In [ ]:

```
import tensorflow as tf
import tensorflow.keras as K
from tensorflow.keras import layers
print('TensorFlow version:', tf.__version__)
print('Eager Execution Mode:', tf.executing_eagerly())
print('available GPU:', tf.config.list_physical_devices('GPU'))
from tensorflow.python.client import device_lib
print('==========================================')
print(device_lib.list_local_devices())
# tf.debugging.set_log_device_placement(False)
```

```
TensorFlow version: 2.4.0
Eager Execution Mode: True
available GPU: []
==========================================
[name: "/device:CPU:0"
device_type: "CPU"
memory_limit: 268435456
locality {
}
incarnation: 7966430930790126726
]
```

In [ ]:

```
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
```

In [ ]:

```
dataset_path = K.utils.get_file("auto-mpg.data", "http://archive.ics.uci.edu/ml/machine-learning-databases/auto-mpg/auto-mpg.data")
dataset_path
#%%
column_names = ['MPG','Cylinders','Displacement','Horsepower','Weight',
                'Acceleration', 'Model Year', 'Origin']
raw_dataset = pd.read_csv(dataset_path, names=column_names,
                      na_values = "?", comment='\t',
                      sep=" ", skipinitialspace=True)
dataset = raw_dataset.copy()
dataset.tail()
#%%
dataset = dataset.dropna()
#%%
origin = dataset.pop('Origin')

dataset['USA'] = (origin == 1)*1.0
dataset['Europe'] = (origin == 2)*1.0
dataset['Japan'] = (origin == 3)*1.0
dataset.tail()
#%%
train_dataset = dataset.sample(frac=0.8,random_state=0)
test_dataset = dataset.drop(train_dataset.index)
#%%
train_labels = train_dataset.pop('MPG')
test_labels = test_dataset.pop('MPG')
#%%
train_stats = train_dataset.describe()
train_stats = train_stats.transpose()
train_stats

def norm(x):
    return (x - train_stats['mean']) / train_stats['std']
normed_train_data = norm(train_dataset)
normed_test_data = norm(test_dataset)
```

In [ ]:

```
def build_model():
    model = tf.keras.models.Sequential([
        layers.Dense(64, activation='relu', input_shape=[len(train_dataset.keys())]),
        layers.Dense(64, activation='relu'),
        layers.Dense(1)
    ])

    optimizer = tf.keras.optimizers.RMSprop(0.001)

    model.compile(loss='mse',
                  optimizer=optimizer,
                  metrics=['mae', 'mse'])
    return model
#%%
model = build_model()
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
dense (Dense)                (None, 64)                640       
_________________________________________________________________
dense_1 (Dense)              (None, 64)                4160      
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 65        
=================================================================
Total params: 4,865
Trainable params: 4,865
Non-trainable params: 0
_________________________________________________________________
```

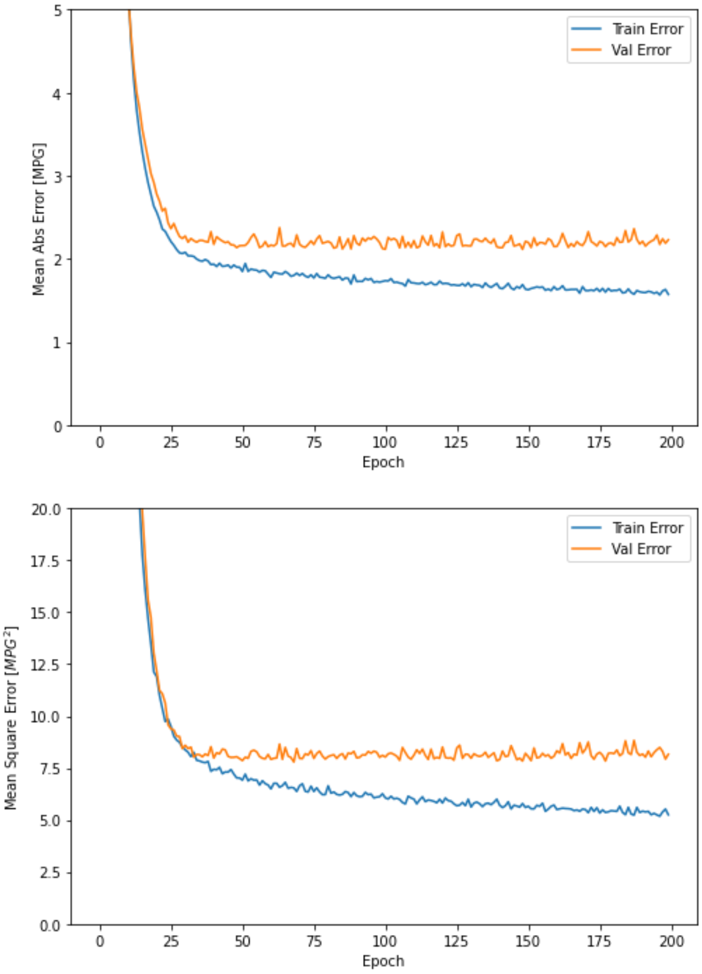
In [ ]:

```
# 에포크가 끝날 때마다 점(.)을 출력해 훈련 진행 과정을 표시합니다
class PrintDot(K.callbacks.Callback):
    def on_epoch_end(self, epoch, logs):
        if epoch % 100 == 0: print('')
        print('.', end='')

EPOCHS = 200

history = model.fit(
    normed_train_data, train_labels,
    epochs=EPOCHS, validation_split = 0.2, verbose=0,
    callbacks=[PrintDot()])
```

```
....................................................................................................
....................................................................................................
```

In [ ]:

```
def plot_history(history):
    hist = pd.DataFrame(history.history)
    hist['epoch'] = history.epoch

    plt.figure(figsize=(8,12))

    plt.subplot(2,1,1)
    plt.xlabel('Epoch')
    plt.ylabel('Mean Abs Error [MPG]')
    plt.plot(hist['epoch'], hist['mae'],
            label='Train Error')
    plt.plot(hist['epoch'], hist['val_mae'],
            label = 'Val Error')
    plt.ylim([0,5])
    plt.legend()

    plt.subplot(2,1,2)
    plt.xlabel('Epoch')
    plt.ylabel('Mean Square Error [$MPG^2$]')
    plt.plot(hist['epoch'], hist['mse'],
            label='Train Error')
    plt.plot(hist['epoch'], hist['val_mse'],
            label = 'Val Error')
    plt.ylim([0,20])
    plt.legend()
    plt.show()

plot_history(history)
```

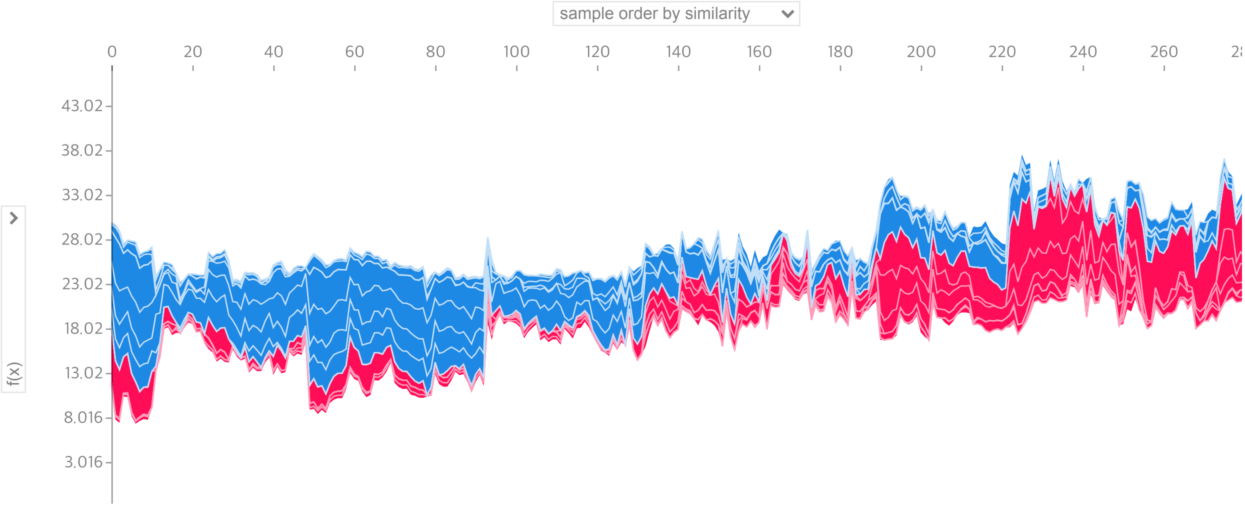


In [ ]:
```python
import shap

#initialize js methods for visualization
shap.initjs()

# create an instance of the DeepSHAP which is called DeepExplainer
explainer_shap = shap.DeepExplainer(model=model,
                                    data=np.array(normed_train_data))

# Fit the explainer on a subset of the data (you can try all but then gets slower)
shap_values = explainer_shap.shap_values(X=np.array(normed_train_data)[:500],
                                        ranked_outputs=True)
```

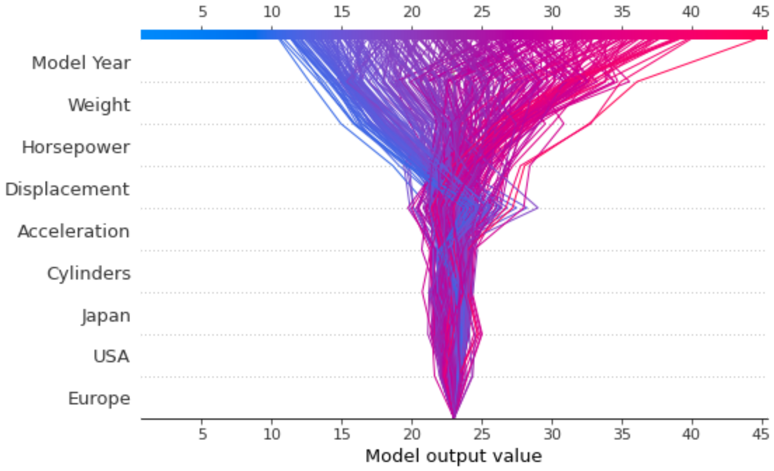
```
keras is no longer supported, please use tf.keras instead.
Your TensorFlow version is newer than 2.4.0 and so graph support has been removed in eager mode and some
static graphs may not be supported. See PR #1483 for discussion.
`tf.keras.backend.set_learning_phase` is deprecated and will be removed after 2020-10-11. To update it, s
imply pass a True/False value to the `training` argument of the `__call__` method of your layer or model.
```

In [ ]:
```python
shap.force_plot(explainer_shap.expected_value.numpy(),
                shap_values[0][0],
                feature_names=normed_train_data.columns)
```

Out[ ]:

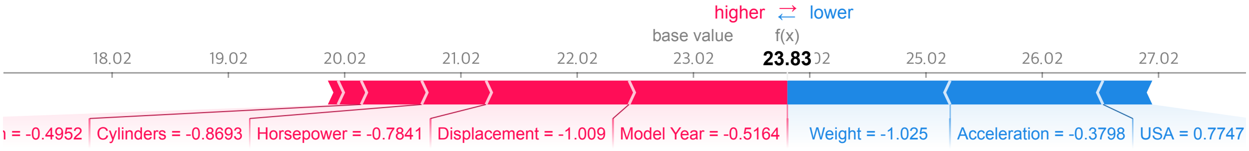


In [ ]:
```python
shap.decision_plot(explainer_shap.expected_value.numpy(),
                   shap_values[0][0],
                   np.array(normed_train_data)[:500],
                   feature_names=normed_train_data.columns.to_list())
```

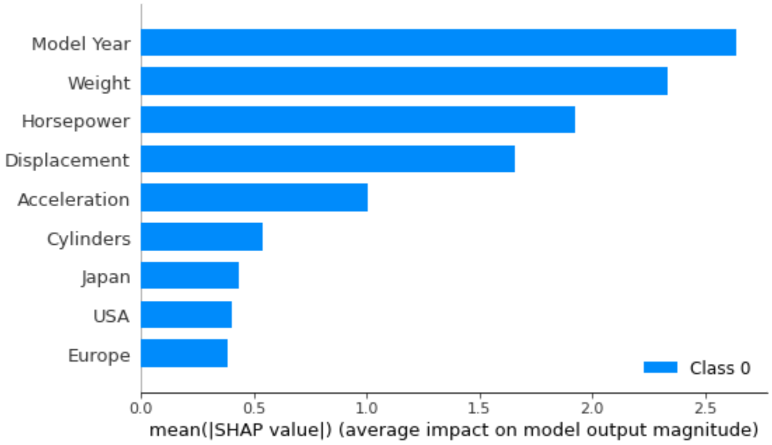


```
In [ ]: shap.force_plot(explainer_shap.expected_value.numpy(),
                        shap_values[0][0][1],
                        np.array(normed_train_data)[:500][0],
                        feature_names=normed_train_data.columns,)
```

Out[ ]:



```
In [ ]: # get the ovearall mean contribution of each feature variable
        shap.summary_plot(shap_values[0], np.array(normed_train_data)[:500], feature_names=normed_train_data.colum
        ns)
```



```
In [ ]:
```