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Homework 1

In [1]:

```
import torch
import imageio
import numpy as np
import pandas as pd
from matplotlib import pyplot as plt
```

Problem One

In [2]:

```
# Load all the images.
# When loading the images, the stride was using negative number. So I used np.ascontiguous
redBagImage = np.ascontiguousarray(imageio.imread("Images/RedCoughDropBag.jpg"))
blueSlidesImage = np.ascontiguousarray(imageio.imread("Images/BlueSlides.jpg"))
greenBagImage = np.ascontiguousarray(imageio.imread("Images/GreenFoodLionBag.jpg"))
blueBoxImage = np.ascontiguousarray(imageio.imread("Images/BlueMask.jpg"))
greenBookImage = np.ascontiguousarray(imageio.imread("Images/GreenTextbook.jpg"))

# Convert the images to a tensors.
redBagImage = torch.from_numpy(redBagImage)
blueSlidesImage = torch.from_numpy(blueSlidesImage)
greenBagImage = torch.from_numpy(greenBagImage)
blueBoxImage = torch.from_numpy(blueBoxImage)
greenBookImage = torch.from_numpy(greenBookImage)
```

In [3]:

```
# Converted the Data type to float in order to take the mean.
redBagImage = redBagImage.float()
blueSlidesImage = blueSlidesImage.float()
greenBagImage = greenBagImage.float()
blueBoxImage = blueBoxImage.float()
greenBookImage = greenBookImage.float()

# Find the mean of the image to find the brightness.
redBagMean = redBagImage.mean()
blueSlidesMean = blueSlidesImage.mean()
greenBagMean = greenBagImage.mean()
blueBoxMean = blueBoxImage.mean()
greenBookMean = greenBookImage.mean()

# Print out the data.
print(f"Red Cough Drop Bag Image Mean: {redBagMean}")
print(f"Blue Slides Image Mean: {blueSlidesMean}")
print(f"Green Food Lion Bag Image Mean: {greenBagMean}")
print(f"Blue Mask Box Image Mean: {blueBoxMean}")
print(f"Green Textbook Image Mean: {greenBookMean}")
```

```
Red Cough Drop Bag Image Mean: 128.55856323242188
Blue Slides Image Mean: 120.75611114501953
Green Food Lion Bag Image Mean: 107.555908203125
Blue Mask Box Image Mean: 116.16453552246094
Green Textbook Image Mean: 117.69412994384766
```

In [4]:

```
# Find the mean for each color channel.
print("Red Cough Drop Bag Image\n")
print(f"Red Channel Tensor Average: {redBagImage[:, :, 0].mean()}")
```

```python
print(f"Green Channel Tensor Average: {redBagImage[:, :, 1].mean()}")
print(f"Blue Channel Tensor Average: {redBagImage[:, :, 2].mean()}")
```

```
Red Cough Drop Bag Image

Red Channel Tensor Average: 175.66952514648438
Green Channel Tensor Average: 116.61083984375
Blue Channel Tensor Average: 93.39703369140625
```

In [5]:

```python
# Find the mean for each color channel.
print("Blue Slides Image\n")
print(f"Red Channel Tensor Average: {blueSlidesImage[:, :, 0].mean()}")
print(f"Green Channel Tensor Average: {blueSlidesImage[:, :, 1].mean()}")
print(f"Blue Channel Tensor Average: {blueSlidesImage[:, :, 2].mean()}")
```

```
Blue Slides Image

Red Channel Tensor Average: 116.03202056884766
Green Channel Tensor Average: 117.91149139404297
Blue Channel Tensor Average: 128.32553100585938
```

In [6]:

```python
# Find the mean for each color channel.
print("Green Food Lion Bag\n")
print(f"Red Channel Tensor Average: {greenBagImage[:, :, 0].mean()}")
print(f"Green Channel Tensor Average: {greenBagImage[:, :, 1].mean()}")
print(f"Blue Channel Tensor Average: {greenBagImage[:, :, 2].mean()}")
```

```
Green Food Lion Bag

Red Channel Tensor Average: 108.63582611083984
Green Channel Tensor Average: 120.59931182861328
Blue Channel Tensor Average: 93.41094207763672
```

In [7]:

```python
# Find the mean for each color channel.
print("Blue Mask Box Image\n")
print(f"Red Channel Tensor Average: {blueBoxImage[:, :, 0].mean()}")
print(f"Green Channel Tensor Average: {blueBoxImage[:, :, 1].mean()}")
print(f"Blue Channel Tensor Average: {blueBoxImage[:, :, 2].mean()}")
```

```
Blue Mask Box Image

Red Channel Tensor Average: 97.59046173095703
Green Channel Tensor Average: 119.61042022705078
Blue Channel Tensor Average: 131.4639434814453
```

In [8]:

```python
# Find the mean for each color channel.
print("Green Textbook Image\n")
print(f"Red Channel Tensor Average: {greenBookImage[:, :, 0].mean()}")
print(f"Green Channel Tensor Average: {greenBookImage[:, :, 1].mean()}")
print(f"Blue Channel Tensor Average: {greenBookImage[:, :, 2].mean()}")
```

```
Green Textbook Image

Red Channel Tensor Average: 121.31265258789062
Green Channel Tensor Average: 137.388702392578
Blue Channel Tensor Average: 94.36238098144531
```

Problem Two

In [9]:

```python
# Define the non-linear model
def model(t_u, w2, w1, b):
```

```
    return w2* t_u ** 2 + w1 * t_u + b

def loss_fn(t_p, t_c):
    squared_diffs = (t_p - t_c) ** 2
    return squared_diffs.mean()
```

In [10]:

```
def training_loop(epochs, learning_rate, params, t_u, t_c):
    for epoch in range(1, epochs + 1):
        w2, w1, b = params

        if params.grad is not None:
            params.grad.zero_()

        # Pass the input vars and parms into the model
        # Find the loss and back progragate.
        t_p = model(t_u, w2, w1, b)
        loss = loss_fn(t_p, t_c)
        loss.backward()

        with torch.no_grad():
            params -= learning_rate * params.grad

        # Every 500 epoch, it will print the loss.
        if (epoch % 500 == 0):
            print('Epoch %d, Loss %f' % (epoch, float(loss)))

    return params
```

In [11]:

```
t_c = [0.5, 14.0, 15.0, 28.0, 11.0, 8.0, 3.0, -4.0, 6.0, 13.0, 21.0]
t_u = [35.7, 55.9, 58.2, 81.9, 56.3, 48.9, 33.9, 21.8, 48.4, 60.4, 68.4]

# Convert the list into tensors.
t_c = torch.tensor(t_c)
t_u = torch.tensor(t_u)

# normalize the input.
t_u_normalize = 0.1 * t_u

# Set it to loop for 5000.
NUM_EPOCHS = 5000
```

In [12]:

```
# Call the training loop with a learning rate of .1
LEARNING_RATE = 0.1
params = torch.tensor([1.0, 1.0, 0.0], requires_grad=True)
training_loop(NUM_EPOCHS, LEARNING_RATE, params, t_u_normalize, t_c)
```

```
Epoch 500, Loss nan
Epoch 1000, Loss nan
Epoch 1500, Loss nan
Epoch 2000, Loss nan
Epoch 2500, Loss nan
Epoch 3000, Loss nan
Epoch 3500, Loss nan
Epoch 4000, Loss nan
Epoch 4500, Loss nan
Epoch 5000, Loss nan
```

Out[12]:

```
tensor([nan, nan, nan], requires_grad=True)
```

In [13]:

```
# Call the training loop with a learning rate of .01
LEARNING_RATE = 0.01
```

```
params = torch.tensor([1.0, 1.0, 0.0], requires_grad=True)
training_loop(NUM_EPOCHS, LEARNING_RATE, params, t_u_normalize, t_c)
```

```
Epoch 500, Loss nan
Epoch 1000, Loss nan
Epoch 1500, Loss nan
Epoch 2000, Loss nan
Epoch 2500, Loss nan
Epoch 3000, Loss nan
Epoch 3500, Loss nan
Epoch 4000, Loss nan
Epoch 4500, Loss nan
Epoch 5000, Loss nan
```

Out[13]:
```
tensor([nan, nan, nan], requires_grad=True)
```

In [14]:
```
# Call the training loop with a learning rate of .001
LEARNING_RATE = 0.001
params = torch.tensor([1.0, 1.0, 0.0], requires_grad=True)
training_loop(NUM_EPOCHS, LEARNING_RATE, params, t_u_normalize, t_c)
```

```
Epoch 500, Loss nan
Epoch 1000, Loss nan
Epoch 1500, Loss nan
Epoch 2000, Loss nan
Epoch 2500, Loss nan
Epoch 3000, Loss nan
Epoch 3500, Loss nan
Epoch 4000, Loss nan
Epoch 4500, Loss nan
Epoch 5000, Loss nan
```

Out[14]:
```
tensor([nan, nan, nan], requires_grad=True)
```

In [15]:
```
# Call the training loop with a learning rate of .0001
LEARNING_RATE = 0.0001
params = torch.tensor([1.0, 1.0, 0.0], requires_grad=True)
params_new = training_loop(NUM_EPOCHS, LEARNING_RATE, params, t_u_normalize, t_c)
params_new
```

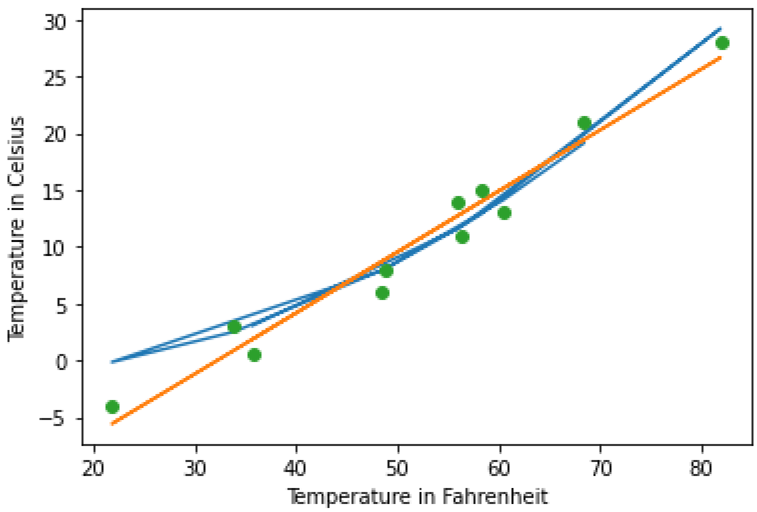
```
Epoch 500, Loss 10.708596
Epoch 1000, Loss 8.642084
Epoch 1500, Loss 7.171004
Epoch 2000, Loss 6.123477
Epoch 2500, Loss 5.377228
Epoch 3000, Loss 4.845287
Epoch 3500, Loss 4.465787
Epoch 4000, Loss 4.194724
Epoch 4500, Loss 4.000801
Epoch 5000, Loss 3.861745
```

Out[15]:
```
tensor([ 0.5570, -0.8881, -0.8753], requires_grad=True)
```

In [16]:
```
# Defined the linear model so I can plot the predicted linear values.
def linear_model(t_u, w, b):
    return t_u*w + b

# Pass the best params with the normalize model.
t_p = model(t_u_normalize, *params_new)

# I got the params from the lecture slides
linear_params = torch.tensor([5.3671, -17.3012])
t_p_linear = linear_model(t_u_normalize, *linear_params)
```

```python
fig = plt.figure()
# Name the x and y axis
plt.xlabel("Temperature in Fahrenheit")
plt.ylabel("Temperature in Celsius")

# Plot the model and the actual values.
plt.plot(t_u.numpy(), t_p.detach().numpy())
plt.plot(t_u.numpy(), t_p_linear.numpy())
plt.plot(t_u.numpy(), t_c.numpy(), 'o')
```

Out[16]: [<matplotlib.lines.Line2D at 0x209b9056bb0>]



Problem Three

In [17]:

```python
# A model using 6 input vars and params.
def model(x5, x4, x3, x2, x1, w5, w4, w3, w2, w1, b):
    return w5*x5 + w4*x4 + w3*x3 + w2*x2 + w1*x1 + b

# Squared difference error loss function.
def loss_fn(prices_p, prices):
    squared_diffs = (prices_p - prices) ** 2
    return squared_diffs.mean()
```

In [18]:

```python
def training_loop(epochs, learning_rate, params, input_vars, prices):
    for epoch in range(1, epochs + 1):

        if params.grad is not None:
            params.grad.zero_()

        prices_p = model(*input_vars, *params)
        loss = loss_fn(prices_p, prices)
        loss.backward()

        with torch.no_grad():
            params -= learning_rate * params.grad

        if (epoch % 500 == 0):
            print('Epoch %d, Loss %f' % (epoch, float(loss)))

    return params
```

In [19]:

```python
NUM_EPOCHS = 5000

# Read the data from the provided CSV files
```

```
housing = pd.DataFrame(pd.read_csv("Housing.csv"))

# split the data into the input vars and the prices.
num_vars = ['area', 'bedrooms', 'bathrooms', 'stories', 'parking']
prices = housing['price']

# Turn input, prices and params into a tensor
input_vars = []
for col in num_vars:
     # Packing the tensor into a list to pass as a param
    input_vars.append(torch.tensor(housing[col]).float())

# Normalize the Area values.
mean = torch.mean(input_vars[0])
std = torch.std(input_vars[0])
input_vars[0] = (input_vars[0] - mean) / std

prices = torch.tensor(prices.values).float()
```

In [20]:

```
# Call the training loop with a learning rate of .1
LEARNING_RATE = 0.1
params = torch.tensor([1.0, 1.0, 1.0, 1.0, 1.0, 0.0], requires_grad=True)
training_loop(NUM_EPOCHS, LEARNING_RATE, params, input_vars, prices)
```

```
Epoch 500, Loss nan
Epoch 1000, Loss nan
Epoch 1500, Loss nan
Epoch 2000, Loss nan
Epoch 2500, Loss nan
Epoch 3000, Loss nan
Epoch 3500, Loss nan
Epoch 4000, Loss nan
Epoch 4500, Loss nan
Epoch 5000, Loss nan
```

Out[20]:

```
tensor([nan, nan, nan, nan, nan, nan], requires_grad=True)
```

In [21]:

```
# Call the training loop with a learning rate of .01
LEARNING_RATE = 0.01
params = torch.tensor([1.0, 1.0, 1.0, 1.0, 1.0, 0.0], requires_grad=True)
params_new = training_loop(NUM_EPOCHS, LEARNING_RATE, params, input_vars, prices)
```

```
Epoch 500, Loss 1567288983552.000000
Epoch 1000, Loss 1543507673088.000000
Epoch 1500, Loss 1535782420480.000000
Epoch 2000, Loss 1532843261952.000000
Epoch 2500, Loss 1531714076672.000000
Epoch 3000, Loss 1531279835136.000000
Epoch 3500, Loss 1531112849408.000000
Epoch 4000, Loss 1531048755200.000000
Epoch 4500, Loss 1531023982592.000000
Epoch 5000, Loss 1531014414336.000000
```

In [22]:

```
# Call the training loop with a learning rate of .001
LEARNING_RATE = 0.001
params = torch.tensor([1.0, 1.0, 1.0, 1.0, 1.0, 0.0], requires_grad=True)
training_loop(NUM_EPOCHS, LEARNING_RATE, params, input_vars, prices)
```

```
Epoch 500, Loss 1792176291840.000000
Epoch 1000, Loss 1691893235712.000000
Epoch 1500, Loss 1652624588800.000000
Epoch 2000, Loss 1627743453184.000000
Epoch 2500, Loss 1609898131456.000000
```

```
Epoch 3000, Loss 1596611493888.000000
Epoch 3500, Loss 1586484871168.000000
Epoch 4000, Loss 1578599841792.000000
Epoch 4500, Loss 1572331061248.000000
Epoch 5000, Loss 1567245336576.000000
```

Out[22]:
```
tensor([ 682388.0000,  415422.4688, 1112289.2500,  564949.5000,  404318.0938,
         764936.3125], requires_grad=True)
```

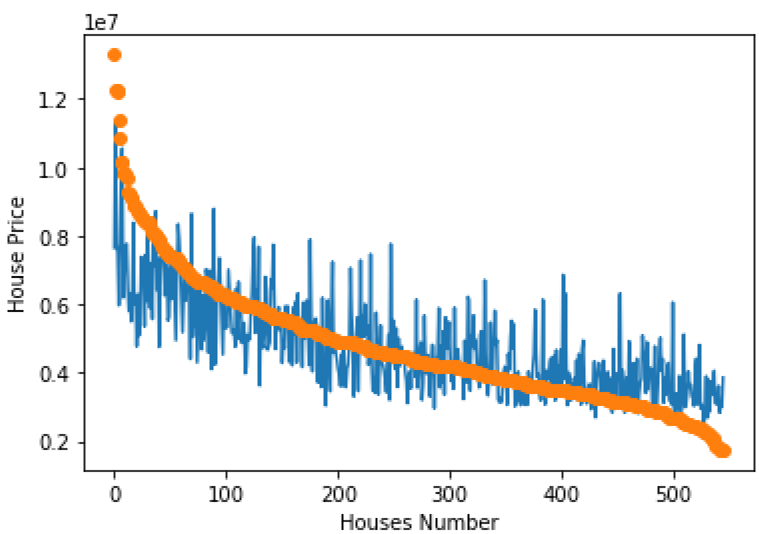
In [23]:
```python
# Call the training loop with a learning rate of .0001
LEARNING_RATE = 0.0001
params = torch.tensor([1.0, 1.0, 1.0, 1.0, 1.0, 0.0], requires_grad=True)
training_loop(NUM_EPOCHS, LEARNING_RATE, params, input_vars, prices)
```

```
Epoch 500, Loss 3214041415680.000000
Epoch 1000, Loss 2189241876480.000000
Epoch 1500, Loss 2069992964096.000000
Epoch 2000, Loss 2001922162688.000000
Epoch 2500, Loss 1947758493696.000000
Epoch 3000, Loss 1903602434048.000000
Epoch 3500, Loss 1867387764736.000000
Epoch 4000, Loss 1837514752000.000000
Epoch 4500, Loss 1812715143168.000000
Epoch 5000, Loss 1791981256704.000000
```

Out[23]:
```
tensor([455855.6875, 793864.2500, 559174.2500, 572905.3125, 403950.6250,
        331979.4688], requires_grad=True)
```

In [24]:
```python
# Find the predicted prices
prices_p = model(*input_vars, *params_new)

fig = plt.figure()
# Name the x and y axis
plt.xlabel("Houses Number")
plt.ylabel("House Price")

# Plot the model and the actual values.
plt.plot(prices_p.detach().numpy())
plt.plot(prices.numpy(), 'o')
```

Out[24]:
```
[<matplotlib.lines.Line2D at 0x209b9134f70>]
```



In [ ]:

In [ ]: