model_training

October 7, 2023

0.0.1 Importing the Libraries

```
[ ]: import numpy as np
     import pandas as pd
     import torch
     import torch.nn as nn
     import torch.optim as optim
     import matplotlib.pyplot as plt
     import datetime
```

0.0.2 Importing the dataset

```
[ ]: def get_date_offset(dates):
         base_date = datetime.datetime.strptime('2021-01-01', "%Y-%m-%d")
         date_offsets = []
         for date_string in dates:
             date_object = datetime.datetime.strptime(date_string, "%Y-%m-%d")
             offset_days = (date_object - base_date).days

             date_offsets.append(offset_days/365)

         return np.array(date_offsets)
```

```
[ ]: df = pd.read_csv('data_daily.csv')

     X = get_date_offset(df['# Date']).reshape(-1, 1)
     X = np.hstack((X, [[1] for _ in range(df.shape[0])]))
     y = df['Receipt_Count'].to_numpy().reshape(-1,1)
```

From the visualization, it is clear that there is a linear relationship between the dates and the number of receipts scanned. So we should create a Linear regression model of type

$$y = Ax + B$$

where y is the number of scanned receipts and x is the number of days from 1 January 2021. A and B are co-efficients learned by the model.

```
[ ]: class LinearRegression(nn.Module):
         def __init__(self, input_dim, output_dim):
             super(LinearRegression, self).__init__()
             self.linear = nn.Linear(input_dim, output_dim, dtype=torch.double)  #␣
      ↪Input dimension is 1, output dimension is 1

         def forward(self, x):
             return self.linear(x)

         def train(self, x_train, y_train, num_epochs=1000, learning_rate=0.01):
             criterion = nn.MSELoss()  # Mean Squared Error loss
             optimizer = optim.SGD(self.parameters(), lr=learning_rate)  #␣
      ↪Stochastic Gradient Descent optimizer

             for epoch in range(num_epochs):
                 # x_train = x_train.double()
                 # y_train = y_train.double()
                 # Forward pass
                 outputs = self(x_train)
                 loss = criterion(outputs, y_train)

                 # Backward pass and optimization
                 optimizer.zero_grad()
                 loss.backward()
                 optimizer.step()

                 if (epoch + 1) % 100000 == 0:
                     print(f'Epoch [{epoch+1}/{num_epochs}], Loss: {loss.item():.
      ↪4f}')

         def test(self, x_test):
             with torch.no_grad():
                 return self(x_test)
```

0.0.3 Training the data set

After tuning the hyper parameters, learning rate of 10^{-5} generates the best fit.

```
[ ]: X = torch.tensor(X, dtype = torch.double)

     y = torch.tensor(y, dtype=torch.double)

     torch.manual_seed(0)

     # Initialize and fit the linear regression model
     model = LinearRegression(2, 1)
     model.train(X, y, num_epochs=1000000, learning_rate=0.00001)
```

```
Epoch [100000/1000000], Loss: 76839516906.2646
Epoch [200000/1000000], Loss: 62249653054.5508
Epoch [300000/1000000], Loss: 58361335465.8239
Epoch [400000/1000000], Loss: 55467840523.3511
Epoch [500000/1000000], Loss: 53314024244.0943
Epoch [600000/1000000], Loss: 51710798777.6123
Epoch [700000/1000000], Loss: 50517413844.4797
Epoch [800000/1000000], Loss: 49629099862.1986
Epoch [900000/1000000], Loss: 48967870019.9178
Epoch [1000000/1000000], Loss: 48475673664.7504
```

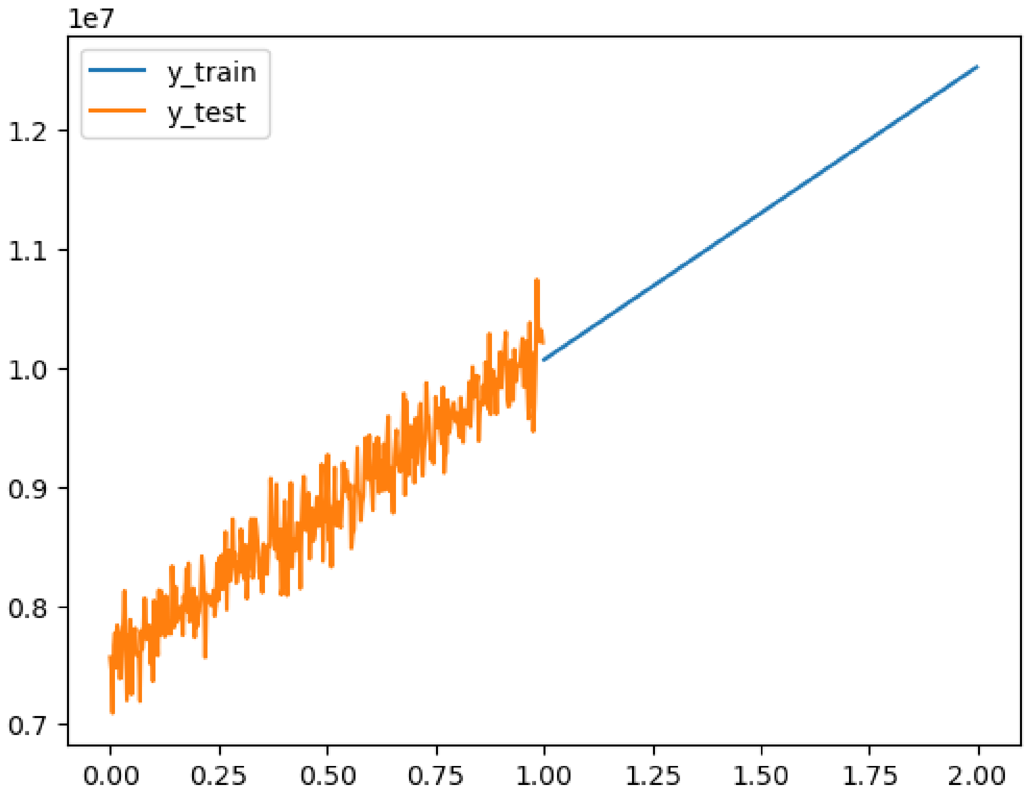
0.0.4 Plotting the Test data and the training data

The training data is given for the year 2021 and the model is to project the trend for the year 2022. So plotting the projection and the validate appropriate projection of the trend for the year 2022.

[ ]:
```
x_test = np.array([x+1 for x in X[:,0]]).reshape(-1, 1)
X_test = np.hstack((x_test, [[1] for _ in range(df.shape[0])]))
X_test = torch.tensor(X_test, dtype = torch.double)
y_pred = model.test(X_test)
print("Predicted value:", y_pred[-1][0], y[-1][0])
plt.plot(X_test[:, 0], y_pred)
plt.plot(X[:, 0], y)
plt.legend(["y_train", "y_test"])
```

```
Predicted value: tensor(12527638.2628, dtype=torch.float64) tensor(10211187.,
dtype=torch.float64)
```

[ ]:
```
<matplotlib.legend.Legend at 0x168b1fd00>
```



0.0.5 Saving the model

Now that the model is a good match, we save the model to be used by our application

```
[ ]: traced_model = torch.jit.trace(model, X)
     traced_model.save("linear_regression_model.pt")
```