CPSC 8430: Deep Learning

Homework #3

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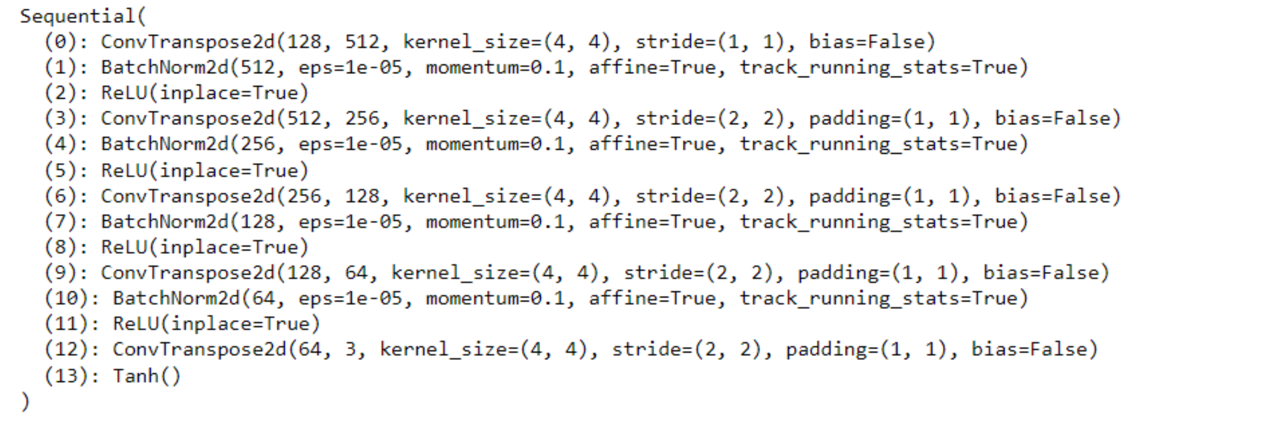
In this homework, we have used the CIFAR-10 dataset with different types of generative adversarial networks (GANs), such as deep convolutional GAN (DCGAN) and auxiliary classifier GAN (ACGAN), to generate fake images of 10 different classes, such as airplane, automobile, bird, cat, deer, dog, frog, horse, ship, and truck.

DCGAN Implementation:

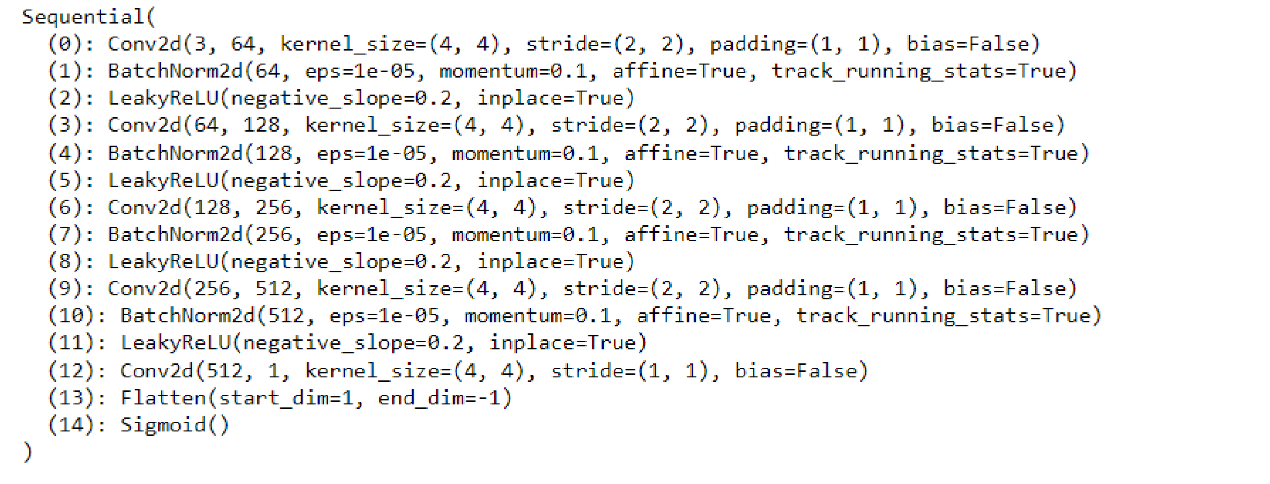
The table below presents the networks used as baselines for the generator and the discriminator for DCGAN implementation used in this project. We also present the best 10 fake images of 10 classes in the CIFAR-10 dataset.

Generator Network



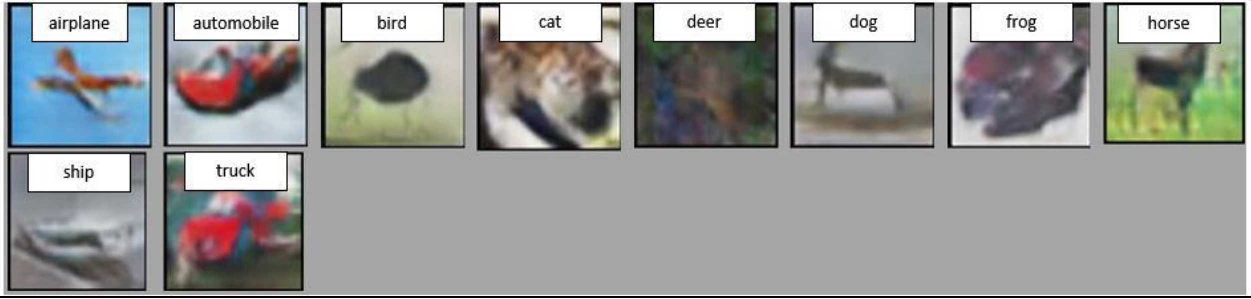
```
Sequential(
  (0): ConvTranspose2d(128, 512, kernel_size=(4, 4), stride=(1, 1), bias=False)
  (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  (2): ReLU(inplace=True)
  (3): ConvTranspose2d(512, 256, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
  (4): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  (5): ReLU(inplace=True)
  (6): ConvTranspose2d(256, 128, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
  (7): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  (8): ReLU(inplace=True)
  (9): ConvTranspose2d(128, 64, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
  (10): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  (11): ReLU(inplace=True)
  (12): ConvTranspose2d(64, 3, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
  (13): Tanh()
)
```

Discriminator Network



```
Sequential(
  (0): Conv2d(3, 64, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
  (1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  (2): LeakyReLU(negative_slope=0.2, inplace=True)
  (3): Conv2d(64, 128, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
  (4): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  (5): LeakyReLU(negative_slope=0.2, inplace=True)
  (6): Conv2d(128, 256, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
  (7): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  (8): LeakyReLU(negative_slope=0.2, inplace=True)
  (9): Conv2d(256, 512, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
  (10): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  (11): LeakyReLU(negative_slope=0.2, inplace=True)
  (12): Conv2d(512, 1, kernel_size=(4, 4), stride=(1, 1), bias=False)
  (13): Flatten(start_dim=1, end_dim=-1)
  (14): Sigmoid()
)
```

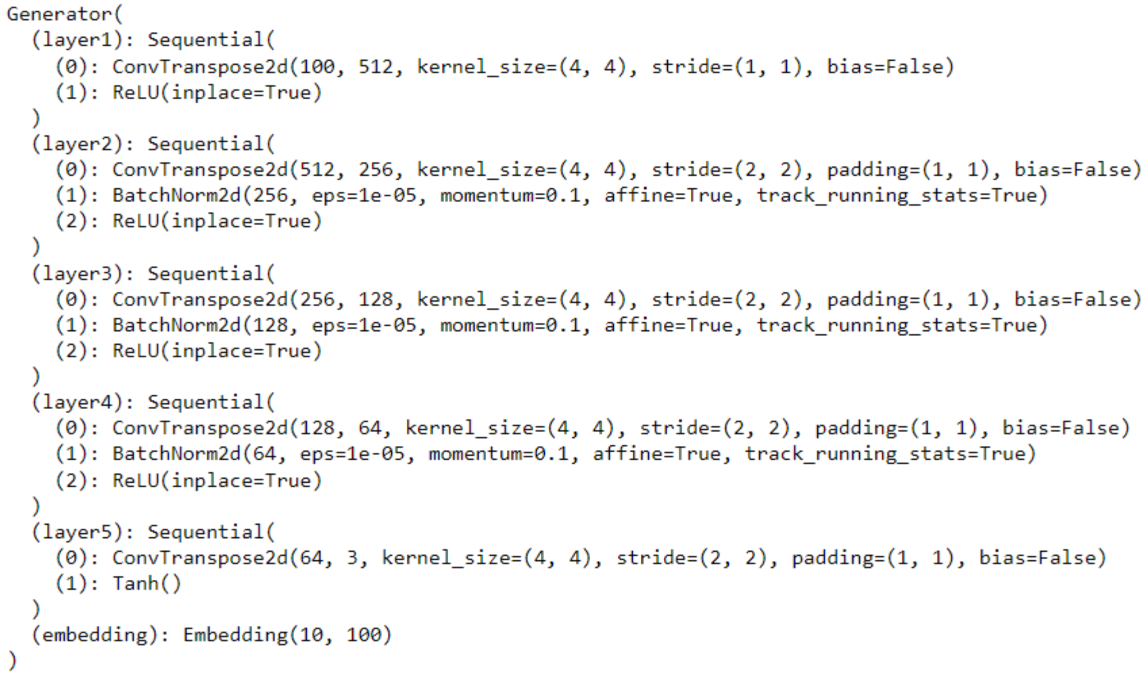
10 Best Fake Images Generated by ACGAN



ACGAN Implementation:

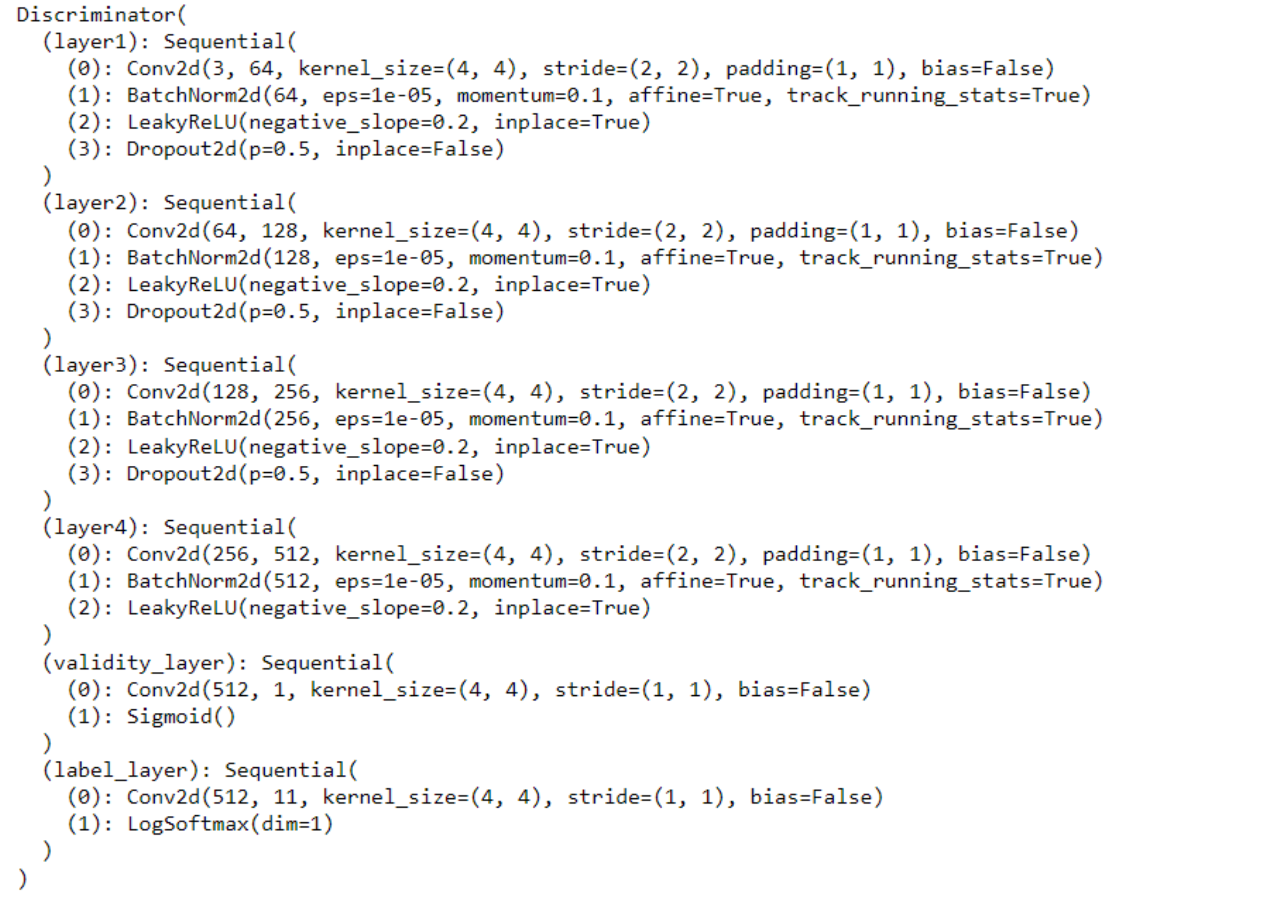
The table below presents the networks used as baselines for the generator and the discriminator for ACGAN implementation used in this project. We also present the best 10 fake images of 10 classes in the CIFAR-10 dataset.

Generator Network



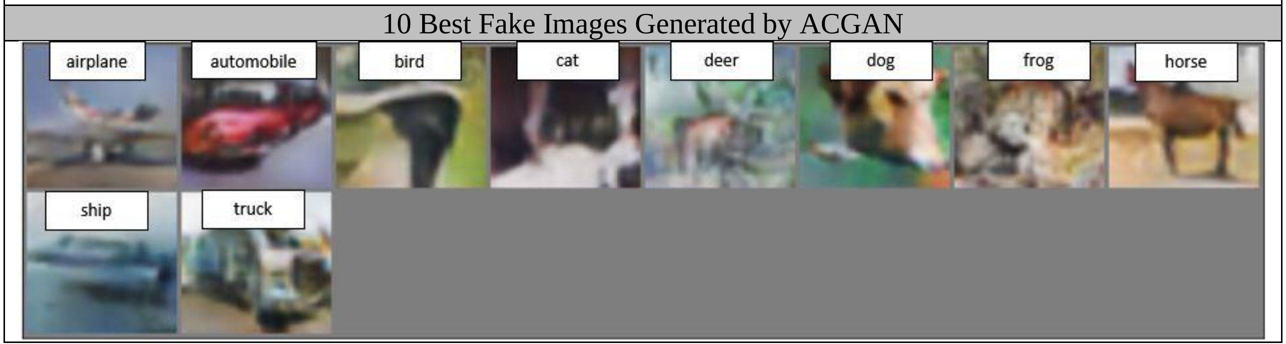
```
Generator(
  (layer1): Sequential(
    (0): ConvTranspose2d(100, 512, kernel_size=(4, 4), stride=(1, 1), bias=False)
    (1): ReLU(inplace=True)
  )
  (layer2): Sequential(
    (0): ConvTranspose2d(512, 256, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): ReLU(inplace=True)
  )
  (layer3): Sequential(
    (0): ConvTranspose2d(256, 128, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): ReLU(inplace=True)
  )
  (layer4): Sequential(
    (0): ConvTranspose2d(128, 64, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): ReLU(inplace=True)
  )
  (layer5): Sequential(
    (0): ConvTranspose2d(64, 3, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (1): Tanh()
  )
  (embedding): Embedding(10, 100)
)
```

Discriminator Network



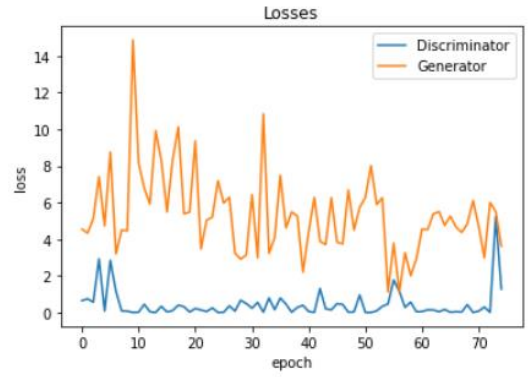
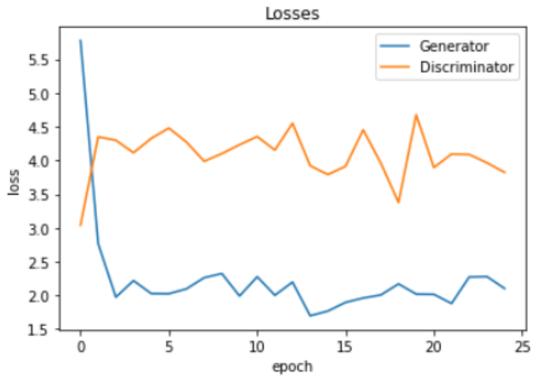
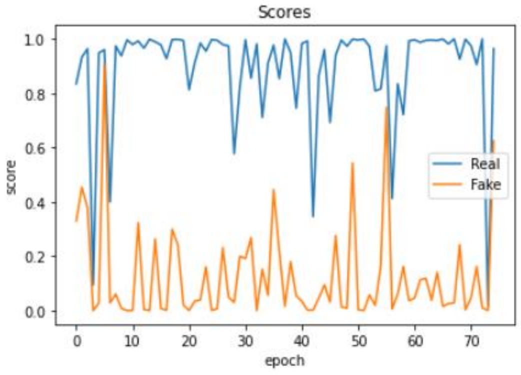
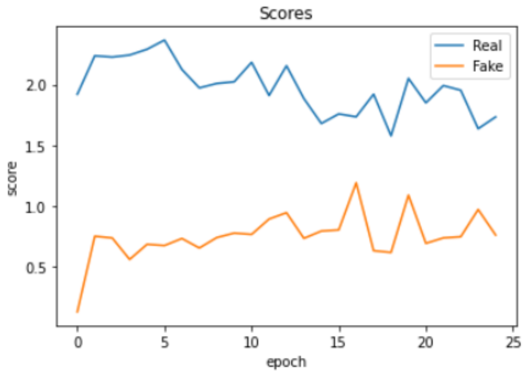
```
Discriminator(
  (layer1): Sequential(
    (0): Conv2d(3, 64, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): LeakyReLU(negative_slope=0.2, inplace=True)
    (3): Dropout2d(p=0.5, inplace=False)
  )
  (layer2): Sequential(
    (0): Conv2d(64, 128, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): LeakyReLU(negative_slope=0.2, inplace=True)
    (3): Dropout2d(p=0.5, inplace=False)
  )
  (layer3): Sequential(
    (0): Conv2d(128, 256, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): LeakyReLU(negative_slope=0.2, inplace=True)
    (3): Dropout2d(p=0.5, inplace=False)
  )
  (layer4): Sequential(
    (0): Conv2d(256, 512, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): LeakyReLU(negative_slope=0.2, inplace=True)
  )
  (validity_layer): Sequential(
    (0): Conv2d(512, 1, kernel_size=(4, 4), stride=(1, 1), bias=False)
    (1): Sigmoid()
  )
  (label_layer): Sequential(
    (0): Conv2d(512, 11, kernel_size=(4, 4), stride=(1, 1), bias=False)
    (1): LogSoftmax(dim=1)
  )
)
```

10 Best Fake Images Generated by ACGAN



Comparison of DCGAN and ACGAN:

We performed both DCGAN and ACGAN operations on the images for 75 epochs and recorded the losses of both the generator and the discriminator. The table below shows the model losses for both GANs. We also present the discriminator's score on the real and fake images in the table below.

Model Losses	
DCGAN	ACGAN
	
Scores	
DCGAN	ACGAN
 Scores Real Fake score 0.0 0.2 0.4 0.6 0.8 1.0 epoch 0 10 20 30 40 50 60 70	 Scores Real Fake score 0.5 1.0 1.5 2.0 epoch 0 5 10 15 20 25