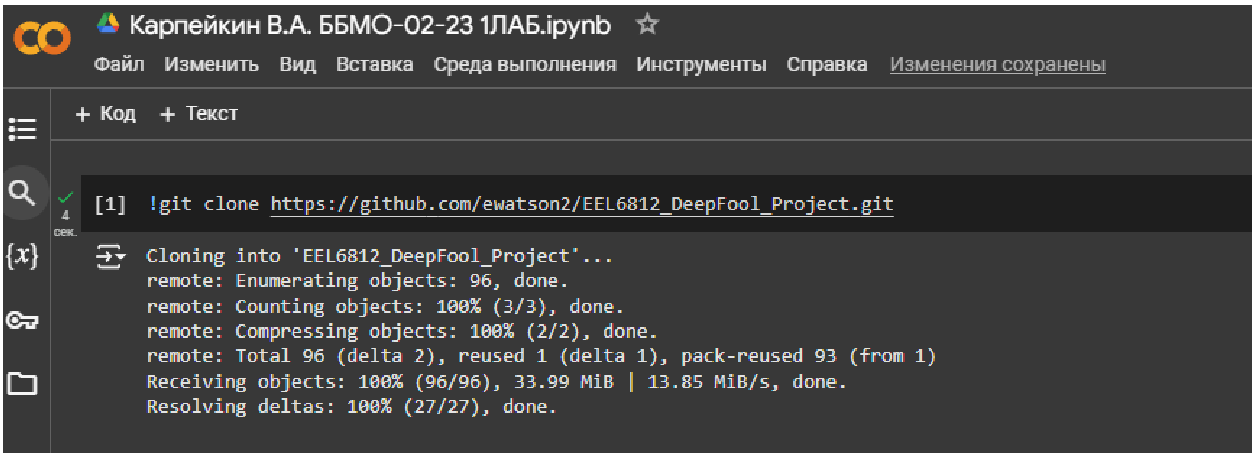
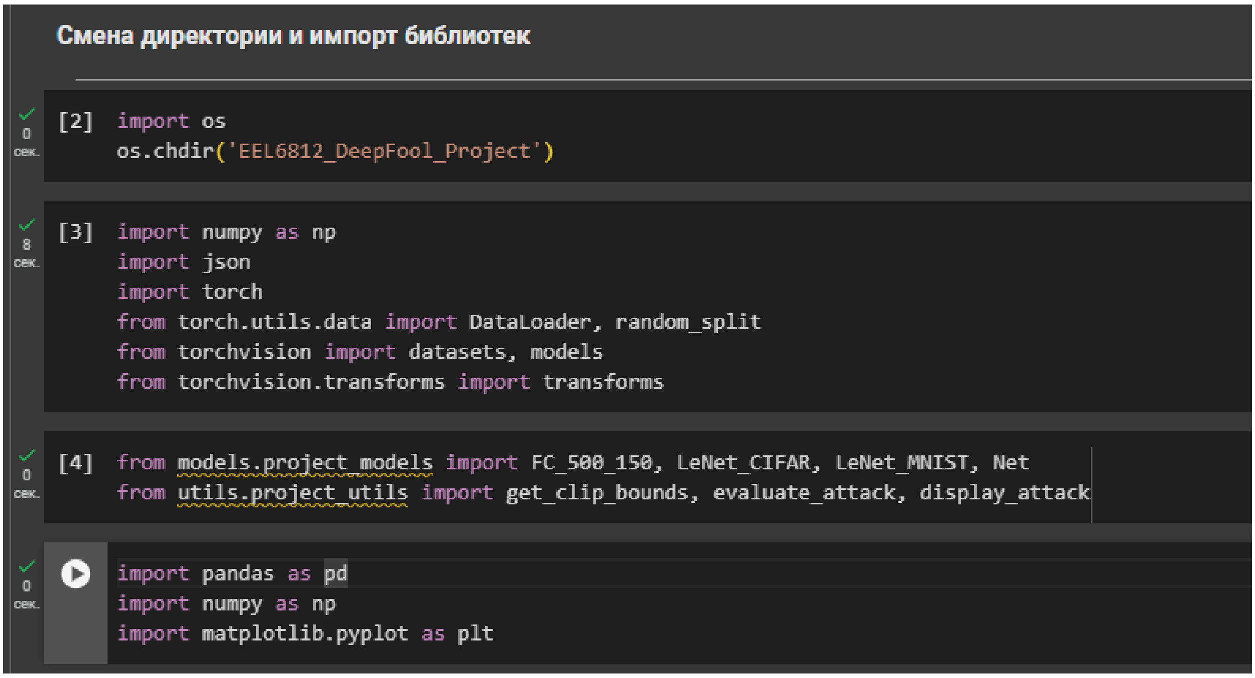
Карпейкин В.А. ББМО-02-23 Номер 10

Клонирование репозитория


Карпейкин В.А. ББМО-02-23 1ЛАБ.ipynb
Файл Изменить Вид Вставка Среда выполнения Инструменты Справка Изменения сохранены
+ Код + Текст
4 сек.

```
[1] !git clone https://github.com/ewatson2/EEL6812_DeepFool_Project.git

Cloning into 'EEL6812_DeepFool_Project'...
remote: Enumerating objects: 96, done.
remote: Counting objects: 100% (3/3), done.
remote: Compressing objects: 100% (2/2), done.
remote: Total 96 (delta 2), reused 1 (delta 1), pack-reused 93 (from 1)
Receiving objects: 100% (96/96), 33.99 MiB | 13.85 MiB/s, done.
Resolving deltas: 100% (27/27), done.
```

Смена директории и импорт библиотек



Смена директории и импорт библиотек

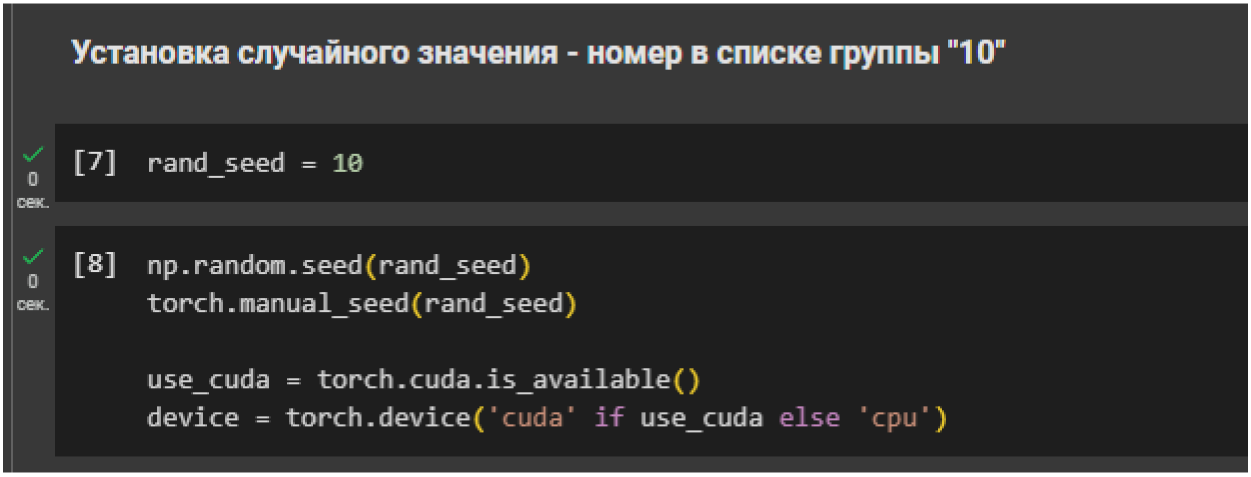
```
[2] import os
    os.chdir('EEL6812_DeepFool_Project')
```

```
[3] import numpy as np
    import json
    import torch
    from torch.utils.data import DataLoader, random_split
    from torchvision import datasets, models
    from torchvision.transforms import transforms
```

```
[4] from models.project_models import FC_500_150, LeNet_CIFAR, LeNet_MNIST, Net
    from utils.project_utils import get_clip_bounds, evaluate_attack, display_attack
```

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

Установка случайного значения – номер в списке группы «7»

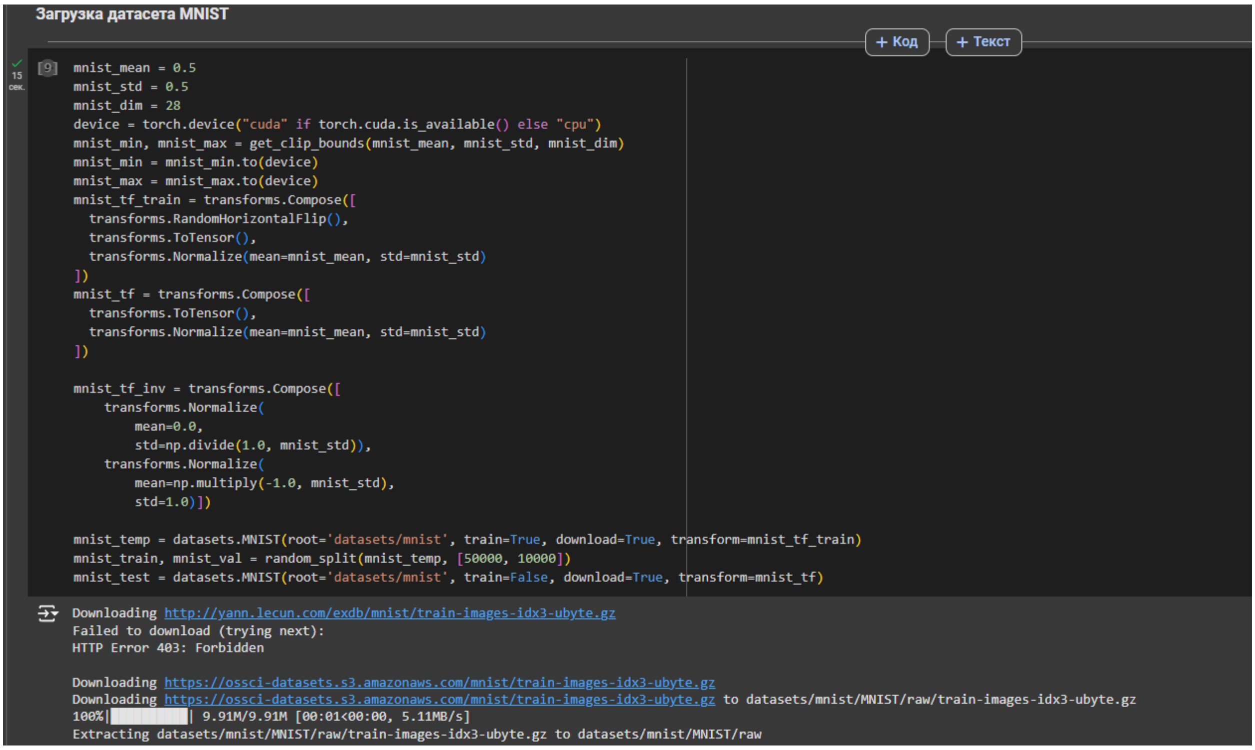


Установка случайного значения - номер в списке группы "10"

```
[7] rand_seed = 10
```

```
[8] np.random.seed(rand_seed)
    torch.manual_seed(rand_seed)

    use_cuda = torch.cuda.is_available()
    device = torch.device('cuda' if use_cuda else 'cpu')
```

Загрузка датасета MNIST

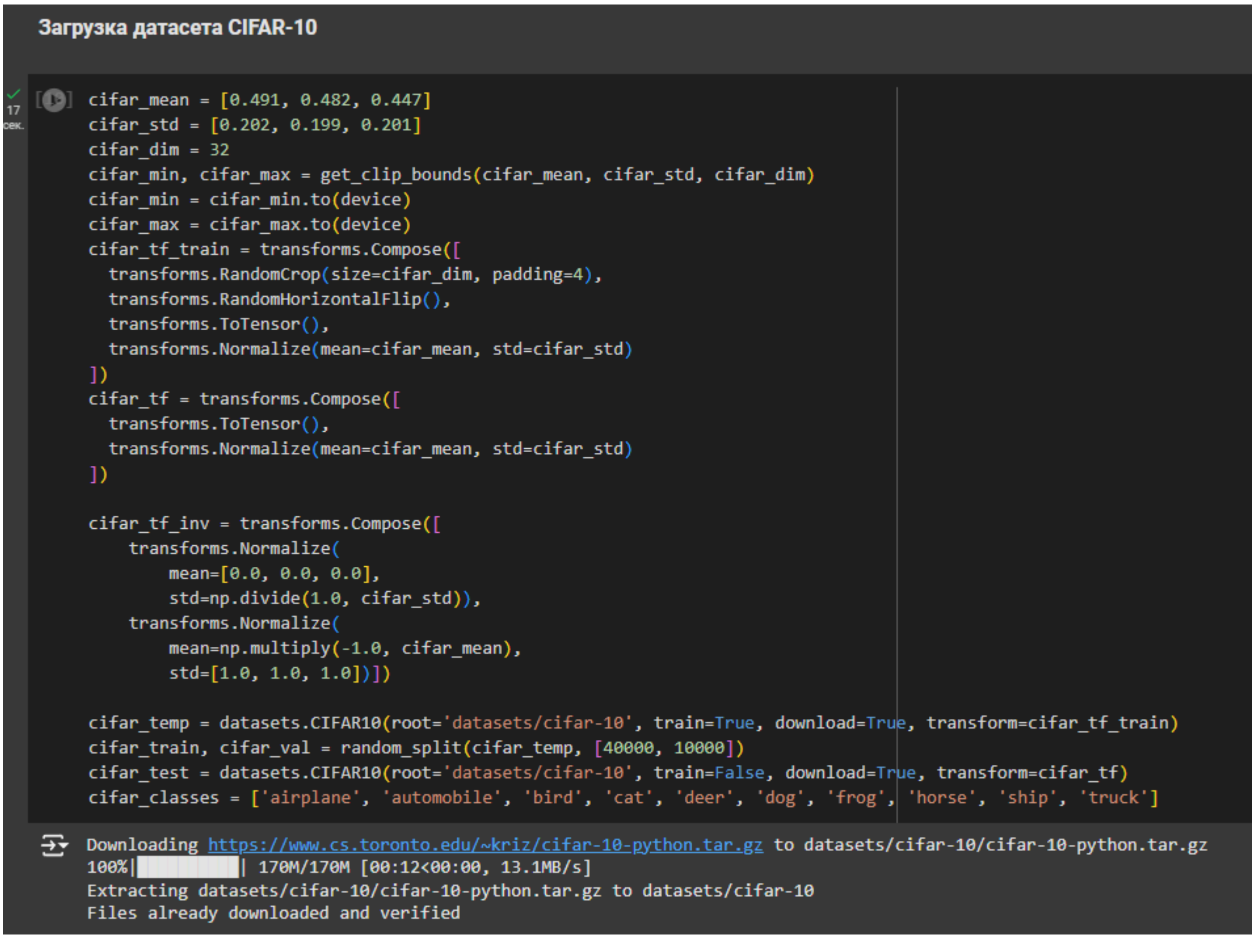


Загрузка датасета MNIST

```
mnist_mean = 0.5
mnist_std = 0.5
mnist_dim = 28
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
mnist_min, mnist_max = get_clip_bounds(mnist_mean, mnist_std, mnist_dim)
mnist_min = mnist_min.to(device)
mnist_max = mnist_max.to(device)
mnist_tf_train = transforms.Compose([
  transforms.RandomHorizontalFlip(),
  transforms.ToTensor(),
  transforms.Normalize(mean=mnist_mean, std=mnist_std)
])
mnist_tf = transforms.Compose([
  transforms.ToTensor(),
  transforms.Normalize(mean=mnist_mean, std=mnist_std)
])

mnist_tf_inv = transforms.Compose([
    transforms.Normalize(
        mean=0.0,
        std=np.divide(1.0, mnist_std)),
    transforms.Normalize(
        mean=np.multiply(-1.0, mnist_std),
        std=1.0)])

mnist_temp = datasets.MNIST(root='datasets/mnist', train=True, download=True, transform=mnist_tf_train)
mnist_train, mnist_val = random_split(mnist_temp, [50000, 10000])
mnist_test = datasets.MNIST(root='datasets/mnist', train=False, download=True, transform=mnist_tf)
```

```
Downloading http://yann.lecun.com/exdb/mnist/train-images-idx3-ubyte.gz
Failed to download (trying next):
HTTP Error 403: Forbidden

Downloading https://ossci-datasets.s3.amazonaws.com/mnist/train-images-idx3-ubyte.gz
Downloading https://ossci-datasets.s3.amazonaws.com/mnist/train-images-idx3-ubyte.gz to datasets/mnist/MNIST/raw/train-images-idx3-ubyte.gz
100%|██████████| 9.91M/9.91M [00:01<00:00, 5.11MB/s]
Extracting datasets/mnist/MNIST/raw/train-images-idx3-ubyte.gz to datasets/mnist/MNIST/raw
```

Загрузка датасета CIFAR-10

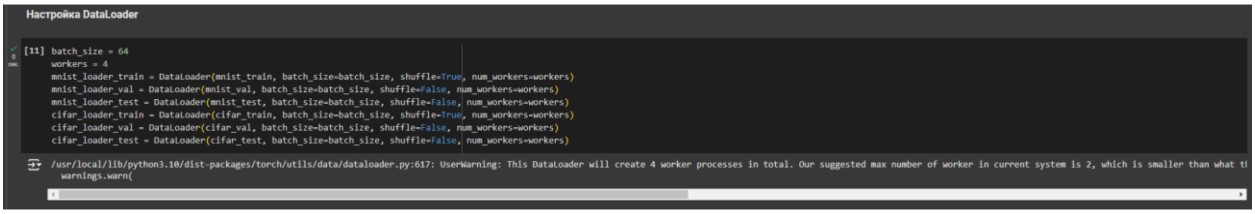


Загрузка датасета CIFAR-10

```
cifar_mean = [0.491, 0.482, 0.447]
cifar_std = [0.202, 0.199, 0.201]
cifar_dim = 32
cifar_min, cifar_max = get_clip_bounds(cifar_mean, cifar_std, cifar_dim)
cifar_min = cifar_min.to(device)
cifar_max = cifar_max.to(device)
cifar_tf_train = transforms.Compose([
  transforms.RandomCrop(size=cifar_dim, padding=4),
  transforms.RandomHorizontalFlip(),
  transforms.ToTensor(),
  transforms.Normalize(mean=cifar_mean, std=cifar_std)
])
cifar_tf = transforms.Compose([
  transforms.ToTensor(),
  transforms.Normalize(mean=cifar_mean, std=cifar_std)
])

cifar_tf_inv = transforms.Compose([
    transforms.Normalize(
        mean=[0.0, 0.0, 0.0],
        std=np.divide(1.0, cifar_std)),
    transforms.Normalize(
        mean=np.multiply(-1.0, cifar_mean),
        std=[1.0, 1.0, 1.0])])

cifar_temp = datasets.CIFAR10(root='datasets/cifar-10', train=True, download=True, transform=cifar_tf_train)
cifar_train, cifar_val = random_split(cifar_temp, [40000, 10000])
cifar_test = datasets.CIFAR10(root='datasets/cifar-10', train=False, download=True, transform=cifar_tf)
cifar_classes = ['airplane', 'automobile', 'bird', 'cat', 'deer', 'dog', 'frog', 'horse', 'ship', 'truck']
```

```
Downloading https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz to datasets/cifar-10/cifar-10-python.tar.gz
100%|██████████| 170M/170M [00:12<00:00, 13.1MB/s]
Extracting datasets/cifar-10/cifar-10-python.tar.gz to datasets/cifar-10
Files already downloaded and verified
```

Настройка DataLoader



Настройка DataLoader

```
batch_size = 64
workers = 4
mnist_loader_train = DataLoader(mnist_train, batch_size=batch_size, shuffle=True, num_workers=workers)
mnist_loader_val = DataLoader(mnist_val, batch_size=batch_size, shuffle=False, num_workers=workers)
mnist_loader_test = DataLoader(mnist_test, batch_size=batch_size, shuffle=False, num_workers=workers)
cifar_loader_train = DataLoader(cifar_train, batch_size=batch_size, shuffle=True, num_workers=workers)
cifar_loader_val = DataLoader(cifar_val, batch_size=batch_size, shuffle=False, num_workers=workers)
cifar_loader_test = DataLoader(cifar_test, batch_size=batch_size, shuffle=False, num_workers=workers)
```

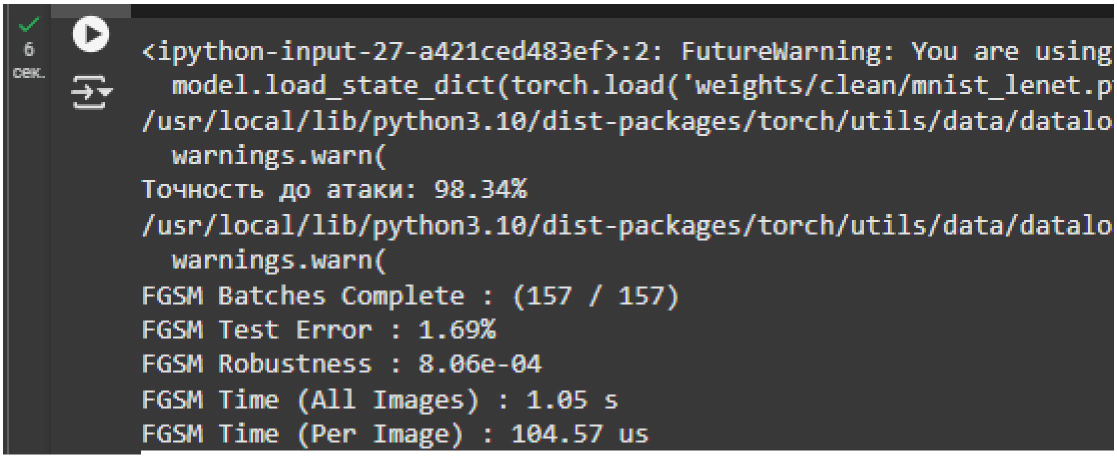
```
/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py:617: UserWarning: This DataLoader will create 4 worker processes in total. Our suggested max number of worker in current system is 2, which is smaller than what tl
  warnings.warn(
```

FGSM атака

Стойкость к атаке моделей LeNet, FC на датасете MNIST и стойкость к атаке моделей Network-In-Network, LeNet на датасете CIFAR-10

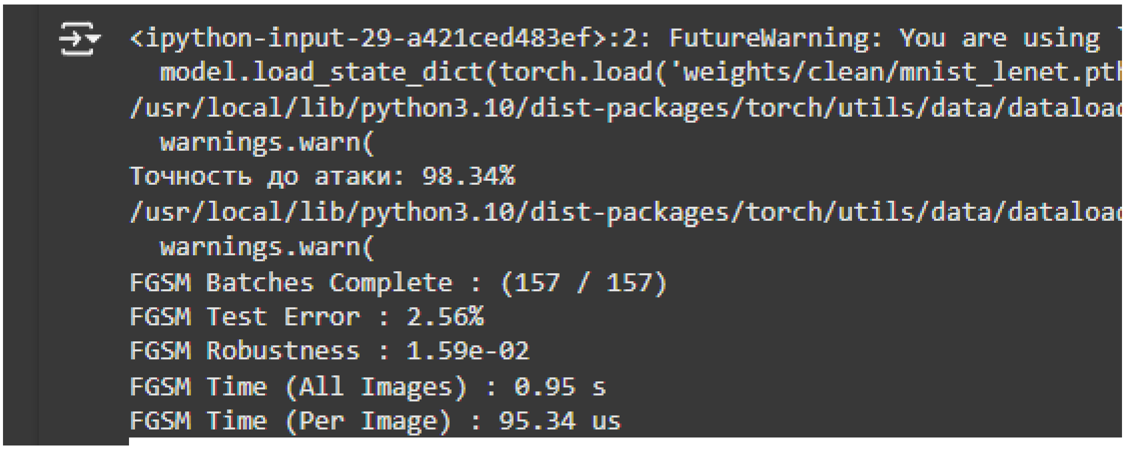
LeNet MNIST

fgsm_eps = 0.001



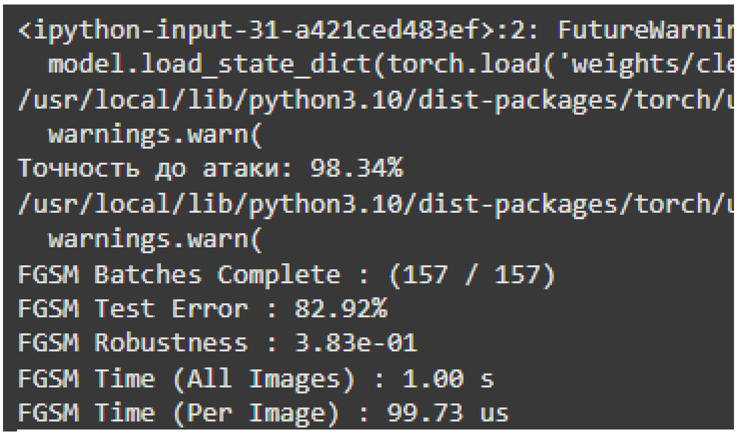
```
<ipython-input-27-a421ced483ef>:2: FutureWarning: You are using
  model.load_state_dict(torch.load('weights/clean/mnist_lenet.p
/usr/local/lib/python3.10/dist-packages/torch/utils/data/datalo
  warnings.warn(
Точность до атаки: 98.34%
/usr/local/lib/python3.10/dist-packages/torch/utils/data/datalo
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 1.69%
FGSM Robustness : 8.06e-04
FGSM Time (All Images) : 1.05 s
FGSM Time (Per Image) : 104.57 us
```

fgsm_eps = 0.02



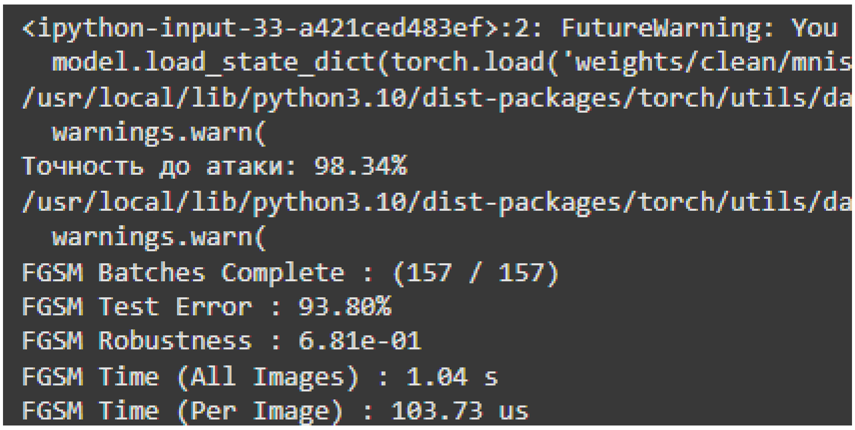
```
<ipython-input-29-a421ced483ef>:2: FutureWarning: You are using
  model.load_state_dict(torch.load('weights/clean/mnist_lenet.pt
/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloa
  warnings.warn(
Точность до атаки: 98.34%
/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloa
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 2.56%
FGSM Robustness : 1.59e-02
FGSM Time (All Images) : 0.95 s
FGSM Time (Per Image) : 95.34 us
```

fgsm_eps = 0.5



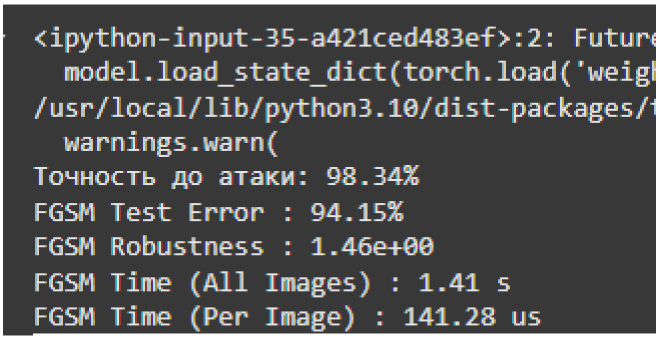
```
<ipython-input-31-a421ced483ef>:2: FutureWarnin
  model.load_state_dict(torch.load('weights/cle
/usr/local/lib/python3.10/dist-packages/torch/u
  warnings.warn(
Точность до атаки: 98.34%
/usr/local/lib/python3.10/dist-packages/torch/u
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 82.92%
FGSM Robustness : 3.83e-01
FGSM Time (All Images) : 1.00 s
FGSM Time (Per Image) : 99.73 us
```

fgsm_eps = 0.9



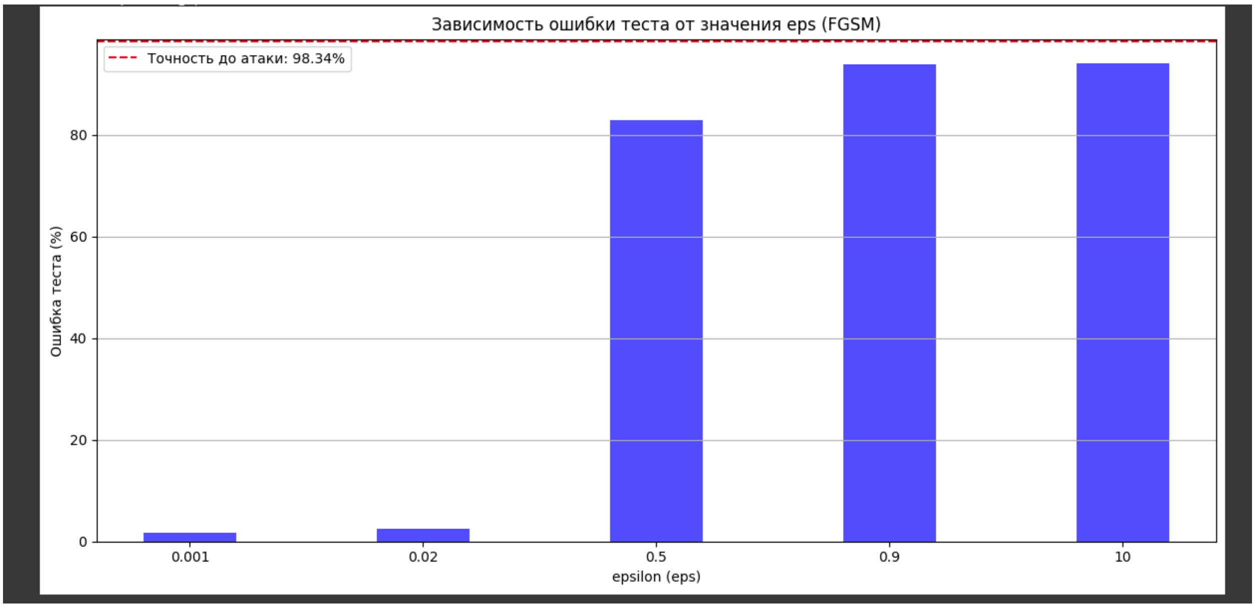
```
<ipython-input-33-a421ced483ef>:2: FutureWarning: You
  model.load_state_dict(torch.load('weights/clean/mnis
/usr/local/lib/python3.10/dist-packages/torch/utils/da
  warnings.warn(
Точность до атаки: 98.34%
/usr/local/lib/python3.10/dist-packages/torch/utils/da
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 93.80%
FGSM Robustness : 6.81e-01
FGSM Time (All Images) : 1.04 s
FGSM Time (Per Image) : 103.73 us
```

fgsm_eps = 10



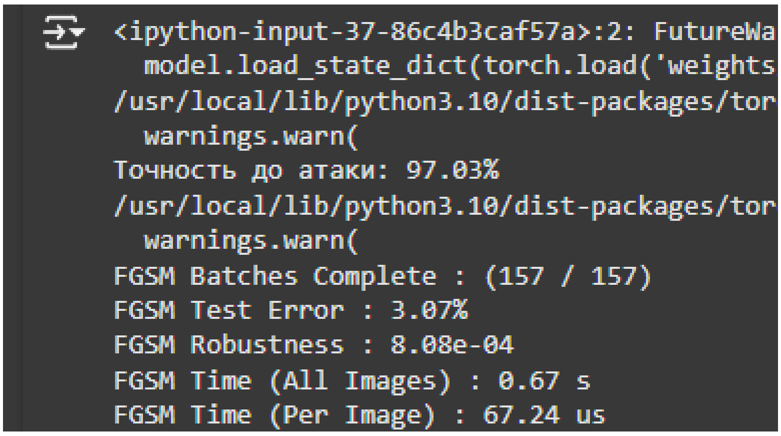
```
<ipython-input-35-a421ced483ef>:2: Future
  model.load_state_dict(torch.load('weig
/usr/local/lib/python3.10/dist-packages/t
  warnings.warn(
Точность до атаки: 98.34%
FGSM Test Error : 94.15%
FGSM Robustness : 1.46e+00
FGSM Time (All Images) : 1.41 s
FGSM Time (Per Image) : 141.28 us
```

График



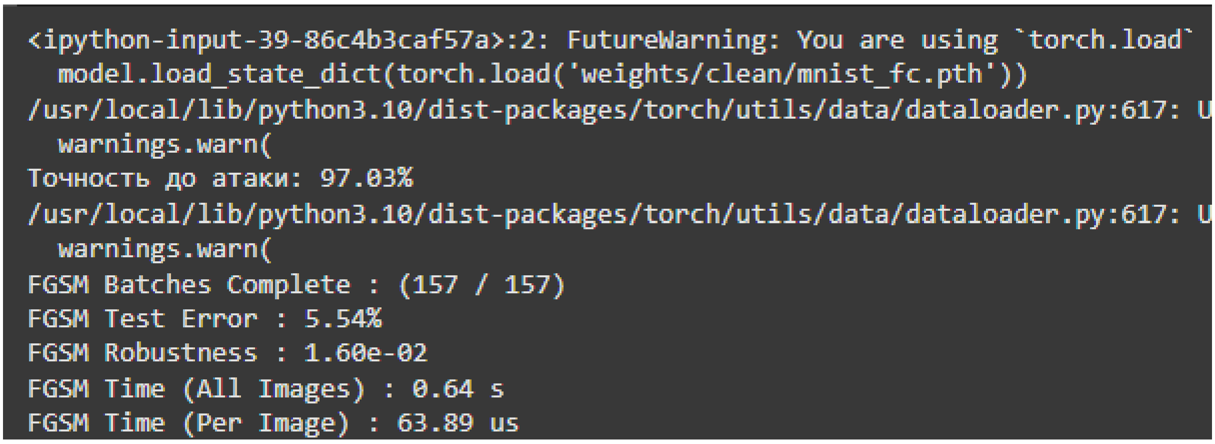
FC MNIST

fgsm_eps = 0.001



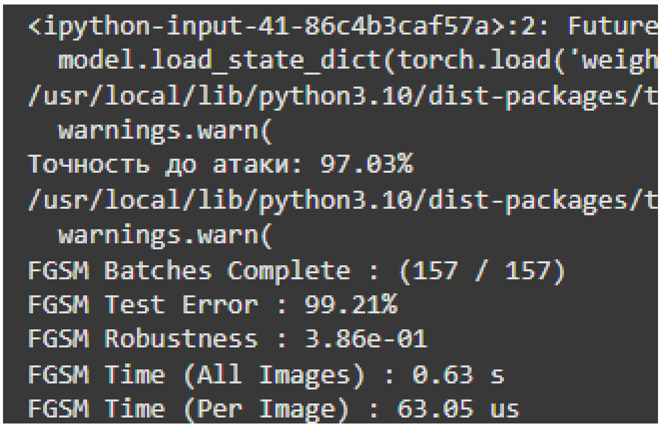
```
<ipython-input-37-86c4b3caf57a>:2: FutureWa
  model.load_state_dict(torch.load('weights
/usr/local/lib/python3.10/dist-packages/tor
  warnings.warn(
Точность до атаки: 97.03%
/usr/local/lib/python3.10/dist-packages/tor
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 3.07%
FGSM Robustness : 8.08e-04
FGSM Time (All Images) : 0.67 s
FGSM Time (Per Image) : 67.24 us
```

fgsm_eps = 0.02



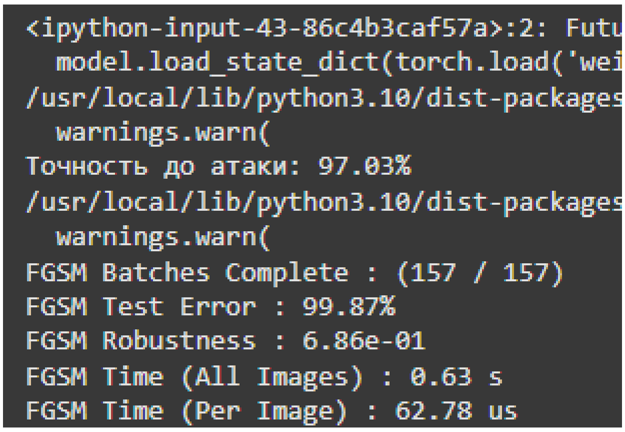
```
<ipython-input-39-86c4b3caf57a>:2: FutureWarning: You are using `torch.load`
  model.load_state_dict(torch.load('weights/clean/mnist_fc.pth'))
/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py:617: U
  warnings.warn(
Точность до атаки: 97.03%
/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py:617: U
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 5.54%
FGSM Robustness : 1.60e-02
FGSM Time (All Images) : 0.64 s
FGSM Time (Per Image) : 63.89 us
```

fgsm_eps = 0.5



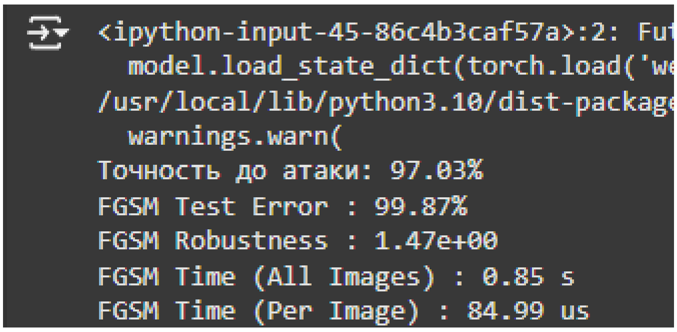
```
<ipython-input-41-86c4b3caf57a>:2: Future
  model.load_state_dict(torch.load('weigh
/usr/local/lib/python3.10/dist-packages/t
  warnings.warn(
Точность до атаки: 97.03%
/usr/local/lib/python3.10/dist-packages/t
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 99.21%
FGSM Robustness : 3.86e-01
FGSM Time (All Images) : 0.63 s
FGSM Time (Per Image) : 63.05 us
```

fgsm_eps = 0.9



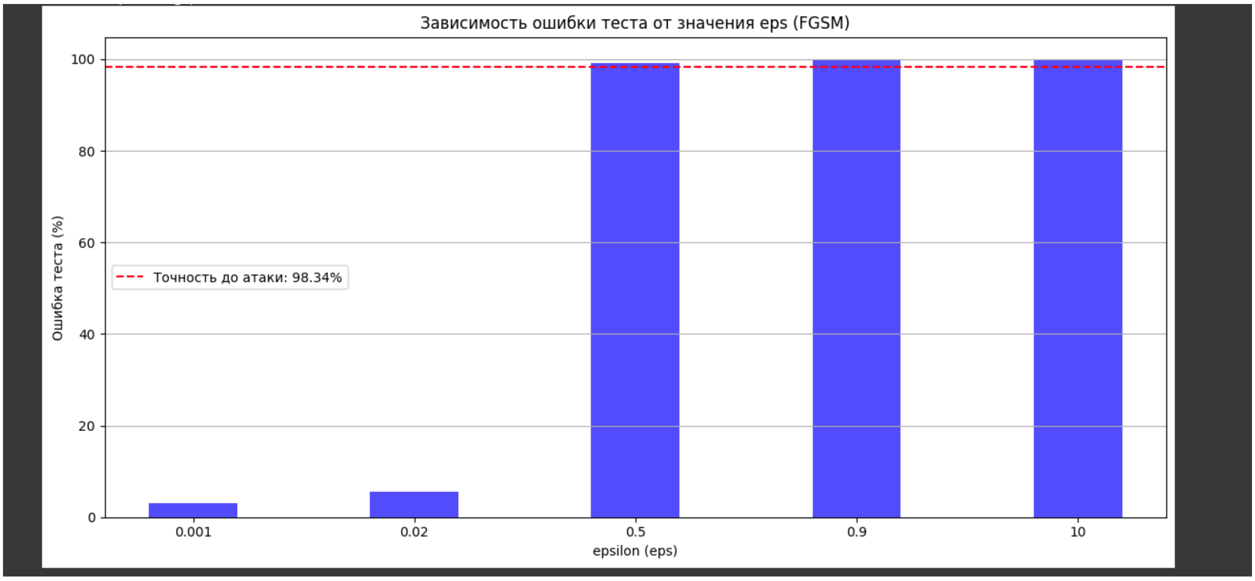
```
<ipython-input-43-86c4b3caf57a>:2: Futu
  model.load_state_dict(torch.load('wei
/usr/local/lib/python3.10/dist-packages
  warnings.warn(
Точность до атаки: 97.03%
/usr/local/lib/python3.10/dist-packages
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 99.87%
FGSM Robustness : 6.86e-01
FGSM Time (All Images) : 0.63 s
FGSM Time (Per Image) : 62.78 us
```

fgsm_eps = 10



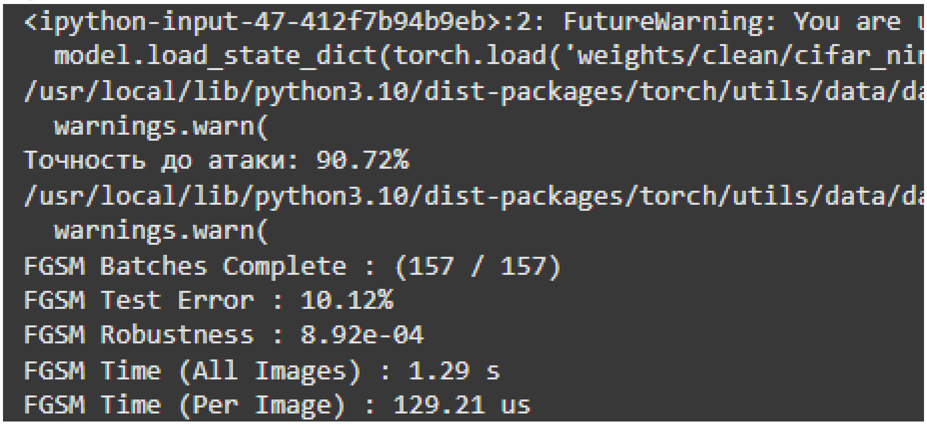
```
<ipython-input-45-86c4b3caf57a>:2: Fut
  model.load_state_dict(torch.load('we
/usr/local/lib/python3.10/dist-package
  warnings.warn(
Точность до атаки: 97.03%
FGSM Test Error : 99.87%
FGSM Robustness : 1.47e+00
FGSM Time (All Images) : 0.85 s
FGSM Time (Per Image) : 84.99 us
```

График



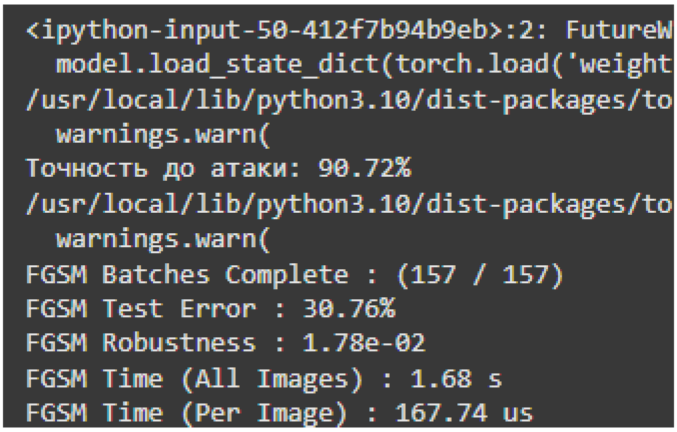
Network-In-Network CIFAR-10

fgsm_eps = 0.001



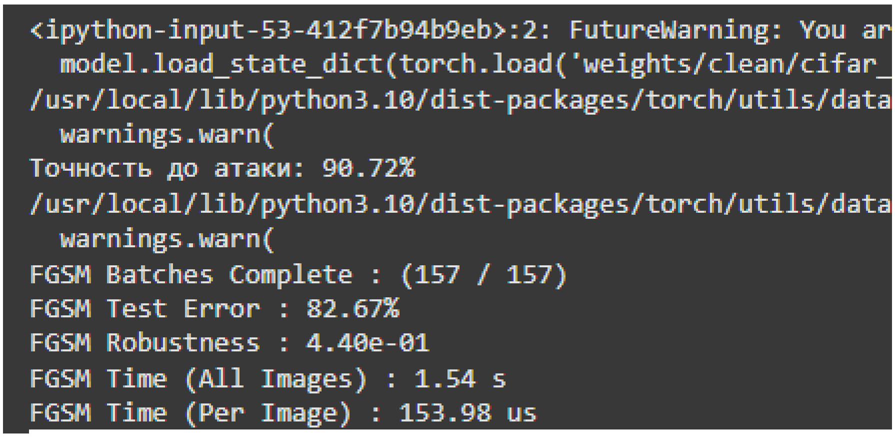
```
<ipython-input-47-412f7b94b9eb>:2: FutureWarning: You are u
  model.load_state_dict(torch.load('weights/clean/cifar_nin
/usr/local/lib/python3.10/dist-packages/torch/utils/data/da
  warnings.warn(
Точность до атаки: 90.72%
/usr/local/lib/python3.10/dist-packages/torch/utils/data/da
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 10.12%
FGSM Robustness : 8.92e-04
FGSM Time (All Images) : 1.29 s
FGSM Time (Per Image) : 129.21 us
```

fgsm_eps = 0.02



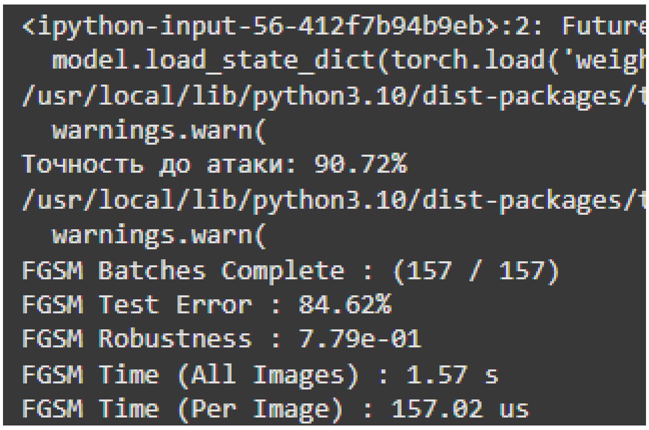
```
<ipython-input-50-412f7b94b9eb>:2: FutureW
  model.load_state_dict(torch.load('weight
/usr/local/lib/python3.10/dist-packages/to
  warnings.warn(
Точность до атаки: 90.72%
/usr/local/lib/python3.10/dist-packages/to
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 30.76%
FGSM Robustness : 1.78e-02
FGSM Time (All Images) : 1.68 s
FGSM Time (Per Image) : 167.74 us
```

fgsm_eps = 0.5



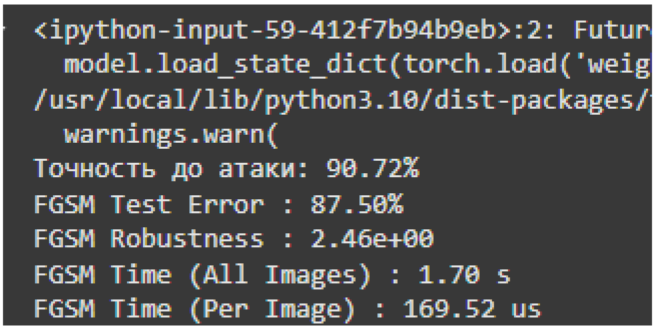
```
<ipython-input-53-412f7b94b9eb>:2: FutureWarning: You ar
  model.load_state_dict(torch.load('weights/clean/cifar_
/usr/local/lib/python3.10/dist-packages/torch/utils/data
  warnings.warn(
Точность до атаки: 90.72%
/usr/local/lib/python3.10/dist-packages/torch/utils/data
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 82.67%
FGSM Robustness : 4.40e-01
FGSM Time (All Images) : 1.54 s
FGSM Time (Per Image) : 153.98 us
```

fgsm_eps = 0.9



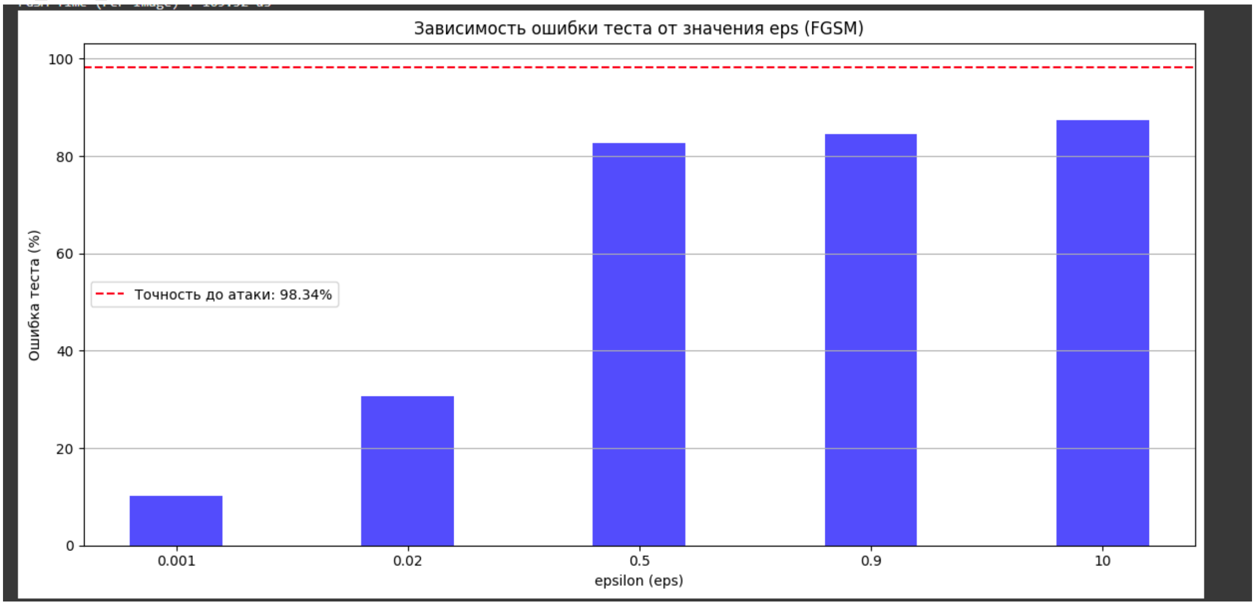
```
<ipython-input-56-412f7b94b9eb>:2: Future
  model.load_state_dict(torch.load('weigh
/usr/local/lib/python3.10/dist-packages/t
  warnings.warn(
Точность до атаки: 90.72%
/usr/local/lib/python3.10/dist-packages/t
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 84.62%
FGSM Robustness : 7.79e-01
FGSM Time (All Images) : 1.57 s
FGSM Time (Per Image) : 157.02 us
```

fgsm_eps = 10



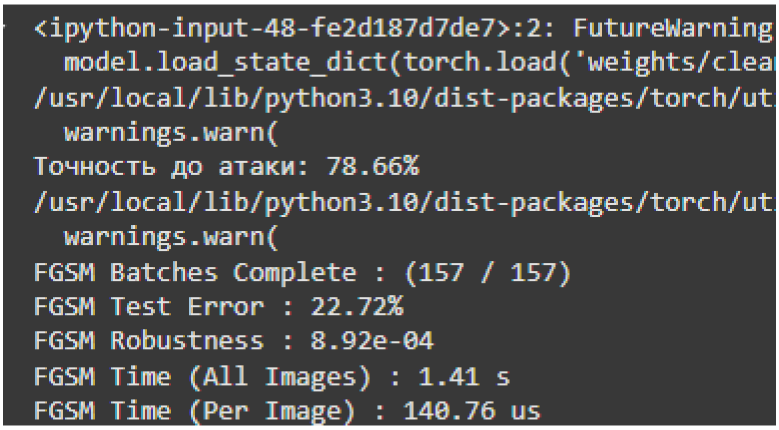
```
<ipython-input-59-412f7b94b9eb>:2: Futur
  model.load_state_dict(torch.load('weig
/usr/local/lib/python3.10/dist-packages/
  warnings.warn(
Точность до атаки: 90.72%
FGSM Test Error : 87.50%
FGSM Robustness : 2.46e+00
FGSM Time (All Images) : 1.70 s
FGSM Time (Per Image) : 169.52 us
```

График



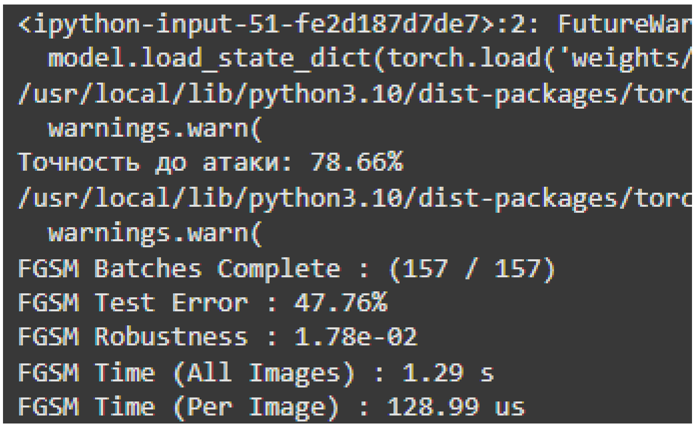
LeNet CIFAR-10

fgsm_eps = 0.001



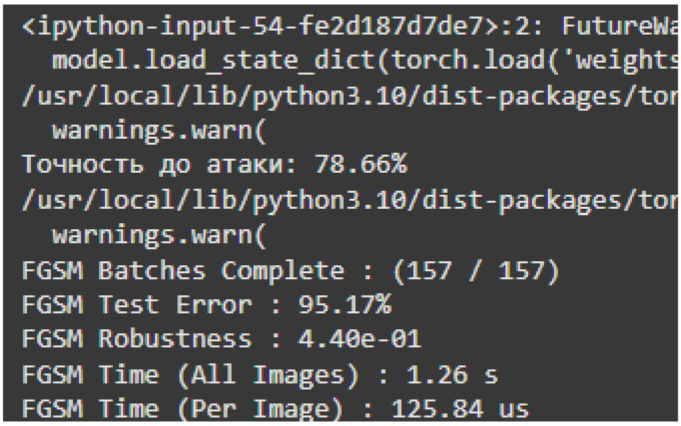
```
<ipython-input-48-fe2d187d7de7>:2: FutureWarning
  model.load_state_dict(torch.load('weights/clea
/usr/local/lib/python3.10/dist-packages/torch/ut
  warnings.warn(
Точность до атаки: 78.66%
/usr/local/lib/python3.10/dist-packages/torch/ut
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 22.72%
FGSM Robustness : 8.92e-04
FGSM Time (All Images) : 1.41 s
FGSM Time (Per Image) : 140.76 us
```

fgsm_eps = 0.02



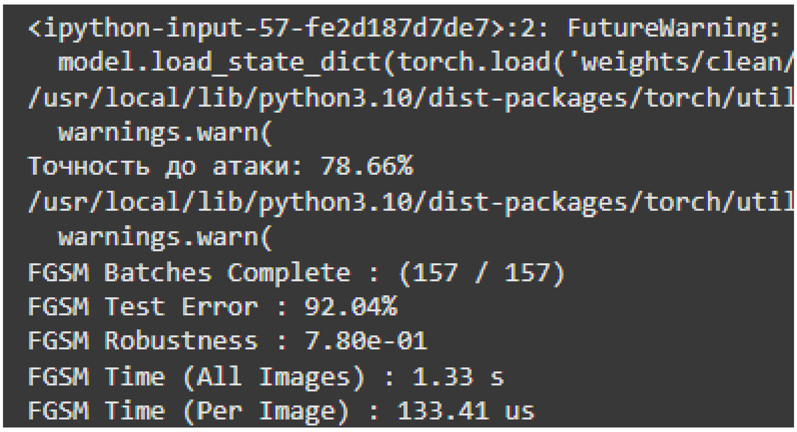
```
<ipython-input-51-fe2d187d7de7>:2: FutureWar
  model.load_state_dict(torch.load('weights/
/usr/local/lib/python3.10/dist-packages/torc
  warnings.warn(
Точность до атаки: 78.66%
/usr/local/lib/python3.10/dist-packages/torc
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 47.76%
FGSM Robustness : 1.78e-02
FGSM Time (All Images) : 1.29 s
FGSM Time (Per Image) : 128.99 us
```

fgsm_eps = 0.5



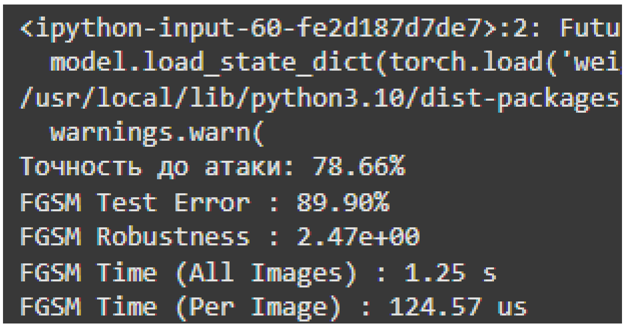
```
<ipython-input-54-fe2d187d7de7>:2: FutureWa
  model.load_state_dict(torch.load('weights
/usr/local/lib/python3.10/dist-packages/tor
  warnings.warn(
Точность до атаки: 78.66%
/usr/local/lib/python3.10/dist-packages/tor
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 95.17%
FGSM Robustness : 4.40e-01
FGSM Time (All Images) : 1.26 s
FGSM Time (Per Image) : 125.84 us
```

fgsm_eps = 0.9



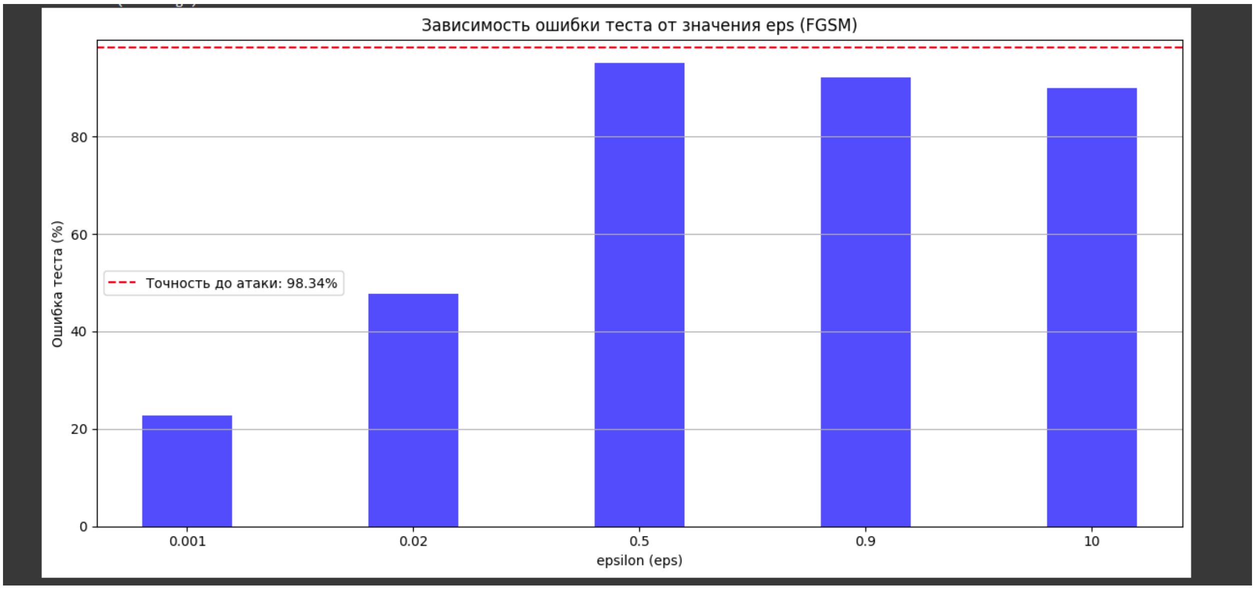
```
<ipython-input-57-fe2d187d7de7>:2: FutureWarning:
  model.load_state_dict(torch.load('weights/clean/
/usr/local/lib/python3.10/dist-packages/torch/util
  warnings.warn(
Точность до атаки: 78.66%
/usr/local/lib/python3.10/dist-packages/torch/util
  warnings.warn(
FGSM Batches Complete : (157 / 157)
FGSM Test Error : 92.04%
FGSM Robustness : 7.80e-01
FGSM Time (All Images) : 1.33 s
FGSM Time (Per Image) : 133.41 us
```

fgsm_eps = 10



```
<ipython-input-60-fe2d187d7de7>:2: Futu
  model.load_state_dict(torch.load('wei
/usr/local/lib/python3.10/dist-packages
  warnings.warn(
Точность до атаки: 78.66%
FGSM Test Error : 89.90%
FGSM Robustness : 2.47e+00
FGSM Time (All Images) : 1.25 s
FGSM Time (Per Image) : 124.57 us
```

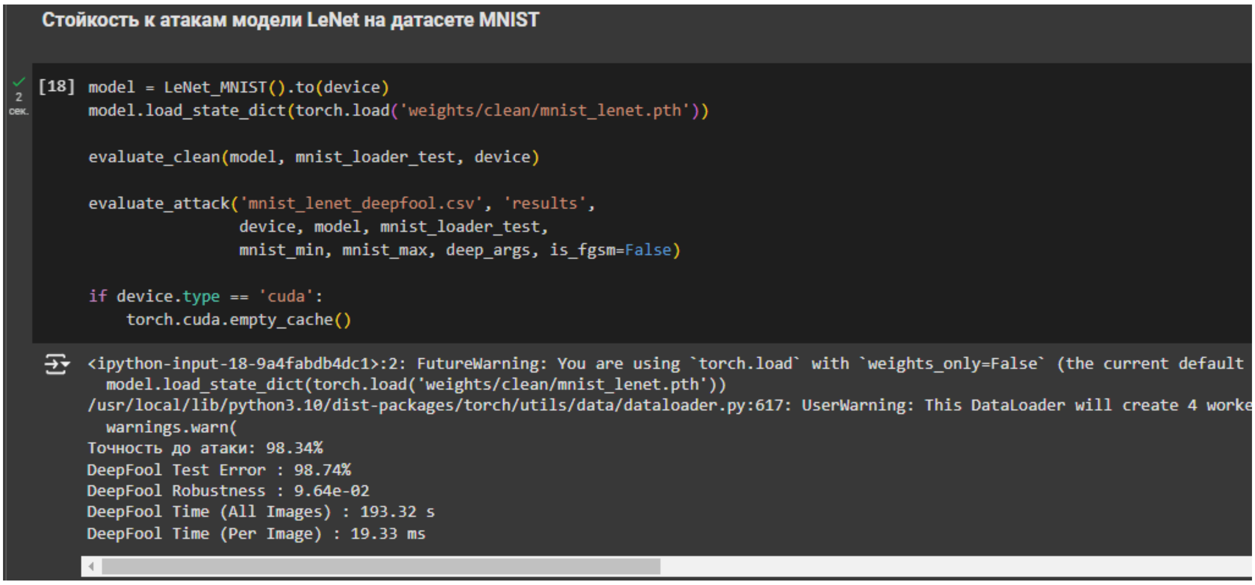
График



DeepFool атака

Стойкость к атаке моделей LeNet, FC на датасете MNIST и стойкость к атакае моделей Network-In-Network, LeNet на датасете CIFAR-10

LeNet MNIST

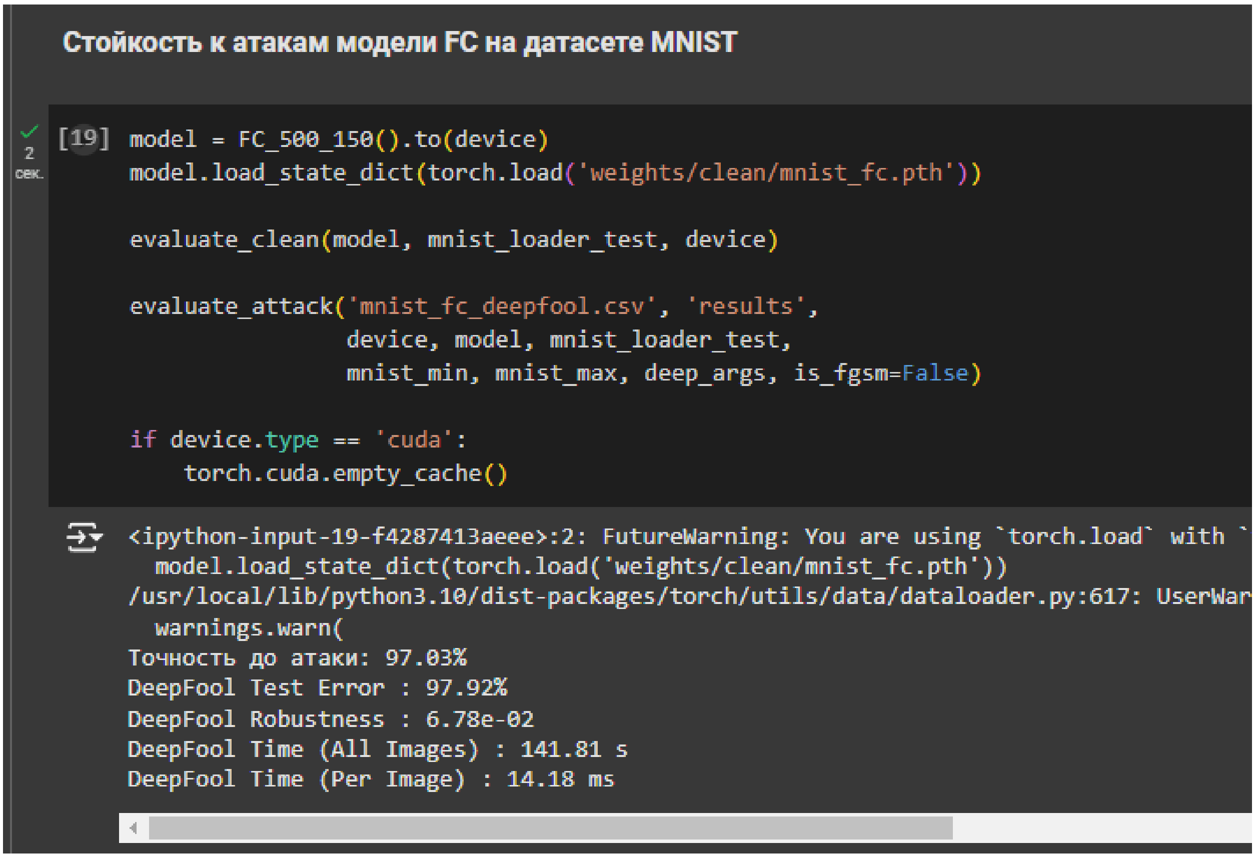


Стойкость к атакам модели LeNet на датасете MNIST

```
[18] model = LeNet_MNIST().to(device)
     model.load_state_dict(torch.load('weights/clean/mnist_lenet.pth'))

     evaluate_clean(model, mnist_loader_test, device)

     evaluate_attack('mnist_lenet_deepfool.csv', 'results',
                     device, model, mnist_loader_test,
                     mnist_min, mnist_max, deep_args, is_fgsm=False)

     if device.type == 'cuda':
         torch.cuda.empty_cache()
```

```
<ipython-input-18-9a4fabdb4dc1>:2: FutureWarning: You are using `torch.load` with `weights_only=False` (the current default
  model.load_state_dict(torch.load('weights/clean/mnist_lenet.pth'))
/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py:617: UserWarning: This DataLoader will create 4 worke
  warnings.warn(
Точность до атаки: 98.34%
DeepFool Test Error : 98.74%
DeepFool Robustness : 9.64e-02
DeepFool Time (All Images) : 193.32 s
DeepFool Time (Per Image) : 19.33 ms
```

FC MNIST

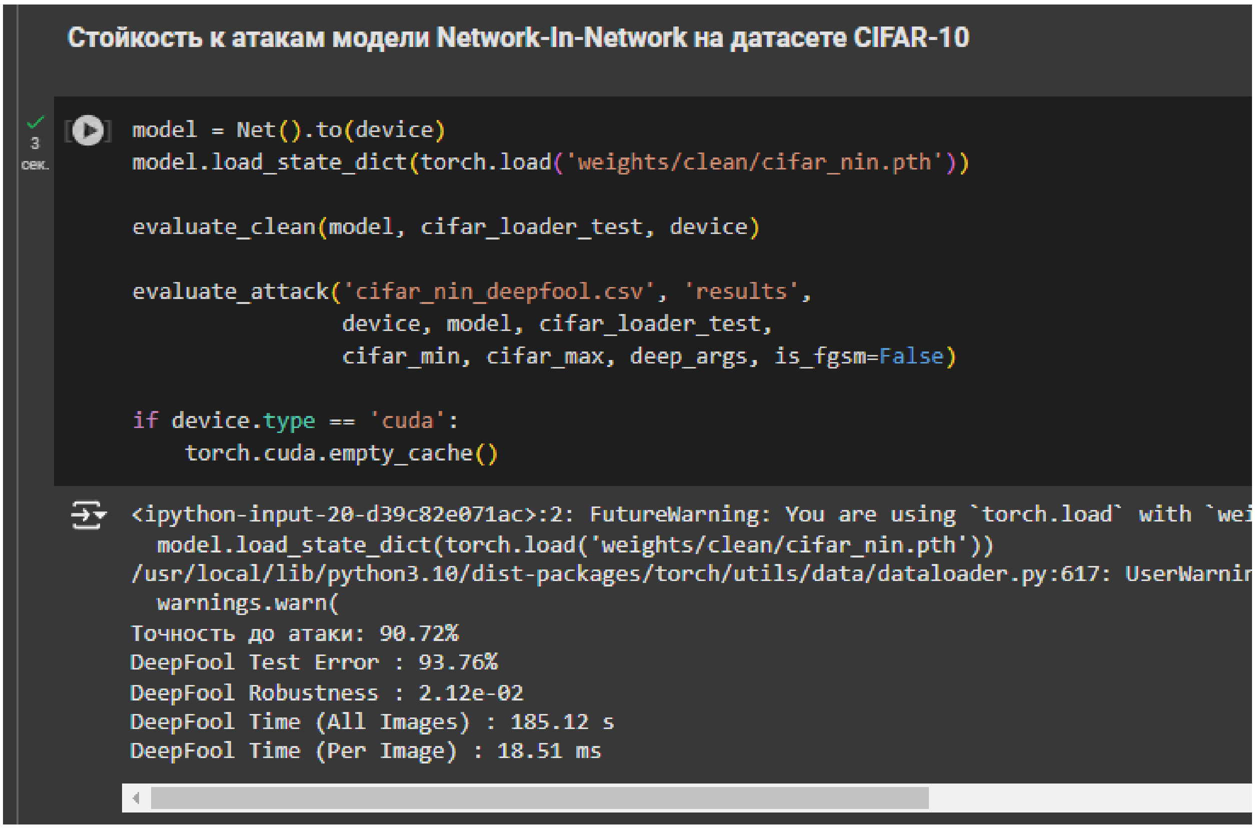


Стойкость к атакам модели FC на датасете MNIST

```
[19] model = FC_500_150().to(device)
     model.load_state_dict(torch.load('weights/clean/mnist_fc.pth'))

     evaluate_clean(model, mnist_loader_test, device)

     evaluate_attack('mnist_fc_deepfool.csv', 'results',
                     device, model, mnist_loader_test,
                     mnist_min, mnist_max, deep_args, is_fgsm=False)

     if device.type == 'cuda':
         torch.cuda.empty_cache()
```

```
<ipython-input-19-f4287413aeee>:2: FutureWarning: You are using `torch.load` with `
  model.load_state_dict(torch.load('weights/clean/mnist_fc.pth'))
/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py:617: UserWar
  warnings.warn(
Точность до атаки: 97.03%
DeepFool Test Error : 97.92%
DeepFool Robustness : 6.78e-02
DeepFool Time (All Images) : 141.81 s
DeepFool Time (Per Image) : 14.18 ms
```

Network-In-Network CIFAR-10

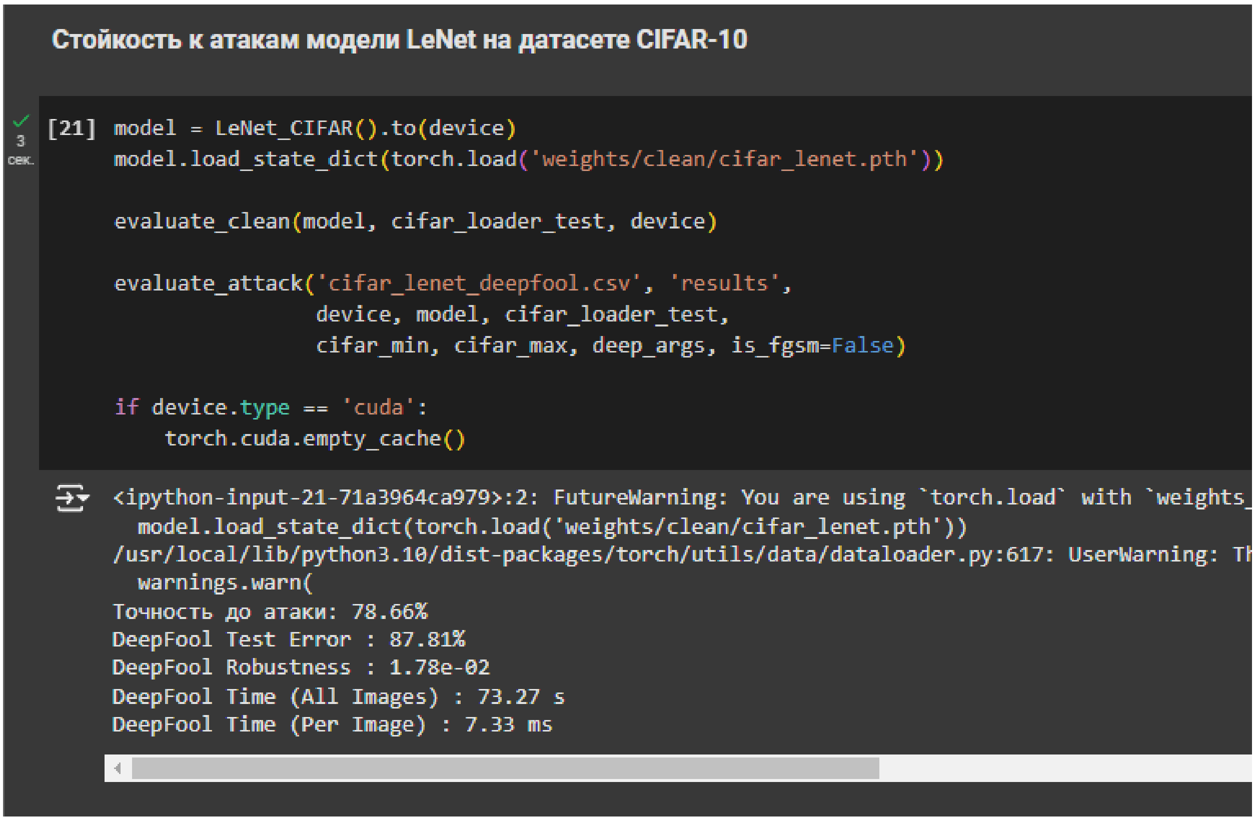


Стойкость к атакам модели Network-In-Network на датасете CIFAR-10

```
model = Net().to(device)
model.load_state_dict(torch.load('weights/clean/cifar_nin.pth'))

evaluate_clean(model, cifar_loader_test, device)

evaluate_attack('cifar_nin_deepfool.csv', 'results',
                device, model, cifar_loader_test,
                cifar_min, cifar_max, deep_args, is_fgsm=False)

if device.type == 'cuda':
    torch.cuda.empty_cache()
```

```
<ipython-input-20-d39c82e071ac>:2: FutureWarning: You are using `torch.load` with `wei
  model.load_state_dict(torch.load('weights/clean/cifar_nin.pth'))
/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py:617: UserWarnin
  warnings.warn(
Точность до атаки: 90.72%
DeepFool Test Error : 93.76%
DeepFool Robustness : 2.12e-02
DeepFool Time (All Images) : 185.12 s
DeepFool Time (Per Image) : 18.51 ms
```

LeNet CIFAR-10



Стойкость к атакам модели LeNet на датасете CIFAR-10

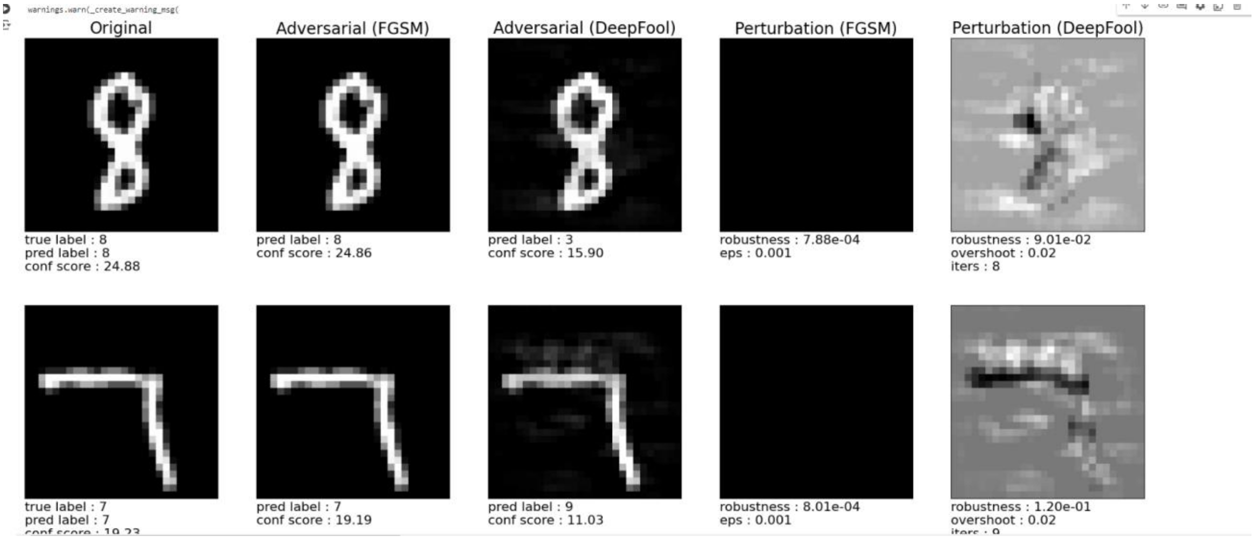
```
[21] model = LeNet_CIFAR().to(device)
     model.load_state_dict(torch.load('weights/clean/cifar_lenet.pth'))

     evaluate_clean(model, cifar_loader_test, device)

     evaluate_attack('cifar_lenet_deepfool.csv', 'results',
                     device, model, cifar_loader_test,
                     cifar_min, cifar_max, deep_args, is_fgsm=False)

     if device.type == 'cuda':
         torch.cuda.empty_cache()
```

```
<ipython-input-21-71a3964ca979>:2: FutureWarning: You are using `torch.load` with `weights_
  model.load_state_dict(torch.load('weights/clean/cifar_lenet.pth'))
/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py:617: UserWarning: Th
  warnings.warn(
Точность до атаки: 78.66%
DeepFool Test Error : 87.81%
DeepFool Robustness : 1.78e-02
DeepFool Time (All Images) : 73.27 s
DeepFool Time (Per Image) : 7.33 ms
```

Визуальное представление

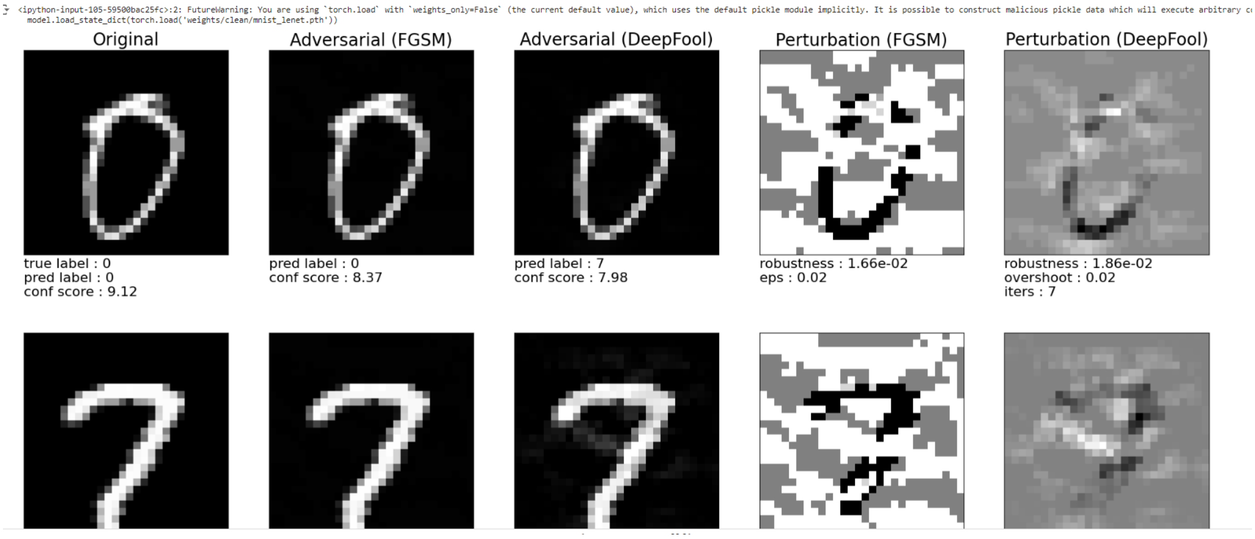
LeNet MNIST

fgsm_eps = 0.001



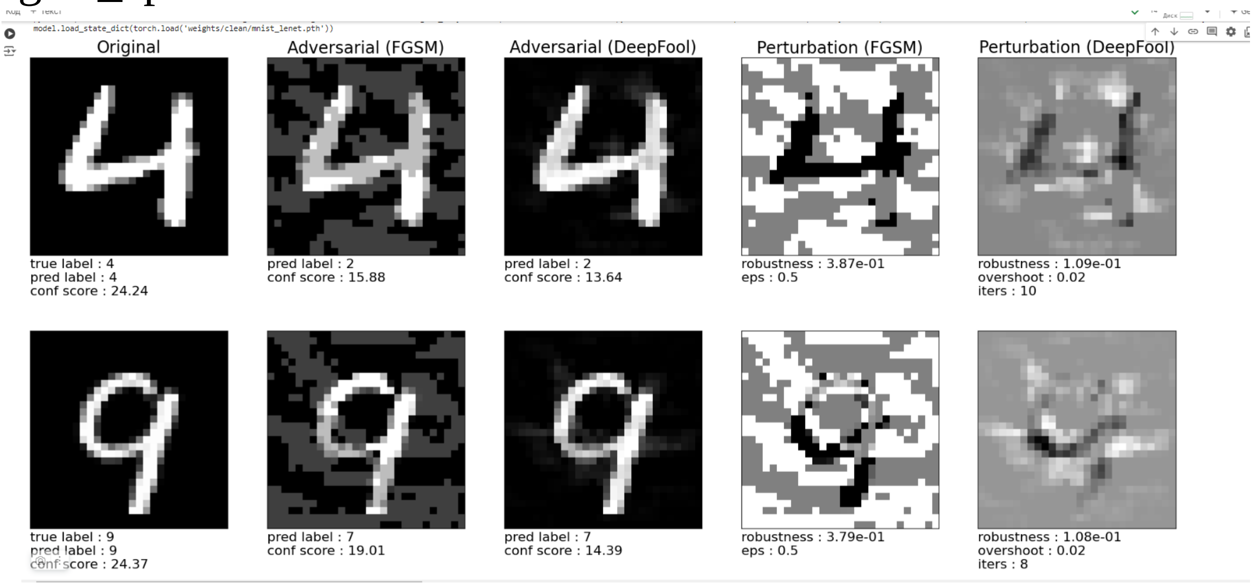
```
warnings.warn(_create_warning_msg(
```

fgsm_eps = 0.02



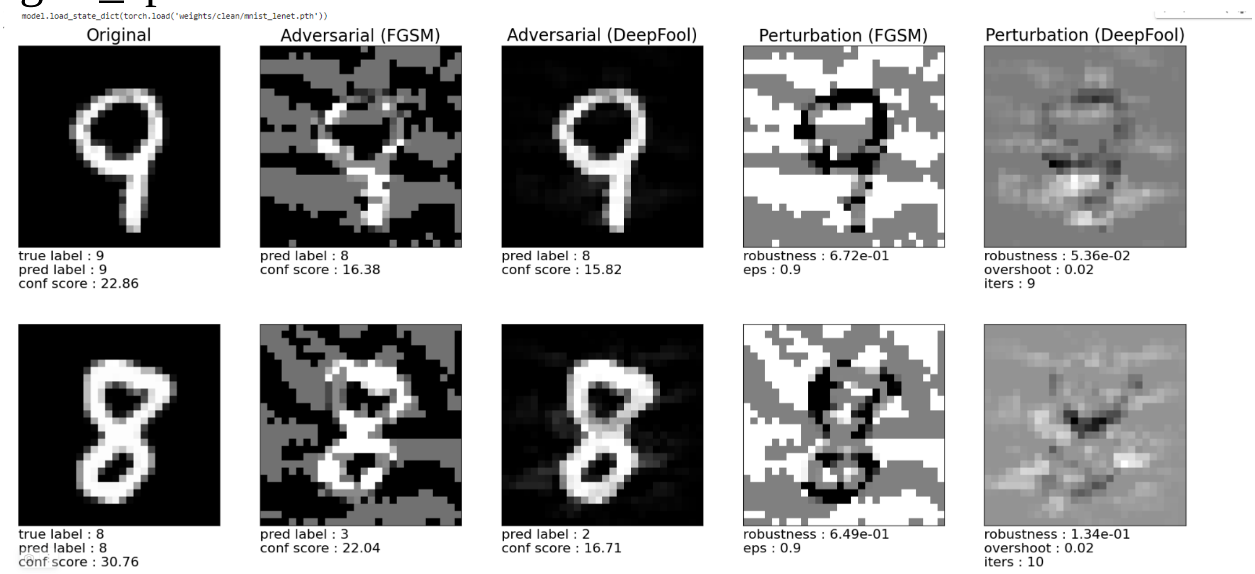
```
<ipython-input-105-59500bac25fc>:2: FutureWarning: You are using `torch.load` with `weights_only=False` (the current default value), which uses the default pickle module implicitly. It is possible to construct malicious pickle data which will execute arbitrary c
  model.load_state_dict(torch.load('weights/clean/mnist_lenet.pth'))
```

fgsm_eps = 0.5



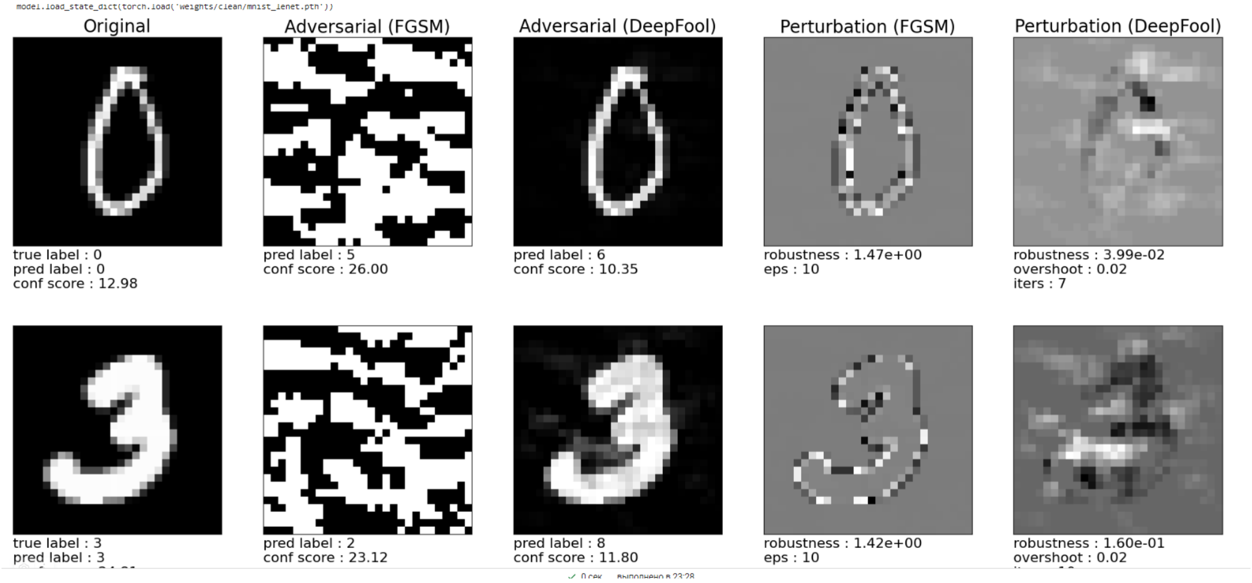
```
model.load_state_dict(torch.load('weights/clean/mnist_lenet.pth'))
```

fgsm_eps = 0.9



```
model.load_state_dict(torch.load('weights/clean/mnist_lenet.pth'))
```

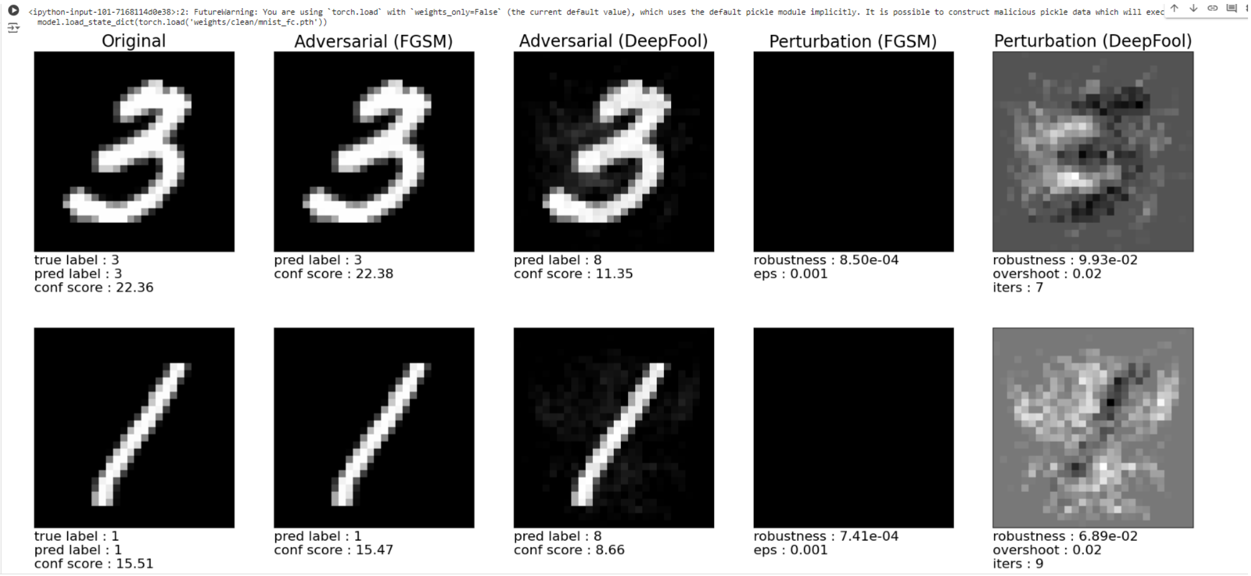
fgsm_eps = 10



```
model.load_state_dict(torch.load('weights/clean/mnist_lenet.pth'))
```

FC MNIST

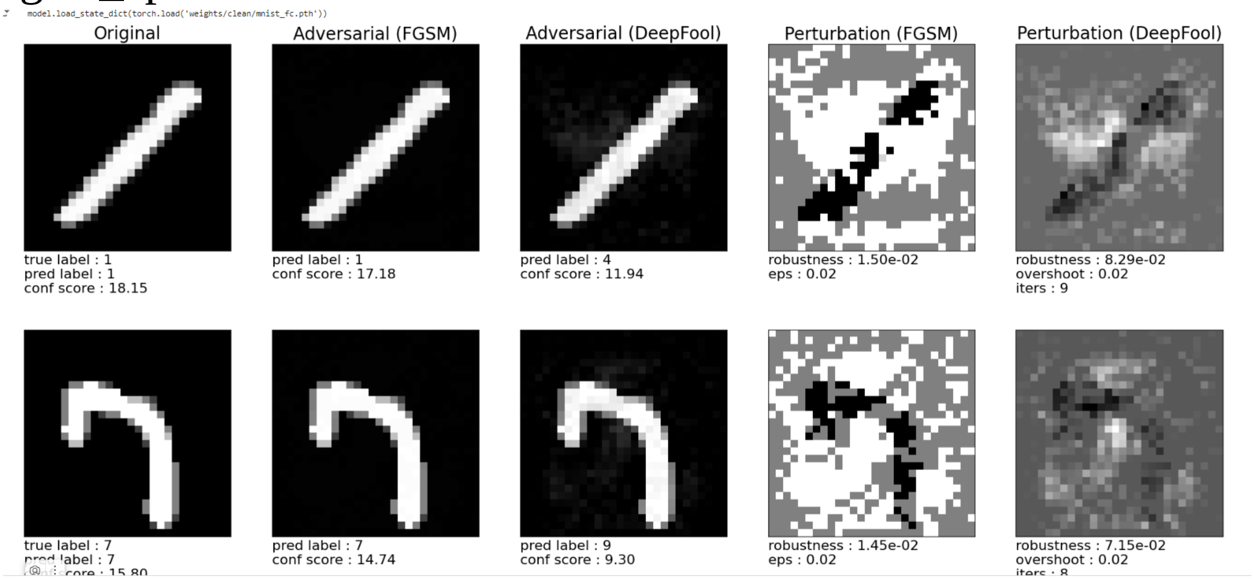
fgsm_eps = 0.001



```
<ipython-input-101-7168114d0e38>:2: FutureWarning: You are using `torch.load` with `weights_only=False` (the current default value), which uses the default pickle module implicitly. It is possible to construct malicious pickle data which will exec
  model.load_state_dict(torch.load('weights/clean/mnist_fc.pth'))
```

```
true label : 3      pred label : 3       pred label : 8       robustness : 8.50e-04   robustness : 9.93e-02
pred label : 3      conf score : 22.38   conf score : 11.35   eps : 0.001             overshoot : 0.02
conf score : 22.36                                                                    iters : 7

true label : 1      pred label : 1       pred label : 8       robustness : 7.41e-04   robustness : 6.89e-02
pred label : 1      conf score : 15.47   conf score : 8.66    eps : 0.001             overshoot : 0.02
conf score : 15.51                                                                    iters : 9
```

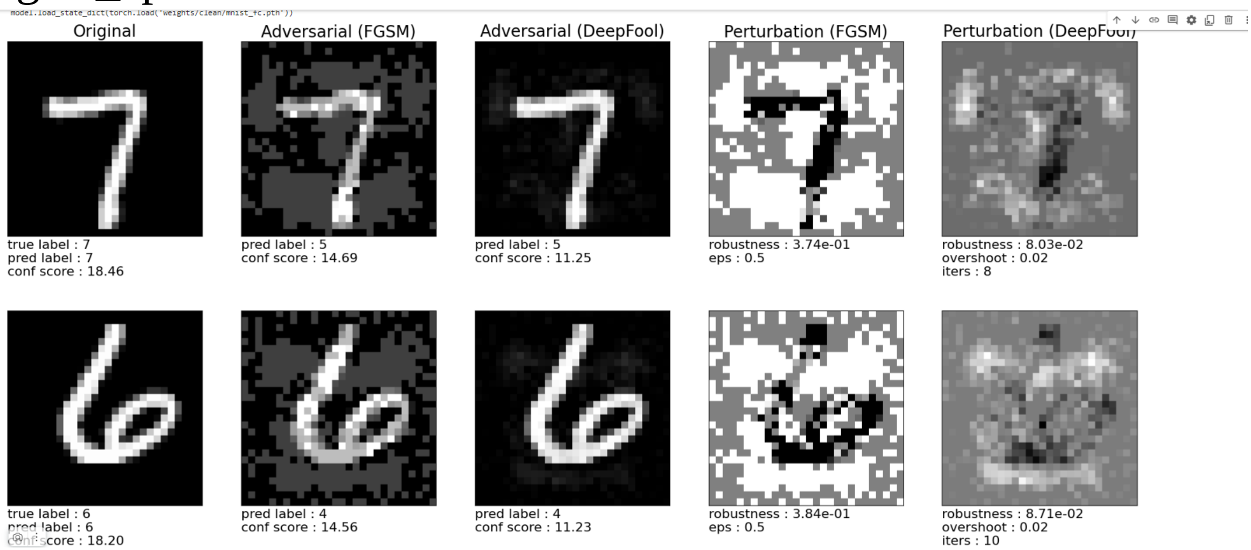
fgsm_eps = 0.02



```
  model.load_state_dict(torch.load('weights/clean/mnist_fc.pth'))
```

```
true label : 1      pred label : 1       pred label : 4       robustness : 1.50e-02   robustness : 8.29e-02
pred label : 1      conf score : 17.18   conf score : 11.94   eps : 0.02              overshoot : 0.02
conf score : 18.15                                                                    iters : 9

true label : 7      pred label : 7       pred label : 9       robustness : 1.45e-02   robustness : 7.15e-02
pred label : 7      conf score : 14.74   conf score : 9.30    eps : 0.02              overshoot : 0.02
conf score : 15.80                                                                    iters : 8
```

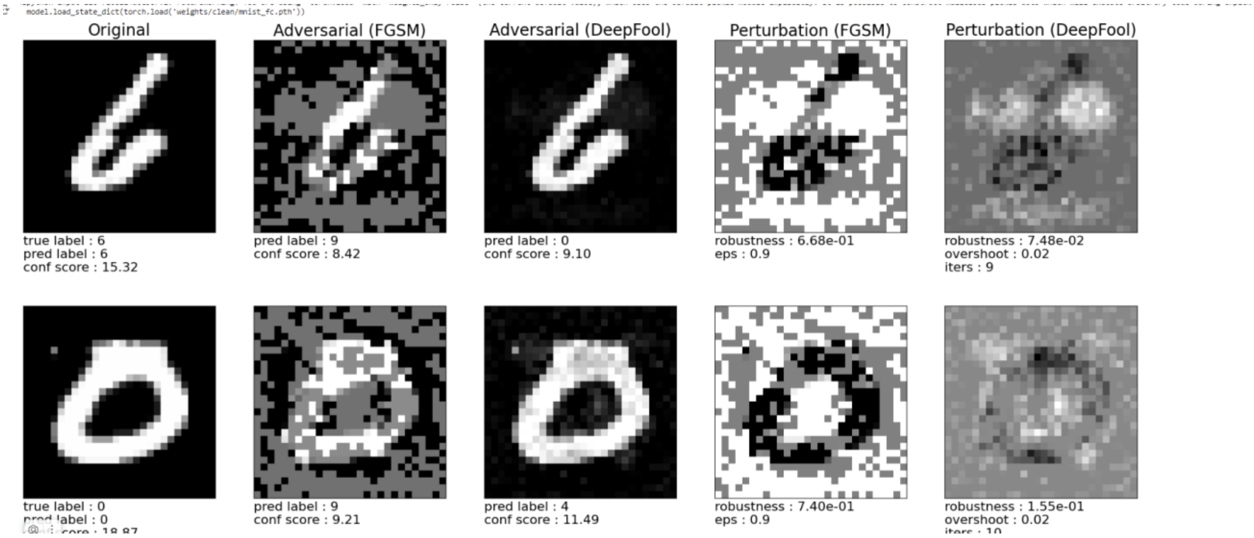
fgsm_eps = 0.5



```
model.load_state_dict(torch.load('weights/clean/mnist_fc.pth'))
```

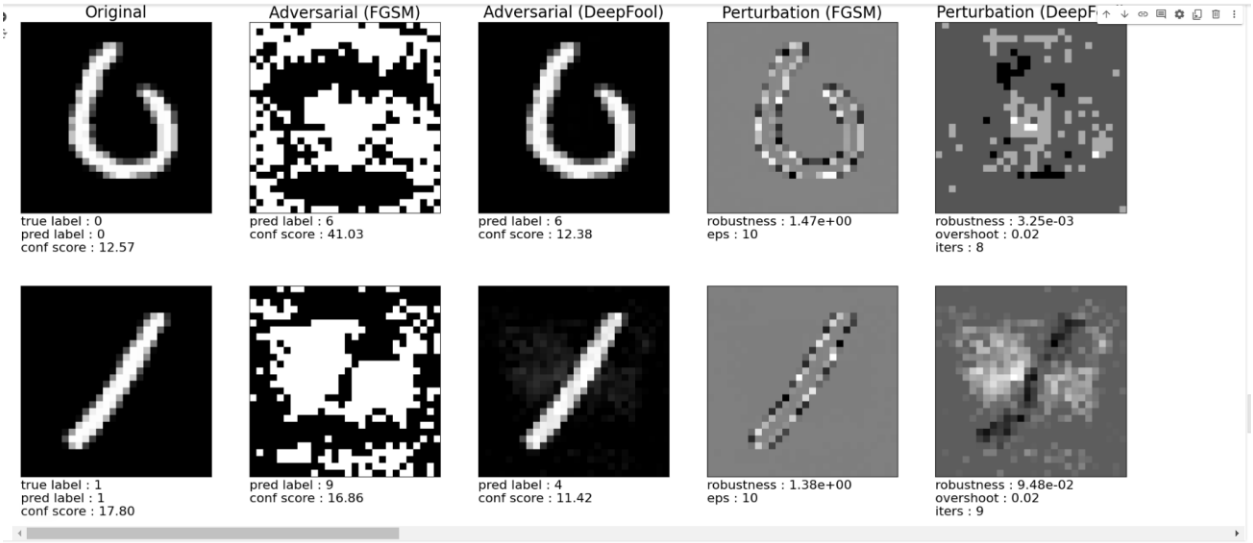
```
true label : 7      pred label : 5       pred label : 5       robustness : 3.74e-01   robustness : 8.03e-02
pred label : 7      conf score : 14.69   conf score : 11.25   eps : 0.5               overshoot : 0.02
conf score : 18.46                                                                    iters : 8

true label : 6      pred label : 4       pred label : 4       robustness : 3.84e-01   robustness : 8.71e-02
pred label : 6      conf score : 14.56   conf score : 11.23   eps : 0.5               overshoot : 0.02
conf score : 18.20                                                                    iters : 10
```

fgsm_eps = 0.9



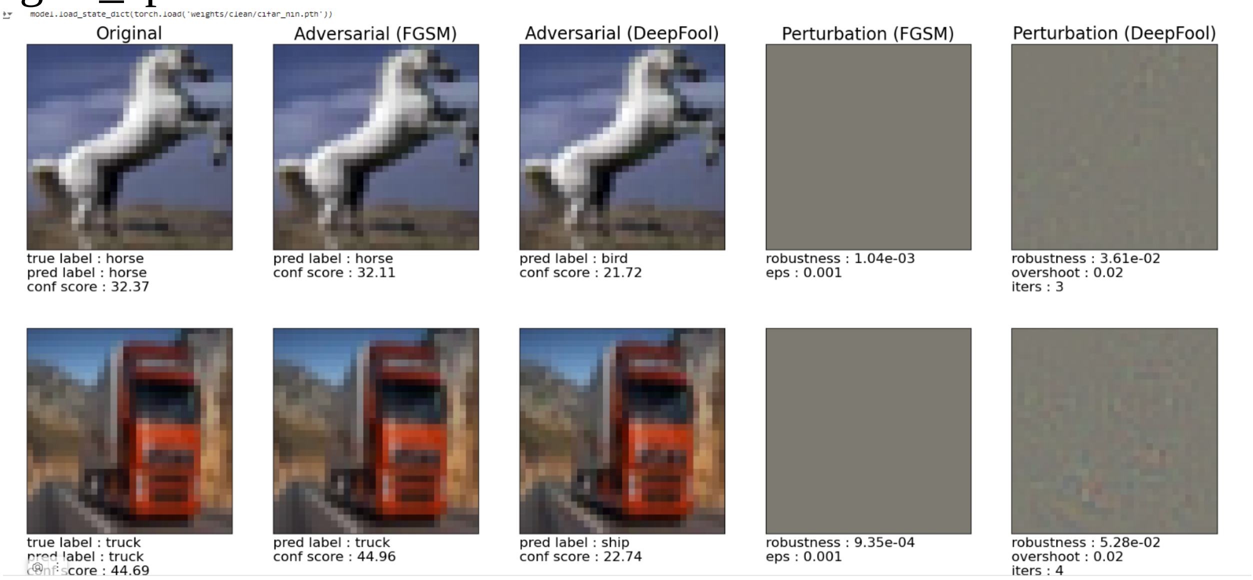
```
model.load_state_dict(torch.load('weights/clean/mnist_fc.pth'))
```

fgsm_eps = 10



Network-In-Network CIFAR-10

fgsm_eps = 0.001



```
model.load_state_dict(torch.load('weights/clean/cifar_nin.pth'))
```

true label : horse
pred label : horse
conf score : 32.37

pred label : horse
conf score : 32.11

pred label : bird
conf score : 21.72

robustness : 1.04e-03
eps : 0.001

robustness : 3.61e-02
overshoot : 0.02
iters : 3

true label : truck
pred label : truck
conf score : 44.69

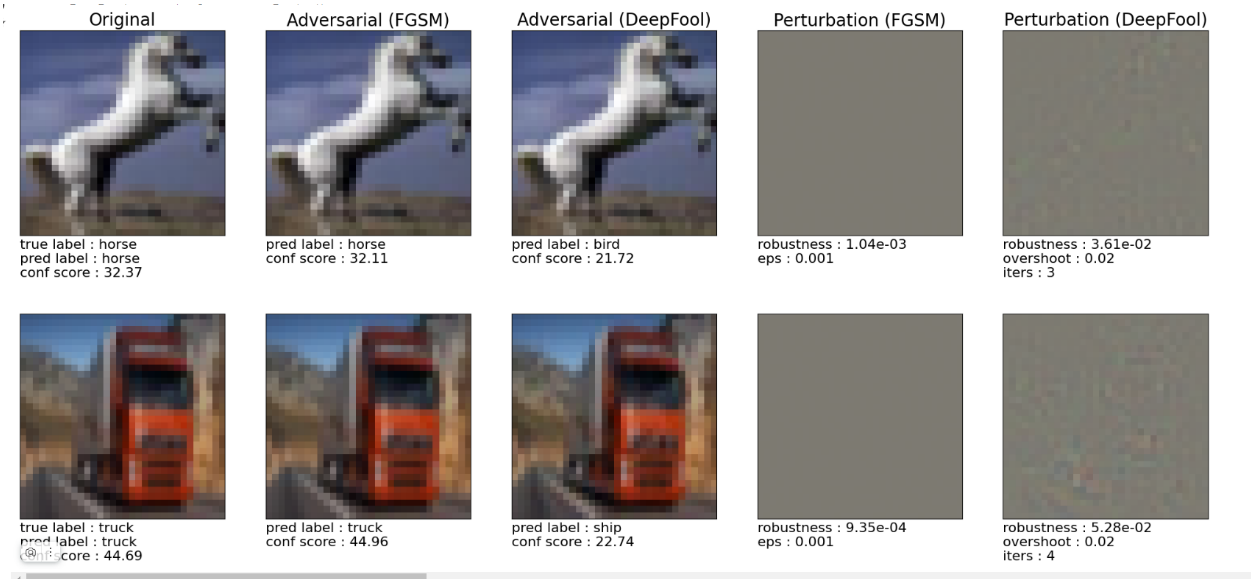
pred label : truck
conf score : 44.96

pred label : ship
conf score : 22.74

robustness : 9.35e-04
eps : 0.001

robustness : 5.28e-02
overshoot : 0.02
iters : 4

fgsm_eps = 0.02



true label : horse
pred label : horse
conf score : 32.37

pred label : horse
conf score : 32.11

pred label : bird
conf score : 21.72

robustness : 1.04e-03
eps : 0.001

robustness : 3.61e-02
overshoot : 0.02
iters : 3

true label : truck
pred label : truck
conf score : 44.69

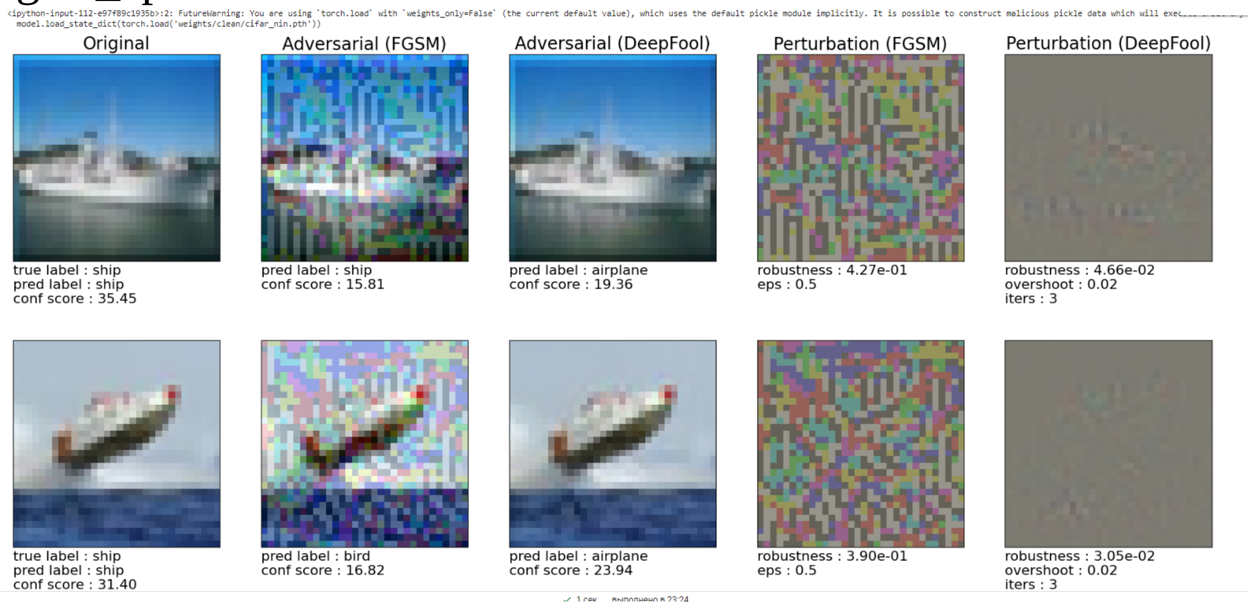
pred label : truck
conf score : 44.96

pred label : ship
conf score : 22.74

robustness : 9.35e-04
eps : 0.001

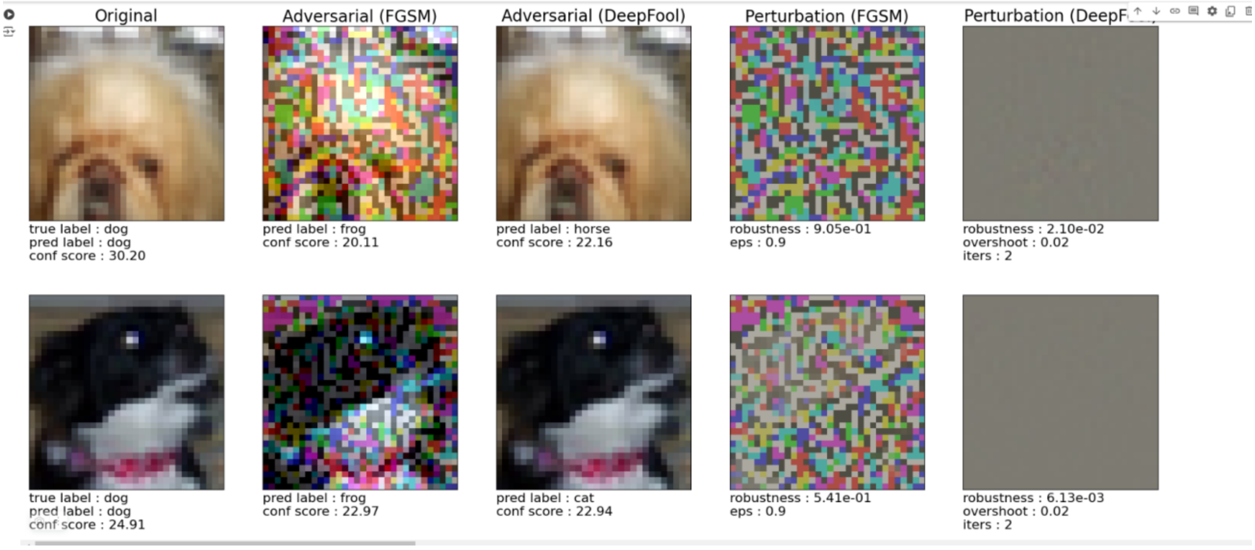
robustness : 5.28e-02
overshoot : 0.02
iters : 4

fgsm_eps = 0.5

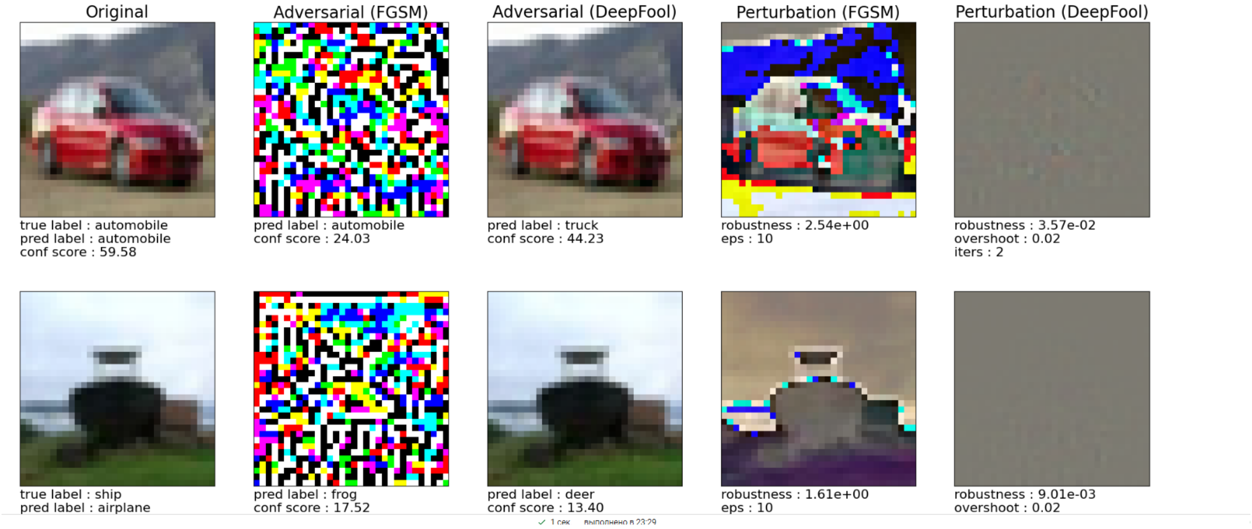


```
<ipython-input-112-e97f89c1935b>:2: FutureWarning: You are using `torch.load` with `weights_only=False` (the current default value), which uses the default pickle module implicitly. It is possible to construct malicious pickle data which will exec
  model.load_state_dict(torch.load('weights/clean/cifar_nin.pth'))
```

fgsm_eps = 0.9

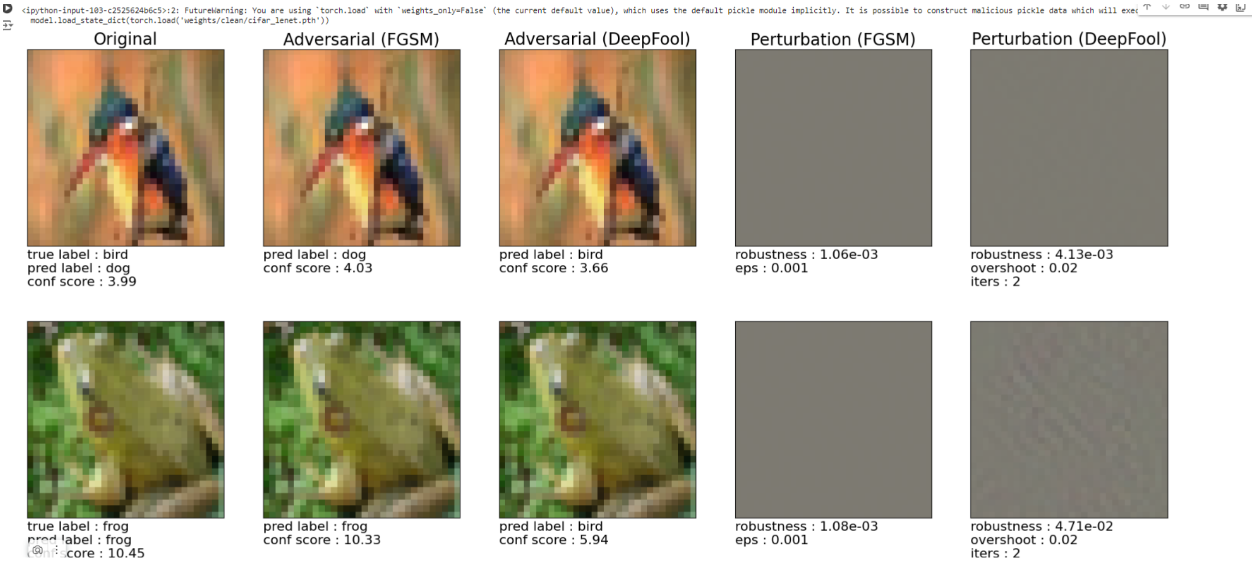


fgsm_eps = 10



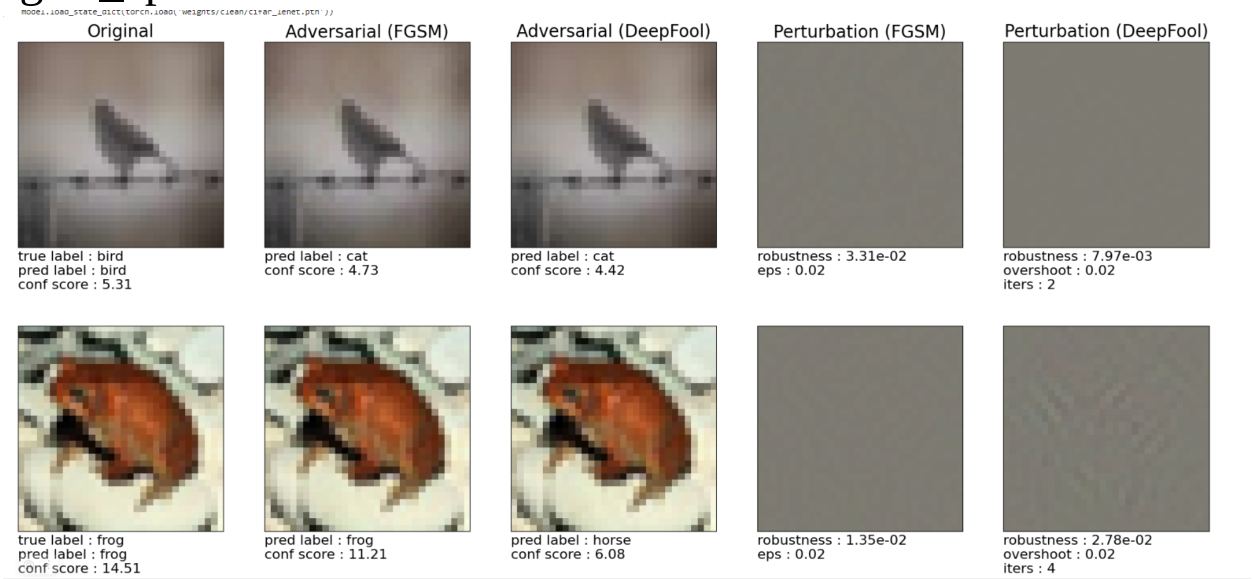
LeNet CIFAR-10

fgsm_eps = 0.001



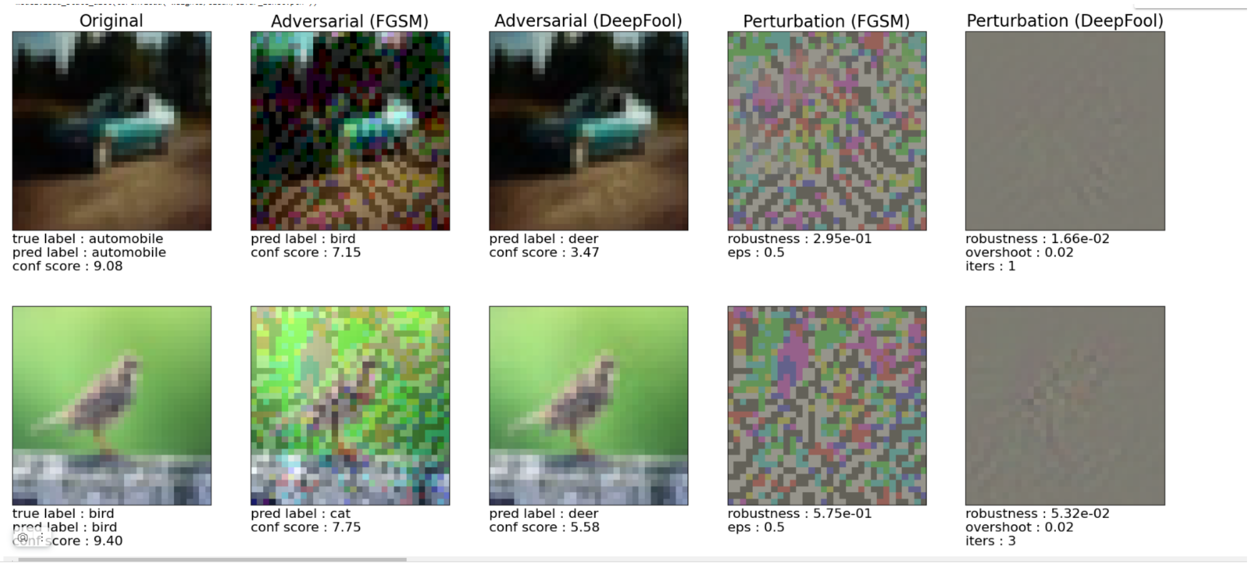
```
<ipython-input-103-c2525624b6c5>:2: FutureWarning: You are using `torch.load` with `weights_only=False` (the current default value), which uses the default pickle module implicitly. It is possible to construct malicious pickle data which will exec
  model.load_state_dict(torch.load('weights/clean/cifar_lenet.pth'))
```

fgsm_eps = 0.02



```
  model.load_state_dict(torch.load('weights/clean/cifar_lenet.pth'))
```

fgsm_eps = 0.5



Original

Adversarial (FGSM)

Adversarial (DeepFool)

Perturbation (FGSM)

Perturbation (DeepFool)

```
true label : automobile
pred label : automobile
conf score : 9.08
```

```
pred label : bird
conf score : 7.15
```

```
pred label : deer
conf score : 3.47
```

```
robustness : 2.95e-01
eps : 0.5
```

```
robustness : 1.66e-02
overshoot : 0.02
iters : 1
```

```
true label : bird
pred label : bird
conf score : 9.40
```

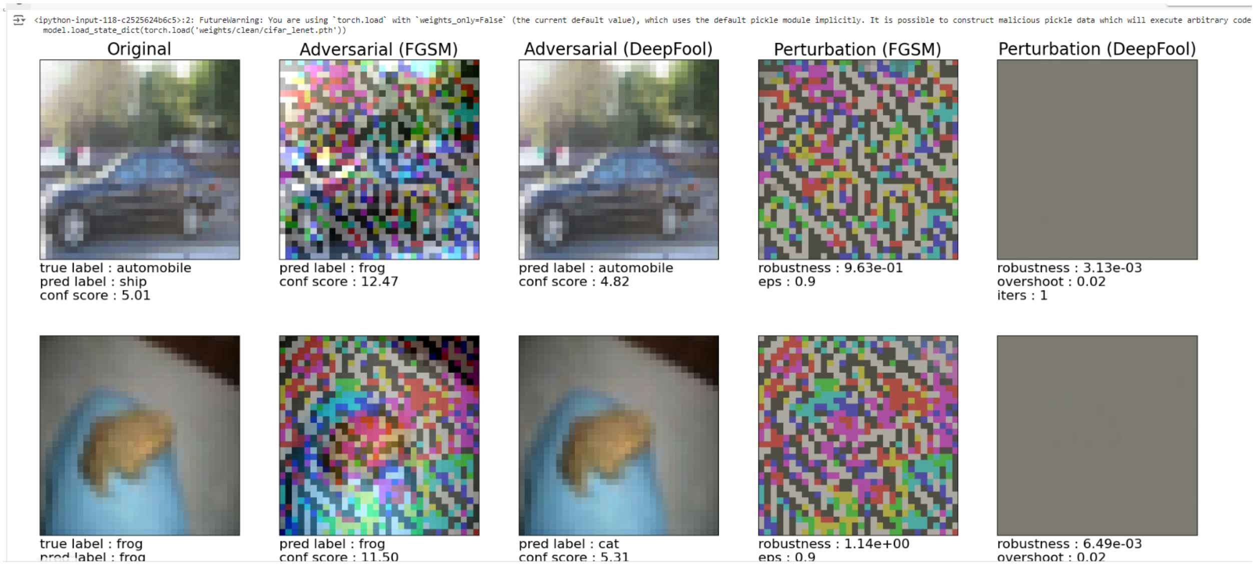
```
pred label : cat
conf score : 7.75
```

```
pred label : deer
conf score : 5.58
```

```
robustness : 5.75e-01
eps : 0.5
```

```
robustness : 5.32e-02
overshoot : 0.02
iters : 3
```

fgsm_eps = 0.9



```
<ipython-input-118-c2525624b6c5>:2: FutureWarning: You are using `torch.load` with `weights_only=False` (the current default value), which uses the default pickle module implicitly. It is possible to construct malicious pickle data which will execute arbitrary code
  model.load_state_dict(torch.load('weights/clean/cifar_lenet.pth'))
```

Original

Adversarial (FGSM)

Adversarial (DeepFool)

Perturbation (FGSM)

Perturbation (DeepFool)

```
true label : automobile
pred label : ship
conf score : 5.01
```

```
pred label : frog
conf score : 12.47
```

```
pred label : automobile
conf score : 4.82
```

```
robustness : 9.63e-01
eps : 0.9
```

```
robustness : 3.13e-03
overshoot : 0.02
iters : 1
```

```
true label : frog
pred label : frog
```

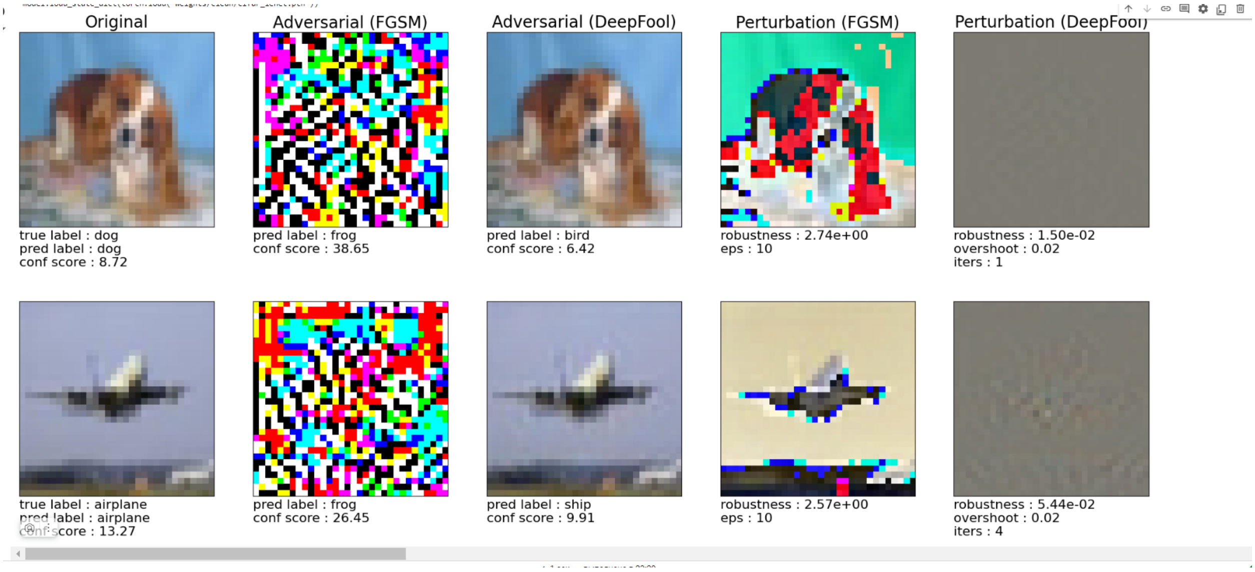
```
pred label : frog
conf score : 11.50
```

```
pred label : cat
conf score : 5.31
```

```
robustness : 1.14e+00
eps : 0.9
```

```
robustness : 6.49e-03
overshoot : 0.02
```

fgsm_eps = 10



Original

Adversarial (FGSM)

Adversarial (DeepFool)

Perturbation (FGSM)

Perturbation (DeepFool)

```
true label : dog
pred label : dog
conf score : 8.72
```

```
pred label : frog
conf score : 38.65
```

```
pred label : bird
conf score : 6.42
```

```
robustness : 2.74e+00
eps : 10
```

```
robustness : 1.50e-02
overshoot : 0.02
iters : 1
```

```
true label : airplane
pred label : airplane
conf score : 13.27
```

```
pred label : frog
conf score : 26.45
```

```
pred label : ship
conf score : 9.91
```

```
robustness : 2.57e+00
eps : 10
```

```
robustness : 5.44e-02
overshoot : 0.02
iters : 4
```

Заключение

Когда fgsm_eps увеличивается, сети становятся уязвимее к атакам. Значительно уязвимее они становятся со значения fgsm_eps = 0.5