Assignment 5.3

July 7, 2021

1 3.6 Predicting house prices: a regression example

1.1 3.6.1 The Boston Housing Price dataset

[1]:
```
from tensorflow.keras.datasets import boston_housing

# Importing the data to training and testing sets
(train_data, train_targets), (test_data, test_targets) = boston_housing.
 ↪load_data()
```

[2]:
```
# Checking the shape of the data
print(train_data.shape)
print(test_data.shape)
```

```
(404, 13)
(102, 13)
```

[3]:
```
# Targets are home prices in thousands of dollars (from the 1970s)
train_targets[:3]
```

[3]:
```
array([15.2, 42.3, 50. ])
```

1.2 3.6.2 Preparing the data

[4]:
```
# Normalizing the data for the neural network
mean = train_data.mean(axis = 0)
train_data -= mean

std = train_data.std(axis = 0)
train_data /= std

test_data -= mean
test_data /= std
```

1.3 3.6.3 Building your network

[5]:
```
from keras import models, layers
```

[6]:
```
# Building a small network to prevent overfitting
def build_model():
    model = models.Sequential()
    model.add(layers.Dense(64, activation = 'relu', input_shape = (train_data.
 ↪shape[1],)))
    model.add(layers.Dense(64, activation = 'relu'))
    model.add(layers.Dense(1))
    model.compile(optimizer = 'rmsprop', loss = 'mse', metrics = ['mae'])
    return model
```

1.4 3.6.4 Validation your approach using K-folds validation

[7]:
```
import numpy as np

# Perform a test of k-fold cross validation
k = 4
num_val_samples = len(train_data) // k
num_epochs = 100
all_scores = []

for i in range(k):
    print(f'Processing Fold #{i+1}')
    val_data = train_data[i * num_val_samples: (i + 1) * num_val_samples]
    val_targets = train_targets[i * num_val_samples: (i + 1) * num_val_samples]

    partial_train_data  = np.concatenate(
        [train_data[:i * num_val_samples],
         train_data[(i + 1) * num_val_samples:]],
        axis = 0 )

    partial_train_targets  = np.concatenate(
        [train_targets[:i * num_val_samples],
         train_targets[(i + 1) * num_val_samples:]],
        axis = 0)

    model = build_model()

    model.fit(partial_train_data, partial_train_targets,
              epochs = num_epochs, batch_size = 1, verbose=False)

    val_mse, val_mae = model.evaluate(val_data, val_targets, verbose=False)

    all_scores.append(val_mae)
```

```
Processing Fold #1
Processing Fold #2
Processing Fold #3
Processing Fold #4
```

[8]:
```
all_scores
```

[8]:
```
[1.9999395608901978, 2.9141619205474854, 2.5237762928009033, 2.259720802307129]
```

[9]:
```
np.mean(all_scores)
```

[9]:
```
2.424399644136429
```

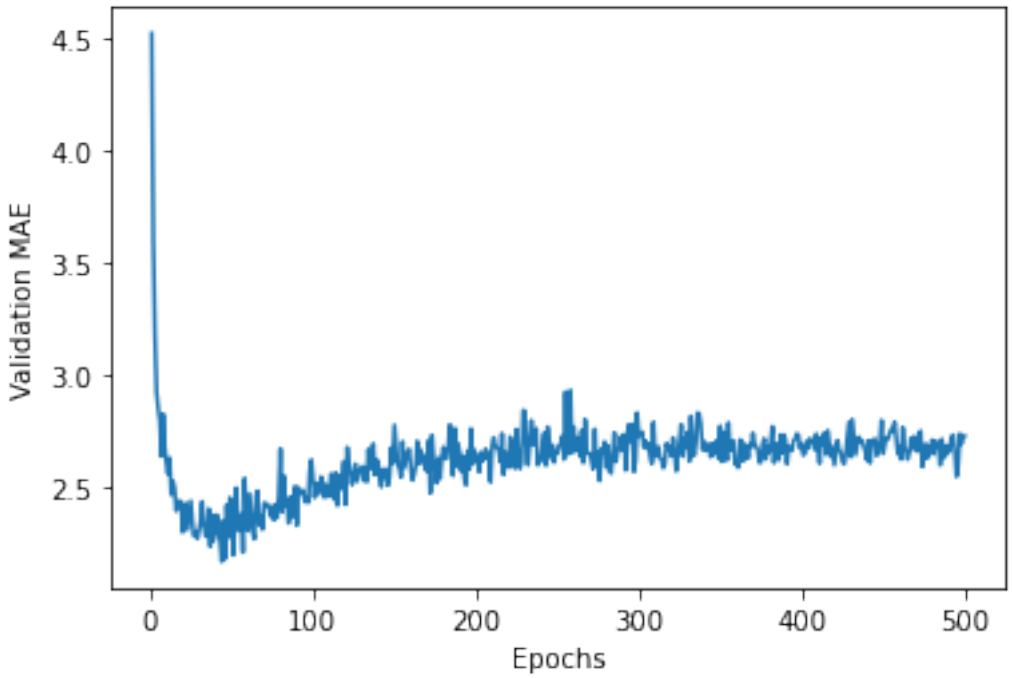
[10]:
```
# Perform a 500 epoch of k-fold cross validation
num_epochs = 500
all_mae_histories = []
for i in range(k):
    print(f'Processing Fold #{i+1}')
    val_data = train_data[i * num_val_samples: (i + 1) * num_val_samples]
    val_targets = train_targets[i * num_val_samples: (i + 1) * num_val_samples]

    partial_train_data = np.concatenate(
        [train_data[:i * num_val_samples],
         train_data[(i + 1) * num_val_samples:]],
        axis=0)

    partial_train_targets = np.concatenate(
        [train_targets[:i * num_val_samples],
         train_targets[(i + 1) * num_val_samples:]],
        axis=0)

    model = build_model()

    history = model.fit(partial_train_data,
                        partial_train_targets,
                        validation_data=(val_data,val_targets),
                        epochs=num_epochs,
                        batch_size=1,
                        verbose=0)

    mae_history = history.history['val_mae']
    all_mae_histories.append(mae_history)
```

```
Processing Fold #1
Processing Fold #2
Processing Fold #3
Processing Fold #4
```

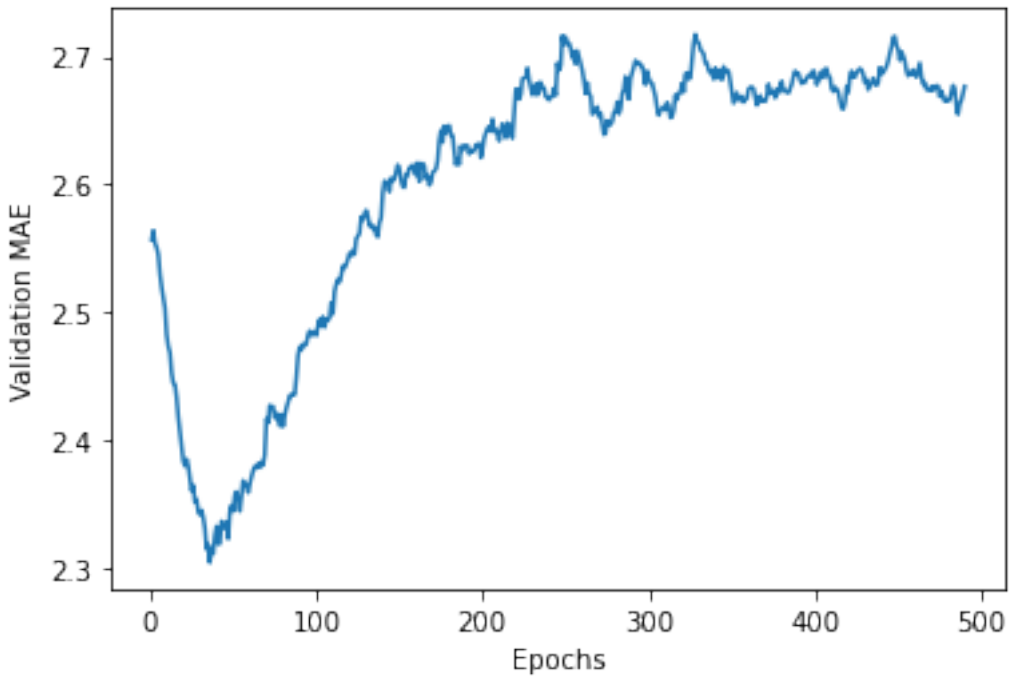
[11]:
```
average_mae_history = [np.mean([x[i] for x in all_mae_histories]) for i in␣
↪range(num_epochs)]
```

[12]:
```
import matplotlib.pyplot as plt
```

```
plt.plot(range(1, len(average_mae_history) + 1), average_mae_history)
plt.xlabel('Epochs')
plt.ylabel('Validation MAE')
plt.show()
```



[13]:
```
def smooth_curve(points, factor=0.9):
    smoothed_points = []
    for point in points:
        if smoothed_points:
            previous = smoothed_points[-1]
            smoothed_points.append(previous * factor + point * (1 - factor))
        else:
            smoothed_points.append(point)
    return smoothed_points

smooth_mae_history = smooth_curve(average_mae_history[10:])

plt.plot(range(1, len(smooth_mae_history) + 1), smooth_mae_history)
plt.xlabel('Epochs')
plt.ylabel('Validation MAE')
plt.show()
```



[14]:
```
model = build_model()
model.fit(train_data,
          train_targets,
          epochs=80,
          batch_size=16,
          verbose=0)

test_mse_score, test_mae_score = model.evaluate(test_data, test_targets)
```

```
4/4 [==============================] - 1s 4ms/step - loss: 19.2182 - mae: 2.7113
```

[15]:
```
test_mae_score
```

[15]: 2.7113044261932373