assignment5.3

December 17, 2021

```python
[1]: import keras
     keras.__version__
```

Using TensorFlow backend.

```
[1]: '2.3.1'
```

```python
[2]: from keras.datasets import boston_housing
     (train_data, train_targets), (test_data, test_targets) = boston_housing.
      ↪load_data()
```

Downloading data from https://s3.amazonaws.com/keras-datasets/boston_housing.npz
57344/57026 [==============================] - 0s 2us/step

```python
[5]: print('train data', train_data.shape)
     print('test data', test_data.shape)
```

train data (404, 13)
test data (102, 13)

```python
[6]: # Preparing the data
     mean = train_data.mean(axis=0)
     train_data -= mean
     std = train_data.std(axis=0)

     test_data -= mean
     test_data /= std
```

```python
[7]: # Building the network
     from keras import models
     from keras import layers


     def build_model():
         # Because we will need to instantiate
         # the same model multiple times,
         # we use a function to construct it.
         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
```

```
[8]: # Validating the approach using k-fold validation
     import numpy as np

     k = 4
     num_val_samples = len(train_data) // k
     num_epochs = 100
     all_scores = []
     for i in range(k):
         print('processing fold #', i)
         # Prepare the validation data: data from partition # k
         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]

         # Prepare the training data: data from all other partitions
         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)

         # Build the Keras model (already compiled)
         model = build_model()
         # Train the model (in silent mode, verbose=0)
         model.fit(partial_train_data, partial_train_targets,
                   epochs=num_epochs, batch_size=1, verbose=0)
         # Evaluate the model on the validation data
         val_mse, val_mae = model.evaluate(val_data, val_targets, verbose=0)
         all_scores.append(val_mae)
```

```
processing fold # 0
processing fold # 1
processing fold # 2
processing fold # 3
```

```
[10]: all_scores
```

```
[10]: [2.360334873199463, 2.5661630630493164, 3.131373882293701, 3.718198299407959]
```

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

```
[11]: 2.94401752948761
```

```
[12]: from keras import backend as K

      # Some memory clean-up
      K.clear_session()
```

```
[20]: num_epochs = 500
      all_mae_histories = []
      for i in range(k):
          print('processing fold #', i)
          # Prepare the validation data: data from partition # k
          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]

          # Prepare the training data: data from all other partitions
          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)

          # Build the Keras model (already compiled)
          model = build_model()
          # Train the model (in silent mode, verbose=0)
          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['mae']
          all_mae_histories.append(mae_history)
```

```
processing fold # 0
processing fold # 1
processing fold # 2
processing fold # 3
```

```
[19]: history.history
```

```
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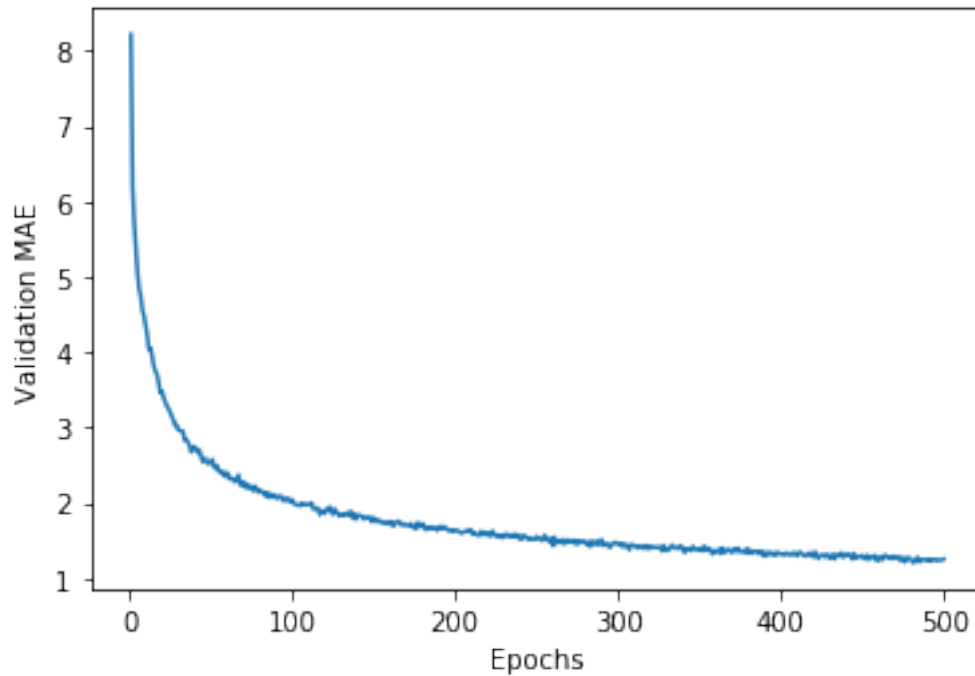1.3807398,
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```python
[21]: # Calculate the average of the per-epoch MAE scores for all folds
      average_mae_history =[np.mean([x[i] for x in all_mae_histories]) for i in␣
       ↪range(num_epochs)]
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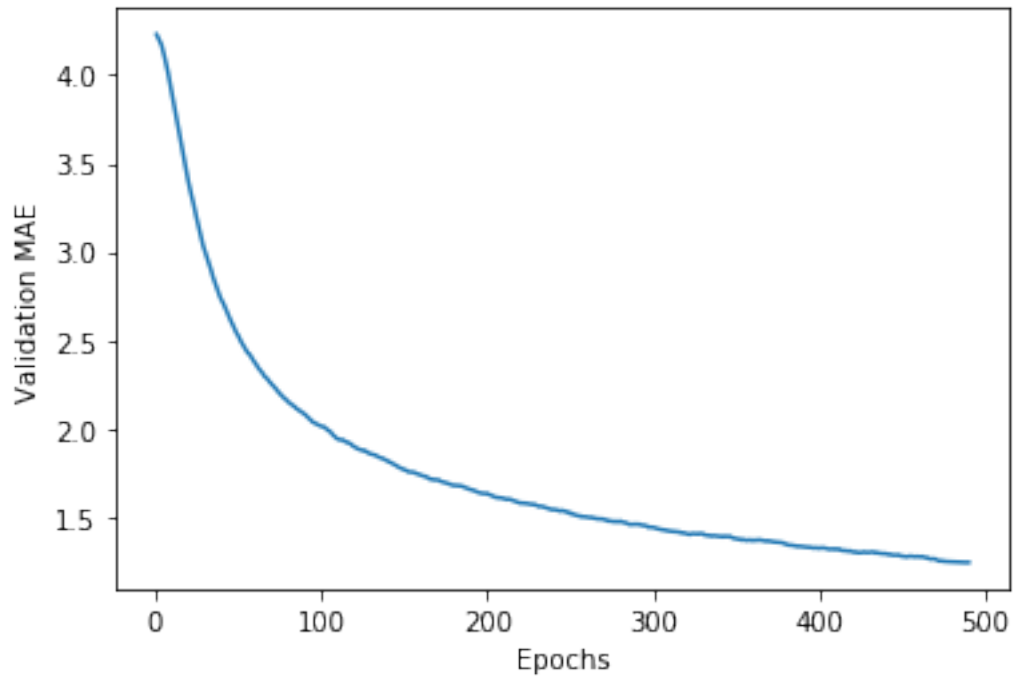
```python
[22]: import matplotlib.pyplot as plt

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

```
[23]: 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()
```

```
[24]: # Get a fresh, compiled model.
      model = build_model()
      # Train it on the entirety of the data.
      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)
```

102/102 [==============================] - 0s 147us/step

```
[25]: test_mae_score
```

[25]: 18.32109832763672