Claude Shyaka

ID#: 801326243

Probl 3.a

In [1]:
```
import pandas as pd
import numpy as np
import torch
import torch.nn as nn
import torch.optim as optim

from sklearn.preprocessing import MinMaxScaler

# Seed for random state
seed = 42
torch.manual_seed(seed)

# Load housing dataset
housing_dataset = pd.read_csv('../../data/Housing.csv', delimiter=',')

# Prepare the dataset.

# List of variable to map to numerical values.
varlist = ['mainroad', 'guestroom', 'basement', 'hotwaterheating', 'aircondition

# Defining the map function
def binary_map(x):
    return x.map({'yes': 1, 'no': 0})

# Applying the function to the housing list
housing_dataset[varlist] = housing_dataset[varlist].apply(binary_map)

# preview the dataset
housing_dataset.head()
```

Out[1]:

	price	area	bedrooms	bathrooms	stories	mainroad	guestroom	basement	hotwaterl
0	13300000	7420	4	2	3	1	0	0	
1	12250000	8960	4	4	4	1	0	0	
2	12250000	9960	3	2	2	1	0	1	
3	12215000	7500	4	2	2	1	0	1	
4	11410000	7420	4	1	2	1	1	1	

In [2]:
```
# Extract the desired features
filter = ['area', 'bedrooms', 'bathrooms', 'stories', 'parking', 'price']

housing_filtered = housing_dataset[filter]
housing_filtered.head()
```

Out[2]:

	area	bedrooms	bathrooms	stories	parking	price
0	7420	4	2	3	2	13300000
1	8960	4	4	4	3	12250000
2	9960	3	2	2	2	12250000
3	7500	4	2	2	3	12215000
4	7420	4	1	2	2	11410000

In [3]:
```
# array of data
data = housing_filtered.values
data.shape
```

Out[3]:
```
(545, 6)
```

In [4]:
```
# Generate random indices for training and validation data.
n_samples = data.shape[0]
n_val = int(0.2 * n_samples)

shuffled_indices = torch.randperm(n_samples)

train_indices = shuffled_indices[:-n_val]
val_indices = shuffled_indices[-n_val:]

# Transform data to a tensor
torch_data = torch.tensor(data, dtype=torch.float32)

# Filter the train and val subsets from the dataset
torch_train_data = torch_data[train_indices]
torch_val_data = torch_data[val_indices]
```

In [5]:
```
# Convert train and val tensors to numpy arrays
np_train_data = torch_train_data.numpy()
np_val_data = torch_val_data.numpy()
print(np_train_data.shape)
print(np_val_data.shape)

# Normalize the train and val subsets using the MinMaxScaler
sc_nn =  MinMaxScaler()
t_n_train = torch.from_numpy(sc_nn.fit_transform(np_train_data)).float()
t_n_val = torch.from_numpy(sc_nn.transform(np_val_data)).float()
```

```
(436, 6)
(109, 6)
```

In [6]:
```
# Filter features and targets for training and validation.
t_un_train = t_n_train[:, :-1]
t_cn_train = t_n_train[:, -1].unsqueeze(1)

t_un_val = t_n_val[:, :-1]
t_cn_val = t_n_val[:, -1].unsqueeze(1)

print(t_un_train.dtype, t_un_val.dtype)
t_un_train.shape, t_cn_train.shape, t_un_val.shape, t_cn_val.shape
```

Out[6]:
```
torch.float32 torch.float32
(torch.Size([436, 5]),
 torch.Size([436, 1]),
 torch.Size([109, 5]),
 torch.Size([109, 1]))
```

In [7]:
```
from collections import OrderedDict

seq_model = nn.Sequential(OrderedDict([
    ('hidden_linear', nn.Linear(5, 8)),
    ('hidden_activation', nn.ReLU()),
    ('output_linear', nn.Linear(8, 1))
]))
```

In [8]:
```
import time

loss_train_list = []
loss_val_list = []
epochs_list = []

def training_loop(n_epochs, optimizer, model, loss_fn, t_u_train, t_u_val, t_c_t

    duration = []
    training_start_time = time.time()

    for epoch in range(1, n_epochs+1):

        t0 = time.time()

        t_p_train = model(t_u_train)
        loss_train = loss_fn(t_p_train, t_c_train)

        with torch.no_grad():
            t_p_val = model(t_u_val)
            loss_val = loss_fn(t_p_val, t_c_val)
            assert loss_val.requires_grad == False

        optimizer.zero_grad()
        loss_train.backward()
        optimizer.step()

        duration.append(time.time() - t0)

        if epoch == 1 or epoch % 50 == 0:
            print(f"Epoch {epoch}, Training loss {loss_train.item():.4f},"
                  f" Validation loss {loss_val.item():.4f}, Time(s) {np.mean(dur
            loss_train_list.append(loss_train.item())
            loss_val_list.append(loss_val.item())
            epochs_list.append(epoch)
    print(f'Training finished, took {time.time() - training_start_time:.5f} seco
```

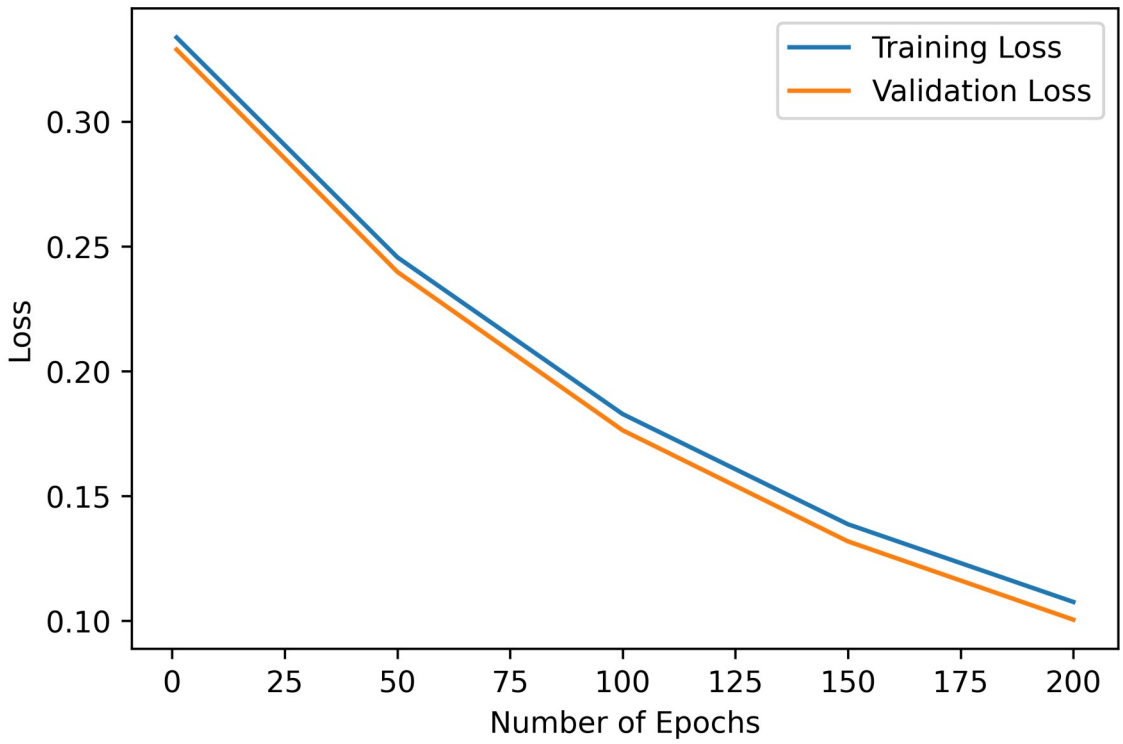
In [9]:
```
optimizer = optim.SGD(seq_model.parameters(), lr=1e-3)

training_loop(
    n_epochs = 200,
    optimizer = optimizer,
    model = seq_model,
    loss_fn = nn.MSELoss(),
    t_u_train = t_un_train,
    t_u_val = t_un_val,
    t_c_train = t_cn_train,
    t_c_val = t_cn_val)
```

```
Epoch 1, Training loss 0.3337, Validation loss 0.3288, Time(s) 0.00624
Epoch 50, Training loss 0.2457, Validation loss 0.2398, Time(s) 0.00032
Epoch 100, Training loss 0.1828, Validation loss 0.1763, Time(s) 0.00033
Epoch 150, Training loss 0.1387, Validation loss 0.1318, Time(s) 0.00032
Epoch 200, Training loss 0.1076, Validation loss 0.1005, Time(s) 0.00032
Training finished, took 0.06326 seconds
```

In [10]:
```
%matplotlib inline
import matplotlib.pyplot as plt

fig = plt.figure(dpi=600)
plt.xlabel("Number of Epochs")
plt.ylabel("Loss")
plt.plot(epochs_list, loss_train_list, label="Training Loss")
plt.plot(epochs_list, loss_val_list, label="Validation Loss")
plt.legend()
plt.savefig("nn_1_hidden_8_nodes.png", format="png")
```



In [11]:
```
model = seq_model
param_size = 0
for param in model.parameters():
    param_size += param.nelement() * param.element_size()
buffer_size = 0
for buffer in model.buffers():
    buffer_size += buffer.nelement() * buffer.element_size()

size_all_mb = (param_size + buffer_size) / 1024**2
print('model size: {:.4f}MB'.format(size_all_mb))
```

```
model size: 0.0002MB
```