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Task_1\dataset\dataset_splitpy

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```
lines = []
import random
with open("func_app1.csv","r") as f:
    lines = f.readlines()
random.shuffle(lines[1:])
train_lines = lines[1:351]
valid_lines = lines[351:401]
test_lines = lines[401:501]

with open("train.csv","w") as f:
    f.write(lines[0])
    for line in train_lines:
        f.write(line)

with open("validation.csv","w") as f:
    f.write(lines[0])
    for line in valid_lines:
        f.write(line)

with open("test.csv","w") as f:
    f.write(lines[0])
    for line in test_lines:
        f.write(line)
```

Task_1\dataset\readmetxt

to top

```
Instructions:
1. The dataset consist of 2 attributes (features ) and 1 Target variable ('y' coloumn)
2. Use 70:10:20 ratio for dividing dataset into Training, Validation and Test datasets,
respectively
```

Task_1\datasetpy

to top

```
from torch.utils.data import Dataset
import pandas as pd
import numpy as np
import torch


class function_dataset(Dataset):
    def __init__(self, data_dir):
        self.data_dir = data_dir
        data = np.array(pd.read_csv(self.data_dir))
        self.input_features = data[:,0:2]
        self.target = data[:,2:]
        self.len = data.shape[0]

    def __len__(self):
        return self.len

    def __getitem__(self, index):
        features_index = torch.from_numpy(self.input_features[index])
        target_index = torch.from_numpy(self.target[index])

        return (features_index, target_index)

def test():
    train_dataset = function_dataset(data_dir='dataset/func_app1.csv')
    train_data, train_label = train_dataset[5]

    # print(train_data)
    # print(train_label)
    # print(train_data.shape)
    # print(train_label.shape)

    print(train_dataset[:][0][:,0].shape)

#test()
```

Task_1\evalpy

to top

```
import torch
import torch.nn as nn
from torch.utils.data import DataLoader
from model import function_approximation
from dataset import function_dataset

device = 'cuda' if torch.cuda.is_available() else 'cpu'

model = function_approximation().to(device=device)
model.load_state_dict(torch.load('model_weights.pth'))

train_dataset = function_dataset("dataset/train.csv")
train_loader = DataLoader(train_dataset)

test_dataset = function_dataset("dataset/test.csv")
test_loader = DataLoader(test_dataset)

valid_dataset = function_dataset("dataset/validation.csv")
valid_loader = DataLoader(valid_dataset)


criterion = nn.MSELoss()


def accuracy(loader, model):



    avg_loss = 0
    cnt=0

    with torch.no_grad():
        for data, target in loader:
            model.eval()
            data = data.to(device=device)
            target = target.to(device=device)

            out = model(data.float())

            loss = criterion(out,target.float())
            avg_loss += loss
            cnt+=1
        avg_loss = avg_loss/cnt
        print(f"Average loss is: {avg_loss:.2f}")
        print("--------------------------------------------------------------------------------")


print("Train Set metrics:")
accuracy(train_loader, model)

print("Test Set metrics:")
```

```
accuracy(test_loader, model)

print("Validation Set metrics:")
accuracy(valid_loader, model)
```

Task_1\lossestxt

to top

```
6469.233530050202
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```

Task_1\modelpy

to top

```
import torch
import torch.nn as nn
import torch.nn.functional as F


class function_approximation(nn.Module):
    def __init__(self):
        super(function_approximation, self).__init__()

        self.linear1 = nn.Linear(in_features=2, out_features=8, bias=True)
        self.linear2 = nn.Linear(in_features=8, out_features=4)
        self.linear3 = nn.Linear(in_features=4, out_features=1)
        self.tanh    = nn.Tanh()
        self.softmax = nn.Softmax(dim=0)


    def forward(self, x):

        x = self.tanh(self.linear1(x))
        x = self.tanh(self.linear2(x))
        x = self.linear3(x)

        return x

def test():
    model = function_approximation()
    input = torch.Tensor([4.321097794848372, 4.769609253163742])
    out = model(input)

    print(input)
    print(model)
    print(out)

#test()
```

Task_1\plotpy

to top

```
import torch
import torch.nn as nn
from torch.utils.data import DataLoader
from dataset import function_dataset
from model import function_approximation
import numpy as np
import matplotlib.pyplot as plt
from matplotlib import cm
import pandas as pd

df = pd.read_csv('dataset/func_app1.csv')

dir = "plots/"

#device = 'cuda' if torch.cuda.is_available() else 'cpu'
device = 'cpu'



train_dataset = function_dataset("dataset/train.csv")
train_loader = DataLoader(train_dataset)

test_dataset = function_dataset("dataset/test.csv")
test_loader = DataLoader(test_dataset)

valid_dataset = function_dataset("dataset/validation.csv")
valid_loader = DataLoader(valid_dataset)


def gen_plots(model,epoch):
    x1 = np.arange(0,6,0.25,dtype="float32")
    x2 = np.arange(0,6,0.25,dtype="float32")
    x1,x2 = np.meshgrid(x1,x2)

    y = np.zeros(x1.shape)

    for i in range(x1.shape[0]):
        for j in range(x1.shape[1]):

            output = model(torch.tensor([x1[i][j],x2[i][j]]))
            y[i][j]= output

    f = plt.figure()
    ax = plt.axes(projection='3d')
    surf = ax.plot_surface(x1, x2, y, cmap = cm.jet, linewidth=0, antialiased=False)
    f.colorbar(surf, shrink=0.5, aspect=10)
    ax.set_title(f'Approximated Function after {epoch} Epochs')
    ax.set_xlabel('x1')
    ax.set_ylabel('x2')
    plt.savefig(dir+'epoch'+f'{epoch}'+"_approximated.png")
    plt.show()
```

```
# Plot of loss variation with epoch
losses = []
with open("losses.txt","r") as f:
    lines = f.readlines()
    for l in lines:
        losses.append(float(l.strip()))

epochs = np.arange(1,len(losses)+1,1)
losses = np.array(losses)
f = plt.figure()
plt.title("Loss v/s Epoch")
plt.plot(epochs,losses)
plt.xlabel('Epochs')
plt.ylabel('Loss')
plt.savefig(dir+"loss.png")
plt.show()
plt.close(f)


# Scatter plot of desired output v/s approximated output
model = function_approximation().to(device=device)
model.load_state_dict(torch.load('model_weights.pth'))

desired =[]
approximated = []


for batch_idx, (data, target) in enumerate(train_loader):
        data = data.to(device=device)
        target = target.to(device=device)

        out = model(data.float())

        approximated.append(out.item())
        desired.append(target.item())
desired = np.array(desired)
approximated = np.array(approximated)


f = plt.figure()
plt.title("Desired v/s Approximated Scatter Plot")
plt.scatter(desired, approximated, c='b', linewidths=1)
plt.plot(desired, desired, 'r')
plt.xlabel('Desired Function')
plt.ylabel('Approximated Function')
plt.savefig(dir+"scatter.png")
plt.show()
plt.close(f)


f = plt.figure()
ax = plt.axes(projection='3d')
```

```
surf = ax.plot_trisurf(df.iloc[:,0], df.iloc[:,1], df.iloc[:,2], cmap=cm.jet,
linewidth=0, antialiased=False)
f.colorbar(surf, shrink=0.5, aspect=10)
ax.set_title(f'Desired Function')
ax.set_xlabel('x1')
ax.set_ylabel('x2')
ax.set_zlabel('Desired Function')
plt.savefig(dir+"desired.png")
plt.show()


for epoch in [1,2,10,50,350]:
    model = function_approximation().to(device)
    model.load_state_dict(torch.load(f"epoch{str(epoch)}.pt",map_location=device))
    gen_plots(model,epoch)
```

Task_1\READMEmd

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Task_1\trainpy

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```
import torch
import torch.nn as nn
from torch.utils.data import DataLoader
import torch.optim as optim
from dataset import function_dataset
from model import function_approximation

data_dir = 'dataset/train.csv'
device = 'cuda' if torch.cuda.is_available() else 'cpu'
batch_size = 1
learning_rate = 2e-6
epochs = 350
momentum = 0.9

train_dataset = function_dataset(data_dir)
train_loader = DataLoader(dataset=train_dataset, batch_size=batch_size, shuffle=True)

losses = []

model = function_approximation().to(device=device)

criterion = nn.MSELoss()
optimizer = optim.SGD(model.parameters(), lr=learning_rate, momentum=momentum)


for epoch in range(epochs):
    total_loss = 0
    cnt = 0
    for batch_idx, (data, target) in enumerate(train_loader):
        data = data.to(device=device)
        target = target.to(device=device)

        out = model(data.float())
        loss = criterion(out, target.float())
        cnt+=1
        total_loss += loss.item()

        optimizer.zero_grad()
        loss.backward()

        optimizer.step()
    losses.append(total_loss/cnt)
    print(f'Epochs:{epoch+1}, Loss:{total_loss/cnt}')
    if(epoch+1 == 1 or epoch+1==2 or epoch+1==10 or epoch+1==50 or epoch+1==epochs):
        torch.save(model.state_dict(), "epoch"+str(epoch+1)+".pt")

with open("losses.txt","w") as f:
    for l in losses:
        f.write(str(l)+"\n")
torch.save(model.state_dict(), 'model_weights.pth')
```

Task_1\untitledhtml

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```
<!DOCTYPE html>
<!--[if lt IE 7]>      <html class="no-js lt-ie9 lt-ie8 lt-ie7"> <![endif]-->
<!--[if IE 7]>         <html class="no-js lt-ie9 lt-ie8"> <![endif]-->
<!--[if IE 8]>         <html class="no-js lt-ie9"> <![endif]-->
<!--[if gt IE 8]><!--> <html class="no-js"> <!--<![endif]-->
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        <!-- Place favicon.ico and apple-touch-icon.png in the root directory -->
        <style>

        </style>
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    <body>
        <!--[if lt IE 7]>
            <p class="browsehappy">You are using an <strong>outdated</strong> browser.
Please <a href="http://browsehappy.com/">upgrade your browser</a> to improve your
experience.</p>
        <![endif]-->

        <!-- Add your site or application content here -->
        <article class="markdown-body"><h1 id=. anchor=true>.</h1>
<h2 id=Contents anchor=true>Contents</h2>
<h4 id=      / anchor=true>      /</h4>
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<h4 id=[    |- ](#plotpy) anchor=true><a href="#plotpy">    |- </a>
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<h4 id=      / anchor=true>      /</h4>
<h4 id=dataset\dataset_splitpy anchor=true>dataset\dataset_splitpy</h4>
<p><a href="#Contents">to top</a></p>
<pre><code class="language-python">lines = []
<span class="hljs-keyword">import</span> random
<span class="hljs-keyword">with</span> <span class="hljs-built_in">open</span>(<span
class="hljs-string">&amp;quot;func_app1.csv&amp;quot;</span>,<span class="hljs-
string">&amp;quot;r&amp;quot;</span>) <span class="hljs-keyword">as</span> f:
    lines = f.readlines()
random.shuffle(lines[<span class="hljs-number">1</span>:])
train_lines = lines[<span class="hljs-number">1</span>:<span class="hljs-
number">351</span>]
valid_lines = lines[<span class="hljs-number">351</span>:<span class="hljs-
number">401</span>]
test_lines = lines[<span class="hljs-number">401</span>:<span class="hljs-
number">501</span>]

<span class="hljs-keyword">with</span> <span class="hljs-built_in">open</span>(<span
class="hljs-string">&amp;quot;train.csv&amp;quot;</span>,<span class="hljs-
string">&amp;quot;w&amp;quot;</span>) <span class="hljs-keyword">as</span> f:
    f.write(lines[<span class="hljs-number">0</span>])
    <span class="hljs-keyword">for</span> line <span class="hljs-keyword">in</span>
train_lines:
        f.write(line)

<span class="hljs-keyword">with</span> <span class="hljs-built_in">open</span>(<span
class="hljs-string">&amp;quot;validation.csv&amp;quot;</span>,<span class="hljs-
string">&amp;quot;w&amp;quot;</span>) <span class="hljs-keyword">as</span> f:
    f.write(lines[<span class="hljs-number">0</span>])
    <span class="hljs-keyword">for</span> line <span class="hljs-keyword">in</span>
valid_lines:
        f.write(line)

<span class="hljs-keyword">with</span> <span class="hljs-built_in">open</span>(<span
class="hljs-string">&amp;quot;test.csv&amp;quot;</span>,<span class="hljs-string">&amp;quot;w&amp;quot;
</span>) <span class="hljs-keyword">as</span> f:
    f.write(lines[<span class="hljs-number">0</span>])
    <span class="hljs-keyword">for</span> line <span class="hljs-keyword">in</span>
test_lines:
        f.write(line)




</code></pre>
<h4 id=dataset\readmetxt anchor=true>dataset\readmetxt</h4>
<p><a href="#Contents">to top</a></p>
```

<pre><code class="language-plaintext">Instructions:
1. The dataset consist of 2 attributes (features) and 1 Target variable ('y'
coloumn)
2. Use 70:10:20 ratio for dividing dataset into Training, Validation and Test datasets,
respectively
</code></pre>
<h4 id=datasetpy anchor=true>datasetpy</h4>
to top
<pre><code class="language-python">from
torch.utils.data import Dataset
import pandas as pd
import numpy as np
import torch

class <span class="hljs-
title">function_dataset(Dataset):
    def <span
class="hljs-title">__init__(self, data_dir):

        self.data_dir = data_dir
        data = np.array(pd.read_csv(self.data_dir))
        self.input_features = data[:,0:<span
class="hljs-number">2]
        self.target = data[:,2:]
        self.len = data.shape[<span class="hljs-
number">0]

    def <span
class="hljs-title">__len__(self):
        return self.<span class="hljs-
built_in">len

    def <span
class="hljs-title">__getitem__(self, index):

        features_index = torch.from_numpy(self.input_features[index])
        target_index = torch.from_numpy(self.target[index])

        return (features_index, target_index)

def <span class="hljs-
title">test():
    train_dataset = function_dataset(data_dir=<span class="hljs-
string">'dataset/func_app1.csv')
    train_data, train_label = train_dataset[5]

    # print(train_data)
    # print(train_label)
    # print(train_data.shape)
    # print(train_label.shape)

    print(train_dataset[:][<span class="hljs-

```
number">0</span>][:,<span class="hljs-number">0</span>].shape)

<span class="hljs-comment">#test()</span>

</code></pre>
<h4 id=evalpy anchor=true>evalpy</h4>
<p><a href="#Contents">to top</a></p>
<pre><code class="language-python"><span class="hljs-keyword">import</span> torch
<span class="hljs-keyword">import</span> torch.nn <span class="hljs-keyword">as</span>
nn
<span class="hljs-keyword">from</span> torch.utils.data <span class="hljs-
keyword">import</span> DataLoader
<span class="hljs-keyword">from</span> model <span class="hljs-keyword">import</span>
function_approximation
<span class="hljs-keyword">from</span> dataset <span class="hljs-keyword">import</span>
function_dataset

device = <span class="hljs-string">&#x27;cuda&#x27;</span> <span class="hljs-
keyword">if</span> torch.cuda.is_available() <span class="hljs-keyword">else</span>
<span class="hljs-string">&#x27;cpu&#x27;</span>

model = function_approximation().to(device=device)
model.load_state_dict(torch.load(<span class="hljs-
string">&#x27;model_weights.pth&#x27;</span>))

train_dataset = function_dataset(<span class="hljs-
string">&quot;dataset/train.csv&quot;</span>)
train_loader = DataLoader(train_dataset)

test_dataset = function_dataset(<span class="hljs-string">&quot;dataset/test.csv&quot;
</span>)
test_loader = DataLoader(test_dataset)

valid_dataset = function_dataset(<span class="hljs-
string">&quot;dataset/validation.csv&quot;</span>)
valid_loader = DataLoader(valid_dataset)


criterion = nn.MSELoss()


<span class="hljs-function"><span class="hljs-keyword">def</span> <span class="hljs-
title">accuracy</span>(<span class="hljs-params">loader, model</span>):</span>



    avg_loss = <span class="hljs-number">0</span>
    cnt=<span class="hljs-number">0</span>

    <span class="hljs-keyword">with</span> torch.no_grad():
        <span class="hljs-keyword">for</span> data, target <span class="hljs-
keyword">in</span> loader:
            model.<span class="hljs-built_in">eval</span>()
```

```
            data = data.to(device=device)
            target = target.to(device=device)

            out = model(data.float())

            loss = criterion(out,target.float())
            avg_loss += loss
            cnt+=1
        avg_loss = avg_loss/cnt
        print(f"Average loss is: {avg_loss:.2f}")
        print("--------------------------------------------------------------------------------")


print("Train Set metrics:")
accuracy(train_loader, model)

print("Test Set metrics:")
accuracy(test_loader, model)

print("Validation Set metrics:")
accuracy(valid_loader, model)
```

lossestxt

to top

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</code></pre>
<h4 id=modelpy anchor=true>modelpy</h4>
<p><a href="#Contents">to top</a></p>
<pre><code class="language-python"><span class="hljs-keyword">import</span> torch
<span class="hljs-keyword">import</span> torch.nn <span class="hljs-keyword">as</span>
nn
<span class="hljs-keyword">import</span> torch.nn.functional <span class="hljs-keyword">as</span> F


<span class="hljs-class"><span class="hljs-keyword">class</span> <span class="hljs-
title">function_approximation</span>(<span class="hljs-params">nn.Module</span>):
</span>
    <span class="hljs-function"><span class="hljs-keyword">def</span> <span
class="hljs-title">__init__</span>(<span class="hljs-params">self</span>):</span>
        <span class="hljs-built_in">super</span>(function_approximation,
self).__init__()

        self.linear1 = nn.Linear(in_features=<span class="hljs-number">2</span>,
out_features=<span class="hljs-number">8</span>, bias=<span class="hljs-
literal">True</span>)
        self.linear2 = nn.Linear(in_features=<span class="hljs-number">8</span>,
out_features=<span class="hljs-number">4</span>)
        self.linear3 = nn.Linear(in_features=<span class="hljs-number">4</span>,
out_features=<span class="hljs-number">1</span>)
        self.tanh    = nn.Tanh()
        self.softmax = nn.Softmax(dim=<span class="hljs-number">0</span>)


    <span class="hljs-function"><span class="hljs-keyword">def</span> <span
class="hljs-title">forward</span>(<span class="hljs-params">self, x</span>):</span>

        x = self.tanh(self.linear1(x))
        x = self.tanh(self.linear2(x))
        x = self.linear3(x)

        <span class="hljs-keyword">return</span> x

<span class="hljs-function"><span class="hljs-keyword">def</span> <span class="hljs-
title">test</span>():</span>
    model = function_approximation()
    <span class="hljs-built_in">input</span> = torch.Tensor([<span class="hljs-
```

```
number">4.321097794848372</span>, <span class="hljs-number">4.769609253163742</span>])
    out = model(<span class="hljs-built_in">input</span>)

    <span class="hljs-built_in">print</span>(<span class="hljs-built_in">input</span>)
    <span class="hljs-built_in">print</span>(model)
    <span class="hljs-built_in">print</span>(out)

<span class="hljs-comment">#test()</span>
</code></pre>
<h4 id=plotpy anchor=true>plotpy</h4>
<p><a href="#Contents">to top</a></p>
<pre><code class="language-python"><span class="hljs-keyword">import</span> torch
<span class="hljs-keyword">import</span> torch.nn <span class="hljs-keyword">as</span>
nn
<span class="hljs-keyword">from</span> torch.utils.data <span class="hljs-keyword">import</span> DataLoader
<span class="hljs-keyword">from</span> dataset <span class="hljs-keyword">import</span>
function_dataset
<span class="hljs-keyword">from</span> model <span class="hljs-keyword">import</span>
function_approximation
<span class="hljs-keyword">import</span> numpy <span class="hljs-keyword">as</span> np
<span class="hljs-keyword">import</span> matplotlib.pyplot <span class="hljs-keyword">as</span>
plt
<span class="hljs-keyword">from</span> matplotlib <span class="hljs-keyword">import</span>
cm
<span class="hljs-keyword">import</span> pandas <span class="hljs-keyword">as</span> pd

df = pd.read_csv(<span class="hljs-string">&amp;#x27;dataset/func_app1.csv&amp;#x27;</span>)

<span class="hljs-built_in">dir</span> = <span class="hljs-string">&quot;plots/&quot;
</span>

<span class="hljs-comment">#device = &amp;#x27;cuda&amp;#x27; if torch.cuda.is_available() else
&amp;#x27;cpu&amp;#x27;</span>
device = <span class="hljs-string">&amp;#x27;cpu&amp;#x27;</span>



train_dataset = function_dataset(<span class="hljs-
string">&quot;dataset/train.csv&quot;</span>)
train_loader = DataLoader(train_dataset)

test_dataset = function_dataset(<span class="hljs-string">&quot;dataset/test.csv&quot;
</span>)
test_loader = DataLoader(test_dataset)

valid_dataset = function_dataset(<span class="hljs-
string">&quot;dataset/validation.csv&quot;</span>)
valid_loader = DataLoader(valid_dataset)


<span class="hljs-function"><span class="hljs-keyword">def</span> <span class="hljs-
title">gen_plots</span>(<span class="hljs-params">model,epoch</span>):</span>
```

```
    x1 = np.arange(0,6,0.25,dtype="float32")
    x2 = np.arange(0,6,0.25,dtype="float32")
    x1,x2 = np.meshgrid(x1,x2)

    y = np.zeros(x1.shape)

    for i in range(x1.shape[0]):
        for j in range(x1.shape[1]):

            output = model(torch.tensor([x1[i][j],x2[i][j]]))
            y[i][j]= output

    f = plt.figure()
    ax = plt.axes(projection='3d')
    surf = ax.plot_surface(x1, x2, y, cmap = cm.jet, linewidth=0, antialiased=False)
    f.colorbar(surf, shrink=0.5, aspect=10)
    ax.set_title('f&#x27;Approximated Function after {epoch} Epochs&#x27;)
    ax.set_xlabel('&#x27;x1&#x27;)
    ax.set_ylabel('&#x27;x2&#x27;)
    plt.savefig(dir+'&#x27;epoch&#x27;+'f&#x27;{epoch}&#x27;+"_approximated.png")
    plt.show()


# Plot of loss variation with epoch
losses = []
with open("losses.txt","r") as f:
    lines = f.readlines()
    for l in lines:
        losses.append(float(l.strip()))

epochs = np.arange(1,len(losses)+1,1)
losses = np.array(losses)
f = plt.figure()
plt.title("Loss v/s Epoch")
plt.plot(epochs,losses)
plt.xlabel('&#x27;Epochs&#x27;)
plt.ylabel('&#x27;Loss&#x27;)
```

```
plt.savefig(dir+"loss.png")
plt.show()
plt.close(f)


# Scatter plot of desired output v/s approximated output
model = function_approximation().to(device=device)
model.load_state_dict(torch.load('model_weights.pth'))

desired =[]
approximated = []


for batch_idx, (data, target) in enumerate(train_loader):
        data = data.to(device=device)
        target = target.to(device=device)

        out = model(data.float())

        approximated.append(out.item())
        desired.append(target.item())
desired = np.array(desired)
approximated = np.array(approximated)


f = plt.figure()
plt.title("Desired v/s Approximated Scatter Plot")
plt.scatter(desired, approximated, c='b', linewidths=1)
plt.plot(desired, desired, 'r')
plt.xlabel('Desired Function')
plt.ylabel('Approximated Function')
plt.savefig(dir+"scatter.png")
plt.show()
plt.close(f)


f = plt.figure()
ax = plt.axes(projection='3d')
surf = ax.plot_trisurf(df.iloc[:,0], df.iloc[:,1], df.iloc[:,2],
cmap=cm.jet, linewidth=0, antialiased=False)
f.colorbar(surf, shrink=0.5, aspect=10)
ax.set_title('f'Desired Function')
ax.set_xlabel('x1')
```

```
ax.set_ylabel(&#x27;x2&#x27;)
ax.set_zlabel(&#x27;Desired Function&#x27;)
plt.savefig(dir+&quot;desired.png&quot;)
plt.show()


for epoch in [1,2,10,50,350]:
    model = function_approximation().to(device)
    model.load_state_dict(torch.load(f&quot;epoch{str(epoch)}.pt&quot;,map_location=device))
    gen_plots(model,epoch)
```

READMEmd

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trainpy

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```
import torch
import torch.nn as nn
from torch.utils.data import DataLoader
import torch.optim as optim
from dataset import function_dataset
from model import function_approximation

data_dir = &#x27;dataset/train.csv&#x27;
device = &#x27;cuda&#x27; if torch.cuda.is_available() else &#x27;cpu&#x27;
batch_size = 1
learning_rate = 2e-6
epochs = 350
momentum = 0.9

train_dataset = function_dataset(data_dir)
train_loader = DataLoader(dataset=train_dataset, batch_size=batch_size, shuffle=True)

losses = []

model = function_approximation().to(device=device)

criterion = nn.MSELoss()
optimizer = optim.SGD(model.parameters(), lr=learning_rate, momentum=momentum)
```

```
<span class="hljs-keyword">for</span> epoch <span class="hljs-keyword">in</span> <span class="hljs-built_in">range</span>(epochs):
    total_loss = <span class="hljs-number">0</span>
    cnt = <span class="hljs-number">0</span>
    <span class="hljs-keyword">for</span> batch_idx, (data, target) <span class="hljs-keyword">in</span> <span class="hljs-built_in">enumerate</span>(train_loader):
        data = data.to(device=device)
        target = target.to(device=device)

        out = model(data.<span class="hljs-built_in">float</span>())
        loss = criterion(out, target.<span class="hljs-built_in">float</span>())
        cnt+=<span class="hljs-number">1</span>
        total_loss += loss.item()

        optimizer.zero_grad()
        loss.backward()

        optimizer.step()
    losses.append(total_loss/cnt)
    <span class="hljs-built_in">print</span>(<span class="hljs-string">f&#x27;Epochs: <span class="hljs-subst">{epoch+<span class="hljs-number">1</span>}</span>, Loss:<span class="hljs-subst">{total_loss/cnt}</span>&#x27;</span>)
    <span class="hljs-keyword">if</span>(epoch+<span class="hljs-number">1</span> == <span class="hljs-number">1</span> <span class="hljs-keyword">or</span> epoch+<span class="hljs-number">1</span>==<span class="hljs-number">2</span> <span class="hljs-keyword">or</span> epoch+<span class="hljs-number">1</span>==<span class="hljs-number">10</span> <span class="hljs-keyword">or</span> epoch+<span class="hljs-number">1</span>==<span class="hljs-number">50</span> <span class="hljs-keyword">or</span> epoch+<span class="hljs-number">1</span>==epochs):
        torch.save(model.state_dict(), <span class="hljs-string">&quot;epoch&quot;</span>+<span class="hljs-built_in">str</span>(epoch+<span class="hljs-number">1</span>)+<span class="hljs-string">&quot;.pt&quot;</span>)

<span class="hljs-keyword">with</span> <span class="hljs-built_in">open</span>(<span class="hljs-string">&quot;losses.txt&quot;</span>,<span class="hljs-string">&quot;w&quot;</span>) <span class="hljs-keyword">as</span> f:
    <span class="hljs-keyword">for</span> l <span class="hljs-keyword">in</span> losses:
        f.write(<span class="hljs-built_in">str</span>(l)+<span class="hljs-string">&quot;\n&quot;</span>)
torch.save(model.state_dict(), <span class="hljs-string">&#x27;model_weights.pth&#x27;</span>)
</code></pre>
</article>


        <script src="file://C:\Users\Akshat Joshi\AppData\Roaming\npm\node_modules\repo-to-pdf\html5bp/js/vendor/jquery-1.10.2.min.js"></script>
        <script src="file://C:\Users\Akshat Joshi\AppData\Roaming\npm\node_modules\repo-to-pdf\html5bp/js/plugins.js"></script>
        <script src="file://C:\Users\Akshat
```

```
Joshi\AppData\Roaming\npm\node_modules\repo-to-pdf\html5bp/js/main.js"></script>
    </body>
</html>
```

Task_2a\plots\gen_latexpy

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```
def getsubString(name):
    stri="\\newpage\n"
    stri+= f"\\subsection{{"+name +f"}}\n"
    return stri
def getImageString(filename,caption,scale):
    stri = f"\\begin{{subfigure}}{{.5\\textwidth}}\n"
    stri+= "\\centering\n"
    #stri+= "\\includegraphics[scale = "+str(scale)+f"]{{"+filename +f"}}\n"
    stri +=
"\includegraphics[width=1.2\\textwidth,height=1.2\\textheight,keepaspectratio]{" +
filename+ "}"
    stri+= f"\\caption{{" + caption +f"}}\n"

    stri += f"\\end{{subfigure}}\n"


    return stri
def getImageString2(filename,caption,scale):

    stri = f"\\begin{{figure}}[H]\n"
    stri+= f"\\caption{{" + caption +f"}}\n"
    #stri+= "\\centering\n"
    stri+= "\\includegraphics[scale = "+str(scale)+f",left]{{"+filename +f"}}\n"
    stri += f"\\end{{figure}}\n"
    return stri

epochs = [1,2,10,50,360]
latex = ""

for epoch in epochs:
    latex += f"\\begin{{figure}}[H]\n"

    #latex+=getsubString(f"Epoch {epoch}")
    for layer in [1,2]:
        nodes = []
        if (layer == 1):
            nodes = [1,2,3,4]
        else:
            nodes = [1,2]
        for node in nodes:
            fname = f"task2a/epoch{str(epoch)}_hl{str(layer)}{str(node)}.png"
            latex+=getImageString(fname,f"Plot for Hidden Layer {layer}, Node {node}
(epoch: {epoch})",0.7)
    fname = f"task2a/epoch{str(epoch)}_output.png"
    latex+="\\pagebreak"
    latex += f"\\end{{figure}}\n"

    latex+=getImageString2(fname,f"Plot for Output Layer  (epoch: {epoch})",1.3)
    latex+="\\pagebreak"
print(latex)
```

Task_2a\plots\latextxt

to top

```
\begin{figure}[H]

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch1_hl11.png}\caption{Plot for Hidden Layer 1, Node 1 (epoch: 1)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch1_hl12.png}\caption{Plot for Hidden Layer 1, Node 2 (epoch: 1)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch1_hl13.png}\caption{Plot for Hidden Layer 1, Node 3 (epoch: 1)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch1_hl14.png}\caption{Plot for Hidden Layer 1, Node 4 (epoch: 1)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch1_hl21.png}\caption{Plot for Hidden Layer 2, Node 1 (epoch: 1)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

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\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
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```
{task2a/epoch1_hl22.png}\caption{Plot for Hidden Layer 2, Node 2 (epoch: 1)}

\end{subfigure}

\pagebreak\end{figure}

\begin{figure}[H]

\caption{Plot for Output Layer  (epoch: 1)}

\includegraphics[scale = 1.3,left]{task2a/epoch1_output.png}

\end{figure}

\pagebreak\begin{figure}[H]

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch2_hl11.png}\caption{Plot for Hidden Layer 1, Node 1 (epoch: 2)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch2_hl12.png}\caption{Plot for Hidden Layer 1, Node 2 (epoch: 2)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch2_hl13.png}\caption{Plot for Hidden Layer 1, Node 3 (epoch: 2)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch2_hl14.png}\caption{Plot for Hidden Layer 1, Node 4 (epoch: 2)}

\end{subfigure}

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\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch2_hl21.png}\caption{Plot for Hidden Layer 2, Node 1 (epoch: 2)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch2_hl22.png}\caption{Plot for Hidden Layer 2, Node 2 (epoch: 2)}

\end{subfigure}

\pagebreak\end{figure}

\begin{figure}[H]

\caption{Plot for Output Layer  (epoch: 2)}

\includegraphics[scale = 1.3,left]{task2a/epoch2_output.png}

\end{figure}

\pagebreak\begin{figure}[H]

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch10_hl11.png}\caption{Plot for Hidden Layer 1, Node 1 (epoch: 10)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch10_hl12.png}\caption{Plot for Hidden Layer 1, Node 2 (epoch: 10)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch10_hl13.png}\caption{Plot for Hidden Layer 1, Node 3 (epoch: 10)}
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\end{subfigure}

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\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch10_hl14.png}\caption{Plot for Hidden Layer 1, Node 4 (epoch: 10)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

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\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch10_hl21.png}\caption{Plot for Hidden Layer 2, Node 1 (epoch: 10)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

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\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch10_hl22.png}\caption{Plot for Hidden Layer 2, Node 2 (epoch: 10)}

\end{subfigure}

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\begin{figure}[H]

\caption{Plot for Output Layer  (epoch: 10)}

\includegraphics[scale = 1.3,left]{task2a/epoch10_output.png}

\end{figure}

\pagebreak\begin{figure}[H]

\begin{subfigure}{.5\textwidth}

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\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch50_hl11.png}\caption{Plot for Hidden Layer 1, Node 1 (epoch: 50)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}
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\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch50_hl12.png}\caption{Plot for Hidden Layer 1, Node 2 (epoch: 50)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch50_hl13.png}\caption{Plot for Hidden Layer 1, Node 3 (epoch: 50)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

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\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch50_hl14.png}\caption{Plot for Hidden Layer 1, Node 4 (epoch: 50)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

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\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch50_hl21.png}\caption{Plot for Hidden Layer 2, Node 1 (epoch: 50)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch50_hl22.png}\caption{Plot for Hidden Layer 2, Node 2 (epoch: 50)}

\end{subfigure}

\pagebreak\end{figure}

\begin{figure}[H]

\caption{Plot for Output Layer  (epoch: 50)}

\includegraphics[scale = 1.3,left]{task2a/epoch50_output.png}

\end{figure}
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\pagebreak\begin{figure}[H]

\begin{subfigure}{.5\textwidth}

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\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch360_hl11.png}\caption{Plot for Hidden Layer 1, Node 1 (epoch: 360)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch360_hl12.png}\caption{Plot for Hidden Layer 1, Node 2 (epoch: 360)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch360_hl13.png}\caption{Plot for Hidden Layer 1, Node 3 (epoch: 360)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch360_hl14.png}\caption{Plot for Hidden Layer 1, Node 4 (epoch: 360)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch360_hl21.png}\caption{Plot for Hidden Layer 2, Node 1 (epoch: 360)}

\end{subfigure}

\begin{subfigure}{.5\textwidth}

\centering

\includegraphics[width=1.2\textwidth,height=1.2\textheight,keepaspectratio]
{task2a/epoch360_hl22.png}\caption{Plot for Hidden Layer 2, Node 2 (epoch: 360)}
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\end{subfigure}

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\begin{figure}[H]

\caption{Plot for Output Layer  (epoch: 360)}

\includegraphics[scale = 1.3,left]{task2a/epoch360_output.png}

\end{figure}

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