```
In [126]: inputs.dtype, targets.dtype
Out[126]: (torch.float32, torch.float32)

In [127]: dataset = TensorDataset(inputs, targets)

In [128]: val_percent = 0.15 # between 0.1 and 0.2
     ...: val_size = int(num_rows * val_percent)
     ...: train_size = num_rows - val_size
     ...:
     ...:
     ...: train_ds, val_ds = random_split(dataset, [train_size, val_size]) # Use the
random_split function to split dataset into 2 parts of the desired length

In [129]: batch_size = 128

In [130]: train_loader = DataLoader(train_ds, batch_size, shuffle=True)
     ...: val_loader = DataLoader(val_ds, batch_size)

In [131]: for xb, yb in train_loader:
     ...:     print("inputs:", xb)
     ...:     print("targets:", yb)
     ...:     break
     ...:
inputs: tensor([[41.0000,  0.0000, 31.2340,  1.0000,  0.0000,  3.0000],
        [27.0000,  0.0000, 30.3174,  1.0000,  0.0000,  1.0000],
        [18.0000,  0.0000, 29.2115,  0.0000,  0.0000,  0.0000],
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```

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In [132]: input_size = len(input_cols)
     ...: output_size = len(output_cols)
     ...: input_size, output_size
Out[132]: (6, 1)

In [133]: class InsuranceModel(nn.Module):
     ...:     def __init__(self):
     ...:         super().__init__()
     ...:         self.linear = nn.Linear(input_size, output_size)  # fill this
(hint: use input_size & output_size defined above)
     ...:
     ...:     def forward(self, xb):
     ...:         out = self.linear(xb)                          # fill this
     ...:         return out
     ...:
     ...:     def training_step(self, batch):
     ...:         inputs, targets = batch
     ...:         # Generate predictions
     ...:         out = self(inputs)
     ...:         # Calcuate loss
     ...:         loss = F.l1_loss(out, targets)                      # fill this
     ...:         return loss
     ...:
     ...:     def validation_step(self, batch):
     ...:         inputs, targets = batch
     ...:         # Generate predictions
     ...:         out = self(inputs)
     ...:         # Calculate loss
     ...:         loss = F.l1_loss(out, targets)                          # fill
```

```
this
     ...:         return {'val_loss': loss.detach()}
     ...:
     ...:     def validation_epoch_end(self, outputs):
     ...:         batch_losses = [x['val_loss'] for x in outputs]
     ...:         epoch_loss = torch.stack(batch_losses).mean()   # Combine losses
     ...:         return {'val_loss': epoch_loss.item()}
     ...:
     ...:     def epoch_end(self, epoch, result, num_epochs):
     ...:         # Print result every 20th epoch
     ...:         if (epoch+1) % 20 == 0 or epoch == num_epochs-1:
     ...:             print("Epoch [{}], val_loss: {:.4f}".format(epoch+1,
result['val_loss']))
     ...:

In [134]: model = InsuranceModel()

In [135]: list(model.parameters())
Out[135]:
[Parameter containing:
 tensor([[-0.3960,  0.1436,  0.0387,  0.3483,  0.2037,  0.3219]],
        requires_grad=True), Parameter containing:
 tensor([0.1723], requires_grad=True)]

In [136]: def evaluate(model, val_loader):
     ...:     outputs = [model.validation_step(batch) for batch in val_loader]
     ...:     return model.validation_epoch_end(outputs)
     ...:
     ...: def fit(epochs, lr, model, train_loader, val_loader,
opt_func=torch.optim.SGD):
     ...:     history = []
     ...:     optimizer = opt_func(model.parameters(), lr)
     ...:     for epoch in range(epochs):
     ...:         # Training Phase
     ...:         for batch in train_loader:
     ...:             loss = model.training_step(batch)
     ...:             loss.backward()
     ...:             optimizer.step()
     ...:             optimizer.zero_grad()
     ...:         # Validation phase
     ...:         result = evaluate(model, val_loader)
     ...:         model.epoch_end(epoch, result, epochs)
     ...:         history.append(result)
     ...:     return history
     ...:

In [137]: result = evaluate(model, val_loader) # Use the the evaluate function
     ...: print(result)
{'val_loss': 15897.75390625}

In [138]: epochs = 1000
     ...: lr = 1e-2
     ...: history1 = fit(epochs, lr, model, train_loader, val_loader)
Epoch [20], val_loss: 11958.7617
Epoch [40], val_loss: 9993.6934
Epoch [60], val_loss: 9451.5273
Epoch [80], val_loss: 9361.6602
Epoch [100], val_loss: 9336.6543
Epoch [120], val_loss: 9320.7852
Epoch [140], val_loss: 9305.4238
Epoch [160], val_loss: 9291.0059
Epoch [180], val_loss: 9274.4961
```

```
Epoch [200], val_loss: 9257.8623
Epoch [220], val_loss: 9239.9258
Epoch [240], val_loss: 9222.4785
Epoch [260], val_loss: 9207.7256
Epoch [280], val_loss: 9192.8877
Epoch [300], val_loss: 9176.6455
Epoch [320], val_loss: 9162.2871
Epoch [340], val_loss: 9147.8086
Epoch [360], val_loss: 9132.5820
Epoch [380], val_loss: 9118.5908
Epoch [400], val_loss: 9103.8740
Epoch [420], val_loss: 9089.5039
Epoch [440], val_loss: 9075.8965
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Epoch [480], val_loss: 9048.6152
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Epoch [540], val_loss: 9012.8311
Epoch [560], val_loss: 9002.6914
Epoch [580], val_loss: 8994.0967
Epoch [600], val_loss: 8985.7197
Epoch [620], val_loss: 8976.9980
Epoch [640], val_loss: 8968.4463
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Epoch [680], val_loss: 8953.6719
Epoch [700], val_loss: 8947.3652
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Epoch [740], val_loss: 8937.0703
Epoch [760], val_loss: 8932.5195
Epoch [780], val_loss: 8928.3633
Epoch [800], val_loss: 8924.0664
Epoch [820], val_loss: 8919.5781
Epoch [840], val_loss: 8916.3740
Epoch [860], val_loss: 8913.7227
Epoch [880], val_loss: 8912.6182
Epoch [900], val_loss: 8911.2832
Epoch [920], val_loss: 8909.8799
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Epoch [980], val_loss: 8907.0879
Epoch [1000], val_loss: 8906.2852

In [139]: epochs = 300
     ...: lr = 1e-3
     ...: history2 = fit(epochs, lr, model, train_loader, val_loader)
Epoch [20], val_loss: 8906.3262
Epoch [40], val_loss: 8906.4902
Epoch [60], val_loss: 8906.6621
Epoch [80], val_loss: 8906.8447
Epoch [100], val_loss: 8906.9141
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Epoch [140], val_loss: 8907.2461
Epoch [160], val_loss: 8907.3516
Epoch [180], val_loss: 8907.3574
Epoch [200], val_loss: 8907.4170
Epoch [220], val_loss: 8907.5508
Epoch [240], val_loss: 8907.5713
Epoch [260], val_loss: 8907.6533
Epoch [280], val_loss: 8907.6787
Epoch [300], val_loss: 8907.8770

In [140]: epochs = 300
```

```
     ...: lr = 1e-4
     ...: history3 = fit(epochs, lr, model, train_loader, val_loader)
Epoch [20], val_loss: 8907.8770
Epoch [40], val_loss: 8907.8887
Epoch [60], val_loss: 8907.9082
Epoch [80], val_loss: 8907.9141
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Epoch [240], val_loss: 8907.9902
Epoch [260], val_loss: 8908.0000
Epoch [280], val_loss: 8908.0186
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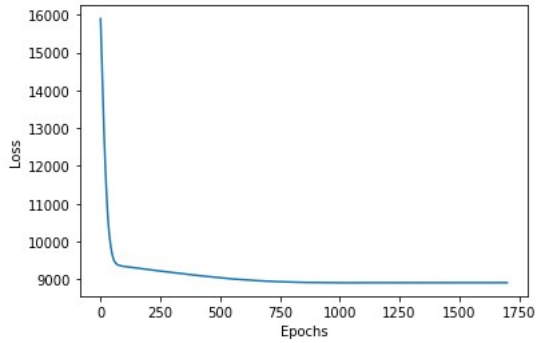
In [141]: epochs = 50
     ...: lr = 1e-5
     ...: history4 = fit(epochs, lr, model, train_loader, val_loader)
Epoch [20], val_loss: 8908.0176
Epoch [40], val_loss: 8908.0176
Epoch [50], val_loss: 8908.0176

In [142]: epochs = 50
     ...: lr = 1e-6
     ...: history5 = fit(epochs, lr, model, train_loader, val_loader)
Epoch [20], val_loss: 8908.0186
Epoch [40], val_loss: 8908.0176
Epoch [50], val_loss: 8908.0176

In [143]: val_loss = [result] + history1 + history2 + history3 + history4 + history5
     ...:
     ...: val_loss_array = [v['val_loss'] for v in val_loss]
     ...: plt.plot(val_loss_array)
     ...: plt.xlabel('Epochs')
     ...: plt.ylabel('Loss')
Out[143]: Text(0, 0.5, 'Loss')
```




```
In [144]: def predict_single(input, target, model):
     ...:     inputs = input.unsqueeze(0)
     ...:     predictions = model(inputs)                # fill this
     ...:     prediction = predictions[0].detach()
     ...:     print("Input:", input)
     ...:     print("Target:", target)
     ...:     print("Prediction:", prediction)
     ...:

In [145]: input, target = val_ds[0]
```

```
     ...: predict_single(input, target, model)
Input: tensor([52.0000,  1.0000, 37.4420,  2.0000,  0.0000,  3.0000])
Target: tensor([11873.9873])
Prediction: tensor([11683.9893])

In [146]: input, target = val_ds[10]
     ...: predict_single(input, target, model)
Input: tensor([51.0000,  0.0000, 38.3150,  1.0000,  0.0000,  3.0000])
Target: tensor([11362.0781])
Prediction: tensor([11312.6377])

In [147]: input, target = val_ds[23]
     ...: predict_single(input, target, model)
Input: tensor([26.0000,  0.0000, 38.9795,  0.0000,  0.0000,  1.0000])
Target: tensor([3681.4319])
Prediction: tensor([4130.9175])

In [148]: #Finish

In [149]:
```