817/11817 [=====] - 0s - loss: 10769.8631 - val_loss: 26404.6797
Epoch 166/500
11817/11817 [=====] - 0s - loss: 10771.4744 - val_loss: 26352.0879
Epoch 167/500
11817/11817 [=====] - 0s - loss: 10754.0263 - val_loss: 26338.9180
Epoch 168/500
11817/11817 [=====] - 0s - loss: 10736.8308 - val_loss: 26343.5977
Epoch 169/500
11817/11817 [=====] - 0s - loss: 10708.6037 - val_loss: 26391.2871
Epoch 170/500
11817/11817 [=====] - 0s - loss: 10748.0231 - val_loss: 26317.1875
Epoch 171/500
11817/11817 [=====] - 0s - loss: 10737.7841 - val_loss: 26313.7109
Epoch 172/500
11817/11817 [=====] - 0s - loss: 10715.2883 - val_loss: 26315.9316
Epoch 173/500
11817/11817 [=====] - 0s - loss: 10732.8988 - val_loss: 26344.0273
Epoch 174/500
11817/11817 [=====] - 0s - loss: 10702.5918 - val_loss: 26274.0527
Epoch 175/500
11817/11817 [=====] - 0s - loss: 10717.6287 - val_loss: 26291.3340
Epoch 176/500
11817/11817 [=====] - 0s - loss: 10763.6896 - val_loss: 26289.2383
Epoch 177/500

```

11817/11817 [=====] - 0s - loss: 10707.9816 - val\_loss: 26257.8691  
Epoch 178/500  
11817/11817 [=====] - 0s - loss: 10664.4952 - val\_loss: 26253.1992  
Epoch 179/500  
11817/11817 [=====] - 0s - loss: 10658.9314 - val\_loss: 26232.1562  
Epoch 180/500  
11817/11817 [=====] - 0s - loss: 10664.7885 - val\_loss: 26203.0723  
Epoch 181/500  
11817/11817 [=====] - 0s - loss: 10690.3068 - val\_loss: 26201.4609  
Epoch 182/500  
11817/11817 [=====] - 0s - loss: 10693.1285 - val\_loss: 26233.1055  
Epoch 183/500  
11817/11817 [=====] - 0s - loss: 10692.0371 - val\_loss: 26227.0859  
Epoch 184/500  
11817/11817 [=====] - 0s - loss: 10682.3285 - val\_loss: 26278.0234  
Epoch 185/500  
11817/11817 [=====] - 0s - loss: 10632.1196 - val\_loss: 26191.4219  
Epoch 186/500  
11817/11817 [=====] - 0s - loss: 10685.7626 - val\_loss: 26223.2129  
Epoch 187/500  
11817/11817 [=====] - 0s - loss: 10635.0576 - val\_loss: 26193.2715  
Epoch 188/500  
11817/11817 [=====] - 0s - loss: 10661.8104 - val\_loss: 26170.2930  
Epoch 189/500  
11817/11817 [=====] - 0s - loss: 10637.5303 - val\_loss: 26194.6953  
Epoch 190/500  
11817/11817 [=====] - 0s - loss: 10634.1339 - val\_loss: 26166.3965  
Epoch 191/500  
11817/11817 [=====] - 0s - loss: 10600.1066 - val\_loss: 26163.9922  
Epoch 192/500  
11817/11817 [=====] - 0s - loss: 10611.5501 - val\_loss: 26202.5938  
Epoch 193/500  
11817/11817 [=====] - 0s - loss: 10606.7455 - val\_loss: 26154.3965  
Epoch 194/500  
11817/11817 [=====] - 0s - loss: 10597.1493 - val\_loss: 26155.9844  
Epoch 195/500  
11817/11817 [=====] - 0s - loss: 10661.5002 - val\_loss: 26132.4004  
Epoch 196/500  
11817/11817 [=====] - 0s - loss: 10648.3522 - val\_loss: 26124.5762  
Epoch 197/500  
11817/11817 [=====] - 0s - loss: 10578.9486 - val\_loss: 26142.1250  
Epoch 198/500  
11817/11817 [=====] - 0s - loss: 10666.8241 - val\_loss: 26074.0645  
Epoch 199/500  
11817/11817 [=====] - 0s - loss: 10552.8604 - val\_loss: 26124.0000  
Epoch 200/500  
11817/11817 [=====] - 0s - loss: 10657.2282 - val\_loss: 26105.4824  
Epoch 201/500



11817/11817 [=====] - 0s - loss: 10614.9434 - val\_loss: 26102.7148  
Epoch 202/500  
11817/11817 [=====] - 0s - loss: 10609.4429 - val\_loss: 26110.8379  
Epoch 203/500  
11817/11817 [=====] - 0s - loss: 10616.4479 - val\_loss: 26120.0742  
Epoch 204/500  
11817/11817 [=====] - 0s - loss: 10543.3293 - val\_loss: 26129.7832  
Epoch 205/500  
11817/11817 [=====] - 0s - loss: 10560.4970 - val\_loss: 26098.9746  
Epoch 206/500  
11817/11817 [=====] - 0s - loss: 10580.1330 - val\_loss: 26164.0000  
Epoch 207/500  
11817/11817 [=====] - 0s - loss: 10589.3238 - val\_loss: 26107.2090  
Epoch 208/500  
11817/11817 [=====] - 0s - loss: 10623.1642 - val\_loss: 26048.9277  
Epoch 209/500  
11817/11817 [=====] - 0s - loss: 10522.3750 - val\_loss: 26062.2363  
Epoch 210/500  
11817/11817 [=====] - 0s - loss: 10552.5320 - val\_loss: 26127.3359  
Epoch 211/500  
11817/11817 [=====] - 0s - loss: 10581.3764 - val\_loss: 26093.8340  
Epoch 212/500  
11817/11817 [=====] - 0s - loss: 10578.6121 - val\_loss: 26065.4336  
Epoch 213/500  
11817/11817 [=====] - 0s - loss: 10558.2776 - val\_loss: 26231.1875  
Epoch 214/500  
11817/11817 [=====] - 0s - loss: 10555.1155 - val\_loss: 26006.6895  
Epoch 215/500  
11817/11817 [=====] - 0s - loss: 10514.4161 - val\_loss: 26109.6328  
Epoch 216/500  
11817/11817 [=====] - 0s - loss: 10566.4724 - val\_loss: 26127.7168  
Epoch 217/500  
11817/11817 [=====] - 0s - loss: 10487.5139 - val\_loss: 26015.1348  
Epoch 218/500  
11817/11817 [=====] - 0s - loss: 10535.2416 - val\_loss: 26187.1484  
Epoch 219/500  
11817/11817 [=====] - 0s - loss: 10504.9621 - val\_loss: 26074.7422  
Epoch 220/500  
11817/11817 [=====] - 0s - loss: 10535.7285 - val\_loss: 26092.9746  
Epoch 221/500  
11817/11817 [=====] - 0s - loss: 10490.9504 - val\_loss: 26112.8047  
Epoch 222/500  
11817/11817 [=====] - 0s - loss: 10523.5637 - val\_loss: 26047.4355  
Epoch 223/500  
11817/11817 [=====] - 0s - loss: 10523.1902 - val\_loss: 26206.3418  
Epoch 224/500  
11817/11817 [=====] - 0s - loss: 10527.2864 - val\_loss: 26047.0820  
Epoch 225/500

11817/11817 [=====] - 0s - loss: 10466.9025 - val\_loss: 26010.6055  
Epoch 226/500  
11817/11817 [=====] - 0s - loss: 10456.5640 - val\_loss: 26149.2520  
Epoch 227/500  
11817/11817 [=====] - 0s - loss: 10457.4864 - val\_loss: 26073.3184  
Epoch 228/500  
11817/11817 [=====] - 0s - loss: 10482.3521 - val\_loss: 26004.2441  
Epoch 229/500  
11817/11817 [=====] - 0s - loss: 10472.4125 - val\_loss: 26241.7383  
Epoch 230/500  
11817/11817 [=====] - 0s - loss: 10491.3972 - val\_loss: 26049.8262  
Epoch 231/500  
11817/11817 [=====] - 0s - loss: 10429.0981 - val\_loss: 25982.7383  
Epoch 232/500  
11817/11817 [=====] - 0s - loss: 10447.3329 - val\_loss: 26081.0742  
Epoch 233/500  
11817/11817 [=====] - 0s - loss: 10453.8296 - val\_loss: 26058.1875  
Epoch 234/500  
11817/11817 [=====] - 0s - loss: 10496.9181 - val\_loss: 25970.6621  
Epoch 235/500  
11817/11817 [=====] - 0s - loss: 10498.2499 - val\_loss: 25951.2402  
Epoch 236/500  
11817/11817 [=====] - 0s - loss: 10468.8394 - val\_loss: 26158.4961  
Epoch 237/500  
11817/11817 [=====] - 0s - loss: 10472.4451 - val\_loss: 26108.7539  
Epoch 238/500  
11817/11817 [=====] - 0s - loss: 10469.3096 - val\_loss: 25997.4102  
Epoch 239/500  
11817/11817 [=====] - 0s - loss: 10400.2568 - val\_loss: 26032.5820  
Epoch 240/500  
11817/11817 [=====] - 0s - loss: 10455.6518 - val\_loss: 26007.8594  
Epoch 241/500  
11817/11817 [=====] - 0s - loss: 10450.1168 - val\_loss: 26089.6348  
Epoch 242/500  
11817/11817 [=====] - 0s - loss: 10416.2668 - val\_loss: 25993.3457  
Epoch 243/500  
11817/11817 [=====] - 0s - loss: 10415.6439 - val\_loss: 26011.1270  
Epoch 244/500  
11817/11817 [=====] - 0s - loss: 10374.4670 - val\_loss: 26071.9785  
Epoch 245/500  
11817/11817 [=====] - 0s - loss: 10451.3059 - val\_loss: 26016.6719  
Epoch 246/500  
11817/11817 [=====] - 0s - loss: 10411.9718 - val\_loss: 25987.2266  
Epoch 247/500  
11817/11817 [=====] - 0s - loss: 10419.7898 - val\_loss: 26145.6055  
Epoch 248/500  
11817/11817 [=====] - 0s - loss: 10406.0976 - val\_loss: 25989.5332  
Epoch 249/500

11817/11817 [=====] - 0s - loss: 10409.7502 - val\_loss: 25878.9434  
Epoch 250/500  
11817/11817 [=====] - 0s - loss: 10398.1226 - val\_loss: 26156.5918  
Epoch 251/500  
11817/11817 [=====] - 0s - loss: 10393.9416 - val\_loss: 26057.8262  
Epoch 252/500  
11817/11817 [=====] - 0s - loss: 10385.5068 - val\_loss: 25969.6582  
Epoch 253/500  
11817/11817 [=====] - 0s - loss: 10378.2259 - val\_loss: 25923.1152  
Epoch 254/500  
11817/11817 [=====] - 0s - loss: 10308.3885 - val\_loss: 26167.2734  
Epoch 255/500  
11817/11817 [=====] - 0s - loss: 10400.8075 - val\_loss: 26001.7461  
Epoch 256/500  
11817/11817 [=====] - 0s - loss: 10397.5403 - val\_loss: 26034.0723  
Epoch 257/500  
11817/11817 [=====] - 0s - loss: 10367.8735 - val\_loss: 26022.8105  
Epoch 258/500  
11817/11817 [=====] - 0s - loss: 10348.9357 - val\_loss: 26068.4180  
Epoch 259/500  
11817/11817 [=====] - 0s - loss: 10362.0990 - val\_loss: 26208.4258  
Epoch 260/500  
11817/11817 [=====] - 0s - loss: 10375.9476 - val\_loss: 26092.4922  
Epoch 261/500  
11817/11817 [=====] - 0s - loss: 10363.1968 - val\_loss: 26018.2324  
Epoch 262/500  
11817/11817 [=====] - 0s - loss: 10382.0645 - val\_loss: 26094.8613  
Epoch 263/500  
11817/11817 [=====] - 0s - loss: 10338.1200 - val\_loss: 26263.7852  
Epoch 264/500  
11817/11817 [=====] - 0s - loss: 10325.6607 - val\_loss: 25963.9609  
Epoch 265/500  
11817/11817 [=====] - 0s - loss: 10321.9578 - val\_loss: 26075.4688  
Epoch 266/500  
11817/11817 [=====] - 0s - loss: 10322.5520 - val\_loss: 26384.9258  
Epoch 267/500  
11817/11817 [=====] - 0s - loss: 10339.3837 - val\_loss: 25866.7500  
Epoch 268/500  
11817/11817 [=====] - 0s - loss: 10303.0459 - val\_loss: 25874.6191  
Epoch 269/500  
11817/11817 [=====] - 0s - loss: 10315.7740 - val\_loss: 26441.8379  
Epoch 270/500  
11817/11817 [=====] - 0s - loss: 10273.5304 - val\_loss: 26232.3516  
Epoch 271/500  
11817/11817 [=====] - 0s - loss: 10310.3231 - val\_loss: 26021.9941  
Epoch 272/500  
11817/11817 [=====] - 0s - loss: 10311.9417 - val\_loss: 26046.8555  
Epoch 273/500

11817/11817 [=====] - 0s - loss: 10300.9284 - val\_loss: 26102.5586  
Epoch 274/500  
11817/11817 [=====] - 0s - loss: 10359.6472 - val\_loss: 26097.8750  
Epoch 275/500  
11817/11817 [=====] - 0s - loss: 10314.2890 - val\_loss: 25923.0488  
Epoch 276/500  
11817/11817 [=====] - 0s - loss: 10324.4531 - val\_loss: 26108.6230  
Epoch 277/500  
11817/11817 [=====] - 0s - loss: 10286.7673 - val\_loss: 26228.4824  
Epoch 278/500  
11817/11817 [=====] - 0s - loss: 10305.5387 - val\_loss: 26019.6836  
Epoch 279/500  
11817/11817 [=====] - 0s - loss: 10251.1806 - val\_loss: 26019.9551  
Epoch 280/500  
11817/11817 [=====] - 0s - loss: 10265.3112 - val\_loss: 26162.7285  
Epoch 281/500  
11817/11817 [=====] - 0s - loss: 10295.2950 - val\_loss: 26080.0078  
Epoch 282/500  
11817/11817 [=====] - 0s - loss: 10290.2105 - val\_loss: 25947.2480  
Epoch 283/500  
11817/11817 [=====] - 0s - loss: 10285.7791 - val\_loss: 26244.2754  
Epoch 284/500  
11817/11817 [=====] - 0s - loss: 10284.0893 - val\_loss: 26005.2656  
Epoch 285/500  
11817/11817 [=====] - 0s - loss: 10303.8438 - val\_loss: 26143.0605  
Epoch 286/500  
11817/11817 [=====] - 0s - loss: 10231.2322 - val\_loss: 26253.5840  
Epoch 287/500  
11817/11817 [=====] - 0s - loss: 10279.3543 - val\_loss: 26126.4004  
Epoch 288/500  
11817/11817 [=====] - 0s - loss: 10289.3037 - val\_loss: 26176.0020  
Epoch 289/500  
11817/11817 [=====] - 0s - loss: 10261.0474 - val\_loss: 26143.0684  
Epoch 290/500  
11817/11817 [=====] - 0s - loss: 10223.2790 - val\_loss: 26035.0840  
Epoch 291/500  
11817/11817 [=====] - 0s - loss: 10243.0358 - val\_loss: 26197.6660  
Epoch 292/500  
11817/11817 [=====] - 0s - loss: 10276.9670 - val\_loss: 26141.8086  
Epoch 293/500  
11817/11817 [=====] - 0s - loss: 10253.6052 - val\_loss: 26180.7832  
Epoch 294/500  
11817/11817 [=====] - 0s - loss: 10233.0529 - val\_loss: 26269.6875  
Epoch 295/500  
11817/11817 [=====] - 0s - loss: 10229.7305 - val\_loss: 26162.9766  
Epoch 296/500  
11817/11817 [=====] - 0s - loss: 10197.2260 - val\_loss: 25912.9668  
Epoch 297/500

11817/11817 [=====] - 0s - loss: 10222.6796 - val\_loss: 26207.4062  
Epoch 298/500  
11817/11817 [=====] - 0s - loss: 10259.8262 - val\_loss: 26419.4863  
Epoch 299/500  
11817/11817 [=====] - 0s - loss: 10221.8577 - val\_loss: 26040.7617  
Epoch 300/500  
11817/11817 [=====] - 0s - loss: 10223.7825 - val\_loss: 25999.0840  
Epoch 301/500  
11817/11817 [=====] - 0s - loss: 10231.9421 - val\_loss: 26342.6953  
Epoch 302/500  
11817/11817 [=====] - 0s - loss: 10246.8659 - val\_loss: 26136.3223  
Epoch 303/500  
11817/11817 [=====] - 0s - loss: 10204.1509 - val\_loss: 25964.6855  
Epoch 304/500  
11817/11817 [=====] - 0s - loss: 10196.7882 - val\_loss: 26116.5156  
Epoch 305/500  
11817/11817 [=====] - 0s - loss: 10212.0221 - val\_loss: 26594.4121  
Epoch 306/500  
11817/11817 [=====] - 0s - loss: 10181.5167 - val\_loss: 25851.7090  
Epoch 307/500  
11817/11817 [=====] - 0s - loss: 10226.8858 - val\_loss: 25979.9746  
Epoch 308/500  
11817/11817 [=====] - 0s - loss: 10190.1127 - val\_loss: 26641.9492  
Epoch 309/500  
11817/11817 [=====] - 0s - loss: 10240.6112 - val\_loss: 25924.0547  
Epoch 310/500  
11817/11817 [=====] - 0s - loss: 10217.4732 - val\_loss: 26073.4980  
Epoch 311/500  
11817/11817 [=====] - 0s - loss: 10175.5177 - val\_loss: 26375.9375  
Epoch 312/500  
11817/11817 [=====] - 0s - loss: 10222.2319 - val\_loss: 26194.2520  
Epoch 313/500  
11817/11817 [=====] - 0s - loss: 10179.5827 - val\_loss: 26292.3164  
Epoch 314/500  
11817/11817 [=====] - 0s - loss: 10179.3135 - val\_loss: 26095.6914  
Epoch 315/500  
11817/11817 [=====] - 0s - loss: 10136.7600 - val\_loss: 26164.7207  
Epoch 316/500  
11817/11817 [=====] - 0s - loss: 10189.4145 - val\_loss: 26109.5254  
Epoch 317/500  
11817/11817 [=====] - 0s - loss: 10161.2074 - val\_loss: 26167.2051  
Epoch 318/500  
11817/11817 [=====] - 0s - loss: 10118.2899 - val\_loss: 26422.2051  
Epoch 319/500  
11817/11817 [=====] - 0s - loss: 10165.4805 - val\_loss: 26069.2539  
Epoch 320/500  
11817/11817 [=====] - 0s - loss: 10154.4046 - val\_loss: 26202.6641  
Epoch 321/500

```

11817/11817 [=====] - 0s - loss: 10206.9294 - val_loss: 26188.2500
Epoch 322/500
11817/11817 [=====] - 0s - loss: 10151.6721 - val_loss: 26202.5156
Epoch 323/500
11817/11817 [=====] - 0s - loss: 10176.2900 - val_loss: 26120.4785
Epoch 324/500
11817/11817 [=====] - 0s - loss: 10183.6530 - val_loss: 26079.9414
Epoch 325/500
11817/11817 [=====] - 0s - loss: 10177.9364 - val_loss: 26376.9180
Epoch 326/500
11817/11817 [=====] - 0s - loss: 10111.7368 - val_loss: 26224.2695
Epoch 327/500
11817/11817 [=====] - 0s - loss: 10178.8052 - val_loss: 26220.8535
Epoch 328/500
11817/11817 [=====] - 0s - loss: 10128.2212 - val_loss: 26318.9082
Epoch 329/500
11817/11817 [=====] - 0s - loss: 10185.7138 - val_loss: 26569.1152
Epoch 330/500
11817/11817 [=====] - 0s - loss: 10122.7997 - val_loss: 26076.3945
Epoch 331/500
11817/11817 [=====] - 0s - loss: 10146.5426 - val_loss: 26391.7812
Epoch 332/500
11817/11817 [=====] - 0s - loss: 10153.2657 - val_loss: 26350.7012
Epoch 333/500
11817/11817 [=====] - 0s - loss: 10113.3620 - val_loss: 26299.5391
Epoch 334/500
11817/11817 [=====] - 0s - loss: 10061.6522 - val_loss: 26204.7930
Epoch 335/500
11817/11817 [=====] - 0s - loss: 10095.8613 - val_loss: 26331.9785
Epoch 336/500
11817/11817 [=====] - 0s - loss: 10085.1692 - val_loss: 26201.7363
Epoch 337/500
11817/11817 [=====] - 0s - loss: 10103.9434 - val_loss: 26258.7598
Epoch 338/500
11817/11817 [=====] - 0s - loss: 10121.2148 - val_loss: 26467.2109
Epoch 339/500
11817/11817 [=====] - 0s - loss: 10133.9617 - val_loss: 26241.8438
Epoch 340/500
11817/11817 [=====] - 0s - loss: 10154.5327 - val_loss: 26149.1191
Epoch 341/500
11817/11817 [=====] - 0s - loss: 10069.9456 - val_loss: 26050.2715
Epoch 342/500
11817/11817 [=====] - 0s - loss: 10096.2990 - val_loss: 26347.1152
Epoch 343/500
11817/11817 [=====] - 0s - loss: 10163.4311 - val_loss: 26209.4766
Epoch 344/500
11817/11817 [=====] - 0s - loss: 10082.7493 - val_loss: 26068.1230
Epoch 345/500

```

```

11817/11817 [=====] - 0s - loss: 10052.8814 - val_loss: 26304.8379
Epoch 346/500
11817/11817 [=====] - 0s - loss: 10088.2835 - val_loss: 26327.2676
Epoch 347/500
11817/11817 [=====] - 0s - loss: 10110.8369 - val_loss: 26011.9961
Epoch 348/500
11817/11817 [=====] - 0s - loss: 10117.1296 - val_loss: 26000.3145
Epoch 349/500
11817/11817 [=====] - 0s - loss: 10062.7348 - val_loss: 26560.1348
Epoch 350/500
11817/11817 [=====] - 0s - loss: 10024.0841 - val_loss: 26227.9922
Epoch 351/500
11817/11817 [=====] - 0s - loss: 10070.8793 - val_loss: 25957.4082
Epoch 352/500
11817/11817 [=====] - 0s - loss: 10086.5487 - val_loss: 26708.7637
Epoch 353/500
11817/11817 [=====] - 0s - loss: 10086.0552 - val_loss: 26123.3164
Epoch 354/500
11817/11817 [=====] - 0s - loss: 10009.7782 - val_loss: 25970.3203
Epoch 355/500
11817/11817 [=====] - 0s - loss: 10081.9847 - val_loss: 26338.5625
Epoch 356/500
11817/11817 [=====] - 0s - loss: 10037.0245 - val_loss: 26251.3047
Epoch 357/500
11817/11817 [=====] - 0s - loss: 10036.2521 - val_loss: 26057.5410

```

```

In [25]: past_preds = model.predict(train_features)[: , 0]
         future_preds = model.predict(test_features)[: , 0]

from sklearn.metrics import r2_score
import numpy as np

# our benchmark is just guessing the average
benchmark = np.mean(train_targets)
print('benchmark r^2 on training:', r2_score(train_targets, [benchmark] * train_targets.shape[0]))

print('training r^2:', r2_score(train_targets, past_preds))
plt.scatter(train_targets, past_preds, alpha=0.1)
plt.xlabel('actual')
plt.ylabel('predicted')
plt.title('train predictions vs actual')
plt.show()

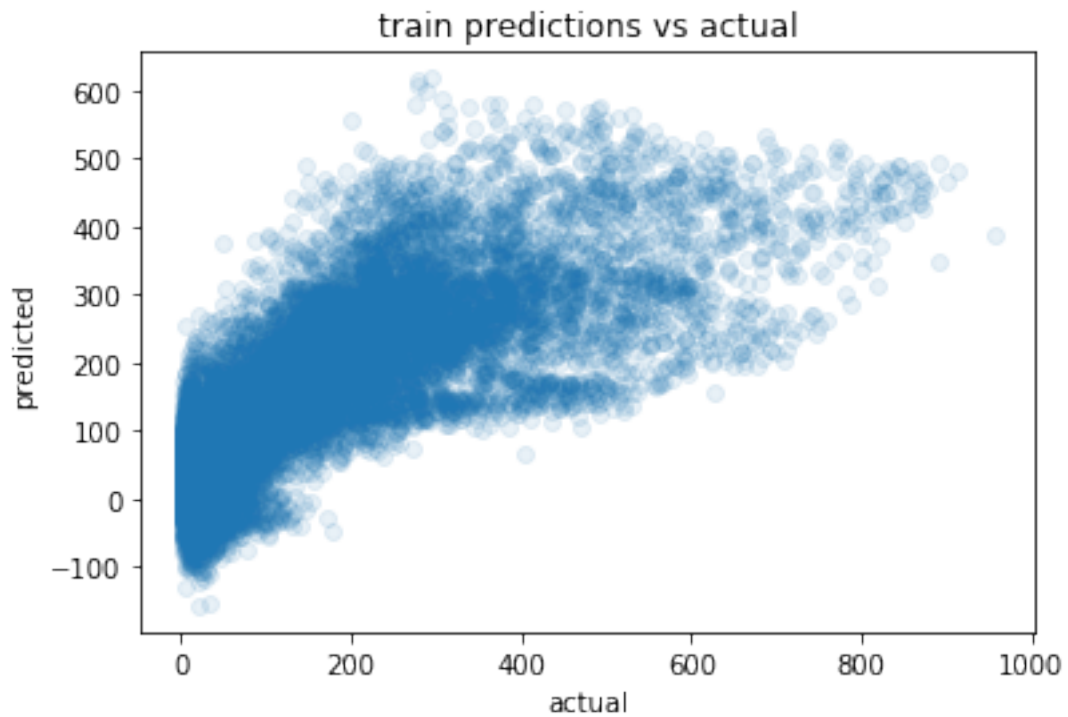
print('benchmark r^2 on test:', r2_score(test_targets, [benchmark] * test_targets.shape[0]))

print('r^2 on test:', r2_score(test_targets, future_preds))
plt.scatter(test_targets, future_preds, alpha=0.1)

```

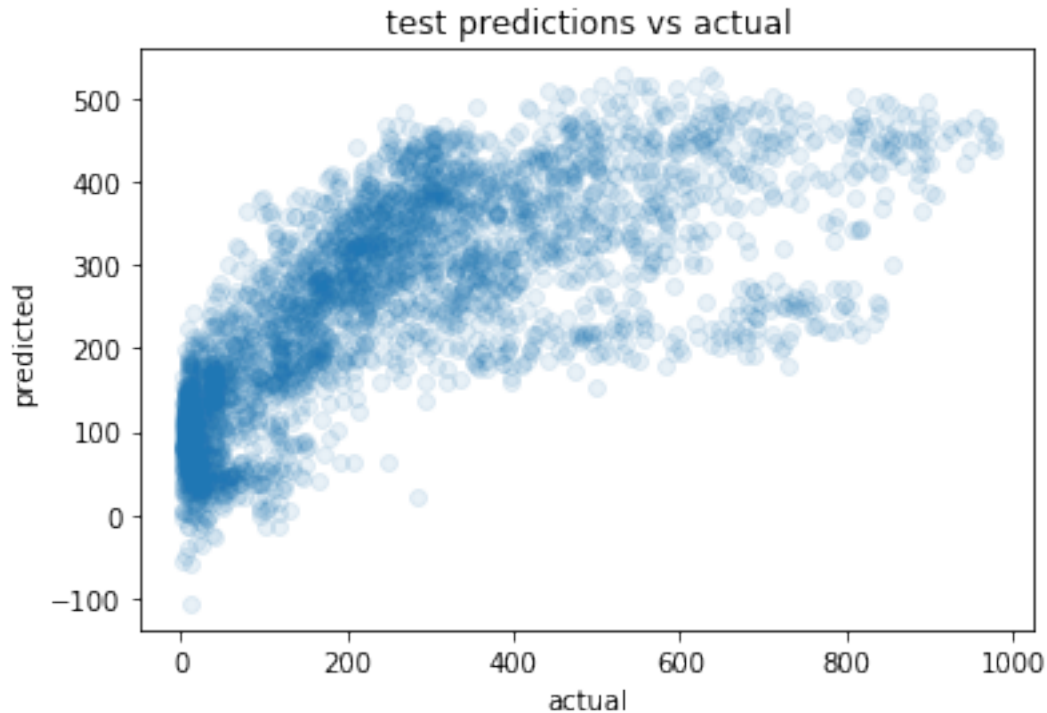
```
plt.xlabel('actual')
plt.ylabel('predicted')
plt.title('test predictions vs actual')
plt.show()
```

benchmark  $r^2$  on training: 0.0  
training  $r^2$ : 0.559189680209



benchmark  $r^2$  on test: -0.112995264662  
 $r^2$  on test: 0.501369302796





- 5 An improvement from  $r^2 = 0.13$  to 0.55 on the test just by increasing the first layer size from 10 to 1000. Now we will add another layer of 500 neurons in the middle.

In [26]: *# creates the model*

```
# restart keras session (clear weights), sometimes this will clear up errors
K.clear_session()
```

```
# functional API
```

```
inputs = Input(shape=(features.shape[1], ))
x1 = Dense(1000, activation='elu')(inputs)
x2 = BatchNormalization()(x1)
x3 = Dropout(0.5)(x2)
x4 = Dense(500, activation='elu')(x3)
x5 = BatchNormalization()(x4)
x6 = Dropout(0.5)(x5)
predictions = Dense(1, activation='linear')(x6)
```

```
# this saves the best model (lowest validation loss)
```

```
checkpoint = ModelCheckpoint('3_layer_dense.h5', monitor='val_loss', save_best_only=True)
# this stops training if the validation loss is not improving for 50 epochs in a row
```

```

es = EarlyStopping(patience=50)
cb = [checkpoint, es]

# this compiles our model so it is ready to fit
model = Model(inputs, predictions)
model.compile(optimizer='adam', loss='mse')

subset_size = trainsize
train_feature_subset = train_features[:subset_size]
train_target_subset = train_targets[:subset_size]
# we actually fit the model here
history = model.fit(train_feature_subset,
                    train_target_subset,
                    epochs=500,
                    validation_split=0.15,
                    callbacks=cb,
                    batch_size=3000)

```

Train on 11817 samples, validate on 2086 samples

```

Epoch 1/500
11817/11817 [=====] - 0s - loss: 45779.7770 - val_loss: 107284.3594
Epoch 2/500
11817/11817 [=====] - 0s - loss: 44322.8684 - val_loss: 98709.4922
Epoch 3/500
11817/11817 [=====] - 0s - loss: 43922.3896 - val_loss: 95485.5469
Epoch 4/500
11817/11817 [=====] - 0s - loss: 43559.1757 - val_loss: 95280.5625
Epoch 5/500
11817/11817 [=====] - 0s - loss: 43111.6929 - val_loss: 96836.4766
Epoch 6/500
11817/11817 [=====] - 0s - loss: 42594.0709 - val_loss: 99154.5312
Epoch 7/500
11817/11817 [=====] - 0s - loss: 41992.6774 - val_loss: 100587.7500
Epoch 8/500
11817/11817 [=====] - 0s - loss: 41331.2163 - val_loss: 100036.6094
Epoch 9/500
11817/11817 [=====] - 0s - loss: 40728.4403 - val_loss: 96601.2422
Epoch 10/500
11817/11817 [=====] - 0s - loss: 40193.9216 - val_loss: 92079.3047
Epoch 11/500
11817/11817 [=====] - 0s - loss: 39653.7740 - val_loss: 88722.0391
Epoch 12/500
11817/11817 [=====] - 0s - loss: 39180.9849 - val_loss: 84620.4062
Epoch 13/500
11817/11817 [=====] - 0s - loss: 38707.0177 - val_loss: 81365.7734
Epoch 14/500
11817/11817 [=====] - 0s - loss: 38285.1590 - val_loss: 78252.6406
Epoch 15/500

```

11817/11817 [=====] - 0s - loss: 37845.5259 - val\_loss: 75659.1562  
Epoch 16/500  
11817/11817 [=====] - 0s - loss: 37439.2539 - val\_loss: 73309.3047  
Epoch 17/500  
11817/11817 [=====] - 0s - loss: 37010.9776 - val\_loss: 71681.2188  
Epoch 18/500  
11817/11817 [=====] - 0s - loss: 36632.9607 - val\_loss: 69426.9141  
Epoch 19/500  
11817/11817 [=====] - 0s - loss: 36232.5395 - val\_loss: 67699.8047  
Epoch 20/500  
11817/11817 [=====] - 0s - loss: 35856.1096 - val\_loss: 66173.6875  
Epoch 21/500  
11817/11817 [=====] - 0s - loss: 35477.0287 - val\_loss: 65076.0898  
Epoch 22/500  
11817/11817 [=====] - 0s - loss: 35096.5076 - val\_loss: 63514.4609  
Epoch 23/500  
11817/11817 [=====] - 0s - loss: 34730.1964 - val\_loss: 62619.4180  
Epoch 24/500  
11817/11817 [=====] - 0s - loss: 34355.3393 - val\_loss: 62289.8164  
Epoch 25/500  
11817/11817 [=====] - 0s - loss: 33981.7653 - val\_loss: 59927.4844  
Epoch 26/500  
11817/11817 [=====] - 0s - loss: 33621.5958 - val\_loss: 59995.0312  
Epoch 27/500  
11817/11817 [=====] - 0s - loss: 33289.3685 - val\_loss: 59517.8359  
Epoch 28/500  
11817/11817 [=====] - 0s - loss: 32941.6746 - val\_loss: 58045.1016  
Epoch 29/500  
11817/11817 [=====] - 0s - loss: 32615.2386 - val\_loss: 57743.0273  
Epoch 30/500  
11817/11817 [=====] - 0s - loss: 32267.2059 - val\_loss: 57327.1055  
Epoch 31/500  
11817/11817 [=====] - 0s - loss: 32031.4373 - val\_loss: 56344.3438  
Epoch 32/500  
11817/11817 [=====] - 0s - loss: 31669.9495 - val\_loss: 56172.9141  
Epoch 33/500  
11817/11817 [=====] - 0s - loss: 31281.1538 - val\_loss: 55216.0039  
Epoch 34/500  
11817/11817 [=====] - 0s - loss: 30967.2779 - val\_loss: 55063.5430  
Epoch 35/500  
11817/11817 [=====] - 0s - loss: 30773.2395 - val\_loss: 54467.8594  
Epoch 36/500  
11817/11817 [=====] - 0s - loss: 30465.3153 - val\_loss: 54444.3164  
Epoch 37/500  
11817/11817 [=====] - 0s - loss: 30162.3219 - val\_loss: 54237.4141  
Epoch 38/500  
11817/11817 [=====] - 0s - loss: 29880.8134 - val\_loss: 53396.3359  
Epoch 39/500

11817/11817 [=====] - 0s - loss: 29586.3120 - val\_loss: 52539.1641  
Epoch 40/500  
11817/11817 [=====] - 0s - loss: 29322.8840 - val\_loss: 53219.2695  
Epoch 41/500  
11817/11817 [=====] - 0s - loss: 29048.5367 - val\_loss: 51975.4922  
Epoch 42/500  
11817/11817 [=====] - 0s - loss: 28742.1645 - val\_loss: 52492.9336  
Epoch 43/500  
11817/11817 [=====] - 0s - loss: 28439.4295 - val\_loss: 51778.1406  
Epoch 44/500  
11817/11817 [=====] - 0s - loss: 28146.7977 - val\_loss: 50047.3320  
Epoch 45/500  
11817/11817 [=====] - 0s - loss: 27899.3828 - val\_loss: 50951.8125  
Epoch 46/500  
11817/11817 [=====] - 0s - loss: 27613.0280 - val\_loss: 48769.3359  
Epoch 47/500  
11817/11817 [=====] - 0s - loss: 27380.2550 - val\_loss: 49486.9570  
Epoch 48/500  
11817/11817 [=====] - 0s - loss: 27059.6375 - val\_loss: 48123.6953  
Epoch 49/500  
11817/11817 [=====] - 0s - loss: 26777.6480 - val\_loss: 46551.8398  
Epoch 50/500  
11817/11817 [=====] - 0s - loss: 26448.5295 - val\_loss: 48168.9219  
Epoch 51/500  
11817/11817 [=====] - 0s - loss: 26243.7945 - val\_loss: 45331.5898  
Epoch 52/500  
11817/11817 [=====] - 0s - loss: 25939.4297 - val\_loss: 46780.4883  
Epoch 53/500  
11817/11817 [=====] - 0s - loss: 25642.2863 - val\_loss: 45750.7500  
Epoch 54/500  
11817/11817 [=====] - 0s - loss: 25337.3685 - val\_loss: 45154.9609  
Epoch 55/500  
11817/11817 [=====] - 0s - loss: 24999.2273 - val\_loss: 45473.8203  
Epoch 56/500  
11817/11817 [=====] - 0s - loss: 24724.7582 - val\_loss: 44253.3828  
Epoch 57/500  
11817/11817 [=====] - 0s - loss: 24453.5480 - val\_loss: 44101.0547  
Epoch 58/500  
11817/11817 [=====] - 0s - loss: 24116.8608 - val\_loss: 43508.1328  
Epoch 59/500  
11817/11817 [=====] - 0s - loss: 23751.5695 - val\_loss: 41672.5352  
Epoch 60/500  
11817/11817 [=====] - 0s - loss: 23455.3952 - val\_loss: 40801.8516  
Epoch 61/500  
11817/11817 [=====] - 0s - loss: 23140.0502 - val\_loss: 40246.0664  
Epoch 62/500  
11817/11817 [=====] - 0s - loss: 22719.5836 - val\_loss: 39129.3086  
Epoch 63/500

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11817/11817 [=====] - 0s - loss: 22423.9767 - val_loss: 37605.5117
Epoch 64/500
11817/11817 [=====] - 0s - loss: 22076.5348 - val_loss: 37078.5547
Epoch 65/500
11817/11817 [=====] - 0s - loss: 21678.2052 - val_loss: 36356.4805
Epoch 66/500
11817/11817 [=====] - 0s - loss: 21445.5064 - val_loss: 35215.7344
Epoch 67/500
11817/11817 [=====] - 0s - loss: 21080.3519 - val_loss: 33996.7773
Epoch 68/500
11817/11817 [=====] - 0s - loss: 20705.7047 - val_loss: 34331.2344
Epoch 69/500
11817/11817 [=====] - 0s - loss: 20420.6314 - val_loss: 33531.1797
Epoch 70/500
11817/11817 [=====] - 0s - loss: 20037.7359 - val_loss: 31967.6348
Epoch 71/500
11817/11817 [=====] - 0s - loss: 19773.9896 - val_loss: 32344.9199
Epoch 72/500
11817/11817 [=====] - 0s - loss: 19462.7574 - val_loss: 30814.3516
Epoch 73/500
11817/11817 [=====] - 0s - loss: 19077.4011 - val_loss: 30792.8203
Epoch 74/500
11817/11817 [=====] - 0s - loss: 18805.7058 - val_loss: 29894.2402
Epoch 75/500
11817/11817 [=====] - 0s - loss: 18453.9916 - val_loss: 29786.7305
Epoch 76/500
11817/11817 [=====] - 0s - loss: 18129.1869 - val_loss: 28971.6230
Epoch 77/500
11817/11817 [=====] - 0s - loss: 17838.7606 - val_loss: 28638.5508
Epoch 78/500
11817/11817 [=====] - 0s - loss: 17592.9039 - val_loss: 27993.8340
Epoch 79/500
11817/11817 [=====] - 0s - loss: 17257.1041 - val_loss: 28048.0723
Epoch 80/500
11817/11817 [=====] - 0s - loss: 16882.3383 - val_loss: 27519.5625
Epoch 81/500
11817/11817 [=====] - 0s - loss: 16606.5279 - val_loss: 27215.1777
Epoch 82/500
11817/11817 [=====] - 0s - loss: 16344.7339 - val_loss: 26720.3047
Epoch 83/500
11817/11817 [=====] - 0s - loss: 16092.8931 - val_loss: 26899.4023
Epoch 84/500
11817/11817 [=====] - 0s - loss: 15777.9949 - val_loss: 26796.4727
Epoch 85/500
11817/11817 [=====] - 0s - loss: 15530.4534 - val_loss: 26143.4590
Epoch 86/500
11817/11817 [=====] - 0s - loss: 15195.0972 - val_loss: 25900.1113
Epoch 87/500

```

11817/11817 [=====] - 0s - loss: 14928.6329 - val\_loss: 26091.4883  
Epoch 88/500  
11817/11817 [=====] - 0s - loss: 14729.4082 - val\_loss: 25800.0039  
Epoch 89/500  
11817/11817 [=====] - 0s - loss: 14441.5175 - val\_loss: 25860.7070  
Epoch 90/500  
11817/11817 [=====] - 0s - loss: 14184.0796 - val\_loss: 25611.0918  
Epoch 91/500  
11817/11817 [=====] - 0s - loss: 13988.8896 - val\_loss: 25704.0156  
Epoch 92/500  
11817/11817 [=====] - 0s - loss: 13731.8715 - val\_loss: 25082.9629  
Epoch 93/500  
11817/11817 [=====] - 0s - loss: 13421.2381 - val\_loss: 25732.0352  
Epoch 94/500  
11817/11817 [=====] - 0s - loss: 13173.5572 - val\_loss: 24991.3594  
Epoch 95/500  
11817/11817 [=====] - 0s - loss: 12994.1283 - val\_loss: 25304.8105  
Epoch 96/500  
11817/11817 [=====] - 0s - loss: 12816.0975 - val\_loss: 24860.1738  
Epoch 97/500  
11817/11817 [=====] - 0s - loss: 12540.6172 - val\_loss: 24676.2051  
Epoch 98/500  
11817/11817 [=====] - 0s - loss: 12374.5188 - val\_loss: 24908.8574  
Epoch 99/500  
11817/11817 [=====] - 0s - loss: 12061.7089 - val\_loss: 24229.9902  
Epoch 100/500  
11817/11817 [=====] - 0s - loss: 11884.3221 - val\_loss: 24977.3555  
Epoch 101/500  
11817/11817 [=====] - 0s - loss: 11693.5077 - val\_loss: 24744.7012  
Epoch 102/500  
11817/11817 [=====] - 0s - loss: 11522.1130 - val\_loss: 24243.4844  
Epoch 103/500  
11817/11817 [=====] - 0s - loss: 11251.8888 - val\_loss: 24181.2871  
Epoch 104/500  
11817/11817 [=====] - 0s - loss: 11116.2615 - val\_loss: 23831.0684  
Epoch 105/500  
11817/11817 [=====] - 0s - loss: 10891.2984 - val\_loss: 24404.8340  
Epoch 106/500  
11817/11817 [=====] - 0s - loss: 10809.7959 - val\_loss: 23610.2070  
Epoch 107/500  
11817/11817 [=====] - 0s - loss: 10632.9028 - val\_loss: 23608.9277  
Epoch 108/500  
11817/11817 [=====] - 0s - loss: 10479.3282 - val\_loss: 23685.3164  
Epoch 109/500  
11817/11817 [=====] - 0s - loss: 10280.6528 - val\_loss: 23800.0195  
Epoch 110/500  
11817/11817 [=====] - 0s - loss: 10121.7858 - val\_loss: 23246.4883  
Epoch 111/500

11817/11817 [=====] - 0s - loss: 9990.4972 - val\_loss: 23715.5859  
Epoch 112/500  
11817/11817 [=====] - 0s - loss: 9828.8155 - val\_loss: 23796.0859  
Epoch 113/500  
11817/11817 [=====] - 0s - loss: 9718.4755 - val\_loss: 22716.8828  
Epoch 114/500  
11817/11817 [=====] - 0s - loss: 9573.3505 - val\_loss: 23280.6895  
Epoch 115/500  
11817/11817 [=====] - 0s - loss: 9508.3779 - val\_loss: 22434.1074  
Epoch 116/500  
11817/11817 [=====] - 0s - loss: 9360.4318 - val\_loss: 23034.1699  
Epoch 117/500  
11817/11817 [=====] - 0s - loss: 9204.3556 - val\_loss: 22502.2930  
Epoch 118/500  
11817/11817 [=====] - 0s - loss: 9060.1731 - val\_loss: 22531.1582  
Epoch 119/500  
11817/11817 [=====] - 0s - loss: 8922.6771 - val\_loss: 21820.3398  
Epoch 120/500  
11817/11817 [=====] - 0s - loss: 8877.9674 - val\_loss: 21959.5625  
Epoch 121/500  
11817/11817 [=====] - 0s - loss: 8822.5561 - val\_loss: 22083.5820  
Epoch 122/500  
11817/11817 [=====] - 0s - loss: 8636.3656 - val\_loss: 21710.7051  
Epoch 123/500  
11817/11817 [=====] - 0s - loss: 8598.6751 - val\_loss: 22083.6758  
Epoch 124/500  
11817/11817 [=====] - 0s - loss: 8500.6079 - val\_loss: 21337.0156  
Epoch 125/500  
11817/11817 [=====] - 0s - loss: 8346.7536 - val\_loss: 21104.5371  
Epoch 126/500  
11817/11817 [=====] - 0s - loss: 8324.8815 - val\_loss: 21670.0801  
Epoch 127/500  
11817/11817 [=====] - 0s - loss: 8302.3901 - val\_loss: 20642.8145  
Epoch 128/500  
11817/11817 [=====] - 0s - loss: 8123.3755 - val\_loss: 20881.0312  
Epoch 129/500  
11817/11817 [=====] - 0s - loss: 8167.5473 - val\_loss: 20475.9199  
Epoch 130/500  
11817/11817 [=====] - 0s - loss: 8074.2571 - val\_loss: 20080.3398  
Epoch 131/500  
11817/11817 [=====] - 0s - loss: 8019.1400 - val\_loss: 19451.9512  
Epoch 132/500  
11817/11817 [=====] - 0s - loss: 7883.7344 - val\_loss: 21071.8379  
Epoch 133/500  
11817/11817 [=====] - 0s - loss: 7875.8697 - val\_loss: 19550.3262  
Epoch 134/500  
11817/11817 [=====] - 0s - loss: 7820.3147 - val\_loss: 19323.1152  
Epoch 135/500

11817/11817 [=====] - 0s - loss: 7709.2467 - val\_loss: 19447.6133  
Epoch 136/500  
11817/11817 [=====] - 0s - loss: 7691.6622 - val\_loss: 19331.6191  
Epoch 137/500  
11817/11817 [=====] - 0s - loss: 7638.2406 - val\_loss: 18720.3730  
Epoch 138/500  
11817/11817 [=====] - 0s - loss: 7629.5818 - val\_loss: 18310.3965  
Epoch 139/500  
11817/11817 [=====] - 0s - loss: 7473.6319 - val\_loss: 18875.7266  
Epoch 140/500  
11817/11817 [=====] - 0s - loss: 7536.7050 - val\_loss: 18092.2539  
Epoch 141/500  
11817/11817 [=====] - 0s - loss: 7409.5313 - val\_loss: 18526.3672  
Epoch 142/500  
11817/11817 [=====] - 0s - loss: 7453.6064 - val\_loss: 18327.3633  
Epoch 143/500  
11817/11817 [=====] - 0s - loss: 7395.1119 - val\_loss: 18416.4707  
Epoch 144/500  
11817/11817 [=====] - 0s - loss: 7407.4591 - val\_loss: 17904.9023  
Epoch 145/500  
11817/11817 [=====] - 0s - loss: 7298.9850 - val\_loss: 18059.6504  
Epoch 146/500  
11817/11817 [=====] - 0s - loss: 7287.6978 - val\_loss: 17548.6133  
Epoch 147/500  
11817/11817 [=====] - 0s - loss: 7263.9090 - val\_loss: 17934.4883  
Epoch 148/500  
11817/11817 [=====] - 0s - loss: 7149.0005 - val\_loss: 17523.7520  
Epoch 149/500  
11817/11817 [=====] - 0s - loss: 7093.5296 - val\_loss: 17567.1484  
Epoch 150/500  
11817/11817 [=====] - 0s - loss: 7076.2359 - val\_loss: 17283.0977  
Epoch 151/500  
11817/11817 [=====] - 0s - loss: 7089.1201 - val\_loss: 17160.2871  
Epoch 152/500  
11817/11817 [=====] - 0s - loss: 6988.8666 - val\_loss: 16854.5332  
Epoch 153/500  
11817/11817 [=====] - 0s - loss: 6965.1226 - val\_loss: 17033.9570  
Epoch 154/500  
11817/11817 [=====] - 0s - loss: 6971.7797 - val\_loss: 16475.3027  
Epoch 155/500  
11817/11817 [=====] - 0s - loss: 7014.0769 - val\_loss: 16834.1465  
Epoch 156/500  
11817/11817 [=====] - 0s - loss: 6830.1557 - val\_loss: 16792.9648  
Epoch 157/500  
11817/11817 [=====] - 0s - loss: 6866.6044 - val\_loss: 16297.8008  
Epoch 158/500  
11817/11817 [=====] - 0s - loss: 6927.4435 - val\_loss: 16589.5078  
Epoch 159/500



11817/11817 [=====] - 0s - loss: 6813.9241 - val\_loss: 16148.2686  
Epoch 160/500  
11817/11817 [=====] - 0s - loss: 6824.8509 - val\_loss: 16676.1816  
Epoch 161/500  
11817/11817 [=====] - 0s - loss: 6810.3721 - val\_loss: 15923.4346  
Epoch 162/500  
11817/11817 [=====] - 0s - loss: 6795.1152 - val\_loss: 16676.2578  
Epoch 163/500  
11817/11817 [=====] - 0s - loss: 6726.1386 - val\_loss: 15701.3008  
Epoch 164/500  
11817/11817 [=====] - 0s - loss: 6767.1681 - val\_loss: 16146.2090  
Epoch 165/500  
11817/11817 [=====] - 0s - loss: 6627.8308 - val\_loss: 15869.2861  
Epoch 166/500  
11817/11817 [=====] - 0s - loss: 6508.4784 - val\_loss: 15870.3379  
Epoch 167/500  
11817/11817 [=====] - 0s - loss: 6580.3161 - val\_loss: 15688.2236  
Epoch 168/500  
11817/11817 [=====] - 0s - loss: 6609.7726 - val\_loss: 16032.5996  
Epoch 169/500  
11817/11817 [=====] - 0s - loss: 6639.3145 - val\_loss: 15614.7666  
Epoch 170/500  
11817/11817 [=====] - 0s - loss: 6482.0619 - val\_loss: 16056.5059  
Epoch 171/500  
11817/11817 [=====] - 0s - loss: 6494.4038 - val\_loss: 15674.8027  
Epoch 172/500  
11817/11817 [=====] - 0s - loss: 6356.7449 - val\_loss: 15818.1338  
Epoch 173/500  
11817/11817 [=====] - 0s - loss: 6429.4042 - val\_loss: 15469.5400  
Epoch 174/500  
11817/11817 [=====] - 0s - loss: 6419.6396 - val\_loss: 15805.6709  
Epoch 175/500  
11817/11817 [=====] - 0s - loss: 6276.5294 - val\_loss: 15437.1172  
Epoch 176/500  
11817/11817 [=====] - 0s - loss: 6325.0746 - val\_loss: 15556.5889  
Epoch 177/500  
11817/11817 [=====] - 0s - loss: 6345.6452 - val\_loss: 15572.5615  
Epoch 178/500  
11817/11817 [=====] - 0s - loss: 6257.0750 - val\_loss: 15579.3447  
Epoch 179/500  
11817/11817 [=====] - 0s - loss: 6162.8364 - val\_loss: 15568.6465  
Epoch 180/500  
11817/11817 [=====] - 0s - loss: 6193.5896 - val\_loss: 15346.2168  
Epoch 181/500  
11817/11817 [=====] - 0s - loss: 6085.7020 - val\_loss: 15580.3457  
Epoch 182/500  
11817/11817 [=====] - 0s - loss: 6035.6053 - val\_loss: 15398.7627  
Epoch 183/500

11817/11817 [=====] - 0s - loss: 6069.5506 - val\_loss: 15148.9092  
Epoch 184/500  
11817/11817 [=====] - 0s - loss: 6033.0146 - val\_loss: 15481.7236  
Epoch 185/500  
11817/11817 [=====] - 0s - loss: 6000.3588 - val\_loss: 15115.1025  
Epoch 186/500  
11817/11817 [=====] - 0s - loss: 5892.8011 - val\_loss: 15283.6973  
Epoch 187/500  
11817/11817 [=====] - 0s - loss: 5883.6595 - val\_loss: 15168.4746  
Epoch 188/500  
11817/11817 [=====] - 0s - loss: 5839.6464 - val\_loss: 15139.1064  
Epoch 189/500  
11817/11817 [=====] - 0s - loss: 5784.9945 - val\_loss: 14853.9609  
Epoch 190/500  
11817/11817 [=====] - 0s - loss: 5706.4286 - val\_loss: 15092.5615  
Epoch 191/500  
11817/11817 [=====] - 0s - loss: 5728.3305 - val\_loss: 15019.3164  
Epoch 192/500  
11817/11817 [=====] - 0s - loss: 5635.6294 - val\_loss: 15268.6826  
Epoch 193/500  
11817/11817 [=====] - 0s - loss: 5504.3694 - val\_loss: 14839.8945  
Epoch 194/500  
11817/11817 [=====] - 0s - loss: 5517.0818 - val\_loss: 15174.7402  
Epoch 195/500  
11817/11817 [=====] - 0s - loss: 5480.6025 - val\_loss: 14772.5801  
Epoch 196/500  
11817/11817 [=====] - 0s - loss: 5495.2578 - val\_loss: 14828.6660  
Epoch 197/500  
11817/11817 [=====] - 0s - loss: 5492.4332 - val\_loss: 14781.3945  
Epoch 198/500  
11817/11817 [=====] - 0s - loss: 5437.3004 - val\_loss: 14930.3213  
Epoch 199/500  
11817/11817 [=====] - 0s - loss: 5371.3177 - val\_loss: 14622.0322  
Epoch 200/500  
11817/11817 [=====] - 0s - loss: 5314.8745 - val\_loss: 15031.9268  
Epoch 201/500  
11817/11817 [=====] - 0s - loss: 5284.8453 - val\_loss: 14475.0039  
Epoch 202/500  
11817/11817 [=====] - 0s - loss: 5293.2154 - val\_loss: 14660.8184  
Epoch 203/500  
11817/11817 [=====] - 0s - loss: 5188.1699 - val\_loss: 14558.3105  
Epoch 204/500  
11817/11817 [=====] - 0s - loss: 5195.2577 - val\_loss: 15200.5098  
Epoch 205/500  
11817/11817 [=====] - 0s - loss: 5215.6291 - val\_loss: 14254.4893  
Epoch 206/500  
11817/11817 [=====] - 0s - loss: 5152.6271 - val\_loss: 15333.6377  
Epoch 207/500

11817/11817 [=====] - 0s - loss: 5186.5110 - val\_loss: 14330.2461  
Epoch 208/500  
11817/11817 [=====] - 0s - loss: 5128.0277 - val\_loss: 15174.1748  
Epoch 209/500  
11817/11817 [=====] - 0s - loss: 4997.4400 - val\_loss: 15000.0215  
Epoch 210/500  
11817/11817 [=====] - 0s - loss: 4972.5616 - val\_loss: 14677.1484  
Epoch 211/500  
11817/11817 [=====] - 0s - loss: 4995.1091 - val\_loss: 14485.4014  
Epoch 212/500  
11817/11817 [=====] - 0s - loss: 4898.8487 - val\_loss: 15380.7256  
Epoch 213/500  
11817/11817 [=====] - 0s - loss: 4969.4129 - val\_loss: 14595.5879  
Epoch 214/500  
11817/11817 [=====] - 0s - loss: 4855.3828 - val\_loss: 14685.5459  
Epoch 215/500  
11817/11817 [=====] - 0s - loss: 4914.4322 - val\_loss: 15013.5195  
Epoch 216/500  
11817/11817 [=====] - 0s - loss: 4816.5571 - val\_loss: 13760.4463  
Epoch 217/500  
11817/11817 [=====] - 0s - loss: 4750.2931 - val\_loss: 14854.0225  
Epoch 218/500  
11817/11817 [=====] - 0s - loss: 4757.1799 - val\_loss: 14203.5244  
Epoch 219/500  
11817/11817 [=====] - 0s - loss: 4700.9423 - val\_loss: 14355.6719  
Epoch 220/500  
11817/11817 [=====] - 0s - loss: 4781.2568 - val\_loss: 13740.3652  
Epoch 221/500  
11817/11817 [=====] - 0s - loss: 4801.2504 - val\_loss: 13789.7275  
Epoch 222/500  
11817/11817 [=====] - 0s - loss: 4727.8884 - val\_loss: 13574.4209  
Epoch 223/500  
11817/11817 [=====] - 0s - loss: 4731.0586 - val\_loss: 13872.0938  
Epoch 224/500  
11817/11817 [=====] - 0s - loss: 4654.9700 - val\_loss: 13770.8936  
Epoch 225/500  
11817/11817 [=====] - 0s - loss: 4594.5396 - val\_loss: 13889.5381  
Epoch 226/500  
11817/11817 [=====] - 0s - loss: 4617.2691 - val\_loss: 13823.5439  
Epoch 227/500  
11817/11817 [=====] - 0s - loss: 4573.9282 - val\_loss: 13538.9268  
Epoch 228/500  
11817/11817 [=====] - 0s - loss: 4532.0718 - val\_loss: 13212.8916  
Epoch 229/500  
11817/11817 [=====] - 0s - loss: 4506.6840 - val\_loss: 13220.2656  
Epoch 230/500  
11817/11817 [=====] - 0s - loss: 4534.0874 - val\_loss: 13762.3125  
Epoch 231/500

11817/11817 [=====] - 0s - loss: 4558.4104 - val\_loss: 13559.5723  
Epoch 232/500  
11817/11817 [=====] - 0s - loss: 4439.7891 - val\_loss: 13802.9307  
Epoch 233/500  
11817/11817 [=====] - 0s - loss: 4398.1828 - val\_loss: 13279.3477  
Epoch 234/500  
11817/11817 [=====] - 0s - loss: 4437.2644 - val\_loss: 13207.9990  
Epoch 235/500  
11817/11817 [=====] - 0s - loss: 4424.9692 - val\_loss: 12546.9902  
Epoch 236/500  
11817/11817 [=====] - 0s - loss: 4486.5845 - val\_loss: 12371.4141  
Epoch 237/500  
11817/11817 [=====] - 0s - loss: 4410.8071 - val\_loss: 13408.9551  
Epoch 238/500  
11817/11817 [=====] - 0s - loss: 4385.0531 - val\_loss: 12730.8340  
Epoch 239/500  
11817/11817 [=====] - 0s - loss: 4311.9037 - val\_loss: 13072.4062  
Epoch 240/500  
11817/11817 [=====] - 0s - loss: 4384.0105 - val\_loss: 12582.0342  
Epoch 241/500  
11817/11817 [=====] - 0s - loss: 4357.9133 - val\_loss: 12940.4756  
Epoch 242/500  
11817/11817 [=====] - 0s - loss: 4339.6391 - val\_loss: 11981.7949  
Epoch 243/500  
11817/11817 [=====] - 0s - loss: 4350.5339 - val\_loss: 12342.1904  
Epoch 244/500  
11817/11817 [=====] - 0s - loss: 4284.6143 - val\_loss: 12511.6006  
Epoch 245/500  
11817/11817 [=====] - 0s - loss: 4247.0339 - val\_loss: 12190.1523  
Epoch 246/500  
11817/11817 [=====] - 0s - loss: 4262.3719 - val\_loss: 13002.7812  
Epoch 247/500  
11817/11817 [=====] - 0s - loss: 4203.8256 - val\_loss: 12051.5840  
Epoch 248/500  
11817/11817 [=====] - 0s - loss: 4267.2567 - val\_loss: 12739.7490  
Epoch 249/500  
11817/11817 [=====] - 0s - loss: 4245.2212 - val\_loss: 11850.0234  
Epoch 250/500  
11817/11817 [=====] - 0s - loss: 4279.8243 - val\_loss: 12750.9736  
Epoch 251/500  
11817/11817 [=====] - 0s - loss: 4239.0235 - val\_loss: 12075.6367  
Epoch 252/500  
11817/11817 [=====] - 0s - loss: 4268.7773 - val\_loss: 11108.8135  
Epoch 253/500  
11817/11817 [=====] - 0s - loss: 4207.0755 - val\_loss: 12868.7793  
Epoch 254/500  
11817/11817 [=====] - 0s - loss: 4226.8814 - val\_loss: 11614.9473  
Epoch 255/500

11817/11817 [=====] - 0s - loss: 4129.8848 - val\_loss: 12116.2344  
Epoch 256/500  
11817/11817 [=====] - 0s - loss: 4229.2506 - val\_loss: 11741.8213  
Epoch 257/500  
11817/11817 [=====] - 0s - loss: 4152.4590 - val\_loss: 11406.6787  
Epoch 258/500  
11817/11817 [=====] - 0s - loss: 4100.5765 - val\_loss: 11895.5205  
Epoch 259/500  
11817/11817 [=====] - 0s - loss: 4190.0741 - val\_loss: 11844.1777  
Epoch 260/500  
11817/11817 [=====] - 0s - loss: 4102.1223 - val\_loss: 12539.0088  
Epoch 261/500  
11817/11817 [=====] - 0s - loss: 4120.9289 - val\_loss: 11937.7480  
Epoch 262/500  
11817/11817 [=====] - 0s - loss: 4079.9495 - val\_loss: 11898.3203  
Epoch 263/500  
11817/11817 [=====] - 0s - loss: 4121.0222 - val\_loss: 11688.4277  
Epoch 264/500  
11817/11817 [=====] - 0s - loss: 4044.9102 - val\_loss: 11841.1904  
Epoch 265/500  
11817/11817 [=====] - 0s - loss: 4036.4091 - val\_loss: 12481.7207  
Epoch 266/500  
11817/11817 [=====] - 0s - loss: 4017.1148 - val\_loss: 11046.5518  
Epoch 267/500  
11817/11817 [=====] - 0s - loss: 4019.2722 - val\_loss: 11292.3408  
Epoch 268/500  
11817/11817 [=====] - 0s - loss: 4053.3297 - val\_loss: 10638.7842  
Epoch 269/500  
11817/11817 [=====] - 0s - loss: 4035.6499 - val\_loss: 11330.7266  
Epoch 270/500  
11817/11817 [=====] - 0s - loss: 4008.6539 - val\_loss: 11640.5693  
Epoch 271/500  
11817/11817 [=====] - 0s - loss: 4004.6102 - val\_loss: 10860.9473  
Epoch 272/500  
11817/11817 [=====] - 0s - loss: 4011.5218 - val\_loss: 11500.8340  
Epoch 273/500  
11817/11817 [=====] - 0s - loss: 3916.4597 - val\_loss: 10307.5957  
Epoch 274/500  
11817/11817 [=====] - 0s - loss: 3999.2245 - val\_loss: 11073.4131  
Epoch 275/500  
11817/11817 [=====] - 0s - loss: 3911.5249 - val\_loss: 11133.4365  
Epoch 276/500  
11817/11817 [=====] - 0s - loss: 3981.1379 - val\_loss: 10918.2578  
Epoch 277/500  
11817/11817 [=====] - 0s - loss: 3937.9493 - val\_loss: 10649.8320  
Epoch 278/500  
11817/11817 [=====] - 0s - loss: 3959.9673 - val\_loss: 10045.6523  
Epoch 279/500

11817/11817 [=====] - 0s - loss: 3961.8277 - val\_loss: 10581.1953  
Epoch 280/500  
11817/11817 [=====] - 0s - loss: 3876.0641 - val\_loss: 10327.1709  
Epoch 281/500  
11817/11817 [=====] - 0s - loss: 3857.2565 - val\_loss: 11333.8398  
Epoch 282/500  
11817/11817 [=====] - 0s - loss: 3945.2571 - val\_loss: 10644.2871  
Epoch 283/500  
11817/11817 [=====] - 0s - loss: 3901.4720 - val\_loss: 10550.3242  
Epoch 284/500  
11817/11817 [=====] - 0s - loss: 3931.2255 - val\_loss: 10333.3555  
Epoch 285/500  
11817/11817 [=====] - 0s - loss: 3887.7788 - val\_loss: 10000.3789  
Epoch 286/500  
11817/11817 [=====] - 0s - loss: 3774.0000 - val\_loss: 9914.0771  
Epoch 287/500  
11817/11817 [=====] - 0s - loss: 3811.9776 - val\_loss: 9687.8330  
Epoch 288/500  
11817/11817 [=====] - 0s - loss: 3844.9904 - val\_loss: 9482.7422  
Epoch 289/500  
11817/11817 [=====] - 0s - loss: 3799.6652 - val\_loss: 9433.1064  
Epoch 290/500  
11817/11817 [=====] - 0s - loss: 3799.9062 - val\_loss: 9571.7002  
Epoch 291/500  
11817/11817 [=====] - 0s - loss: 3762.1202 - val\_loss: 10253.0957  
Epoch 292/500  
11817/11817 [=====] - 0s - loss: 3850.7569 - val\_loss: 9809.2354  
Epoch 293/500  
11817/11817 [=====] - 0s - loss: 3775.8549 - val\_loss: 9388.4062  
Epoch 294/500  
11817/11817 [=====] - 0s - loss: 3831.0303 - val\_loss: 9996.9492  
Epoch 295/500  
11817/11817 [=====] - 0s - loss: 3876.3306 - val\_loss: 9480.8672  
Epoch 296/500  
11817/11817 [=====] - 0s - loss: 3844.5867 - val\_loss: 10261.0156  
Epoch 297/500  
11817/11817 [=====] - 0s - loss: 3759.8970 - val\_loss: 9161.0947  
Epoch 298/500  
11817/11817 [=====] - 0s - loss: 3814.5009 - val\_loss: 9978.2529  
Epoch 299/500  
11817/11817 [=====] - 0s - loss: 3740.9684 - val\_loss: 9706.8350  
Epoch 300/500  
11817/11817 [=====] - 0s - loss: 3787.9388 - val\_loss: 10219.2441  
Epoch 301/500  
11817/11817 [=====] - 0s - loss: 3708.1484 - val\_loss: 9665.8994  
Epoch 302/500  
11817/11817 [=====] - 0s - loss: 3714.7690 - val\_loss: 9952.1631  
Epoch 303/500

11817/11817 [=====] - 0s - loss: 3792.1610 - val\_loss: 9444.6865  
Epoch 304/500  
11817/11817 [=====] - 0s - loss: 3773.5804 - val\_loss: 9176.7783  
Epoch 305/500  
11817/11817 [=====] - 0s - loss: 3755.2076 - val\_loss: 10070.9932  
Epoch 306/500  
11817/11817 [=====] - 0s - loss: 3724.7799 - val\_loss: 8916.5762  
Epoch 307/500  
11817/11817 [=====] - 0s - loss: 3843.3223 - val\_loss: 9639.1201  
Epoch 308/500  
11817/11817 [=====] - 0s - loss: 3766.8581 - val\_loss: 9024.6621  
Epoch 309/500  
11817/11817 [=====] - 0s - loss: 3696.3239 - val\_loss: 8769.6006  
Epoch 310/500  
11817/11817 [=====] - 0s - loss: 3703.4695 - val\_loss: 9489.3672  
Epoch 311/500  
11817/11817 [=====] - 0s - loss: 3657.9063 - val\_loss: 8714.3525  
Epoch 312/500  
11817/11817 [=====] - 0s - loss: 3713.1210 - val\_loss: 8595.1494  
Epoch 313/500  
11817/11817 [=====] - 0s - loss: 3625.0625 - val\_loss: 8851.3770  
Epoch 314/500  
11817/11817 [=====] - 0s - loss: 3655.7842 - val\_loss: 8389.7305  
Epoch 315/500  
11817/11817 [=====] - 0s - loss: 3653.3114 - val\_loss: 8561.3184  
Epoch 316/500  
11817/11817 [=====] - 0s - loss: 3615.2610 - val\_loss: 8720.0127  
Epoch 317/500  
11817/11817 [=====] - 0s - loss: 3704.8593 - val\_loss: 8977.7988  
Epoch 318/500  
11817/11817 [=====] - 0s - loss: 3593.9715 - val\_loss: 8748.8379  
Epoch 319/500  
11817/11817 [=====] - 0s - loss: 3697.0652 - val\_loss: 9079.9580  
Epoch 320/500  
11817/11817 [=====] - 0s - loss: 3609.7973 - val\_loss: 9540.1035  
Epoch 321/500  
11817/11817 [=====] - 0s - loss: 3643.3852 - val\_loss: 7981.3481  
Epoch 322/500  
11817/11817 [=====] - 0s - loss: 3633.1272 - val\_loss: 8655.8574  
Epoch 323/500  
11817/11817 [=====] - 0s - loss: 3708.8753 - val\_loss: 8247.9902  
Epoch 324/500  
11817/11817 [=====] - 0s - loss: 3596.3437 - val\_loss: 8345.0332  
Epoch 325/500  
11817/11817 [=====] - 0s - loss: 3532.9798 - val\_loss: 8299.5742  
Epoch 326/500  
11817/11817 [=====] - 0s - loss: 3600.3985 - val\_loss: 7851.7388  
Epoch 327/500

11817/11817 [=====] - 0s - loss: 3657.2953 - val\_loss: 8270.5225  
Epoch 328/500  
11817/11817 [=====] - 0s - loss: 3597.1599 - val\_loss: 8203.0498  
Epoch 329/500  
11817/11817 [=====] - 0s - loss: 3541.8007 - val\_loss: 7926.7441  
Epoch 330/500  
11817/11817 [=====] - 0s - loss: 3572.3690 - val\_loss: 8479.7852  
Epoch 331/500  
11817/11817 [=====] - 0s - loss: 3598.9826 - val\_loss: 8161.2568  
Epoch 332/500  
11817/11817 [=====] - 0s - loss: 3556.4185 - val\_loss: 7992.9331  
Epoch 333/500  
11817/11817 [=====] - 0s - loss: 3550.7760 - val\_loss: 7807.0698  
Epoch 334/500  
11817/11817 [=====] - 0s - loss: 3521.5280 - val\_loss: 8172.9321  
Epoch 335/500  
11817/11817 [=====] - 0s - loss: 3601.0853 - val\_loss: 8274.3877  
Epoch 336/500  
11817/11817 [=====] - 0s - loss: 3491.5903 - val\_loss: 8066.1484  
Epoch 337/500  
11817/11817 [=====] - 0s - loss: 3538.6475 - val\_loss: 7604.3760  
Epoch 338/500  
11817/11817 [=====] - 0s - loss: 3460.6325 - val\_loss: 7832.8457  
Epoch 339/500  
11817/11817 [=====] - 0s - loss: 3485.4622 - val\_loss: 7631.5186  
Epoch 340/500  
11817/11817 [=====] - 0s - loss: 3541.4438 - val\_loss: 7937.5840  
Epoch 341/500  
11817/11817 [=====] - 0s - loss: 3525.9869 - val\_loss: 7919.7539  
Epoch 342/500  
11817/11817 [=====] - 0s - loss: 3464.2995 - val\_loss: 7737.3975  
Epoch 343/500  
11817/11817 [=====] - 0s - loss: 3501.2780 - val\_loss: 7934.5967  
Epoch 344/500  
11817/11817 [=====] - 0s - loss: 3514.7658 - val\_loss: 8499.3057  
Epoch 345/500  
11817/11817 [=====] - 0s - loss: 3447.7161 - val\_loss: 7679.0664  
Epoch 346/500  
11817/11817 [=====] - 0s - loss: 3425.0213 - val\_loss: 7575.0581  
Epoch 347/500  
11817/11817 [=====] - 0s - loss: 3555.6474 - val\_loss: 8123.2925  
Epoch 348/500  
11817/11817 [=====] - 0s - loss: 3544.5892 - val\_loss: 7930.3730  
Epoch 349/500  
11817/11817 [=====] - 0s - loss: 3521.7087 - val\_loss: 7562.4307  
Epoch 350/500  
11817/11817 [=====] - 0s - loss: 3497.5391 - val\_loss: 7735.1279  
Epoch 351/500



11817/11817 [=====] - 0s - loss: 3486.3117 - val\_loss: 7923.3086  
Epoch 352/500  
11817/11817 [=====] - 0s - loss: 3406.1954 - val\_loss: 7630.2417  
Epoch 353/500  
11817/11817 [=====] - 0s - loss: 3454.8157 - val\_loss: 7471.7939  
Epoch 354/500  
11817/11817 [=====] - 0s - loss: 3439.4721 - val\_loss: 7987.1104  
Epoch 355/500  
11817/11817 [=====] - 0s - loss: 3455.3547 - val\_loss: 7257.1572  
Epoch 356/500  
11817/11817 [=====] - 0s - loss: 3460.7944 - val\_loss: 7179.3306  
Epoch 357/500  
11817/11817 [=====] - 0s - loss: 3417.9533 - val\_loss: 7903.6743  
Epoch 358/500  
11817/11817 [=====] - 0s - loss: 3458.8558 - val\_loss: 7951.0303  
Epoch 359/500  
11817/11817 [=====] - 0s - loss: 3370.1015 - val\_loss: 8024.0308  
Epoch 360/500  
11817/11817 [=====] - 0s - loss: 3434.1632 - val\_loss: 7461.2539  
Epoch 361/500  
11817/11817 [=====] - 0s - loss: 3365.4414 - val\_loss: 7493.9795  
Epoch 362/500  
11817/11817 [=====] - 0s - loss: 3423.8793 - val\_loss: 6905.1812  
Epoch 363/500  
11817/11817 [=====] - 0s - loss: 3376.8316 - val\_loss: 7660.1128  
Epoch 364/500  
11817/11817 [=====] - 0s - loss: 3393.0373 - val\_loss: 7683.0645  
Epoch 365/500  
11817/11817 [=====] - 0s - loss: 3379.8495 - val\_loss: 7994.3926  
Epoch 366/500  
11817/11817 [=====] - 0s - loss: 3434.6284 - val\_loss: 7240.6396  
Epoch 367/500  
11817/11817 [=====] - 0s - loss: 3429.3053 - val\_loss: 7770.0303  
Epoch 368/500  
11817/11817 [=====] - 0s - loss: 3434.7332 - val\_loss: 6932.9810  
Epoch 369/500  
11817/11817 [=====] - 0s - loss: 3389.2254 - val\_loss: 6533.4536  
Epoch 370/500  
11817/11817 [=====] - 0s - loss: 3339.2125 - val\_loss: 6582.2808  
Epoch 371/500  
11817/11817 [=====] - 0s - loss: 3349.7211 - val\_loss: 6809.0283  
Epoch 372/500  
11817/11817 [=====] - 0s - loss: 3364.1688 - val\_loss: 7731.5776  
Epoch 373/500  
11817/11817 [=====] - 0s - loss: 3413.0512 - val\_loss: 6909.5581  
Epoch 374/500  
11817/11817 [=====] - 0s - loss: 3327.9053 - val\_loss: 7805.2188  
Epoch 375/500

11817/11817 [=====] - 0s - loss: 3392.1916 - val\_loss: 6669.8994  
Epoch 376/500  
11817/11817 [=====] - 0s - loss: 3400.2513 - val\_loss: 6761.5513  
Epoch 377/500  
11817/11817 [=====] - 0s - loss: 3340.6953 - val\_loss: 6831.4429  
Epoch 378/500  
11817/11817 [=====] - 0s - loss: 3360.1279 - val\_loss: 7043.0747  
Epoch 379/500  
11817/11817 [=====] - 0s - loss: 3325.1780 - val\_loss: 6863.0010  
Epoch 380/500  
11817/11817 [=====] - 0s - loss: 3312.1901 - val\_loss: 6781.7832  
Epoch 381/500  
11817/11817 [=====] - 0s - loss: 3352.2888 - val\_loss: 6649.6704  
Epoch 382/500  
11817/11817 [=====] - 0s - loss: 3332.2244 - val\_loss: 6869.4268  
Epoch 383/500  
11817/11817 [=====] - 0s - loss: 3330.5056 - val\_loss: 7056.0923  
Epoch 384/500  
11817/11817 [=====] - 0s - loss: 3327.9751 - val\_loss: 6909.6680  
Epoch 385/500  
11817/11817 [=====] - 0s - loss: 3313.3829 - val\_loss: 6973.0947  
Epoch 386/500  
11817/11817 [=====] - 0s - loss: 3319.1309 - val\_loss: 6395.0176  
Epoch 387/500  
11817/11817 [=====] - 0s - loss: 3292.5961 - val\_loss: 6602.9883  
Epoch 388/500  
11817/11817 [=====] - 0s - loss: 3351.0533 - val\_loss: 6818.1924  
Epoch 389/500  
11817/11817 [=====] - 0s - loss: 3350.9400 - val\_loss: 6615.5400  
Epoch 390/500  
11817/11817 [=====] - 0s - loss: 3278.4848 - val\_loss: 6502.4209  
Epoch 391/500  
11817/11817 [=====] - 0s - loss: 3354.4943 - val\_loss: 6369.8032  
Epoch 392/500  
11817/11817 [=====] - 0s - loss: 3273.9084 - val\_loss: 6447.4399  
Epoch 393/500  
11817/11817 [=====] - 0s - loss: 3266.4156 - val\_loss: 6652.5547  
Epoch 394/500  
11817/11817 [=====] - 0s - loss: 3334.5330 - val\_loss: 6479.7402  
Epoch 395/500  
11817/11817 [=====] - 0s - loss: 3269.6610 - val\_loss: 6470.2324  
Epoch 396/500  
11817/11817 [=====] - 0s - loss: 3308.1770 - val\_loss: 6236.6431  
Epoch 397/500  
11817/11817 [=====] - 0s - loss: 3293.6247 - val\_loss: 6489.8013  
Epoch 398/500  
11817/11817 [=====] - 0s - loss: 3258.6581 - val\_loss: 6528.5176  
Epoch 399/500

11817/11817 [=====] - 0s - loss: 3264.6161 - val\_loss: 6145.5303  
Epoch 400/500  
11817/11817 [=====] - 0s - loss: 3232.5574 - val\_loss: 6312.8398  
Epoch 401/500  
11817/11817 [=====] - 0s - loss: 3280.9532 - val\_loss: 6174.7646  
Epoch 402/500  
11817/11817 [=====] - 0s - loss: 3184.5090 - val\_loss: 6095.1777  
Epoch 403/500  
11817/11817 [=====] - 0s - loss: 3224.1384 - val\_loss: 6047.5693  
Epoch 404/500  
11817/11817 [=====] - 0s - loss: 3234.6490 - val\_loss: 6418.0107  
Epoch 405/500  
11817/11817 [=====] - 0s - loss: 3218.2120 - val\_loss: 6147.3511  
Epoch 406/500  
11817/11817 [=====] - 0s - loss: 3235.1971 - val\_loss: 6388.5962  
Epoch 407/500  
11817/11817 [=====] - 0s - loss: 3264.6073 - val\_loss: 6265.9775  
Epoch 408/500  
11817/11817 [=====] - 0s - loss: 3268.7295 - val\_loss: 6128.1143  
Epoch 409/500  
11817/11817 [=====] - 0s - loss: 3217.6291 - val\_loss: 6200.0869  
Epoch 410/500  
11817/11817 [=====] - 0s - loss: 3287.8364 - val\_loss: 6319.6768  
Epoch 411/500  
11817/11817 [=====] - 0s - loss: 3257.9149 - val\_loss: 6413.6226  
Epoch 412/500  
11817/11817 [=====] - 0s - loss: 3186.4521 - val\_loss: 5992.8535  
Epoch 413/500  
11817/11817 [=====] - 0s - loss: 3263.3325 - val\_loss: 6112.9336  
Epoch 414/500  
11817/11817 [=====] - 0s - loss: 3202.1681 - val\_loss: 6051.0889  
Epoch 415/500  
11817/11817 [=====] - 0s - loss: 3232.6228 - val\_loss: 6090.1025  
Epoch 416/500  
11817/11817 [=====] - 0s - loss: 3169.6163 - val\_loss: 5820.9077  
Epoch 417/500  
11817/11817 [=====] - 0s - loss: 3192.0158 - val\_loss: 5852.3779  
Epoch 418/500  
11817/11817 [=====] - 0s - loss: 3213.1692 - val\_loss: 6118.2607  
Epoch 419/500  
11817/11817 [=====] - 0s - loss: 3165.6510 - val\_loss: 5977.7798  
Epoch 420/500  
11817/11817 [=====] - 0s - loss: 3184.1625 - val\_loss: 5903.8423  
Epoch 421/500  
11817/11817 [=====] - 0s - loss: 3232.8413 - val\_loss: 6320.7803  
Epoch 422/500  
11817/11817 [=====] - 0s - loss: 3155.8478 - val\_loss: 5935.5908  
Epoch 423/500

11817/11817 [=====] - 0s - loss: 3219.8265 - val\_loss: 5890.7529  
Epoch 424/500  
11817/11817 [=====] - 0s - loss: 3191.7743 - val\_loss: 5917.6987  
Epoch 425/500  
11817/11817 [=====] - 0s - loss: 3168.1559 - val\_loss: 5846.2388  
Epoch 426/500  
11817/11817 [=====] - 0s - loss: 3263.2505 - val\_loss: 6140.6953  
Epoch 427/500  
11817/11817 [=====] - 0s - loss: 3265.2512 - val\_loss: 6286.3018  
Epoch 428/500  
11817/11817 [=====] - 0s - loss: 3152.6264 - val\_loss: 6065.7583  
Epoch 429/500  
11817/11817 [=====] - 0s - loss: 3222.2533 - val\_loss: 5784.3291  
Epoch 430/500  
11817/11817 [=====] - 0s - loss: 3187.0096 - val\_loss: 6058.2935  
Epoch 431/500  
11817/11817 [=====] - 0s - loss: 3137.6095 - val\_loss: 5974.7461  
Epoch 432/500  
11817/11817 [=====] - 0s - loss: 3191.2224 - val\_loss: 5829.4053  
Epoch 433/500  
11817/11817 [=====] - 0s - loss: 3116.0272 - val\_loss: 5893.5356  
Epoch 434/500  
11817/11817 [=====] - 0s - loss: 3175.9213 - val\_loss: 5971.7788  
Epoch 435/500  
11817/11817 [=====] - 0s - loss: 3238.5809 - val\_loss: 6109.4478  
Epoch 436/500  
11817/11817 [=====] - 0s - loss: 3181.5231 - val\_loss: 5896.7803  
Epoch 437/500  
11817/11817 [=====] - 0s - loss: 3131.6122 - val\_loss: 5890.1509  
Epoch 438/500  
11817/11817 [=====] - 0s - loss: 3195.0907 - val\_loss: 5884.4863  
Epoch 439/500  
11817/11817 [=====] - 0s - loss: 3190.7522 - val\_loss: 5814.5679  
Epoch 440/500  
11817/11817 [=====] - 0s - loss: 3073.7698 - val\_loss: 5768.1499  
Epoch 441/500  
11817/11817 [=====] - 0s - loss: 3120.5592 - val\_loss: 5661.8765  
Epoch 442/500  
11817/11817 [=====] - 0s - loss: 3147.9223 - val\_loss: 5563.1533  
Epoch 443/500  
11817/11817 [=====] - 0s - loss: 3123.7142 - val\_loss: 5656.1157  
Epoch 444/500  
11817/11817 [=====] - 0s - loss: 3158.6142 - val\_loss: 5820.7803  
Epoch 445/500  
11817/11817 [=====] - 0s - loss: 3084.6660 - val\_loss: 5659.9800  
Epoch 446/500  
11817/11817 [=====] - 0s - loss: 3096.9553 - val\_loss: 5583.2803  
Epoch 447/500

11817/11817 [=====] - 0s - loss: 3058.0824 - val\_loss: 5717.7354  
Epoch 448/500  
11817/11817 [=====] - 0s - loss: 3086.2511 - val\_loss: 6034.4785  
Epoch 449/500  
11817/11817 [=====] - 0s - loss: 3106.5733 - val\_loss: 6044.1753  
Epoch 450/500  
11817/11817 [=====] - 0s - loss: 3087.0504 - val\_loss: 5603.3267  
Epoch 451/500  
11817/11817 [=====] - 0s - loss: 3019.3591 - val\_loss: 5486.4087  
Epoch 452/500  
11817/11817 [=====] - 0s - loss: 3154.7621 - val\_loss: 5688.9883  
Epoch 453/500  
11817/11817 [=====] - 0s - loss: 3089.3897 - val\_loss: 5718.2778  
Epoch 454/500  
11817/11817 [=====] - 0s - loss: 3101.2445 - val\_loss: 5857.8535  
Epoch 455/500  
11817/11817 [=====] - 0s - loss: 3115.5826 - val\_loss: 6074.2915  
Epoch 456/500  
11817/11817 [=====] - 0s - loss: 3110.9832 - val\_loss: 5936.0737  
Epoch 457/500  
11817/11817 [=====] - 0s - loss: 3087.6079 - val\_loss: 6051.4341  
Epoch 458/500  
11817/11817 [=====] - 0s - loss: 3155.0084 - val\_loss: 6023.3789  
Epoch 459/500  
11817/11817 [=====] - 0s - loss: 3099.1266 - val\_loss: 5783.9644  
Epoch 460/500  
11817/11817 [=====] - 0s - loss: 3156.4415 - val\_loss: 5708.2637  
Epoch 461/500  
11817/11817 [=====] - 0s - loss: 3070.9027 - val\_loss: 5901.7192  
Epoch 462/500  
11817/11817 [=====] - 0s - loss: 3101.2084 - val\_loss: 6016.0190  
Epoch 463/500  
11817/11817 [=====] - 0s - loss: 3085.2791 - val\_loss: 5846.5923  
Epoch 464/500  
11817/11817 [=====] - 0s - loss: 3084.5575 - val\_loss: 5623.9429  
Epoch 465/500  
11817/11817 [=====] - 0s - loss: 3149.3837 - val\_loss: 5702.8618  
Epoch 466/500  
11817/11817 [=====] - 0s - loss: 3132.1237 - val\_loss: 5797.4277  
Epoch 467/500  
11817/11817 [=====] - 0s - loss: 3059.7101 - val\_loss: 5778.0151  
Epoch 468/500  
11817/11817 [=====] - 0s - loss: 3015.3337 - val\_loss: 5572.5698  
Epoch 469/500  
11817/11817 [=====] - 0s - loss: 3016.9733 - val\_loss: 5401.4248  
Epoch 470/500  
11817/11817 [=====] - 0s - loss: 3080.8679 - val\_loss: 5607.5889  
Epoch 471/500

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11817/11817 [=====] - 0s - loss: 3059.1499 - val_loss: 5594.0532
Epoch 472/500
11817/11817 [=====] - 0s - loss: 3080.5825 - val_loss: 5826.0449
Epoch 473/500
11817/11817 [=====] - 0s - loss: 3096.7604 - val_loss: 5712.4775
Epoch 474/500
11817/11817 [=====] - 0s - loss: 3067.2295 - val_loss: 5579.3125
Epoch 475/500
11817/11817 [=====] - 0s - loss: 3018.0206 - val_loss: 5487.7183
Epoch 476/500
11817/11817 [=====] - 0s - loss: 3053.7252 - val_loss: 5418.3364
Epoch 477/500
11817/11817 [=====] - 0s - loss: 3088.8329 - val_loss: 5426.4912
Epoch 478/500
11817/11817 [=====] - 0s - loss: 3007.8489 - val_loss: 5527.1621
Epoch 479/500
11817/11817 [=====] - 0s - loss: 2927.7908 - val_loss: 5421.9888
Epoch 480/500
11817/11817 [=====] - 0s - loss: 3045.0185 - val_loss: 5250.8188
Epoch 481/500
11817/11817 [=====] - 0s - loss: 2959.4774 - val_loss: 5414.7583
Epoch 482/500
11817/11817 [=====] - 0s - loss: 2997.4907 - val_loss: 5532.6362
Epoch 483/500
11817/11817 [=====] - 0s - loss: 3078.1079 - val_loss: 5255.9517
Epoch 484/500
11817/11817 [=====] - 0s - loss: 3027.2163 - val_loss: 5361.9761
Epoch 485/500
11817/11817 [=====] - 0s - loss: 2973.4117 - val_loss: 5780.0806
Epoch 486/500
11817/11817 [=====] - 0s - loss: 3041.0447 - val_loss: 5743.6592
Epoch 487/500
11817/11817 [=====] - 0s - loss: 2986.1837 - val_loss: 5303.5366
Epoch 488/500
11817/11817 [=====] - 0s - loss: 3034.2672 - val_loss: 5476.2349
Epoch 489/500
11817/11817 [=====] - 0s - loss: 2969.7001 - val_loss: 5565.9468
Epoch 490/500
11817/11817 [=====] - 0s - loss: 2977.1380 - val_loss: 5752.1294
Epoch 491/500
11817/11817 [=====] - 0s - loss: 2989.7870 - val_loss: 5639.3984
Epoch 492/500
11817/11817 [=====] - 0s - loss: 3056.8624 - val_loss: 5412.1753
Epoch 493/500
11817/11817 [=====] - 0s - loss: 3026.6557 - val_loss: 5422.9224
Epoch 494/500
11817/11817 [=====] - 0s - loss: 3034.7125 - val_loss: 5544.8164
Epoch 495/500

```

```

11817/11817 [=====] - 0s - loss: 2903.9966 - val_loss: 5588.0981
Epoch 496/500
11817/11817 [=====] - 0s - loss: 2923.6760 - val_loss: 6006.0229
Epoch 497/500
11817/11817 [=====] - 0s - loss: 2966.2106 - val_loss: 5889.5718
Epoch 498/500
11817/11817 [=====] - 0s - loss: 3054.1902 - val_loss: 5578.1973
Epoch 499/500
11817/11817 [=====] - 0s - loss: 2934.4341 - val_loss: 5589.7515
Epoch 500/500
11817/11817 [=====] - 0s - loss: 3042.4512 - val_loss: 5497.9004

```

```

In [27]: past_preds = model.predict(train_features)[: , 0]
         future_preds = model.predict(test_features)[: , 0]

         from sklearn.metrics import r2_score
         import numpy as np

         # our benchmark is just guessing the average
         benchmark = np.mean(train_targets)
         print('benchmark r^2 on training:', r2_score(train_targets, [benchmark] * train_targets.shape[0]))

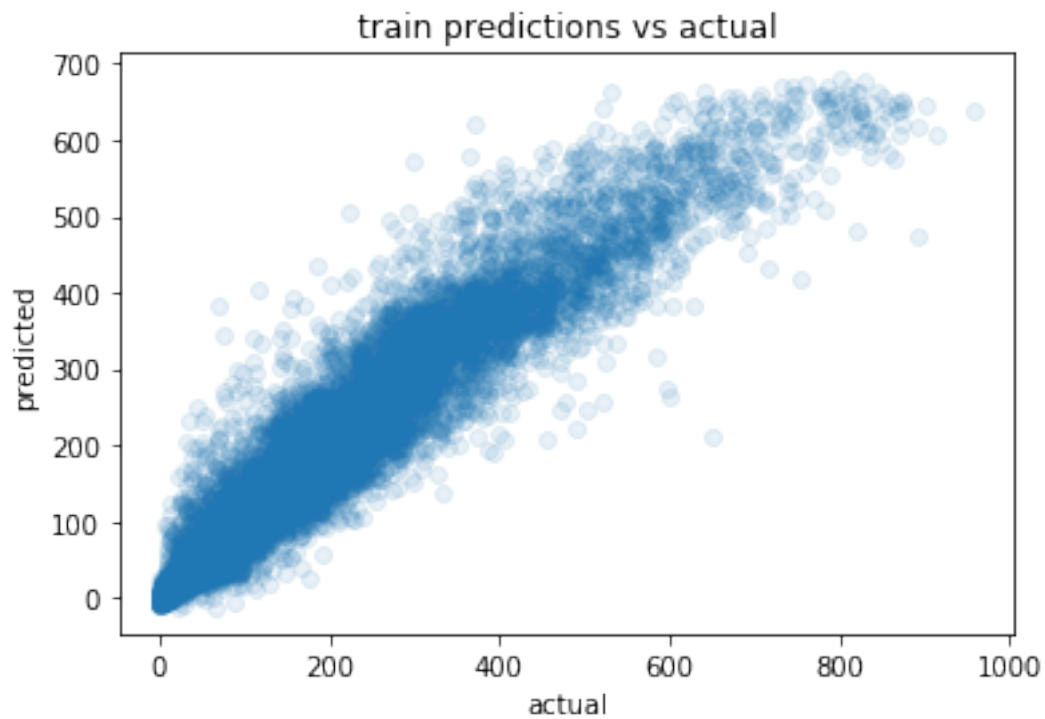
         print('training r^2:', r2_score(train_targets, past_preds))
         plt.scatter(train_targets, past_preds, alpha=0.1)
         plt.xlabel('actual')
         plt.ylabel('predicted')
         plt.title('train predictions vs actual')
         plt.show()

         print('benchmark r^2 on test:', r2_score(test_targets, [benchmark] * test_targets.shape[0]))

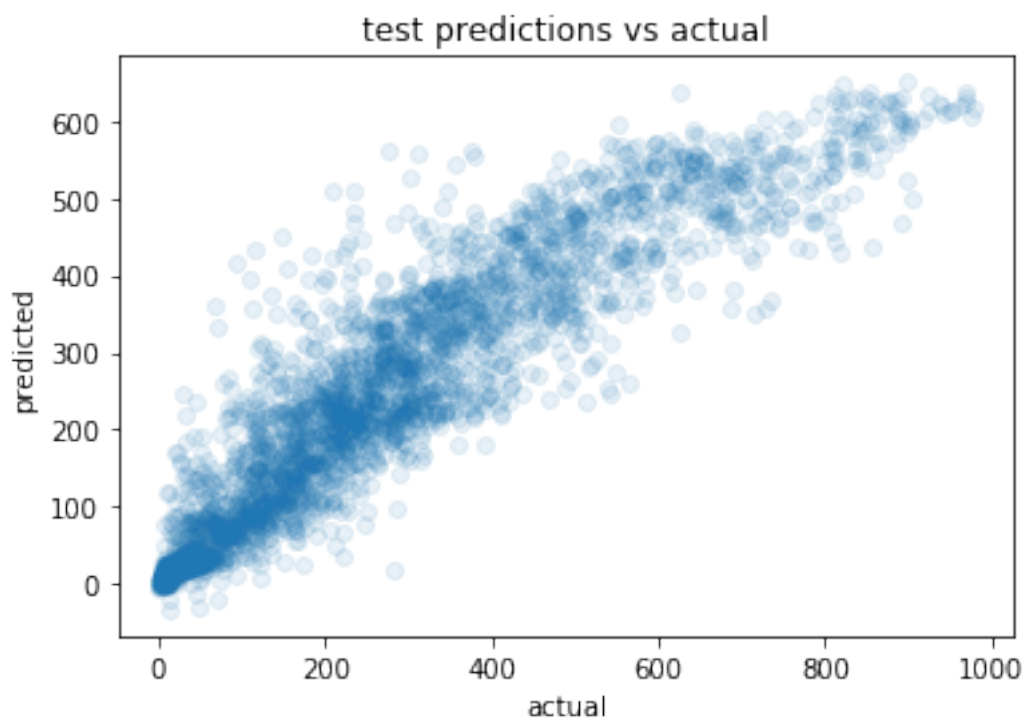
         print('r^2 on test:', r2_score(test_targets, future_preds))
         plt.scatter(test_targets, future_preds, alpha=0.1)
         plt.xlabel('actual')
         plt.ylabel('predicted')
         plt.title('test predictions vs actual')
         plt.show()

benchmark r^2 on training: 0.0
training r^2: 0.90947835224

```



benchmark  $r^2$  on test: -0.112995264662  
 $r^2$  on test: 0.82747418683





## 6 Looking better but a bit of overfitting perhaps. Adding one more layer in between the 500 and output

In [28]: *# creates the model*

```
# restart keras session (clear weights), sometimes this will clear up errors
K.clear_session()

# functional API
inputs = Input(shape=(features.shape[1], ))
x1 = Dense(1000, activation='elu')(inputs)
x2 = BatchNormalization()(x1)
x3 = Dropout(0.5)(x2)
x4 = Dense(500, activation='elu')(x3)
x5 = BatchNormalization()(x4)
x6 = Dropout(0.5)(x5)
x7 = Dense(100, activation='elu')(x6)
x8 = BatchNormalization()(x7)
x9 = Dropout(0.5)(x8)
predictions = Dense(1, activation='linear')(x9)

# this saves the best model (lowest validation loss)
checkpoint = ModelCheckpoint('3_layer_dense.h5', monitor='val_loss', save_best_only=True)
# this stops training if the validation loss is not improving for 50 epochs in a row
es = EarlyStopping(patience=50)
cb = [checkpoint, es]

# this compiles our model so it is ready to fit
model = Model(inputs, predictions)
model.compile(optimizer='adam', loss='mse')

subset_size = trainsize
train_feature_subset = train_features[:subset_size]
train_target_subset = train_targets[:subset_size]
# we actually fit the model here
history = model.fit(train_feature_subset,
                    train_target_subset,
                    epochs=500,
                    validation_split=0.15,
                    callbacks=cb,
                    batch_size=3000)
```

Train on 11817 samples, validate on 2086 samples  
Epoch 1/500

```

11817/11817 [=====] - 0s - loss: 46293.1818 - val_loss: 110711.0703
Epoch 2/500
11817/11817 [=====] - 0s - loss: 45548.6000 - val_loss: 106289.9609
Epoch 3/500
11817/11817 [=====] - 0s - loss: 45292.6840 - val_loss: 107417.6719
Epoch 4/500
11817/11817 [=====] - 0s - loss: 45085.7948 - val_loss: 110944.0156
Epoch 5/500
11817/11817 [=====] - 0s - loss: 44870.0878 - val_loss: 114439.9609
Epoch 6/500
11817/11817 [=====] - 0s - loss: 44663.1310 - val_loss: 116194.6094
Epoch 7/500
11817/11817 [=====] - 0s - loss: 44443.6268 - val_loss: 114817.9609
Epoch 8/500
11817/11817 [=====] - 0s - loss: 44252.9131 - val_loss: 111969.9453
Epoch 9/500
11817/11817 [=====] - 0s - loss: 44066.5702 - val_loss: 109055.6875
Epoch 10/500
11817/11817 [=====] - 0s - loss: 43906.6594 - val_loss: 106054.8438
Epoch 11/500
11817/11817 [=====] - 0s - loss: 43750.6009 - val_loss: 104198.3438
Epoch 12/500
11817/11817 [=====] - 0s - loss: 43567.4115 - val_loss: 102795.1172
Epoch 13/500
11817/11817 [=====] - 0s - loss: 43424.1176 - val_loss: 101443.7812
Epoch 14/500
11817/11817 [=====] - 0s - loss: 43270.8661 - val_loss: 100313.3359
Epoch 15/500
11817/11817 [=====] - 0s - loss: 43086.4122 - val_loss: 99226.0000
Epoch 16/500
11817/11817 [=====] - 0s - loss: 42924.4791 - val_loss: 99487.7109
Epoch 17/500
11817/11817 [=====] - 0s - loss: 42748.7536 - val_loss: 98246.9531
Epoch 18/500
11817/11817 [=====] - 0s - loss: 42594.1471 - val_loss: 97557.6172
Epoch 19/500
11817/11817 [=====] - 0s - loss: 42408.4739 - val_loss: 97362.0078
Epoch 20/500
11817/11817 [=====] - 0s - loss: 42243.9910 - val_loss: 96725.2812
Epoch 21/500
11817/11817 [=====] - 0s - loss: 42093.6361 - val_loss: 96373.0078
Epoch 22/500
11817/11817 [=====] - 0s - loss: 41897.3537 - val_loss: 95974.6406
Epoch 23/500
11817/11817 [=====] - 0s - loss: 41719.2051 - val_loss: 95693.2188
Epoch 24/500
11817/11817 [=====] - 0s - loss: 41531.4369 - val_loss: 95189.2734
Epoch 25/500

```

```

11817/11817 [=====] - 0s - loss: 41376.8914 - val_loss: 94710.6562
Epoch 26/500
11817/11817 [=====] - 0s - loss: 41169.6957 - val_loss: 94543.3984
Epoch 27/500
11817/11817 [=====] - 0s - loss: 40990.8494 - val_loss: 94045.5547
Epoch 28/500
11817/11817 [=====] - 0s - loss: 40806.8906 - val_loss: 93504.3828
Epoch 29/500
11817/11817 [=====] - 0s - loss: 40588.3754 - val_loss: 93244.8906
Epoch 30/500
11817/11817 [=====] - 0s - loss: 40369.9738 - val_loss: 92354.8906
Epoch 31/500
11817/11817 [=====] - 0s - loss: 40131.2932 - val_loss: 92163.8828
Epoch 32/500
11817/11817 [=====] - 0s - loss: 39944.0953 - val_loss: 91675.9609
Epoch 33/500
11817/11817 [=====] - 0s - loss: 39702.8025 - val_loss: 91395.7891
Epoch 34/500
11817/11817 [=====] - 0s - loss: 39507.9213 - val_loss: 91145.3359
Epoch 35/500
11817/11817 [=====] - 0s - loss: 39297.8842 - val_loss: 91125.1719
Epoch 36/500
11817/11817 [=====] - 0s - loss: 39055.0333 - val_loss: 90728.0469
Epoch 37/500
11817/11817 [=====] - 0s - loss: 38826.8918 - val_loss: 90966.5469
Epoch 38/500
11817/11817 [=====] - 0s - loss: 38660.5221 - val_loss: 91025.7969
Epoch 39/500
11817/11817 [=====] - 0s - loss: 38409.7384 - val_loss: 91023.2109
Epoch 40/500
11817/11817 [=====] - 0s - loss: 38204.8283 - val_loss: 91005.2109
Epoch 41/500
11817/11817 [=====] - 0s - loss: 37913.0995 - val_loss: 91268.8203
Epoch 42/500
11817/11817 [=====] - 0s - loss: 37762.4110 - val_loss: 91089.0000
Epoch 43/500
11817/11817 [=====] - 0s - loss: 37528.4478 - val_loss: 91156.0781
Epoch 44/500
11817/11817 [=====] - 0s - loss: 37270.9914 - val_loss: 90825.5312
Epoch 45/500
11817/11817 [=====] - 0s - loss: 37094.1659 - val_loss: 91278.0391
Epoch 46/500
11817/11817 [=====] - 0s - loss: 36869.9799 - val_loss: 91829.9922
Epoch 47/500
11817/11817 [=====] - 0s - loss: 36620.3718 - val_loss: 91071.5391
Epoch 48/500
11817/11817 [=====] - 0s - loss: 36404.8709 - val_loss: 91898.4609
Epoch 49/500

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11817/11817 [=====] - 0s - loss: 36120.7514 - val\_loss: 91191.9531  
Epoch 50/500  
11817/11817 [=====] - 0s - loss: 35906.3228 - val\_loss: 91219.5547  
Epoch 51/500  
11817/11817 [=====] - 0s - loss: 35673.2293 - val\_loss: 92109.8672  
Epoch 52/500  
11817/11817 [=====] - 0s - loss: 35426.3938 - val\_loss: 91633.9844  
Epoch 53/500  
11817/11817 [=====] - 0s - loss: 35228.3471 - val\_loss: 92296.6953  
Epoch 54/500  
11817/11817 [=====] - 0s - loss: 34996.6360 - val\_loss: 92548.5234  
Epoch 55/500  
11817/11817 [=====] - 0s - loss: 34706.4399 - val\_loss: 92209.4609  
Epoch 56/500  
11817/11817 [=====] - 0s - loss: 34521.6635 - val\_loss: 92951.0156  
Epoch 57/500  
11817/11817 [=====] - 0s - loss: 34233.6438 - val\_loss: 92362.6484  
Epoch 58/500  
11817/11817 [=====] - 0s - loss: 34011.4014 - val\_loss: 92459.1953  
Epoch 59/500  
11817/11817 [=====] - 0s - loss: 33809.6724 - val\_loss: 92404.0859  
Epoch 60/500  
11817/11817 [=====] - 0s - loss: 33533.4835 - val\_loss: 92784.7422  
Epoch 61/500  
11817/11817 [=====] - 0s - loss: 33288.8615 - val\_loss: 93942.8281  
Epoch 62/500  
11817/11817 [=====] - 0s - loss: 33012.4038 - val\_loss: 93233.4219  
Epoch 63/500  
11817/11817 [=====] - 0s - loss: 32740.0556 - val\_loss: 93089.2734  
Epoch 64/500  
11817/11817 [=====] - 0s - loss: 32558.7443 - val\_loss: 92611.1328  
Epoch 65/500  
11817/11817 [=====] - 0s - loss: 32307.1109 - val\_loss: 92942.5859  
Epoch 66/500  
11817/11817 [=====] - 0s - loss: 31977.0495 - val\_loss: 92212.0156  
Epoch 67/500  
11817/11817 [=====] - 0s - loss: 31778.1966 - val\_loss: 93713.0547  
Epoch 68/500  
11817/11817 [=====] - 0s - loss: 31504.2554 - val\_loss: 93001.6484  
Epoch 69/500  
11817/11817 [=====] - 0s - loss: 31229.4821 - val\_loss: 92168.8438  
Epoch 70/500  
11817/11817 [=====] - 0s - loss: 31055.9683 - val\_loss: 92462.7891  
Epoch 71/500  
11817/11817 [=====] - 0s - loss: 30674.9733 - val\_loss: 91145.1406  
Epoch 72/500  
11817/11817 [=====] - 0s - loss: 30577.0761 - val\_loss: 91234.0703  
Epoch 73/500

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11817/11817 [=====] - 0s - loss: 30265.8138 - val_loss: 90268.8047
Epoch 74/500
11817/11817 [=====] - 0s - loss: 30104.6899 - val_loss: 93492.9766
Epoch 75/500
11817/11817 [=====] - 0s - loss: 29759.2300 - val_loss: 89307.2969
Epoch 76/500
11817/11817 [=====] - 0s - loss: 29520.5034 - val_loss: 91872.7266
Epoch 77/500
11817/11817 [=====] - 0s - loss: 29300.2318 - val_loss: 90543.0703
Epoch 78/500
11817/11817 [=====] - 0s - loss: 29002.1613 - val_loss: 90658.8516
Epoch 79/500
11817/11817 [=====] - 0s - loss: 28777.4414 - val_loss: 91016.8359
Epoch 80/500
11817/11817 [=====] - 0s - loss: 28551.7051 - val_loss: 89103.7891
Epoch 81/500
11817/11817 [=====] - 0s - loss: 28303.3238 - val_loss: 88963.7266
Epoch 82/500
11817/11817 [=====] - 0s - loss: 28012.3285 - val_loss: 88444.0234
Epoch 83/500
11817/11817 [=====] - 0s - loss: 27711.0591 - val_loss: 89245.1016
Epoch 84/500
11817/11817 [=====] - 0s - loss: 27550.8836 - val_loss: 86249.2344
Epoch 85/500
11817/11817 [=====] - 0s - loss: 27271.4759 - val_loss: 87109.1953
Epoch 86/500
11817/11817 [=====] - 0s - loss: 26978.2806 - val_loss: 85897.0625
Epoch 87/500
11817/11817 [=====] - 0s - loss: 26928.6387 - val_loss: 85465.4062
Epoch 88/500
11817/11817 [=====] - 0s - loss: 26602.0783 - val_loss: 83926.4453
Epoch 89/500
11817/11817 [=====] - 0s - loss: 26366.9270 - val_loss: 83904.9375
Epoch 90/500
11817/11817 [=====] - 0s - loss: 26055.2035 - val_loss: 82742.3359
Epoch 91/500
11817/11817 [=====] - 0s - loss: 25861.9437 - val_loss: 83568.1953
Epoch 92/500
11817/11817 [=====] - 0s - loss: 25566.4072 - val_loss: 81822.3359
Epoch 93/500
11817/11817 [=====] - 0s - loss: 25408.6885 - val_loss: 81087.5703
Epoch 94/500
11817/11817 [=====] - 0s - loss: 25065.4030 - val_loss: 81239.2500
Epoch 95/500
11817/11817 [=====] - 0s - loss: 24799.2846 - val_loss: 80362.3203
Epoch 96/500
11817/11817 [=====] - 0s - loss: 24600.8235 - val_loss: 79279.3203
Epoch 97/500

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11817/11817 [=====] - 0s - loss: 24297.5542 - val\_loss: 76956.8047  
Epoch 98/500  
11817/11817 [=====] - 0s - loss: 24125.2290 - val\_loss: 79952.1406  
Epoch 99/500  
11817/11817 [=====] - 0s - loss: 24004.5618 - val\_loss: 76209.8281  
Epoch 100/500  
11817/11817 [=====] - 0s - loss: 23624.2254 - val\_loss: 77624.6875  
Epoch 101/500  
11817/11817 [=====] - 0s - loss: 23409.1505 - val\_loss: 76516.5469  
Epoch 102/500  
11817/11817 [=====] - 0s - loss: 23104.4105 - val\_loss: 74520.1953  
Epoch 103/500  
11817/11817 [=====] - 0s - loss: 23052.4470 - val\_loss: 74145.2578  
Epoch 104/500  
11817/11817 [=====] - 0s - loss: 22721.9206 - val\_loss: 72156.1250  
Epoch 105/500  
11817/11817 [=====] - 0s - loss: 22458.8899 - val\_loss: 71902.0391  
Epoch 106/500  
11817/11817 [=====] - 0s - loss: 22261.6062 - val\_loss: 70964.2891  
Epoch 107/500  
11817/11817 [=====] - 0s - loss: 22104.3048 - val\_loss: 71064.1641  
Epoch 108/500  
11817/11817 [=====] - 0s - loss: 21758.5889 - val\_loss: 69995.5625  
Epoch 109/500  
11817/11817 [=====] - 0s - loss: 21544.2596 - val\_loss: 69354.2734  
Epoch 110/500  
11817/11817 [=====] - 0s - loss: 21274.9370 - val\_loss: 70328.4453  
Epoch 111/500  
11817/11817 [=====] - 0s - loss: 21103.6287 - val\_loss: 66151.9609  
Epoch 112/500  
11817/11817 [=====] - 0s - loss: 20993.8691 - val\_loss: 69651.6094  
Epoch 113/500  
11817/11817 [=====] - 0s - loss: 20679.8327 - val\_loss: 67532.3516  
Epoch 114/500  
11817/11817 [=====] - 0s - loss: 20487.6343 - val\_loss: 64538.4766  
Epoch 115/500  
11817/11817 [=====] - 0s - loss: 20219.3063 - val\_loss: 65609.6406  
Epoch 116/500  
11817/11817 [=====] - 0s - loss: 19929.0661 - val\_loss: 64824.4453  
Epoch 117/500  
11817/11817 [=====] - 0s - loss: 19866.2872 - val\_loss: 63837.6484  
Epoch 118/500  
11817/11817 [=====] - 0s - loss: 19463.1842 - val\_loss: 63119.0625  
Epoch 119/500  
11817/11817 [=====] - 0s - loss: 19390.9389 - val\_loss: 63262.6562  
Epoch 120/500  
11817/11817 [=====] - 0s - loss: 19018.2307 - val\_loss: 61541.6445  
Epoch 121/500

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11817/11817 [=====] - 0s - loss: 18952.6500 - val_loss: 61217.7812
Epoch 122/500
11817/11817 [=====] - 0s - loss: 18678.8498 - val_loss: 60929.6875
Epoch 123/500
11817/11817 [=====] - 0s - loss: 18332.5304 - val_loss: 59544.9844
Epoch 124/500
11817/11817 [=====] - 0s - loss: 18294.7487 - val_loss: 59720.6055
Epoch 125/500
11817/11817 [=====] - 0s - loss: 18128.5607 - val_loss: 59095.7852
Epoch 126/500
11817/11817 [=====] - 0s - loss: 17743.0790 - val_loss: 58541.9297
Epoch 127/500
11817/11817 [=====] - 0s - loss: 17727.3726 - val_loss: 57904.4141
Epoch 128/500
11817/11817 [=====] - 0s - loss: 17386.7837 - val_loss: 56636.5039
Epoch 129/500
11817/11817 [=====] - 0s - loss: 17231.9798 - val_loss: 56162.4453
Epoch 130/500
11817/11817 [=====] - 0s - loss: 17019.1582 - val_loss: 55678.3789
Epoch 131/500
11817/11817 [=====] - 0s - loss: 16852.3389 - val_loss: 55989.6367
Epoch 132/500
11817/11817 [=====] - 0s - loss: 16567.2259 - val_loss: 54297.8477
Epoch 133/500
11817/11817 [=====] - 0s - loss: 16462.9766 - val_loss: 53796.3125
Epoch 134/500
11817/11817 [=====] - 0s - loss: 16315.1635 - val_loss: 53202.8359
Epoch 135/500
11817/11817 [=====] - 0s - loss: 16014.4299 - val_loss: 49657.4766
Epoch 136/500
11817/11817 [=====] - 0s - loss: 15949.7187 - val_loss: 49458.1289
Epoch 137/500
11817/11817 [=====] - 0s - loss: 15783.8876 - val_loss: 51503.6055
Epoch 138/500
11817/11817 [=====] - 0s - loss: 15616.0041 - val_loss: 49298.4102
Epoch 139/500
11817/11817 [=====] - 0s - loss: 15385.8771 - val_loss: 51097.7695
Epoch 140/500
11817/11817 [=====] - 0s - loss: 15198.0507 - val_loss: 48620.9102
Epoch 141/500
11817/11817 [=====] - 0s - loss: 15055.6063 - val_loss: 47495.9961
Epoch 142/500
11817/11817 [=====] - 0s - loss: 14706.9447 - val_loss: 47604.3242
Epoch 143/500
11817/11817 [=====] - 0s - loss: 14568.6566 - val_loss: 47887.5664
Epoch 144/500
11817/11817 [=====] - 0s - loss: 14516.8562 - val_loss: 46883.7031
Epoch 145/500

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11817/11817 [=====] - 0s - loss: 14402.6189 - val_loss: 45306.8438
Epoch 146/500
11817/11817 [=====] - 0s - loss: 14177.2686 - val_loss: 45752.3828
Epoch 147/500
11817/11817 [=====] - 0s - loss: 13946.9641 - val_loss: 44663.4844
Epoch 148/500
11817/11817 [=====] - 0s - loss: 13749.1462 - val_loss: 43357.1523
Epoch 149/500
11817/11817 [=====] - 0s - loss: 13635.4903 - val_loss: 43599.6797
Epoch 150/500
11817/11817 [=====] - 0s - loss: 13483.4010 - val_loss: 42867.7500
Epoch 151/500
11817/11817 [=====] - 0s - loss: 13282.8528 - val_loss: 42202.2773
Epoch 152/500
11817/11817 [=====] - 0s - loss: 13073.2439 - val_loss: 42315.0039
Epoch 153/500
11817/11817 [=====] - 0s - loss: 12984.0956 - val_loss: 40095.6133
Epoch 154/500
11817/11817 [=====] - 0s - loss: 12979.1945 - val_loss: 38814.6953
Epoch 155/500
11817/11817 [=====] - 0s - loss: 12833.8885 - val_loss: 37859.0000
Epoch 156/500
11817/11817 [=====] - 0s - loss: 12530.9344 - val_loss: 39055.6875
Epoch 157/500
11817/11817 [=====] - 0s - loss: 12356.3737 - val_loss: 37560.2188
Epoch 158/500
11817/11817 [=====] - 0s - loss: 12196.5311 - val_loss: 35429.7070
Epoch 159/500
11817/11817 [=====] - 0s - loss: 12063.7628 - val_loss: 37947.5820
Epoch 160/500
11817/11817 [=====] - 0s - loss: 12035.1454 - val_loss: 35253.3398
Epoch 161/500
11817/11817 [=====] - 0s - loss: 11898.6045 - val_loss: 36535.3047
Epoch 162/500
11817/11817 [=====] - 0s - loss: 11662.4078 - val_loss: 35564.8398
Epoch 163/500
11817/11817 [=====] - 0s - loss: 11712.5260 - val_loss: 33781.2617
Epoch 164/500
11817/11817 [=====] - 0s - loss: 11543.3885 - val_loss: 33297.0000
Epoch 165/500
11817/11817 [=====] - 0s - loss: 11332.6401 - val_loss: 30365.8379
Epoch 166/500
11817/11817 [=====] - 0s - loss: 11042.9118 - val_loss: 32142.8613
Epoch 167/500
11817/11817 [=====] - 0s - loss: 10950.5536 - val_loss: 30810.7617
Epoch 168/500
11817/11817 [=====] - 0s - loss: 10942.6216 - val_loss: 32741.1465
Epoch 169/500

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11817/11817 [=====] - 0s - loss: 10659.7885 - val\_loss: 31080.0195  
Epoch 170/500  
11817/11817 [=====] - 0s - loss: 10670.5936 - val\_loss: 31450.3262  
Epoch 171/500  
11817/11817 [=====] - 0s - loss: 10452.8445 - val\_loss: 28757.7715  
Epoch 172/500  
11817/11817 [=====] - 0s - loss: 10330.1050 - val\_loss: 29260.8281  
Epoch 173/500  
11817/11817 [=====] - 0s - loss: 10272.8365 - val\_loss: 27526.8027  
Epoch 174/500  
11817/11817 [=====] - 0s - loss: 10165.6400 - val\_loss: 29891.6875  
Epoch 175/500  
11817/11817 [=====] - 0s - loss: 10045.9918 - val\_loss: 26066.5430  
Epoch 176/500  
11817/11817 [=====] - 0s - loss: 9925.9518 - val\_loss: 27025.5684  
Epoch 177/500  
11817/11817 [=====] - 0s - loss: 9841.3233 - val\_loss: 27937.9961  
Epoch 178/500  
11817/11817 [=====] - 0s - loss: 9534.9026 - val\_loss: 26477.8496  
Epoch 179/500  
11817/11817 [=====] - 0s - loss: 9515.9999 - val\_loss: 26987.7617  
Epoch 180/500  
11817/11817 [=====] - 0s - loss: 9529.6734 - val\_loss: 25157.6504  
Epoch 181/500  
11817/11817 [=====] - 0s - loss: 9383.9661 - val\_loss: 25155.7773  
Epoch 182/500  
11817/11817 [=====] - 0s - loss: 9126.3103 - val\_loss: 24567.1289  
Epoch 183/500  
11817/11817 [=====] - 0s - loss: 8947.4387 - val\_loss: 24507.2988  
Epoch 184/500  
11817/11817 [=====] - 0s - loss: 9014.4891 - val\_loss: 23887.2480  
Epoch 185/500  
11817/11817 [=====] - 0s - loss: 8876.8555 - val\_loss: 23498.6992  
Epoch 186/500  
11817/11817 [=====] - 0s - loss: 8751.2950 - val\_loss: 23171.7500  
Epoch 187/500  
11817/11817 [=====] - 0s - loss: 8800.4137 - val\_loss: 22241.6211  
Epoch 188/500  
11817/11817 [=====] - 0s - loss: 8558.9803 - val\_loss: 21344.0098  
Epoch 189/500  
11817/11817 [=====] - 0s - loss: 8462.9510 - val\_loss: 22110.8438  
Epoch 190/500  
11817/11817 [=====] - 0s - loss: 8461.5926 - val\_loss: 21805.6523  
Epoch 191/500  
11817/11817 [=====] - 0s - loss: 8303.7533 - val\_loss: 20238.7129  
Epoch 192/500  
11817/11817 [=====] - 0s - loss: 8342.7750 - val\_loss: 20739.4258  
Epoch 193/500

11817/11817 [=====] - 0s - loss: 8307.6985 - val\_loss: 19420.7070  
Epoch 194/500  
11817/11817 [=====] - 0s - loss: 8099.0158 - val\_loss: 20626.7520  
Epoch 195/500  
11817/11817 [=====] - 0s - loss: 7965.1327 - val\_loss: 17766.0469  
Epoch 196/500  
11817/11817 [=====] - 0s - loss: 7878.3604 - val\_loss: 18504.4727  
Epoch 197/500  
11817/11817 [=====] - 0s - loss: 7841.2631 - val\_loss: 17071.5371  
Epoch 198/500  
11817/11817 [=====] - 0s - loss: 7649.8095 - val\_loss: 18073.4336  
Epoch 199/500  
11817/11817 [=====] - 0s - loss: 7590.8470 - val\_loss: 17073.6875  
Epoch 200/500  
11817/11817 [=====] - 0s - loss: 7526.7428 - val\_loss: 17867.4141  
Epoch 201/500  
11817/11817 [=====] - 0s - loss: 7452.8549 - val\_loss: 16733.4551  
Epoch 202/500  
11817/11817 [=====] - 0s - loss: 7318.0441 - val\_loss: 16227.7949  
Epoch 203/500  
11817/11817 [=====] - 0s - loss: 7256.0506 - val\_loss: 17348.5879  
Epoch 204/500  
11817/11817 [=====] - 0s - loss: 7171.9330 - val\_loss: 15729.7109  
Epoch 205/500  
11817/11817 [=====] - 0s - loss: 7081.7739 - val\_loss: 18130.9785  
Epoch 206/500  
11817/11817 [=====] - 0s - loss: 6983.9772 - val\_loss: 15834.7090  
Epoch 207/500  
11817/11817 [=====] - 0s - loss: 6877.5339 - val\_loss: 16653.7832  
Epoch 208/500  
11817/11817 [=====] - 0s - loss: 6792.7106 - val\_loss: 16305.4727  
Epoch 209/500  
11817/11817 [=====] - 0s - loss: 6700.8362 - val\_loss: 14325.4395  
Epoch 210/500  
11817/11817 [=====] - 0s - loss: 6644.7672 - val\_loss: 14144.5498  
Epoch 211/500  
11817/11817 [=====] - 0s - loss: 6669.9869 - val\_loss: 14522.8584  
Epoch 212/500  
11817/11817 [=====] - 0s - loss: 6523.9566 - val\_loss: 14734.8857  
Epoch 213/500  
11817/11817 [=====] - 0s - loss: 6520.5790 - val\_loss: 13715.6367  
Epoch 214/500  
11817/11817 [=====] - 0s - loss: 6410.3374 - val\_loss: 14976.6875  
Epoch 215/500  
11817/11817 [=====] - 0s - loss: 6344.9858 - val\_loss: 12137.1104  
Epoch 216/500  
11817/11817 [=====] - 0s - loss: 6238.7840 - val\_loss: 14911.7461  
Epoch 217/500

11817/11817 [=====] - 0s - loss: 6215.7237 - val\_loss: 12816.2607  
Epoch 218/500  
11817/11817 [=====] - 0s - loss: 6044.8897 - val\_loss: 13068.4912  
Epoch 219/500  
11817/11817 [=====] - 0s - loss: 6068.8671 - val\_loss: 13590.0303  
Epoch 220/500  
11817/11817 [=====] - 0s - loss: 6004.7084 - val\_loss: 12222.9102  
Epoch 221/500  
11817/11817 [=====] - 0s - loss: 5859.5199 - val\_loss: 13349.3760  
Epoch 222/500  
11817/11817 [=====] - 0s - loss: 5820.5332 - val\_loss: 11814.3008  
Epoch 223/500  
11817/11817 [=====] - 0s - loss: 5865.2205 - val\_loss: 12501.9189  
Epoch 224/500  
11817/11817 [=====] - 0s - loss: 5771.7370 - val\_loss: 13152.5479  
Epoch 225/500  
11817/11817 [=====] - 0s - loss: 5696.6864 - val\_loss: 12607.6768  
Epoch 226/500  
11817/11817 [=====] - 0s - loss: 5595.6178 - val\_loss: 12742.5410  
Epoch 227/500  
11817/11817 [=====] - 0s - loss: 5440.6646 - val\_loss: 12241.6396  
Epoch 228/500  
11817/11817 [=====] - 0s - loss: 5497.8503 - val\_loss: 11095.3145  
Epoch 229/500  
11817/11817 [=====] - 0s - loss: 5377.6254 - val\_loss: 11611.5205  
Epoch 230/500  
11817/11817 [=====] - 0s - loss: 5320.2392 - val\_loss: 10697.3389  
Epoch 231/500  
11817/11817 [=====] - 0s - loss: 5263.5984 - val\_loss: 10845.3721  
Epoch 232/500  
11817/11817 [=====] - 0s - loss: 5374.7045 - val\_loss: 10138.7852  
Epoch 233/500  
11817/11817 [=====] - 0s - loss: 5273.6940 - val\_loss: 8983.1953  
Epoch 234/500  
11817/11817 [=====] - 0s - loss: 5265.1633 - val\_loss: 9812.3428  
Epoch 235/500  
11817/11817 [=====] - 0s - loss: 5060.0218 - val\_loss: 11008.5254  
Epoch 236/500  
11817/11817 [=====] - 0s - loss: 5126.7536 - val\_loss: 10174.7314  
Epoch 237/500  
11817/11817 [=====] - 0s - loss: 5073.2883 - val\_loss: 9198.9746  
Epoch 238/500  
11817/11817 [=====] - 0s - loss: 5015.7928 - val\_loss: 8224.7559  
Epoch 239/500  
11817/11817 [=====] - 0s - loss: 4876.1789 - val\_loss: 10623.2256  
Epoch 240/500  
11817/11817 [=====] - 0s - loss: 4944.0512 - val\_loss: 10890.7070  
Epoch 241/500

11817/11817 [=====] - 0s - loss: 4825.8447 - val\_loss: 9136.2441  
Epoch 242/500  
11817/11817 [=====] - 0s - loss: 4845.1160 - val\_loss: 10201.1836  
Epoch 243/500  
11817/11817 [=====] - 0s - loss: 4733.4649 - val\_loss: 9315.0205  
Epoch 244/500  
11817/11817 [=====] - 0s - loss: 4686.1370 - val\_loss: 10065.7490  
Epoch 245/500  
11817/11817 [=====] - 0s - loss: 4641.0109 - val\_loss: 7587.7920  
Epoch 246/500  
11817/11817 [=====] - 0s - loss: 4621.5417 - val\_loss: 9075.3252  
Epoch 247/500  
11817/11817 [=====] - 0s - loss: 4636.2948 - val\_loss: 9171.0840  
Epoch 248/500  
11817/11817 [=====] - 0s - loss: 4537.5386 - val\_loss: 8657.9082  
Epoch 249/500  
11817/11817 [=====] - 0s - loss: 4464.5408 - val\_loss: 10108.6006  
Epoch 250/500  
11817/11817 [=====] - 0s - loss: 4462.6430 - val\_loss: 8046.0269  
Epoch 251/500  
11817/11817 [=====] - 0s - loss: 4425.8042 - val\_loss: 8747.3525  
Epoch 252/500  
11817/11817 [=====] - 0s - loss: 4405.9821 - val\_loss: 8752.4014  
Epoch 253/500  
11817/11817 [=====] - 0s - loss: 4311.4053 - val\_loss: 10044.3447  
Epoch 254/500  
11817/11817 [=====] - 0s - loss: 4215.0278 - val\_loss: 7590.1870  
Epoch 255/500  
11817/11817 [=====] - 0s - loss: 4166.4795 - val\_loss: 8857.0205  
Epoch 256/500  
11817/11817 [=====] - 0s - loss: 4224.9575 - val\_loss: 7321.3936  
Epoch 257/500  
11817/11817 [=====] - 0s - loss: 4190.4736 - val\_loss: 7919.6826  
Epoch 258/500  
11817/11817 [=====] - 0s - loss: 4187.2678 - val\_loss: 8753.7998  
Epoch 259/500  
11817/11817 [=====] - 0s - loss: 4118.2630 - val\_loss: 7861.5601  
Epoch 260/500  
11817/11817 [=====] - 0s - loss: 4161.5063 - val\_loss: 8252.2021  
Epoch 261/500  
11817/11817 [=====] - 0s - loss: 3991.7975 - val\_loss: 9004.5586  
Epoch 262/500  
11817/11817 [=====] - 0s - loss: 4073.7175 - val\_loss: 7396.2183  
Epoch 263/500  
11817/11817 [=====] - 0s - loss: 4084.3281 - val\_loss: 7796.5308  
Epoch 264/500  
11817/11817 [=====] - 0s - loss: 3965.5235 - val\_loss: 6221.9492  
Epoch 265/500

11817/11817 [=====] - 0s - loss: 3906.2682 - val\_loss: 6263.0620  
Epoch 266/500  
11817/11817 [=====] - 0s - loss: 3886.8948 - val\_loss: 8775.5928  
Epoch 267/500  
11817/11817 [=====] - 0s - loss: 3828.8206 - val\_loss: 7564.3940  
Epoch 268/500  
11817/11817 [=====] - 0s - loss: 3867.7982 - val\_loss: 6931.8257  
Epoch 269/500  
11817/11817 [=====] - 0s - loss: 3761.7966 - val\_loss: 8319.3184  
Epoch 270/500  
11817/11817 [=====] - 0s - loss: 3793.0538 - val\_loss: 7542.4727  
Epoch 271/500  
11817/11817 [=====] - 0s - loss: 3709.5698 - val\_loss: 8187.0356  
Epoch 272/500  
11817/11817 [=====] - 0s - loss: 3712.9710 - val\_loss: 6954.9170  
Epoch 273/500  
11817/11817 [=====] - 0s - loss: 3758.1291 - val\_loss: 5923.7163  
Epoch 274/500  
11817/11817 [=====] - 0s - loss: 3734.5751 - val\_loss: 6295.9849  
Epoch 275/500  
11817/11817 [=====] - 0s - loss: 3668.0399 - val\_loss: 7286.9326  
Epoch 276/500  
11817/11817 [=====] - 0s - loss: 3644.2785 - val\_loss: 6183.3511  
Epoch 277/500  
11817/11817 [=====] - 0s - loss: 3601.5766 - val\_loss: 5713.7178  
Epoch 278/500  
11817/11817 [=====] - 0s - loss: 3602.2055 - val\_loss: 6219.3687  
Epoch 279/500  
11817/11817 [=====] - 0s - loss: 3586.9042 - val\_loss: 6989.5405  
Epoch 280/500  
11817/11817 [=====] - 0s - loss: 3524.9465 - val\_loss: 5975.1040  
Epoch 281/500  
11817/11817 [=====] - 0s - loss: 3459.6274 - val\_loss: 5577.4985  
Epoch 282/500  
11817/11817 [=====] - 0s - loss: 3440.1318 - val\_loss: 6381.7832  
Epoch 283/500  
11817/11817 [=====] - 0s - loss: 3492.6338 - val\_loss: 6478.6025  
Epoch 284/500  
11817/11817 [=====] - 0s - loss: 3389.6273 - val\_loss: 6500.0127  
Epoch 285/500  
11817/11817 [=====] - 0s - loss: 3622.1208 - val\_loss: 6389.1797  
Epoch 286/500  
11817/11817 [=====] - 0s - loss: 3378.0032 - val\_loss: 6625.4326  
Epoch 287/500  
11817/11817 [=====] - 0s - loss: 3426.7845 - val\_loss: 6677.7432  
Epoch 288/500  
11817/11817 [=====] - 0s - loss: 3333.9886 - val\_loss: 7025.4209  
Epoch 289/500

11817/11817 [=====] - 0s - loss: 3403.1821 - val\_loss: 5728.9985  
Epoch 290/500  
11817/11817 [=====] - 0s - loss: 3302.6266 - val\_loss: 6666.9863  
Epoch 291/500  
11817/11817 [=====] - 0s - loss: 3332.1582 - val\_loss: 5949.3101  
Epoch 292/500  
11817/11817 [=====] - 0s - loss: 3422.6630 - val\_loss: 6400.8184  
Epoch 293/500  
11817/11817 [=====] - 0s - loss: 3258.4136 - val\_loss: 6460.8921  
Epoch 294/500  
11817/11817 [=====] - 0s - loss: 3278.3372 - val\_loss: 6245.0884  
Epoch 295/500  
11817/11817 [=====] - 0s - loss: 3190.8566 - val\_loss: 7838.9858  
Epoch 296/500  
11817/11817 [=====] - 0s - loss: 3349.0612 - val\_loss: 7039.7754  
Epoch 297/500  
11817/11817 [=====] - 0s - loss: 3159.1917 - val\_loss: 6059.9863  
Epoch 298/500  
11817/11817 [=====] - 0s - loss: 3119.2942 - val\_loss: 5737.7300  
Epoch 299/500  
11817/11817 [=====] - 0s - loss: 3167.6285 - val\_loss: 6407.3335  
Epoch 300/500  
11817/11817 [=====] - 0s - loss: 3088.8208 - val\_loss: 6545.2817  
Epoch 301/500  
11817/11817 [=====] - 0s - loss: 3067.6360 - val\_loss: 6134.9214  
Epoch 302/500  
11817/11817 [=====] - 0s - loss: 3167.5869 - val\_loss: 5967.9561  
Epoch 303/500  
11817/11817 [=====] - 0s - loss: 3172.0813 - val\_loss: 5162.1772  
Epoch 304/500  
11817/11817 [=====] - 0s - loss: 3202.7158 - val\_loss: 5983.6929  
Epoch 305/500  
11817/11817 [=====] - 0s - loss: 3185.4911 - val\_loss: 5663.9590  
Epoch 306/500  
11817/11817 [=====] - 0s - loss: 3077.1408 - val\_loss: 6461.2490  
Epoch 307/500  
11817/11817 [=====] - 0s - loss: 3207.2089 - val\_loss: 5496.2031  
Epoch 308/500  
11817/11817 [=====] - 0s - loss: 3077.2185 - val\_loss: 5303.2261  
Epoch 309/500  
11817/11817 [=====] - 0s - loss: 3122.3534 - val\_loss: 5136.3320  
Epoch 310/500  
11817/11817 [=====] - 0s - loss: 3027.3907 - val\_loss: 5033.0493  
Epoch 311/500  
11817/11817 [=====] - 0s - loss: 3166.9325 - val\_loss: 5670.6289  
Epoch 312/500  
11817/11817 [=====] - 0s - loss: 2969.6651 - val\_loss: 5230.2520  
Epoch 313/500

11817/11817 [=====] - 0s - loss: 3083.7457 - val\_loss: 4827.4326  
Epoch 314/500  
11817/11817 [=====] - 0s - loss: 3096.7165 - val\_loss: 5571.5815  
Epoch 315/500  
11817/11817 [=====] - 0s - loss: 3003.2434 - val\_loss: 4858.1880  
Epoch 316/500  
11817/11817 [=====] - 0s - loss: 2973.9868 - val\_loss: 4653.0718  
Epoch 317/500  
11817/11817 [=====] - 0s - loss: 2932.0701 - val\_loss: 5592.5537  
Epoch 318/500  
11817/11817 [=====] - 0s - loss: 2941.1072 - val\_loss: 5686.5947  
Epoch 319/500  
11817/11817 [=====] - 0s - loss: 3026.5068 - val\_loss: 4927.1274  
Epoch 320/500  
11817/11817 [=====] - 0s - loss: 3021.7645 - val\_loss: 6245.4121  
Epoch 321/500  
11817/11817 [=====] - 0s - loss: 2949.5682 - val\_loss: 5630.2983  
Epoch 322/500  
11817/11817 [=====] - 0s - loss: 3045.7853 - val\_loss: 5402.4189  
Epoch 323/500  
11817/11817 [=====] - 0s - loss: 2869.9560 - val\_loss: 6026.7764  
Epoch 324/500  
11817/11817 [=====] - 0s - loss: 2992.1485 - val\_loss: 6410.8467  
Epoch 325/500  
11817/11817 [=====] - 0s - loss: 2916.6384 - val\_loss: 6021.2583  
Epoch 326/500  
11817/11817 [=====] - 0s - loss: 2844.8848 - val\_loss: 5199.2905  
Epoch 327/500  
11817/11817 [=====] - 0s - loss: 2885.6168 - val\_loss: 4850.4497  
Epoch 328/500  
11817/11817 [=====] - 0s - loss: 2890.9788 - val\_loss: 5415.6987  
Epoch 329/500  
11817/11817 [=====] - 0s - loss: 2857.1574 - val\_loss: 6345.9736  
Epoch 330/500  
11817/11817 [=====] - 0s - loss: 2899.7537 - val\_loss: 5461.4766  
Epoch 331/500  
11817/11817 [=====] - 0s - loss: 2855.4905 - val\_loss: 5534.5317  
Epoch 332/500  
11817/11817 [=====] - 0s - loss: 2951.4636 - val\_loss: 5501.5806  
Epoch 333/500  
11817/11817 [=====] - 0s - loss: 2803.5182 - val\_loss: 5510.7490  
Epoch 334/500  
11817/11817 [=====] - 0s - loss: 2949.8573 - val\_loss: 6342.4082  
Epoch 335/500  
11817/11817 [=====] - 0s - loss: 2782.2364 - val\_loss: 6057.3071  
Epoch 336/500  
11817/11817 [=====] - 0s - loss: 2846.6717 - val\_loss: 5502.6445  
Epoch 337/500

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11817/11817 [=====] - 0s - loss: 2782.7902 - val_loss: 5830.6182
Epoch 338/500
11817/11817 [=====] - 0s - loss: 2724.8548 - val_loss: 5778.2422
Epoch 339/500
11817/11817 [=====] - 0s - loss: 2753.3835 - val_loss: 5133.7261
Epoch 340/500
11817/11817 [=====] - 0s - loss: 2792.2233 - val_loss: 6191.0171
Epoch 341/500
11817/11817 [=====] - 0s - loss: 2863.2911 - val_loss: 5943.6997
Epoch 342/500
11817/11817 [=====] - 0s - loss: 2826.5672 - val_loss: 5976.2593
Epoch 343/500
11817/11817 [=====] - 0s - loss: 2717.6835 - val_loss: 5730.1064
Epoch 344/500
11817/11817 [=====] - 0s - loss: 2839.1400 - val_loss: 5035.7227
Epoch 345/500
11817/11817 [=====] - 0s - loss: 2901.8694 - val_loss: 5412.8345
Epoch 346/500
11817/11817 [=====] - 0s - loss: 2877.1598 - val_loss: 5131.8262
Epoch 347/500
11817/11817 [=====] - 0s - loss: 2736.4359 - val_loss: 4597.7090
Epoch 348/500
11817/11817 [=====] - 0s - loss: 2800.3612 - val_loss: 4903.5674
Epoch 349/500
11817/11817 [=====] - 0s - loss: 2713.3920 - val_loss: 5831.8613
Epoch 350/500
11817/11817 [=====] - 0s - loss: 2781.3369 - val_loss: 5760.0137
Epoch 351/500
11817/11817 [=====] - 0s - loss: 2731.2887 - val_loss: 6300.4604
Epoch 352/500
11817/11817 [=====] - 0s - loss: 2774.9025 - val_loss: 4897.7734
Epoch 353/500
11817/11817 [=====] - 0s - loss: 2745.0432 - val_loss: 4809.4326
Epoch 354/500
11817/11817 [=====] - 0s - loss: 2803.0284 - val_loss: 4815.2681
Epoch 355/500
11817/11817 [=====] - 0s - loss: 2755.7047 - val_loss: 5120.9419
Epoch 356/500
11817/11817 [=====] - 0s - loss: 2766.9404 - val_loss: 5594.5112
Epoch 357/500
11817/11817 [=====] - 0s - loss: 2731.6410 - val_loss: 5402.6123
Epoch 358/500
11817/11817 [=====] - 0s - loss: 2703.5500 - val_loss: 6889.8779
Epoch 359/500
11817/11817 [=====] - 0s - loss: 2764.1292 - val_loss: 5068.0913
Epoch 360/500
11817/11817 [=====] - 0s - loss: 2747.2515 - val_loss: 5184.0273
Epoch 361/500

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11817/11817 [=====] - 0s - loss: 2695.4043 - val\_loss: 4624.6802  
Epoch 362/500  
11817/11817 [=====] - 0s - loss: 2776.8743 - val\_loss: 4570.6177  
Epoch 363/500  
11817/11817 [=====] - 0s - loss: 2775.4273 - val\_loss: 5184.7144  
Epoch 364/500  
11817/11817 [=====] - 0s - loss: 2767.8253 - val\_loss: 4865.2559  
Epoch 365/500  
11817/11817 [=====] - 0s - loss: 2789.7071 - val\_loss: 4463.1123  
Epoch 366/500  
11817/11817 [=====] - 0s - loss: 2698.2992 - val\_loss: 5572.1890  
Epoch 367/500  
11817/11817 [=====] - 0s - loss: 2750.8998 - val\_loss: 5581.4341  
Epoch 368/500  
11817/11817 [=====] - 0s - loss: 2703.1423 - val\_loss: 4265.7939  
Epoch 369/500  
11817/11817 [=====] - 0s - loss: 2777.0886 - val\_loss: 4715.6494  
Epoch 370/500  
11817/11817 [=====] - 0s - loss: 2667.2545 - val\_loss: 5365.1919  
Epoch 371/500  
11817/11817 [=====] - 0s - loss: 2718.3507 - val\_loss: 4574.3154  
Epoch 372/500  
11817/11817 [=====] - 0s - loss: 2661.3557 - val\_loss: 5134.7998  
Epoch 373/500  
11817/11817 [=====] - 0s - loss: 2695.8913 - val\_loss: 5110.1587  
Epoch 374/500  
11817/11817 [=====] - 0s - loss: 2641.3459 - val\_loss: 4247.9502  
Epoch 375/500  
11817/11817 [=====] - 0s - loss: 2708.1398 - val\_loss: 4494.7305  
Epoch 376/500  
11817/11817 [=====] - 0s - loss: 2659.3959 - val\_loss: 4411.7793  
Epoch 377/500  
11817/11817 [=====] - 0s - loss: 2682.0962 - val\_loss: 4524.5562  
Epoch 378/500  
11817/11817 [=====] - 0s - loss: 2653.3448 - val\_loss: 4479.8442  
Epoch 379/500  
11817/11817 [=====] - 0s - loss: 2610.7096 - val\_loss: 4358.4775  
Epoch 380/500  
11817/11817 [=====] - 0s - loss: 2721.7456 - val\_loss: 4266.5854  
Epoch 381/500  
11817/11817 [=====] - 0s - loss: 2689.9225 - val\_loss: 4338.7637  
Epoch 382/500  
11817/11817 [=====] - 0s - loss: 2528.5472 - val\_loss: 4356.9819  
Epoch 383/500  
11817/11817 [=====] - 0s - loss: 2680.3254 - val\_loss: 4177.1147  
Epoch 384/500  
11817/11817 [=====] - 0s - loss: 2687.6928 - val\_loss: 4171.9326  
Epoch 385/500

11817/11817 [=====] - 0s - loss: 2618.0355 - val\_loss: 4183.7124  
Epoch 386/500  
11817/11817 [=====] - 0s - loss: 2672.7378 - val\_loss: 4188.8462  
Epoch 387/500  
11817/11817 [=====] - 0s - loss: 2614.7443 - val\_loss: 4610.9722  
Epoch 388/500  
11817/11817 [=====] - 0s - loss: 2683.8850 - val\_loss: 5190.5254  
Epoch 389/500  
11817/11817 [=====] - 0s - loss: 2613.6925 - val\_loss: 4773.6738  
Epoch 390/500  
11817/11817 [=====] - 0s - loss: 2581.1584 - val\_loss: 4762.4253  
Epoch 391/500  
11817/11817 [=====] - 0s - loss: 2603.5723 - val\_loss: 4541.3491  
Epoch 392/500  
11817/11817 [=====] - 0s - loss: 2737.0983 - val\_loss: 4917.0933  
Epoch 393/500  
11817/11817 [=====] - 0s - loss: 2669.3748 - val\_loss: 5186.4092  
Epoch 394/500  
11817/11817 [=====] - 0s - loss: 2802.2463 - val\_loss: 5648.9126  
Epoch 395/500  
11817/11817 [=====] - 0s - loss: 2622.9810 - val\_loss: 4546.1475  
Epoch 396/500  
11817/11817 [=====] - 0s - loss: 2559.1876 - val\_loss: 4445.9272  
Epoch 397/500  
11817/11817 [=====] - 0s - loss: 2665.3528 - val\_loss: 5280.9297  
Epoch 398/500  
11817/11817 [=====] - 0s - loss: 2603.4597 - val\_loss: 4865.1128  
Epoch 399/500  
11817/11817 [=====] - 0s - loss: 2581.4963 - val\_loss: 4447.5288  
Epoch 400/500  
11817/11817 [=====] - 0s - loss: 2629.8340 - val\_loss: 5591.9531  
Epoch 401/500  
11817/11817 [=====] - 0s - loss: 2714.7053 - val\_loss: 5501.3574  
Epoch 402/500  
11817/11817 [=====] - 0s - loss: 2726.8581 - val\_loss: 4823.5430  
Epoch 403/500  
11817/11817 [=====] - 0s - loss: 2670.2715 - val\_loss: 5257.1265  
Epoch 404/500  
11817/11817 [=====] - 0s - loss: 2595.2436 - val\_loss: 4854.6807  
Epoch 405/500  
11817/11817 [=====] - 0s - loss: 2637.7364 - val\_loss: 5002.4160  
Epoch 406/500  
11817/11817 [=====] - 0s - loss: 2672.9542 - val\_loss: 4922.9346  
Epoch 407/500  
11817/11817 [=====] - 0s - loss: 2573.5879 - val\_loss: 5200.3721  
Epoch 408/500  
11817/11817 [=====] - 0s - loss: 2561.5371 - val\_loss: 5347.6445  
Epoch 409/500

11817/11817 [=====] - 0s - loss: 2576.3388 - val\_loss: 5239.6396  
Epoch 410/500  
11817/11817 [=====] - 0s - loss: 2650.6874 - val\_loss: 4463.9316  
Epoch 411/500  
11817/11817 [=====] - 0s - loss: 2566.0630 - val\_loss: 4616.3330  
Epoch 412/500  
11817/11817 [=====] - 0s - loss: 2555.2308 - val\_loss: 4627.2427  
Epoch 413/500  
11817/11817 [=====] - 0s - loss: 2548.3507 - val\_loss: 4540.7471  
Epoch 414/500  
11817/11817 [=====] - 0s - loss: 2644.2355 - val\_loss: 5179.9878  
Epoch 415/500  
11817/11817 [=====] - 0s - loss: 2597.9647 - val\_loss: 4548.6084  
Epoch 416/500  
11817/11817 [=====] - 0s - loss: 2654.6587 - val\_loss: 4681.4897  
Epoch 417/500  
11817/11817 [=====] - 0s - loss: 2614.7820 - val\_loss: 4575.7251  
Epoch 418/500  
11817/11817 [=====] - 0s - loss: 2569.7662 - val\_loss: 4999.6953  
Epoch 419/500  
11817/11817 [=====] - 0s - loss: 2561.8096 - val\_loss: 4659.3330  
Epoch 420/500  
11817/11817 [=====] - 0s - loss: 2701.1168 - val\_loss: 4876.1641  
Epoch 421/500  
11817/11817 [=====] - 0s - loss: 2623.6645 - val\_loss: 5387.2656  
Epoch 422/500  
11817/11817 [=====] - 0s - loss: 2513.4948 - val\_loss: 5325.8457  
Epoch 423/500  
11817/11817 [=====] - 0s - loss: 2559.0486 - val\_loss: 5174.0542  
Epoch 424/500  
11817/11817 [=====] - 0s - loss: 2550.1946 - val\_loss: 4708.7129  
Epoch 425/500  
11817/11817 [=====] - 0s - loss: 2476.4800 - val\_loss: 5144.2046  
Epoch 426/500  
11817/11817 [=====] - 0s - loss: 2561.8459 - val\_loss: 4777.3081  
Epoch 427/500  
11817/11817 [=====] - 0s - loss: 2570.8500 - val\_loss: 4796.4009  
Epoch 428/500  
11817/11817 [=====] - 0s - loss: 2573.8218 - val\_loss: 4516.7910  
Epoch 429/500  
11817/11817 [=====] - 0s - loss: 2665.0587 - val\_loss: 4844.7280  
Epoch 430/500  
11817/11817 [=====] - 0s - loss: 2598.4253 - val\_loss: 5030.3027  
Epoch 431/500  
11817/11817 [=====] - 0s - loss: 2617.0211 - val\_loss: 4632.5967  
Epoch 432/500  
11817/11817 [=====] - 0s - loss: 2629.5639 - val\_loss: 4612.8301  
Epoch 433/500

```

11817/11817 [=====] - 0s - loss: 2570.3644 - val_loss: 5527.6997
Epoch 434/500
11817/11817 [=====] - 0s - loss: 2710.1454 - val_loss: 5248.8110
Epoch 435/500
11817/11817 [=====] - 0s - loss: 2564.6311 - val_loss: 5692.5576

```

```

In [29]: past_preds = model.predict(train_features)[: , 0]
         future_preds = model.predict(test_features)[: , 0]

         from sklearn.metrics import r2_score
         import numpy as np

         # our benchmark is just guessing the average
         benchmark = np.mean(train_targets)
         print('benchmark r^2 on training:', r2_score(train_targets, [benchmark] * train_targets.shape[0]))

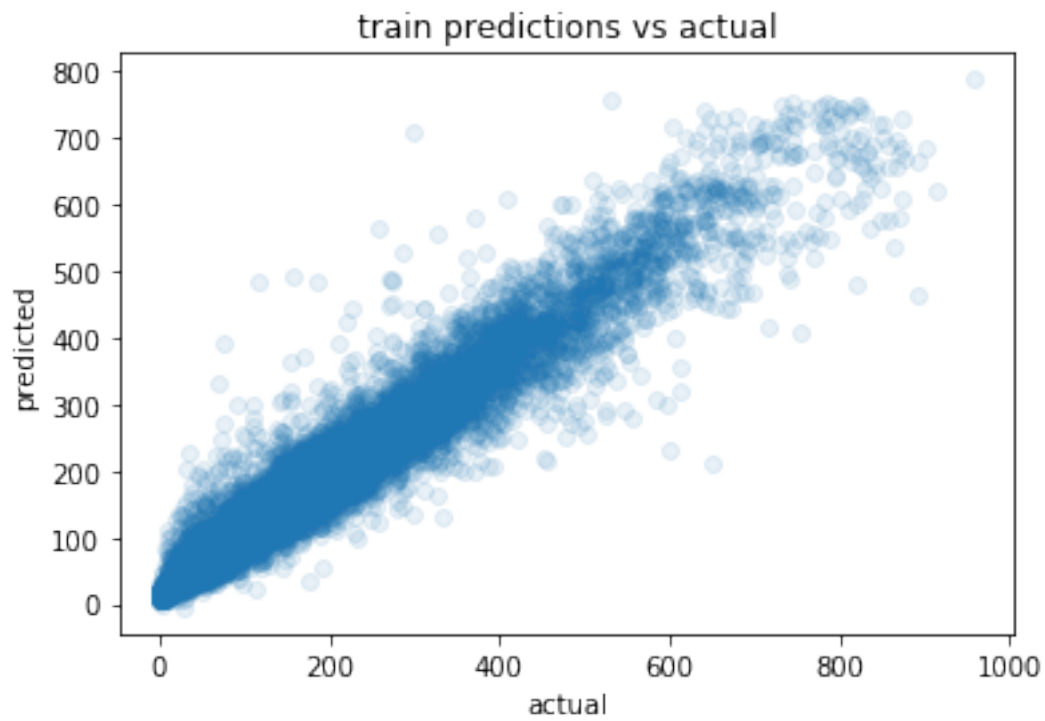
         print('training r^2:', r2_score(train_targets, past_preds))
         plt.scatter(train_targets, past_preds, alpha=0.1)
         plt.xlabel('actual')
         plt.ylabel('predicted')
         plt.title('train predictions vs actual')
         plt.show()

         print('benchmark r^2 on test:', r2_score(test_targets, [benchmark] * test_targets.shape[0]))

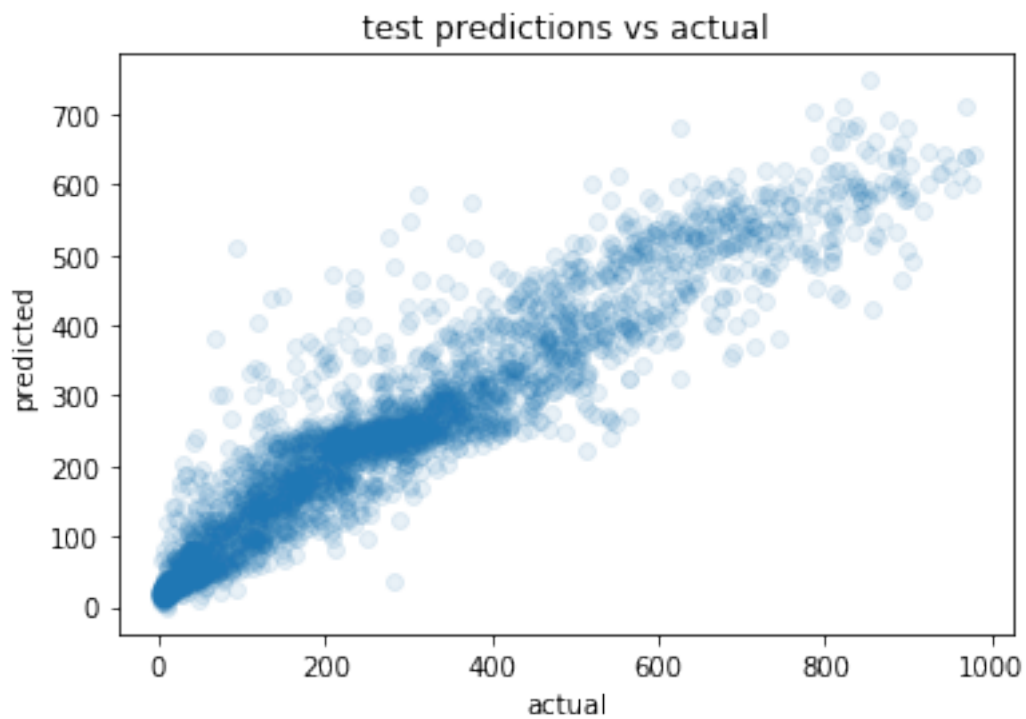
         print('r^2 on test:', r2_score(test_targets, future_preds))
         plt.scatter(test_targets, future_preds, alpha=0.1)
         plt.xlabel('actual')
         plt.ylabel('predicted')
         plt.title('test predictions vs actual')
         plt.show()

benchmark r^2 on training: 0.0
training r^2: 0.929369672141

```



benchmark  $r^2$  on test: -0.112995264662  
 $r^2$  on test: 0.829568217322



## 7 a small improvement, we can probably get a little more performance by adding one more small layer before the output.

In [40]: *# creates the model*

```
# restart keras session (clear weights), sometimes this will clear up errors
K.clear_session()

# functional API
inputs = Input(shape=(features.shape[1], ))
x1 = Dense(1000, activation='elu')(inputs)
x2 = BatchNormalization()(x1)
x3 = Dropout(0.5)(x2)
x4 = Dense(500, activation='elu')(x3)
x5 = BatchNormalization()(x4)
x6 = Dropout(0.5)(x5)
x7 = Dense(100, activation='elu')(x6)
x8 = BatchNormalization()(x7)
x9 = Dropout(0.5)(x8)
x10 = Dense(10, activation='elu')(x9)
x11 = BatchNormalization()(x10)
x12 = Dropout(0.5)(x11)
predictions = Dense(1, activation='linear')(x12)

# this saves the best model (lowest validation loss)
checkpoint = ModelCheckpoint('3_layer_dense.h5', monitor='val_loss', save_best_only=True)
# have to increase patience, because this larger net trains more slowly
es = EarlyStopping(patience=200)
cb = [checkpoint, es]

# this compiles our model so it is ready to fit
model = Model(inputs, predictions)
model.compile(optimizer='adam', loss='mse')

subset_size = trainsize
train_feature_subset = train_features[:subset_size]
train_target_subset = train_targets[:subset_size]
# we actually fit the model here
history = model.fit(train_feature_subset,
                    train_target_subset,
                    epochs=2000,
                    validation_split=0.15,
                    callbacks=cb,
                    batch_size=3000)
```

Train on 11817 samples, validate on 2086 samples

Epoch 1/2000

11817/11817 [=====] - 0s - loss: 46636.5816 - val\_loss: 114557.1172

Epoch 2/2000

11817/11817 [=====] - 0s - loss: 46458.9378 - val\_loss: 115334.9688

Epoch 3/2000

11817/11817 [=====] - 0s - loss: 46387.2336 - val\_loss: 118083.3359

Epoch 4/2000

11817/11817 [=====] - 0s - loss: 46319.6015 - val\_loss: 119970.7969

Epoch 5/2000

11817/11817 [=====] - 0s - loss: 46269.9423 - val\_loss: 120101.0391

Epoch 6/2000

11817/11817 [=====] - 0s - loss: 46221.7992 - val\_loss: 118859.5547

Epoch 7/2000

11817/11817 [=====] - 0s - loss: 46166.6329 - val\_loss: 117735.6016

Epoch 8/2000

11817/11817 [=====] - 0s - loss: 46146.2623 - val\_loss: 117252.5781

Epoch 9/2000

11817/11817 [=====] - 0s - loss: 46119.5825 - val\_loss: 116563.7969

Epoch 10/2000

11817/11817 [=====] - 0s - loss: 46089.0039 - val\_loss: 115822.9844

Epoch 11/2000

11817/11817 [=====] - 0s - loss: 46068.6100 - val\_loss: 115525.5234

Epoch 12/2000

11817/11817 [=====] - 0s - loss: 46027.6004 - val\_loss: 115606.0859

Epoch 13/2000

11817/11817 [=====] - 0s - loss: 45995.0924 - val\_loss: 115361.7188

Epoch 14/2000

11817/11817 [=====] - 0s - loss: 45970.9222 - val\_loss: 115396.6797

Epoch 15/2000

11817/11817 [=====] - 0s - loss: 45950.1388 - val\_loss: 115295.5703

Epoch 16/2000

11817/11817 [=====] - 0s - loss: 45920.7060 - val\_loss: 115270.1172

Epoch 17/2000

11817/11817 [=====] - 0s - loss: 45880.5777 - val\_loss: 115315.2969

Epoch 18/2000

11817/11817 [=====] - 0s - loss: 45856.4550 - val\_loss: 115405.6719

Epoch 19/2000

11817/11817 [=====] - 0s - loss: 45820.2223 - val\_loss: 115575.6797

Epoch 20/2000

11817/11817 [=====] - 0s - loss: 45795.0617 - val\_loss: 115513.6953

Epoch 21/2000

11817/11817 [=====] - 0s - loss: 45770.7099 - val\_loss: 115694.0312

Epoch 22/2000

11817/11817 [=====] - 0s - loss: 45730.0969 - val\_loss: 115909.5703

Epoch 23/2000

11817/11817 [=====] - 0s - loss: 45704.0536 - val\_loss: 115928.7344

Epoch 24/2000

11817/11817 [=====] - 0s - loss: 45670.1472 - val\_loss: 116034.8984  
 Epoch 25/2000  
 11817/11817 [=====] - 0s - loss: 45642.3342 - val\_loss: 116230.0781  
 Epoch 26/2000  
 11817/11817 [=====] - 0s - loss: 45624.8307 - val\_loss: 116237.3359  
 Epoch 27/2000  
 11817/11817 [=====] - 0s - loss: 45589.4751 - val\_loss: 116377.5391  
 Epoch 28/2000  
 11817/11817 [=====] - 0s - loss: 45536.2501 - val\_loss: 116450.4844  
 Epoch 29/2000  
 11817/11817 [=====] - 0s - loss: 45516.0855 - val\_loss: 116295.8984  
 Epoch 30/2000  
 11817/11817 [=====] - 0s - loss: 45486.8388 - val\_loss: 116412.9922  
 Epoch 31/2000  
 11817/11817 [=====] - 0s - loss: 45444.3350 - val\_loss: 116425.9375  
 Epoch 32/2000  
 11817/11817 [=====] - 0s - loss: 45439.7452 - val\_loss: 116184.8516  
 Epoch 33/2000  
 11817/11817 [=====] - 0s - loss: 45380.7040 - val\_loss: 116269.3359  
 Epoch 34/2000  
 11817/11817 [=====] - 0s - loss: 45369.2537 - val\_loss: 116245.5703  
 Epoch 35/2000  
 11817/11817 [=====] - 0s - loss: 45317.4376 - val\_loss: 116344.3359  
 Epoch 36/2000  
 11817/11817 [=====] - 0s - loss: 45294.4839 - val\_loss: 116426.0469  
 Epoch 37/2000  
 11817/11817 [=====] - 0s - loss: 45239.0477 - val\_loss: 116380.3594  
 Epoch 38/2000  
 11817/11817 [=====] - 0s - loss: 45210.1184 - val\_loss: 116361.1875  
 Epoch 39/2000  
 11817/11817 [=====] - 0s - loss: 45167.3691 - val\_loss: 116248.1562  
 Epoch 40/2000  
 11817/11817 [=====] - 0s - loss: 45094.3048 - val\_loss: 116336.2812  
 Epoch 41/2000  
 11817/11817 [=====] - 0s - loss: 45093.2858 - val\_loss: 116390.8125  
 Epoch 42/2000  
 11817/11817 [=====] - 0s - loss: 45080.7034 - val\_loss: 116315.4297  
 Epoch 43/2000  
 11817/11817 [=====] - 0s - loss: 45002.7242 - val\_loss: 116399.5000  
 Epoch 44/2000  
 11817/11817 [=====] - 0s - loss: 45008.5553 - val\_loss: 116288.8125  
 Epoch 45/2000  
 11817/11817 [=====] - 0s - loss: 44956.0742 - val\_loss: 116294.5547  
 Epoch 46/2000  
 11817/11817 [=====] - 0s - loss: 44906.3318 - val\_loss: 116477.2578  
 Epoch 47/2000  
 11817/11817 [=====] - 0s - loss: 44861.4673 - val\_loss: 116348.3047  
 Epoch 48/2000



11817/11817 [=====] - 0s - loss: 44850.5874 - val\_loss: 116534.1641  
Epoch 49/2000  
11817/11817 [=====] - 0s - loss: 44767.3350 - val\_loss: 116547.1328  
Epoch 50/2000  
11817/11817 [=====] - 0s - loss: 44755.6932 - val\_loss: 116755.9531  
Epoch 51/2000  
11817/11817 [=====] - 0s - loss: 44700.8018 - val\_loss: 116724.4609  
Epoch 52/2000  
11817/11817 [=====] - 0s - loss: 44672.5854 - val\_loss: 116578.2266  
Epoch 53/2000  
11817/11817 [=====] - 0s - loss: 44628.7114 - val\_loss: 116560.3281  
Epoch 54/2000  
11817/11817 [=====] - 0s - loss: 44610.2971 - val\_loss: 116433.5859  
Epoch 55/2000  
11817/11817 [=====] - 0s - loss: 44508.0855 - val\_loss: 116455.4297  
Epoch 56/2000  
11817/11817 [=====] - 0s - loss: 44515.0100 - val\_loss: 116446.1484  
Epoch 57/2000  
11817/11817 [=====] - 0s - loss: 44484.0892 - val\_loss: 116769.8516  
Epoch 58/2000  
11817/11817 [=====] - 0s - loss: 44423.2213 - val\_loss: 116865.3672  
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11817/11817 [=====] - 0s - loss: 44394.5490 - val\_loss: 116789.0000  
Epoch 60/2000  
11817/11817 [=====] - 0s - loss: 44358.1290 - val\_loss: 116544.3516  
Epoch 61/2000  
11817/11817 [=====] - 0s - loss: 44290.0976 - val\_loss: 116698.8906  
Epoch 62/2000  
11817/11817 [=====] - 0s - loss: 44240.5512 - val\_loss: 116562.8594  
Epoch 63/2000  
11817/11817 [=====] - 0s - loss: 44218.3894 - val\_loss: 116746.6641  
Epoch 64/2000  
11817/11817 [=====] - 0s - loss: 44189.8577 - val\_loss: 116990.4297  
Epoch 65/2000  
11817/11817 [=====] - 0s - loss: 44132.5281 - val\_loss: 116720.2344  
Epoch 66/2000  
11817/11817 [=====] - 0s - loss: 44056.4832 - val\_loss: 116765.7969  
Epoch 67/2000  
11817/11817 [=====] - 0s - loss: 44033.4289 - val\_loss: 116515.4531  
Epoch 68/2000  
11817/11817 [=====] - 0s - loss: 43953.8256 - val\_loss: 116770.8281  
Epoch 69/2000  
11817/11817 [=====] - 0s - loss: 43952.4509 - val\_loss: 116816.3203  
Epoch 70/2000  
11817/11817 [=====] - 0s - loss: 43897.4789 - val\_loss: 116826.9688  
Epoch 71/2000  
11817/11817 [=====] - 0s - loss: 43841.0446 - val\_loss: 116999.5391  
Epoch 72/2000

11817/11817 [=====] - 0s - loss: 43823.2926 - val\_loss: 116462.2578  
 Epoch 73/2000  
 11817/11817 [=====] - 0s - loss: 43798.9131 - val\_loss: 116486.8906  
 Epoch 74/2000  
 11817/11817 [=====] - 0s - loss: 43699.5737 - val\_loss: 116434.4609  
 Epoch 75/2000  
 11817/11817 [=====] - 0s - loss: 43639.2345 - val\_loss: 116273.3672  
 Epoch 76/2000  
 11817/11817 [=====] - 0s - loss: 43572.0348 - val\_loss: 116649.9375  
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 11817/11817 [=====] - 0s - loss: 43527.3758 - val\_loss: 117357.1172  
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 11817/11817 [=====] - 0s - loss: 43496.4611 - val\_loss: 117252.1797  
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 11817/11817 [=====] - 0s - loss: 43445.8270 - val\_loss: 116493.9531  
 Epoch 80/2000  
 11817/11817 [=====] - 0s - loss: 43373.2314 - val\_loss: 116815.7109  
 Epoch 81/2000  
 11817/11817 [=====] - 0s - loss: 43308.5568 - val\_loss: 117053.3984  
 Epoch 82/2000  
 11817/11817 [=====] - 0s - loss: 43310.2576 - val\_loss: 117151.4141  
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 11817/11817 [=====] - 0s - loss: 43220.7664 - val\_loss: 116959.0000  
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 11817/11817 [=====] - 0s - loss: 43182.3235 - val\_loss: 117207.5234  
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 11817/11817 [=====] - 0s - loss: 43110.6387 - val\_loss: 117615.1328  
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 11817/11817 [=====] - 0s - loss: 43104.2965 - val\_loss: 116901.9453  
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 11817/11817 [=====] - 0s - loss: 43013.1715 - val\_loss: 117298.2500  
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 11817/11817 [=====] - 0s - loss: 43007.4724 - val\_loss: 117353.1484  
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 11817/11817 [=====] - 0s - loss: 42937.9104 - val\_loss: 117325.1016  
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 11817/11817 [=====] - 0s - loss: 42740.8738 - val\_loss: 116756.7578  
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 11817/11817 [=====] - 0s - loss: 42578.7598 - val\_loss: 116390.6328  
 Epoch 96/2000

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 11817/11817 [=====] - 0s - loss: 42466.1308 - val\_loss: 115857.2500  
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 11817/11817 [=====] - 0s - loss: 42243.5152 - val\_loss: 115345.3984  
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 11817/11817 [=====] - 0s - loss: 42028.5399 - val\_loss: 114819.3203  
 Epoch 106/2000  
 11817/11817 [=====] - 0s - loss: 41943.8723 - val\_loss: 114848.9531  
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 11817/11817 [=====] - 0s - loss: 41821.1380 - val\_loss: 113988.6719  
 Epoch 108/2000  
 11817/11817 [=====] - 0s - loss: 41814.8485 - val\_loss: 113638.5547  
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 11817/11817 [=====] - 0s - loss: 41692.7402 - val\_loss: 113840.2734  
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 11817/11817 [=====] - 0s - loss: 41675.4747 - val\_loss: 113460.0312  
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 11817/11817 [=====] - 0s - loss: 41455.2516 - val\_loss: 113757.5781  
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 Epoch 120/2000

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11817/11817 [=====] - 0s - loss: 40860.6380 - val\_loss: 112016.8359  
Epoch 124/2000  
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11817/11817 [=====] - 0s - loss: 40449.5290 - val\_loss: 110909.2422  
Epoch 130/2000  
11817/11817 [=====] - 0s - loss: 40469.7091 - val\_loss: 110476.8828  
Epoch 131/2000  
11817/11817 [=====] - 0s - loss: 40377.6921 - val\_loss: 110590.6250  
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11817/11817 [=====] - 0s - loss: 40276.0190 - val\_loss: 109791.6719  
Epoch 133/2000  
11817/11817 [=====] - 0s - loss: 40227.4366 - val\_loss: 109597.1953  
Epoch 134/2000  
11817/11817 [=====] - 0s - loss: 40140.2567 - val\_loss: 109866.1484  
Epoch 135/2000  
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Epoch 136/2000  
11817/11817 [=====] - 0s - loss: 39994.6094 - val\_loss: 109421.2734  
Epoch 137/2000  
11817/11817 [=====] - 0s - loss: 39982.7255 - val\_loss: 109338.6719  
Epoch 138/2000  
11817/11817 [=====] - 0s - loss: 39887.4399 - val\_loss: 109147.1016  
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11817/11817 [=====] - 0s - loss: 39548.5367 - val\_loss: 108504.5625  
Epoch 144/2000

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11817/11817 [=====] - 0s - loss: 39323.2574 - val\_loss: 107761.0234  
Epoch 147/2000  
11817/11817 [=====] - 0s - loss: 39292.3063 - val\_loss: 107439.6484  
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Epoch 162/2000  
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11817/11817 [=====] - 0s - loss: 37857.9206 - val\_loss: 104103.1719  
Epoch 166/2000  
11817/11817 [=====] - 0s - loss: 37965.9230 - val\_loss: 102703.8672  
Epoch 167/2000  
11817/11817 [=====] - 0s - loss: 37831.2045 - val\_loss: 101517.0469  
Epoch 168/2000

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 Epoch 240/2000



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11817/11817 [=====] - 0s - loss: 30436.5900 - val\_loss: 80803.0703  
Epoch 259/2000  
11817/11817 [=====] - 0s - loss: 30638.8264 - val\_loss: 81635.6641  
Epoch 260/2000  
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Epoch 264/2000

11817/11817 [=====] - 0s - loss: 29992.1383 - val\_loss: 78851.3750  
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11817/11817 [=====] - 0s - loss: 14233.3809 - val\_loss: 32680.1602  
Epoch 480/2000

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Epoch 624/2000



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Epoch 666/2000  
11817/11817 [=====] - 0s - loss: 8120.0222 - val\_loss: 15302.6104  
Epoch 667/2000  
11817/11817 [=====] - 0s - loss: 7801.6234 - val\_loss: 15978.4688  
Epoch 668/2000  
11817/11817 [=====] - 0s - loss: 7795.9100 - val\_loss: 15516.6602  
Epoch 669/2000  
11817/11817 [=====] - 0s - loss: 7895.9003 - val\_loss: 15855.1572  
Epoch 670/2000  
11817/11817 [=====] - 0s - loss: 7777.9439 - val\_loss: 17152.0117  
Epoch 671/2000  
11817/11817 [=====] - 0s - loss: 7877.1908 - val\_loss: 16083.6182  
Epoch 672/2000

11817/11817 [=====] - 0s - loss: 8026.7925 - val\_loss: 13881.1387  
Epoch 673/2000  
11817/11817 [=====] - 0s - loss: 7841.6245 - val\_loss: 13164.2070  
Epoch 674/2000  
11817/11817 [=====] - 0s - loss: 7793.2244 - val\_loss: 14004.1807  
Epoch 675/2000  
11817/11817 [=====] - 0s - loss: 7896.9079 - val\_loss: 14198.4648  
Epoch 676/2000  
11817/11817 [=====] - 0s - loss: 7667.3537 - val\_loss: 14750.3916  
Epoch 677/2000  
11817/11817 [=====] - 0s - loss: 7656.1339 - val\_loss: 15219.1836  
Epoch 678/2000  
11817/11817 [=====] - 0s - loss: 8053.0824 - val\_loss: 15033.7881  
Epoch 679/2000  
11817/11817 [=====] - 0s - loss: 7847.3084 - val\_loss: 13697.3613  
Epoch 680/2000  
11817/11817 [=====] - 0s - loss: 7493.6239 - val\_loss: 11835.4443  
Epoch 681/2000  
11817/11817 [=====] - 0s - loss: 7499.1002 - val\_loss: 12204.3340  
Epoch 682/2000  
11817/11817 [=====] - 0s - loss: 7667.6848 - val\_loss: 12663.0332  
Epoch 683/2000  
11817/11817 [=====] - 0s - loss: 7520.1038 - val\_loss: 12036.1660  
Epoch 684/2000  
11817/11817 [=====] - 0s - loss: 7630.4361 - val\_loss: 12020.2275  
Epoch 685/2000  
11817/11817 [=====] - 0s - loss: 7482.8092 - val\_loss: 13289.9043  
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11817/11817 [=====] - 0s - loss: 7799.5907 - val\_loss: 14540.5039  
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11817/11817 [=====] - 0s - loss: 7885.5045 - val\_loss: 13895.5605  
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11817/11817 [=====] - 0s - loss: 7541.7010 - val\_loss: 13539.3340  
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11817/11817 [=====] - 0s - loss: 7551.1683 - val\_loss: 14254.4004  
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11817/11817 [=====] - 0s - loss: 7801.7861 - val\_loss: 16127.3174  
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11817/11817 [=====] - 0s - loss: 7757.5349 - val\_loss: 16114.0879  
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11817/11817 [=====] - 0s - loss: 7388.6362 - val\_loss: 12461.4014  
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11817/11817 [=====] - 0s - loss: 7587.5306 - val\_loss: 12157.5107  
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11817/11817 [=====] - 0s - loss: 7584.6266 - val\_loss: 12682.1670  
Epoch 696/2000

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11817/11817 [=====] - 0s - loss: 7351.2413 - val\_loss: 9990.2090  
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11817/11817 [=====] - 0s - loss: 7518.9256 - val\_loss: 10741.5977  
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11817/11817 [=====] - 0s - loss: 7582.4571 - val\_loss: 11477.1406  
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11817/11817 [=====] - 0s - loss: 7357.1097 - val\_loss: 12724.0098  
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11817/11817 [=====] - 0s - loss: 7598.0950 - val\_loss: 13551.7129  
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11817/11817 [=====] - 0s - loss: 7412.7383 - val\_loss: 13956.1357  
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11817/11817 [=====] - 0s - loss: 7112.2838 - val\_loss: 13663.9980  
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11817/11817 [=====] - 0s - loss: 7417.2448 - val\_loss: 12529.8955  
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11817/11817 [=====] - 0s - loss: 7515.0675 - val\_loss: 12000.7881  
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11817/11817 [=====] - 0s - loss: 7363.7003 - val\_loss: 13149.5586  
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11817/11817 [=====] - 0s - loss: 7317.5509 - val\_loss: 11637.1748  
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11817/11817 [=====] - 0s - loss: 7479.6909 - val\_loss: 11532.2227  
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11817/11817 [=====] - 0s - loss: 7099.3978 - val\_loss: 11273.7568  
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11817/11817 [=====] - 0s - loss: 7209.1574 - val\_loss: 11539.9512  
Epoch 718/2000  
11817/11817 [=====] - 0s - loss: 7047.2641 - val\_loss: 11358.8311  
Epoch 719/2000  
11817/11817 [=====] - 0s - loss: 7304.5319 - val\_loss: 10739.6055  
Epoch 720/2000

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11817/11817 [=====] - 0s - loss: 7234.0016 - val\_loss: 9825.3740  
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11817/11817 [=====] - 0s - loss: 7074.5579 - val\_loss: 9852.4316  
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11817/11817 [=====] - 0s - loss: 6995.8778 - val\_loss: 10169.0283  
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11817/11817 [=====] - 0s - loss: 7155.4679 - val\_loss: 11226.3486  
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11817/11817 [=====] - 0s - loss: 7140.1463 - val\_loss: 11092.0068  
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11817/11817 [=====] - 0s - loss: 7078.1598 - val\_loss: 9661.3623  
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11817/11817 [=====] - 0s - loss: 7245.9626 - val\_loss: 8957.5801  
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11817/11817 [=====] - 0s - loss: 6969.3369 - val\_loss: 11253.5391  
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11817/11817 [=====] - 0s - loss: 7026.7942 - val\_loss: 10130.7314  
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11817/11817 [=====] - 0s - loss: 6912.4275 - val\_loss: 10310.1846  
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11817/11817 [=====] - 0s - loss: 7058.3233 - val\_loss: 10920.8525  
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11817/11817 [=====] - 0s - loss: 6946.7700 - val\_loss: 12137.2012  
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11817/11817 [=====] - 0s - loss: 6962.9082 - val\_loss: 10713.1816  
Epoch 742/2000  
11817/11817 [=====] - 0s - loss: 6933.6823 - val\_loss: 10480.6152  
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11817/11817 [=====] - 0s - loss: 7178.2444 - val\_loss: 10189.8594  
Epoch 744/2000

11817/11817 [=====] - 0s - loss: 7206.3847 - val\_loss: 10903.5615  
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11817/11817 [=====] - 0s - loss: 6999.6829 - val\_loss: 9624.7305  
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11817/11817 [=====] - 0s - loss: 7023.1391 - val\_loss: 9565.3271  
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11817/11817 [=====] - 0s - loss: 6971.7771 - val\_loss: 10398.9287  
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11817/11817 [=====] - 0s - loss: 6811.8827 - val\_loss: 9238.4824  
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11817/11817 [=====] - 0s - loss: 7012.8246 - val\_loss: 8591.6396  
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11817/11817 [=====] - 0s - loss: 6973.9421 - val\_loss: 9760.6055  
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11817/11817 [=====] - 0s - loss: 6920.7617 - val\_loss: 9616.5918  
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11817/11817 [=====] - 0s - loss: 6511.6166 - val\_loss: 9707.3184  
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11817/11817 [=====] - 0s - loss: 6673.4483 - val\_loss: 9275.2031  
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11817/11817 [=====] - 0s - loss: 6719.9382 - val\_loss: 8794.7822  
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11817/11817 [=====] - 0s - loss: 6794.1745 - val\_loss: 9566.2627  
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11817/11817 [=====] - 0s - loss: 6790.0612 - val\_loss: 11173.7793  
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11817/11817 [=====] - 0s - loss: 6545.0842 - val\_loss: 9604.4893  
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11817/11817 [=====] - 0s - loss: 6572.0251 - val\_loss: 9733.6494  
Epoch 768/2000

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Epoch 781/2000  
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11817/11817 [=====] - 0s - loss: 6449.9790 - val\_loss: 10002.7041  
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11817/11817 [=====] - 0s - loss: 6428.5026 - val\_loss: 9858.7529  
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11817/11817 [=====] - 0s - loss: 6771.7297 - val\_loss: 7764.9419  
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Epoch 792/2000

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Epoch 801/2000  
11817/11817 [=====] - 0s - loss: 6483.3969 - val\_loss: 8690.0928  
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11817/11817 [=====] - 0s - loss: 6605.6914 - val\_loss: 7297.1646  
Epoch 803/2000  
11817/11817 [=====] - 0s - loss: 6562.0459 - val\_loss: 7115.6055  
Epoch 804/2000  
11817/11817 [=====] - 0s - loss: 6422.4937 - val\_loss: 7805.3984  
Epoch 805/2000  
11817/11817 [=====] - 0s - loss: 6495.1861 - val\_loss: 8569.4873  
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11817/11817 [=====] - 0s - loss: 6516.6487 - val\_loss: 9438.1377  
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11817/11817 [=====] - 0s - loss: 6434.9628 - val\_loss: 10462.9277  
Epoch 816/2000



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11817/11817 [=====] - 0s - loss: 6477.3404 - val\_loss: 7735.1572  
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11817/11817 [=====] - 0s - loss: 6490.8642 - val\_loss: 8227.0947  
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11817/11817 [=====] - 0s - loss: 6353.2964 - val\_loss: 7764.2090  
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11817/11817 [=====] - 0s - loss: 6356.4776 - val\_loss: 7803.4541  
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11817/11817 [=====] - 0s - loss: 6218.1885 - val\_loss: 8455.9355  
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11817/11817 [=====] - 0s - loss: 6284.7313 - val\_loss: 9046.6377  
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11817/11817 [=====] - 0s - loss: 6215.9704 - val\_loss: 9549.2725  
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11817/11817 [=====] - 0s - loss: 6521.5507 - val\_loss: 9886.4033  
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11817/11817 [=====] - 0s - loss: 6241.2763 - val\_loss: 9524.4141  
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11817/11817 [=====] - 0s - loss: 6561.4772 - val\_loss: 8905.3955  
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11817/11817 [=====] - 0s - loss: 6389.0013 - val\_loss: 7780.2402  
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11817/11817 [=====] - 0s - loss: 6437.4035 - val\_loss: 8173.4351  
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11817/11817 [=====] - 0s - loss: 6187.3740 - val\_loss: 8383.6777  
Epoch 839/2000  
11817/11817 [=====] - 0s - loss: 6130.5084 - val\_loss: 8720.0771  
Epoch 840/2000

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11817/11817 [=====] - 0s - loss: 6296.0262 - val_loss: 8838.5625
Epoch 841/2000
11817/11817 [=====] - 0s - loss: 6232.1946 - val_loss: 8376.1143
Epoch 842/2000
11817/11817 [=====] - 0s - loss: 6316.4238 - val_loss: 8362.0938
Epoch 843/2000
11817/11817 [=====] - 0s - loss: 6404.2770 - val_loss: 8252.1953
Epoch 844/2000
11817/11817 [=====] - 0s - loss: 6287.6065 - val_loss: 8501.8213
Epoch 845/2000
11817/11817 [=====] - 0s - loss: 6521.9659 - val_loss: 9055.4893
Epoch 846/2000
11817/11817 [=====] - 0s - loss: 6181.5256 - val_loss: 8891.5039
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11817/11817 [=====] - 0s - loss: 6255.3141 - val_loss: 9290.3545
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11817/11817 [=====] - 0s - loss: 6389.0954 - val_loss: 9400.9707
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11817/11817 [=====] - 0s - loss: 6280.7400 - val_loss: 8851.2549
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11817/11817 [=====] - 0s - loss: 6341.3097 - val_loss: 8806.5869
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11817/11817 [=====] - 0s - loss: 6153.4639 - val_loss: 8498.5410
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11817/11817 [=====] - 0s - loss: 6275.9662 - val_loss: 8640.9912
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11817/11817 [=====] - 0s - loss: 6448.4954 - val_loss: 8023.9575
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11817/11817 [=====] - 0s - loss: 6441.9627 - val_loss: 8052.8418
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11817/11817 [=====] - 0s - loss: 6199.4100 - val_loss: 8780.1846
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11817/11817 [=====] - 0s - loss: 6410.9633 - val_loss: 8833.6338
Epoch 857/2000
11817/11817 [=====] - 0s - loss: 6225.4215 - val_loss: 8618.2998
Epoch 858/2000
11817/11817 [=====] - 0s - loss: 6048.3905 - val_loss: 8580.8838
Epoch 859/2000
11817/11817 [=====] - 0s - loss: 6221.6902 - val_loss: 8347.8555
Epoch 860/2000
11817/11817 [=====] - 0s - loss: 6540.3717 - val_loss: 7970.9590
Epoch 861/2000
11817/11817 [=====] - 0s - loss: 6104.6540 - val_loss: 7783.9233
Epoch 862/2000
11817/11817 [=====] - 0s - loss: 6252.2768 - val_loss: 8027.5396
Epoch 863/2000
11817/11817 [=====] - 0s - loss: 6184.5965 - val_loss: 8486.7686
Epoch 864/2000

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11817/11817 [=====] - 0s - loss: 6261.9497 - val\_loss: 8725.2168  
Epoch 865/2000  
11817/11817 [=====] - 0s - loss: 6108.7319 - val\_loss: 8832.7686  
Epoch 866/2000  
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Epoch 867/2000  
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Epoch 888/2000

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Epoch 1008/2000



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11817/11817 [=====] - 0s - loss: 5949.2511 - val_loss: 5991.3799
Epoch 1009/2000
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Epoch 1013/2000
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11817/11817 [=====] - 0s - loss: 5757.5079 - val_loss: 7973.6152
Epoch 1032/2000

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Epoch 1067/2000
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Epoch 1078/2000
11817/11817 [=====] - 0s - loss: 5797.5556 - val_loss: 7806.5352
Epoch 1079/2000
11817/11817 [=====] - 0s - loss: 5714.8630 - val_loss: 7898.5537
Epoch 1080/2000

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Epoch 1104/2000

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11817/11817 [=====] - 0s - loss: 5768.4328 - val\_loss: 6858.1567  
Epoch 1267/2000  
11817/11817 [=====] - 0s - loss: 5729.4495 - val\_loss: 6961.4492  
Epoch 1268/2000  
11817/11817 [=====] - 0s - loss: 5685.5468 - val\_loss: 7215.2124  
Epoch 1269/2000  
11817/11817 [=====] - 0s - loss: 5758.7644 - val\_loss: 6859.3975  
Epoch 1270/2000  
11817/11817 [=====] - 0s - loss: 5837.2674 - val\_loss: 6558.4282  
Epoch 1271/2000  
11817/11817 [=====] - 0s - loss: 5773.7479 - val\_loss: 6205.1050  
Epoch 1272/2000

11817/11817 [=====] - 0s - loss: 5527.8810 - val\_loss: 6176.0806  
 Epoch 1273/2000  
 11817/11817 [=====] - 0s - loss: 5664.4490 - val\_loss: 6445.8784  
 Epoch 1274/2000  
 11817/11817 [=====] - 0s - loss: 5813.4772 - val\_loss: 6541.9346  
 Epoch 1275/2000  
 11817/11817 [=====] - 0s - loss: 5937.6229 - val\_loss: 6669.4282  
 Epoch 1276/2000  
 11817/11817 [=====] - 0s - loss: 5848.0658 - val\_loss: 7551.4863  
 Epoch 1277/2000  
 11817/11817 [=====] - 0s - loss: 5690.2006 - val\_loss: 7899.3735  
 Epoch 1278/2000  
 11817/11817 [=====] - 0s - loss: 5914.7360 - val\_loss: 7402.4199  
 Epoch 1279/2000  
 11817/11817 [=====] - 0s - loss: 5728.0127 - val\_loss: 7437.5073  
 Epoch 1280/2000  
 11817/11817 [=====] - 0s - loss: 5764.3143 - val\_loss: 7385.4077  
 Epoch 1281/2000  
 11817/11817 [=====] - 0s - loss: 5802.2846 - val\_loss: 7051.1240  
 Epoch 1282/2000  
 11817/11817 [=====] - 0s - loss: 5675.9519 - val\_loss: 6893.0435  
 Epoch 1283/2000  
 11817/11817 [=====] - 0s - loss: 5880.3732 - val\_loss: 7227.3862  
 Epoch 1284/2000  
 11817/11817 [=====] - 0s - loss: 5815.2890 - val\_loss: 7635.3276  
 Epoch 1285/2000  
 11817/11817 [=====] - 0s - loss: 5736.5226 - val\_loss: 7638.6167  
 Epoch 1286/2000  
 11817/11817 [=====] - 0s - loss: 5810.3625 - val\_loss: 7281.0615  
 Epoch 1287/2000  
 11817/11817 [=====] - 0s - loss: 5752.2858 - val\_loss: 7064.7729  
 Epoch 1288/2000  
 11817/11817 [=====] - 0s - loss: 5474.2645 - val\_loss: 6788.8164  
 Epoch 1289/2000  
 11817/11817 [=====] - 0s - loss: 5748.1240 - val\_loss: 6604.3262  
 Epoch 1290/2000  
 11817/11817 [=====] - 0s - loss: 5934.3277 - val\_loss: 6530.9946  
 Epoch 1291/2000  
 11817/11817 [=====] - 0s - loss: 5653.4666 - val\_loss: 6374.8208  
 Epoch 1292/2000  
 11817/11817 [=====] - 0s - loss: 5894.4258 - val\_loss: 6493.1357  
 Epoch 1293/2000  
 11817/11817 [=====] - 0s - loss: 5723.8233 - val\_loss: 6859.4043  
 Epoch 1294/2000  
 11817/11817 [=====] - 0s - loss: 5726.8564 - val\_loss: 6951.7871  
 Epoch 1295/2000  
 11817/11817 [=====] - 0s - loss: 5901.1149 - val\_loss: 7431.4834  
 Epoch 1296/2000

```

11817/11817 [=====] - 0s - loss: 5850.3198 - val_loss: 7303.1479
Epoch 1297/2000
11817/11817 [=====] - 0s - loss: 5845.9364 - val_loss: 7109.6895
Epoch 1298/2000
11817/11817 [=====] - 0s - loss: 5589.6110 - val_loss: 7101.2520
Epoch 1299/2000
11817/11817 [=====] - 0s - loss: 5940.5098 - val_loss: 6854.0796
Epoch 1300/2000
11817/11817 [=====] - 0s - loss: 5722.5932 - val_loss: 7130.9448
Epoch 1301/2000
11817/11817 [=====] - 0s - loss: 5787.2395 - val_loss: 7719.7310

```

```

In [41]: past_preds = model.predict(train_features)[: , 0]
         future_preds = model.predict(test_features)[: , 0]

         from sklearn.metrics import r2_score
         import numpy as np

         # our benchmark is just guessing the average
         benchmark = np.mean(train_targets)
         print('benchmark r^2 on training:', r2_score(train_targets, [benchmark] * train_targets.shape[0]))

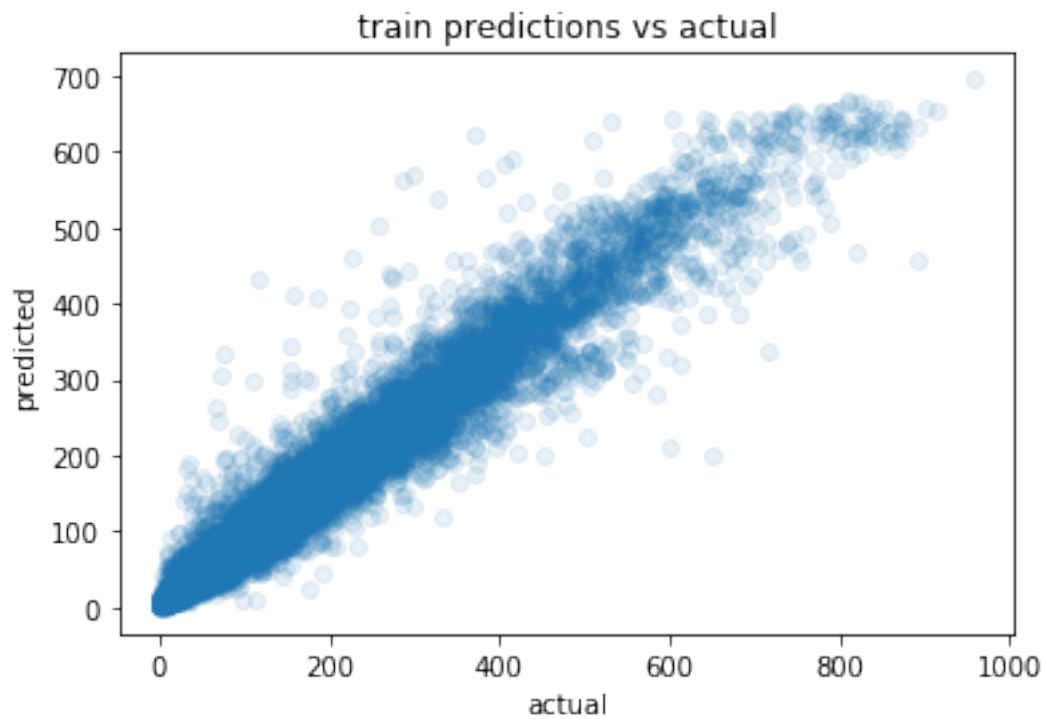
         print('training r^2:', r2_score(train_targets, past_preds))
         plt.scatter(train_targets, past_preds, alpha=0.1)
         plt.xlabel('actual')
         plt.ylabel('predicted')
         plt.title('train predictions vs actual')
         plt.show()

         print('benchmark r^2 on test:', r2_score(test_targets, [benchmark] * test_targets.shape[0]))

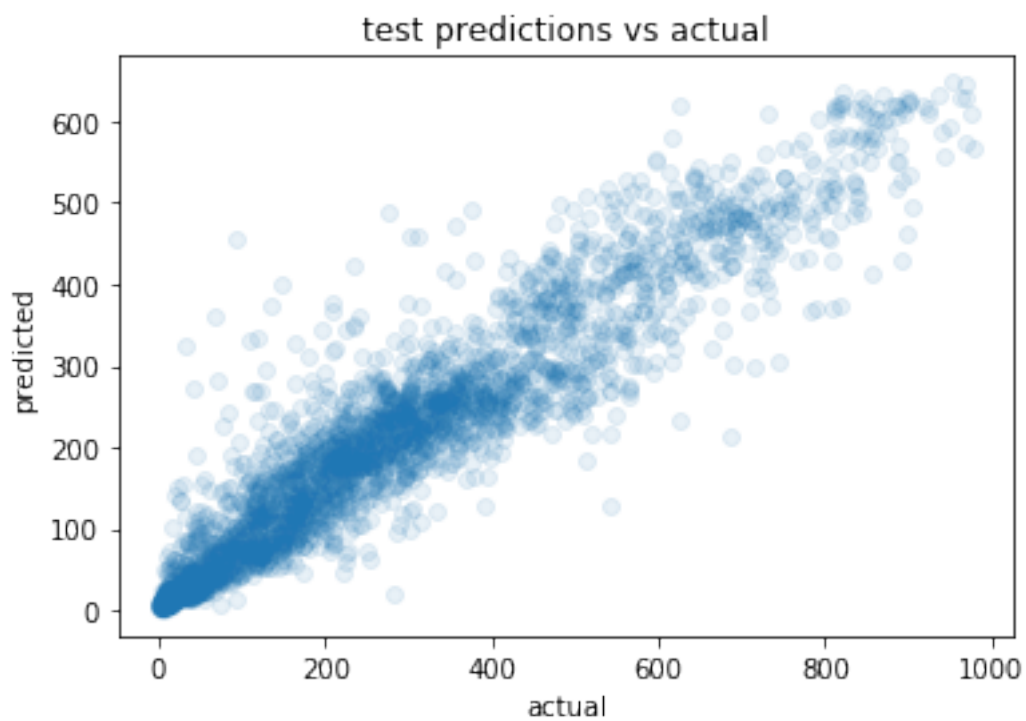
         print('r^2 on test:', r2_score(test_targets, future_preds))
         plt.scatter(test_targets, future_preds, alpha=0.1)
         plt.xlabel('actual')
         plt.ylabel('predicted')
         plt.title('test predictions vs actual')
         plt.show()

benchmark r^2 on training: 0.0
training r^2: 0.906318500515

```



benchmark  $r^2$  on test: -0.112995264662  
 $r^2$  on test: 0.748600396798



8 performance didn't seem to improve much with the added last layer, so we will leave it out. Checking effect of mean squared log error as the loss function:

In [42]: *# creates the model*

```
# restart keras session (clear weights), sometimes this will clear up errors
K.clear_session()

# functional API
inputs = Input(shape=(features.shape[1], ))
x1 = Dense(1000, activation='elu')(inputs)
x2 = BatchNormalization()(x1)
x3 = Dropout(0.5)(x2)
x4 = Dense(500, activation='elu')(x3)
x5 = BatchNormalization()(x4)
x6 = Dropout(0.5)(x5)
x7 = Dense(100, activation='elu')(x6)
x8 = BatchNormalization()(x7)
x9 = Dropout(0.5)(x8)
predictions = Dense(1, activation='linear')(x9)

# this saves the best model (lowest validation loss)
checkpoint = ModelCheckpoint('3_layer_dense.h5', monitor='val_loss', save_best_only=True)
# this stops training if the validation loss is not improving for 50 epochs in a row
es = EarlyStopping(patience=50)
cb = [checkpoint, es]

# this compiles our model so it is ready to fit
model = Model(inputs, predictions)
model.compile(optimizer='adam', loss='msle')

subset_size = trainsize
train_feature_subset = train_features[:subset_size]
train_target_subset = train_targets[:subset_size]
# we actually fit the model here
history = model.fit(train_feature_subset,
                    train_target_subset,
                    epochs=500,
                    validation_split=0.15,
                    callbacks=cb,
                    batch_size=3000)
```

Train on 11817 samples, validate on 2086 samples

Epoch 1/500  
11817/11817 [=====] - 0s - loss: 14.8808 - val\_loss: 5.8870  
Epoch 2/500  
11817/11817 [=====] - 0s - loss: 11.9932 - val\_loss: 5.8795  
Epoch 3/500  
11817/11817 [=====] - 0s - loss: 11.0991 - val\_loss: 7.2161  
Epoch 4/500  
11817/11817 [=====] - 0s - loss: 10.4644 - val\_loss: 9.3180  
Epoch 5/500  
11817/11817 [=====] - 0s - loss: 10.1569 - val\_loss: 10.5714  
Epoch 6/500  
11817/11817 [=====] - 0s - loss: 9.9200 - val\_loss: 9.6096  
Epoch 7/500  
11817/11817 [=====] - 0s - loss: 9.6808 - val\_loss: 8.2269  
Epoch 8/500  
11817/11817 [=====] - 0s - loss: 9.4921 - val\_loss: 7.6037  
Epoch 9/500  
11817/11817 [=====] - 0s - loss: 9.3259 - val\_loss: 7.6200  
Epoch 10/500  
11817/11817 [=====] - 0s - loss: 9.1590 - val\_loss: 7.7865  
Epoch 11/500  
11817/11817 [=====] - 0s - loss: 9.0005 - val\_loss: 7.7887  
Epoch 12/500  
11817/11817 [=====] - 0s - loss: 8.8280 - val\_loss: 7.3987  
Epoch 13/500  
11817/11817 [=====] - 0s - loss: 8.6668 - val\_loss: 6.9619  
Epoch 14/500  
11817/11817 [=====] - 0s - loss: 8.5142 - val\_loss: 6.8358  
Epoch 15/500  
11817/11817 [=====] - 0s - loss: 8.3420 - val\_loss: 6.7551  
Epoch 16/500  
11817/11817 [=====] - 0s - loss: 8.1969 - val\_loss: 6.6410  
Epoch 17/500  
11817/11817 [=====] - 0s - loss: 8.0165 - val\_loss: 6.6075  
Epoch 18/500  
11817/11817 [=====] - 0s - loss: 7.8254 - val\_loss: 6.5429  
Epoch 19/500  
11817/11817 [=====] - 0s - loss: 7.6853 - val\_loss: 6.3431  
Epoch 20/500  
11817/11817 [=====] - 0s - loss: 7.4985 - val\_loss: 6.2216  
Epoch 21/500  
11817/11817 [=====] - 0s - loss: 7.3267 - val\_loss: 6.1319  
Epoch 22/500  
11817/11817 [=====] - 0s - loss: 7.1705 - val\_loss: 6.0545  
Epoch 23/500  
11817/11817 [=====] - 0s - loss: 6.9987 - val\_loss: 6.0036  
Epoch 24/500  
11817/11817 [=====] - 0s - loss: 6.8451 - val\_loss: 5.8508



Epoch 25/500  
11817/11817 [=====] - 0s - loss: 6.7042 - val\_loss: 5.7140  
Epoch 26/500  
11817/11817 [=====] - 0s - loss: 6.5958 - val\_loss: 5.7438  
Epoch 27/500  
11817/11817 [=====] - 0s - loss: 6.4668 - val\_loss: 5.7372  
Epoch 28/500  
11817/11817 [=====] - 0s - loss: 6.3503 - val\_loss: 5.6576  
Epoch 29/500  
11817/11817 [=====] - 0s - loss: 6.2514 - val\_loss: 5.6023  
Epoch 30/500  
11817/11817 [=====] - 0s - loss: 6.1447 - val\_loss: 5.5184  
Epoch 31/500  
11817/11817 [=====] - 0s - loss: 6.0422 - val\_loss: 5.3977  
Epoch 32/500  
11817/11817 [=====] - 0s - loss: 5.9453 - val\_loss: 5.4388  
Epoch 33/500  
11817/11817 [=====] - 0s - loss: 5.8705 - val\_loss: 5.3166  
Epoch 34/500  
11817/11817 [=====] - 0s - loss: 5.7846 - val\_loss: 5.2662  
Epoch 35/500  
11817/11817 [=====] - 0s - loss: 5.6947 - val\_loss: 5.1250  
Epoch 36/500  
11817/11817 [=====] - 0s - loss: 5.6375 - val\_loss: 5.1115  
Epoch 37/500  
11817/11817 [=====] - 0s - loss: 5.5591 - val\_loss: 5.2345  
Epoch 38/500  
11817/11817 [=====] - 0s - loss: 5.4914 - val\_loss: 5.2911  
Epoch 39/500  
11817/11817 [=====] - 0s - loss: 5.4253 - val\_loss: 5.3333  
Epoch 40/500  
11817/11817 [=====] - 0s - loss: 5.3634 - val\_loss: 5.3470  
Epoch 41/500  
11817/11817 [=====] - 0s - loss: 5.3046 - val\_loss: 5.2985  
Epoch 42/500  
11817/11817 [=====] - 0s - loss: 5.2648 - val\_loss: 5.2937  
Epoch 43/500  
11817/11817 [=====] - 0s - loss: 5.1861 - val\_loss: 5.1977  
Epoch 44/500  
11817/11817 [=====] - 0s - loss: 5.1295 - val\_loss: 5.1462  
Epoch 45/500  
11817/11817 [=====] - 0s - loss: 5.0643 - val\_loss: 5.1217  
Epoch 46/500  
11817/11817 [=====] - 0s - loss: 5.0161 - val\_loss: 5.2052  
Epoch 47/500  
11817/11817 [=====] - 0s - loss: 4.9707 - val\_loss: 5.2377  
Epoch 48/500  
11817/11817 [=====] - 0s - loss: 4.9075 - val\_loss: 5.2164

Epoch 49/500  
11817/11817 [=====] - 0s - loss: 4.8811 - val\_loss: 5.2302  
Epoch 50/500  
11817/11817 [=====] - 0s - loss: 4.8202 - val\_loss: 5.2476  
Epoch 51/500  
11817/11817 [=====] - 0s - loss: 4.7831 - val\_loss: 5.2890  
Epoch 52/500  
11817/11817 [=====] - 0s - loss: 4.7456 - val\_loss: 5.3087  
Epoch 53/500  
11817/11817 [=====] - 0s - loss: 4.7053 - val\_loss: 5.2825  
Epoch 54/500  
11817/11817 [=====] - 0s - loss: 4.6477 - val\_loss: 5.2510  
Epoch 55/500  
11817/11817 [=====] - 0s - loss: 4.6072 - val\_loss: 5.1810  
Epoch 56/500  
11817/11817 [=====] - 0s - loss: 4.5810 - val\_loss: 5.1420  
Epoch 57/500  
11817/11817 [=====] - 0s - loss: 4.5362 - val\_loss: 5.1826  
Epoch 58/500  
11817/11817 [=====] - 0s - loss: 4.5001 - val\_loss: 5.1765  
Epoch 59/500  
11817/11817 [=====] - 0s - loss: 4.4545 - val\_loss: 5.1887  
Epoch 60/500  
11817/11817 [=====] - 0s - loss: 4.4224 - val\_loss: 5.1829  
Epoch 61/500  
11817/11817 [=====] - 0s - loss: 4.3855 - val\_loss: 5.1447  
Epoch 62/500  
11817/11817 [=====] - 0s - loss: 4.3537 - val\_loss: 5.2094  
Epoch 63/500  
11817/11817 [=====] - 0s - loss: 4.3052 - val\_loss: 5.1811  
Epoch 64/500  
11817/11817 [=====] - 0s - loss: 4.2968 - val\_loss: 5.1486  
Epoch 65/500  
11817/11817 [=====] - 0s - loss: 4.2471 - val\_loss: 5.1171  
Epoch 66/500  
11817/11817 [=====] - 0s - loss: 4.2309 - val\_loss: 5.1165  
Epoch 67/500  
11817/11817 [=====] - 0s - loss: 4.1958 - val\_loss: 5.0984  
Epoch 68/500  
11817/11817 [=====] - 0s - loss: 4.1622 - val\_loss: 5.1186  
Epoch 69/500  
11817/11817 [=====] - 0s - loss: 4.1318 - val\_loss: 5.1118  
Epoch 70/500  
11817/11817 [=====] - 0s - loss: 4.0966 - val\_loss: 5.0884  
Epoch 71/500  
11817/11817 [=====] - 0s - loss: 4.0811 - val\_loss: 5.0174  
Epoch 72/500  
11817/11817 [=====] - 0s - loss: 4.0457 - val\_loss: 5.0433

Epoch 73/500  
11817/11817 [=====] - 0s - loss: 4.0080 - val\_loss: 5.0259  
Epoch 74/500  
11817/11817 [=====] - 0s - loss: 3.9792 - val\_loss: 5.0627  
Epoch 75/500  
11817/11817 [=====] - 0s - loss: 3.9653 - val\_loss: 5.0536  
Epoch 76/500  
11817/11817 [=====] - 0s - loss: 3.9339 - val\_loss: 5.0391  
Epoch 77/500  
11817/11817 [=====] - 0s - loss: 3.9122 - val\_loss: 4.9584  
Epoch 78/500  
11817/11817 [=====] - 0s - loss: 3.8905 - val\_loss: 4.9414  
Epoch 79/500  
11817/11817 [=====] - 0s - loss: 3.8613 - val\_loss: 4.9437  
Epoch 80/500  
11817/11817 [=====] - 0s - loss: 3.8416 - val\_loss: 4.9093  
Epoch 81/500  
11817/11817 [=====] - 0s - loss: 3.8181 - val\_loss: 4.9580  
Epoch 82/500  
11817/11817 [=====] - 0s - loss: 3.7884 - val\_loss: 4.9143  
Epoch 83/500  
11817/11817 [=====] - 0s - loss: 3.7754 - val\_loss: 4.9242  
Epoch 84/500  
11817/11817 [=====] - 0s - loss: 3.7524 - val\_loss: 4.9351  
Epoch 85/500  
11817/11817 [=====] - 0s - loss: 3.7253 - val\_loss: 4.8967  
Epoch 86/500  
11817/11817 [=====] - 0s - loss: 3.7013 - val\_loss: 4.8753  
Epoch 87/500  
11817/11817 [=====] - 0s - loss: 3.6787 - val\_loss: 4.8471  
Epoch 88/500  
11817/11817 [=====] - 0s - loss: 3.6573 - val\_loss: 4.9620  
Epoch 89/500  
11817/11817 [=====] - 0s - loss: 3.6378 - val\_loss: 4.9495  
Epoch 90/500  
11817/11817 [=====] - 0s - loss: 3.6187 - val\_loss: 4.8916  
Epoch 91/500  
11817/11817 [=====] - 0s - loss: 3.6034 - val\_loss: 4.8666  
Epoch 92/500  
11817/11817 [=====] - 0s - loss: 3.5759 - val\_loss: 4.9100  
Epoch 93/500  
11817/11817 [=====] - 0s - loss: 3.5619 - val\_loss: 4.8895  
Epoch 94/500  
11817/11817 [=====] - 0s - loss: 3.5369 - val\_loss: 4.8384  
Epoch 95/500  
11817/11817 [=====] - 0s - loss: 3.5265 - val\_loss: 4.8016  
Epoch 96/500  
11817/11817 [=====] - 0s - loss: 3.5066 - val\_loss: 4.8731

Epoch 97/500  
11817/11817 [=====] - 0s - loss: 3.4937 - val\_loss: 4.8098  
Epoch 98/500  
11817/11817 [=====] - 0s - loss: 3.4777 - val\_loss: 4.7834  
Epoch 99/500  
11817/11817 [=====] - 0s - loss: 3.4582 - val\_loss: 4.7952  
Epoch 100/500  
11817/11817 [=====] - 0s - loss: 3.4349 - val\_loss: 4.7731  
Epoch 101/500  
11817/11817 [=====] - 0s - loss: 3.4095 - val\_loss: 4.7367  
Epoch 102/500  
11817/11817 [=====] - 0s - loss: 3.3885 - val\_loss: 4.7737  
Epoch 103/500  
11817/11817 [=====] - 0s - loss: 3.3774 - val\_loss: 4.7949  
Epoch 104/500  
11817/11817 [=====] - 0s - loss: 3.3499 - val\_loss: 4.7333  
Epoch 105/500  
11817/11817 [=====] - 0s - loss: 3.3568 - val\_loss: 4.6882  
Epoch 106/500  
11817/11817 [=====] - 0s - loss: 3.3347 - val\_loss: 4.6625  
Epoch 107/500  
11817/11817 [=====] - 0s - loss: 3.3111 - val\_loss: 4.6920  
Epoch 108/500  
11817/11817 [=====] - 0s - loss: 3.2963 - val\_loss: 4.6689  
Epoch 109/500  
11817/11817 [=====] - 0s - loss: 3.2882 - val\_loss: 4.6336  
Epoch 110/500  
11817/11817 [=====] - 0s - loss: 3.2806 - val\_loss: 4.6700  
Epoch 111/500  
11817/11817 [=====] - 0s - loss: 3.2544 - val\_loss: 4.5534  
Epoch 112/500  
11817/11817 [=====] - 0s - loss: 3.2713 - val\_loss: 4.5834  
Epoch 113/500  
11817/11817 [=====] - 0s - loss: 3.2349 - val\_loss: 4.6778  
Epoch 114/500  
11817/11817 [=====] - 0s - loss: 3.2192 - val\_loss: 4.5569  
Epoch 115/500  
11817/11817 [=====] - 0s - loss: 3.2073 - val\_loss: 4.5080  
Epoch 116/500  
11817/11817 [=====] - 0s - loss: 3.1828 - val\_loss: 4.5444  
Epoch 117/500  
11817/11817 [=====] - 0s - loss: 3.1704 - val\_loss: 4.5198  
Epoch 118/500  
11817/11817 [=====] - 0s - loss: 3.1576 - val\_loss: 4.4923  
Epoch 119/500  
11817/11817 [=====] - 0s - loss: 3.1556 - val\_loss: 4.4917  
Epoch 120/500  
11817/11817 [=====] - 0s - loss: 3.1356 - val\_loss: 4.4724

Epoch 121/500  
11817/11817 [=====] - 0s - loss: 3.1258 - val\_loss: 4.4892  
Epoch 122/500  
11817/11817 [=====] - 0s - loss: 3.1045 - val\_loss: 4.4336  
Epoch 123/500  
11817/11817 [=====] - 0s - loss: 3.0823 - val\_loss: 4.3935  
Epoch 124/500  
11817/11817 [=====] - 0s - loss: 3.0925 - val\_loss: 4.4210  
Epoch 125/500  
11817/11817 [=====] - 0s - loss: 3.0759 - val\_loss: 4.4099  
Epoch 126/500  
11817/11817 [=====] - 0s - loss: 3.0619 - val\_loss: 4.3999  
Epoch 127/500  
11817/11817 [=====] - 0s - loss: 3.0492 - val\_loss: 4.4256  
Epoch 128/500  
11817/11817 [=====] - 0s - loss: 3.0284 - val\_loss: 4.3753  
Epoch 129/500  
11817/11817 [=====] - 0s - loss: 3.0227 - val\_loss: 4.3281  
Epoch 130/500  
11817/11817 [=====] - 0s - loss: 3.0073 - val\_loss: 4.3170  
Epoch 131/500  
11817/11817 [=====] - 0s - loss: 3.0025 - val\_loss: 4.2871  
Epoch 132/500  
11817/11817 [=====] - 0s - loss: 2.9921 - val\_loss: 4.2668  
Epoch 133/500  
11817/11817 [=====] - 0s - loss: 2.9829 - val\_loss: 4.3099  
Epoch 134/500  
11817/11817 [=====] - 0s - loss: 2.9653 - val\_loss: 4.2804  
Epoch 135/500  
11817/11817 [=====] - 0s - loss: 2.9501 - val\_loss: 4.2732  
Epoch 136/500  
11817/11817 [=====] - 0s - loss: 2.9386 - val\_loss: 4.3062  
Epoch 137/500  
11817/11817 [=====] - 0s - loss: 2.9484 - val\_loss: 4.3228  
Epoch 138/500  
11817/11817 [=====] - 0s - loss: 2.9248 - val\_loss: 4.2320  
Epoch 139/500  
11817/11817 [=====] - 0s - loss: 2.9064 - val\_loss: 4.2289  
Epoch 140/500  
11817/11817 [=====] - 0s - loss: 2.9027 - val\_loss: 4.2093  
Epoch 141/500  
11817/11817 [=====] - 0s - loss: 2.8884 - val\_loss: 4.1946  
Epoch 142/500  
11817/11817 [=====] - 0s - loss: 2.8750 - val\_loss: 4.1681  
Epoch 143/500  
11817/11817 [=====] - 0s - loss: 2.8844 - val\_loss: 4.1870  
Epoch 144/500  
11817/11817 [=====] - 0s - loss: 2.8658 - val\_loss: 4.1343

Epoch 145/500  
11817/11817 [=====] - 0s - loss: 2.8557 - val\_loss: 4.1537  
Epoch 146/500  
11817/11817 [=====] - 0s - loss: 2.8423 - val\_loss: 4.1788  
Epoch 147/500  
11817/11817 [=====] - 0s - loss: 2.8307 - val\_loss: 4.1281  
Epoch 148/500  
11817/11817 [=====] - 0s - loss: 2.8233 - val\_loss: 4.1388  
Epoch 149/500  
11817/11817 [=====] - 0s - loss: 2.8258 - val\_loss: 4.1562  
Epoch 150/500  
11817/11817 [=====] - 0s - loss: 2.8113 - val\_loss: 4.0601  
Epoch 151/500  
11817/11817 [=====] - 0s - loss: 2.7939 - val\_loss: 4.0272  
Epoch 152/500  
11817/11817 [=====] - 0s - loss: 2.7976 - val\_loss: 4.0332  
Epoch 153/500  
11817/11817 [=====] - 0s - loss: 2.7800 - val\_loss: 4.0184  
Epoch 154/500  
11817/11817 [=====] - 0s - loss: 2.7740 - val\_loss: 4.0493  
Epoch 155/500  
11817/11817 [=====] - 0s - loss: 2.7749 - val\_loss: 4.0901  
Epoch 156/500  
11817/11817 [=====] - 0s - loss: 2.7568 - val\_loss: 4.0128  
Epoch 157/500  
11817/11817 [=====] - 0s - loss: 2.7548 - val\_loss: 3.9932  
Epoch 158/500  
11817/11817 [=====] - 0s - loss: 2.7387 - val\_loss: 4.0450  
Epoch 159/500  
11817/11817 [=====] - 0s - loss: 2.7304 - val\_loss: 4.0081  
Epoch 160/500  
11817/11817 [=====] - 0s - loss: 2.7316 - val\_loss: 4.0203  
Epoch 161/500  
11817/11817 [=====] - 0s - loss: 2.7150 - val\_loss: 4.0137  
Epoch 162/500  
11817/11817 [=====] - 0s - loss: 2.6979 - val\_loss: 3.9503  
Epoch 163/500  
11817/11817 [=====] - 0s - loss: 2.7004 - val\_loss: 3.9310  
Epoch 164/500  
11817/11817 [=====] - 0s - loss: 2.6941 - val\_loss: 3.9648  
Epoch 165/500  
11817/11817 [=====] - 0s - loss: 2.6807 - val\_loss: 3.9524  
Epoch 166/500  
11817/11817 [=====] - 0s - loss: 2.6793 - val\_loss: 3.9496  
Epoch 167/500  
11817/11817 [=====] - 0s - loss: 2.6623 - val\_loss: 3.9404  
Epoch 168/500  
11817/11817 [=====] - 0s - loss: 2.6613 - val\_loss: 3.8828

Epoch 169/500  
11817/11817 [=====] - 0s - loss: 2.6544 - val\_loss: 3.8526  
Epoch 170/500  
11817/11817 [=====] - 0s - loss: 2.6585 - val\_loss: 3.8692  
Epoch 171/500  
11817/11817 [=====] - 0s - loss: 2.6491 - val\_loss: 3.8660  
Epoch 172/500  
11817/11817 [=====] - 0s - loss: 2.6360 - val\_loss: 3.8547  
Epoch 173/500  
11817/11817 [=====] - 0s - loss: 2.6208 - val\_loss: 3.8335  
Epoch 174/500  
11817/11817 [=====] - 0s - loss: 2.6163 - val\_loss: 3.8319  
Epoch 175/500  
11817/11817 [=====] - 0s - loss: 2.6286 - val\_loss: 3.8037  
Epoch 176/500  
11817/11817 [=====] - 0s - loss: 2.6108 - val\_loss: 3.7953  
Epoch 177/500  
11817/11817 [=====] - 0s - loss: 2.6113 - val\_loss: 3.8102  
Epoch 178/500  
11817/11817 [=====] - 0s - loss: 2.6012 - val\_loss: 3.8112  
Epoch 179/500  
11817/11817 [=====] - 0s - loss: 2.5867 - val\_loss: 3.7247  
Epoch 180/500  
11817/11817 [=====] - 0s - loss: 2.5841 - val\_loss: 3.6935  
Epoch 181/500  
11817/11817 [=====] - 0s - loss: 2.5744 - val\_loss: 3.7434  
Epoch 182/500  
11817/11817 [=====] - 0s - loss: 2.5747 - val\_loss: 3.7158  
Epoch 183/500  
11817/11817 [=====] - 0s - loss: 2.5635 - val\_loss: 3.7377  
Epoch 184/500  
11817/11817 [=====] - 0s - loss: 2.5601 - val\_loss: 3.7660  
Epoch 185/500  
11817/11817 [=====] - 0s - loss: 2.5510 - val\_loss: 3.7851  
Epoch 186/500  
11817/11817 [=====] - 0s - loss: 2.5421 - val\_loss: 3.7321  
Epoch 187/500  
11817/11817 [=====] - 0s - loss: 2.5392 - val\_loss: 3.7304  
Epoch 188/500  
11817/11817 [=====] - 0s - loss: 2.5369 - val\_loss: 3.7108  
Epoch 189/500  
11817/11817 [=====] - 0s - loss: 2.5197 - val\_loss: 3.6671  
Epoch 190/500  
11817/11817 [=====] - 0s - loss: 2.5263 - val\_loss: 3.7084  
Epoch 191/500  
11817/11817 [=====] - 0s - loss: 2.5111 - val\_loss: 3.7492  
Epoch 192/500  
11817/11817 [=====] - 0s - loss: 2.5067 - val\_loss: 3.6943

Epoch 193/500  
11817/11817 [=====] - 0s - loss: 2.4994 - val\_loss: 3.6451  
Epoch 194/500  
11817/11817 [=====] - 0s - loss: 2.5018 - val\_loss: 3.6721  
Epoch 195/500  
11817/11817 [=====] - 0s - loss: 2.4958 - val\_loss: 3.6720  
Epoch 196/500  
11817/11817 [=====] - 0s - loss: 2.4856 - val\_loss: 3.6327  
Epoch 197/500  
11817/11817 [=====] - 0s - loss: 2.4894 - val\_loss: 3.6123  
Epoch 198/500  
11817/11817 [=====] - 0s - loss: 2.4815 - val\_loss: 3.6428  
Epoch 199/500  
11817/11817 [=====] - 0s - loss: 2.4755 - val\_loss: 3.6440  
Epoch 200/500  
11817/11817 [=====] - 0s - loss: 2.4695 - val\_loss: 3.5912  
Epoch 201/500  
11817/11817 [=====] - 0s - loss: 2.4670 - val\_loss: 3.5775  
Epoch 202/500  
11817/11817 [=====] - 0s - loss: 2.4496 - val\_loss: 3.6072  
Epoch 203/500  
11817/11817 [=====] - 0s - loss: 2.4561 - val\_loss: 3.6002  
Epoch 204/500  
11817/11817 [=====] - 0s - loss: 2.4536 - val\_loss: 3.5500  
Epoch 205/500  
11817/11817 [=====] - 0s - loss: 2.4458 - val\_loss: 3.5514  
Epoch 206/500  
11817/11817 [=====] - 0s - loss: 2.4503 - val\_loss: 3.6217  
Epoch 207/500  
11817/11817 [=====] - 0s - loss: 2.4493 - val\_loss: 3.5668  
Epoch 208/500  
11817/11817 [=====] - 0s - loss: 2.4277 - val\_loss: 3.4990  
Epoch 209/500  
11817/11817 [=====] - 0s - loss: 2.4215 - val\_loss: 3.4920  
Epoch 210/500  
11817/11817 [=====] - 0s - loss: 2.4161 - val\_loss: 3.4954  
Epoch 211/500  
11817/11817 [=====] - 0s - loss: 2.4101 - val\_loss: 3.4837  
Epoch 212/500  
11817/11817 [=====] - 0s - loss: 2.4076 - val\_loss: 3.5216  
Epoch 213/500  
11817/11817 [=====] - 0s - loss: 2.4042 - val\_loss: 3.5384  
Epoch 214/500  
11817/11817 [=====] - 0s - loss: 2.3879 - val\_loss: 3.5085  
Epoch 215/500  
11817/11817 [=====] - 0s - loss: 2.3911 - val\_loss: 3.4987  
Epoch 216/500  
11817/11817 [=====] - 0s - loss: 2.4011 - val\_loss: 3.5248



Epoch 217/500  
11817/11817 [=====] - 0s - loss: 2.3912 - val\_loss: 3.4713  
Epoch 218/500  
11817/11817 [=====] - 0s - loss: 2.3818 - val\_loss: 3.4394  
Epoch 219/500  
11817/11817 [=====] - 0s - loss: 2.3761 - val\_loss: 3.4629  
Epoch 220/500  
11817/11817 [=====] - 0s - loss: 2.3629 - val\_loss: 3.4707  
Epoch 221/500  
11817/11817 [=====] - 0s - loss: 2.3648 - val\_loss: 3.4978  
Epoch 222/500  
11817/11817 [=====] - 0s - loss: 2.3675 - val\_loss: 3.4880  
Epoch 223/500  
11817/11817 [=====] - 0s - loss: 2.3598 - val\_loss: 3.4676  
Epoch 224/500  
11817/11817 [=====] - 0s - loss: 2.3573 - val\_loss: 3.4757  
Epoch 225/500  
11817/11817 [=====] - 0s - loss: 2.3511 - val\_loss: 3.4493  
Epoch 226/500  
11817/11817 [=====] - 0s - loss: 2.3452 - val\_loss: 3.4634  
Epoch 227/500  
11817/11817 [=====] - 0s - loss: 2.3381 - val\_loss: 3.4579  
Epoch 228/500  
11817/11817 [=====] - 0s - loss: 2.3301 - val\_loss: 3.4184  
Epoch 229/500  
11817/11817 [=====] - 0s - loss: 2.3331 - val\_loss: 3.4207  
Epoch 230/500  
11817/11817 [=====] - 0s - loss: 2.3239 - val\_loss: 3.4063  
Epoch 231/500  
11817/11817 [=====] - 0s - loss: 2.3229 - val\_loss: 3.4267  
Epoch 232/500  
11817/11817 [=====] - 0s - loss: 2.3209 - val\_loss: 3.4030  
Epoch 233/500  
11817/11817 [=====] - 0s - loss: 2.3154 - val\_loss: 3.3676  
Epoch 234/500  
11817/11817 [=====] - 0s - loss: 2.3118 - val\_loss: 3.4195  
Epoch 235/500  
11817/11817 [=====] - 0s - loss: 2.3048 - val\_loss: 3.4330  
Epoch 236/500  
11817/11817 [=====] - 0s - loss: 2.3108 - val\_loss: 3.4497  
Epoch 237/500  
11817/11817 [=====] - 0s - loss: 2.3165 - val\_loss: 3.4112  
Epoch 238/500  
11817/11817 [=====] - 0s - loss: 2.2898 - val\_loss: 3.4099  
Epoch 239/500  
11817/11817 [=====] - 0s - loss: 2.2947 - val\_loss: 3.3641  
Epoch 240/500  
11817/11817 [=====] - 0s - loss: 2.3024 - val\_loss: 3.3893

Epoch 241/500  
11817/11817 [=====] - 0s - loss: 2.2934 - val\_loss: 3.3969  
Epoch 242/500  
11817/11817 [=====] - 0s - loss: 2.2936 - val\_loss: 3.3956  
Epoch 243/500  
11817/11817 [=====] - 0s - loss: 2.2725 - val\_loss: 3.3993  
Epoch 244/500  
11817/11817 [=====] - 0s - loss: 2.2770 - val\_loss: 3.3912  
Epoch 245/500  
11817/11817 [=====] - 0s - loss: 2.2644 - val\_loss: 3.3590  
Epoch 246/500  
11817/11817 [=====] - 0s - loss: 2.2762 - val\_loss: 3.3560  
Epoch 247/500  
11817/11817 [=====] - 0s - loss: 2.2712 - val\_loss: 3.3408  
Epoch 248/500  
11817/11817 [=====] - 0s - loss: 2.2640 - val\_loss: 3.3397  
Epoch 249/500  
11817/11817 [=====] - 0s - loss: 2.2594 - val\_loss: 3.3459  
Epoch 250/500  
11817/11817 [=====] - 0s - loss: 2.2568 - val\_loss: 3.3456  
Epoch 251/500  
11817/11817 [=====] - 0s - loss: 2.2605 - val\_loss: 3.3120  
Epoch 252/500  
11817/11817 [=====] - 0s - loss: 2.2454 - val\_loss: 3.3159  
Epoch 253/500  
11817/11817 [=====] - 0s - loss: 2.2437 - val\_loss: 3.3475  
Epoch 254/500  
11817/11817 [=====] - 0s - loss: 2.2455 - val\_loss: 3.3140  
Epoch 255/500  
11817/11817 [=====] - 0s - loss: 2.2506 - val\_loss: 3.2755  
Epoch 256/500  
11817/11817 [=====] - 0s - loss: 2.2329 - val\_loss: 3.3088  
Epoch 257/500  
11817/11817 [=====] - 0s - loss: 2.2377 - val\_loss: 3.3253  
Epoch 258/500  
11817/11817 [=====] - 0s - loss: 2.2302 - val\_loss: 3.3455  
Epoch 259/500  
11817/11817 [=====] - 0s - loss: 2.2336 - val\_loss: 3.3163  
Epoch 260/500  
11817/11817 [=====] - 0s - loss: 2.2397 - val\_loss: 3.3035  
Epoch 261/500  
11817/11817 [=====] - 0s - loss: 2.2205 - val\_loss: 3.2776  
Epoch 262/500  
11817/11817 [=====] - 0s - loss: 2.2210 - val\_loss: 3.2633  
Epoch 263/500  
11817/11817 [=====] - 0s - loss: 2.2338 - val\_loss: 3.3096  
Epoch 264/500  
11817/11817 [=====] - 0s - loss: 2.2387 - val\_loss: 3.3250

Epoch 265/500  
11817/11817 [=====] - 0s - loss: 2.2263 - val\_loss: 3.2175  
Epoch 266/500  
11817/11817 [=====] - 0s - loss: 2.2197 - val\_loss: 3.1913  
Epoch 267/500  
11817/11817 [=====] - 0s - loss: 2.2112 - val\_loss: 3.2088  
Epoch 268/500  
11817/11817 [=====] - 0s - loss: 2.2024 - val\_loss: 3.2402  
Epoch 269/500  
11817/11817 [=====] - 0s - loss: 2.1949 - val\_loss: 3.2137  
Epoch 270/500  
11817/11817 [=====] - 0s - loss: 2.2053 - val\_loss: 3.2181  
Epoch 271/500  
11817/11817 [=====] - 0s - loss: 2.1958 - val\_loss: 3.2175  
Epoch 272/500  
11817/11817 [=====] - 0s - loss: 2.1922 - val\_loss: 3.2163  
Epoch 273/500  
11817/11817 [=====] - 0s - loss: 2.1916 - val\_loss: 3.2261  
Epoch 274/500  
11817/11817 [=====] - 0s - loss: 2.1925 - val\_loss: 3.1959  
Epoch 275/500  
11817/11817 [=====] - 0s - loss: 2.1851 - val\_loss: 3.1543  
Epoch 276/500  
11817/11817 [=====] - 0s - loss: 2.1742 - val\_loss: 3.1523  
Epoch 277/500  
11817/11817 [=====] - 0s - loss: 2.1768 - val\_loss: 3.1402  
Epoch 278/500  
11817/11817 [=====] - 0s - loss: 2.1721 - val\_loss: 3.1232  
Epoch 279/500  
11817/11817 [=====] - 0s - loss: 2.1729 - val\_loss: 3.1667  
Epoch 280/500  
11817/11817 [=====] - 0s - loss: 2.1685 - val\_loss: 3.1289  
Epoch 281/500  
11817/11817 [=====] - 0s - loss: 2.1711 - val\_loss: 3.1036  
Epoch 282/500  
11817/11817 [=====] - 0s - loss: 2.1635 - val\_loss: 3.0993  
Epoch 283/500  
11817/11817 [=====] - 0s - loss: 2.1569 - val\_loss: 3.1348  
Epoch 284/500  
11817/11817 [=====] - 0s - loss: 2.1613 - val\_loss: 3.1050  
Epoch 285/500  
11817/11817 [=====] - 0s - loss: 2.1553 - val\_loss: 3.0472  
Epoch 286/500  
11817/11817 [=====] - 0s - loss: 2.1569 - val\_loss: 3.0482  
Epoch 287/500  
11817/11817 [=====] - 0s - loss: 2.1577 - val\_loss: 3.1020  
Epoch 288/500  
11817/11817 [=====] - 0s - loss: 2.1648 - val\_loss: 3.1392

Epoch 289/500  
11817/11817 [=====] - 0s - loss: 2.1483 - val\_loss: 3.1186  
Epoch 290/500  
11817/11817 [=====] - 0s - loss: 2.1487 - val\_loss: 3.1555  
Epoch 291/500  
11817/11817 [=====] - 0s - loss: 2.1444 - val\_loss: 3.1026  
Epoch 292/500  
11817/11817 [=====] - 0s - loss: 2.1397 - val\_loss: 3.0485  
Epoch 293/500  
11817/11817 [=====] - 0s - loss: 2.1407 - val\_loss: 3.0313  
Epoch 294/500  
11817/11817 [=====] - 0s - loss: 2.1324 - val\_loss: 3.0757  
Epoch 295/500  
11817/11817 [=====] - 0s - loss: 2.1237 - val\_loss: 3.0413  
Epoch 296/500  
11817/11817 [=====] - 0s - loss: 2.1262 - val\_loss: 3.0360  
Epoch 297/500  
11817/11817 [=====] - 0s - loss: 2.1229 - val\_loss: 3.0607  
Epoch 298/500  
11817/11817 [=====] - 0s - loss: 2.1239 - val\_loss: 3.0537  
Epoch 299/500  
11817/11817 [=====] - 0s - loss: 2.1165 - val\_loss: 3.0426  
Epoch 300/500  
11817/11817 [=====] - 0s - loss: 2.1142 - val\_loss: 3.0874  
Epoch 301/500  
11817/11817 [=====] - 0s - loss: 2.1161 - val\_loss: 3.0623  
Epoch 302/500  
11817/11817 [=====] - 0s - loss: 2.1065 - val\_loss: 3.0562  
Epoch 303/500  
11817/11817 [=====] - 0s - loss: 2.1119 - val\_loss: 3.0638  
Epoch 304/500  
11817/11817 [=====] - 0s - loss: 2.1091 - val\_loss: 3.0389  
Epoch 305/500  
11817/11817 [=====] - 0s - loss: 2.1092 - val\_loss: 3.0104  
Epoch 306/500  
11817/11817 [=====] - 0s - loss: 2.1050 - val\_loss: 3.0156  
Epoch 307/500  
11817/11817 [=====] - 0s - loss: 2.1038 - val\_loss: 3.0042  
Epoch 308/500  
11817/11817 [=====] - 0s - loss: 2.0925 - val\_loss: 2.9941  
Epoch 309/500  
11817/11817 [=====] - 0s - loss: 2.1064 - val\_loss: 3.0441  
Epoch 310/500  
11817/11817 [=====] - 0s - loss: 2.0939 - val\_loss: 3.0390  
Epoch 311/500  
11817/11817 [=====] - 0s - loss: 2.0938 - val\_loss: 3.0078  
Epoch 312/500  
11817/11817 [=====] - 0s - loss: 2.0868 - val\_loss: 3.0369

Epoch 313/500  
11817/11817 [=====] - 0s - loss: 2.0843 - val\_loss: 2.9932  
Epoch 314/500  
11817/11817 [=====] - 0s - loss: 2.0838 - val\_loss: 2.9521  
Epoch 315/500  
11817/11817 [=====] - 0s - loss: 2.0911 - val\_loss: 2.9790  
Epoch 316/500  
11817/11817 [=====] - 0s - loss: 2.0889 - val\_loss: 3.0115  
Epoch 317/500  
11817/11817 [=====] - 0s - loss: 2.0828 - val\_loss: 2.9742  
Epoch 318/500  
11817/11817 [=====] - 0s - loss: 2.0793 - val\_loss: 2.9656  
Epoch 319/500  
11817/11817 [=====] - 0s - loss: 2.0839 - val\_loss: 2.9999  
Epoch 320/500  
11817/11817 [=====] - 0s - loss: 2.0841 - val\_loss: 3.0182  
Epoch 321/500  
11817/11817 [=====] - 0s - loss: 2.0724 - val\_loss: 2.9571  
Epoch 322/500  
11817/11817 [=====] - 0s - loss: 2.0703 - val\_loss: 2.9779  
Epoch 323/500  
11817/11817 [=====] - 0s - loss: 2.0697 - val\_loss: 2.9723  
Epoch 324/500  
11817/11817 [=====] - 0s - loss: 2.0687 - val\_loss: 2.9470  
Epoch 325/500  
11817/11817 [=====] - 0s - loss: 2.0641 - val\_loss: 2.9861  
Epoch 326/500  
11817/11817 [=====] - 0s - loss: 2.0657 - val\_loss: 2.9729  
Epoch 327/500  
11817/11817 [=====] - 0s - loss: 2.0609 - val\_loss: 2.9441  
Epoch 328/500  
11817/11817 [=====] - 0s - loss: 2.0700 - val\_loss: 2.9564  
Epoch 329/500  
11817/11817 [=====] - 0s - loss: 2.0521 - val\_loss: 2.9576  
Epoch 330/500  
11817/11817 [=====] - 0s - loss: 2.0477 - val\_loss: 2.9511  
Epoch 331/500  
11817/11817 [=====] - 0s - loss: 2.0516 - val\_loss: 2.9235  
Epoch 332/500  
11817/11817 [=====] - 0s - loss: 2.0497 - val\_loss: 2.9266  
Epoch 333/500  
11817/11817 [=====] - 0s - loss: 2.0453 - val\_loss: 2.9523  
Epoch 334/500  
11817/11817 [=====] - 0s - loss: 2.0567 - val\_loss: 2.9711  
Epoch 335/500  
11817/11817 [=====] - 0s - loss: 2.0361 - val\_loss: 2.9409  
Epoch 336/500  
11817/11817 [=====] - 0s - loss: 2.0514 - val\_loss: 2.9231

Epoch 337/500  
11817/11817 [=====] - 0s - loss: 2.0457 - val\_loss: 2.9552  
Epoch 338/500  
11817/11817 [=====] - 0s - loss: 2.0423 - val\_loss: 2.9206  
Epoch 339/500  
11817/11817 [=====] - 0s - loss: 2.0416 - val\_loss: 2.8929  
Epoch 340/500  
11817/11817 [=====] - 0s - loss: 2.0340 - val\_loss: 2.9348  
Epoch 341/500  
11817/11817 [=====] - 0s - loss: 2.0379 - val\_loss: 2.9547  
Epoch 342/500  
11817/11817 [=====] - 0s - loss: 2.0362 - val\_loss: 2.9100  
Epoch 343/500  
11817/11817 [=====] - 0s - loss: 2.0302 - val\_loss: 2.9152  
Epoch 344/500  
11817/11817 [=====] - 0s - loss: 2.0292 - val\_loss: 2.9138  
Epoch 345/500  
11817/11817 [=====] - 0s - loss: 2.0496 - val\_loss: 2.9414  
Epoch 346/500  
11817/11817 [=====] - 0s - loss: 2.0295 - val\_loss: 2.8916  
Epoch 347/500  
11817/11817 [=====] - 0s - loss: 2.0299 - val\_loss: 2.8989  
Epoch 348/500  
11817/11817 [=====] - 0s - loss: 2.0327 - val\_loss: 2.9344  
Epoch 349/500  
11817/11817 [=====] - 0s - loss: 2.0295 - val\_loss: 2.8664  
Epoch 350/500  
11817/11817 [=====] - 0s - loss: 2.0219 - val\_loss: 2.8416  
Epoch 351/500  
11817/11817 [=====] - 0s - loss: 2.0180 - val\_loss: 2.8740  
Epoch 352/500  
11817/11817 [=====] - 0s - loss: 2.0151 - val\_loss: 2.8593  
Epoch 353/500  
11817/11817 [=====] - 0s - loss: 2.0224 - val\_loss: 2.8599  
Epoch 354/500  
11817/11817 [=====] - 0s - loss: 2.0141 - val\_loss: 2.9100  
Epoch 355/500  
11817/11817 [=====] - 0s - loss: 2.0194 - val\_loss: 2.9197  
Epoch 356/500  
11817/11817 [=====] - 0s - loss: 2.0098 - val\_loss: 2.8854  
Epoch 357/500  
11817/11817 [=====] - 0s - loss: 2.0435 - val\_loss: 2.9547  
Epoch 358/500  
11817/11817 [=====] - 0s - loss: 2.0278 - val\_loss: 2.9474  
Epoch 359/500  
11817/11817 [=====] - 0s - loss: 2.0253 - val\_loss: 2.8382  
Epoch 360/500  
11817/11817 [=====] - 0s - loss: 2.0258 - val\_loss: 2.8132

Epoch 361/500  
11817/11817 [=====] - 0s - loss: 2.0183 - val\_loss: 2.8084  
Epoch 362/500  
11817/11817 [=====] - 0s - loss: 2.0173 - val\_loss: 2.8008  
Epoch 363/500  
11817/11817 [=====] - 0s - loss: 2.0109 - val\_loss: 2.7919  
Epoch 364/500  
11817/11817 [=====] - 0s - loss: 2.0097 - val\_loss: 2.7846  
Epoch 365/500  
11817/11817 [=====] - 0s - loss: 2.0092 - val\_loss: 2.7898  
Epoch 366/500  
11817/11817 [=====] - 0s - loss: 2.0019 - val\_loss: 2.7802  
Epoch 367/500  
11817/11817 [=====] - 0s - loss: 2.0070 - val\_loss: 2.8120  
Epoch 368/500  
11817/11817 [=====] - 0s - loss: 2.0057 - val\_loss: 2.7768  
Epoch 369/500  
11817/11817 [=====] - 0s - loss: 2.0015 - val\_loss: 2.7663  
Epoch 370/500  
11817/11817 [=====] - 0s - loss: 1.9953 - val\_loss: 2.7991  
Epoch 371/500  
11817/11817 [=====] - 0s - loss: 1.9928 - val\_loss: 2.8166  
Epoch 372/500  
11817/11817 [=====] - 0s - loss: 1.9910 - val\_loss: 2.8013  
Epoch 373/500  
11817/11817 [=====] - 0s - loss: 1.9875 - val\_loss: 2.8175  
Epoch 374/500  
11817/11817 [=====] - 0s - loss: 2.0016 - val\_loss: 2.8218  
Epoch 375/500  
11817/11817 [=====] - 0s - loss: 1.9978 - val\_loss: 2.8215  
Epoch 376/500  
11817/11817 [=====] - 0s - loss: 1.9857 - val\_loss: 2.7692  
Epoch 377/500  
11817/11817 [=====] - 0s - loss: 1.9899 - val\_loss: 2.7857  
Epoch 378/500  
11817/11817 [=====] - 0s - loss: 1.9816 - val\_loss: 2.7763  
Epoch 379/500  
11817/11817 [=====] - 0s - loss: 1.9768 - val\_loss: 2.7596  
Epoch 380/500  
11817/11817 [=====] - 0s - loss: 1.9830 - val\_loss: 2.7779  
Epoch 381/500  
11817/11817 [=====] - 0s - loss: 1.9860 - val\_loss: 2.7475  
Epoch 382/500  
11817/11817 [=====] - 0s - loss: 1.9755 - val\_loss: 2.7377  
Epoch 383/500  
11817/11817 [=====] - 0s - loss: 1.9753 - val\_loss: 2.7627  
Epoch 384/500  
11817/11817 [=====] - 0s - loss: 1.9710 - val\_loss: 2.7639

Epoch 385/500  
11817/11817 [=====] - 0s - loss: 1.9708 - val\_loss: 2.7342  
Epoch 386/500  
11817/11817 [=====] - 0s - loss: 1.9734 - val\_loss: 2.7504  
Epoch 387/500  
11817/11817 [=====] - 0s - loss: 1.9781 - val\_loss: 2.7159  
Epoch 388/500  
11817/11817 [=====] - 0s - loss: 1.9771 - val\_loss: 2.7446  
Epoch 389/500  
11817/11817 [=====] - 0s - loss: 1.9753 - val\_loss: 2.7750  
Epoch 390/500  
11817/11817 [=====] - 0s - loss: 1.9732 - val\_loss: 2.7338  
Epoch 391/500  
11817/11817 [=====] - 0s - loss: 1.9762 - val\_loss: 2.7435  
Epoch 392/500  
11817/11817 [=====] - 0s - loss: 1.9655 - val\_loss: 2.7887  
Epoch 393/500  
11817/11817 [=====] - 0s - loss: 1.9787 - val\_loss: 2.7839  
Epoch 394/500  
11817/11817 [=====] - 0s - loss: 1.9653 - val\_loss: 2.7201  
Epoch 395/500  
11817/11817 [=====] - 0s - loss: 1.9638 - val\_loss: 2.7028  
Epoch 396/500  
11817/11817 [=====] - 0s - loss: 1.9681 - val\_loss: 2.7216  
Epoch 397/500  
11817/11817 [=====] - 0s - loss: 1.9575 - val\_loss: 2.7314  
Epoch 398/500  
11817/11817 [=====] - 0s - loss: 1.9640 - val\_loss: 2.7544  
Epoch 399/500  
11817/11817 [=====] - 0s - loss: 1.9678 - val\_loss: 2.7569  
Epoch 400/500  
11817/11817 [=====] - 0s - loss: 1.9634 - val\_loss: 2.7038  
Epoch 401/500  
11817/11817 [=====] - 0s - loss: 1.9551 - val\_loss: 2.7083  
Epoch 402/500  
11817/11817 [=====] - 0s - loss: 1.9714 - val\_loss: 2.7114  
Epoch 403/500  
11817/11817 [=====] - 0s - loss: 1.9552 - val\_loss: 2.7118  
Epoch 404/500  
11817/11817 [=====] - 0s - loss: 1.9538 - val\_loss: 2.6982  
Epoch 405/500  
11817/11817 [=====] - 0s - loss: 1.9561 - val\_loss: 2.6801  
Epoch 406/500  
11817/11817 [=====] - 0s - loss: 1.9527 - val\_loss: 2.7086  
Epoch 407/500  
11817/11817 [=====] - 0s - loss: 1.9652 - val\_loss: 2.7333  
Epoch 408/500  
11817/11817 [=====] - 0s - loss: 1.9491 - val\_loss: 2.6941



Epoch 409/500  
11817/11817 [=====] - 0s - loss: 1.9550 - val\_loss: 2.6806  
Epoch 410/500  
11817/11817 [=====] - 0s - loss: 1.9562 - val\_loss: 2.7038  
Epoch 411/500  
11817/11817 [=====] - 0s - loss: 1.9571 - val\_loss: 2.7244  
Epoch 412/500  
11817/11817 [=====] - 0s - loss: 1.9441 - val\_loss: 2.6991  
Epoch 413/500  
11817/11817 [=====] - 0s - loss: 1.9503 - val\_loss: 2.6939  
Epoch 414/500  
11817/11817 [=====] - 0s - loss: 1.9473 - val\_loss: 2.6825  
Epoch 415/500  
11817/11817 [=====] - 0s - loss: 1.9440 - val\_loss: 2.6690  
Epoch 416/500  
11817/11817 [=====] - 0s - loss: 1.9463 - val\_loss: 2.6650  
Epoch 417/500  
11817/11817 [=====] - 0s - loss: 1.9362 - val\_loss: 2.6894  
Epoch 418/500  
11817/11817 [=====] - 0s - loss: 1.9389 - val\_loss: 2.6957  
Epoch 419/500  
11817/11817 [=====] - 0s - loss: 1.9347 - val\_loss: 2.6918  
Epoch 420/500  
11817/11817 [=====] - 0s - loss: 1.9355 - val\_loss: 2.6805  
Epoch 421/500  
11817/11817 [=====] - 0s - loss: 1.9360 - val\_loss: 2.6650  
Epoch 422/500  
11817/11817 [=====] - 0s - loss: 1.9297 - val\_loss: 2.6668  
Epoch 423/500  
11817/11817 [=====] - 0s - loss: 1.9408 - val\_loss: 2.6640  
Epoch 424/500  
11817/11817 [=====] - 0s - loss: 1.9377 - val\_loss: 2.6633  
Epoch 425/500  
11817/11817 [=====] - 0s - loss: 1.9367 - val\_loss: 2.6435  
Epoch 426/500  
11817/11817 [=====] - 0s - loss: 1.9364 - val\_loss: 2.6719  
Epoch 427/500  
11817/11817 [=====] - 0s - loss: 1.9350 - val\_loss: 2.6611  
Epoch 428/500  
11817/11817 [=====] - 0s - loss: 1.9635 - val\_loss: 2.6470  
Epoch 429/500  
11817/11817 [=====] - 0s - loss: 1.9436 - val\_loss: 2.6820  
Epoch 430/500  
11817/11817 [=====] - 0s - loss: 1.9251 - val\_loss: 2.7115  
Epoch 431/500  
11817/11817 [=====] - 0s - loss: 1.9255 - val\_loss: 2.6896  
Epoch 432/500  
11817/11817 [=====] - 0s - loss: 1.9208 - val\_loss: 2.6540

Epoch 433/500  
11817/11817 [=====] - 0s - loss: 1.9271 - val\_loss: 2.6569  
Epoch 434/500  
11817/11817 [=====] - 0s - loss: 1.9212 - val\_loss: 2.6862  
Epoch 435/500  
11817/11817 [=====] - 0s - loss: 1.9343 - val\_loss: 2.6681  
Epoch 436/500  
11817/11817 [=====] - 0s - loss: 1.9259 - val\_loss: 2.6457  
Epoch 437/500  
11817/11817 [=====] - 0s - loss: 1.9163 - val\_loss: 2.6694  
Epoch 438/500  
11817/11817 [=====] - 0s - loss: 1.9245 - val\_loss: 2.6528  
Epoch 439/500  
11817/11817 [=====] - 0s - loss: 1.9220 - val\_loss: 2.6123  
Epoch 440/500  
11817/11817 [=====] - 0s - loss: 1.9233 - val\_loss: 2.6198  
Epoch 441/500  
11817/11817 [=====] - 0s - loss: 1.9261 - val\_loss: 2.6565  
Epoch 442/500  
11817/11817 [=====] - 0s - loss: 1.9303 - val\_loss: 2.6242  
Epoch 443/500  
11817/11817 [=====] - 0s - loss: 1.9180 - val\_loss: 2.6125  
Epoch 444/500  
11817/11817 [=====] - 0s - loss: 1.9236 - val\_loss: 2.6281  
Epoch 445/500  
11817/11817 [=====] - 0s - loss: 1.9182 - val\_loss: 2.6381  
Epoch 446/500  
11817/11817 [=====] - 0s - loss: 1.9121 - val\_loss: 2.6368  
Epoch 447/500  
11817/11817 [=====] - 0s - loss: 1.9142 - val\_loss: 2.6170  
Epoch 448/500  
11817/11817 [=====] - 0s - loss: 1.9083 - val\_loss: 2.6253  
Epoch 449/500  
11817/11817 [=====] - 0s - loss: 1.9130 - val\_loss: 2.6189  
Epoch 450/500  
11817/11817 [=====] - 0s - loss: 1.9131 - val\_loss: 2.6286  
Epoch 451/500  
11817/11817 [=====] - 0s - loss: 1.9077 - val\_loss: 2.6315  
Epoch 452/500  
11817/11817 [=====] - 0s - loss: 1.9040 - val\_loss: 2.5973  
Epoch 453/500  
11817/11817 [=====] - 0s - loss: 1.9045 - val\_loss: 2.5962  
Epoch 454/500  
11817/11817 [=====] - 0s - loss: 1.9085 - val\_loss: 2.6289  
Epoch 455/500  
11817/11817 [=====] - 0s - loss: 1.9183 - val\_loss: 2.6068  
Epoch 456/500  
11817/11817 [=====] - 0s - loss: 1.9121 - val\_loss: 2.5836

Epoch 457/500  
11817/11817 [=====] - 0s - loss: 1.9161 - val\_loss: 2.5983  
Epoch 458/500  
11817/11817 [=====] - 0s - loss: 1.9028 - val\_loss: 2.6220  
Epoch 459/500  
11817/11817 [=====] - 0s - loss: 1.9136 - val\_loss: 2.6243  
Epoch 460/500  
11817/11817 [=====] - 0s - loss: 1.9092 - val\_loss: 2.6230  
Epoch 461/500  
11817/11817 [=====] - 0s - loss: 1.9102 - val\_loss: 2.6232  
Epoch 462/500  
11817/11817 [=====] - 0s - loss: 1.9089 - val\_loss: 2.5977  
Epoch 463/500  
11817/11817 [=====] - 0s - loss: 1.9002 - val\_loss: 2.5808  
Epoch 464/500  
11817/11817 [=====] - 0s - loss: 1.9096 - val\_loss: 2.5750  
Epoch 465/500  
11817/11817 [=====] - 0s - loss: 1.8912 - val\_loss: 2.5724  
Epoch 466/500  
11817/11817 [=====] - 0s - loss: 1.9030 - val\_loss: 2.5673  
Epoch 467/500  
11817/11817 [=====] - 0s - loss: 1.8998 - val\_loss: 2.5714  
Epoch 468/500  
11817/11817 [=====] - 0s - loss: 1.9019 - val\_loss: 2.5861  
Epoch 469/500  
11817/11817 [=====] - 0s - loss: 1.9024 - val\_loss: 2.5916  
Epoch 470/500  
11817/11817 [=====] - 0s - loss: 1.8959 - val\_loss: 2.5868  
Epoch 471/500  
11817/11817 [=====] - 0s - loss: 1.9040 - val\_loss: 2.5956  
Epoch 472/500  
11817/11817 [=====] - 0s - loss: 1.9034 - val\_loss: 2.5861  
Epoch 473/500  
11817/11817 [=====] - 0s - loss: 1.8978 - val\_loss: 2.5836  
Epoch 474/500  
11817/11817 [=====] - 0s - loss: 1.8879 - val\_loss: 2.5649  
Epoch 475/500  
11817/11817 [=====] - 0s - loss: 1.8954 - val\_loss: 2.5633  
Epoch 476/500  
11817/11817 [=====] - 0s - loss: 1.8997 - val\_loss: 2.5920  
Epoch 477/500  
11817/11817 [=====] - 0s - loss: 1.9027 - val\_loss: 2.5548  
Epoch 478/500  
11817/11817 [=====] - 0s - loss: 1.8903 - val\_loss: 2.5419  
Epoch 479/500  
11817/11817 [=====] - 0s - loss: 1.8922 - val\_loss: 2.5546  
Epoch 480/500  
11817/11817 [=====] - 0s - loss: 1.8950 - val\_loss: 2.5715

```

Epoch 481/500
11817/11817 [=====] - 0s - loss: 1.8923 - val_loss: 2.5453
Epoch 482/500
11817/11817 [=====] - 0s - loss: 1.9015 - val_loss: 2.5352
Epoch 483/500
11817/11817 [=====] - 0s - loss: 1.8938 - val_loss: 2.5599
Epoch 484/500
11817/11817 [=====] - 0s - loss: 1.9023 - val_loss: 2.5702
Epoch 485/500
11817/11817 [=====] - 0s - loss: 1.8855 - val_loss: 2.5668
Epoch 486/500
11817/11817 [=====] - 0s - loss: 1.8973 - val_loss: 2.5653
Epoch 487/500
11817/11817 [=====] - 0s - loss: 1.8833 - val_loss: 2.5768
Epoch 488/500
11817/11817 [=====] - 0s - loss: 1.8870 - val_loss: 2.5702
Epoch 489/500
11817/11817 [=====] - 0s - loss: 1.8898 - val_loss: 2.5693
Epoch 490/500
11817/11817 [=====] - 0s - loss: 1.8802 - val_loss: 2.5612
Epoch 491/500
11817/11817 [=====] - 0s - loss: 1.8855 - val_loss: 2.5578
Epoch 492/500
11817/11817 [=====] - 0s - loss: 1.8787 - val_loss: 2.5515
Epoch 493/500
11817/11817 [=====] - 0s - loss: 1.8824 - val_loss: 2.5511
Epoch 494/500
11817/11817 [=====] - 0s - loss: 1.8905 - val_loss: 2.5447
Epoch 495/500
11817/11817 [=====] - 0s - loss: 1.8811 - val_loss: 2.5706
Epoch 496/500
11817/11817 [=====] - 0s - loss: 1.8800 - val_loss: 2.5659
Epoch 497/500
11817/11817 [=====] - 0s - loss: 1.8866 - val_loss: 2.5459
Epoch 498/500
11817/11817 [=====] - 0s - loss: 1.8814 - val_loss: 2.5414
Epoch 499/500
11817/11817 [=====] - 0s - loss: 1.8874 - val_loss: 2.5412
Epoch 500/500
11817/11817 [=====] - 0s - loss: 1.8762 - val_loss: 2.5481

```

```

In [43]: past_preds = model.predict(train_features)[: , 0]
         future_preds = model.predict(test_features)[: , 0]

         from sklearn.metrics import r2_score
         import numpy as np

```

```

# our benchmark is just guessing the average
benchmark = np.mean(train_targets)
print('benchmark r^2 on training:', r2_score(train_targets, [benchmark] * train_targets.shape[0]))

print('training r^2:', r2_score(train_targets, past_preds))
plt.scatter(train_targets, past_preds, alpha=0.1)
plt.xlabel('actual')
plt.ylabel('predicted')
plt.title('train predictions vs actual')
plt.show()

print('benchmark r^2 on test:', r2_score(test_targets, [benchmark] * test_targets.shape[0]))

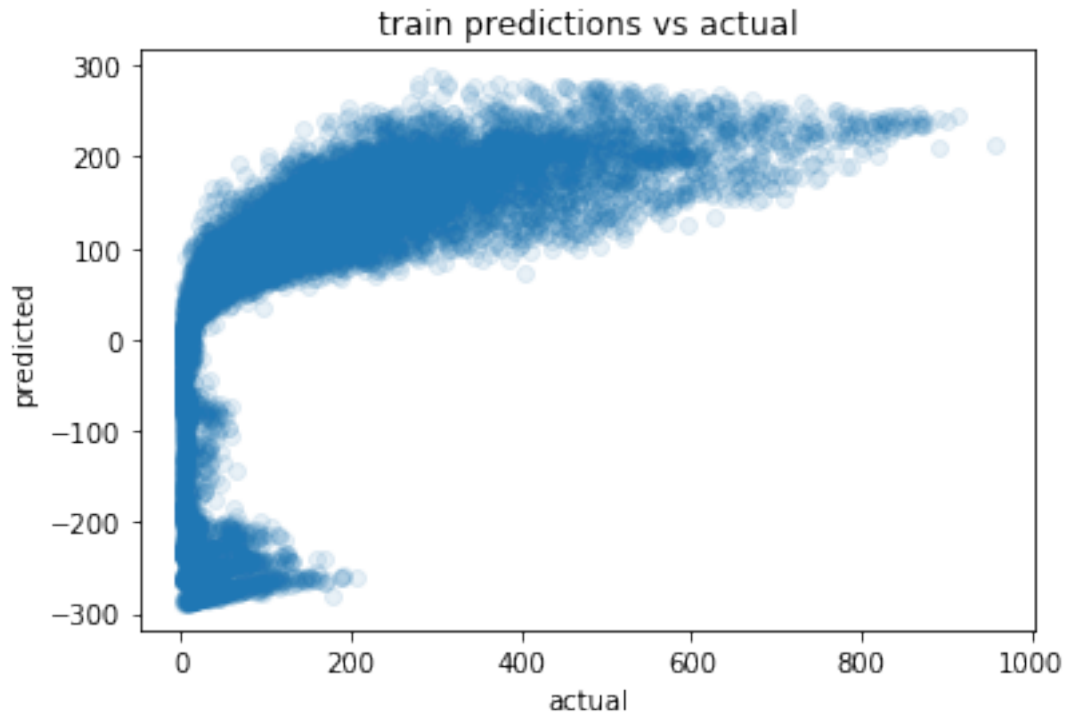
print('r^2 on test:', r2_score(test_targets, future_preds))
plt.scatter(test_targets, future_preds, alpha=0.1)
plt.xlabel('actual')
plt.ylabel('predicted')
plt.title('test predictions vs actual')
plt.show()

```

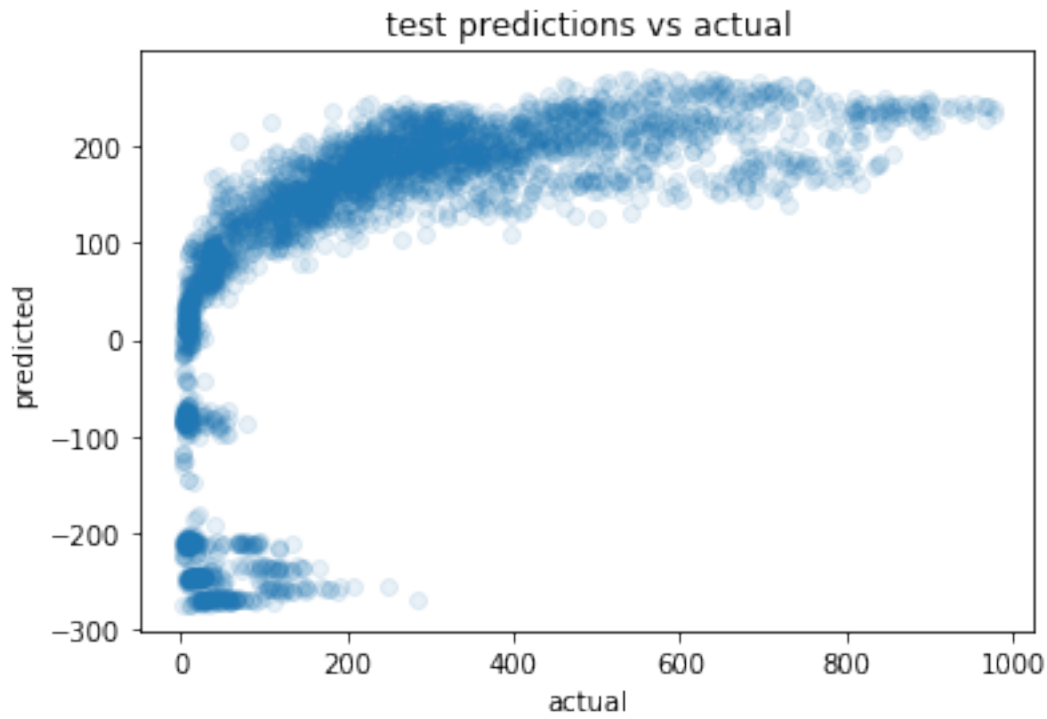
```

benchmark r^2 on training: 0.0
training r^2: -0.031770368095

```



benchmark  $r^2$  on test: -0.112995264662  
 $r^2$  on test: -0.0440845429422



## 9 this doesn't seem to work well, especially for the small values

In [47]: *# creates the model*

```
# restart keras session (clear weights), sometimes this will clear up errors  
K.clear_session()
```

```
# functional API
```

```
inputs = Input(shape=(features.shape[1], ))  
x1 = Dense(1000, activation='elu')(inputs)  
x2 = BatchNormalization()(x1)  
x3 = Dropout(0.5)(x2)  
x4 = Dense(500, activation='elu')(x3)  
x5 = BatchNormalization()(x4)  
x6 = Dropout(0.5)(x5)  
x7 = Dense(100, activation='elu')(x6)  
x8 = BatchNormalization()(x7)  
x9 = Dropout(0.5)(x8)  
predictions = Dense(1, activation='linear')(x9)
```

```

# this saves the best model (lowest validation loss)
checkpoint = ModelCheckpoint('3_layer_dense.h5', monitor='val_loss', save_best_only=True)
es = EarlyStopping(patience=100)
cb = [checkpoint, es]

# this compiles our model so it is ready to fit
model = Model(inputs, predictions)
model.compile(optimizer='adam', loss='mape')

subset_size = trainsize
train_feature_subset = train_features[:subset_size]
train_target_subset = train_targets[:subset_size]
# we actually fit the model here
history = model.fit(train_feature_subset,
                    train_target_subset,
                    epochs=500,
                    validation_split=0.15,
                    callbacks=cb,
                    batch_size=3000)

```

Train on 11817 samples, validate on 2086 samples

```

Epoch 1/500
11817/11817 [=====] - 0s - loss: 98.9253 - val_loss: 105.2798
Epoch 2/500
11817/11817 [=====] - 0s - loss: 94.9841 - val_loss: 105.1519
Epoch 3/500
11817/11817 [=====] - 0s - loss: 94.5545 - val_loss: 106.5328
Epoch 4/500
11817/11817 [=====] - 0s - loss: 94.5050 - val_loss: 105.6232
Epoch 5/500
11817/11817 [=====] - 0s - loss: 93.6285 - val_loss: 105.1990
Epoch 6/500
11817/11817 [=====] - 0s - loss: 93.4309 - val_loss: 106.3109
Epoch 7/500
11817/11817 [=====] - 0s - loss: 93.5454 - val_loss: 106.8793
Epoch 8/500
11817/11817 [=====] - 0s - loss: 93.3973 - val_loss: 106.6835
Epoch 9/500
11817/11817 [=====] - 0s - loss: 93.1791 - val_loss: 106.6913
Epoch 10/500
11817/11817 [=====] - 0s - loss: 92.6918 - val_loss: 106.7994
Epoch 11/500
11817/11817 [=====] - 0s - loss: 92.5061 - val_loss: 106.4601
Epoch 12/500
11817/11817 [=====] - 0s - loss: 92.5031 - val_loss: 106.2339
Epoch 13/500
11817/11817 [=====] - 0s - loss: 92.3856 - val_loss: 105.8765

```

Epoch 14/500  
11817/11817 [=====] - 0s - loss: 92.2128 - val\_loss: 105.2744  
Epoch 15/500  
11817/11817 [=====] - 0s - loss: 92.1477 - val\_loss: 105.0602  
Epoch 16/500  
11817/11817 [=====] - 0s - loss: 91.8351 - val\_loss: 104.9429  
Epoch 17/500  
11817/11817 [=====] - 0s - loss: 91.5554 - val\_loss: 104.3513  
Epoch 18/500  
11817/11817 [=====] - 0s - loss: 91.6928 - val\_loss: 104.0603  
Epoch 19/500  
11817/11817 [=====] - 0s - loss: 91.5143 - val\_loss: 103.7709  
Epoch 20/500  
11817/11817 [=====] - 0s - loss: 90.9389 - val\_loss: 103.7355  
Epoch 21/500  
11817/11817 [=====] - 0s - loss: 90.9376 - val\_loss: 103.6006  
Epoch 22/500  
11817/11817 [=====] - 0s - loss: 90.6207 - val\_loss: 102.7473  
Epoch 23/500  
11817/11817 [=====] - 0s - loss: 90.9166 - val\_loss: 102.2993  
Epoch 24/500  
11817/11817 [=====] - 0s - loss: 90.6346 - val\_loss: 102.1196  
Epoch 25/500  
11817/11817 [=====] - 0s - loss: 90.4162 - val\_loss: 101.9302  
Epoch 26/500  
11817/11817 [=====] - 0s - loss: 90.4803 - val\_loss: 101.4409  
Epoch 27/500  
11817/11817 [=====] - 0s - loss: 90.3327 - val\_loss: 101.1852  
Epoch 28/500  
11817/11817 [=====] - 0s - loss: 89.9062 - val\_loss: 100.7856  
Epoch 29/500  
11817/11817 [=====] - 0s - loss: 89.6848 - val\_loss: 100.5844  
Epoch 30/500  
11817/11817 [=====] - 0s - loss: 89.8599 - val\_loss: 100.6410  
Epoch 31/500  
11817/11817 [=====] - 0s - loss: 89.5350 - val\_loss: 100.5772  
Epoch 32/500  
11817/11817 [=====] - 0s - loss: 89.4562 - val\_loss: 100.2506  
Epoch 33/500  
11817/11817 [=====] - 0s - loss: 89.5496 - val\_loss: 100.2025  
Epoch 34/500  
11817/11817 [=====] - 0s - loss: 89.4726 - val\_loss: 100.6717  
Epoch 35/500  
11817/11817 [=====] - 0s - loss: 89.4258 - val\_loss: 101.2920  
Epoch 36/500  
11817/11817 [=====] - 0s - loss: 89.1302 - val\_loss: 100.9441  
Epoch 37/500  
11817/11817 [=====] - 0s - loss: 89.2927 - val\_loss: 100.8951



Epoch 38/500  
11817/11817 [=====] - 0s - loss: 88.7739 - val\_loss: 100.5547  
Epoch 39/500  
11817/11817 [=====] - 0s - loss: 88.6367 - val\_loss: 99.9854  
Epoch 40/500  
11817/11817 [=====] - 0s - loss: 88.5560 - val\_loss: 99.4249  
Epoch 41/500  
11817/11817 [=====] - 0s - loss: 88.7613 - val\_loss: 99.5557  
Epoch 42/500  
11817/11817 [=====] - 0s - loss: 88.3901 - val\_loss: 100.1705  
Epoch 43/500  
11817/11817 [=====] - 0s - loss: 88.2608 - val\_loss: 100.6612  
Epoch 44/500  
11817/11817 [=====] - 0s - loss: 87.9878 - val\_loss: 100.5968  
Epoch 45/500  
11817/11817 [=====] - 0s - loss: 88.2630 - val\_loss: 100.4746  
Epoch 46/500  
11817/11817 [=====] - 0s - loss: 88.0658 - val\_loss: 100.4524  
Epoch 47/500  
11817/11817 [=====] - 0s - loss: 88.0326 - val\_loss: 100.5274  
Epoch 48/500  
11817/11817 [=====] - 0s - loss: 87.9551 - val\_loss: 100.2113  
Epoch 49/500  
11817/11817 [=====] - 0s - loss: 87.8550 - val\_loss: 99.4807  
Epoch 50/500  
11817/11817 [=====] - 0s - loss: 87.4243 - val\_loss: 99.0625  
Epoch 51/500  
11817/11817 [=====] - 0s - loss: 87.6216 - val\_loss: 98.9406  
Epoch 52/500  
11817/11817 [=====] - 0s - loss: 87.4927 - val\_loss: 99.0074  
Epoch 53/500  
11817/11817 [=====] - 0s - loss: 87.3705 - val\_loss: 99.0651  
Epoch 54/500  
11817/11817 [=====] - 0s - loss: 87.2128 - val\_loss: 98.9114  
Epoch 55/500  
11817/11817 [=====] - 0s - loss: 87.0378 - val\_loss: 98.3466  
Epoch 56/500  
11817/11817 [=====] - 0s - loss: 86.9258 - val\_loss: 98.1089  
Epoch 57/500  
11817/11817 [=====] - 0s - loss: 86.9286 - val\_loss: 98.2893  
Epoch 58/500  
11817/11817 [=====] - 0s - loss: 86.9597 - val\_loss: 98.8635  
Epoch 59/500  
11817/11817 [=====] - 0s - loss: 87.0473 - val\_loss: 98.8067  
Epoch 60/500  
11817/11817 [=====] - 0s - loss: 86.6904 - val\_loss: 98.1660  
Epoch 61/500  
11817/11817 [=====] - 0s - loss: 86.4941 - val\_loss: 97.7233

Epoch 62/500  
11817/11817 [=====] - 0s - loss: 86.2767 - val\_loss: 97.8187  
Epoch 63/500  
11817/11817 [=====] - 0s - loss: 86.2299 - val\_loss: 97.9876  
Epoch 64/500  
11817/11817 [=====] - 0s - loss: 85.5395 - val\_loss: 98.3673  
Epoch 65/500  
11817/11817 [=====] - 0s - loss: 85.9219 - val\_loss: 98.3915  
Epoch 66/500  
11817/11817 [=====] - 0s - loss: 85.6713 - val\_loss: 98.2656  
Epoch 67/500  
11817/11817 [=====] - 0s - loss: 85.7677 - val\_loss: 98.2406  
Epoch 68/500  
11817/11817 [=====] - 0s - loss: 85.7234 - val\_loss: 97.8744  
Epoch 69/500  
11817/11817 [=====] - 0s - loss: 85.6423 - val\_loss: 97.6051  
Epoch 70/500  
11817/11817 [=====] - 0s - loss: 85.6196 - val\_loss: 97.1287  
Epoch 71/500  
11817/11817 [=====] - 0s - loss: 85.1959 - val\_loss: 97.2738  
Epoch 72/500  
11817/11817 [=====] - 0s - loss: 85.3998 - val\_loss: 97.1905  
Epoch 73/500  
11817/11817 [=====] - 0s - loss: 84.9658 - val\_loss: 96.7359  
Epoch 74/500  
11817/11817 [=====] - 0s - loss: 84.9619 - val\_loss: 96.7068  
Epoch 75/500  
11817/11817 [=====] - 0s - loss: 85.0299 - val\_loss: 96.4849  
Epoch 76/500  
11817/11817 [=====] - 0s - loss: 84.4823 - val\_loss: 96.5693  
Epoch 77/500  
11817/11817 [=====] - 0s - loss: 84.3493 - val\_loss: 96.3581  
Epoch 78/500  
11817/11817 [=====] - 0s - loss: 84.3636 - val\_loss: 95.9408  
Epoch 79/500  
11817/11817 [=====] - 0s - loss: 84.4010 - val\_loss: 95.3974  
Epoch 80/500  
11817/11817 [=====] - 0s - loss: 84.4648 - val\_loss: 95.0832  
Epoch 81/500  
11817/11817 [=====] - 0s - loss: 84.1974 - val\_loss: 94.7413  
Epoch 82/500  
11817/11817 [=====] - 0s - loss: 83.7496 - val\_loss: 94.7229  
Epoch 83/500  
11817/11817 [=====] - 0s - loss: 83.6970 - val\_loss: 95.0817  
Epoch 84/500  
11817/11817 [=====] - 0s - loss: 83.7580 - val\_loss: 94.8666  
Epoch 85/500  
11817/11817 [=====] - 0s - loss: 83.1969 - val\_loss: 94.0737

Epoch 86/500  
11817/11817 [=====] - 0s - loss: 83.7884 - val\_loss: 93.5930  
Epoch 87/500  
11817/11817 [=====] - 0s - loss: 83.0826 - val\_loss: 92.9962  
Epoch 88/500  
11817/11817 [=====] - 0s - loss: 83.1609 - val\_loss: 92.8778  
Epoch 89/500  
11817/11817 [=====] - 0s - loss: 82.8389 - val\_loss: 93.4062  
Epoch 90/500  
11817/11817 [=====] - 0s - loss: 82.9657 - val\_loss: 94.0110  
Epoch 91/500  
11817/11817 [=====] - 0s - loss: 82.6370 - val\_loss: 93.7639  
Epoch 92/500  
11817/11817 [=====] - 0s - loss: 82.6518 - val\_loss: 93.0866  
Epoch 93/500  
11817/11817 [=====] - 0s - loss: 82.5941 - val\_loss: 92.4462  
Epoch 94/500  
11817/11817 [=====] - 0s - loss: 82.4606 - val\_loss: 92.1620  
Epoch 95/500  
11817/11817 [=====] - 0s - loss: 82.2941 - val\_loss: 91.0958  
Epoch 96/500  
11817/11817 [=====] - 0s - loss: 82.0820 - val\_loss: 91.3196  
Epoch 97/500  
11817/11817 [=====] - 0s - loss: 82.4088 - val\_loss: 92.0068  
Epoch 98/500  
11817/11817 [=====] - 0s - loss: 81.7093 - val\_loss: 92.0133  
Epoch 99/500  
11817/11817 [=====] - 0s - loss: 81.7159 - val\_loss: 91.7372  
Epoch 100/500  
11817/11817 [=====] - 0s - loss: 81.6853 - val\_loss: 91.8515  
Epoch 101/500  
11817/11817 [=====] - 0s - loss: 81.8072 - val\_loss: 92.0816  
Epoch 102/500  
11817/11817 [=====] - 0s - loss: 81.6797 - val\_loss: 91.2105  
Epoch 103/500  
11817/11817 [=====] - 0s - loss: 81.2011 - val\_loss: 90.4925  
Epoch 104/500  
11817/11817 [=====] - 0s - loss: 80.9407 - val\_loss: 90.2963  
Epoch 105/500  
11817/11817 [=====] - 0s - loss: 81.0235 - val\_loss: 89.8317  
Epoch 106/500  
11817/11817 [=====] - 0s - loss: 80.7610 - val\_loss: 90.4436  
Epoch 107/500  
11817/11817 [=====] - 0s - loss: 80.6667 - val\_loss: 90.7117  
Epoch 108/500  
11817/11817 [=====] - 0s - loss: 80.5273 - val\_loss: 89.8501  
Epoch 109/500  
11817/11817 [=====] - 0s - loss: 80.3220 - val\_loss: 89.3893

Epoch 110/500  
11817/11817 [=====] - 0s - loss: 80.2853 - val\_loss: 89.7968  
Epoch 111/500  
11817/11817 [=====] - 0s - loss: 79.9792 - val\_loss: 90.0369  
Epoch 112/500  
11817/11817 [=====] - 0s - loss: 79.9631 - val\_loss: 90.0882  
Epoch 113/500  
11817/11817 [=====] - 0s - loss: 79.9166 - val\_loss: 90.4035  
Epoch 114/500  
11817/11817 [=====] - 0s - loss: 79.7104 - val\_loss: 90.1087  
Epoch 115/500  
11817/11817 [=====] - 0s - loss: 79.4251 - val\_loss: 89.8448  
Epoch 116/500  
11817/11817 [=====] - 0s - loss: 79.5716 - val\_loss: 89.3345  
Epoch 117/500  
11817/11817 [=====] - 0s - loss: 79.0917 - val\_loss: 89.3646  
Epoch 118/500  
11817/11817 [=====] - 0s - loss: 79.4406 - val\_loss: 89.3249  
Epoch 119/500  
11817/11817 [=====] - 0s - loss: 78.8440 - val\_loss: 89.4169  
Epoch 120/500  
11817/11817 [=====] - 0s - loss: 78.8099 - val\_loss: 88.9337  
Epoch 121/500  
11817/11817 [=====] - 0s - loss: 78.5786 - val\_loss: 88.6927  
Epoch 122/500  
11817/11817 [=====] - 0s - loss: 78.7734 - val\_loss: 89.7063  
Epoch 123/500  
11817/11817 [=====] - 0s - loss: 78.4659 - val\_loss: 90.6502  
Epoch 124/500  
11817/11817 [=====] - 0s - loss: 77.9945 - val\_loss: 89.9364  
Epoch 125/500  
11817/11817 [=====] - 0s - loss: 78.2389 - val\_loss: 89.4791  
Epoch 126/500  
11817/11817 [=====] - 0s - loss: 77.7991 - val\_loss: 90.4075  
Epoch 127/500  
11817/11817 [=====] - 0s - loss: 77.4011 - val\_loss: 90.5265  
Epoch 128/500  
11817/11817 [=====] - 0s - loss: 77.4622 - val\_loss: 90.0758  
Epoch 129/500  
11817/11817 [=====] - 0s - loss: 77.3368 - val\_loss: 89.0834  
Epoch 130/500  
11817/11817 [=====] - 0s - loss: 77.2495 - val\_loss: 88.6841  
Epoch 131/500  
11817/11817 [=====] - 0s - loss: 77.0056 - val\_loss: 88.6123  
Epoch 132/500  
11817/11817 [=====] - 0s - loss: 76.9492 - val\_loss: 89.8396  
Epoch 133/500  
11817/11817 [=====] - 0s - loss: 76.6612 - val\_loss: 89.8718

Epoch 134/500  
11817/11817 [=====] - 0s - loss: 76.7106 - val\_loss: 89.7835  
Epoch 135/500  
11817/11817 [=====] - 0s - loss: 76.5138 - val\_loss: 89.1677  
Epoch 136/500  
11817/11817 [=====] - 0s - loss: 76.4910 - val\_loss: 88.1386  
Epoch 137/500  
11817/11817 [=====] - 0s - loss: 76.4555 - val\_loss: 87.7925  
Epoch 138/500  
11817/11817 [=====] - 0s - loss: 75.7121 - val\_loss: 88.6467  
Epoch 139/500  
11817/11817 [=====] - 0s - loss: 75.5884 - val\_loss: 88.7287  
Epoch 140/500  
11817/11817 [=====] - 0s - loss: 75.6240 - val\_loss: 89.5080  
Epoch 141/500  
11817/11817 [=====] - 0s - loss: 75.2550 - val\_loss: 89.6640  
Epoch 142/500  
11817/11817 [=====] - 0s - loss: 75.3290 - val\_loss: 89.0540  
Epoch 143/500  
11817/11817 [=====] - 0s - loss: 75.2904 - val\_loss: 87.2134  
Epoch 144/500  
11817/11817 [=====] - 0s - loss: 74.6705 - val\_loss: 87.5754  
Epoch 145/500  
11817/11817 [=====] - 0s - loss: 74.8124 - val\_loss: 88.0473  
Epoch 146/500  
11817/11817 [=====] - 0s - loss: 74.7190 - val\_loss: 88.1233  
Epoch 147/500  
11817/11817 [=====] - 0s - loss: 74.2734 - val\_loss: 87.3912  
Epoch 148/500  
11817/11817 [=====] - 0s - loss: 74.0035 - val\_loss: 86.3566  
Epoch 149/500  
11817/11817 [=====] - 0s - loss: 74.3889 - val\_loss: 88.0919  
Epoch 150/500  
11817/11817 [=====] - 0s - loss: 73.9617 - val\_loss: 89.2889  
Epoch 151/500  
11817/11817 [=====] - 0s - loss: 73.5601 - val\_loss: 88.1423  
Epoch 152/500  
11817/11817 [=====] - 0s - loss: 73.2528 - val\_loss: 87.9242  
Epoch 153/500  
11817/11817 [=====] - 0s - loss: 73.3341 - val\_loss: 87.0567  
Epoch 154/500  
11817/11817 [=====] - 0s - loss: 73.2209 - val\_loss: 86.8976  
Epoch 155/500  
11817/11817 [=====] - 0s - loss: 72.6642 - val\_loss: 86.6176  
Epoch 156/500  
11817/11817 [=====] - 0s - loss: 72.9552 - val\_loss: 85.7483  
Epoch 157/500  
11817/11817 [=====] - 0s - loss: 72.6300 - val\_loss: 87.7707

Epoch 158/500  
11817/11817 [=====] - 0s - loss: 72.2882 - val\_loss: 87.6567  
Epoch 159/500  
11817/11817 [=====] - 0s - loss: 72.1889 - val\_loss: 86.8136  
Epoch 160/500  
11817/11817 [=====] - 0s - loss: 72.0259 - val\_loss: 84.9648  
Epoch 161/500  
11817/11817 [=====] - 0s - loss: 71.7002 - val\_loss: 85.0669  
Epoch 162/500  
11817/11817 [=====] - 0s - loss: 71.7593 - val\_loss: 85.0912  
Epoch 163/500  
11817/11817 [=====] - 0s - loss: 71.7614 - val\_loss: 84.8974  
Epoch 164/500  
11817/11817 [=====] - 0s - loss: 71.0859 - val\_loss: 85.2886  
Epoch 165/500  
11817/11817 [=====] - 0s - loss: 71.2309 - val\_loss: 86.0226  
Epoch 166/500  
11817/11817 [=====] - 0s - loss: 70.8412 - val\_loss: 85.9855  
Epoch 167/500  
11817/11817 [=====] - 0s - loss: 71.0490 - val\_loss: 85.9715  
Epoch 168/500  
11817/11817 [=====] - 0s - loss: 70.5471 - val\_loss: 86.1806  
Epoch 169/500  
11817/11817 [=====] - 0s - loss: 70.7515 - val\_loss: 84.4713  
Epoch 170/500  
11817/11817 [=====] - 0s - loss: 70.5215 - val\_loss: 84.2916  
Epoch 171/500  
11817/11817 [=====] - 0s - loss: 70.1017 - val\_loss: 84.8436  
Epoch 172/500  
11817/11817 [=====] - 0s - loss: 70.2859 - val\_loss: 84.2941  
Epoch 173/500  
11817/11817 [=====] - 0s - loss: 70.1011 - val\_loss: 83.9822  
Epoch 174/500  
11817/11817 [=====] - 0s - loss: 69.7996 - val\_loss: 84.1059  
Epoch 175/500  
11817/11817 [=====] - 0s - loss: 69.3982 - val\_loss: 84.0103  
Epoch 176/500  
11817/11817 [=====] - 0s - loss: 69.0403 - val\_loss: 83.2939  
Epoch 177/500  
11817/11817 [=====] - 0s - loss: 68.8163 - val\_loss: 83.6264  
Epoch 178/500  
11817/11817 [=====] - 0s - loss: 68.8103 - val\_loss: 83.0017  
Epoch 179/500  
11817/11817 [=====] - 0s - loss: 68.8040 - val\_loss: 83.4995  
Epoch 180/500  
11817/11817 [=====] - 0s - loss: 68.2099 - val\_loss: 82.9497  
Epoch 181/500  
11817/11817 [=====] - 0s - loss: 68.4028 - val\_loss: 82.3759

Epoch 182/500  
11817/11817 [=====] - 0s - loss: 68.1857 - val\_loss: 82.7386  
Epoch 183/500  
11817/11817 [=====] - 0s - loss: 68.1538 - val\_loss: 81.9603  
Epoch 184/500  
11817/11817 [=====] - 0s - loss: 67.7911 - val\_loss: 82.1427  
Epoch 185/500  
11817/11817 [=====] - 0s - loss: 68.2932 - val\_loss: 81.2487  
Epoch 186/500  
11817/11817 [=====] - 0s - loss: 67.6814 - val\_loss: 82.5670  
Epoch 187/500  
11817/11817 [=====] - 0s - loss: 67.5014 - val\_loss: 81.9739  
Epoch 188/500  
11817/11817 [=====] - 0s - loss: 67.1840 - val\_loss: 80.7843  
Epoch 189/500  
11817/11817 [=====] - 0s - loss: 67.0264 - val\_loss: 81.3312  
Epoch 190/500  
11817/11817 [=====] - 0s - loss: 66.9595 - val\_loss: 80.1514  
Epoch 191/500  
11817/11817 [=====] - 0s - loss: 66.8543 - val\_loss: 82.7803  
Epoch 192/500  
11817/11817 [=====] - 0s - loss: 66.7302 - val\_loss: 78.1506  
Epoch 193/500  
11817/11817 [=====] - 0s - loss: 66.6024 - val\_loss: 82.2590  
Epoch 194/500  
11817/11817 [=====] - 0s - loss: 66.8390 - val\_loss: 80.7747  
Epoch 195/500  
11817/11817 [=====] - 0s - loss: 66.1588 - val\_loss: 82.3875  
Epoch 196/500  
11817/11817 [=====] - 0s - loss: 66.4094 - val\_loss: 78.3565  
Epoch 197/500  
11817/11817 [=====] - 0s - loss: 66.0758 - val\_loss: 80.4003  
Epoch 198/500  
11817/11817 [=====] - 0s - loss: 65.5797 - val\_loss: 80.4155  
Epoch 199/500  
11817/11817 [=====] - 0s - loss: 65.7407 - val\_loss: 80.7922  
Epoch 200/500  
11817/11817 [=====] - 0s - loss: 65.6766 - val\_loss: 79.7367  
Epoch 201/500  
11817/11817 [=====] - 0s - loss: 65.2524 - val\_loss: 76.6259  
Epoch 202/500  
11817/11817 [=====] - 0s - loss: 64.8914 - val\_loss: 77.6049  
Epoch 203/500  
11817/11817 [=====] - 0s - loss: 64.9131 - val\_loss: 77.9808  
Epoch 204/500  
11817/11817 [=====] - 0s - loss: 64.7182 - val\_loss: 79.8567  
Epoch 205/500  
11817/11817 [=====] - 0s - loss: 65.2484 - val\_loss: 79.3736

Epoch 206/500  
11817/11817 [=====] - 0s - loss: 64.3305 - val\_loss: 77.4556  
Epoch 207/500  
11817/11817 [=====] - 0s - loss: 64.5164 - val\_loss: 77.3147  
Epoch 208/500  
11817/11817 [=====] - 0s - loss: 64.1687 - val\_loss: 77.7892  
Epoch 209/500  
11817/11817 [=====] - 0s - loss: 63.9388 - val\_loss: 75.8815  
Epoch 210/500  
11817/11817 [=====] - 0s - loss: 64.2942 - val\_loss: 75.8225  
Epoch 211/500  
11817/11817 [=====] - 0s - loss: 63.2475 - val\_loss: 74.4840  
Epoch 212/500  
11817/11817 [=====] - 0s - loss: 63.5711 - val\_loss: 75.7076  
Epoch 213/500  
11817/11817 [=====] - 0s - loss: 63.2649 - val\_loss: 73.7899  
Epoch 214/500  
11817/11817 [=====] - 0s - loss: 63.0528 - val\_loss: 75.4648  
Epoch 215/500  
11817/11817 [=====] - 0s - loss: 62.8982 - val\_loss: 74.7499  
Epoch 216/500  
11817/11817 [=====] - 0s - loss: 62.6591 - val\_loss: 75.5192  
Epoch 217/500  
11817/11817 [=====] - 0s - loss: 62.6958 - val\_loss: 72.7061  
Epoch 218/500  
11817/11817 [=====] - 0s - loss: 62.4466 - val\_loss: 74.7714  
Epoch 219/500  
11817/11817 [=====] - 0s - loss: 62.4928 - val\_loss: 73.8927  
Epoch 220/500  
11817/11817 [=====] - 0s - loss: 62.3170 - val\_loss: 74.5409  
Epoch 221/500  
11817/11817 [=====] - 0s - loss: 62.0235 - val\_loss: 74.4842  
Epoch 222/500  
11817/11817 [=====] - 0s - loss: 61.5390 - val\_loss: 74.6753  
Epoch 223/500  
11817/11817 [=====] - 0s - loss: 61.5316 - val\_loss: 73.2647  
Epoch 224/500  
11817/11817 [=====] - 0s - loss: 61.1945 - val\_loss: 72.3470  
Epoch 225/500  
11817/11817 [=====] - 0s - loss: 61.0715 - val\_loss: 71.4052  
Epoch 226/500  
11817/11817 [=====] - 0s - loss: 61.3451 - val\_loss: 73.0358  
Epoch 227/500  
11817/11817 [=====] - 0s - loss: 60.9943 - val\_loss: 72.4952  
Epoch 228/500  
11817/11817 [=====] - 0s - loss: 60.8088 - val\_loss: 73.0900  
Epoch 229/500  
11817/11817 [=====] - 0s - loss: 60.9715 - val\_loss: 71.9457



Epoch 230/500  
11817/11817 [=====] - 0s - loss: 61.0275 - val\_loss: 71.6722  
Epoch 231/500  
11817/11817 [=====] - 0s - loss: 60.9861 - val\_loss: 74.6409  
Epoch 232/500  
11817/11817 [=====] - 0s - loss: 60.7249 - val\_loss: 72.5882  
Epoch 233/500  
11817/11817 [=====] - 0s - loss: 60.5008 - val\_loss: 72.3858  
Epoch 234/500  
11817/11817 [=====] - 0s - loss: 60.5039 - val\_loss: 70.5164  
Epoch 235/500  
11817/11817 [=====] - 0s - loss: 59.7465 - val\_loss: 72.4755  
Epoch 236/500  
11817/11817 [=====] - 0s - loss: 59.7134 - val\_loss: 73.6383  
Epoch 237/500  
11817/11817 [=====] - 0s - loss: 59.6690 - val\_loss: 73.4954  
Epoch 238/500  
11817/11817 [=====] - 0s - loss: 59.0862 - val\_loss: 72.5995  
Epoch 239/500  
11817/11817 [=====] - 0s - loss: 58.8393 - val\_loss: 71.7017  
Epoch 240/500  
11817/11817 [=====] - 0s - loss: 58.8877 - val\_loss: 70.8886  
Epoch 241/500  
11817/11817 [=====] - 0s - loss: 58.6759 - val\_loss: 71.9337  
Epoch 242/500  
11817/11817 [=====] - 0s - loss: 58.6160 - val\_loss: 72.3457  
Epoch 243/500  
11817/11817 [=====] - 0s - loss: 58.3316 - val\_loss: 72.6810  
Epoch 244/500  
11817/11817 [=====] - 0s - loss: 58.3574 - val\_loss: 71.7169  
Epoch 245/500  
11817/11817 [=====] - 0s - loss: 57.8874 - val\_loss: 70.5144  
Epoch 246/500  
11817/11817 [=====] - 0s - loss: 58.0914 - val\_loss: 68.9371  
Epoch 247/500  
11817/11817 [=====] - 0s - loss: 57.5553 - val\_loss: 72.6915  
Epoch 248/500  
11817/11817 [=====] - 0s - loss: 58.1125 - val\_loss: 71.7633  
Epoch 249/500  
11817/11817 [=====] - 0s - loss: 58.0305 - val\_loss: 71.1292  
Epoch 250/500  
11817/11817 [=====] - 0s - loss: 57.7445 - val\_loss: 71.5909  
Epoch 251/500  
11817/11817 [=====] - 0s - loss: 57.7244 - val\_loss: 72.2840  
Epoch 252/500  
11817/11817 [=====] - 0s - loss: 56.9715 - val\_loss: 71.8803  
Epoch 253/500  
11817/11817 [=====] - 0s - loss: 57.0049 - val\_loss: 72.2447

Epoch 254/500  
11817/11817 [=====] - 0s - loss: 57.6318 - val\_loss: 71.1698  
Epoch 255/500  
11817/11817 [=====] - 0s - loss: 56.8172 - val\_loss: 73.4128  
Epoch 256/500  
11817/11817 [=====] - 0s - loss: 56.5340 - val\_loss: 74.5969  
Epoch 257/500  
11817/11817 [=====] - 0s - loss: 57.0373 - val\_loss: 73.6747  
Epoch 258/500  
11817/11817 [=====] - 0s - loss: 56.3821 - val\_loss: 68.4340  
Epoch 259/500  
11817/11817 [=====] - 0s - loss: 56.1774 - val\_loss: 66.7397  
Epoch 260/500  
11817/11817 [=====] - 0s - loss: 55.7600 - val\_loss: 69.8558  
Epoch 261/500  
11817/11817 [=====] - 0s - loss: 56.0721 - val\_loss: 69.7810  
Epoch 262/500  
11817/11817 [=====] - 0s - loss: 55.8289 - val\_loss: 71.7671  
Epoch 263/500  
11817/11817 [=====] - 0s - loss: 55.4205 - val\_loss: 71.1964  
Epoch 264/500  
11817/11817 [=====] - 0s - loss: 54.9238 - val\_loss: 69.5509  
Epoch 265/500  
11817/11817 [=====] - 0s - loss: 54.9970 - val\_loss: 67.2516  
Epoch 266/500  
11817/11817 [=====] - 0s - loss: 55.2432 - val\_loss: 71.5024  
Epoch 267/500  
11817/11817 [=====] - 0s - loss: 55.0751 - val\_loss: 72.9762  
Epoch 268/500  
11817/11817 [=====] - 0s - loss: 55.0689 - val\_loss: 75.7416  
Epoch 269/500  
11817/11817 [=====] - 0s - loss: 54.6255 - val\_loss: 72.6484  
Epoch 270/500  
11817/11817 [=====] - 0s - loss: 54.6353 - val\_loss: 71.0769  
Epoch 271/500  
11817/11817 [=====] - 0s - loss: 54.2440 - val\_loss: 69.2690  
Epoch 272/500  
11817/11817 [=====] - 0s - loss: 54.1638 - val\_loss: 67.4304  
Epoch 273/500  
11817/11817 [=====] - 0s - loss: 53.9793 - val\_loss: 67.3626  
Epoch 274/500  
11817/11817 [=====] - 0s - loss: 53.9170 - val\_loss: 69.9123  
Epoch 275/500  
11817/11817 [=====] - 0s - loss: 53.7868 - val\_loss: 73.1856  
Epoch 276/500  
11817/11817 [=====] - 0s - loss: 53.7383 - val\_loss: 71.6359  
Epoch 277/500  
11817/11817 [=====] - 0s - loss: 54.3773 - val\_loss: 70.6825

Epoch 278/500  
11817/11817 [=====] - 0s - loss: 54.1907 - val\_loss: 73.0827  
Epoch 279/500  
11817/11817 [=====] - 0s - loss: 53.8436 - val\_loss: 70.3498  
Epoch 280/500  
11817/11817 [=====] - 0s - loss: 53.7012 - val\_loss: 72.4451  
Epoch 281/500  
11817/11817 [=====] - 0s - loss: 53.7019 - val\_loss: 68.0821  
Epoch 282/500  
11817/11817 [=====] - 0s - loss: 54.0736 - val\_loss: 70.7523  
Epoch 283/500  
11817/11817 [=====] - 0s - loss: 53.4330 - val\_loss: 70.3438  
Epoch 284/500  
11817/11817 [=====] - 0s - loss: 52.8679 - val\_loss: 67.4172  
Epoch 285/500  
11817/11817 [=====] - 0s - loss: 52.9009 - val\_loss: 64.7828  
Epoch 286/500  
11817/11817 [=====] - 0s - loss: 52.8284 - val\_loss: 64.9549  
Epoch 287/500  
11817/11817 [=====] - 0s - loss: 52.7523 - val\_loss: 66.4817  
Epoch 288/500  
11817/11817 [=====] - 0s - loss: 52.8518 - val\_loss: 66.3940  
Epoch 289/500  
11817/11817 [=====] - 0s - loss: 51.9468 - val\_loss: 67.2543  
Epoch 290/500  
11817/11817 [=====] - 0s - loss: 52.1542 - val\_loss: 67.6317  
Epoch 291/500  
11817/11817 [=====] - 0s - loss: 52.5692 - val\_loss: 66.5232  
Epoch 292/500  
11817/11817 [=====] - 0s - loss: 52.8056 - val\_loss: 67.9481  
Epoch 293/500  
11817/11817 [=====] - 0s - loss: 52.4881 - val\_loss: 71.6142  
Epoch 294/500  
11817/11817 [=====] - 0s - loss: 51.5341 - val\_loss: 70.5810  
Epoch 295/500  
11817/11817 [=====] - 0s - loss: 51.5245 - val\_loss: 68.3444  
Epoch 296/500  
11817/11817 [=====] - 0s - loss: 51.2606 - val\_loss: 65.8589  
Epoch 297/500  
11817/11817 [=====] - 0s - loss: 51.3688 - val\_loss: 63.1900  
Epoch 298/500  
11817/11817 [=====] - 0s - loss: 51.3951 - val\_loss: 60.4001  
Epoch 299/500  
11817/11817 [=====] - 0s - loss: 50.7991 - val\_loss: 60.5207  
Epoch 300/500  
11817/11817 [=====] - 0s - loss: 50.9322 - val\_loss: 63.5504  
Epoch 301/500  
11817/11817 [=====] - 0s - loss: 50.7257 - val\_loss: 65.4949

Epoch 302/500  
11817/11817 [=====] - 0s - loss: 50.6552 - val\_loss: 63.9611  
Epoch 303/500  
11817/11817 [=====] - 0s - loss: 50.6216 - val\_loss: 66.0055  
Epoch 304/500  
11817/11817 [=====] - 0s - loss: 50.5338 - val\_loss: 64.0571  
Epoch 305/500  
11817/11817 [=====] - 0s - loss: 50.4476 - val\_loss: 64.7711  
Epoch 306/500  
11817/11817 [=====] - 0s - loss: 50.2662 - val\_loss: 66.9587  
Epoch 307/500  
11817/11817 [=====] - 0s - loss: 50.9296 - val\_loss: 65.6773  
Epoch 308/500  
11817/11817 [=====] - 0s - loss: 50.6276 - val\_loss: 64.0418  
Epoch 309/500  
11817/11817 [=====] - 0s - loss: 49.9948 - val\_loss: 59.8567  
Epoch 310/500  
11817/11817 [=====] - 0s - loss: 50.1958 - val\_loss: 57.6309  
Epoch 311/500  
11817/11817 [=====] - 0s - loss: 50.3905 - val\_loss: 57.1131  
Epoch 312/500  
11817/11817 [=====] - 0s - loss: 49.6753 - val\_loss: 57.0602  
Epoch 313/500  
11817/11817 [=====] - 0s - loss: 49.6947 - val\_loss: 58.0074  
Epoch 314/500  
11817/11817 [=====] - 0s - loss: 50.1103 - val\_loss: 59.3954  
Epoch 315/500  
11817/11817 [=====] - 0s - loss: 50.1483 - val\_loss: 63.7654  
Epoch 316/500  
11817/11817 [=====] - 0s - loss: 49.6254 - val\_loss: 70.2530  
Epoch 317/500  
11817/11817 [=====] - 0s - loss: 49.9918 - val\_loss: 67.3015  
Epoch 318/500  
11817/11817 [=====] - 0s - loss: 49.3797 - val\_loss: 69.0405  
Epoch 319/500  
11817/11817 [=====] - 0s - loss: 49.3717 - val\_loss: 70.4143  
Epoch 320/500  
11817/11817 [=====] - 0s - loss: 48.9622 - val\_loss: 67.8871  
Epoch 321/500  
11817/11817 [=====] - 0s - loss: 48.9377 - val\_loss: 66.9183  
Epoch 322/500  
11817/11817 [=====] - 0s - loss: 48.7691 - val\_loss: 64.5578  
Epoch 323/500  
11817/11817 [=====] - 0s - loss: 48.8368 - val\_loss: 62.2587  
Epoch 324/500  
11817/11817 [=====] - 0s - loss: 48.4979 - val\_loss: 59.9993  
Epoch 325/500  
11817/11817 [=====] - 0s - loss: 48.5874 - val\_loss: 62.0204

Epoch 326/500  
11817/11817 [=====] - 0s - loss: 48.6125 - val\_loss: 66.8115  
Epoch 327/500  
11817/11817 [=====] - 0s - loss: 48.1360 - val\_loss: 66.4232  
Epoch 328/500  
11817/11817 [=====] - 0s - loss: 49.0744 - val\_loss: 65.5461  
Epoch 329/500  
11817/11817 [=====] - 0s - loss: 48.1006 - val\_loss: 63.0343  
Epoch 330/500  
11817/11817 [=====] - 0s - loss: 48.6177 - val\_loss: 62.0493  
Epoch 331/500  
11817/11817 [=====] - 0s - loss: 48.3338 - val\_loss: 60.7293  
Epoch 332/500  
11817/11817 [=====] - 0s - loss: 49.0893 - val\_loss: 65.1989  
Epoch 333/500  
11817/11817 [=====] - 0s - loss: 48.4888 - val\_loss: 67.8033  
Epoch 334/500  
11817/11817 [=====] - 0s - loss: 50.3586 - val\_loss: 88.2535  
Epoch 335/500  
11817/11817 [=====] - 0s - loss: 51.0644 - val\_loss: 94.2530  
Epoch 336/500  
11817/11817 [=====] - 0s - loss: 48.4113 - val\_loss: 81.4455  
Epoch 337/500  
11817/11817 [=====] - 0s - loss: 48.6817 - val\_loss: 69.6383  
Epoch 338/500  
11817/11817 [=====] - 0s - loss: 47.5110 - val\_loss: 66.2155  
Epoch 339/500  
11817/11817 [=====] - 0s - loss: 47.7115 - val\_loss: 64.3054  
Epoch 340/500  
11817/11817 [=====] - 0s - loss: 48.7751 - val\_loss: 75.1100  
Epoch 341/500  
11817/11817 [=====] - 0s - loss: 48.3581 - val\_loss: 81.9610  
Epoch 342/500  
11817/11817 [=====] - 0s - loss: 48.3915 - val\_loss: 87.4880  
Epoch 343/500  
11817/11817 [=====] - 0s - loss: 47.6665 - val\_loss: 76.5682  
Epoch 344/500  
11817/11817 [=====] - 0s - loss: 47.3155 - val\_loss: 68.9464  
Epoch 345/500  
11817/11817 [=====] - 0s - loss: 47.7000 - val\_loss: 59.2478  
Epoch 346/500  
11817/11817 [=====] - 0s - loss: 46.6954 - val\_loss: 55.9328  
Epoch 347/500  
11817/11817 [=====] - 0s - loss: 47.9050 - val\_loss: 55.2917  
Epoch 348/500  
11817/11817 [=====] - 0s - loss: 47.7555 - val\_loss: 57.4459  
Epoch 349/500  
11817/11817 [=====] - 0s - loss: 47.2471 - val\_loss: 63.2489

Epoch 350/500  
11817/11817 [=====] - 0s - loss: 47.0153 - val\_loss: 64.3102  
Epoch 351/500  
11817/11817 [=====] - 0s - loss: 46.6267 - val\_loss: 64.9262  
Epoch 352/500  
11817/11817 [=====] - 0s - loss: 47.1836 - val\_loss: 62.2756  
Epoch 353/500  
11817/11817 [=====] - 0s - loss: 47.6559 - val\_loss: 65.6047  
Epoch 354/500  
11817/11817 [=====] - 0s - loss: 47.1527 - val\_loss: 64.3074  
Epoch 355/500  
11817/11817 [=====] - 0s - loss: 46.7248 - val\_loss: 62.1474  
Epoch 356/500  
11817/11817 [=====] - 0s - loss: 46.7202 - val\_loss: 57.4666  
Epoch 357/500  
11817/11817 [=====] - 0s - loss: 46.6013 - val\_loss: 56.0102  
Epoch 358/500  
11817/11817 [=====] - 0s - loss: 46.8022 - val\_loss: 53.3132  
Epoch 359/500  
11817/11817 [=====] - 0s - loss: 46.7266 - val\_loss: 54.2631  
Epoch 360/500  
11817/11817 [=====] - 0s - loss: 45.8806 - val\_loss: 54.1017  
Epoch 361/500  
11817/11817 [=====] - 0s - loss: 46.0850 - val\_loss: 51.7692  
Epoch 362/500  
11817/11817 [=====] - 0s - loss: 45.5897 - val\_loss: 51.4072  
Epoch 363/500  
11817/11817 [=====] - 0s - loss: 45.9276 - val\_loss: 53.4943  
Epoch 364/500  
11817/11817 [=====] - 0s - loss: 45.8321 - val\_loss: 56.6021  
Epoch 365/500  
11817/11817 [=====] - 0s - loss: 46.4343 - val\_loss: 58.3347  
Epoch 366/500  
11817/11817 [=====] - 0s - loss: 47.3668 - val\_loss: 62.1479  
Epoch 367/500  
11817/11817 [=====] - 0s - loss: 46.5527 - val\_loss: 69.3814  
Epoch 368/500  
11817/11817 [=====] - 0s - loss: 45.9793 - val\_loss: 76.5018  
Epoch 369/500  
11817/11817 [=====] - 0s - loss: 46.2370 - val\_loss: 78.3423  
Epoch 370/500  
11817/11817 [=====] - 0s - loss: 46.0918 - val\_loss: 74.0672  
Epoch 371/500  
11817/11817 [=====] - 0s - loss: 46.4380 - val\_loss: 66.5449  
Epoch 372/500  
11817/11817 [=====] - 0s - loss: 45.7205 - val\_loss: 59.9197  
Epoch 373/500  
11817/11817 [=====] - 0s - loss: 45.3119 - val\_loss: 58.8025

Epoch 374/500  
11817/11817 [=====] - 0s - loss: 45.4892 - val\_loss: 53.6280  
Epoch 375/500  
11817/11817 [=====] - 0s - loss: 44.9701 - val\_loss: 51.1847  
Epoch 376/500  
11817/11817 [=====] - 0s - loss: 44.9082 - val\_loss: 52.0667  
Epoch 377/500  
11817/11817 [=====] - 0s - loss: 45.4098 - val\_loss: 51.7210  
Epoch 378/500  
11817/11817 [=====] - 0s - loss: 46.9699 - val\_loss: 54.0110  
Epoch 379/500  
11817/11817 [=====] - 0s - loss: 45.0854 - val\_loss: 54.2287  
Epoch 380/500  
11817/11817 [=====] - 0s - loss: 45.3506 - val\_loss: 53.7821  
Epoch 381/500  
11817/11817 [=====] - 0s - loss: 44.7110 - val\_loss: 54.1645  
Epoch 382/500  
11817/11817 [=====] - 0s - loss: 45.0537 - val\_loss: 55.1629  
Epoch 383/500  
11817/11817 [=====] - 0s - loss: 45.7413 - val\_loss: 58.7498  
Epoch 384/500  
11817/11817 [=====] - 0s - loss: 44.4816 - val\_loss: 62.6477  
Epoch 385/500  
11817/11817 [=====] - 0s - loss: 45.1192 - val\_loss: 61.4492  
Epoch 386/500  
11817/11817 [=====] - 0s - loss: 45.3294 - val\_loss: 61.9170  
Epoch 387/500  
11817/11817 [=====] - 0s - loss: 44.5526 - val\_loss: 61.6218  
Epoch 388/500  
11817/11817 [=====] - 0s - loss: 43.9062 - val\_loss: 58.0207  
Epoch 389/500  
11817/11817 [=====] - 0s - loss: 45.1094 - val\_loss: 55.0502  
Epoch 390/500  
11817/11817 [=====] - 0s - loss: 45.3617 - val\_loss: 54.4564  
Epoch 391/500  
11817/11817 [=====] - 0s - loss: 45.9502 - val\_loss: 50.2642  
Epoch 392/500  
11817/11817 [=====] - 0s - loss: 44.2490 - val\_loss: 48.4929  
Epoch 393/500  
11817/11817 [=====] - 0s - loss: 44.6811 - val\_loss: 48.8778  
Epoch 394/500  
11817/11817 [=====] - 0s - loss: 45.0873 - val\_loss: 51.3541  
Epoch 395/500  
11817/11817 [=====] - 0s - loss: 45.0602 - val\_loss: 55.7454  
Epoch 396/500  
11817/11817 [=====] - 0s - loss: 44.3133 - val\_loss: 55.9882  
Epoch 397/500  
11817/11817 [=====] - 0s - loss: 44.5776 - val\_loss: 52.5613

Epoch 398/500  
11817/11817 [=====] - 0s - loss: 46.0521 - val\_loss: 49.3732  
Epoch 399/500  
11817/11817 [=====] - 0s - loss: 45.3901 - val\_loss: 47.1298  
Epoch 400/500  
11817/11817 [=====] - 0s - loss: 44.7809 - val\_loss: 47.3804  
Epoch 401/500  
11817/11817 [=====] - 0s - loss: 45.4903 - val\_loss: 48.7926  
Epoch 402/500  
11817/11817 [=====] - 0s - loss: 45.4277 - val\_loss: 51.4899  
Epoch 403/500  
11817/11817 [=====] - 0s - loss: 45.5370 - val\_loss: 56.7821  
Epoch 404/500  
11817/11817 [=====] - 0s - loss: 43.9614 - val\_loss: 58.5093  
Epoch 405/500  
11817/11817 [=====] - 0s - loss: 44.2685 - val\_loss: 53.5071  
Epoch 406/500  
11817/11817 [=====] - 0s - loss: 43.9551 - val\_loss: 50.0081  
Epoch 407/500  
11817/11817 [=====] - 0s - loss: 44.7738 - val\_loss: 51.4492  
Epoch 408/500  
11817/11817 [=====] - 0s - loss: 45.3215 - val\_loss: 51.5777  
Epoch 409/500  
11817/11817 [=====] - 0s - loss: 43.9677 - val\_loss: 53.9338  
Epoch 410/500  
11817/11817 [=====] - 0s - loss: 44.1633 - val\_loss: 54.0842  
Epoch 411/500  
11817/11817 [=====] - 0s - loss: 44.4820 - val\_loss: 55.6451  
Epoch 412/500  
11817/11817 [=====] - 0s - loss: 43.6099 - val\_loss: 55.3393  
Epoch 413/500  
11817/11817 [=====] - 0s - loss: 43.3651 - val\_loss: 53.3385  
Epoch 414/500  
11817/11817 [=====] - 0s - loss: 43.0795 - val\_loss: 51.1884  
Epoch 415/500  
11817/11817 [=====] - 0s - loss: 43.0458 - val\_loss: 49.0226  
Epoch 416/500  
11817/11817 [=====] - 0s - loss: 43.0882 - val\_loss: 47.1675  
Epoch 417/500  
11817/11817 [=====] - 0s - loss: 43.4515 - val\_loss: 44.8098  
Epoch 418/500  
11817/11817 [=====] - 0s - loss: 42.9680 - val\_loss: 44.7175  
Epoch 419/500  
11817/11817 [=====] - 0s - loss: 43.2984 - val\_loss: 45.9921  
Epoch 420/500  
11817/11817 [=====] - 0s - loss: 43.4339 - val\_loss: 47.6544  
Epoch 421/500  
11817/11817 [=====] - 0s - loss: 43.9985 - val\_loss: 50.8650



Epoch 422/500  
11817/11817 [=====] - 0s - loss: 43.1312 - val\_loss: 54.3999  
Epoch 423/500  
11817/11817 [=====] - 0s - loss: 43.1296 - val\_loss: 55.9182  
Epoch 424/500  
11817/11817 [=====] - 0s - loss: 42.9679 - val\_loss: 54.8246  
Epoch 425/500  
11817/11817 [=====] - 0s - loss: 43.2127 - val\_loss: 52.2507  
Epoch 426/500  
11817/11817 [=====] - 0s - loss: 44.4113 - val\_loss: 51.1061  
Epoch 427/500  
11817/11817 [=====] - 0s - loss: 44.4251 - val\_loss: 52.1617  
Epoch 428/500  
11817/11817 [=====] - 0s - loss: 42.7340 - val\_loss: 50.0708  
Epoch 429/500  
11817/11817 [=====] - 0s - loss: 43.6230 - val\_loss: 47.7969  
Epoch 430/500  
11817/11817 [=====] - 0s - loss: 42.8017 - val\_loss: 48.9827  
Epoch 431/500  
11817/11817 [=====] - 0s - loss: 43.0265 - val\_loss: 52.2213  
Epoch 432/500  
11817/11817 [=====] - 0s - loss: 42.6986 - val\_loss: 53.6937  
Epoch 433/500  
11817/11817 [=====] - 0s - loss: 42.6736 - val\_loss: 51.8348  
Epoch 434/500  
11817/11817 [=====] - 0s - loss: 43.7783 - val\_loss: 48.0247  
Epoch 435/500  
11817/11817 [=====] - 0s - loss: 43.3985 - val\_loss: 46.9910  
Epoch 436/500  
11817/11817 [=====] - 0s - loss: 44.3708 - val\_loss: 49.5480  
Epoch 437/500  
11817/11817 [=====] - 0s - loss: 44.1911 - val\_loss: 52.9778  
Epoch 438/500  
11817/11817 [=====] - 0s - loss: 43.0634 - val\_loss: 55.4990  
Epoch 439/500  
11817/11817 [=====] - 0s - loss: 43.1613 - val\_loss: 57.3615  
Epoch 440/500  
11817/11817 [=====] - 0s - loss: 42.1116 - val\_loss: 57.1214  
Epoch 441/500  
11817/11817 [=====] - 0s - loss: 42.6660 - val\_loss: 54.0210  
Epoch 442/500  
11817/11817 [=====] - 0s - loss: 41.9974 - val\_loss: 50.7714  
Epoch 443/500  
11817/11817 [=====] - 0s - loss: 42.7925 - val\_loss: 51.4319  
Epoch 444/500  
11817/11817 [=====] - 0s - loss: 42.3645 - val\_loss: 50.9427  
Epoch 445/500  
11817/11817 [=====] - 0s - loss: 42.5073 - val\_loss: 50.6414

Epoch 446/500  
11817/11817 [=====] - 0s - loss: 42.3245 - val\_loss: 49.1633  
Epoch 447/500  
11817/11817 [=====] - 0s - loss: 43.3928 - val\_loss: 47.9193  
Epoch 448/500  
11817/11817 [=====] - 0s - loss: 43.0453 - val\_loss: 49.0420  
Epoch 449/500  
11817/11817 [=====] - 0s - loss: 43.4348 - val\_loss: 50.4292  
Epoch 450/500  
11817/11817 [=====] - 0s - loss: 42.2306 - val\_loss: 51.0806  
Epoch 451/500  
11817/11817 [=====] - 0s - loss: 41.8162 - val\_loss: 50.3155  
Epoch 452/500  
11817/11817 [=====] - 0s - loss: 43.1007 - val\_loss: 49.4465  
Epoch 453/500  
11817/11817 [=====] - 0s - loss: 41.8069 - val\_loss: 47.9578  
Epoch 454/500  
11817/11817 [=====] - 0s - loss: 42.3360 - val\_loss: 47.4257  
Epoch 455/500  
11817/11817 [=====] - 0s - loss: 42.3532 - val\_loss: 46.6919  
Epoch 456/500  
11817/11817 [=====] - 0s - loss: 41.3533 - val\_loss: 46.3388  
Epoch 457/500  
11817/11817 [=====] - 0s - loss: 42.2171 - val\_loss: 45.4874  
Epoch 458/500  
11817/11817 [=====] - 0s - loss: 41.9170 - val\_loss: 45.7463  
Epoch 459/500  
11817/11817 [=====] - 0s - loss: 41.2767 - val\_loss: 45.5742  
Epoch 460/500  
11817/11817 [=====] - 0s - loss: 41.9997 - val\_loss: 45.0034  
Epoch 461/500  
11817/11817 [=====] - 0s - loss: 42.5876 - val\_loss: 44.9475  
Epoch 462/500  
11817/11817 [=====] - 0s - loss: 43.4095 - val\_loss: 45.0031  
Epoch 463/500  
11817/11817 [=====] - 0s - loss: 43.9836 - val\_loss: 44.5389  
Epoch 464/500  
11817/11817 [=====] - 0s - loss: 41.0046 - val\_loss: 44.0326  
Epoch 465/500  
11817/11817 [=====] - 0s - loss: 42.3371 - val\_loss: 42.6412  
Epoch 466/500  
11817/11817 [=====] - 0s - loss: 42.2432 - val\_loss: 42.6087  
Epoch 467/500  
11817/11817 [=====] - 0s - loss: 41.5629 - val\_loss: 43.2916  
Epoch 468/500  
11817/11817 [=====] - 0s - loss: 41.0066 - val\_loss: 43.6328  
Epoch 469/500  
11817/11817 [=====] - 0s - loss: 41.6983 - val\_loss: 44.4441

Epoch 470/500  
11817/11817 [=====] - 0s - loss: 42.9906 - val\_loss: 45.1768  
Epoch 471/500  
11817/11817 [=====] - 0s - loss: 41.7465 - val\_loss: 45.7936  
Epoch 472/500  
11817/11817 [=====] - 0s - loss: 42.4341 - val\_loss: 45.7273  
Epoch 473/500  
11817/11817 [=====] - 0s - loss: 42.2874 - val\_loss: 45.7968  
Epoch 474/500  
11817/11817 [=====] - 0s - loss: 42.2217 - val\_loss: 45.9342  
Epoch 475/500  
11817/11817 [=====] - 0s - loss: 41.5957 - val\_loss: 42.1170  
Epoch 476/500  
11817/11817 [=====] - 0s - loss: 41.8797 - val\_loss: 41.6164  
Epoch 477/500  
11817/11817 [=====] - 0s - loss: 41.2060 - val\_loss: 41.1074  
Epoch 478/500  
11817/11817 [=====] - 0s - loss: 41.7010 - val\_loss: 41.4617  
Epoch 479/500  
11817/11817 [=====] - 0s - loss: 41.0393 - val\_loss: 42.5752  
Epoch 480/500  
11817/11817 [=====] - 0s - loss: 41.3613 - val\_loss: 43.2461  
Epoch 481/500  
11817/11817 [=====] - 0s - loss: 40.7668 - val\_loss: 43.5186  
Epoch 482/500  
11817/11817 [=====] - 0s - loss: 40.7956 - val\_loss: 43.9781  
Epoch 483/500  
11817/11817 [=====] - 0s - loss: 40.7816 - val\_loss: 45.4506  
Epoch 484/500  
11817/11817 [=====] - 0s - loss: 42.4796 - val\_loss: 46.3702  
Epoch 485/500  
11817/11817 [=====] - 0s - loss: 42.5487 - val\_loss: 46.2387  
Epoch 486/500  
11817/11817 [=====] - 0s - loss: 41.1201 - val\_loss: 42.9965  
Epoch 487/500  
11817/11817 [=====] - 0s - loss: 42.0898 - val\_loss: 41.6027  
Epoch 488/500  
11817/11817 [=====] - 0s - loss: 42.8639 - val\_loss: 41.2085  
Epoch 489/500  
11817/11817 [=====] - 0s - loss: 41.4630 - val\_loss: 42.9302  
Epoch 490/500  
11817/11817 [=====] - 0s - loss: 42.3753 - val\_loss: 42.8549  
Epoch 491/500  
11817/11817 [=====] - 0s - loss: 41.1468 - val\_loss: 43.9889  
Epoch 492/500  
11817/11817 [=====] - 0s - loss: 40.6436 - val\_loss: 43.3292  
Epoch 493/500  
11817/11817 [=====] - 0s - loss: 41.2469 - val\_loss: 43.8849

```

Epoch 494/500
11817/11817 [=====] - 0s - loss: 40.3810 - val_loss: 43.9236
Epoch 495/500
11817/11817 [=====] - 0s - loss: 40.3423 - val_loss: 44.3145
Epoch 496/500
11817/11817 [=====] - 0s - loss: 40.6507 - val_loss: 44.7493
Epoch 497/500
11817/11817 [=====] - 0s - loss: 40.4079 - val_loss: 44.5422
Epoch 498/500
11817/11817 [=====] - 0s - loss: 41.3719 - val_loss: 43.7982
Epoch 499/500
11817/11817 [=====] - 0s - loss: 40.6415 - val_loss: 41.2838
Epoch 500/500
11817/11817 [=====] - 0s - loss: 41.8749 - val_loss: 41.1106

```

```

In [48]: past_preds = model.predict(train_features)[: , 0]
        future_preds = model.predict(test_features)[: , 0]

        from sklearn.metrics import r2_score
        import numpy as np

        # our benchmark is just guessing the average
        benchmark = np.mean(train_targets)
        print('benchmark r^2 on training:', r2_score(train_targets, [benchmark] * train_targets.shape[0]))

        print('training r^2:', r2_score(train_targets, past_preds))
        plt.scatter(train_targets, past_preds, alpha=0.1)
        plt.xlabel('actual')
        plt.ylabel('predicted')
        plt.title('train predictions vs actual')
        plt.show()

        print('benchmark r^2 on test:', r2_score(test_targets, [benchmark] * test_targets.shape[0]))

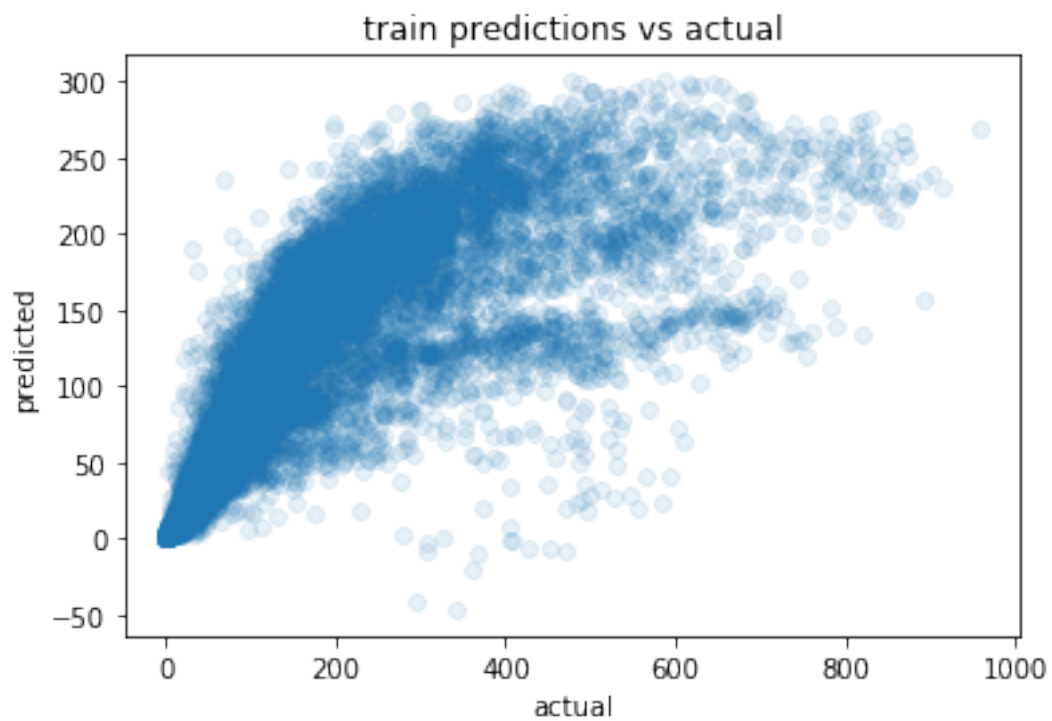
        print('r^2 on test:', r2_score(test_targets, future_preds))
        plt.scatter(test_targets, future_preds, alpha=0.1)
        plt.xlabel('actual')
        plt.ylabel('predicted')
        plt.title('test predictions vs actual')
        plt.show()

```

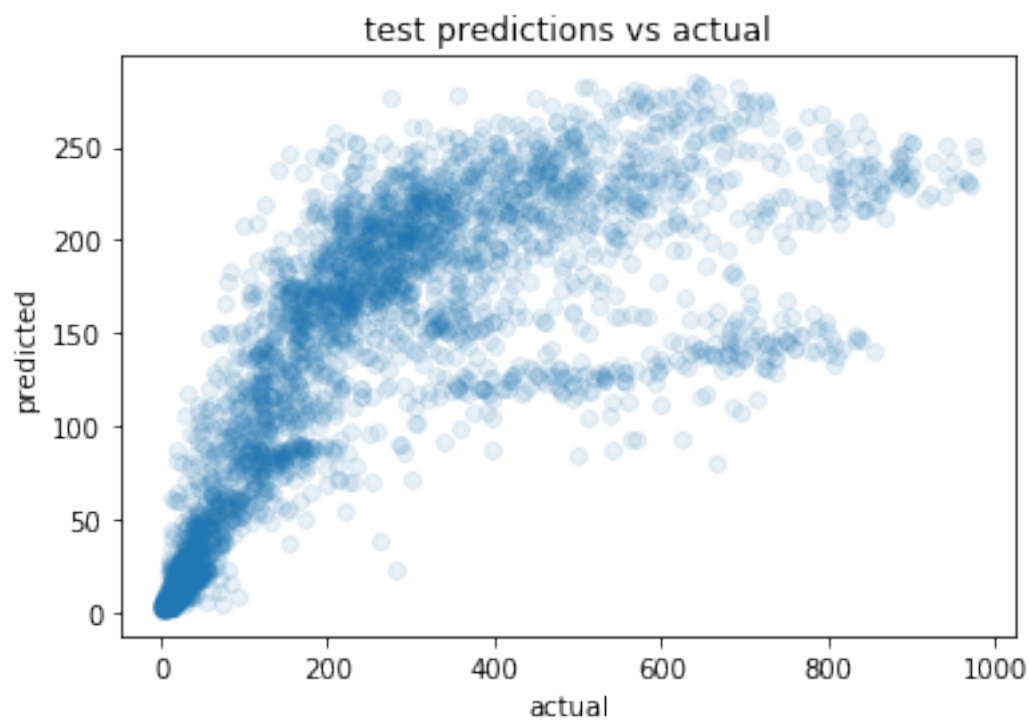
```

benchmark r^2 on training: 0.0
training r^2: 0.368044858342

```



benchmark  $r^2$  on test: -0.112995264662  
 $r^2$  on test: 0.142694982686



**10** mape doesn't seem to work well. Both poisson and logcosh give NAN, so were unusable. It seems the best network was 4 dense layers of sizes:

- 1000
- 500
- 100
- 1

And I used batchnormalization and dropout between each layer. elu was the activator, and the best loss function seemed to be MSE. The best  $r^2$  was around 0.93 on train, and around 0.83 on test.