In [ ]:

```
%matplotlib inline
import torch
import numpy as np
import pandas as pd
from torch import nn
import matplotlib.pyplot as plt
```

In [175…

```
def squared_loss(y_hat, y):
    """均方损失。"""
    return ((y_hat - y.reshape(y_hat.shape))**2 / 2).mean()
```

In [176…

```
def set_learning_rate(optimizer, lr):
    for param_group in optimizer.param_groups:
        param_group['lr'] = lr
```

In [177…

```
def train(net,optimizer,loss,train_features,train_res,get_step=None,newton_Method=Fa
    theta=torch.ones(net[0].weight.shape)
    loss_list=[]
    theta_bias=[]
    while  torch.norm((net[0].weight-theta).squeeze(0),p=2,dim=0).item()**2 >10**(-
        theta=torch.tensor(net[0].weight)
        l=loss(net(train_features),train_res)

        if net[0].weight.grad!=None:
            net[0].weight.grad.zero_()
        grad = torch.autograd.grad(l, net[0].weight, retain_graph=True, create_graph=
        grad=grad[0]

        if newton_Method==True:
            grad=grad.squeeze(0)
            Print = torch.tensor([])
            for anygrad in grad:
                Print = torch.cat((Print, torch.autograd.grad(anygrad, net[0].weight,
            grad=torch.mm(grad.reshape(1,3),torch.linalg.inv(Print))
        net[0].weight.grad=grad

        if get_step!=None:
            set_learning_rate(optimizer,get_step(loss,net,train_features,train_res))

        optimizer.step()
        #准备可视化的数据
        #print("l:",l)
        loss_list.append(l.item())
        #print(torch.norm((net[0].weight-theta).squeeze(0),p=2,dim=0).item()**2 )
        theta_bias.append(torch.norm((net[0].weight-theta).squeeze(0),p=2,dim=0).iten
    return loss_list,theta_bias,theta
```

In [178…

```
#1-1-1
train_data_x=pd.read_csv("T:\project\programming\DeepLearning\experiment\dataset\data
train_data_y=pd.read_csv("T:\project\programming\DeepLearning\experiment\dataset\data

train_features=torch.tensor(train_data_x.values,dtype=torch.float32)
train_features=torch.cat([train_features,torch.ones(49,1)],dim=1)
train_res=torch.tensor(train_data_y.values,dtype=torch.float32)
```

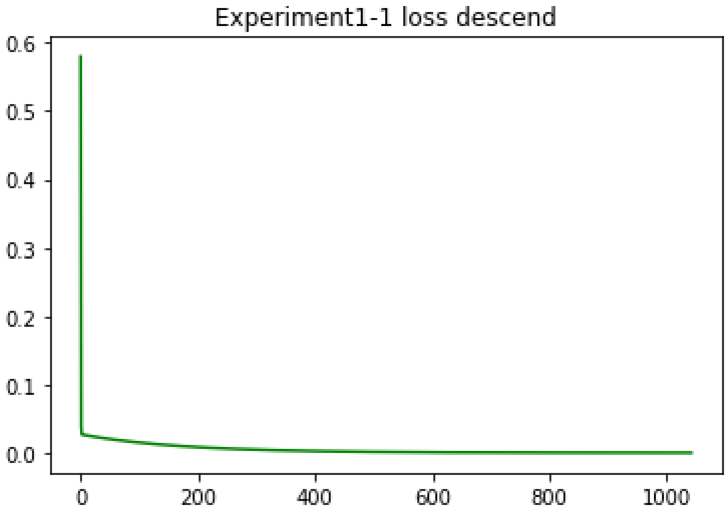
In [179…

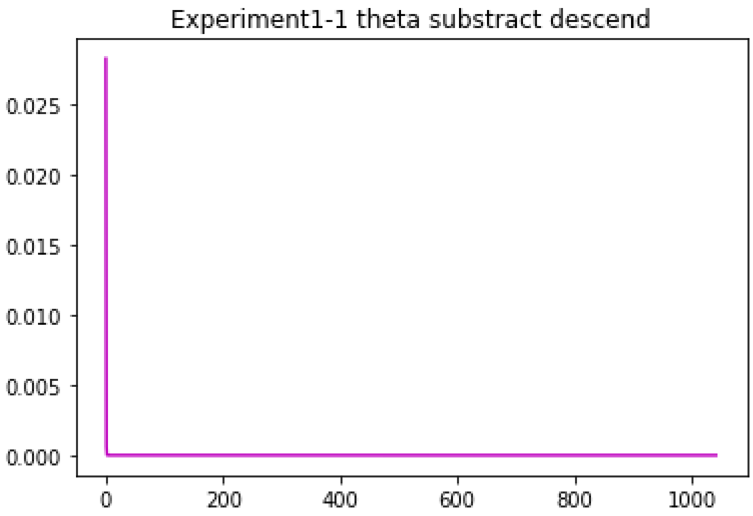
```
#初始化超参数
net=nn.Sequential( nn.Linear(train_features.shape[1],1,bias=False) )
net[0].weight.data.fill_(0)
#net[0].bias.data.fill_(0)
optimizer=torch.optim.SGD(net.parameters(), 0.03)
loss = squared_loss
```

In [180…

```
loss_list,theta_bias,theta=train(net,optimizer,loss,train_features,train_res)
epoches=np.arange(len(loss_list))
fig, ax = plt.subplots()
fmt='g-'
ax.set_title('Experiment1-1 loss descend')
ax.plot(epoches, loss_list,fmt)

fig_2, ax_2 = plt.subplots()
fmt='m-'
ax_2.set_title('Experiment1-1 theta substract descend')
ax_2.plot(epoches, theta_bias,fmt)

print("Experiment1-1 weight ",net[0].weight)
print("Experiment1-1 theta substraction ",(torch.norm((net[0].weight-theta).squeeze(0
print("Experiment1-1 loss ",squared_loss(net(train_features),train_res).data)
```

```
C:\Users\Young\AppData\Local\Temp\ipykernel_2440\3376330002.py:6: UserWarning: To copy
construct from a tensor, it is recommended to use sourceTensor.clone().detach() or sou
rceTensor.clone().detach().requires_grad_(True), rather than torch.tensor(sourceTenso
r).
  theta=torch.tensor(net[0].weight)
Experiment1-1 theta substraction  9.976567192460472e-09
Experiment1-1 loss  tensor(0.0009)
```





In [181…

```
#1-1-2
train_data2_x=pd.read_csv("T:\project\programming\DeepLearning\experiment\dataset\data
train_data2_y=pd.read_csv("T:\project\programming\DeepLearning\experiment\dataset\data
mean=torch.mean(torch.tensor(train_data2_x.values),0)
std=torch.std(torch.tensor(train_data2_x.values),0)

#标准化
train_data2_x[:] = train_data2_x[:].apply(
    lambda x: (x - x.mean()) / (x.std()))

train2_features=torch.tensor(train_data2_x.values,dtype=torch.float32)
train2_features=torch.cat([torch.ones(46,1),train2_features],dim=1)
train2_res=torch.tensor(train_data2_y.values,dtype=torch.float32)
```

In [182…

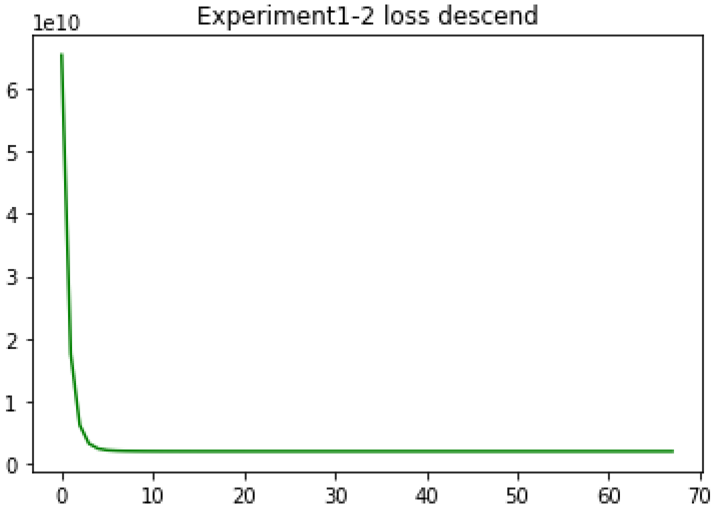
```
#初始化超参数
net=nn.Sequential( nn.Linear(train2_features.shape[1],1,bias=False) )
net[0].weight.data.fill_(0)
#net[0].bias.data.fill_(0)
optimizer_train2=torch.optim.SGD(net.parameters(), 0.5)
loss = squared_loss
```

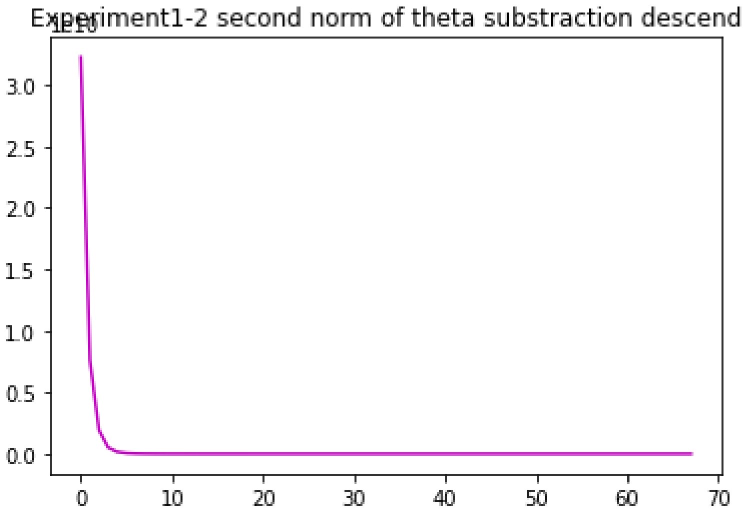
In [183…

```
loss_list_train2,theta_bias_train2,theta_train2=train(net,optimizer_train2,loss,train2

epoches_train2=np.arange(len(loss_list_train2))
fig_train2, ax_train2 = plt.subplots()
fmt='g-'
ax_train2.set_title('Experiment1-2 loss descend')
ax_train2.plot(epoches_train2, loss_list_train2,fmt)

fig_2_train2, ax_2_train2 = plt.subplots()
fmt='m-'
ax_2_train2.set_title('Experiment1-2 second norm of theta substraction descend')
ax_2_train2.plot(epoches_train2, theta_bias_train2,fmt)

print("weight is ",net[0].weight.data)
print("Experiment1-2 the second norm of theta substraction ",(torch.norm((net[0].weigh
print("Experiment1-2 loss ",squared_loss(net(train2_features),train2_res).data)
```

```
C:\Users\Young\AppData\Local\Temp\ipykernel_2440\3376330002.py:6: UserWarning: To copy
construct from a tensor, it is recommended to use sourceTensor.clone().detach() or sou
rceTensor.clone().detach().requires_grad_(True), rather than torch.tensor(sourceTenso
r).
  theta=torch.tensor(net[0].weight)
```

```
weight is  tensor([[339119.4375, 111467.1641,  -6295.0171]])
Experiment1-2 the second norm of theta substraction  0.0
Experiment1-2 loss  tensor(2.0665e+09)
```





In [184…

```
res=torch.div((torch.tensor([1650.0,3.0])-mean),std)
res=torch.cat([torch.tensor([1.0]),res],dim=0)
print( "房价为",net(torch.tensor(res,dtype=torch.float32))[0].item() )
```

```
房价为 292195.78125
C:\Users\Young\AppData\Local\Temp\ipykernel_2440\1219516734.py:3: UserWarning: To copy
construct from a tensor, it is recommended to use sourceTensor.clone().detach() or sou
rceTensor.clone().detach().requires_grad_(True), rather than torch.tensor(sourceTenso
r).
  print( "房价为",net(torch.tensor(res,dtype=torch.float32))[0].item() )
```

In [185…

```
#2
train_data3x=pd.read_csv("T:\project\programming\DeepLearning\experiment\dataset\data
train_data3y=pd.read_csv("T:\project\programming\DeepLearning\experiment\dataset\data

train3_features=torch.tensor(train_data3x.values,dtype=torch.float32)
train3_features=torch.cat([torch.ones(79,1),train3_features],dim=1)
train3_res=torch.tensor(train_data3y.values,dtype=torch.float32)
```

In [186…

```
#我自己写的优化方法，假设方向为一阶导数，改变步长；
# 会出现z字形曲线，效果一般
def get_step(loss,net,train_features,train_res):
    a=torch.tensor(0.0,requires_grad=True)
    #weight=net[0].weight.clone().detach().requires_grad_(True)
    #test=torch.mm(train_features,torch.transpose(net[0].weight+a*net[0].weight.grad.c
    test=torch.sigmoid(torch.mm(train_features,torch.transpose(net[0].weight+a*net[0]
    l=loss(test,train_res)
    gd_1 = torch.autograd.grad(l, a, create_graph=True)
    gd_2 = torch.autograd.grad(gd_1, a)
    #print(float(gd_1[0].data)/float(gd_2[0].data))
    #net[0].weight.data=weight
    return float(gd_1[0].data)/float(gd_2[0].data)
```

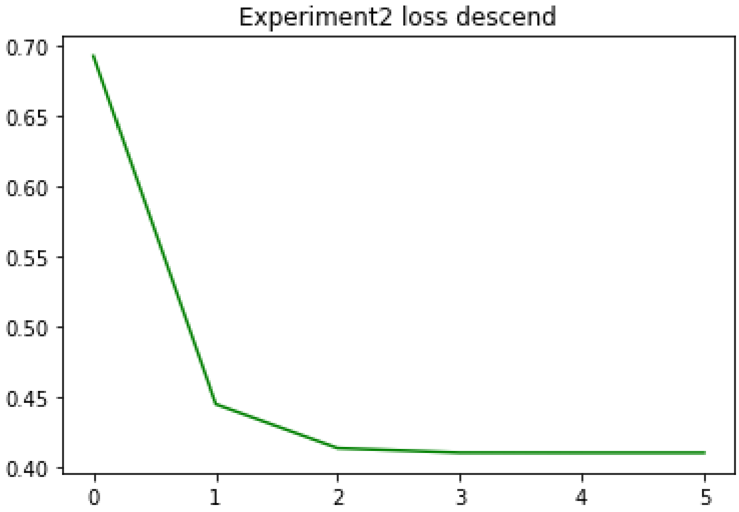
In [187…

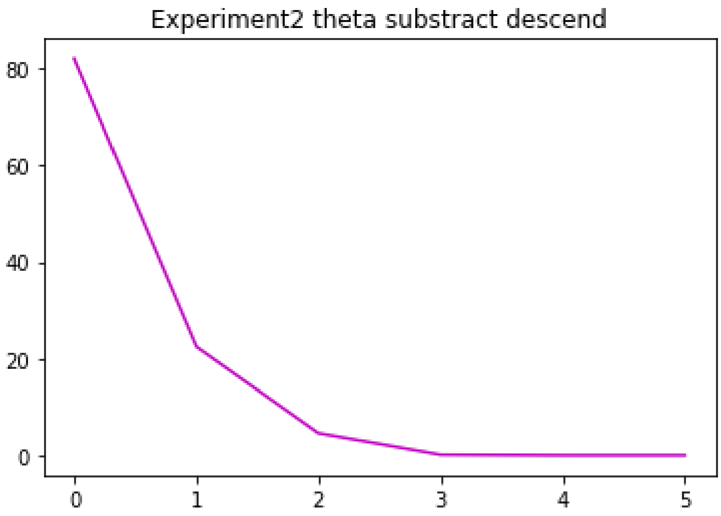
```
#初始化超参数
net=nn.Sequential( nn.Linear(train3_features.shape[1],1,bias=False),nn.Sigmoid())
net[0].weight.data.fill_(0)
#net[0].bias.data.fill_(0) 不设置bias
optimizer=torch.optim.SGD(net.parameters(), 1)
loss = nn.BCELoss()
```

In [188…

```
loss_list_train3,theta_bias_train3,theta_train3=train(net,optimizer,loss,train3_featur

#loss_list_train3,theta_bias_train3,theta_train3=train(net,optimizer,loss,train3_featu

epoches_train3=np.arange(len(loss_list_train3))
fig_train3, ax_train3 = plt.subplots()
fmt='g-'
ax_train3.set_title('Experiment2 loss descend')
ax_train3.plot(epoches_train3, loss_list_train3,fmt)

fig_3_train3, ax_3_train3 = plt.subplots()
fmt='m-'
ax_3_train3.set_title('Experiment2 theta substract descend')
ax_3_train3.plot(epoches_train3, theta_bias_train3,fmt)

print("Experiment2 theta substraction ",(torch.norm((net[0].weight-theta_train3).sque
print("Experiment2 loss ",squared_loss(net(train3_features),train3_res).data)
print("Experiment2 weight ",net[0].weight.data)
```

```
C:\Users\Young\AppData\Local\Temp\ipykernel_2440\3376330002.py:6: UserWarning: To copy
construct from a tensor, it is recommended to use sourceTensor.clone().detach() or sou
rceTensor.clone().detach().requires_grad_(True), rather than torch.tensor(sourceTenso
r).
  theta=torch.tensor(net[0].weight)
Experiment2 theta substraction  7.131593556955106e-10
Experiment2 loss  tensor(0.0675)
Experiment2 weight  tensor([[-16.2773,   0.1468,   0.1582]])
```





In [189…

```
print("录取率为",net(torch.tensor([1.0,20.0,80.0]))[0].item())
#录取率只有33.54%，因此大概率不会录取
```

```
录取率为 0.33542034029960633
```

In [190…

```
#求二阶导数的方法
x = torch.tensor([0., 0, 0], requires_grad=True)
b = torch.tensor([1., 3, 5],requires_grad=True)
A = torch.tensor([[-5, -3, -0.5], [-3, -2, 0], [-0.5, 0, -0.5]])
y = b@x + 0.5*x@A@x

# 计算一阶导数,因为我们需要继续计算二阶导数,所以创建并保留计算图
grad = torch.autograd.grad(y, x, retain_graph=True, create_graph=True)
print(grad[0])#grad返回一个元组,依次包含了[x,b]的梯度,但是并不会存储在x.grad中
#值得注意的是，grad[0].shape=[3]，这样显然不能参与数组的运算，必须变为[1,3]，此时可以
Print = torch.tensor([])
grad=grad[0]
for anygrad in grad:
    print(anygrad)
    Print = torch.cat((Print, torch.autograd.grad(anygrad, x, retain_graph=True)[0].

print("Hessian ",Print)
print("inverse of Hessian ",torch.linalg.inv(Print))

print(torch.mm(grad.reshape(1,3),torch.linalg.inv(Print)))
x.grad=torch.mm(grad.reshape(1,3),torch.linalg.inv(Print)).squeeze(0)
```

```
tensor([1., 3., 5.], grad_fn=<AddBackward0>)
tensor(1., grad_fn=<UnbindBackward0>)
tensor(3., grad_fn=<UnbindBackward0>)
tensor(5., grad_fn=<UnbindBackward0>)
Hessian  tensor([[-5.0000, -3.0000, -0.5000],
        [-3.0000, -2.0000,  0.0000],
        [-0.5000,  0.0000, -0.5000]])
inverse of Hessian  tensor([[ 4473924.5000, -6710886.5000, -4473924.5000],
        [-6710886.0000, 10066329.0000,  6710886.5000],
        [-4473924.0000,  6710886.5000,  4473922.5000]])
tensor([[-38028352.,  57042536.,  38028348.]], grad_fn=<MmBackward0>)
```