Relatório da Atividade Prática

Disciplina	**DLE – Fundamentos de Deep Learning**
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Atividades

1. Você deve executar o programa cinco vezes para cada rede e analisar em cada vez os resultados da performance obtidos pelas redes. Faça um relatório informando o resultado de todas as execuções, explicação da arquitetura de rede que foi construída e respondendo o motivo pelo qual uma redes apresentou melhor desempenho que a outra.

Versão sem rede Convolucional.

Primeira execução:

Train on 60000 samples, validate on 10000 samples

Epoch 1/10

- 8s - loss: 0.2766 - acc: 0.9219 - val_loss: 0.1330 - val_acc: 0.9617

Epoch 2/10

- 8s - loss: 0.1101 - acc: 0.9683 - val_loss: 0.0930 - val_acc: 0.9717

Epoch 3/10

- 8s - loss: 0.0701 - acc: 0.9795 - val_loss: 0.0775 - val_acc: 0.9769

Epoch 4/10

- 8s - loss: 0.0500 - acc: 0.9856 - val_loss: 0.0707 - val_acc: 0.9780

Epoch 5/10

- 8s - loss: 0.0360 - acc: 0.9894 - val_loss: 0.0624 - val_acc: 0.9808

Epoch 6/10

- 8s - loss: 0.0250 - acc: 0.9935 - val_loss: 0.0576 - val_acc: 0.9812

Epoch 7/10

- 8s - loss: 0.0186 - acc: 0.9957 - val_loss: 0.0630 - val_acc: 0.9800

Epoch 8/10

- 8s - loss: 0.0150 - acc: 0.9966 - val_loss: 0.0619 - val_acc: 0.9819

Epoch 9/10

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 - 8s - loss: 0.0108 - acc: 0.9976 - val_loss: 0.0616 - val_acc: 0.9806
Epoch 10/10
 - 8s - loss: 0.0092 - acc: 0.9980 - val_loss: 0.0638 - val_acc: 0.9811
acc: 98.11%
```

Segunda execução:

```
Train on 60000 samples, validate on 10000 samples
Epoch 1/10
 - 9s - loss: 0.2785 - acc: 0.9205 - val_loss: 0.1406 - val_acc: 0.9569
Epoch 2/10
 - 9s - loss: 0.1089 - acc: 0.9690 - val_loss: 0.1023 - val_acc: 0.9708
Epoch 3/10
 - 8s - loss: 0.0710 - acc: 0.9795 - val_loss: 0.0713 - val_acc: 0.9786
Epoch 4/10
 - 8s - loss: 0.0495 - acc: 0.9858 - val_loss: 0.0654 - val_acc: 0.9792
Epoch 5/10
 - 8s - loss: 0.0356 - acc: 0.9895 - val_loss: 0.0677 - val_acc: 0.9778
Epoch 6/10
 - 8s - loss: 0.0260 - acc: 0.9931 - val_loss: 0.0630 - val_acc: 0.9804
Epoch 7/10
 - 9s - loss: 0.0185 - acc: 0.9955 - val_loss: 0.0617 - val_acc: 0.9807
Epoch 8/10
 - 9s - loss: 0.0138 - acc: 0.9972 - val_loss: 0.0624 - val_acc: 0.9814
Epoch 9/10
 - 8s - loss: 0.0107 - acc: 0.9978 - val_loss: 0.0582 - val_acc: 0.9824
Epoch 10/10
 - 9s - loss: 0.0081 - acc: 0.9988 - val_loss: 0.0624 - val_acc: 0.9814
acc: 98.14%
```

Terceira execução:

```
Train on 60000 samples, validate on 10000 samples
Epoch 1/10
 - 9s - loss: 0.0120 - acc: 0.9968 - val_loss: 0.0710 - val_acc: 0.9791
Epoch 2/10
 - 8s - loss: 0.0062 - acc: 0.9986 - val_loss: 0.0648 - val_acc: 0.9817
```

Epoch 3/10
 - 8s - loss: 0.0052 - acc: 0.9989 - val_loss: 0.0678 - val_acc: 0.9809
Epoch 4/10
 - 8s - loss: 0.0067 - acc: 0.9982 - val_loss: 0.0675 - val_acc: 0.9814
Epoch 5/10
 - 8s - loss: 0.0056 - acc: 0.9986 - val_loss: 0.0645 - val_acc: 0.9828
Epoch 6/10
 - 9s - loss: 0.0014 - acc: 0.9999 - val_loss: 0.0615 - val_acc: 0.9848
Epoch 7/10
 - 10s - loss: 6.4725e-04 - acc: 1.0000 - val_loss: 0.0643 - val_acc: 0.9832
Epoch 8/10
 - 10s - loss: 4.1684e-04 - acc: 1.0000 - val_loss: 0.0655 - val_acc: 0.9835
Epoch 9/10
 - 9s - loss: 3.3114e-04 - acc: 1.0000 - val_loss: 0.0660 - val_acc: 0.9836
Epoch 10/10
 - 10s - loss: 2.7272e-04 - acc: 1.0000 - val_loss: 0.0663 - val_acc: 0.9839
acc: 98.39%

Quarta Execução:

Train on 60000 samples, validate on 10000 samples
Epoch 1/10
 - 10s - loss: 0.0052 - acc: 0.9984 - val_loss: 0.0769 - val_acc: 0.9813
Epoch 2/10
 - 8s - loss: 0.0020 - acc: 0.9995 - val_loss: 0.0771 - val_acc: 0.9817
Epoch 3/10
 - 8s - loss: 4.7603e-04 - acc: 1.0000 - val_loss: 0.0694 - val_acc: 0.9835
Epoch 4/10
 - 8s - loss: 2.0189e-04 - acc: 1.0000 - val_loss: 0.0689 - val_acc: 0.9839
Epoch 5/10
 - 8s - loss: 1.4941e-04 - acc: 1.0000 - val_loss: 0.0704 - val_acc: 0.9842
Epoch 6/10
 - 8s - loss: 1.2268e-04 - acc: 1.0000 - val_loss: 0.0710 - val_acc: 0.9843
Epoch 7/10
 - 8s - loss: 1.0499e-04 - acc: 1.0000 - val_loss: 0.0713 - val_acc: 0.9841
Epoch 8/10
 - 8s - loss: 9.2351e-05 - acc: 1.0000 - val_loss: 0.0716 - val_acc: 0.9839

```
Epoch 9/10
 - 8s - loss: 8.1530e-05 - acc: 1.0000 - val_loss: 0.0727 - val_acc: 0.9844
Epoch 10/10
 - 9s - loss: 7.1055e-05 - acc: 1.0000 - val_loss: 0.0733 - val_acc: 0.9844
acc: 98.44%

Quinta Execução:

Train on 60000 samples, validate on 10000 samples
Epoch 1/10
 - 8s - loss: 0.0051 - acc: 0.9981 - val_loss: 0.0918 - val_acc: 0.9807
Epoch 2/10
 - 8s - loss: 0.0018 - acc: 0.9995 - val_loss: 0.0816 - val_acc: 0.9828
Epoch 3/10
 - 8s - loss: 0.0017 - acc: 0.9995 - val_loss: 0.0809 - val_acc: 0.9833
Epoch 4/10
 - 8s - loss: 0.0019 - acc: 0.9994 - val_loss: 0.0867 - val_acc: 0.9808
Epoch 5/10
 - 8s - loss: 0.0065 - acc: 0.9981 - val_loss: 0.0944 - val_acc: 0.9793
Epoch 6/10
 - 8s - loss: 0.0053 - acc: 0.9984 - val_loss: 0.0893 - val_acc: 0.9820
Epoch 7/10
 - 9s - loss: 0.0022 - acc: 0.9993 - val_loss: 0.0839 - val_acc: 0.9822
Epoch 8/10
 - 9s - loss: 2.1089e-04 - acc: 1.0000 - val_loss: 0.0787 - val_acc: 0.9835
Epoch 9/10
 - 8s - loss: 9.0324e-05 - acc: 1.0000 - val_loss: 0.0788 - val_acc: 0.9836
Epoch 10/10
 - 8s - loss: 7.1030e-05 - acc: 1.0000 - val_loss: 0.0792 - val_acc: 0.9837
acc: 98.37%
```

Análise do primeiro item rede não Convolucional: A rede melhorou a acurácia até a quarta execução e começou a diminuir o tempo de execução. Mas na quinta execução começou a baixar a acurácia, de 89.44% para 98.37%.

Versão com rede Convolucional.

Primeira execução:

Train on 60000 samples, validate on 10000 samples
Epoch 1/10
 - 45s - loss: 0.2352 - acc: 0.9322 - val_loss: 0.0732 - val_acc: 0.9784
Epoch 2/10
 - 44s - loss: 0.0714 - acc: 0.9785 - val_loss: 0.0474 - val_acc: 0.9848
Epoch 3/10
 - 49s - loss: 0.0496 - acc: 0.9854 - val_loss: 0.0410 - val_acc: 0.9870
Epoch 4/10
 - 53s - loss: 0.0387 - acc: 0.9884 - val_loss: 0.0362 - val_acc: 0.9877
Epoch 5/10
 - 48s - loss: 0.0322 - acc: 0.9898 - val_loss: 0.0357 - val_acc: 0.9872
Epoch 6/10
 - 46s - loss: 0.0260 - acc: 0.9918 - val_loss: 0.0343 - val_acc: 0.9884
Epoch 7/10
 - 41s - loss: 0.0229 - acc: 0.9925 - val_loss: 0.0363 - val_acc: 0.9881
Epoch 8/10
 - 40s - loss: 0.0184 - acc: 0.9939 - val_loss: 0.0334 - val_acc: 0.9894
Epoch 9/10
 - 40s - loss: 0.0158 - acc: 0.9950 - val_loss: 0.0369 - val_acc: 0.9886
Epoch 10/10
 - 41s - loss: 0.0133 - acc: 0.9960 - val_loss: 0.0363 - val_acc: 0.9896
acc: 98.96%

Segunda execução:

Train on 60000 samples, validate on 10000 samples
Epoch 1/10
 - 44s - loss: 0.2319 - acc: 0.9338 - val_loss: 0.0754 - val_acc: 0.9766
Epoch 2/10
 - 40s - loss: 0.0705 - acc: 0.9790 - val_loss: 0.0500 - val_acc: 0.9844
Epoch 3/10
 - 42s - loss: 0.0508 - acc: 0.9844 - val_loss: 0.0460 - val_acc: 0.9844
Epoch 4/10
 - 40s - loss: 0.0376 - acc: 0.9882 - val_loss: 0.0374 - val_acc: 0.9877
Epoch 5/10

- 40s - loss: 0.0316 - acc: 0.9905 - val_loss: 0.0415 - val_acc: 0.9869
Epoch 6/10
- 43s - loss: 0.0259 - acc: 0.9918 - val_loss: 0.0338 - val_acc: 0.9894
Epoch 7/10
- 42s - loss: 0.0208 - acc: 0.9931 - val_loss: 0.0309 - val_acc: 0.9895
Epoch 8/10
- 46s - loss: 0.0170 - acc: 0.9943 - val_loss: 0.0422 - val_acc: 0.9871
Epoch 9/10
- 42s - loss: 0.0145 - acc: 0.9950 - val_loss: 0.0327 - val_acc: 0.9894
Epoch 10/10
- 44s - loss: 0.0130 - acc: 0.9961 - val_loss: 0.0370 - val_acc: 0.9884
acc: 98.84%

Terceira execução:

Train on 60000 samples, validate on 10000 samples
Epoch 1/10
- 44s - loss: 0.0129 - acc: 0.9958 - val_loss: 0.0357 - val_acc: 0.9890
Epoch 2/10
- 42s - loss: 0.0115 - acc: 0.9961 - val_loss: 0.0400 - val_acc: 0.9890
Epoch 3/10
- 43s - loss: 0.0088 - acc: 0.9973 - val_loss: 0.0391 - val_acc: 0.9879
Epoch 4/10
- 43s - loss: 0.0072 - acc: 0.9977 - val_loss: 0.0394 - val_acc: 0.9887
Epoch 5/10
- 44s - loss: 0.0077 - acc: 0.9973 - val_loss: 0.0380 - val_acc: 0.9906
Epoch 6/10
- 42s - loss: 0.0070 - acc: 0.9979 - val_loss: 0.0333 - val_acc: 0.9905
Epoch 7/10
- 45s - loss: 0.0058 - acc: 0.9981 - val_loss: 0.0400 - val_acc: 0.9897
Epoch 8/10
- 42s - loss: 0.0056 - acc: 0.9981 - val_loss: 0.0403 - val_acc: 0.9889
Epoch 9/10
- 43s - loss: 0.0049 - acc: 0.9985 - val_loss: 0.0400 - val_acc: 0.9902
Epoch 10/10
- 44s - loss: 0.0039 - acc: 0.9988 - val_loss: 0.0455 - val_acc: 0.9886
acc: 98.86%

Quarta Execução:

Train on 60000 samples, validate on 10000 samples
Epoch 1/10
 - 45s - loss: 0.0041 - acc: 0.9986 - val_loss: 0.0483 - val_acc: 0.9894
Epoch 2/10
 - 43s - loss: 0.0044 - acc: 0.9987 - val_loss: 0.0538 - val_acc: 0.9886
Epoch 3/10
 - 45s - loss: 0.0043 - acc: 0.9986 - val_loss: 0.0472 - val_acc: 0.9889
Epoch 4/10
 - 45s - loss: 0.0044 - acc: 0.9987 - val_loss: 0.0536 - val_acc: 0.9872
Epoch 5/10
 - 42s - loss: 0.0031 - acc: 0.9990 - val_loss: 0.0519 - val_acc: 0.9891
Epoch 6/10
 - 46s - loss: 0.0036 - acc: 0.9989 - val_loss: 0.0411 - val_acc: 0.9906
Epoch 7/10
 - 44s - loss: 0.0026 - acc: 0.9991 - val_loss: 0.0460 - val_acc: 0.9896
Epoch 8/10
 - 42s - loss: 0.0021 - acc: 0.9994 - val_loss: 0.0421 - val_acc: 0.9903
Epoch 9/10
 - 46s - loss: 0.0033 - acc: 0.9990 - val_loss: 0.0493 - val_acc: 0.9895
Epoch 10/10
 - 43s - loss: 0.0033 - acc: 0.9989 - val_loss: 0.0503 - val_acc: 0.9901
acc: 99.00%

Quinta execução:

Train on 60000 samples, validate on 10000 samples
Epoch 1/10
 - 44s - loss: 0.0030 - acc: 0.9991 - val_loss: 0.0493 - val_acc: 0.9893
Epoch 2/10
 - 43s - loss: 0.0024 - acc: 0.9991 - val_loss: 0.0519 - val_acc: 0.9905
Epoch 3/10
 - 46s - loss: 0.0039 - acc: 0.9989 - val_loss: 0.0475 - val_acc: 0.9910
Epoch 4/10
 - 47s - loss: 0.0019 - acc: 0.9994 - val_loss: 0.0509 - val_acc: 0.9902

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Epoch 5/10
 - 50s - loss: 0.0024 - acc: 0.9992 - val_loss: 0.0555 - val_acc: 0.9888
Epoch 6/10
 - 48s - loss: 0.0029 - acc: 0.9991 - val_loss: 0.0495 - val_acc: 0.9895
Epoch 7/10
 - 46s - loss: 0.0024 - acc: 0.9993 - val_loss: 0.0562 - val_acc: 0.9896
Epoch 8/10
 - 47s - loss: 0.0023 - acc: 0.9993 - val_loss: 0.0530 - val_acc: 0.9896
Epoch 9/10
 - 50s - loss: 0.0021 - acc: 0.9993 - val_loss: 0.0541 - val_acc: 0.9892
Epoch 10/10
 - 46s - loss: 0.0028 - acc: 0.9990 - val_loss: 0.0558 - val_acc: 0.9900
acc: 99.00%
```

Análise do primeiro item Rede Convolucional: A rede melhorou a acurácia em todas as suas execuções, a quarta e a quinta execução não houve alterações na saída da acurácia de 99.00%.