TME4_Module

November 1, 2018

1 TME 4 Module

Ici nous allons etudier les features Sequentiel, Module et Optimiser de PyTorch. On commence en implementant l'architecture classique :
Lineaire --> Relu --> Lineaire --> Logistic -> CrossEntropy

```
In [55]: import numpy as np
         import pandas as pd
         import torch
         from sklearn.model_selection import train_test_split
         import matplotlib.pyplot as plt
         import sys

         from load_data import get_train_test_loaders
         from tools import get_minibatches

         from torch.nn.modules.loss import CrossEntropyLoss
         from torch.nn import Tanh, Sigmoid, Linear
         from ReluFunction import Relu
         from torch.nn.modules import Sequential
         from torch.optim import Adam, SGD
         from torch.nn.modules.loss import MSELoss, CrossEntropyLoss

         %load_ext autoreload
         %autoreload 2
```

```
The autoreload extension is already loaded. To reload it, use:
  %reload_ext autoreload
```

```
In [2]: train_loader, val_loader, test_loader, train_size, val_size, test_size = get_train_tes
        torch.cuda.set_device(0)
        device = torch.device('cuda')
        dtype = torch.float
```

```
In [14]: class EarlyStop:

             def __init__(self, min_delta=0, patience=2):
```

```
        self.patience = patience
        self.best_loss = 1e-15
        self.min_delta = min_delta
        self.wait = 0

    def continue_still(self, current_loss):
        if (current_loss - self.best_loss) < -self.min_delta:
            self.best_loss = current_loss
            self.wait = 1
        else:
            if self.wait >= self.patience:
                return False # don't continue anymore
            self.wait += 1
        return True# continue still
```

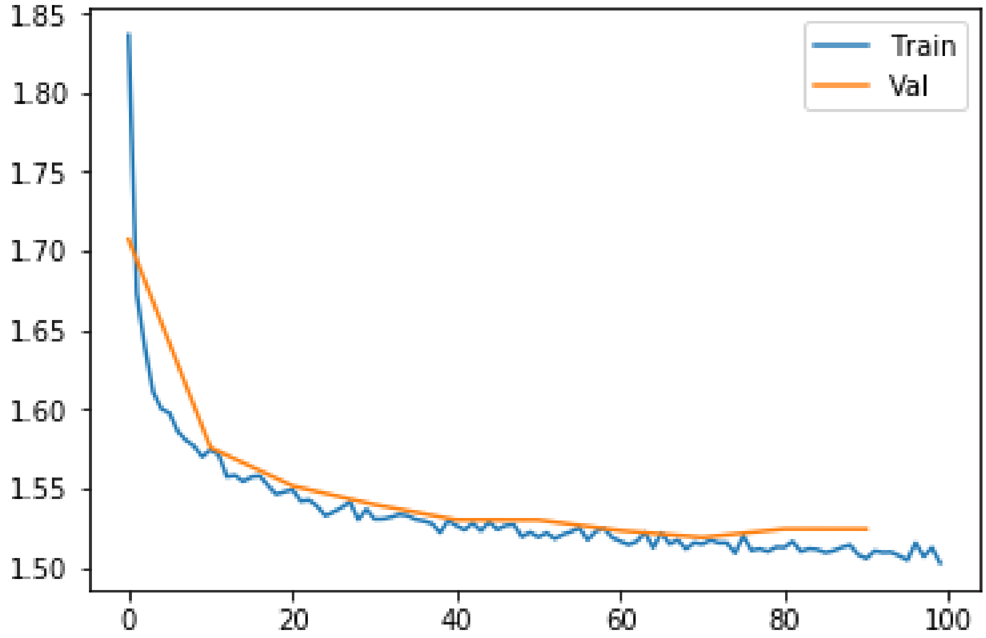
```
In [58]: def n_layer_nn(optimiser_function, layer_dims=[28*28 + 1, 128, 10], learning_rate=0.1
             layers = len(layer_dims)
             assert layers >= 3, "Please give at leaset 3 dimensions"

             modules = [Linear(layer_dims[0], layer_dims[1]), Relu()]
             for i in range(1, layers - 2):
                 modules.append(Linear(layer_dims[i], layer_dims[i+1]))
                 modules.append(Relu())

             modules.append(Linear(layer_dims[layers-2], layer_dims[layers-1]))
             modules.append(Sigmoid())
             print(modules)
             model = Sequential(*modules).cuda('cuda:0')

             loss_function = CrossEntropyLoss()

             optimiser = optimiser_function(model.parameters(), lr=learning_rate)

             stopper = EarlyStop(patience=3)
             train_losses=[]
             val_losses=[]
             accuracy=[]

             for epoch in range(epochs):
                 losses=[]
                 for i,(X, y) in enumerate(get_minibatches(train_loader, device)):
                     optimiser.zero_grad()
                     yhat = model.forward(X)
                     loss = loss_function(yhat, y.argmax(1))
                     losses.append(loss.item())
                     loss.backward()
                     optimiser.step()
```

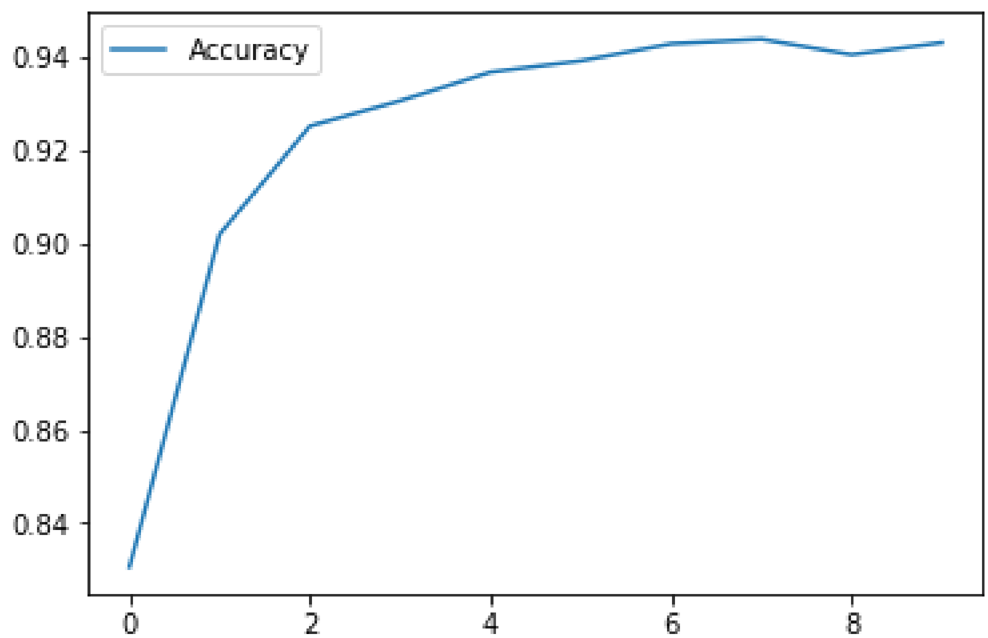
```
            train_losses.append(np.mean(losses))

            if epoch % 3 == 0:
                with torch.no_grad():
                    losses = []
                    corrects = 0
                    for i,(X, y) in enumerate(get_minibatches(val_loader, device)):
                        y = y.argmax(1)
                        yhat = model.forward(X)
                        losses.append(loss_function(yhat, y).item())
                        ypred = yhat.argmax(1)
                        corrects += (ypred == y).sum()
                    val_loss = np.mean(losses)
                    val_losses.append(val_loss)
                    acc = corrects.cpu().numpy() / val_size
                    #print("Accuracy {}".format(acc))
                    accuracy.append(acc)
                    if not stopper.continue_still(val_loss):
                        print("Early stop at epoch {}".format(epoch))
                        break
        return val_losses, accuracy
```

In [36]:
```
train_loss=np.array(train_loss)
val_loss=np.array(val_loss)
accuracy=np.array(accuracy)
```

In [37]:
```
plt.figure()
plt.plot(range(len(train_loss)), train_loss, label="Train")
plt.plot(val_loss[:,0], val_loss[:,1], label="Val")
plt.legend()

plt.figure()
plt.plot(range(len(accuracy)), accuracy, label="Accuracy")
plt.legend()
```

Out[37]:
```
<matplotlib.legend.Legend at 0x7f0eb81e9278>
```





1.0.1 HighWay

https://arxiv.org/pdf/1507.06228.pdf High Way est une module non-linéaire, qui permet d'apprendre les reseax trés profondes.

```
In [12]: from torch.nn import ModuleList, Module

         class Highway(Module):

             def __init__(self, size, layers_n, f):
                 super(Highway, self).__init__()

                 self.func = f()
                 layers = []
                 for _ in range(layers_n):
                     layers.append(Linear(size, size))

                 self.layers_n = layers_n
                 self.nonlinear = ModuleList(layers.copy())
                 self.linear = ModuleList(layers.copy())
                 self.gate = ModuleList(layers.copy())

             def forward(self, x):

                 for layer in range(self.layers_n):
                     gate = torch.sigmoid(self.gate[layer](x))

                     nonlinear = self.func(self.nonlinear[layer](x))
                     linear = self.linear[layer](x)

                     x = gate * nonlinear + (1 - gate) * linear

                 return x
```

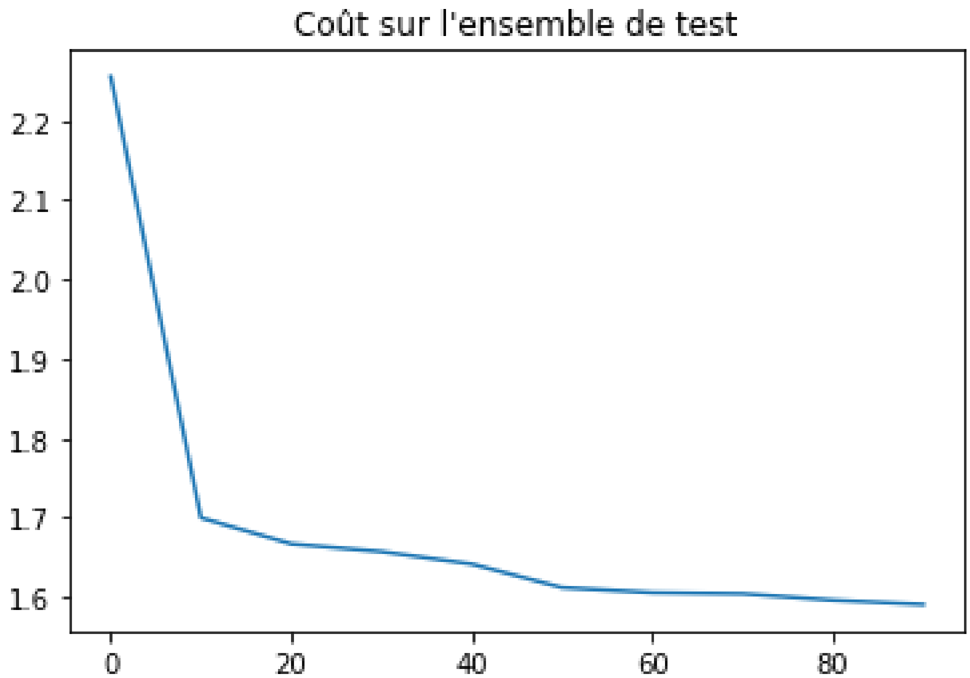
J'ai essaié differentes nombres des couches : 5 couches converge beaucoup plus lentement, que 3 couches.

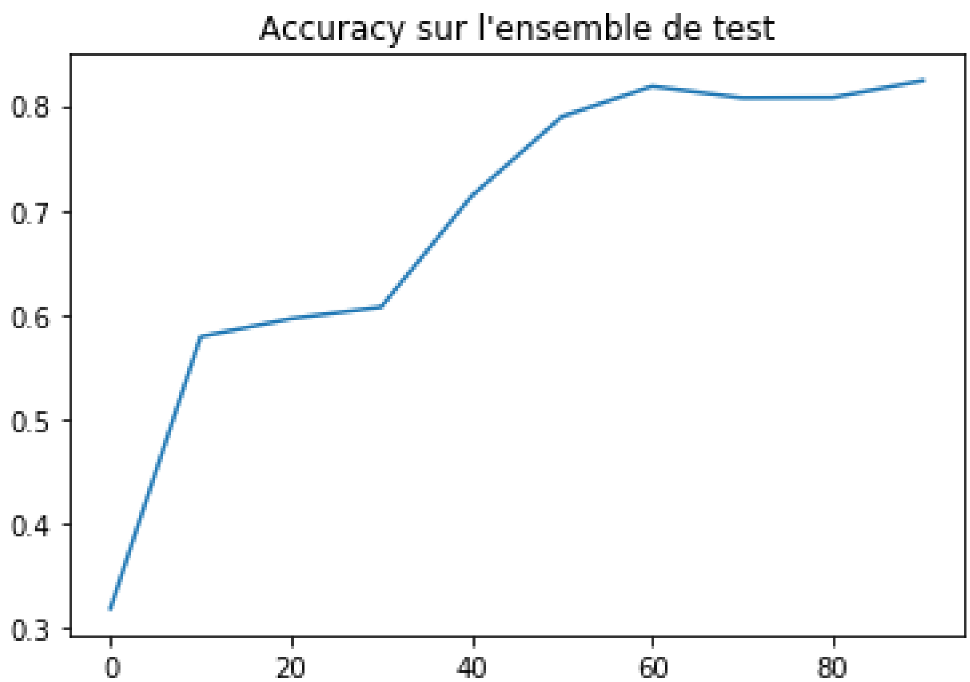
```
In [ ]: layers_dim_IN = 28*28 + 1
        layers_dim_H = 50
        layers_dim_OUT = 10

        model = Sequential(
            Linear(layers_dim_IN, layers_dim_H),
            Highway(layers_dim_H, 3, Relu),
            Linear(layers_dim_H, layers_dim_OUT),
            Sigmoid()
        ).cuda('cuda:0')

        loss_function = CrossEntropyLoss()

        optimiser = SGD(model.parameters(), lr=0.02)

        train_loss=[]
```

```
    val_loss=[]
    accuracy=[]

    for epoch in range(100):
        losses=[]
        for i,(X, y) in enumerate(get_minibatches(train_loader, device)):
            optimiser.zero_grad()
            yhat = model.forward(X)
            loss = loss_function(yhat, y.argmax(1))
            losses.append(loss.item())
            loss.backward()
            optimiser.step()

        train_loss.append(np.mean(losses))

        if epoch % 10 == 0:
            with torch.no_grad():
                losses = []
                corrects = 0
                for i,(X, y) in enumerate(get_minibatches(val_loader, device)):
                    y = y.argmax(1)
                    yhat = model.forward(X)
                    losses.append(loss_function(yhat, y).item())
                    ypred = yhat.argmax(1)
                    corrects += (ypred == y).sum()

                val_loss.append((epoch, np.mean(losses)))
                acc = corrects.cpu().numpy() / val_size
                print("Accuracy {}".format(acc))
                accuracy.append(acc)
```

```
In [22]: losses = np.array(val_loss)
         plt.title("Coût sur l'ensemble de test")
         plt.plot(losses[:,0],losses[:,1])
         plt.figure()
         plt.title("Accuracy sur l'ensemble de test")
         plt.plot(losses[:,0], accuracy)
```

```
Out[22]: [<matplotlib.lines.Line2D at 0x7f06a2d72f98>]
```


Coût sur l'ensemble de test
2.2
2.1
2.0
1.9
1.8
1.7
1.6
0
20
40
60
80


Accuracy sur l'ensemble de test
0.8
0.7
0.6
0.5
0.4
0.3
0
20
40
60
80

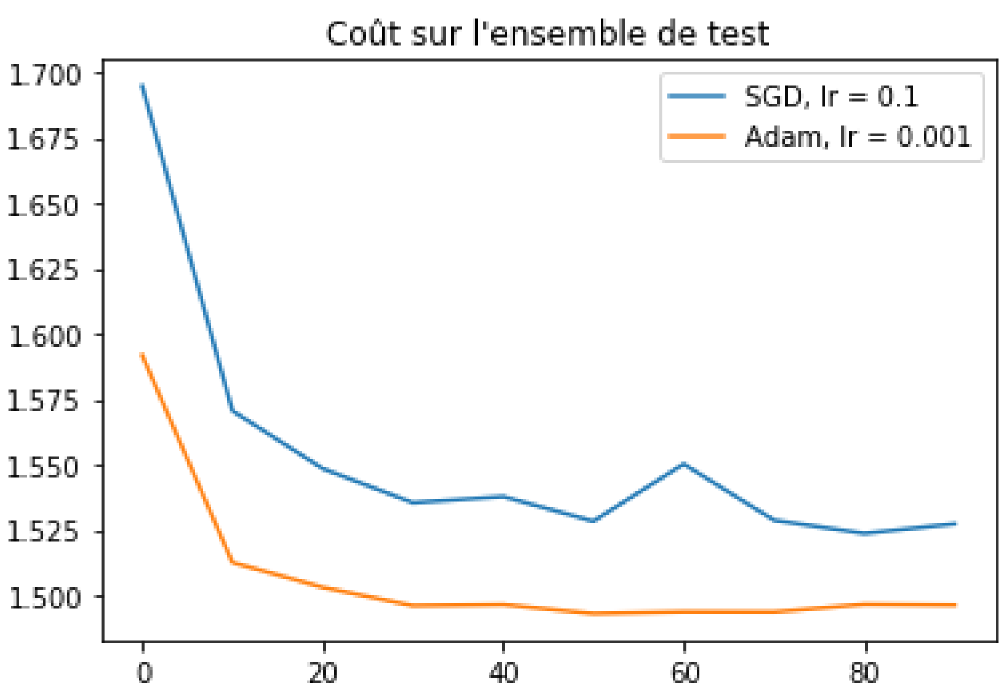
1.0.2 Comparaison du Adam et SGD

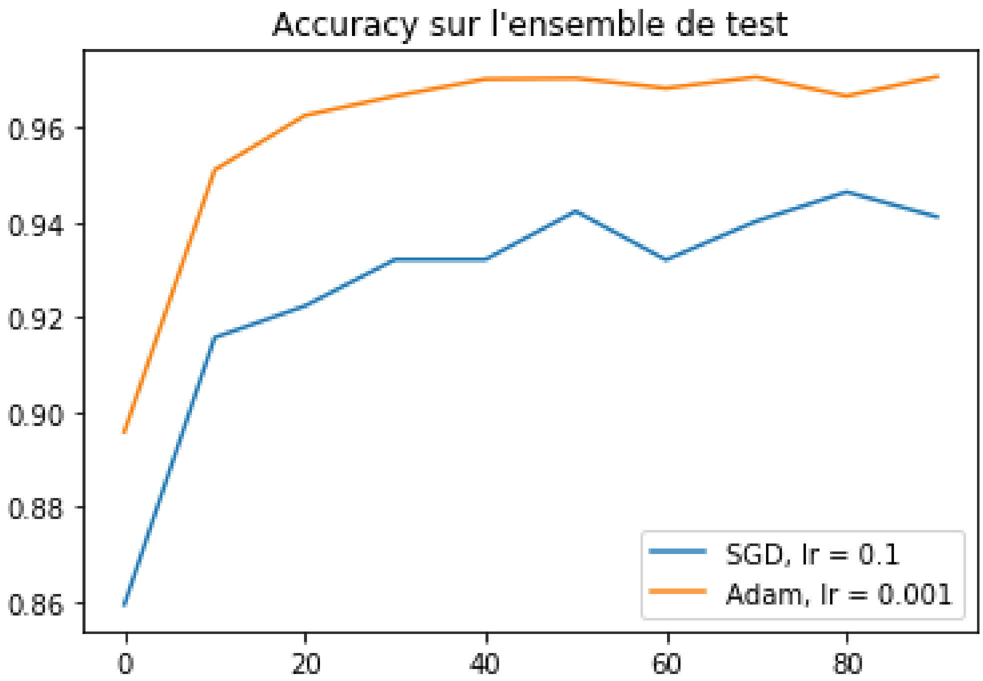
```
In [8]: adam_val_loss, adam_accuracy = two_layer_nn(Adam, learning_rate=0.001)
        print("ADAM finished")
        sgd_val_loss, sgd_accuracy = two_layer_nn(SGD, learning_rate=0.1)
        print("SGD finished")
```

```
ADAM finished
SGD finished
```

```
In [9]: def plot_loss_accuracys(results):
            plt.title("Coût sur l'ensemble de test")
            for (loss, acc) in results:
                loss = np.array(loss)
                plt.plot(loss[:,0],loss[:,1])
            plt.legend()
            plt.figure()
            plt.title("Accuracy sur l'ensemble de test")
            for (loss, acc) in results:
                loss = np.array(loss)
                plt.plot(loss[:,0],loss[:,1])
            plt.plot(loss[:,0], accuracy, lr = 0.1")
            plt.legend()
```

```
Out[9]: <matplotlib.legend.Legend at 0x7fd7ac021908>
```





Adam l'air de performer un peu mieux : il converge plus vite vers mieux accuracy.

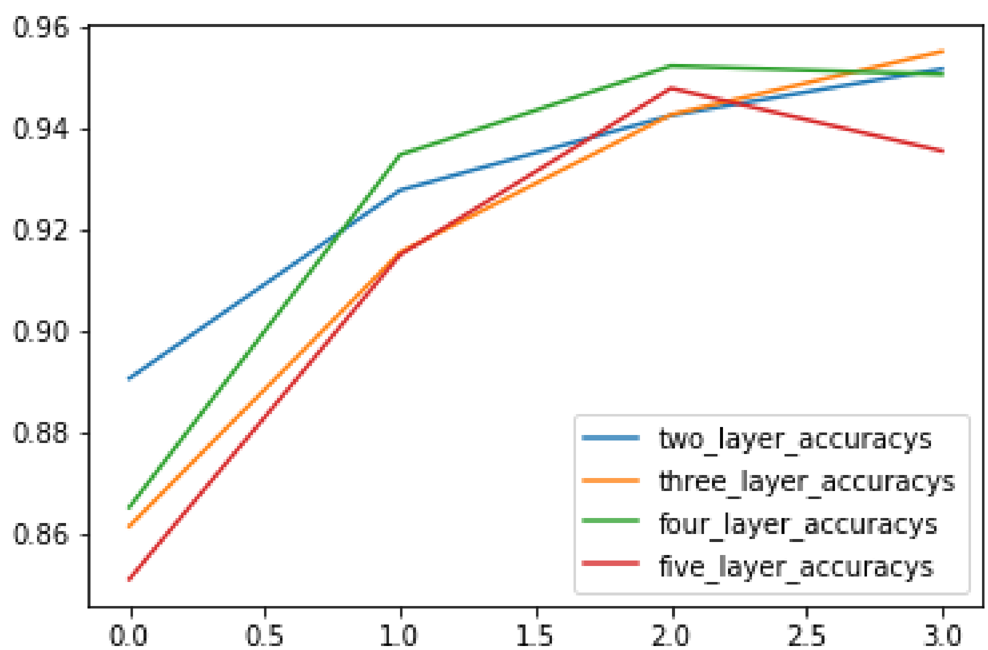
1.1 Variation du taille de reseaux

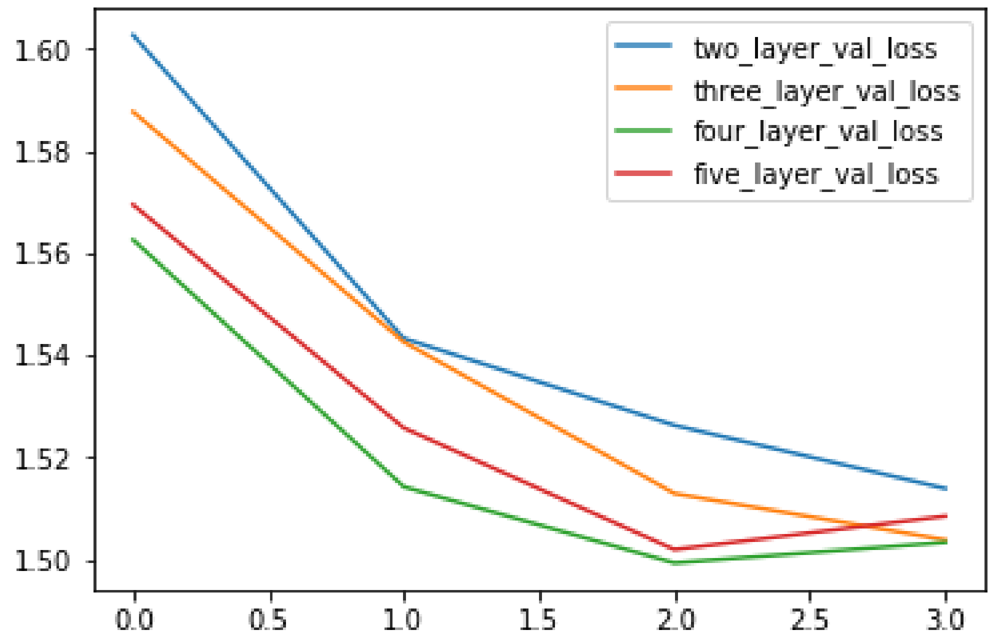
```
In [61]: results = {}
         dims = [
             ("two_layer", [28*28 + 1, 128, 10]),
             ("three_layer", [28*28 + 1, 128, 64, 10]),
             ("four_layer", [28*28 + 1, 256, 128, 64, 10]),
             ("five_layer", [28*28 + 1, 256, 256, 128, 64, 10])
         ]
         for (name, dim) in dims:
             print(name)
             print(dim)
             val_losses, accuracys = n_layer_nn(Adam, layer_dims=dim, learning_rate=0.001, epoc
             results[name + '_val_loss'] = val_losses
             results[name + '_accuracys'] = accuracys

         results_df = pd.DataFrame(results)
         acc_cols = [col for col in results_df.columns.tolist() if 'acc' in col]
         loss_cols = [col for col in results_df.columns.tolist() if 'loss' in col]
         results_df[acc_cols].plot()
         results_df[loss_cols].plot()
```

```
two_layer
[785, 128, 10]
```

```
[Linear(in_features=785, out_features=128, bias=True), Relu(), Linear(in_features=128, out_fea
Early stop at epoch 9
three_layer
[785, 128, 64, 10]
[Linear(in_features=785, out_features=128, bias=True), Relu(), Linear(in_features=128, out_fea
Early stop at epoch 9
four_layer
[785, 256, 128, 64, 10]
[Linear(in_features=785, out_features=256, bias=True), Relu(), Linear(in_features=256, out_fea
Early stop at epoch 9
five_layer
[785, 256, 256, 128, 64, 10]
[Linear(in_features=785, out_features=256, bias=True), Relu(), Linear(in_features=256, out_fea
Early stop at epoch 9
```

```
Out[61]: <matplotlib.axes._subplots.AxesSubplot at 0x7ff929335198>
```





Nous pouvons voir que il n'y a pas gros différence entre le loss et accuracy de differentes reseaux. Les reseaux de deux et trois couches se performe un peu mieux que les reseaux de quatre et cinq couches. À cause de grand dombre des poids dans les reseaux de