Pytorch Workflow Fundamentals

1. Get data ready
2. Build or pick a pre-trained model
3. Fit the model to the data and make a prediction
4. Evaluate the model
5. Imporve through experimentations
6. Save and reload the model

```
import torch
from torch import nn  # nn contains all of Pytorch's building blocks of neural networks
import matplotlib.pyplot as plt

torch.__version__
```

```
'2.5.1+cu124'
```

1. Data(preparing and loading)

Machine learning is a game of two parts:

1. Turn your data, whatever it is, into numbers(a representation).
2. Pick or build a model to learn the representations as best as possible.

```
weight=0.7
bias=0.3

# create data
start=0
end=1
step=0.02
X=torch.arange(start,end,step).unsqueeze(dim=1)
y=weight*X+bias
X[:10],y[:10]
```

```
(tensor([[0.0000],
         [0.0200],
         [0.0400],
         [0.0600],
         [0.0800],
         [0.1000],
         [0.1200],
         [0.1400],
         [0.1600],
         [0.1800]]),
```

```
      tensor([[0.3000],
              [0.3140],
              [0.3280],
              [0.3420],
              [0.3560],
              [0.3700],
              [0.3840],
              [0.3980],
              [0.4120],
              [0.4260]]))
```

```
# create train/test split
train_split=int(0.8*len(X))
X_train,y_train=X[:train_split],y[:train_split]
X_test,y_test=X[train_split:],y[train_split:]

len(X_train),len(y_train),len(X_test),len(y_test)
```

```
(40, 40, 10, 10)
```

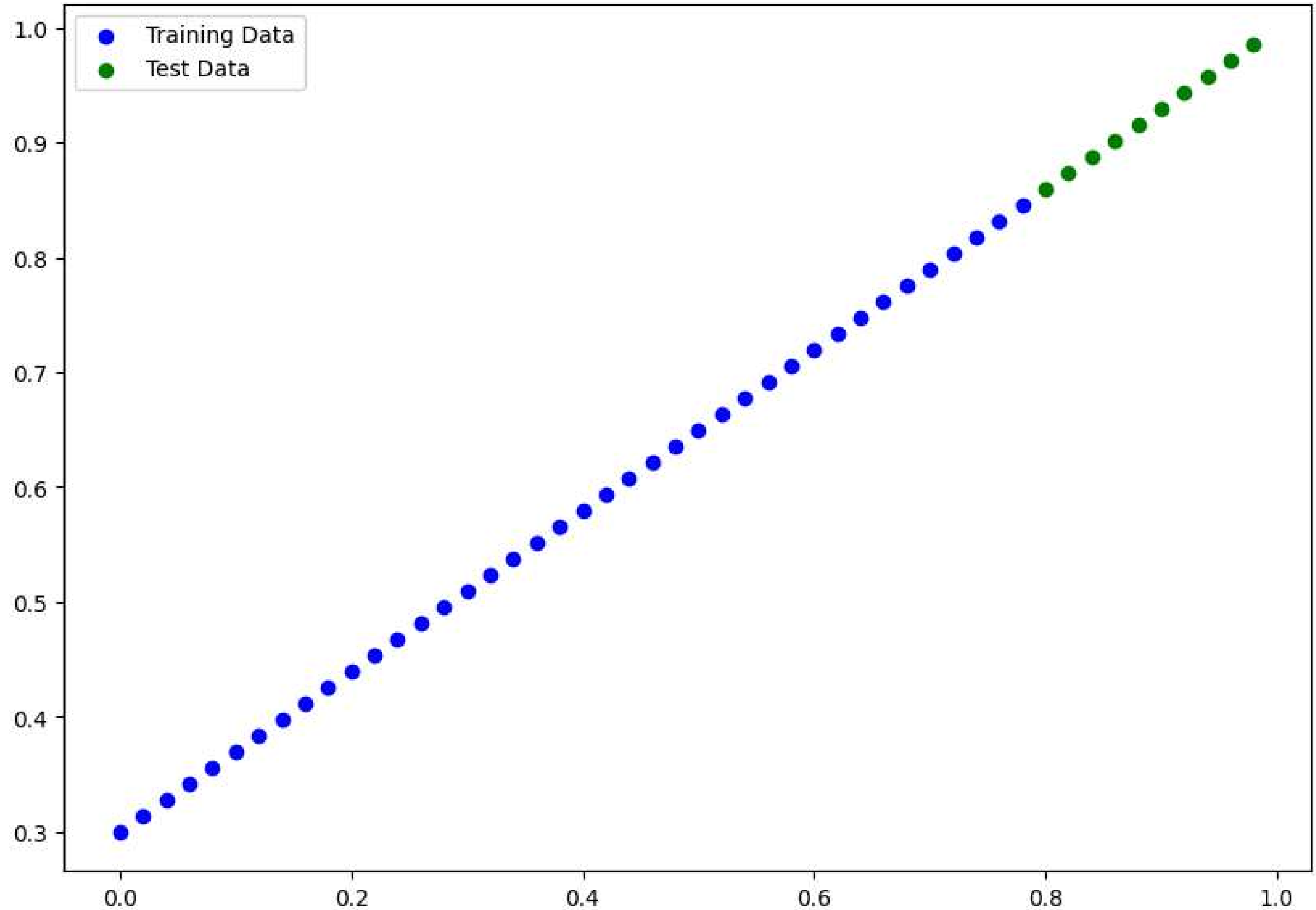
```
# let's plot the dataset

def plot_predictions(train_data=X_train,train_labels=y_train,test_data=X_test,test_labels=y_
  plt.figure(figsize=(10,7))
  plt.scatter(train_data,train_labels,c='b',label="Training Data")
  plt.scatter(test_data,test_labels,c='g',label="Test Data")

  if predictions is not None:
    plt.scatter(test_data,predictions,label="Predictions")

  plt.legend()


plot_predictions()
```

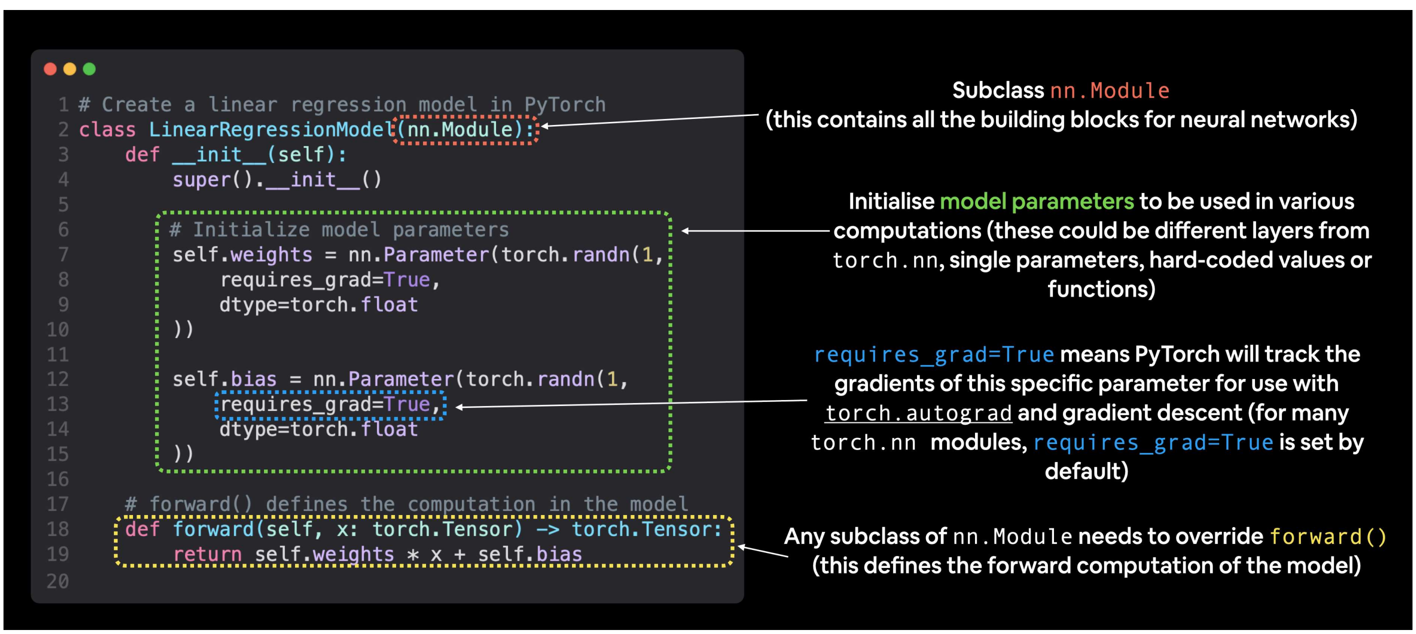


2. Build a Model

```
# create a Linear Regression model in pytorch

class LinearRegressionModel(nn.Module):
  def __init__(self):
    super().__init__()
    #initialize model parameters
    self.weights=nn.Parameter(torch.randn(1,dtype=torch.float),requires_grad=True)
    self.bias=nn.Parameter(torch.randn(1,dtype=torch.float),requires_grad=True)
  # forward() defines the computation in the model
  def forward(self,x:torch.Tensor)->torch.Tensor:
    return self.weights*x+self.bias
```

PyTorch module	What does it do?
`torch.nn`	Contains all of the building blocks for computational graphs (essentially a series of computations executed in a particular way).
`torch.nn.Parameter`	Stores tensors that can be used with `nn.Module`. If `requires_grad=True` gradients (used for updating model parameters via **gradient descent**) are calculated automatically, this is often referred to as "autograd".
`torch.nn.Module`	The base class for all neural network modules, all the building blocks for neural networks are subclasses. If you're building a neural network in PyTorch, your models should subclass `nn.Module`. Requires a `forward()` method be implemented.
`torch.optim`	Contains various optimization algorithms (these tell the model parameters stored in `nn.Parameter` how to best change to improve gradient descent and in turn reduce the loss).
`def forward()`	All `nn.Module` subclasses require a `forward()` method, this defines the computation that will take place on the data passed to the particular `nn.Module` (e.g. the linear regression formula above).




```
# set manual seed since nn.Parameter are randomly initialized
torch.manual_seed(42)
```

```
model_0=LinearRegressionModel()
list(model_0.parameters())
```

```
[Parameter containing:
 tensor([0.3367], requires_grad=True),
 Parameter containing:
 tensor([0.1288], requires_grad=True)]
```

```
# we can also get the state of the model using .state_dict()
model_0.state_dict()
```

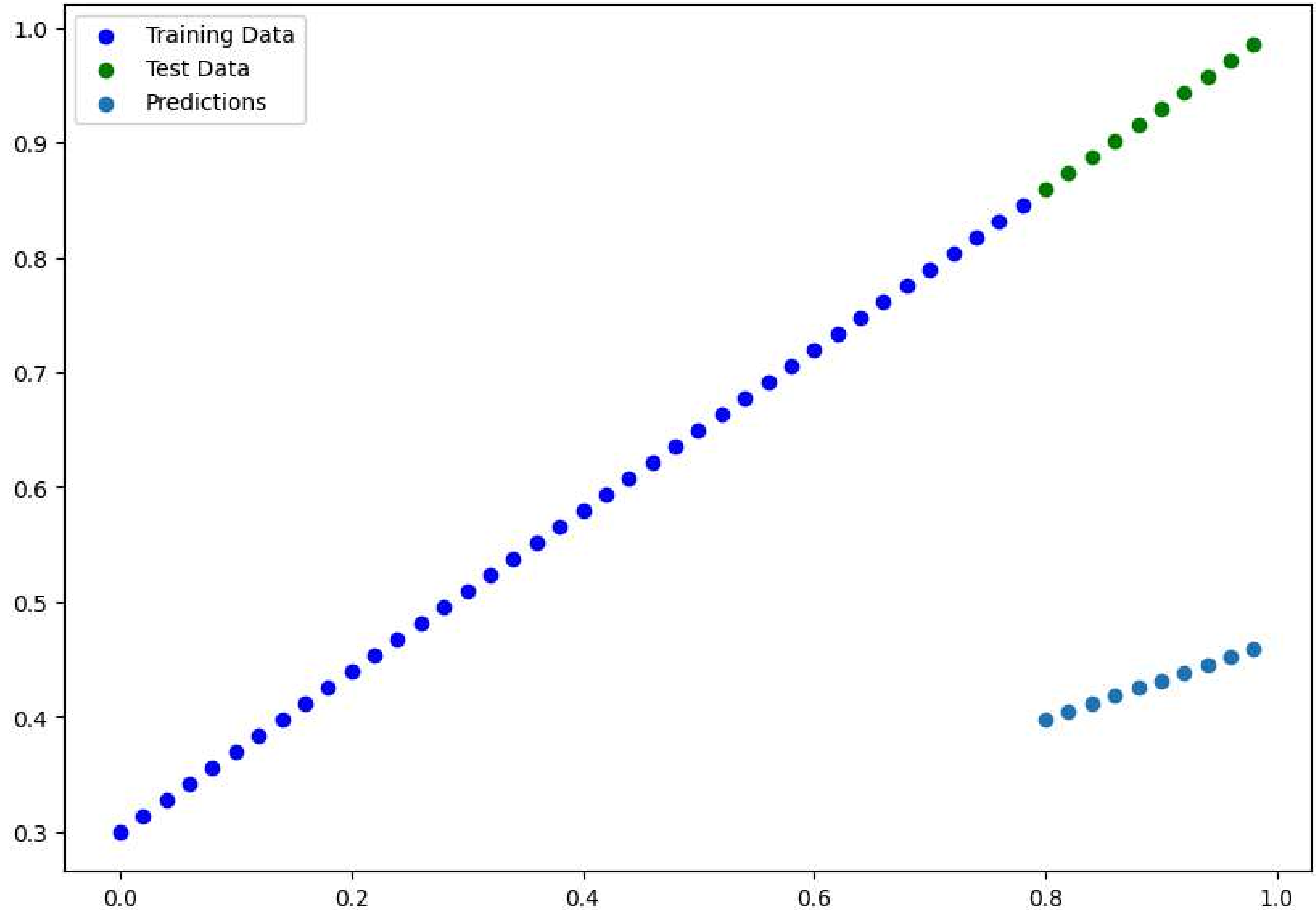
```
OrderedDict([('weights', tensor([0.3367])), ('bias', tensor([0.1288]))])
```

```
# Make predictions with model
with torch.inference_mode():
  y_preds=model_0(X_test)


# check the predictions
print(f"Number of testing samples: {len(X_test)}")
print(f"Number of predictions made: {len(y_preds)}")
print(f"Predicted value:\n {y_preds}")
```

```
Number of testing samples: 10
Number of predictions made: 10
Predicted value:
 tensor([[0.3982],
        [0.4049],
        [0.4116],
        [0.4184],
        [0.4251],
        [0.4318],
        [0.4386],
        [0.4453],
        [0.4520],
        [0.4588]])
```

```
plot_predictions(predictions=y_preds)
```




```
y_test-y_preds
```

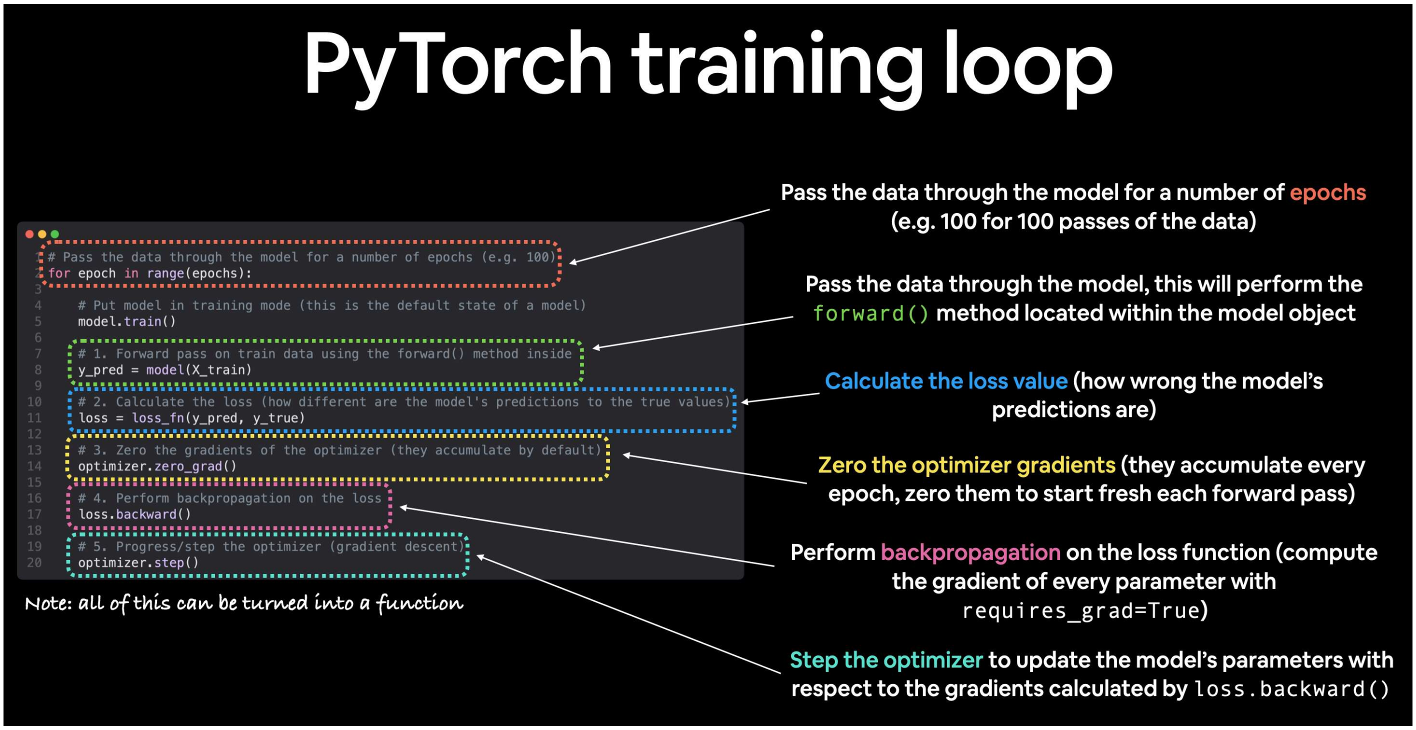
```
tensor([[0.4618],
        [0.4691],
        [0.4764],
        [0.4836],
        [0.4909],
        [0.4982],
        [0.5054],
        [0.5127],
        [0.5200],
        [0.5272]])
```

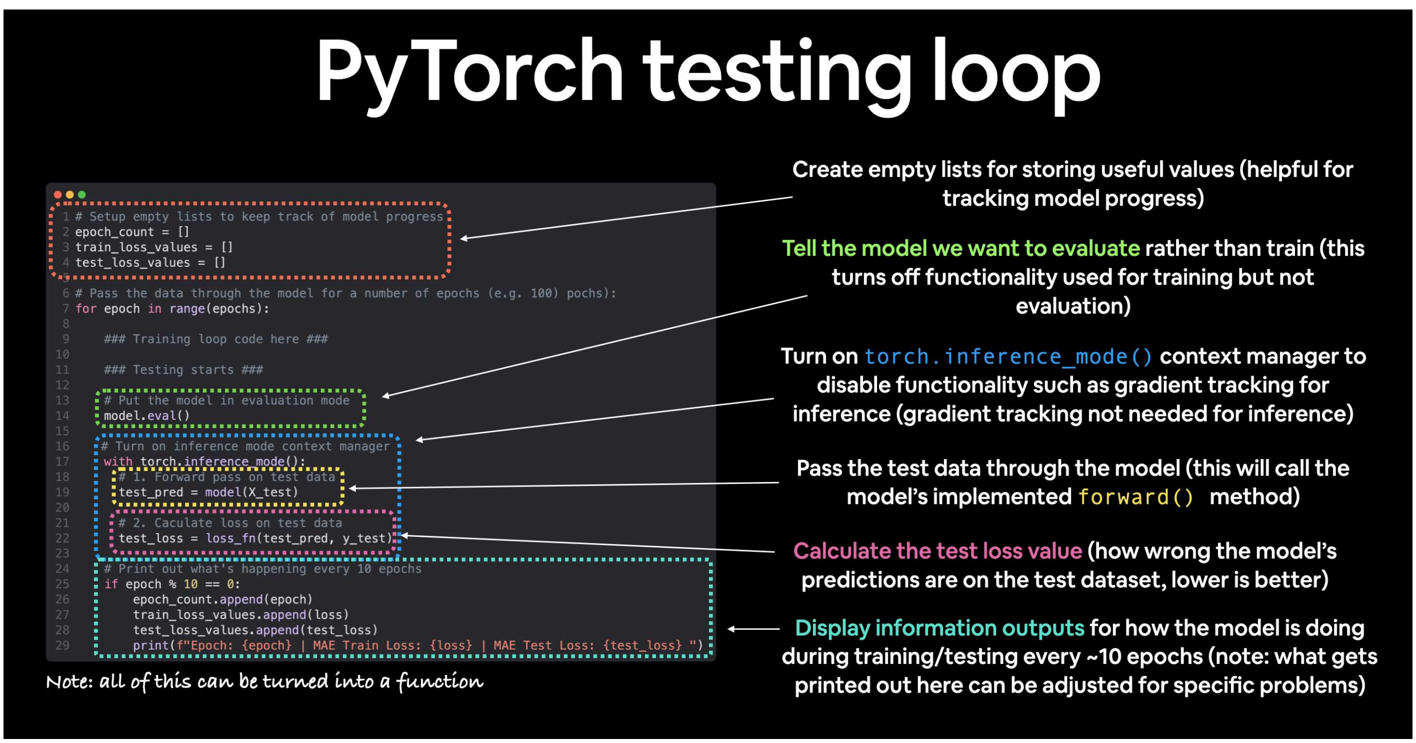
3. Train the model

```
#create the loss function

loss_fun=nn.L1Loss()
```

```
optimizer=torch.optim.SGD(params=model_0.parameters(),lr=0.01)
```






```
torch.manual_seed(42)

# set the number of epochs(how many times the model will pass over the training data)
epochs=100
```

```
# create empty loss lists to track the values

train_loss_values=[]
test_loss_values=[]
epoch_count=[]


for epoch in range(epochs):
  ### Training

  # put the model in training mode(this is the default state of the model)
  model_0.train()
  # 1. Forward pass on the train data using forward() method inside
  y_pred=model_0(X_train)
  # 2. calculate the loss(how different are our models predictions to the ground truth)
  loss=loss_fun(y_pred,y_train)
  # 3. Zero grad of the optimizer
  optimizer.zero_grad()
  # 4. loss backwards
  loss.backward()
  # 5. Progress the optimizer
  optimizer.step()


  ### Testing

  # Put the model in evaluation mode
  model_0.eval()
  with torch.inference_mode():
    # 1. Forward pass on the test data
    test_pred=model_0(X_test)
    # 2. Calculate loss on the test data
    test_loss=loss_fun(test_pred,y_test.type(torch.float))

    # Print out what is happening

    if epoch%10==0:
      epoch_count.append(epoch)
      train_loss_values.append(loss.detach().numpy())
      test_loss_values.append(test_loss.detach().numpy())
      print(f"Epoch:{epoch} | MAE Train loss: {loss} | MAE Test loss: {test_loss}")
```

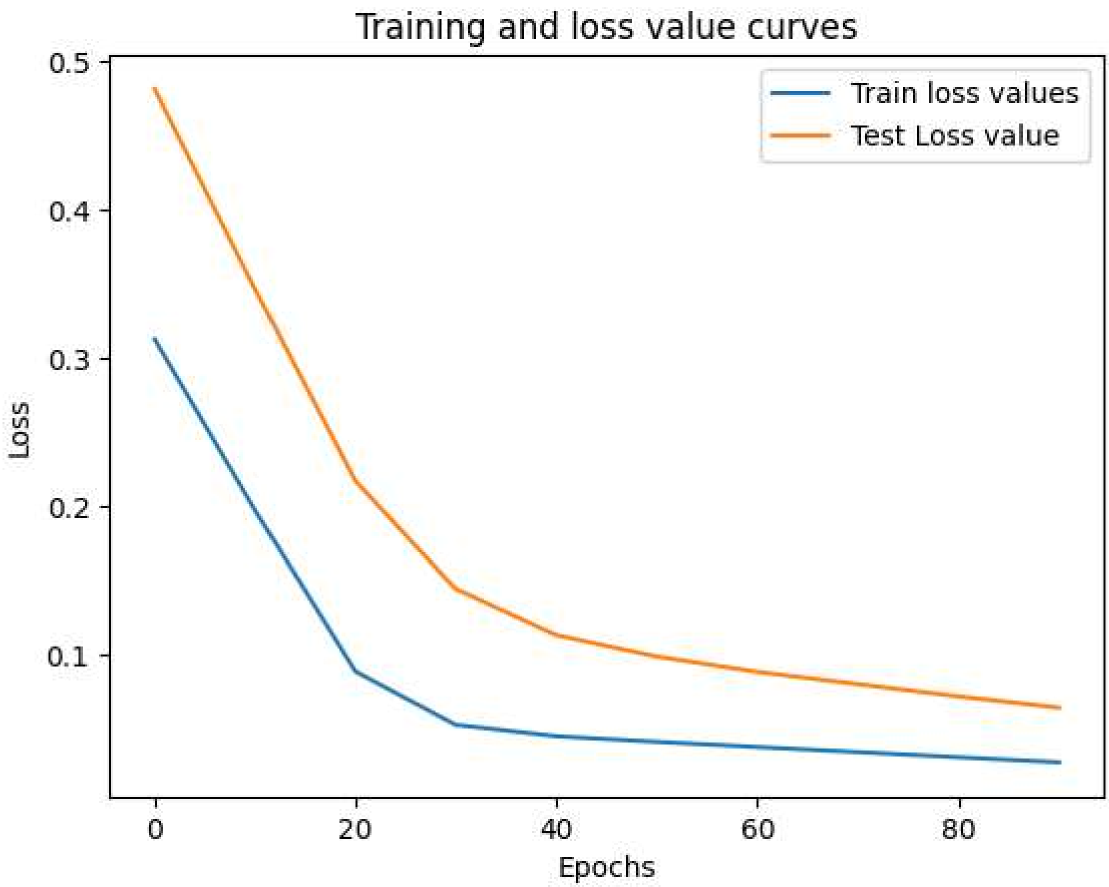
```
Epoch:0 | MAE Train loss: 0.31288138031959534 | MAE Test loss: 0.48106518387794495
Epoch:10 | MAE Train loss: 0.1976713240146637 | MAE Test loss: 0.3463551998138428
Epoch:20 | MAE Train loss: 0.08908725529909134 | MAE Test loss: 0.21729660034179688
Epoch:30 | MAE Train loss: 0.053148526698350906 | MAE Test loss: 0.14464017748832703
Epoch:40 | MAE Train loss: 0.04543796554207802 | MAE Test loss: 0.11360953003168106
Epoch:50 | MAE Train loss: 0.04167863354086876 | MAE Test loss: 0.09919948130846024
Epoch:60 | MAE Train loss: 0.03818932920694351 | MAE Test loss: 0.08886633068323135
```

```
Epoch:70 | MAE Train loss: 0.03476089984178543 | MAE Test loss: 0.0805937647819519
Epoch:80 | MAE Train loss: 0.03132382780313492 | MAE Test loss: 0.07232122868299484
Epoch:90 | MAE Train loss: 0.02788739837706089 | MAE Test loss: 0.06473556160926819
```

```
# plot the loss curves

plt.plot(epoch_count,train_loss_values,label="Train loss values")
plt.plot(epoch_count,test_loss_values,label="Test Loss value")
plt.title("Training and loss value curves")
plt.ylabel("Loss")
plt.xlabel("Epochs")
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7906b8dd5ad0>
```




```
# find the model parameters
print(f"The model learned the following values for weights and bias: {model_0.state_dict()}'
print(f"Original values for weights and bias: {weight} and {bias}")
```

```
The model learned the following values for weights and bias: OrderedDict([('weights', te
Original values for weights and bias: 0.7 and 0.3
```

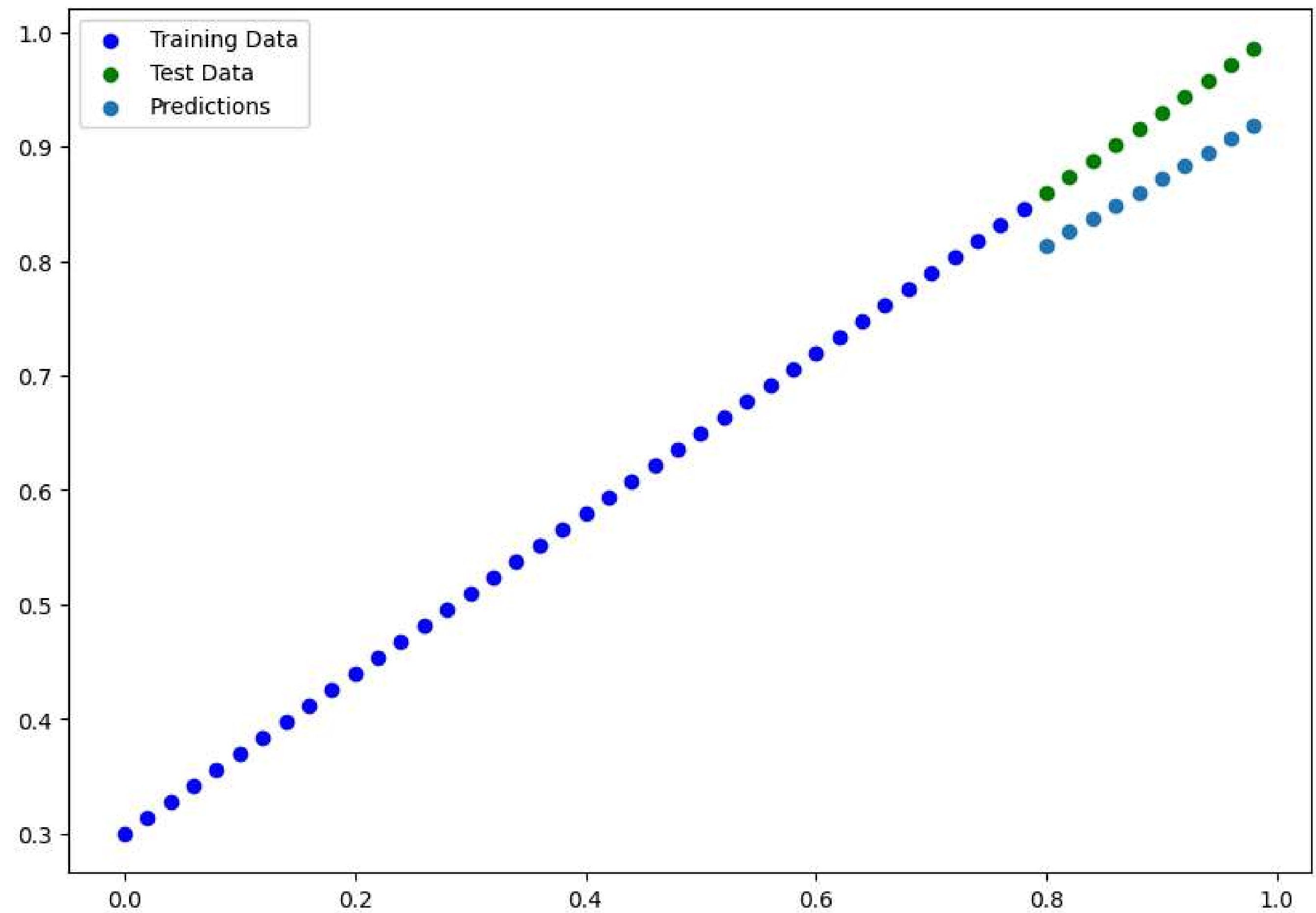
4. Making predictions with a pre_trained Pytorch model(inference)

```
# 1. Set the model in evaluation mode
model_0.eval()

# 2. Setup the inference mode context manager
with torch.inference_mode():
  # 3. Make sure the calculations are done with the model and data on the same device
  # in our case, we haven't setup device-agnostic code yet so our data and model are
  # on the CPU by default.
  # model_0.to(device)
  # X_test = X_test.to(device)
  y_preds = model_0(X_test)
y_preds
```

```
tensor([[0.8141],
        [0.8256],
        [0.8372],
        [0.8488],
        [0.8603],
        [0.8719],
        [0.8835],
        [0.8950],
        [0.9066],
        [0.9182]])
```

```
plot_predictions(predictions=y_preds)
```




```
y_test-y_preds
```

```
tensor([[0.0459],
        [0.0484],
        [0.0508],
        [0.0532],
        [0.0557],
        [0.0581],
        [0.0605],
        [0.0630],
        [0.0654],
        [0.0678]])
```

5. Loading a model and saving a Pytorch model

```
from pathlib import Path

#1. Create models directory
```

```
Model_Path=Path("models")
Model_Path.mkdir(parents=True,exist_ok=True)

# 2. Create model save path

model_name="01_pytorch_workflow_model_0.pth"
model_save_path=Model_Path/model_name


# 3. Save the model state dict

print(f"Saving model to : {model_save_path}")
torch.save(obj=model_0.state_dict(),f=model_save_path)
```

```
Saving model to : models/01_pytorch_workflow_model_0.pth
```

```
# check the saved model file path
!ls -l models/01_pytorch_workflow_model_0.pth
```

```
-rw-r--r-- 1 root root 1680 Feb 28 05:01 models/01_pytorch_workflow_model_0.pth
```

```
# loading a saved pytorch model's state_dict()

loaded_model_0=LinearRegressionModel()

loaded_model_0.load_state_dict(torch.load(f=model_save_path))
```

```
<ipython-input-58-0ccbbce14452>:5: FutureWarning: You are using `torch.load` with `weigh
  loaded_model_0.load_state_dict(torch.load(f=model_save_path))
```