

Build, Train, and Compare ML Models

Development and selection of models for the top layer model.

Will develop the windspeed model separately.

Will integrate the models and system separately.

Imports

```
In [29]: import sklearn
from sklearn.preprocessing import OneHotEncoder
import numpy as np
import pandas as pd
import tensorflow as tf
from sklearn.preprocessing import StandardScaler
from sklearn.pipeline import make_pipeline
from sklearn.svm import SVR
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import classification_report
import matplotlib.pyplot as plt
from sklearn.linear_model import SGDRegressor
import os
import pickle
```

Data

Get Data

```
In [50]: train = None
val = None
test = None
dir = "drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/"
data_dir = "%sdata/"%dir
model_dir = "%smodel_files/"%dir
with open("%strain.csv"%data_dir) as file:
    train = pd.read_csv(file)
with open("%sval.csv"%data_dir) as file:
    val = pd.read_csv(file)
with open("%stest.csv"%data_dir) as file:
    test = pd.read_csv(file)
```

In [31]: train

Out[31]:

	Unnamed: 0	Property	Occupancy	Construction	YearBuilt	Floor	SquareFootage	Windsp
0	0	1	MultiFamily	Masonry	1995-2005	1	1700+	
1	1	2	SingleFamily	Concrete	2005+	1	<1500	
2	2	3	SingleFamily	Masonry	<=1995	0	<1500	
3	3	4	SingleFamily	Masonry	2005+	1	1500-1700	
4	4	5	MultiFamily	Frame	<=1995	1	1500-1700	
...
20995	20995	20996	MultiFamily	Frame	<=1995	2+	1500-1700	
20996	20996	20997	MultiFamily	Frame	2005+	2+	1500-1700	
20997	20997	20998	SingleFamily	Frame	<=1995	1	<1500	
20998	20998	20999	SingleFamily	Frame	1995-2005	1	1500-1700	
20999	20999	21000	MultiFamily	Frame	2005+	0	<1500	

21000 rows × 9 columns



Transform Data

```
In [32]: train_x = train[["Occupancy", "Construction", "YearBuilt", "Floor", "SquareFootage"]]
train_x_wind = train[["Windspeed"]]
train_y = train[["Loss"]]
val_x = val[["Occupancy", "Construction", "YearBuilt", "Floor", "SquareFootage"]]
val_x_wind = val[["Windspeed"]]
val_y = val[["Loss"]]
test_x = test[["Occupancy", "Construction", "YearBuilt", "Floor", "SquareFootage"]]
test_x_wind = test[["Windspeed"]]
test_y = test[["Loss"]]
```

In [33]: train_x

Out[33]:

	Occupancy	Construction	YearBuilt	Floor	SquareFootage
0	MultiFamily	Masonry	1995-2005	1	1700+
1	SingleFamily	Concrete	2005+	1	<1500
2	SingleFamily	Masonry	<=1995	0	<1500
3	SingleFamily	Masonry	2005+	1	1500-1700
4	MultiFamily	Frame	<=1995	1	1500-1700
...
20995	MultiFamily	Frame	<=1995	2+	1500-1700
20996	MultiFamily	Frame	2005+	2+	1500-1700
20997	SingleFamily	Frame	<=1995	1	<1500
20998	SingleFamily	Frame	1995-2005	1	1500-1700
20999	MultiFamily	Frame	2005+	0	<1500

21000 rows × 5 columns

In [34]: train_x_wind

Out[34]:

	Windspeed
0	1
1	3
2	2
3	3
4	1
...	...
20995	3
20996	2
20997	2
20998	1
20999	2

21000 rows × 1 columns

In [35]: train_y

Out[35]:

	Loss
0	0.306110
1	0.110225
2	0.212576
3	0.167962
4	0.340122
...	...
20995	0.524880
20996	0.283435
20997	0.236196
20998	0.255092
20999	0.191319

21000 rows × 1 columns

In [36]: val_y

Out[36]:

	Loss
0	0.226800
1	0.125971
2	0.486000
3	0.275562
4	0.236196
...	...
4495	0.354294
4496	0.177147
4497	0.142851
4498	0.318865
4499	0.340122

4500 rows × 1 columns

Data Preprocessing

```
In [37]: ohe = OneHotEncoder()
ohe.fit(train_x)
with open("%sone_hot_encoder.pickle"%model_dir, "wb") as f:
    pickle.dump(ohe, f)
```

```
Out[37]: OneHotEncoder(categories='auto', drop=None, dtype=<class 'numpy.float64'>,
                        handle_unknown='error', sparse=True)
```

```
In [38]: def encode(x, wind, y, enc):
    x_hot = enc.transform(x).toarray()
    wind = wind.to_numpy()

    x = []
    for i, r in enumerate(x_hot):
        row = []
        for j in r:
            row.append(j)
            row.append(wind[i][0]*1.0)
        x.append(row)

    y_n = []
    for r in np.ndarray.tolist(y.to_numpy()):
        y_n.append(r[0])

    return x, y_n
```

```
In [39]: train_x, train_y = encode(train_x, train_x_wind, train_y, ohe)
val_x, val_y = encode(val_x, val_x_wind, val_y, ohe)
test_x, test_y = encode(test_x, test_x_wind, test_y, ohe)
```

```
In [40]: print("train_x shape: %d, %d"%(len(train_x), len(train_x[0])))
print("val_x shape: %d, %d"%(len(val_x), len(val_x[0])))
print("test_x shape: %d, %d"%(len(test_x), len(test_x[0])))
```

```
train_x shape: 21000, 15
val_x shape: 4500, 15
test_x shape: 4500, 15
```

Models

```
In [ ]: bests = {}
```

SVM

```

In [43]: # params = [{"kernel": ["linear", "poly", "rbf", "sigmoid"],
#               "degree": np.arange(1, 6, 1),
#               "gamma": ["scale", "auto"],
#               "shrinking": [True, False],
#               }]
# scores = [
#     # "explained_variance",
#     # "r2",
#     "neg_mean_absolute_error",
# ]
# bests = []

# for s in scores:
#     print("# Tuning hyper-parameters for %s" % s)
#     print()

#     model = SVR(max_iter=100)
#     model = GridSearchCV(model, params, scoring=s, verbose=3)
#     model.fit(train_x, train_y)

#     print("Best parameters set found on development set:")
#     print()
#     print(model.best_params_)
#     print()
#     print("Grid scores on development set:")
#     print()
#     means = model.cv_results_['mean_test_score']
#     stds = model.cv_results_['std_test_score']
#     for mean, std, params in zip(means, stds, model.cv_results_['params']):
#         print("%0.3f (+/-%0.03f) for %r" % (mean, std * 2, params))
#     bests.append(model)

```

Ridge Regressor

```

In [44]: # params = [{"loss": ["squared_loss", "huber", "epsilon_insensitive", "squared_epsilon_insensitive"],
#               "penalty": ["l2", "l1", "elasticnet"],
#               "fit_intercept": [True, False],
#               "learning_rate": ["constant", "optimal", "invscaling", "adaptive"],
#               "epsilon": [0.0, 0.1, 0.2, 0.4, 0.6, 0.8, 1.0],
#               "eta0": [0.005, 0.01, 0.015, 0.02],
#               "power_t": [0.0, 0.1, 0.2, 0.3, 0.4, 0.5],

#           }]
# scores = [
#     # "explained_variance",
#     # "r2",
#     "neg_mean_absolute_error",
# ]
# bests = []

# for s in scores:
#     print("# Tuning hyper-parameters for %s" % s)
#     print()

#     model = SGDRegressor(max_iter=100)
#     model = GridSearchCV(model, params, scoring=s, verbose=3)
#     model.fit(train_x, train_y)

#     print("Best parameters set found on development set:")
#     print()
#     print(model.best_params_)
#     print()
#     print("Grid scores on development set:")
#     print()
#     means = model.cv_results_['mean_test_score']
#     stds = model.cv_results_['std_test_score']
#     for mean, std, params in zip(means, stds, model.cv_results_['params']):
#         print("%0.3f (+/-%0.03f) for %r" % (mean, std * 2, params))
#     bests.append(model)

```

1-Layer NN

```

In [45]: model = tf.keras.Sequential([
    tf.keras.layers.Input((15,)),
    tf.keras.layers.Dense(128, activation='relu'),
    tf.keras.layers.Dense(1)
])
model.summary()

model.compile(optimizer='adam',
              loss=tf.keras.losses.MeanSquaredError(),
              metrics=['mean_absolute_error'])

ckpt_dir = "%sckpts_1_nn/"%model_dir
if not os.path.exists(ckpt_dir):
    os.makedirs(ckpt_dir)

checkpoint_path = "%scp-{epoch:04d}.hdf5"%ckpt_dir
checkpoint_dir = os.path.dirname(checkpoint_path)
cp_callback = tf.keras.callbacks.ModelCheckpoint(filepath=checkpoint_path,
                                                  verbose=1,
                                                  save_weights_only=True,
                                                  save_freq="epoch"
                                                  )

history = model.fit(train_x, train_y, epochs=100, validation_data=(val_x, val_y),
                    callbacks=[cp_callback])
best = [-1, 1]
for k in history.history:
    print("%s:"%k)
    for i, r in enumerate(history.history[k]):
        print("epoch %d: %f"%(i+1, r))
        if k == "val_mean_absolute_error" and r < best[1]:
            best[0] = i+1
            best[1] = r
    print()
bests.update({"1_nn": {"val_MAE": best[1], "best_epoch": best[0]}})
print("The best MAE is:", best[1], "at epoch", best[0])
print()

# Evaluate the model on the test data using `evaluate`
print("Evaluate on test data")
model.load_weights("%scp-%04d.hdf5"%(ckpt_dir, best[0]))
results = model.evaluate(val_x, val_y)
print("test loss, test acc:", results)

# Generate predictions (probabilities -- the output of the last layer)
# on new data using `predict`
print("Generate predictions for 3 samples")
predictions = model.predict(val_x[:3])
for i, p in enumerate(predictions):
    print("pred:", p, "\ttrue:", val_y[i])

```


Model: "sequential_3"

Layer (type)	Output Shape	Param #
dense_9 (Dense)	(None, 128)	2048
dense_10 (Dense)	(None, 1)	129

=====
Total params: 2,177

Trainable params: 2,177

Non-trainable params: 0

Epoch 1/100

657/657 [=====] - 2s 2ms/step - loss: 0.0179 - mean_absolute_error: 0.0651 - val_loss: 1.9046e-04 - val_mean_absolute_error: 0.0094

Epoch 00001: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0001.hdf5

Epoch 2/100

657/657 [=====] - 1s 1ms/step - loss: 1.6168e-04 - mean_absolute_error: 0.0089 - val_loss: 8.3569e-05 - val_mean_absolute_error: 0.0062

Epoch 00002: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0002.hdf5

Epoch 3/100

657/657 [=====] - 1s 1ms/step - loss: 7.8776e-05 - mean_absolute_error: 0.0061 - val_loss: 4.7763e-05 - val_mean_absolute_error: 0.0045

Epoch 00003: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0003.hdf5

Epoch 4/100

657/657 [=====] - 1s 2ms/step - loss: 4.2506e-05 - mean_absolute_error: 0.0046 - val_loss: 3.5337e-05 - val_mean_absolute_error: 0.0039

Epoch 00004: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0004.hdf5

Epoch 5/100

657/657 [=====] - 1s 2ms/step - loss: 3.4530e-05 - mean_absolute_error: 0.0042 - val_loss: 4.1419e-05 - val_mean_absolute_error: 0.0044

Epoch 00005: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0005.hdf5

Epoch 6/100

657/657 [=====] - 1s 2ms/step - loss: 3.0149e-05 - mean_absolute_error: 0.0040 - val_loss: 1.6221e-04 - val_mean_absolute_error: 0.0114

Epoch 00006: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0006.hdf5

Epoch 7/100

657/657 [=====] - 1s 2ms/step - loss: 3.3262e-05 - mean_absolute_error: 0.0042 - val_loss: 1.3777e-05 - val_mean_absolute_error:

0.0025

Epoch 00007: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0007.hdf5

Epoch 8/100

657/657 [=====] - 1s 1ms/step - loss: 2.7532e-05 - mean_absolute_error: 0.0040 - val_loss: 4.0165e-05 - val_mean_absolute_error: 0.0049

Epoch 00008: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0008.hdf5

Epoch 9/100

657/657 [=====] - 1s 2ms/step - loss: 3.7426e-05 - mean_absolute_error: 0.0046 - val_loss: 2.6322e-05 - val_mean_absolute_error: 0.0038

Epoch 00009: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0009.hdf5

Epoch 10/100

657/657 [=====] - 1s 1ms/step - loss: 3.4206e-05 - mean_absolute_error: 0.0043 - val_loss: 4.3207e-05 - val_mean_absolute_error: 0.0049

Epoch 00010: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0010.hdf5

Epoch 11/100

657/657 [=====] - 1s 1ms/step - loss: 2.0090e-05 - mean_absolute_error: 0.0033 - val_loss: 2.0945e-05 - val_mean_absolute_error: 0.0037

Epoch 00011: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0011.hdf5

Epoch 12/100

657/657 [=====] - 1s 2ms/step - loss: 2.3088e-05 - mean_absolute_error: 0.0036 - val_loss: 6.6010e-05 - val_mean_absolute_error: 0.0074

Epoch 00012: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0012.hdf5

Epoch 13/100

657/657 [=====] - 1s 2ms/step - loss: 2.7090e-05 - mean_absolute_error: 0.0039 - val_loss: 1.4401e-05 - val_mean_absolute_error: 0.0027

Epoch 00013: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0013.hdf5

Epoch 14/100

657/657 [=====] - 1s 2ms/step - loss: 2.5045e-05 - mean_absolute_error: 0.0038 - val_loss: 2.2478e-04 - val_mean_absolute_error: 0.0142

Epoch 00014: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0014.hdf5

Epoch 15/100

657/657 [=====] - 1s 1ms/step - loss: 6.6109e-05 - mean_absolute_error: 0.0054 - val_loss: 5.7513e-05 - val_mean_absolute_error: 0.0069

Epoch 00015: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0015.hdf5

Epoch 16/100

657/657 [=====] - 1s 1ms/step - loss: 3.7795e-05 - mean_absolute_error: 0.0043 - val_loss: 1.0619e-05 - val_mean_absolute_error: 0.0024

Epoch 00016: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0016.hdf5

Epoch 17/100

657/657 [=====] - 1s 2ms/step - loss: 1.0129e-05 - mean_absolute_error: 0.0024 - val_loss: 9.0582e-05 - val_mean_absolute_error: 0.0077

Epoch 00017: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0017.hdf5

Epoch 18/100

657/657 [=====] - 1s 2ms/step - loss: 3.0768e-05 - mean_absolute_error: 0.0042 - val_loss: 3.0177e-05 - val_mean_absolute_error: 0.0047

Epoch 00018: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0018.hdf5

Epoch 19/100

657/657 [=====] - 1s 2ms/step - loss: 3.2651e-05 - mean_absolute_error: 0.0043 - val_loss: 2.6902e-05 - val_mean_absolute_error: 0.0041

Epoch 00019: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0019.hdf5

Epoch 20/100

657/657 [=====] - 1s 2ms/step - loss: 1.4987e-05 - mean_absolute_error: 0.0029 - val_loss: 8.4732e-06 - val_mean_absolute_error: 0.0022

Epoch 00020: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0020.hdf5

Epoch 21/100

657/657 [=====] - 1s 2ms/step - loss: 3.4107e-05 - mean_absolute_error: 0.0042 - val_loss: 1.0899e-05 - val_mean_absolute_error: 0.0025

Epoch 00021: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0021.hdf5

Epoch 22/100

657/657 [=====] - 1s 1ms/step - loss: 1.7121e-05 - mean_absolute_error: 0.0031 - val_loss: 3.7711e-05 - val_mean_absolute_error: 0.0050

Epoch 00022: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0022.hdf5

Epoch 23/100

657/657 [=====] - 1s 2ms/step - loss: 2.1188e-05 - mean_absolute_error: 0.0035 - val_loss: 1.1538e-05 - val_mean_absolute_error: 0.0026

Epoch 00023: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0023.hdf5

Epoch 24/100

657/657 [=====] - 1s 2ms/step - loss: 1.8072e-05 - mean_absolute_error: 0.0030 - val_loss: 6.5298e-06 - val_mean_absolute_error: 0.0020

Epoch 00024: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0024.hdf5

Epoch 25/100

657/657 [=====] - 1s 1ms/step - loss: 1.1560e-05 - mean_absolute_error: 0.0026 - val_loss: 1.1356e-05 - val_mean_absolute_error: 0.0025

Epoch 00025: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0025.hdf5

Epoch 26/100

657/657 [=====] - 1s 2ms/step - loss: 1.6275e-05 - mean_absolute_error: 0.0030 - val_loss: 1.4191e-05 - val_mean_absolute_error: 0.0030

Epoch 00026: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0026.hdf5

Epoch 27/100

657/657 [=====] - 1s 2ms/step - loss: 1.4144e-05 - mean_absolute_error: 0.0028 - val_loss: 1.0414e-05 - val_mean_absolute_error: 0.0025

Epoch 00027: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0027.hdf5

Epoch 28/100

657/657 [=====] - 1s 2ms/step - loss: 1.3925e-05 - mean_absolute_error: 0.0028 - val_loss: 3.0770e-05 - val_mean_absolute_error: 0.0051

Epoch 00028: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0028.hdf5

Epoch 29/100

657/657 [=====] - 1s 2ms/step - loss: 1.6298e-05 - mean_absolute_error: 0.0030 - val_loss: 4.1302e-05 - val_mean_absolute_error: 0.0053

Epoch 00029: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0029.hdf5

Epoch 30/100

657/657 [=====] - 1s 2ms/step - loss: 1.5740e-05 - mean_absolute_error: 0.0029 - val_loss: 2.1214e-05 - val_mean_absolute_error: 0.0037

Epoch 00030: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0030.hdf5

Epoch 31/100

657/657 [=====] - 1s 2ms/step - loss: 1.3670e-05 - mean_absolute_error: 0.0027 - val_loss: 5.1926e-06 - val_mean_absolute_error: 0.0018

Epoch 00031: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for

```
_AI/project/checkpoints/1_nn/cp-0031.hdf5
Epoch 32/100
657/657 [=====] - 1s 2ms/step - loss: 1.0251e-05 - m
ean_absolute_error: 0.0022 - val_loss: 1.0002e-05 - val_mean_absolute_error:
0.0024

Epoch 00032: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0032.hdf5
Epoch 33/100
657/657 [=====] - 1s 2ms/step - loss: 9.4882e-06 - m
ean_absolute_error: 0.0023 - val_loss: 6.9709e-06 - val_mean_absolute_error:
0.0021

Epoch 00033: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0033.hdf5
Epoch 34/100
657/657 [=====] - 1s 1ms/step - loss: 7.9232e-06 - m
ean_absolute_error: 0.0020 - val_loss: 2.1810e-05 - val_mean_absolute_error:
0.0039

Epoch 00034: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0034.hdf5
Epoch 35/100
657/657 [=====] - 1s 2ms/step - loss: 1.5778e-05 - m
ean_absolute_error: 0.0030 - val_loss: 3.8462e-06 - val_mean_absolute_error:
0.0015

Epoch 00035: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0035.hdf5
Epoch 36/100
657/657 [=====] - 1s 2ms/step - loss: 7.9527e-06 - m
ean_absolute_error: 0.0020 - val_loss: 1.3212e-05 - val_mean_absolute_error:
0.0027

Epoch 00036: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0036.hdf5
Epoch 37/100
657/657 [=====] - 1s 2ms/step - loss: 9.8888e-06 - m
ean_absolute_error: 0.0024 - val_loss: 1.0668e-05 - val_mean_absolute_error:
0.0027

Epoch 00037: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0037.hdf5
Epoch 38/100
657/657 [=====] - 1s 2ms/step - loss: 1.2443e-05 - m
ean_absolute_error: 0.0027 - val_loss: 1.7146e-05 - val_mean_absolute_error:
0.0033

Epoch 00038: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0038.hdf5
Epoch 39/100
657/657 [=====] - 1s 2ms/step - loss: 3.2371e-05 - m
ean_absolute_error: 0.0040 - val_loss: 5.1466e-06 - val_mean_absolute_error:
0.0018

Epoch 00039: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0039.hdf5
```

Epoch 40/100

657/657 [=====] - 1s 2ms/step - loss: 5.1241e-06 - mean_absolute_error: 0.0017 - val_loss: 2.5321e-06 - val_mean_absolute_error: 0.0012

Epoch 00040: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0040.hdf5

Epoch 41/100

657/657 [=====] - 1s 2ms/step - loss: 8.4237e-06 - mean_absolute_error: 0.0021 - val_loss: 4.9952e-06 - val_mean_absolute_error: 0.0018

Epoch 00041: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0041.hdf5

Epoch 42/100

657/657 [=====] - 1s 2ms/step - loss: 8.2242e-06 - mean_absolute_error: 0.0020 - val_loss: 9.7006e-06 - val_mean_absolute_error: 0.0023

Epoch 00042: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0042.hdf5

Epoch 43/100

657/657 [=====] - 1s 2ms/step - loss: 3.8312e-06 - mean_absolute_error: 0.0015 - val_loss: 3.8922e-05 - val_mean_absolute_error: 0.0055

Epoch 00043: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0043.hdf5

Epoch 44/100

657/657 [=====] - 1s 2ms/step - loss: 2.0432e-05 - mean_absolute_error: 0.0033 - val_loss: 1.7236e-06 - val_mean_absolute_error: 9.5678e-04

Epoch 00044: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0044.hdf5

Epoch 45/100

657/657 [=====] - 1s 2ms/step - loss: 5.6672e-06 - mean_absolute_error: 0.0017 - val_loss: 5.6290e-06 - val_mean_absolute_error: 0.0019

Epoch 00045: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0045.hdf5

Epoch 46/100

657/657 [=====] - 1s 2ms/step - loss: 8.1974e-06 - mean_absolute_error: 0.0021 - val_loss: 1.8144e-06 - val_mean_absolute_error: 9.2097e-04

Epoch 00046: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0046.hdf5

Epoch 47/100

657/657 [=====] - 1s 2ms/step - loss: 5.3673e-06 - mean_absolute_error: 0.0017 - val_loss: 3.5527e-06 - val_mean_absolute_error: 0.0014

Epoch 00047: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0047.hdf5

Epoch 48/100

657/657 [=====] - 1s 2ms/step - loss: 6.3527e-06 - mean_absolute_error: 0.0018 - val_loss: 4.4570e-06 - val_mean_absolute_error: 0.0016

Epoch 00048: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0048.hdf5

Epoch 49/100

657/657 [=====] - 1s 2ms/step - loss: 5.2788e-06 - mean_absolute_error: 0.0017 - val_loss: 1.6908e-06 - val_mean_absolute_error: 9.7509e-04

Epoch 00049: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0049.hdf5

Epoch 50/100

657/657 [=====] - 1s 2ms/step - loss: 1.0453e-05 - mean_absolute_error: 0.0022 - val_loss: 3.9888e-06 - val_mean_absolute_error: 0.0016

Epoch 00050: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0050.hdf5

Epoch 51/100

657/657 [=====] - 1s 1ms/step - loss: 1.0027e-05 - mean_absolute_error: 0.0023 - val_loss: 8.2182e-06 - val_mean_absolute_error: 0.0024

Epoch 00051: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0051.hdf5

Epoch 52/100

657/657 [=====] - 1s 2ms/step - loss: 4.9364e-06 - mean_absolute_error: 0.0016 - val_loss: 2.8755e-06 - val_mean_absolute_error: 0.0013

Epoch 00052: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0052.hdf5

Epoch 53/100

657/657 [=====] - 1s 2ms/step - loss: 4.3184e-06 - mean_absolute_error: 0.0015 - val_loss: 9.8243e-06 - val_mean_absolute_error: 0.0026

Epoch 00053: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0053.hdf5

Epoch 54/100

657/657 [=====] - 1s 2ms/step - loss: 1.0915e-05 - mean_absolute_error: 0.0023 - val_loss: 2.3573e-06 - val_mean_absolute_error: 0.0011

Epoch 00054: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0054.hdf5

Epoch 55/100

657/657 [=====] - 1s 2ms/step - loss: 2.5445e-06 - mean_absolute_error: 0.0012 - val_loss: 3.8636e-06 - val_mean_absolute_error: 0.0016

Epoch 00055: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0055.hdf5

Epoch 56/100

657/657 [=====] - 1s 2ms/step - loss: 4.4251e-06 - m

ean_absolute_error: 0.0016 - val_loss: 2.8089e-06 - val_mean_absolute_error: 0.0013

Epoch 00056: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0056.hdf5

Epoch 57/100

657/657 [=====] - 1s 2ms/step - loss: 4.3821e-06 - mean_absolute_error: 0.0015 - val_loss: 3.5421e-06 - val_mean_absolute_error: 0.0015

Epoch 00057: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0057.hdf5

Epoch 58/100

657/657 [=====] - 1s 2ms/step - loss: 1.9873e-05 - mean_absolute_error: 0.0029 - val_loss: 3.3371e-06 - val_mean_absolute_error: 0.0014

Epoch 00058: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0058.hdf5

Epoch 59/100

657/657 [=====] - 1s 2ms/step - loss: 5.1706e-06 - mean_absolute_error: 0.0016 - val_loss: 1.6000e-06 - val_mean_absolute_error: 9.7710e-04

Epoch 00059: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0059.hdf5

Epoch 60/100

657/657 [=====] - 1s 2ms/step - loss: 4.7157e-06 - mean_absolute_error: 0.0016 - val_loss: 4.0614e-06 - val_mean_absolute_error: 0.0016

Epoch 00060: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0060.hdf5

Epoch 61/100

657/657 [=====] - 1s 2ms/step - loss: 6.2816e-06 - mean_absolute_error: 0.0019 - val_loss: 2.6202e-06 - val_mean_absolute_error: 0.0012

Epoch 00061: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0061.hdf5

Epoch 62/100

657/657 [=====] - 1s 2ms/step - loss: 4.4265e-06 - mean_absolute_error: 0.0016 - val_loss: 6.0222e-06 - val_mean_absolute_error: 0.0018

Epoch 00062: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0062.hdf5

Epoch 63/100

657/657 [=====] - 1s 2ms/step - loss: 5.2658e-06 - mean_absolute_error: 0.0016 - val_loss: 7.4818e-06 - val_mean_absolute_error: 0.0021

Epoch 00063: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0063.hdf5

Epoch 64/100

657/657 [=====] - 1s 2ms/step - loss: 4.0356e-06 - mean_absolute_error: 0.0015 - val_loss: 9.2684e-06 - val_mean_absolute_error:

0.0023

Epoch 00064: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0064.hdf5

Epoch 65/100

657/657 [=====] - 1s 2ms/step - loss: 8.8679e-06 - mean_absolute_error: 0.0022 - val_loss: 1.5487e-06 - val_mean_absolute_error: 9.3343e-04

Epoch 00065: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0065.hdf5

Epoch 66/100

657/657 [=====] - 1s 1ms/step - loss: 3.8929e-06 - mean_absolute_error: 0.0015 - val_loss: 2.5448e-05 - val_mean_absolute_error: 0.0043

Epoch 00066: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0066.hdf5

Epoch 67/100

657/657 [=====] - 1s 2ms/step - loss: 6.9663e-06 - mean_absolute_error: 0.0020 - val_loss: 3.2580e-06 - val_mean_absolute_error: 0.0013

Epoch 00067: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0067.hdf5

Epoch 68/100

657/657 [=====] - 1s 2ms/step - loss: 3.3919e-06 - mean_absolute_error: 0.0014 - val_loss: 3.9238e-06 - val_mean_absolute_error: 0.0014

Epoch 00068: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0068.hdf5

Epoch 69/100

657/657 [=====] - 1s 2ms/step - loss: 4.2070e-06 - mean_absolute_error: 0.0015 - val_loss: 9.0922e-06 - val_mean_absolute_error: 0.0026

Epoch 00069: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0069.hdf5

Epoch 70/100

657/657 [=====] - 1s 2ms/step - loss: 6.3932e-06 - mean_absolute_error: 0.0018 - val_loss: 8.5635e-06 - val_mean_absolute_error: 0.0021

Epoch 00070: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0070.hdf5

Epoch 71/100

657/657 [=====] - 1s 2ms/step - loss: 4.1190e-06 - mean_absolute_error: 0.0015 - val_loss: 7.2911e-06 - val_mean_absolute_error: 0.0022

Epoch 00071: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0071.hdf5

Epoch 72/100

657/657 [=====] - 1s 2ms/step - loss: 4.8010e-06 - mean_absolute_error: 0.0016 - val_loss: 1.2748e-06 - val_mean_absolute_error: 7.5071e-04

Epoch 00072: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0072.hdf5

Epoch 73/100

657/657 [=====] - 1s 2ms/step - loss: 4.0921e-06 - mean_absolute_error: 0.0015 - val_loss: 4.5788e-06 - val_mean_absolute_error: 0.0016

Epoch 00073: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0073.hdf5

Epoch 74/100

657/657 [=====] - 1s 2ms/step - loss: 5.1080e-06 - mean_absolute_error: 0.0017 - val_loss: 8.0053e-07 - val_mean_absolute_error: 6.4302e-04

Epoch 00074: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0074.hdf5

Epoch 75/100

657/657 [=====] - 1s 2ms/step - loss: 2.8629e-06 - mean_absolute_error: 0.0013 - val_loss: 4.9751e-06 - val_mean_absolute_error: 0.0020

Epoch 00075: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0075.hdf5

Epoch 76/100

657/657 [=====] - 1s 2ms/step - loss: 2.7554e-06 - mean_absolute_error: 0.0012 - val_loss: 4.4987e-06 - val_mean_absolute_error: 0.0017

Epoch 00076: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0076.hdf5

Epoch 77/100

657/657 [=====] - 1s 2ms/step - loss: 4.4714e-06 - mean_absolute_error: 0.0015 - val_loss: 2.8839e-06 - val_mean_absolute_error: 0.0013

Epoch 00077: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0077.hdf5

Epoch 78/100

657/657 [=====] - 1s 2ms/step - loss: 7.8831e-06 - mean_absolute_error: 0.0020 - val_loss: 1.9763e-06 - val_mean_absolute_error: 0.0010

Epoch 00078: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0078.hdf5

Epoch 79/100

657/657 [=====] - 1s 2ms/step - loss: 4.1425e-06 - mean_absolute_error: 0.0015 - val_loss: 1.6553e-06 - val_mean_absolute_error: 8.2059e-04

Epoch 00079: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0079.hdf5

Epoch 80/100

657/657 [=====] - 1s 2ms/step - loss: 2.0824e-06 - mean_absolute_error: 0.0011 - val_loss: 1.6333e-05 - val_mean_absolute_error: 0.0034

Epoch 00080: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0080.hdf5

Epoch 81/100

657/657 [=====] - 1s 2ms/step - loss: 6.0495e-06 - mean_absolute_error: 0.0018 - val_loss: 2.1199e-06 - val_mean_absolute_error: 0.0012

Epoch 00081: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0081.hdf5

Epoch 82/100

657/657 [=====] - 1s 2ms/step - loss: 3.2256e-06 - mean_absolute_error: 0.0013 - val_loss: 1.8653e-06 - val_mean_absolute_error: 0.0010

Epoch 00082: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0082.hdf5

Epoch 83/100

657/657 [=====] - 1s 2ms/step - loss: 2.0340e-06 - mean_absolute_error: 0.0010 - val_loss: 4.7701e-06 - val_mean_absolute_error: 0.0019

Epoch 00083: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0083.hdf5

Epoch 84/100

657/657 [=====] - 1s 2ms/step - loss: 3.6924e-06 - mean_absolute_error: 0.0014 - val_loss: 1.9519e-05 - val_mean_absolute_error: 0.0036

Epoch 00084: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0084.hdf5

Epoch 85/100

657/657 [=====] - 1s 2ms/step - loss: 5.7952e-06 - mean_absolute_error: 0.0018 - val_loss: 1.9326e-05 - val_mean_absolute_error: 0.0037

Epoch 00085: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0085.hdf5

Epoch 86/100

657/657 [=====] - 1s 2ms/step - loss: 3.0091e-06 - mean_absolute_error: 0.0012 - val_loss: 4.7471e-06 - val_mean_absolute_error: 0.0017

Epoch 00086: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0086.hdf5

Epoch 87/100

657/657 [=====] - 1s 2ms/step - loss: 4.2345e-06 - mean_absolute_error: 0.0014 - val_loss: 1.0939e-06 - val_mean_absolute_error: 7.4635e-04

Epoch 00087: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0087.hdf5

Epoch 88/100

657/657 [=====] - 1s 2ms/step - loss: 1.9574e-06 - mean_absolute_error: 0.0010 - val_loss: 5.9994e-06 - val_mean_absolute_error: 0.0019

Epoch 00088: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for

```
_AI/project/checkpoints/1_nn/cp-0088.hdf5
Epoch 89/100
657/657 [=====] - 1s 2ms/step - loss: 5.4686e-06 - m
ean_absolute_error: 0.0017 - val_loss: 5.4784e-07 - val_mean_absolute_error:
4.9034e-04

Epoch 00089: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0089.hdf5
Epoch 90/100
657/657 [=====] - 1s 2ms/step - loss: 2.3716e-06 - m
ean_absolute_error: 0.0011 - val_loss: 1.5571e-06 - val_mean_absolute_error:
9.7695e-04

Epoch 00090: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0090.hdf5
Epoch 91/100
657/657 [=====] - 1s 2ms/step - loss: 1.3076e-06 - m
ean_absolute_error: 8.3514e-04 - val_loss: 3.3332e-05 - val_mean_absolute_err
or: 0.0052

Epoch 00091: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0091.hdf5
Epoch 92/100
657/657 [=====] - 1s 2ms/step - loss: 4.3568e-06 - m
ean_absolute_error: 0.0015 - val_loss: 9.7208e-06 - val_mean_absolute_error:
0.0024

Epoch 00092: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0092.hdf5
Epoch 93/100
657/657 [=====] - 1s 2ms/step - loss: 4.6798e-06 - m
ean_absolute_error: 0.0016 - val_loss: 9.3703e-06 - val_mean_absolute_error:
0.0023

Epoch 00093: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0093.hdf5
Epoch 94/100
657/657 [=====] - 1s 2ms/step - loss: 2.9902e-06 - m
ean_absolute_error: 0.0012 - val_loss: 5.3163e-06 - val_mean_absolute_error:
0.0019

Epoch 00094: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0094.hdf5
Epoch 95/100
657/657 [=====] - 1s 2ms/step - loss: 2.4608e-06 - m
ean_absolute_error: 0.0012 - val_loss: 6.3859e-06 - val_mean_absolute_error:
0.0020

Epoch 00095: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0095.hdf5
Epoch 96/100
657/657 [=====] - 1s 2ms/step - loss: 2.0618e-06 - m
ean_absolute_error: 0.0011 - val_loss: 8.9705e-06 - val_mean_absolute_error:
0.0024

Epoch 00096: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/1_nn/cp-0096.hdf5
```

Epoch 97/100

657/657 [=====] - 1s 2ms/step - loss: 2.8795e-06 - mean_absolute_error: 0.0012 - val_loss: 1.4276e-05 - val_mean_absolute_error: 0.0031

Epoch 00097: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0097.hdf5

Epoch 98/100

657/657 [=====] - 1s 2ms/step - loss: 2.2954e-06 - mean_absolute_error: 0.0011 - val_loss: 1.6142e-06 - val_mean_absolute_error: 0.0010

Epoch 00098: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0098.hdf5

Epoch 99/100

657/657 [=====] - 1s 2ms/step - loss: 2.0369e-06 - mean_absolute_error: 9.7077e-04 - val_loss: 3.5130e-06 - val_mean_absolute_error: 0.0017

Epoch 00099: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0099.hdf5

Epoch 100/100

657/657 [=====] - 1s 2ms/step - loss: 2.5583e-06 - mean_absolute_error: 0.0012 - val_loss: 1.0760e-06 - val_mean_absolute_error: 7.4930e-04

Epoch 00100: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/1_nn/cp-0100.hdf5

loss:

epoch 1: 0.004177
epoch 2: 0.000131
epoch 3: 0.000064
epoch 4: 0.000040
epoch 5: 0.000032
epoch 6: 0.000032
epoch 7: 0.000029
epoch 8: 0.000028
epoch 9: 0.000039
epoch 10: 0.000061
epoch 11: 0.000020
epoch 12: 0.000029
epoch 13: 0.000026
epoch 14: 0.000026
epoch 15: 0.000027
epoch 16: 0.000037
epoch 17: 0.000014
epoch 18: 0.000024
epoch 19: 0.000029
epoch 20: 0.000016
epoch 21: 0.000028
epoch 22: 0.000014
epoch 23: 0.000021
epoch 24: 0.000020
epoch 25: 0.000012
epoch 26: 0.000019
epoch 27: 0.000016
epoch 28: 0.000015

epoch 29: 0.000018
epoch 30: 0.000014
epoch 31: 0.000013
epoch 32: 0.000011
epoch 33: 0.000011
epoch 34: 0.000010
epoch 35: 0.000015
epoch 36: 0.000009
epoch 37: 0.000011
epoch 38: 0.000013
epoch 39: 0.000018
epoch 40: 0.000007
epoch 41: 0.000009
epoch 42: 0.000015
epoch 43: 0.000004
epoch 44: 0.000012
epoch 45: 0.000008
epoch 46: 0.000010
epoch 47: 0.000006
epoch 48: 0.000009
epoch 49: 0.000005
epoch 50: 0.000009
epoch 51: 0.000009
epoch 52: 0.000006
epoch 53: 0.000006
epoch 54: 0.000011
epoch 55: 0.000003
epoch 56: 0.000005
epoch 57: 0.000005
epoch 58: 0.000011
epoch 59: 0.000006
epoch 60: 0.000004
epoch 61: 0.000007
epoch 62: 0.000004
epoch 63: 0.000008
epoch 64: 0.000004
epoch 65: 0.000006
epoch 66: 0.000005
epoch 67: 0.000006
epoch 68: 0.000004
epoch 69: 0.000005
epoch 70: 0.000005
epoch 71: 0.000004
epoch 72: 0.000006
epoch 73: 0.000004
epoch 74: 0.000005
epoch 75: 0.000003
epoch 76: 0.000004
epoch 77: 0.000004
epoch 78: 0.000007
epoch 79: 0.000004
epoch 80: 0.000004
epoch 81: 0.000004
epoch 82: 0.000004
epoch 83: 0.000003
epoch 84: 0.000003
epoch 85: 0.000004

```
epoch 86: 0.000003
epoch 87: 0.000004
epoch 88: 0.000003
epoch 89: 0.000004
epoch 90: 0.000003
epoch 91: 0.000002
epoch 92: 0.000004
epoch 93: 0.000004
epoch 94: 0.000003
epoch 95: 0.000003
epoch 96: 0.000003
epoch 97: 0.000003
epoch 98: 0.000002
epoch 99: 0.000003
epoch 100: 0.000003
```

mean_absolute_error:

```
epoch 1: 0.027761
epoch 2: 0.007908
epoch 3: 0.005491
epoch 4: 0.004430
epoch 5: 0.004090
epoch 6: 0.004170
epoch 7: 0.003940
epoch 8: 0.004013
epoch 9: 0.004688
epoch 10: 0.005465
epoch 11: 0.003341
epoch 12: 0.004064
epoch 13: 0.003765
epoch 14: 0.003881
epoch 15: 0.003374
epoch 16: 0.004035
epoch 17: 0.002729
epoch 18: 0.003666
epoch 19: 0.003930
epoch 20: 0.002900
epoch 21: 0.003594
epoch 22: 0.002806
epoch 23: 0.003456
epoch 24: 0.003158
epoch 25: 0.002626
epoch 26: 0.003215
epoch 27: 0.002986
epoch 28: 0.002857
epoch 29: 0.003114
epoch 30: 0.002809
epoch 31: 0.002522
epoch 32: 0.002398
epoch 33: 0.002526
epoch 34: 0.002290
epoch 35: 0.002923
epoch 36: 0.002229
epoch 37: 0.002384
epoch 38: 0.002659
epoch 39: 0.002722
epoch 40: 0.001923
```

epoch 41: 0.002211
epoch 42: 0.002660
epoch 43: 0.001497
epoch 44: 0.002425
epoch 45: 0.002024
epoch 46: 0.002210
epoch 47: 0.001710
epoch 48: 0.002231
epoch 49: 0.001606
epoch 50: 0.002120
epoch 51: 0.002110
epoch 52: 0.001715
epoch 53: 0.001767
epoch 54: 0.002228
epoch 55: 0.001282
epoch 56: 0.001734
epoch 57: 0.001618
epoch 58: 0.002120
epoch 59: 0.001701
epoch 60: 0.001421
epoch 61: 0.002069
epoch 62: 0.001567
epoch 63: 0.001989
epoch 64: 0.001412
epoch 65: 0.001842
epoch 66: 0.001544
epoch 67: 0.001798
epoch 68: 0.001417
epoch 69: 0.001627
epoch 70: 0.001607
epoch 71: 0.001398
epoch 72: 0.001722
epoch 73: 0.001492
epoch 74: 0.001630
epoch 75: 0.001274
epoch 76: 0.001359
epoch 77: 0.001354
epoch 78: 0.001836
epoch 79: 0.001450
epoch 80: 0.001427
epoch 81: 0.001475
epoch 82: 0.001422
epoch 83: 0.001199
epoch 84: 0.001281
epoch 85: 0.001468
epoch 86: 0.001333
epoch 87: 0.001390
epoch 88: 0.001275
epoch 89: 0.001454
epoch 90: 0.001198
epoch 91: 0.001028
epoch 92: 0.001394
epoch 93: 0.001387
epoch 94: 0.001149
epoch 95: 0.001277
epoch 96: 0.001148
epoch 97: 0.001303

epoch 98: 0.000984
epoch 99: 0.001168
epoch 100: 0.001255

val_loss:

epoch 1: 0.000190
epoch 2: 0.000084
epoch 3: 0.000048
epoch 4: 0.000035
epoch 5: 0.000041
epoch 6: 0.000162
epoch 7: 0.000014
epoch 8: 0.000040
epoch 9: 0.000026
epoch 10: 0.000043
epoch 11: 0.000021
epoch 12: 0.000066
epoch 13: 0.000014
epoch 14: 0.000225
epoch 15: 0.000058
epoch 16: 0.000011
epoch 17: 0.000091
epoch 18: 0.000030
epoch 19: 0.000027
epoch 20: 0.000008
epoch 21: 0.000011
epoch 22: 0.000038
epoch 23: 0.000012
epoch 24: 0.000007
epoch 25: 0.000011
epoch 26: 0.000014
epoch 27: 0.000010
epoch 28: 0.000031
epoch 29: 0.000041
epoch 30: 0.000021
epoch 31: 0.000005
epoch 32: 0.000010
epoch 33: 0.000007
epoch 34: 0.000022
epoch 35: 0.000004
epoch 36: 0.000013
epoch 37: 0.000011
epoch 38: 0.000017
epoch 39: 0.000005
epoch 40: 0.000003
epoch 41: 0.000005
epoch 42: 0.000010
epoch 43: 0.000039
epoch 44: 0.000002
epoch 45: 0.000006
epoch 46: 0.000002
epoch 47: 0.000004
epoch 48: 0.000004
epoch 49: 0.000002
epoch 50: 0.000004
epoch 51: 0.000008
epoch 52: 0.000003

```
epoch 53: 0.000010
epoch 54: 0.000002
epoch 55: 0.000004
epoch 56: 0.000003
epoch 57: 0.000004
epoch 58: 0.000003
epoch 59: 0.000002
epoch 60: 0.000004
epoch 61: 0.000003
epoch 62: 0.000006
epoch 63: 0.000007
epoch 64: 0.000009
epoch 65: 0.000002
epoch 66: 0.000025
epoch 67: 0.000003
epoch 68: 0.000004
epoch 69: 0.000009
epoch 70: 0.000009
epoch 71: 0.000007
epoch 72: 0.000001
epoch 73: 0.000005
epoch 74: 0.000001
epoch 75: 0.000005
epoch 76: 0.000004
epoch 77: 0.000003
epoch 78: 0.000002
epoch 79: 0.000002
epoch 80: 0.000016
epoch 81: 0.000002
epoch 82: 0.000002
epoch 83: 0.000005
epoch 84: 0.000020
epoch 85: 0.000019
epoch 86: 0.000005
epoch 87: 0.000001
epoch 88: 0.000006
epoch 89: 0.000001
epoch 90: 0.000002
epoch 91: 0.000033
epoch 92: 0.000010
epoch 93: 0.000009
epoch 94: 0.000005
epoch 95: 0.000006
epoch 96: 0.000009
epoch 97: 0.000014
epoch 98: 0.000002
epoch 99: 0.000004
epoch 100: 0.000001
```

```
val_mean_absolute_error:
```

```
epoch 1: 0.009438
epoch 2: 0.006159
epoch 3: 0.004500
epoch 4: 0.003945
epoch 5: 0.004421
epoch 6: 0.011394
epoch 7: 0.002479
```

epoch 8: 0.004877
epoch 9: 0.003805
epoch 10: 0.004896
epoch 11: 0.003707
epoch 12: 0.007428
epoch 13: 0.002722
epoch 14: 0.014223
epoch 15: 0.006864
epoch 16: 0.002391
epoch 17: 0.007706
epoch 18: 0.004671
epoch 19: 0.004069
epoch 20: 0.002206
epoch 21: 0.002466
epoch 22: 0.005026
epoch 23: 0.002621
epoch 24: 0.002002
epoch 25: 0.002548
epoch 26: 0.002983
epoch 27: 0.002484
epoch 28: 0.005056
epoch 29: 0.005263
epoch 30: 0.003725
epoch 31: 0.001775
epoch 32: 0.002421
epoch 33: 0.002093
epoch 34: 0.003876
epoch 35: 0.001531
epoch 36: 0.002658
epoch 37: 0.002691
epoch 38: 0.003253
epoch 39: 0.001808
epoch 40: 0.001188
epoch 41: 0.001815
epoch 42: 0.002290
epoch 43: 0.005544
epoch 44: 0.000957
epoch 45: 0.001936
epoch 46: 0.000921
epoch 47: 0.001399
epoch 48: 0.001598
epoch 49: 0.000975
epoch 50: 0.001587
epoch 51: 0.002362
epoch 52: 0.001311
epoch 53: 0.002561
epoch 54: 0.001065
epoch 55: 0.001644
epoch 56: 0.001272
epoch 57: 0.001502
epoch 58: 0.001448
epoch 59: 0.000977
epoch 60: 0.001645
epoch 61: 0.001222
epoch 62: 0.001779
epoch 63: 0.002133
epoch 64: 0.002327

```
epoch 65: 0.000933
epoch 66: 0.004321
epoch 67: 0.001331
epoch 68: 0.001422
epoch 69: 0.002551
epoch 70: 0.002074
epoch 71: 0.002227
epoch 72: 0.000751
epoch 73: 0.001616
epoch 74: 0.000643
epoch 75: 0.001957
epoch 76: 0.001651
epoch 77: 0.001320
epoch 78: 0.001033
epoch 79: 0.000821
epoch 80: 0.003358
epoch 81: 0.001210
epoch 82: 0.001033
epoch 83: 0.001899
epoch 84: 0.003571
epoch 85: 0.003749
epoch 86: 0.001735
epoch 87: 0.000746
epoch 88: 0.001933
epoch 89: 0.000490
epoch 90: 0.000977
epoch 91: 0.005249
epoch 92: 0.002367
epoch 93: 0.002300
epoch 94: 0.001926
epoch 95: 0.001985
epoch 96: 0.002390
epoch 97: 0.003107
epoch 98: 0.001003
epoch 99: 0.001652
epoch 100: 0.000749
```

The best MAE is: 0.0004903394728899002 at epoch 89

Evaluate on test data

```
141/141 [=====] - 0s 1ms/step - loss: 5.4784e-07 - m
ean_absolute_error: 4.9034e-04
test loss, test acc: [5.478392495206208e-07, 0.0004903394728899002]
Generate predictions for 3 samples
pred: [0.22522014]      true: 0.2268
pred: [0.1272082]      true: 0.1259712
pred: [0.4848623]      true: 0.486
```

2-Layer NN

```

In [46]: model = tf.keras.Sequential([
    tf.keras.layers.Input((15,)),
    tf.keras.layers.Dense(128, activation='relu'),
    tf.keras.layers.Dense(64, activation='relu'),
    tf.keras.layers.Dense(1)
])
model.summary()

model.compile(optimizer='adam',
              loss=tf.keras.losses.MeanSquaredError(),
              metrics=['mean_absolute_error'])

ckpt_dir = "%sckpts_2_nn/"%model_dir
if not os.path.exists(ckpt_dir):
    os.makedirs(ckpt_dir)

checkpoint_path = "%scp-{epoch:04d}.hdf5"%ckpt_dir
checkpoint_dir = os.path.dirname(checkpoint_path)
cp_callback = tf.keras.callbacks.ModelCheckpoint(filepath=checkpoint_path,
                                                  verbose=1,
                                                  save_weights_only=True,
                                                  save_freq="epoch"
                                                  )

history = model.fit(train_x, train_y, epochs=100, validation_data=(val_x, val_y),
                    callbacks=[cp_callback])
best = [-1, 1]
for k in history.history:
    print("%s:"%k)
    for i, r in enumerate(history.history[k]):
        print("epoch %d: %f"%(i+1, r))
        if k == "val_mean_absolute_error" and r < best[1]:
            best[0] = i+1
            best[1] = r
    print()
bests.update({"2_nn": {"val_MAE": best[1], "best_epoch": best[0]}})
print("The best MAE is:", best[1], "at epoch", best[0])
print()

# Evaluate the model on the test data using `evaluate`
print("Evaluate on test data")
model.load_weights("%scp-%04d.hdf5"%(ckpt_dir, best[0]))
results = model.evaluate(val_x, val_y)
print("test loss, test acc:", results)

# Generate predictions (probabilities -- the output of the last layer)
# on new data using `predict`
print("Generate predictions for 3 samples")
predictions = model.predict(val_x[:3])
for i, p in enumerate(predictions):
    print("pred:", p, "\ttrue:", val_y[i])

```

Model: "sequential_4"

Layer (type)	Output Shape	Param #
dense_11 (Dense)	(None, 128)	2048
dense_12 (Dense)	(None, 64)	8256
dense_13 (Dense)	(None, 1)	65
Total params: 10,369		
Trainable params: 10,369		
Non-trainable params: 0		

Epoch 1/100

657/657 [=====] - 2s 2ms/step - loss: 0.0077 - mean_absolute_error: 0.0408 - val_loss: 6.1232e-05 - val_mean_absolute_error: 0.0054

Epoch 00001: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0001.hdf5

Epoch 2/100

657/657 [=====] - 1s 2ms/step - loss: 4.7422e-05 - mean_absolute_error: 0.0047 - val_loss: 7.5254e-05 - val_mean_absolute_error: 0.0074

Epoch 00002: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0002.hdf5

Epoch 3/100

657/657 [=====] - 1s 2ms/step - loss: 3.2864e-05 - mean_absolute_error: 0.0041 - val_loss: 2.6551e-05 - val_mean_absolute_error: 0.0035

Epoch 00003: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0003.hdf5

Epoch 4/100

657/657 [=====] - 1s 2ms/step - loss: 3.1382e-05 - mean_absolute_error: 0.0041 - val_loss: 1.1467e-04 - val_mean_absolute_error: 0.0087

Epoch 00004: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0004.hdf5

Epoch 5/100

657/657 [=====] - 1s 2ms/step - loss: 4.8027e-05 - mean_absolute_error: 0.0050 - val_loss: 8.4956e-05 - val_mean_absolute_error: 0.0080

Epoch 00005: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0005.hdf5

Epoch 6/100

657/657 [=====] - 1s 2ms/step - loss: 4.6003e-05 - mean_absolute_error: 0.0051 - val_loss: 1.9582e-05 - val_mean_absolute_error: 0.0033

Epoch 00006: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0006.hdf5

Epoch 7/100

657/657 [=====] - 1s 2ms/step - loss: 3.0498e-05 - mean_absolute_error: 0.0040 - val_loss: 1.8552e-05 - val_mean_absolute_error: 0.0033

Epoch 00007: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0007.hdf5

Epoch 8/100

657/657 [=====] - 1s 2ms/step - loss: 2.4687e-05 - mean_absolute_error: 0.0036 - val_loss: 2.6982e-05 - val_mean_absolute_error: 0.0041

Epoch 00008: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0008.hdf5

Epoch 9/100

657/657 [=====] - 1s 2ms/step - loss: 4.2079e-05 - mean_absolute_error: 0.0048 - val_loss: 9.6582e-06 - val_mean_absolute_error: 0.0021

Epoch 00009: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0009.hdf5

Epoch 10/100

657/657 [=====] - 1s 2ms/step - loss: 1.9083e-05 - mean_absolute_error: 0.0032 - val_loss: 2.7225e-05 - val_mean_absolute_error: 0.0039

Epoch 00010: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0010.hdf5

Epoch 11/100

657/657 [=====] - 1s 2ms/step - loss: 2.4305e-05 - mean_absolute_error: 0.0035 - val_loss: 1.7408e-05 - val_mean_absolute_error: 0.0032

Epoch 00011: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0011.hdf5

Epoch 12/100

657/657 [=====] - 1s 2ms/step - loss: 2.0342e-05 - mean_absolute_error: 0.0032 - val_loss: 1.4429e-05 - val_mean_absolute_error: 0.0025

Epoch 00012: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0012.hdf5

Epoch 13/100

657/657 [=====] - 1s 2ms/step - loss: 1.5286e-05 - mean_absolute_error: 0.0029 - val_loss: 1.1377e-05 - val_mean_absolute_error: 0.0024

Epoch 00013: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0013.hdf5

Epoch 14/100

657/657 [=====] - 1s 2ms/step - loss: 1.7847e-05 - mean_absolute_error: 0.0031 - val_loss: 1.3295e-05 - val_mean_absolute_error: 0.0027

Epoch 00014: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0014.hdf5

Epoch 15/100

657/657 [=====] - 1s 2ms/step - loss: 2.2055e-05 - m

ean_absolute_error: 0.0035 - val_loss: 1.4821e-05 - val_mean_absolute_error: 0.0030

Epoch 00015: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0015.hdf5

Epoch 16/100

657/657 [=====] - 1s 2ms/step - loss: 1.2352e-05 - mean_absolute_error: 0.0025 - val_loss: 4.4895e-06 - val_mean_absolute_error: 0.0015

Epoch 00016: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0016.hdf5

Epoch 17/100

657/657 [=====] - 1s 2ms/step - loss: 9.6631e-06 - mean_absolute_error: 0.0022 - val_loss: 9.6207e-06 - val_mean_absolute_error: 0.0024

Epoch 00017: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0017.hdf5

Epoch 18/100

657/657 [=====] - 1s 2ms/step - loss: 1.2673e-05 - mean_absolute_error: 0.0025 - val_loss: 3.2033e-06 - val_mean_absolute_error: 0.0012

Epoch 00018: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0018.hdf5

Epoch 19/100

657/657 [=====] - 1s 2ms/step - loss: 5.3967e-06 - mean_absolute_error: 0.0017 - val_loss: 1.4177e-05 - val_mean_absolute_error: 0.0029

Epoch 00019: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0019.hdf5

Epoch 20/100

657/657 [=====] - 1s 2ms/step - loss: 1.1197e-05 - mean_absolute_error: 0.0024 - val_loss: 4.9324e-06 - val_mean_absolute_error: 0.0017

Epoch 00020: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0020.hdf5

Epoch 21/100

657/657 [=====] - 1s 2ms/step - loss: 3.7873e-06 - mean_absolute_error: 0.0014 - val_loss: 2.9826e-05 - val_mean_absolute_error: 0.0048

Epoch 00021: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0021.hdf5

Epoch 22/100

657/657 [=====] - 2s 2ms/step - loss: 5.4314e-06 - mean_absolute_error: 0.0016 - val_loss: 9.9172e-06 - val_mean_absolute_error: 0.0024

Epoch 00022: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0022.hdf5

Epoch 23/100

657/657 [=====] - 2s 2ms/step - loss: 6.9210e-06 - mean_absolute_error: 0.0019 - val_loss: 5.2879e-06 - val_mean_absolute_error:

0.0016

Epoch 00023: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0023.hdf5

Epoch 24/100

657/657 [=====] - 1s 2ms/step - loss: 6.0999e-06 - mean_absolute_error: 0.0018 - val_loss: 1.5228e-06 - val_mean_absolute_error: 8.9647e-04

Epoch 00024: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0024.hdf5

Epoch 25/100

657/657 [=====] - 1s 2ms/step - loss: 2.4989e-06 - mean_absolute_error: 0.0012 - val_loss: 1.9770e-06 - val_mean_absolute_error: 0.0011

Epoch 00025: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0025.hdf5

Epoch 26/100

657/657 [=====] - 1s 2ms/step - loss: 8.2650e-06 - mean_absolute_error: 0.0020 - val_loss: 4.1779e-06 - val_mean_absolute_error: 0.0015

Epoch 00026: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0026.hdf5

Epoch 27/100

657/657 [=====] - 1s 2ms/step - loss: 3.5104e-06 - mean_absolute_error: 0.0013 - val_loss: 1.2847e-06 - val_mean_absolute_error: 7.9229e-04

Epoch 00027: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0027.hdf5

Epoch 28/100

657/657 [=====] - 1s 2ms/step - loss: 3.8026e-06 - mean_absolute_error: 0.0014 - val_loss: 3.7243e-06 - val_mean_absolute_error: 0.0015

Epoch 00028: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0028.hdf5

Epoch 29/100

657/657 [=====] - 1s 2ms/step - loss: 5.0816e-06 - mean_absolute_error: 0.0016 - val_loss: 1.3557e-06 - val_mean_absolute_error: 8.2531e-04

Epoch 00029: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0029.hdf5

Epoch 30/100

657/657 [=====] - 1s 2ms/step - loss: 1.9190e-06 - mean_absolute_error: 9.8079e-04 - val_loss: 1.0829e-06 - val_mean_absolute_error: 7.5409e-04

Epoch 00030: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0030.hdf5

Epoch 31/100

657/657 [=====] - 1s 2ms/step - loss: 3.5231e-06 - mean_absolute_error: 0.0013 - val_loss: 1.1170e-06 - val_mean_absolute_error: 7.8572e-04

Epoch 00031: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0031.hdf5
Epoch 32/100
657/657 [=====] - 1s 2ms/step - loss: 1.6582e-06 - mean_absolute_error: 9.5160e-04 - val_loss: 2.9442e-06 - val_mean_absolute_error: 0.0013

Epoch 00032: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0032.hdf5
Epoch 33/100
657/657 [=====] - 1s 2ms/step - loss: 4.3629e-06 - mean_absolute_error: 0.0015 - val_loss: 2.2707e-06 - val_mean_absolute_error: 0.0011

Epoch 00033: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0033.hdf5
Epoch 34/100
657/657 [=====] - 1s 2ms/step - loss: 3.1657e-06 - mean_absolute_error: 0.0013 - val_loss: 2.4831e-06 - val_mean_absolute_error: 0.0013

Epoch 00034: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0034.hdf5
Epoch 35/100
657/657 [=====] - 1s 2ms/step - loss: 1.7814e-06 - mean_absolute_error: 9.6909e-04 - val_loss: 3.7076e-06 - val_mean_absolute_error: 0.0014

Epoch 00035: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0035.hdf5
Epoch 36/100
657/657 [=====] - 1s 2ms/step - loss: 2.0196e-06 - mean_absolute_error: 0.0010 - val_loss: 2.2314e-06 - val_mean_absolute_error: 0.0011

Epoch 00036: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0036.hdf5
Epoch 37/100
657/657 [=====] - 1s 2ms/step - loss: 1.8701e-06 - mean_absolute_error: 9.5818e-04 - val_loss: 4.3141e-06 - val_mean_absolute_error: 0.0016

Epoch 00037: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0037.hdf5
Epoch 38/100
657/657 [=====] - 1s 2ms/step - loss: 1.7178e-06 - mean_absolute_error: 9.3837e-04 - val_loss: 4.3488e-06 - val_mean_absolute_error: 0.0017

Epoch 00038: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0038.hdf5
Epoch 39/100
657/657 [=====] - 1s 2ms/step - loss: 2.1860e-06 - mean_absolute_error: 0.0011 - val_loss: 2.2164e-06 - val_mean_absolute_error: 0.0012

Epoch 00039: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0039.hdf5

Epoch 40/100

657/657 [=====] - 1s 2ms/step - loss: 1.8139e-06 - mean_absolute_error: 9.6214e-04 - val_loss: 5.8635e-06 - val_mean_absolute_error: 0.0021

Epoch 00040: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0040.hdf5

Epoch 41/100

657/657 [=====] - 1s 2ms/step - loss: 2.8197e-06 - mean_absolute_error: 0.0012 - val_loss: 1.7648e-06 - val_mean_absolute_error: 0.0011

Epoch 00041: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0041.hdf5

Epoch 42/100

657/657 [=====] - 1s 2ms/step - loss: 2.0050e-06 - mean_absolute_error: 9.8326e-04 - val_loss: 1.5200e-06 - val_mean_absolute_error: 7.6782e-04

Epoch 00042: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0042.hdf5

Epoch 43/100

657/657 [=====] - 1s 2ms/step - loss: 1.0833e-06 - mean_absolute_error: 7.5721e-04 - val_loss: 7.5247e-07 - val_mean_absolute_error: 6.6105e-04

Epoch 00043: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0043.hdf5

Epoch 44/100

657/657 [=====] - 1s 2ms/step - loss: 1.7896e-06 - mean_absolute_error: 9.5458e-04 - val_loss: 1.4806e-06 - val_mean_absolute_error: 9.0386e-04

Epoch 00044: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0044.hdf5

Epoch 45/100

657/657 [=====] - 1s 2ms/step - loss: 2.0280e-06 - mean_absolute_error: 9.8095e-04 - val_loss: 1.3550e-06 - val_mean_absolute_error: 7.7958e-04

Epoch 00045: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0045.hdf5

Epoch 46/100

657/657 [=====] - 1s 2ms/step - loss: 1.3894e-06 - mean_absolute_error: 8.4453e-04 - val_loss: 1.1841e-06 - val_mean_absolute_error: 8.6847e-04

Epoch 00046: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0046.hdf5

Epoch 47/100

657/657 [=====] - 1s 2ms/step - loss: 1.2328e-06 - mean_absolute_error: 7.7184e-04 - val_loss: 1.0793e-06 - val_mean_absolute_error: 7.7915e-04

Epoch 00047: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for

_AI/project/checkpoints/2_nn/cp-0047.hdf5
Epoch 48/100
657/657 [=====] - 1s 2ms/step - loss: 1.3772e-06 - mean_absolute_error: 8.4759e-04 - val_loss: 1.1534e-06 - val_mean_absolute_error: 7.9565e-04

Epoch 00048: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0048.hdf5
Epoch 49/100
657/657 [=====] - 1s 2ms/step - loss: 2.1327e-06 - mean_absolute_error: 0.0011 - val_loss: 4.0141e-07 - val_mean_absolute_error: 4.0797e-04

Epoch 00049: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0049.hdf5
Epoch 50/100
657/657 [=====] - 1s 2ms/step - loss: 1.5441e-06 - mean_absolute_error: 8.5417e-04 - val_loss: 5.6675e-07 - val_mean_absolute_error: 5.0598e-04

Epoch 00050: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0050.hdf5
Epoch 51/100
657/657 [=====] - 1s 2ms/step - loss: 1.4513e-06 - mean_absolute_error: 8.5381e-04 - val_loss: 4.4702e-07 - val_mean_absolute_error: 4.5582e-04

Epoch 00051: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0051.hdf5
Epoch 52/100
657/657 [=====] - 1s 2ms/step - loss: 7.8204e-07 - mean_absolute_error: 6.1466e-04 - val_loss: 8.5155e-07 - val_mean_absolute_error: 5.5541e-04

Epoch 00052: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0052.hdf5
Epoch 53/100
657/657 [=====] - 1s 2ms/step - loss: 1.5221e-06 - mean_absolute_error: 8.6907e-04 - val_loss: 2.1041e-06 - val_mean_absolute_error: 0.0012

Epoch 00053: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0053.hdf5
Epoch 54/100
657/657 [=====] - 1s 2ms/step - loss: 1.3783e-06 - mean_absolute_error: 8.0476e-04 - val_loss: 1.7744e-06 - val_mean_absolute_error: 0.0011

Epoch 00054: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0054.hdf5
Epoch 55/100
657/657 [=====] - 1s 2ms/step - loss: 1.9050e-06 - mean_absolute_error: 0.0010 - val_loss: 4.6763e-07 - val_mean_absolute_error: 4.5522e-04

Epoch 00055: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0055.hdf5

Epoch 56/100

657/657 [=====] - 1s 2ms/step - loss: 1.2161e-06 - mean_absolute_error: 7.1528e-04 - val_loss: 5.0210e-06 - val_mean_absolute_error: 0.0020

Epoch 00056: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0056.hdf5

Epoch 57/100

657/657 [=====] - 1s 2ms/step - loss: 1.1760e-06 - mean_absolute_error: 7.8658e-04 - val_loss: 6.4185e-06 - val_mean_absolute_error: 0.0019

Epoch 00057: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0057.hdf5

Epoch 58/100

657/657 [=====] - 1s 2ms/step - loss: 2.5190e-06 - mean_absolute_error: 0.0011 - val_loss: 3.4043e-06 - val_mean_absolute_error: 0.0013

Epoch 00058: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0058.hdf5

Epoch 59/100

657/657 [=====] - 1s 2ms/step - loss: 2.2140e-06 - mean_absolute_error: 0.0010 - val_loss: 4.6611e-07 - val_mean_absolute_error: 4.8439e-04

Epoch 00059: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0059.hdf5

Epoch 60/100

657/657 [=====] - 1s 2ms/step - loss: 8.1668e-07 - mean_absolute_error: 6.4001e-04 - val_loss: 9.5242e-07 - val_mean_absolute_error: 6.4463e-04

Epoch 00060: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0060.hdf5

Epoch 61/100

657/657 [=====] - 1s 2ms/step - loss: 1.9526e-06 - mean_absolute_error: 8.8424e-04 - val_loss: 7.8753e-07 - val_mean_absolute_error: 7.3478e-04

Epoch 00061: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0061.hdf5

Epoch 62/100

657/657 [=====] - 1s 2ms/step - loss: 6.4430e-07 - mean_absolute_error: 5.7189e-04 - val_loss: 7.8013e-07 - val_mean_absolute_error: 5.8198e-04

Epoch 00062: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0062.hdf5

Epoch 63/100

657/657 [=====] - 1s 2ms/step - loss: 1.0329e-06 - mean_absolute_error: 7.3341e-04 - val_loss: 1.6454e-06 - val_mean_absolute_error: 9.8001e-04

Epoch 00063: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0063.hdf5

Epoch 64/100

657/657 [=====] - 1s 2ms/step - loss: 1.2637e-06 - mean_absolute_error: 7.8958e-04 - val_loss: 7.5952e-07 - val_mean_absolute_error: 6.3027e-04

Epoch 00064: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0064.hdf5

Epoch 65/100

657/657 [=====] - 1s 2ms/step - loss: 6.4948e-07 - mean_absolute_error: 5.7198e-04 - val_loss: 4.9893e-07 - val_mean_absolute_error: 4.8357e-04

Epoch 00065: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0065.hdf5

Epoch 66/100

657/657 [=====] - 1s 2ms/step - loss: 9.4369e-07 - mean_absolute_error: 6.6815e-04 - val_loss: 3.2689e-06 - val_mean_absolute_error: 0.0014

Epoch 00066: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0066.hdf5

Epoch 67/100

657/657 [=====] - 1s 2ms/step - loss: 8.2805e-07 - mean_absolute_error: 6.5039e-04 - val_loss: 6.7809e-07 - val_mean_absolute_error: 5.8495e-04

Epoch 00067: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0067.hdf5

Epoch 68/100

657/657 [=====] - 1s 2ms/step - loss: 1.3535e-06 - mean_absolute_error: 7.7969e-04 - val_loss: 3.1674e-06 - val_mean_absolute_error: 0.0013

Epoch 00068: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0068.hdf5

Epoch 69/100

657/657 [=====] - 1s 2ms/step - loss: 9.6993e-07 - mean_absolute_error: 6.9597e-04 - val_loss: 2.9193e-06 - val_mean_absolute_error: 0.0014

Epoch 00069: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0069.hdf5

Epoch 70/100

657/657 [=====] - 1s 2ms/step - loss: 1.7356e-06 - mean_absolute_error: 9.1688e-04 - val_loss: 1.6112e-06 - val_mean_absolute_error: 8.5073e-04

Epoch 00070: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0070.hdf5

Epoch 71/100

657/657 [=====] - 1s 2ms/step - loss: 1.1209e-06 - mean_absolute_error: 7.5417e-04 - val_loss: 3.2559e-07 - val_mean_absolute_error: 3.1659e-04

Epoch 00071: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0071.hdf5

Epoch 72/100

657/657 [=====] - 1s 2ms/step - loss: 1.2655e-06 - m

ean_absolute_error: 6.8124e-04 - val_loss: 3.2819e-07 - val_mean_absolute_err
or: 3.4014e-04

Epoch 00072: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/2_nn/cp-0072.hdf5

Epoch 73/100

657/657 [=====] - 1s 2ms/step - loss: 6.3789e-07 - m
ean_absolute_error: 5.6271e-04 - val_loss: 2.8934e-06 - val_mean_absolute_err
or: 0.0014

Epoch 00073: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/2_nn/cp-0073.hdf5

Epoch 74/100

657/657 [=====] - 1s 2ms/step - loss: 1.3151e-06 - m
ean_absolute_error: 7.8978e-04 - val_loss: 4.8101e-06 - val_mean_absolute_err
or: 0.0014

Epoch 00074: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/2_nn/cp-0074.hdf5

Epoch 75/100

657/657 [=====] - 1s 2ms/step - loss: 1.2715e-06 - m
ean_absolute_error: 7.6459e-04 - val_loss: 1.8696e-06 - val_mean_absolute_err
or: 9.7847e-04

Epoch 00075: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/2_nn/cp-0075.hdf5

Epoch 76/100

657/657 [=====] - 1s 2ms/step - loss: 1.5233e-06 - m
ean_absolute_error: 8.4318e-04 - val_loss: 3.1464e-07 - val_mean_absolute_err
or: 3.6952e-04

Epoch 00076: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/2_nn/cp-0076.hdf5

Epoch 77/100

657/657 [=====] - 1s 2ms/step - loss: 5.7484e-07 - m
ean_absolute_error: 5.2841e-04 - val_loss: 2.1426e-07 - val_mean_absolute_err
or: 2.8974e-04

Epoch 00077: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/2_nn/cp-0077.hdf5

Epoch 78/100

657/657 [=====] - 1s 2ms/step - loss: 7.1057e-07 - m
ean_absolute_error: 5.6774e-04 - val_loss: 4.5951e-07 - val_mean_absolute_err
or: 5.4442e-04

Epoch 00078: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/2_nn/cp-0078.hdf5

Epoch 79/100

657/657 [=====] - 1s 2ms/step - loss: 1.1467e-06 - m
ean_absolute_error: 7.1659e-04 - val_loss: 2.9351e-06 - val_mean_absolute_err
or: 0.0013

Epoch 00079: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/2_nn/cp-0079.hdf5

Epoch 80/100

657/657 [=====] - 1s 2ms/step - loss: 1.9162e-06 - m
ean_absolute_error: 9.1320e-04 - val_loss: 1.7705e-06 - val_mean_absolute_err

or: 9.5089e-04

Epoch 00080: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0080.hdf5

Epoch 81/100

657/657 [=====] - 1s 2ms/step - loss: 1.3520e-06 - mean_absolute_error: 7.5341e-04 - val_loss: 2.8459e-07 - val_mean_absolute_error: 3.5981e-04

Epoch 00081: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0081.hdf5

Epoch 82/100

657/657 [=====] - 1s 2ms/step - loss: 5.6539e-07 - mean_absolute_error: 5.2079e-04 - val_loss: 3.8585e-07 - val_mean_absolute_error: 4.2810e-04

Epoch 00082: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0082.hdf5

Epoch 83/100

657/657 [=====] - 1s 2ms/step - loss: 8.4824e-07 - mean_absolute_error: 5.7439e-04 - val_loss: 1.8019e-06 - val_mean_absolute_error: 7.9567e-04

Epoch 00083: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0083.hdf5

Epoch 84/100

657/657 [=====] - 1s 2ms/step - loss: 1.4242e-06 - mean_absolute_error: 8.0181e-04 - val_loss: 2.5332e-07 - val_mean_absolute_error: 3.2122e-04

Epoch 00084: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0084.hdf5

Epoch 85/100

657/657 [=====] - 1s 2ms/step - loss: 1.8873e-06 - mean_absolute_error: 7.8184e-04 - val_loss: 4.8817e-07 - val_mean_absolute_error: 3.8674e-04

Epoch 00085: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0085.hdf5

Epoch 86/100

657/657 [=====] - 1s 2ms/step - loss: 7.3914e-07 - mean_absolute_error: 6.1098e-04 - val_loss: 6.0939e-07 - val_mean_absolute_error: 5.9348e-04

Epoch 00086: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0086.hdf5

Epoch 87/100

657/657 [=====] - 1s 2ms/step - loss: 4.6223e-07 - mean_absolute_error: 4.8647e-04 - val_loss: 5.1923e-07 - val_mean_absolute_error: 4.6610e-04

Epoch 00087: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0087.hdf5

Epoch 88/100

657/657 [=====] - 1s 2ms/step - loss: 8.4599e-07 - mean_absolute_error: 6.5367e-04 - val_loss: 1.2674e-06 - val_mean_absolute_error: 8.0044e-04

Epoch 00088: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0088.hdf5

Epoch 89/100

657/657 [=====] - 1s 2ms/step - loss: 1.4534e-06 - mean_absolute_error: 8.0182e-04 - val_loss: 1.7471e-06 - val_mean_absolute_error: 0.0012

Epoch 00089: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0089.hdf5

Epoch 90/100

657/657 [=====] - 1s 2ms/step - loss: 1.0556e-06 - mean_absolute_error: 7.3119e-04 - val_loss: 3.6011e-07 - val_mean_absolute_error: 3.6869e-04

Epoch 00090: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0090.hdf5

Epoch 91/100

657/657 [=====] - 1s 2ms/step - loss: 8.0599e-07 - mean_absolute_error: 6.2530e-04 - val_loss: 1.4437e-06 - val_mean_absolute_error: 9.1987e-04

Epoch 00091: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0091.hdf5

Epoch 92/100

657/657 [=====] - 1s 2ms/step - loss: 3.1964e-06 - mean_absolute_error: 0.0012 - val_loss: 3.5858e-07 - val_mean_absolute_error: 4.2812e-04

Epoch 00092: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0092.hdf5

Epoch 93/100

657/657 [=====] - 1s 2ms/step - loss: 4.8798e-07 - mean_absolute_error: 4.7078e-04 - val_loss: 7.4544e-07 - val_mean_absolute_error: 6.4719e-04

Epoch 00093: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0093.hdf5

Epoch 94/100

657/657 [=====] - 1s 2ms/step - loss: 4.7409e-07 - mean_absolute_error: 4.8659e-04 - val_loss: 1.1027e-06 - val_mean_absolute_error: 7.0885e-04

Epoch 00094: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0094.hdf5

Epoch 95/100

657/657 [=====] - 1s 2ms/step - loss: 1.2425e-06 - mean_absolute_error: 7.4716e-04 - val_loss: 5.9624e-07 - val_mean_absolute_error: 5.2610e-04

Epoch 00095: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0095.hdf5

Epoch 96/100

657/657 [=====] - 1s 2ms/step - loss: 5.0940e-07 - mean_absolute_error: 5.1741e-04 - val_loss: 1.8438e-06 - val_mean_absolute_error: 0.0011

Epoch 00096: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0096.hdf5

Epoch 97/100

657/657 [=====] - 1s 2ms/step - loss: 6.7557e-07 - mean_absolute_error: 5.6214e-04 - val_loss: 9.8448e-07 - val_mean_absolute_error: 7.8670e-04

Epoch 00097: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0097.hdf5

Epoch 98/100

657/657 [=====] - 1s 2ms/step - loss: 5.8799e-07 - mean_absolute_error: 5.3784e-04 - val_loss: 3.0744e-07 - val_mean_absolute_error: 3.9286e-04

Epoch 00098: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0098.hdf5

Epoch 99/100

657/657 [=====] - 1s 2ms/step - loss: 8.8185e-07 - mean_absolute_error: 6.1955e-04 - val_loss: 3.2406e-07 - val_mean_absolute_error: 3.4124e-04

Epoch 00099: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0099.hdf5

Epoch 100/100

657/657 [=====] - 1s 2ms/step - loss: 5.4908e-07 - mean_absolute_error: 5.0618e-04 - val_loss: 3.8396e-07 - val_mean_absolute_error: 4.4435e-04

Epoch 00100: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/2_nn/cp-0100.hdf5

loss:

epoch 1: 0.001741
epoch 2: 0.000043
epoch 3: 0.000036
epoch 4: 0.000031
epoch 5: 0.000044
epoch 6: 0.000043
epoch 7: 0.000029
epoch 8: 0.000032
epoch 9: 0.000036
epoch 10: 0.000023
epoch 11: 0.000026
epoch 12: 0.000019
epoch 13: 0.000012
epoch 14: 0.000017
epoch 15: 0.000019
epoch 16: 0.000010
epoch 17: 0.000011
epoch 18: 0.000014
epoch 19: 0.000007
epoch 20: 0.000009
epoch 21: 0.000004
epoch 22: 0.000007
epoch 23: 0.000005
epoch 24: 0.000007
epoch 25: 0.000002
epoch 26: 0.000006

epoch 27: 0.000004
epoch 28: 0.000004
epoch 29: 0.000006
epoch 30: 0.000002
epoch 31: 0.000004
epoch 32: 0.000002
epoch 33: 0.000004
epoch 34: 0.000002
epoch 35: 0.000002
epoch 36: 0.000002
epoch 37: 0.000004
epoch 38: 0.000001
epoch 39: 0.000002
epoch 40: 0.000002
epoch 41: 0.000002
epoch 42: 0.000003
epoch 43: 0.000001
epoch 44: 0.000002
epoch 45: 0.000002
epoch 46: 0.000002
epoch 47: 0.000002
epoch 48: 0.000001
epoch 49: 0.000002
epoch 50: 0.000002
epoch 51: 0.000002
epoch 52: 0.000001
epoch 53: 0.000001
epoch 54: 0.000002
epoch 55: 0.000002
epoch 56: 0.000001
epoch 57: 0.000001
epoch 58: 0.000001
epoch 59: 0.000002
epoch 60: 0.000001
epoch 61: 0.000003
epoch 62: 0.000001
epoch 63: 0.000001
epoch 64: 0.000002
epoch 65: 0.000001
epoch 66: 0.000002
epoch 67: 0.000001
epoch 68: 0.000002
epoch 69: 0.000001
epoch 70: 0.000001
epoch 71: 0.000001
epoch 72: 0.000001
epoch 73: 0.000001
epoch 74: 0.000002
epoch 75: 0.000001
epoch 76: 0.000001
epoch 77: 0.000001
epoch 78: 0.000001
epoch 79: 0.000001
epoch 80: 0.000001
epoch 81: 0.000002
epoch 82: 0.000001
epoch 83: 0.000001

```
epoch 84: 0.000001
epoch 85: 0.000001
epoch 86: 0.000001
epoch 87: 0.000001
epoch 88: 0.000001
epoch 89: 0.000001
epoch 90: 0.000001
epoch 91: 0.000001
epoch 92: 0.000002
epoch 93: 0.000001
epoch 94: 0.000001
epoch 95: 0.000001
epoch 96: 0.000001
epoch 97: 0.000001
epoch 98: 0.000001
epoch 99: 0.000001
epoch 100: 0.000001
```

mean_absolute_error:

```
epoch 1: 0.016654
epoch 2: 0.004491
epoch 3: 0.004320
epoch 4: 0.004060
epoch 5: 0.004834
epoch 6: 0.004897
epoch 7: 0.003925
epoch 8: 0.004080
epoch 9: 0.004394
epoch 10: 0.003465
epoch 11: 0.003533
epoch 12: 0.003189
epoch 13: 0.002603
epoch 14: 0.002999
epoch 15: 0.003192
epoch 16: 0.002255
epoch 17: 0.002345
epoch 18: 0.002619
epoch 19: 0.001916
epoch 20: 0.002124
epoch 21: 0.001485
epoch 22: 0.001774
epoch 23: 0.001659
epoch 24: 0.001812
epoch 25: 0.001140
epoch 26: 0.001699
epoch 27: 0.001466
epoch 28: 0.001478
epoch 29: 0.001665
epoch 30: 0.001046
epoch 31: 0.001380
epoch 32: 0.000996
epoch 33: 0.001467
epoch 34: 0.001053
epoch 35: 0.001013
epoch 36: 0.001040
epoch 37: 0.001250
epoch 38: 0.000837
```

epoch 39: 0.001031
epoch 40: 0.000947
epoch 41: 0.001016
epoch 42: 0.001142
epoch 43: 0.000729
epoch 44: 0.000999
epoch 45: 0.000946
epoch 46: 0.000873
epoch 47: 0.000980
epoch 48: 0.000842
epoch 49: 0.001041
epoch 50: 0.000909
epoch 51: 0.000897
epoch 52: 0.000731
epoch 53: 0.000828
epoch 54: 0.000900
epoch 55: 0.001002
epoch 56: 0.000720
epoch 57: 0.000744
epoch 58: 0.000734
epoch 59: 0.000852
epoch 60: 0.000705
epoch 61: 0.001067
epoch 62: 0.000655
epoch 63: 0.000671
epoch 64: 0.000934
epoch 65: 0.000682
epoch 66: 0.000820
epoch 67: 0.000601
epoch 68: 0.001025
epoch 69: 0.000679
epoch 70: 0.000762
epoch 71: 0.000752
epoch 72: 0.000725
epoch 73: 0.000694
epoch 74: 0.000785
epoch 75: 0.000601
epoch 76: 0.000784
epoch 77: 0.000554
epoch 78: 0.000681
epoch 79: 0.000669
epoch 80: 0.000735
epoch 81: 0.000804
epoch 82: 0.000528
epoch 83: 0.000746
epoch 84: 0.000621
epoch 85: 0.000659
epoch 86: 0.000702
epoch 87: 0.000503
epoch 88: 0.000725
epoch 89: 0.000620
epoch 90: 0.000686
epoch 91: 0.000587
epoch 92: 0.000845
epoch 93: 0.000494
epoch 94: 0.000546
epoch 95: 0.000738

```
epoch 96: 0.000542  
epoch 97: 0.000591  
epoch 98: 0.000575  
epoch 99: 0.000739  
epoch 100: 0.000533
```

val_loss:

```
epoch 1: 0.000061  
epoch 2: 0.000075  
epoch 3: 0.000027  
epoch 4: 0.000115  
epoch 5: 0.000085  
epoch 6: 0.000020  
epoch 7: 0.000019  
epoch 8: 0.000027  
epoch 9: 0.000010  
epoch 10: 0.000027  
epoch 11: 0.000017  
epoch 12: 0.000014  
epoch 13: 0.000011  
epoch 14: 0.000013  
epoch 15: 0.000015  
epoch 16: 0.000004  
epoch 17: 0.000010  
epoch 18: 0.000003  
epoch 19: 0.000014  
epoch 20: 0.000005  
epoch 21: 0.000030  
epoch 22: 0.000010  
epoch 23: 0.000005  
epoch 24: 0.000002  
epoch 25: 0.000002  
epoch 26: 0.000004  
epoch 27: 0.000001  
epoch 28: 0.000004  
epoch 29: 0.000001  
epoch 30: 0.000001  
epoch 31: 0.000001  
epoch 32: 0.000003  
epoch 33: 0.000002  
epoch 34: 0.000002  
epoch 35: 0.000004  
epoch 36: 0.000002  
epoch 37: 0.000004  
epoch 38: 0.000004  
epoch 39: 0.000002  
epoch 40: 0.000006  
epoch 41: 0.000002  
epoch 42: 0.000002  
epoch 43: 0.000001  
epoch 44: 0.000001  
epoch 45: 0.000001  
epoch 46: 0.000001  
epoch 47: 0.000001  
epoch 48: 0.000001  
epoch 49: 0.000000  
epoch 50: 0.000001
```

```
epoch 51: 0.000000
epoch 52: 0.000001
epoch 53: 0.000002
epoch 54: 0.000002
epoch 55: 0.000000
epoch 56: 0.000005
epoch 57: 0.000006
epoch 58: 0.000003
epoch 59: 0.000000
epoch 60: 0.000001
epoch 61: 0.000001
epoch 62: 0.000001
epoch 63: 0.000002
epoch 64: 0.000001
epoch 65: 0.000000
epoch 66: 0.000003
epoch 67: 0.000001
epoch 68: 0.000003
epoch 69: 0.000003
epoch 70: 0.000002
epoch 71: 0.000000
epoch 72: 0.000000
epoch 73: 0.000003
epoch 74: 0.000005
epoch 75: 0.000002
epoch 76: 0.000000
epoch 77: 0.000000
epoch 78: 0.000000
epoch 79: 0.000003
epoch 80: 0.000002
epoch 81: 0.000000
epoch 82: 0.000000
epoch 83: 0.000002
epoch 84: 0.000000
epoch 85: 0.000000
epoch 86: 0.000001
epoch 87: 0.000001
epoch 88: 0.000001
epoch 89: 0.000002
epoch 90: 0.000000
epoch 91: 0.000001
epoch 92: 0.000000
epoch 93: 0.000001
epoch 94: 0.000001
epoch 95: 0.000001
epoch 96: 0.000002
epoch 97: 0.000001
epoch 98: 0.000000
epoch 99: 0.000000
epoch 100: 0.000000
```

val_mean_absolute_error:

```
epoch 1: 0.005391
epoch 2: 0.007372
epoch 3: 0.003483
epoch 4: 0.008712
epoch 5: 0.008041
```

epoch 6: 0.003348
epoch 7: 0.003276
epoch 8: 0.004084
epoch 9: 0.002097
epoch 10: 0.003859
epoch 11: 0.003220
epoch 12: 0.002543
epoch 13: 0.002411
epoch 14: 0.002674
epoch 15: 0.003028
epoch 16: 0.001473
epoch 17: 0.002439
epoch 18: 0.001190
epoch 19: 0.002887
epoch 20: 0.001705
epoch 21: 0.004819
epoch 22: 0.002410
epoch 23: 0.001646
epoch 24: 0.000896
epoch 25: 0.001102
epoch 26: 0.001451
epoch 27: 0.000792
epoch 28: 0.001483
epoch 29: 0.000825
epoch 30: 0.000754
epoch 31: 0.000786
epoch 32: 0.001274
epoch 33: 0.001086
epoch 34: 0.001347
epoch 35: 0.001371
epoch 36: 0.001128
epoch 37: 0.001586
epoch 38: 0.001743
epoch 39: 0.001155
epoch 40: 0.002056
epoch 41: 0.001059
epoch 42: 0.000768
epoch 43: 0.000661
epoch 44: 0.000904
epoch 45: 0.000780
epoch 46: 0.000868
epoch 47: 0.000779
epoch 48: 0.000796
epoch 49: 0.000408
epoch 50: 0.000506
epoch 51: 0.000456
epoch 52: 0.000555
epoch 53: 0.001189
epoch 54: 0.001058
epoch 55: 0.000455
epoch 56: 0.001952
epoch 57: 0.001936
epoch 58: 0.001343
epoch 59: 0.000484
epoch 60: 0.000645
epoch 61: 0.000735
epoch 62: 0.000582


```

epoch 63: 0.000980
epoch 64: 0.000630
epoch 65: 0.000484
epoch 66: 0.001367
epoch 67: 0.000585
epoch 68: 0.001269
epoch 69: 0.001369
epoch 70: 0.000851
epoch 71: 0.000317
epoch 72: 0.000340
epoch 73: 0.001441
epoch 74: 0.001389
epoch 75: 0.000978
epoch 76: 0.000370
epoch 77: 0.000290
epoch 78: 0.000544
epoch 79: 0.001254
epoch 80: 0.000951
epoch 81: 0.000360
epoch 82: 0.000428
epoch 83: 0.000796
epoch 84: 0.000321
epoch 85: 0.000387
epoch 86: 0.000593
epoch 87: 0.000466
epoch 88: 0.000800
epoch 89: 0.001216
epoch 90: 0.000369
epoch 91: 0.000920
epoch 92: 0.000428
epoch 93: 0.000647
epoch 94: 0.000709
epoch 95: 0.000526
epoch 96: 0.001105
epoch 97: 0.000787
epoch 98: 0.000393
epoch 99: 0.000341
epoch 100: 0.000444

```

The best MAE is: 0.00028973849839530885 at epoch 77

Evaluate on test data

```

141/141 [=====] - 0s 1ms/step - loss: 2.1426e-07 - m
ean_absolute_error: 2.8974e-04

```

```

test loss, test acc: [2.1426028240512096e-07, 0.00028973849839530885]

```

Generate predictions for 3 samples

```

WARNING:tensorflow:5 out of the last 5 calls to <function Model.make_predict_
function.<locals>.predict_function at 0x7f58cd4c4840> triggered tf.function r
etracing. Tracing is expensive and the excessive number of tracings could be
due to (1) creating @tf.function repeatedly in a loop, (2) passing tensors wi
th different shapes, (3) passing Python objects instead of tensors. For (1),
please define your @tf.function outside of the loop. For (2), @tf.function ha
s experimental_relax_shapes=True option that relaxes argument shapes that can
avoid unnecessary retracing. For (3), please refer to https://www.tensorflow.
org/guide/function#controlling_retracing and https://www.tensorflow.org/api_d
ocs/python/tf/function for more details.

```

```

pred: [0.22737193]      true: 0.2268

```

pred: [0.12659088]

true: 0.1259712

pred: [0.4863432]

true: 0.486

3-Layer NN

```

In [47]: model = tf.keras.Sequential([
    tf.keras.layers.Input((15,)),
    tf.keras.layers.Dense(128, activation='relu'),
    tf.keras.layers.Dense(64, activation='relu'),
    tf.keras.layers.Dense(32, activation='relu'),
    tf.keras.layers.Dense(1)
])
model.summary()

model.compile(optimizer='adam',
              loss=tf.keras.losses.MeanSquaredError(),
              metrics=['mean_absolute_error'])

ckpt_dir = "%sckpts_3_nn/"%model_dir
if not os.path.exists(ckpt_dir):
    os.makedirs(ckpt_dir)

checkpoint_path = "%scp-{epoch:04d}.hdf5"%ckpt_dir
checkpoint_dir = os.path.dirname(checkpoint_path)
cp_callback = tf.keras.callbacks.ModelCheckpoint(filepath=checkpoint_path,
                                                  verbose=1,
                                                  save_weights_only=True,
                                                  save_freq="epoch"
                                                  )

history = model.fit(train_x, train_y, epochs=100, validation_data=(val_x, val_y),
                    callbacks=[cp_callback])
best = [-1, 1]
for k in history.history:
    print("%s:"%k)
    for i, r in enumerate(history.history[k]):
        print("epoch %d: %f"%(i+1, r))
        if k == "val_mean_absolute_error" and r < best[1]:
            best[0] = i+1
            best[1] = r
    print()
bests.update({"3_nn": {"val_MAE": best[1], "best_epoch": best[0]}})
print("The best MAE is:", best[1], "at epoch", best[0])
print()

# Evaluate the model on the test data using `evaluate`
print("Evaluate on test data")
model.load_weights("%scp-%04d.hdf5"%(ckpt_dir, best[0]))
results = model.evaluate(val_x, val_y)
print("test loss, test acc:", results)

# Generate predictions (probabilities -- the output of the last layer)
# on new data using `predict`
print("Generate predictions for 3 samples")
predictions = model.predict(val_x[:3])
for i, p in enumerate(predictions):
    print("pred:", p, "\ttrue:", val_y[i])

```

Model: "sequential_5"

Layer (type)	Output Shape	Param #
dense_14 (Dense)	(None, 128)	2048
dense_15 (Dense)	(None, 64)	8256
dense_16 (Dense)	(None, 32)	2080
dense_17 (Dense)	(None, 1)	33
Total params: 12,417		
Trainable params: 12,417		
Non-trainable params: 0		

Epoch 1/100

657/657 [=====] - 2s 3ms/step - loss: 0.0081 - mean_absolute_error: 0.0374 - val_loss: 6.6442e-05 - val_mean_absolute_error: 0.0052

Epoch 00001: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0001.hdf5

Epoch 2/100

657/657 [=====] - 1s 2ms/step - loss: 4.0737e-05 - mean_absolute_error: 0.0042 - val_loss: 2.7216e-05 - val_mean_absolute_error: 0.0036

Epoch 00002: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0002.hdf5

Epoch 3/100

657/657 [=====] - 1s 2ms/step - loss: 1.8355e-05 - mean_absolute_error: 0.0029 - val_loss: 3.0689e-05 - val_mean_absolute_error: 0.0043

Epoch 00003: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0003.hdf5

Epoch 4/100

657/657 [=====] - 1s 2ms/step - loss: 1.6154e-05 - mean_absolute_error: 0.0028 - val_loss: 3.2371e-05 - val_mean_absolute_error: 0.0042

Epoch 00004: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0004.hdf5

Epoch 5/100

657/657 [=====] - 1s 2ms/step - loss: 1.6359e-05 - mean_absolute_error: 0.0028 - val_loss: 1.2310e-05 - val_mean_absolute_error: 0.0028

Epoch 00005: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0005.hdf5

Epoch 6/100

657/657 [=====] - 1s 2ms/step - loss: 2.4995e-05 - mean_absolute_error: 0.0035 - val_loss: 1.3724e-05 - val_mean_absolute_error: 0.0029

Epoch 00006: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for

```
_AI/project/checkpoints/3_nn/cp-0006.hdf5
Epoch 7/100
657/657 [=====] - 1s 2ms/step - loss: 2.0071e-05 - m
ean_absolute_error: 0.0032 - val_loss: 1.7696e-05 - val_mean_absolute_error:
0.0033

Epoch 00007: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0007.hdf5
Epoch 8/100
657/657 [=====] - 1s 2ms/step - loss: 2.5190e-05 - m
ean_absolute_error: 0.0036 - val_loss: 3.5856e-05 - val_mean_absolute_error:
0.0050

Epoch 00008: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0008.hdf5
Epoch 9/100
657/657 [=====] - 1s 2ms/step - loss: 1.8739e-05 - m
ean_absolute_error: 0.0031 - val_loss: 2.7043e-05 - val_mean_absolute_error:
0.0039

Epoch 00009: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0009.hdf5
Epoch 10/100
657/657 [=====] - 1s 2ms/step - loss: 2.5857e-05 - m
ean_absolute_error: 0.0037 - val_loss: 7.4188e-06 - val_mean_absolute_error:
0.0021

Epoch 00010: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0010.hdf5
Epoch 11/100
657/657 [=====] - 1s 2ms/step - loss: 1.1598e-05 - m
ean_absolute_error: 0.0025 - val_loss: 1.3372e-05 - val_mean_absolute_error:
0.0027

Epoch 00011: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0011.hdf5
Epoch 12/100
657/657 [=====] - 1s 2ms/step - loss: 1.0053e-05 - m
ean_absolute_error: 0.0022 - val_loss: 6.5878e-06 - val_mean_absolute_error:
0.0019

Epoch 00012: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0012.hdf5
Epoch 13/100
657/657 [=====] - 1s 2ms/step - loss: 1.1558e-05 - m
ean_absolute_error: 0.0024 - val_loss: 5.8366e-06 - val_mean_absolute_error:
0.0017

Epoch 00013: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0013.hdf5
Epoch 14/100
657/657 [=====] - 1s 2ms/step - loss: 1.0330e-05 - m
ean_absolute_error: 0.0022 - val_loss: 2.5920e-06 - val_mean_absolute_error:
0.0011

Epoch 00014: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0014.hdf5
```

Epoch 15/100

657/657 [=====] - 1s 2ms/step - loss: 7.6462e-06 - mean_absolute_error: 0.0020 - val_loss: 5.6098e-06 - val_mean_absolute_error: 0.0019

Epoch 00015: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0015.hdf5

Epoch 16/100

657/657 [=====] - 1s 2ms/step - loss: 7.9908e-06 - mean_absolute_error: 0.0020 - val_loss: 6.4523e-06 - val_mean_absolute_error: 0.0019

Epoch 00016: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0016.hdf5

Epoch 17/100

657/657 [=====] - 1s 2ms/step - loss: 1.4442e-05 - mean_absolute_error: 0.0027 - val_loss: 1.1682e-05 - val_mean_absolute_error: 0.0030

Epoch 00017: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0017.hdf5

Epoch 18/100

657/657 [=====] - 1s 2ms/step - loss: 6.1793e-06 - mean_absolute_error: 0.0018 - val_loss: 4.0574e-06 - val_mean_absolute_error: 0.0016

Epoch 00018: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0018.hdf5

Epoch 19/100

657/657 [=====] - 1s 2ms/step - loss: 7.5476e-06 - mean_absolute_error: 0.0017 - val_loss: 2.8838e-06 - val_mean_absolute_error: 0.0012

Epoch 00019: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0019.hdf5

Epoch 20/100

657/657 [=====] - 1s 2ms/step - loss: 9.4702e-06 - mean_absolute_error: 0.0019 - val_loss: 1.2869e-06 - val_mean_absolute_error: 8.0313e-04

Epoch 00020: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0020.hdf5

Epoch 21/100

657/657 [=====] - 1s 2ms/step - loss: 3.6596e-06 - mean_absolute_error: 0.0014 - val_loss: 2.9703e-06 - val_mean_absolute_error: 0.0012

Epoch 00021: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0021.hdf5

Epoch 22/100

657/657 [=====] - 1s 2ms/step - loss: 3.1146e-06 - mean_absolute_error: 0.0013 - val_loss: 4.5182e-06 - val_mean_absolute_error: 0.0016

Epoch 00022: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0022.hdf5

Epoch 23/100

657/657 [=====] - 1s 2ms/step - loss: 5.7134e-06 - mean_absolute_error: 0.0017 - val_loss: 4.9059e-06 - val_mean_absolute_error: 0.0017

Epoch 00023: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0023.hdf5

Epoch 24/100

657/657 [=====] - 1s 2ms/step - loss: 6.7273e-06 - mean_absolute_error: 0.0018 - val_loss: 2.4250e-05 - val_mean_absolute_error: 0.0042

Epoch 00024: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0024.hdf5

Epoch 25/100

657/657 [=====] - 1s 2ms/step - loss: 7.6767e-06 - mean_absolute_error: 0.0018 - val_loss: 1.5206e-06 - val_mean_absolute_error: 9.0189e-04

Epoch 00025: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0025.hdf5

Epoch 26/100

657/657 [=====] - 1s 2ms/step - loss: 3.8841e-06 - mean_absolute_error: 0.0013 - val_loss: 4.3521e-06 - val_mean_absolute_error: 0.0018

Epoch 00026: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0026.hdf5

Epoch 27/100

657/657 [=====] - 1s 2ms/step - loss: 2.8619e-06 - mean_absolute_error: 0.0012 - val_loss: 2.1420e-06 - val_mean_absolute_error: 0.0011

Epoch 00027: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0027.hdf5

Epoch 28/100

657/657 [=====] - 1s 2ms/step - loss: 4.0119e-06 - mean_absolute_error: 0.0013 - val_loss: 1.7980e-06 - val_mean_absolute_error: 0.0010

Epoch 00028: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0028.hdf5

Epoch 29/100

657/657 [=====] - 1s 2ms/step - loss: 2.4837e-06 - mean_absolute_error: 0.0011 - val_loss: 2.4962e-06 - val_mean_absolute_error: 0.0013

Epoch 00029: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0029.hdf5

Epoch 30/100

657/657 [=====] - 1s 2ms/step - loss: 1.7799e-06 - mean_absolute_error: 9.5177e-04 - val_loss: 7.3035e-07 - val_mean_absolute_error: 6.0701e-04

Epoch 00030: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0030.hdf5

Epoch 31/100

657/657 [=====] - 1s 2ms/step - loss: 2.3936e-06 - m

ean_absolute_error: 9.8559e-04 - val_loss: 2.5073e-06 - val_mean_absolute_err
or: 0.0011

Epoch 00031: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0031.hdf5

Epoch 32/100

657/657 [=====] - 1s 2ms/step - loss: 1.9039e-06 - m
ean_absolute_error: 9.5128e-04 - val_loss: 5.5545e-07 - val_mean_absolute_err
or: 5.1423e-04

Epoch 00032: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0032.hdf5

Epoch 33/100

657/657 [=====] - 1s 2ms/step - loss: 1.0956e-06 - m
ean_absolute_error: 7.4619e-04 - val_loss: 2.7814e-06 - val_mean_absolute_err
or: 0.0011

Epoch 00033: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0033.hdf5

Epoch 34/100

657/657 [=====] - 1s 2ms/step - loss: 3.8029e-06 - m
ean_absolute_error: 0.0013 - val_loss: 1.8019e-06 - val_mean_absolute_error:
9.0759e-04

Epoch 00034: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0034.hdf5

Epoch 35/100

657/657 [=====] - 1s 2ms/step - loss: 2.0621e-06 - m
ean_absolute_error: 0.0010 - val_loss: 2.9917e-06 - val_mean_absolute_error:
0.0014

Epoch 00035: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0035.hdf5

Epoch 36/100

657/657 [=====] - 1s 2ms/step - loss: 2.0080e-06 - m
ean_absolute_error: 9.9669e-04 - val_loss: 1.9394e-06 - val_mean_absolute_err
or: 7.8525e-04

Epoch 00036: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0036.hdf5

Epoch 37/100

657/657 [=====] - 1s 2ms/step - loss: 2.4915e-06 - m
ean_absolute_error: 0.0010 - val_loss: 2.9356e-06 - val_mean_absolute_error:
0.0014

Epoch 00037: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0037.hdf5

Epoch 38/100

657/657 [=====] - 1s 2ms/step - loss: 3.7951e-06 - m
ean_absolute_error: 0.0013 - val_loss: 6.4154e-07 - val_mean_absolute_error:
5.4806e-04

Epoch 00038: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for
_AI/project/checkpoints/3_nn/cp-0038.hdf5

Epoch 39/100

657/657 [=====] - 1s 2ms/step - loss: 1.5126e-06 - m
ean_absolute_error: 7.5041e-04 - val_loss: 1.4990e-06 - val_mean_absolute_err

or: 9.2496e-04

Epoch 00039: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0039.hdf5

Epoch 40/100

657/657 [=====] - 1s 2ms/step - loss: 1.7947e-06 - mean_absolute_error: 9.3719e-04 - val_loss: 5.9599e-07 - val_mean_absolute_error: 5.2705e-04

Epoch 00040: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0040.hdf5

Epoch 41/100

657/657 [=====] - 1s 2ms/step - loss: 1.6490e-06 - mean_absolute_error: 8.4558e-04 - val_loss: 7.4710e-07 - val_mean_absolute_error: 6.2288e-04

Epoch 00041: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0041.hdf5

Epoch 42/100

657/657 [=====] - 1s 2ms/step - loss: 6.6118e-07 - mean_absolute_error: 5.6899e-04 - val_loss: 8.5261e-07 - val_mean_absolute_error: 6.3056e-04

Epoch 00042: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0042.hdf5

Epoch 43/100

657/657 [=====] - 1s 2ms/step - loss: 2.2712e-06 - mean_absolute_error: 9.3262e-04 - val_loss: 1.1497e-06 - val_mean_absolute_error: 7.8902e-04

Epoch 00043: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0043.hdf5

Epoch 44/100

657/657 [=====] - 1s 2ms/step - loss: 1.3223e-06 - mean_absolute_error: 8.1986e-04 - val_loss: 7.4758e-06 - val_mean_absolute_error: 0.0021

Epoch 00044: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0044.hdf5

Epoch 45/100

657/657 [=====] - 1s 2ms/step - loss: 1.3543e-06 - mean_absolute_error: 7.8984e-04 - val_loss: 7.7299e-07 - val_mean_absolute_error: 5.6840e-04

Epoch 00045: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0045.hdf5

Epoch 46/100

657/657 [=====] - 1s 2ms/step - loss: 1.0975e-06 - mean_absolute_error: 7.5039e-04 - val_loss: 9.4004e-07 - val_mean_absolute_error: 6.5709e-04

Epoch 00046: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0046.hdf5

Epoch 47/100

657/657 [=====] - 1s 2ms/step - loss: 2.2103e-06 - mean_absolute_error: 0.0010 - val_loss: 4.0995e-06 - val_mean_absolute_error: 0.0016

Epoch 00047: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0047.hdf5

Epoch 48/100

657/657 [=====] - 1s 2ms/step - loss: 2.6533e-06 - mean_absolute_error: 0.0011 - val_loss: 2.3929e-07 - val_mean_absolute_error: 3.2129e-04

Epoch 00048: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0048.hdf5

Epoch 49/100

657/657 [=====] - 1s 2ms/step - loss: 4.7928e-07 - mean_absolute_error: 4.8435e-04 - val_loss: 9.5475e-07 - val_mean_absolute_error: 7.1700e-04

Epoch 00049: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0049.hdf5

Epoch 50/100

657/657 [=====] - 1s 2ms/step - loss: 1.1158e-06 - mean_absolute_error: 7.1327e-04 - val_loss: 1.0062e-05 - val_mean_absolute_error: 0.0027

Epoch 00050: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0050.hdf5

Epoch 51/100

657/657 [=====] - 1s 2ms/step - loss: 3.1701e-06 - mean_absolute_error: 0.0012 - val_loss: 3.2834e-07 - val_mean_absolute_error: 3.9914e-04

Epoch 00051: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0051.hdf5

Epoch 52/100

657/657 [=====] - 1s 2ms/step - loss: 7.3039e-07 - mean_absolute_error: 5.5058e-04 - val_loss: 7.6917e-07 - val_mean_absolute_error: 6.2916e-04

Epoch 00052: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0052.hdf5

Epoch 53/100

657/657 [=====] - 1s 2ms/step - loss: 9.5882e-07 - mean_absolute_error: 6.4066e-04 - val_loss: 1.1271e-06 - val_mean_absolute_error: 8.6426e-04

Epoch 00053: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0053.hdf5

Epoch 54/100

657/657 [=====] - 1s 2ms/step - loss: 7.8591e-07 - mean_absolute_error: 6.4480e-04 - val_loss: 5.1397e-06 - val_mean_absolute_error: 0.0017

Epoch 00054: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0054.hdf5

Epoch 55/100

657/657 [=====] - 1s 2ms/step - loss: 2.2115e-06 - mean_absolute_error: 0.0011 - val_loss: 7.1711e-07 - val_mean_absolute_error: 5.4990e-04

Epoch 00055: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0055.hdf5

Epoch 56/100

657/657 [=====] - 1s 2ms/step - loss: 1.0926e-06 - mean_absolute_error: 6.7689e-04 - val_loss: 3.7123e-07 - val_mean_absolute_error: 3.9111e-04

Epoch 00056: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0056.hdf5

Epoch 57/100

657/657 [=====] - 1s 2ms/step - loss: 8.4865e-07 - mean_absolute_error: 6.0884e-04 - val_loss: 5.5257e-06 - val_mean_absolute_error: 0.0022

Epoch 00057: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0057.hdf5

Epoch 58/100

657/657 [=====] - 1s 2ms/step - loss: 1.3750e-06 - mean_absolute_error: 8.1084e-04 - val_loss: 5.3532e-07 - val_mean_absolute_error: 3.8451e-04

Epoch 00058: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0058.hdf5

Epoch 59/100

657/657 [=====] - 1s 2ms/step - loss: 2.5250e-06 - mean_absolute_error: 0.0010 - val_loss: 1.8959e-07 - val_mean_absolute_error: 2.4752e-04

Epoch 00059: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0059.hdf5

Epoch 60/100

657/657 [=====] - 1s 2ms/step - loss: 6.1449e-07 - mean_absolute_error: 4.5677e-04 - val_loss: 2.9048e-07 - val_mean_absolute_error: 3.7076e-04

Epoch 00060: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0060.hdf5

Epoch 61/100

657/657 [=====] - 1s 2ms/step - loss: 6.3677e-07 - mean_absolute_error: 4.9537e-04 - val_loss: 7.3493e-07 - val_mean_absolute_error: 6.9934e-04

Epoch 00061: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0061.hdf5

Epoch 62/100

657/657 [=====] - 1s 2ms/step - loss: 5.4117e-07 - mean_absolute_error: 5.1615e-04 - val_loss: 2.3738e-07 - val_mean_absolute_error: 3.0360e-04

Epoch 00062: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0062.hdf5

Epoch 63/100

657/657 [=====] - 1s 2ms/step - loss: 7.4702e-07 - mean_absolute_error: 5.7625e-04 - val_loss: 2.7413e-07 - val_mean_absolute_error: 3.4083e-04

Epoch 00063: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for

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_AI/project/checkpoints/3_nn/cp-0063.hdf5
Epoch 64/100
657/657 [=====] - 1s 2ms/step - loss: 1.2091e-06 - mean_absolute_error: 7.4043e-04 - val_loss: 3.5227e-06 - val_mean_absolute_error: 0.0017

Epoch 00064: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0064.hdf5
Epoch 65/100
657/657 [=====] - 1s 2ms/step - loss: 2.5620e-06 - mean_absolute_error: 0.0010 - val_loss: 2.8166e-06 - val_mean_absolute_error: 0.0014

Epoch 00065: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0065.hdf5
Epoch 66/100
657/657 [=====] - 1s 2ms/step - loss: 1.4127e-06 - mean_absolute_error: 7.7588e-04 - val_loss: 6.5344e-07 - val_mean_absolute_error: 5.2599e-04

Epoch 00066: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0066.hdf5
Epoch 67/100
657/657 [=====] - 1s 2ms/step - loss: 2.0473e-06 - mean_absolute_error: 9.1070e-04 - val_loss: 3.8762e-07 - val_mean_absolute_error: 4.9800e-04

Epoch 00067: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0067.hdf5
Epoch 68/100
657/657 [=====] - 1s 2ms/step - loss: 6.0039e-07 - mean_absolute_error: 5.0392e-04 - val_loss: 6.3507e-07 - val_mean_absolute_error: 6.2905e-04

Epoch 00068: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0068.hdf5
Epoch 69/100
657/657 [=====] - 1s 2ms/step - loss: 1.0045e-06 - mean_absolute_error: 6.3279e-04 - val_loss: 2.4641e-07 - val_mean_absolute_error: 3.4491e-04

Epoch 00069: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0069.hdf5
Epoch 70/100
657/657 [=====] - 1s 2ms/step - loss: 7.9994e-07 - mean_absolute_error: 5.7209e-04 - val_loss: 1.0215e-06 - val_mean_absolute_error: 7.8662e-04

Epoch 00070: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0070.hdf5
Epoch 71/100
657/657 [=====] - 1s 2ms/step - loss: 6.6407e-07 - mean_absolute_error: 5.3606e-04 - val_loss: 3.7431e-06 - val_mean_absolute_error: 0.0015

Epoch 00071: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0071.hdf5
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Epoch 72/100

657/657 [=====] - 1s 2ms/step - loss: 9.4032e-07 - mean_absolute_error: 6.5656e-04 - val_loss: 1.4479e-07 - val_mean_absolute_error: 2.3896e-04

Epoch 00072: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0072.hdf5

Epoch 73/100

657/657 [=====] - 1s 2ms/step - loss: 1.9052e-06 - mean_absolute_error: 8.5797e-04 - val_loss: 4.7675e-07 - val_mean_absolute_error: 4.2963e-04

Epoch 00073: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0073.hdf5

Epoch 74/100

657/657 [=====] - 1s 2ms/step - loss: 8.7902e-07 - mean_absolute_error: 5.9194e-04 - val_loss: 3.9122e-06 - val_mean_absolute_error: 0.0014

Epoch 00074: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0074.hdf5

Epoch 75/100

657/657 [=====] - 1s 2ms/step - loss: 9.2162e-07 - mean_absolute_error: 6.3163e-04 - val_loss: 2.1860e-07 - val_mean_absolute_error: 3.2180e-04

Epoch 00075: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0075.hdf5

Epoch 76/100

657/657 [=====] - 1s 2ms/step - loss: 5.0685e-07 - mean_absolute_error: 4.4753e-04 - val_loss: 3.9246e-07 - val_mean_absolute_error: 4.1944e-04

Epoch 00076: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0076.hdf5

Epoch 77/100

657/657 [=====] - 1s 2ms/step - loss: 4.0552e-07 - mean_absolute_error: 4.5904e-04 - val_loss: 5.8380e-07 - val_mean_absolute_error: 5.0259e-04

Epoch 00077: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0077.hdf5

Epoch 78/100

657/657 [=====] - 1s 2ms/step - loss: 1.1525e-06 - mean_absolute_error: 6.9899e-04 - val_loss: 4.4193e-07 - val_mean_absolute_error: 4.4350e-04

Epoch 00078: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0078.hdf5

Epoch 79/100

657/657 [=====] - 1s 2ms/step - loss: 9.9726e-07 - mean_absolute_error: 6.5786e-04 - val_loss: 2.8073e-07 - val_mean_absolute_error: 3.7604e-04

Epoch 00079: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0079.hdf5

Epoch 80/100

657/657 [=====] - 1s 2ms/step - loss: 6.5250e-07 - mean_absolute_error: 4.6866e-04 - val_loss: 2.1198e-07 - val_mean_absolute_error: 3.3855e-04

Epoch 00080: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0080.hdf5

Epoch 81/100

657/657 [=====] - 1s 2ms/step - loss: 4.9239e-07 - mean_absolute_error: 4.6676e-04 - val_loss: 3.5729e-06 - val_mean_absolute_error: 0.0015

Epoch 00081: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0081.hdf5

Epoch 82/100

657/657 [=====] - 1s 2ms/step - loss: 9.9173e-07 - mean_absolute_error: 7.1231e-04 - val_loss: 3.8108e-07 - val_mean_absolute_error: 4.3814e-04

Epoch 00082: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0082.hdf5

Epoch 83/100

657/657 [=====] - 1s 2ms/step - loss: 4.6409e-07 - mean_absolute_error: 4.6234e-04 - val_loss: 6.9406e-07 - val_mean_absolute_error: 6.8675e-04

Epoch 00083: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0083.hdf5

Epoch 84/100

657/657 [=====] - 1s 2ms/step - loss: 9.3305e-07 - mean_absolute_error: 6.8338e-04 - val_loss: 1.7718e-06 - val_mean_absolute_error: 9.8792e-04

Epoch 00084: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0084.hdf5

Epoch 85/100

657/657 [=====] - 1s 2ms/step - loss: 1.1475e-06 - mean_absolute_error: 7.4400e-04 - val_loss: 2.8257e-07 - val_mean_absolute_error: 4.0007e-04

Epoch 00085: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0085.hdf5

Epoch 86/100

657/657 [=====] - 1s 2ms/step - loss: 4.8039e-07 - mean_absolute_error: 4.6198e-04 - val_loss: 1.6046e-07 - val_mean_absolute_error: 3.2338e-04

Epoch 00086: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0086.hdf5

Epoch 87/100

657/657 [=====] - 1s 2ms/step - loss: 4.7856e-07 - mean_absolute_error: 4.5900e-04 - val_loss: 1.1221e-07 - val_mean_absolute_error: 2.3173e-04

Epoch 00087: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0087.hdf5

Epoch 88/100

657/657 [=====] - 1s 2ms/step - loss: 1.0315e-06 - m

ean_absolute_error: 5.7796e-04 - val_loss: 4.9484e-07 - val_mean_absolute_error: 4.9006e-04

Epoch 00088: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0088.hdf5

Epoch 89/100

657/657 [=====] - 1s 2ms/step - loss: 5.0966e-07 - mean_absolute_error: 4.4720e-04 - val_loss: 1.5328e-06 - val_mean_absolute_error: 9.7471e-04

Epoch 00089: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0089.hdf5

Epoch 90/100

657/657 [=====] - 1s 2ms/step - loss: 1.0198e-06 - mean_absolute_error: 7.0698e-04 - val_loss: 9.1683e-07 - val_mean_absolute_error: 7.1272e-04

Epoch 00090: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0090.hdf5

Epoch 91/100

657/657 [=====] - 1s 2ms/step - loss: 7.1379e-07 - mean_absolute_error: 5.2642e-04 - val_loss: 7.9025e-07 - val_mean_absolute_error: 6.5303e-04

Epoch 00091: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0091.hdf5

Epoch 92/100

657/657 [=====] - 1s 2ms/step - loss: 6.4909e-07 - mean_absolute_error: 5.1105e-04 - val_loss: 3.2833e-06 - val_mean_absolute_error: 0.0015

Epoch 00092: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0092.hdf5

Epoch 93/100

657/657 [=====] - 1s 2ms/step - loss: 9.9364e-07 - mean_absolute_error: 6.5053e-04 - val_loss: 4.6120e-07 - val_mean_absolute_error: 5.3845e-04

Epoch 00093: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0093.hdf5

Epoch 94/100

657/657 [=====] - 1s 2ms/step - loss: 6.8289e-07 - mean_absolute_error: 5.1947e-04 - val_loss: 1.9751e-07 - val_mean_absolute_error: 2.9284e-04

Epoch 00094: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0094.hdf5

Epoch 95/100

657/657 [=====] - 1s 2ms/step - loss: 7.2759e-07 - mean_absolute_error: 5.6949e-04 - val_loss: 3.5165e-06 - val_mean_absolute_error: 0.0012

Epoch 00095: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0095.hdf5

Epoch 96/100

657/657 [=====] - 1s 2ms/step - loss: 2.0103e-06 - mean_absolute_error: 9.0006e-04 - val_loss: 1.2244e-06 - val_mean_absolute_error:

or: 8.5722e-04

Epoch 00096: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0096.hdf5

Epoch 97/100

657/657 [=====] - 1s 2ms/step - loss: 4.4686e-07 - mean_absolute_error: 4.5405e-04 - val_loss: 4.1076e-07 - val_mean_absolute_error: 5.1533e-04

Epoch 00097: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0097.hdf5

Epoch 98/100

657/657 [=====] - 1s 2ms/step - loss: 8.1569e-07 - mean_absolute_error: 5.6911e-04 - val_loss: 2.7634e-07 - val_mean_absolute_error: 3.5438e-04

Epoch 00098: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0098.hdf5

Epoch 99/100

657/657 [=====] - 1s 2ms/step - loss: 1.3452e-06 - mean_absolute_error: 7.2892e-04 - val_loss: 2.1710e-07 - val_mean_absolute_error: 3.1529e-04

Epoch 00099: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0099.hdf5

Epoch 100/100

657/657 [=====] - 1s 2ms/step - loss: 5.8157e-07 - mean_absolute_error: 5.1272e-04 - val_loss: 6.8012e-07 - val_mean_absolute_error: 5.8574e-04

Epoch 00100: saving model to drive/MyDrive/Classes/CSCE_5214_Software_Dev_for_AI/project/checkpoints/3_nn/cp-0100.hdf5

loss:

epoch 1: 0.001629
epoch 2: 0.000032
epoch 3: 0.000016
epoch 4: 0.000015
epoch 5: 0.000018
epoch 6: 0.000017
epoch 7: 0.000021
epoch 8: 0.000017
epoch 9: 0.000021
epoch 10: 0.000017
epoch 11: 0.000015
epoch 12: 0.000012
epoch 13: 0.000015
epoch 14: 0.000007
epoch 15: 0.000007
epoch 16: 0.000008
epoch 17: 0.000009
epoch 18: 0.000004
epoch 19: 0.000009
epoch 20: 0.000005
epoch 21: 0.000004
epoch 22: 0.000004
epoch 23: 0.000005
epoch 24: 0.000006

epoch 25: 0.000004
epoch 26: 0.000004
epoch 27: 0.000003
epoch 28: 0.000003
epoch 29: 0.000005
epoch 30: 0.000002
epoch 31: 0.000003
epoch 32: 0.000002
epoch 33: 0.000002
epoch 34: 0.000003
epoch 35: 0.000002
epoch 36: 0.000002
epoch 37: 0.000003
epoch 38: 0.000003
epoch 39: 0.000002
epoch 40: 0.000002
epoch 41: 0.000003
epoch 42: 0.000001
epoch 43: 0.000002
epoch 44: 0.000003
epoch 45: 0.000001
epoch 46: 0.000001
epoch 47: 0.000002
epoch 48: 0.000002
epoch 49: 0.000001
epoch 50: 0.000002
epoch 51: 0.000002
epoch 52: 0.000001
epoch 53: 0.000001
epoch 54: 0.000002
epoch 55: 0.000002
epoch 56: 0.000001
epoch 57: 0.000001
epoch 58: 0.000001
epoch 59: 0.000002
epoch 60: 0.000001
epoch 61: 0.000001
epoch 62: 0.000001
epoch 63: 0.000001
epoch 64: 0.000002
epoch 65: 0.000001
epoch 66: 0.000001
epoch 67: 0.000002
epoch 68: 0.000001
epoch 69: 0.000002
epoch 70: 0.000001
epoch 71: 0.000001
epoch 72: 0.000001
epoch 73: 0.000001
epoch 74: 0.000001
epoch 75: 0.000001
epoch 76: 0.000001
epoch 77: 0.000000
epoch 78: 0.000001
epoch 79: 0.000001
epoch 80: 0.000001
epoch 81: 0.000001

```
epoch 82: 0.000001
epoch 83: 0.000000
epoch 84: 0.000001
epoch 85: 0.000001
epoch 86: 0.000000
epoch 87: 0.000001
epoch 88: 0.000002
epoch 89: 0.000001
epoch 90: 0.000001
epoch 91: 0.000001
epoch 92: 0.000001
epoch 93: 0.000001
epoch 94: 0.000001
epoch 95: 0.000001
epoch 96: 0.000002
epoch 97: 0.000000
epoch 98: 0.000001
epoch 99: 0.000001
epoch 100: 0.000001
```

mean_absolute_error:

```
epoch 1: 0.014608
epoch 2: 0.003701
epoch 3: 0.002682
epoch 4: 0.002720
epoch 5: 0.003002
epoch 6: 0.002872
epoch 7: 0.003311
epoch 8: 0.002979
epoch 9: 0.003242
epoch 10: 0.002956
epoch 11: 0.002862
epoch 12: 0.002487
epoch 13: 0.002733
epoch 14: 0.001880
epoch 15: 0.001931
epoch 16: 0.002055
epoch 17: 0.002091
epoch 18: 0.001440
epoch 19: 0.001902
epoch 20: 0.001438
epoch 21: 0.001361
epoch 22: 0.001373
epoch 23: 0.001635
epoch 24: 0.001498
epoch 25: 0.001297
epoch 26: 0.001362
epoch 27: 0.001149
epoch 28: 0.001232
epoch 29: 0.001358
epoch 30: 0.000872
epoch 31: 0.001198
epoch 32: 0.001029
epoch 33: 0.000951
epoch 34: 0.001049
epoch 35: 0.001043
epoch 36: 0.000971
```

epoch 37: 0.001150
epoch 38: 0.001099
epoch 39: 0.000892
epoch 40: 0.000878
epoch 41: 0.001063
epoch 42: 0.000692
epoch 43: 0.000754
epoch 44: 0.001139
epoch 45: 0.000641
epoch 46: 0.000812
epoch 47: 0.000980
epoch 48: 0.000789
epoch 49: 0.000632
epoch 50: 0.000923
epoch 51: 0.000825
epoch 52: 0.000680
epoch 53: 0.000739
epoch 54: 0.000772
epoch 55: 0.000959
epoch 56: 0.000635
epoch 57: 0.000746
epoch 58: 0.000811
epoch 59: 0.000831
epoch 60: 0.000645
epoch 61: 0.000576
epoch 62: 0.000554
epoch 63: 0.000551
epoch 64: 0.000882
epoch 65: 0.000744
epoch 66: 0.000537
epoch 67: 0.000901
epoch 68: 0.000529
epoch 69: 0.000744
epoch 70: 0.000498
epoch 71: 0.000745
epoch 72: 0.000528
epoch 73: 0.000759
epoch 74: 0.000657
epoch 75: 0.000647
epoch 76: 0.000661
epoch 77: 0.000421
epoch 78: 0.000716
epoch 79: 0.000522
epoch 80: 0.000536
epoch 81: 0.000568
epoch 82: 0.000636
epoch 83: 0.000471
epoch 84: 0.000796
epoch 85: 0.000632
epoch 86: 0.000365
epoch 87: 0.000548
epoch 88: 0.000757
epoch 89: 0.000574
epoch 90: 0.000688
epoch 91: 0.000498
epoch 92: 0.000584
epoch 93: 0.000714

```
epoch 94: 0.000564  
epoch 95: 0.000532  
epoch 96: 0.000810  
epoch 97: 0.000441  
epoch 98: 0.000573  
epoch 99: 0.000600  
epoch 100: 0.000572
```

```
val_loss:
```

```
epoch 1: 0.000066  
epoch 2: 0.000027  
epoch 3: 0.000031  
epoch 4: 0.000032  
epoch 5: 0.000012  
epoch 6: 0.000014  
epoch 7: 0.000018  
epoch 8: 0.000036  
epoch 9: 0.000027  
epoch 10: 0.000007  
epoch 11: 0.000013  
epoch 12: 0.000007  
epoch 13: 0.000006  
epoch 14: 0.000003  
epoch 15: 0.000006  
epoch 16: 0.000006  
epoch 17: 0.000012  
epoch 18: 0.000004  
epoch 19: 0.000003  
epoch 20: 0.000001  
epoch 21: 0.000003  
epoch 22: 0.000005  
epoch 23: 0.000005  
epoch 24: 0.000024  
epoch 25: 0.000002  
epoch 26: 0.000004  
epoch 27: 0.000002  
epoch 28: 0.000002  
epoch 29: 0.000002  
epoch 30: 0.000001  
epoch 31: 0.000003  
epoch 32: 0.000001  
epoch 33: 0.000003  
epoch 34: 0.000002  
epoch 35: 0.000003  
epoch 36: 0.000002  
epoch 37: 0.000003  
epoch 38: 0.000001  
epoch 39: 0.000001  
epoch 40: 0.000001  
epoch 41: 0.000001  
epoch 42: 0.000001  
epoch 43: 0.000001  
epoch 44: 0.000007  
epoch 45: 0.000001  
epoch 46: 0.000001  
epoch 47: 0.000004  
epoch 48: 0.000000
```

```
epoch 49: 0.000001
epoch 50: 0.000010
epoch 51: 0.000000
epoch 52: 0.000001
epoch 53: 0.000001
epoch 54: 0.000005
epoch 55: 0.000001
epoch 56: 0.000000
epoch 57: 0.000006
epoch 58: 0.000001
epoch 59: 0.000000
epoch 60: 0.000000
epoch 61: 0.000001
epoch 62: 0.000000
epoch 63: 0.000000
epoch 64: 0.000004
epoch 65: 0.000003
epoch 66: 0.000001
epoch 67: 0.000000
epoch 68: 0.000001
epoch 69: 0.000000
epoch 70: 0.000001
epoch 71: 0.000004
epoch 72: 0.000000
epoch 73: 0.000000
epoch 74: 0.000004
epoch 75: 0.000000
epoch 76: 0.000000
epoch 77: 0.000001
epoch 78: 0.000000
epoch 79: 0.000000
epoch 80: 0.000000
epoch 81: 0.000004
epoch 82: 0.000000
epoch 83: 0.000001
epoch 84: 0.000002
epoch 85: 0.000000
epoch 86: 0.000000
epoch 87: 0.000000
epoch 88: 0.000000
epoch 89: 0.000002
epoch 90: 0.000001
epoch 91: 0.000001
epoch 92: 0.000003
epoch 93: 0.000000
epoch 94: 0.000000
epoch 95: 0.000004
epoch 96: 0.000001
epoch 97: 0.000000
epoch 98: 0.000000
epoch 99: 0.000000
epoch 100: 0.000001
```

```
val_mean_absolute_error:
epoch 1: 0.005187
epoch 2: 0.003624
epoch 3: 0.004272
```

epoch 4: 0.004190
epoch 5: 0.002793
epoch 6: 0.002924
epoch 7: 0.003327
epoch 8: 0.004970
epoch 9: 0.003883
epoch 10: 0.002096
epoch 11: 0.002664
epoch 12: 0.001948
epoch 13: 0.001674
epoch 14: 0.001132
epoch 15: 0.001892
epoch 16: 0.001941
epoch 17: 0.002969
epoch 18: 0.001601
epoch 19: 0.001248
epoch 20: 0.000803
epoch 21: 0.001247
epoch 22: 0.001563
epoch 23: 0.001697
epoch 24: 0.004239
epoch 25: 0.000902
epoch 26: 0.001848
epoch 27: 0.001063
epoch 28: 0.001021
epoch 29: 0.001318
epoch 30: 0.000607
epoch 31: 0.001064
epoch 32: 0.000514
epoch 33: 0.001127
epoch 34: 0.000908
epoch 35: 0.001393
epoch 36: 0.000785
epoch 37: 0.001384
epoch 38: 0.000548
epoch 39: 0.000925
epoch 40: 0.000527
epoch 41: 0.000623
epoch 42: 0.000631
epoch 43: 0.000789
epoch 44: 0.002128
epoch 45: 0.000568
epoch 46: 0.000657
epoch 47: 0.001624
epoch 48: 0.000321
epoch 49: 0.000717
epoch 50: 0.002653
epoch 51: 0.000399
epoch 52: 0.000629
epoch 53: 0.000864
epoch 54: 0.001693
epoch 55: 0.000550
epoch 56: 0.000391
epoch 57: 0.002244
epoch 58: 0.000385
epoch 59: 0.000248
epoch 60: 0.000371

```
epoch 61: 0.000699
epoch 62: 0.000304
epoch 63: 0.000341
epoch 64: 0.001708
epoch 65: 0.001366
epoch 66: 0.000526
epoch 67: 0.000498
epoch 68: 0.000629
epoch 69: 0.000345
epoch 70: 0.000787
epoch 71: 0.001547
epoch 72: 0.000239
epoch 73: 0.000430
epoch 74: 0.001448
epoch 75: 0.000322
epoch 76: 0.000419
epoch 77: 0.000503
epoch 78: 0.000444
epoch 79: 0.000376
epoch 80: 0.000339
epoch 81: 0.001489
epoch 82: 0.000438
epoch 83: 0.000687
epoch 84: 0.000988
epoch 85: 0.000400
epoch 86: 0.000323
epoch 87: 0.000232
epoch 88: 0.000490
epoch 89: 0.000975
epoch 90: 0.000713
epoch 91: 0.000653
epoch 92: 0.001504
epoch 93: 0.000538
epoch 94: 0.000293
epoch 95: 0.001231
epoch 96: 0.000857
epoch 97: 0.000515
epoch 98: 0.000354
epoch 99: 0.000315
epoch 100: 0.000586
```

The best MAE is: 0.00023172648798208684 at epoch 87

Evaluate on test data

141/141 [=====] - 0s 1ms/step - loss: 1.1221e-07 - mean_absolute_error: 2.3173e-04

test loss, test acc: [1.1221093387803194e-07, 0.00023172648798208684]

Generate predictions for 3 samples

WARNING:tensorflow:6 out of the last 6 calls to <function Model.make_predict_function.<locals>.predict_function at 0x7f58cfbf1400> triggered tf.function retracing. Tracing is expensive and the excessive number of tracings could be due to (1) creating @tf.function repeatedly in a loop, (2) passing tensors with different shapes, (3) passing Python objects instead of tensors. For (1), please define your @tf.function outside of the loop. For (2), @tf.function has experimental_relax_shapes=True option that relaxes argument shapes that can avoid unnecessary retracing. For (3), please refer to https://www.tensorflow.org/guide/function#controlling_retracing and [localhost:8888/nbconvert/html/Desktop/hurricane_damage_assessment/model_trainer.ipynb?download=false](https://www.tensorflow.org/api_d</p></div><div data-bbox=)

ocs/python/tf/function for more details.

pred: [0.22801805] true: 0.2268

pred: [0.1261356] true: 0.1259712

pred: [0.48571414] true: 0.486

In [48]: bests

Out[48]: {'1_nn': {'best_epoch': 89, 'val_MAE': 0.0004903394728899002},
'2_nn': {'best_epoch': 77, 'val_MAE': 0.00028973849839530885},
'3_nn': {'best_epoch': 87, 'val_MAE': 0.00023172648798208684}}

Select Best Model

In []: