МИНОБРНАУКИ РОССИИ
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РТУ МИРЭА

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Кафедра КБ-4 «Интеллектуальные системы информационной безопасности»

Практическая работа №4

по дисциплине

«Анализ защищенности систем искусственного интеллекта»

Группа:
ББМО-01-22
Выполнил:
Новиков С.И.

Проверил:
Спирин А.А.

Москва 2023

Установил пакет art

```
# устанавливаем пакет art
!pip install adversarial-robustness-toolbox
```

```
Collecting adversarial-robustness-toolbox
  Downloading adversarial_robustness_toolbox-1.17.0-py3-none-any.whl (1.7 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 1.7/1.7 MB 7.2 MB/s eta 0:00:00
Requirement already satisfied: numpy>=1.18.0 in /usr/local/lib/python3.10/dist-packages (from adversarial-robustness-toolbox) (1.23.5)
Requirement already satisfied: scipy>=1.4.1 in /usr/local/lib/python3.10/dist-packages (from adversarial-robustness-toolbox) (1.11.4)
Collecting scikit-learn<1.2.0,>=0.22.2 (from adversarial-robustness-toolbox)
  Downloading scikit_learn-1.1.3-cp310-cp310-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (30.5 MB)
     ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 30.5/30.5 MB 34.5 MB/s eta 0:00:00
Requirement already satisfied: six in /usr/local/lib/python3.10/dist-packages (from adversarial-robustness-toolbox) (1.16.0)
Requirement already satisfied: setuptools in /usr/local/lib/python3.10/dist-packages (from adversarial-robustness-toolbox) (67.7.2)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages (from adversarial-robustness-toolbox) (4.66.1)
Requirement already satisfied: joblib>=1.0.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn<1.2.0,>=0.22.2->adversarial-rob
Requirement already satisfied: threadpoolctl>=2.0.0 in /usr/local/lib/python3.10/dist-packages (from scikit-learn<1.2.0,>=0.22.2->adversar
Installing collected packages: scikit-learn, adversarial-robustness-toolbox
  Attempting uninstall: scikit-learn
    Found existing installation: scikit-learn 1.2.2
    Uninstalling scikit-learn-1.2.2:
      Successfully uninstalled scikit-learn-1.2.2
ERROR: pip's dependency resolver does not currently take into account all the packages that are installed. This behaviour is the source of
bigframes 0.19.2 requires scikit-learn>=1.2.2, but you have scikit-learn 1.1.3 which is incompatible.
Successfully installed adversarial-robustness-toolbox-1.17.0 scikit-learn-1.1.3
```

Загрузил библиотеки

```
[ ] # загружаем библиотеки
    from __future__ import absolute_import, division, print_function, unicode_literals

    import os, sys
    from os.path import abspath

    module_path = os.path.abspath(os.path.join('..'))
    if module_path not in sys.path:
      sys.path.append(module_path)

    import warnings
    warnings.filterwarnings('ignore')

    import tensorflow as tf
    tf.compat.v1.disable_eager_execution()
    tf.get_logger().setLevel('ERROR')

    import tensorflow.keras.backend as k
    from tensorflow.keras.models import Sequential
    from tensorflow.keras.layers import Dense, Flatten, Conv2D, MaxPooling2D, Activation, Dropout

    import numpy as np
    import matplotlib.pyplot as plt

    %matplotlib inline

    from art.estimators.classification import KerasClassifier
    from art.attacks.poisoning import PoisoningAttackBackdoor, PoisoningAttackCleanLabelBackdoor
    from art.attacks.poisoning.perturbations import add_pattern_bd
    from art.utils import load_mnist, preprocess, to_categorical
    from art.defences.trainer import AdversarialTrainerMadryPGD
```

Загружаем датасет MNIST и разделяем его на обучающую и тестовую выборки

Загрузил датасет MINST

```
[ ]  (x_raw, y_raw), (x_raw_test, y_raw_test), min_, max_ = load_mnist(raw=True)
```

Произвел случайную выборку

```
[ ]  n_train = np.shape(x_raw)[0]
     num_selection = 10000
     random_selection_indices = np.random.choice(n_train, num_selection)
     x_raw = x_raw[random_selection_indices]
     y_raw = y_raw[random_selection_indices]
```

Выполнил отравление данных

Сделал предоработку и отравление данных

```
percent_poison = .33
x_train, y_train = preprocess(x_raw, y_raw)
x_train = np.expand_dims(x_train, axis=3)

x_test, y_test = preprocess(x_raw_test, y_raw_test)
x_test = np.expand_dims(x_test, axis=3)
```

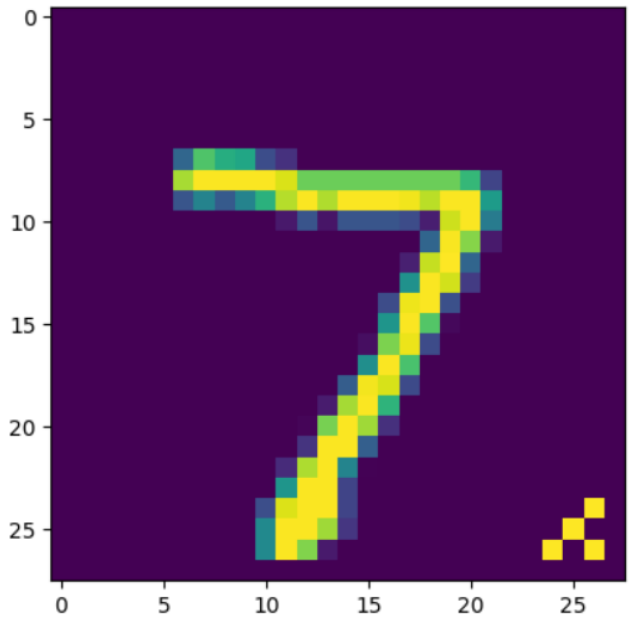
Написал функцию create_model() для создания последовательной модели из 9 слоев

```
[ ]  from tensorflow.keras.models import Sequential
     from tensorflow.keras.layers import Dense, Flatten, Conv2D, MaxPooling2D, Dropout

     def create_model():
         # архитектура модели
         model = Sequential()
         # сверточные слои
         model.add(Conv2D(32, (3, 3), activation='relu', input_shape=(28, 28, 1)))
         model.add(Conv2D(64, (3, 3), activation='relu'))
         # пулинговый слой
         model.add(MaxPooling2D(pool_size=(2, 2)))
         # dropout слой
         model.add(Dropout(0.25))
         # выравнивающий слой
         model.add(Flatten())
         # полносвязные слои
         model.add(Dense(128, activation='relu'))
         model.add(Dropout(0.25))
         model.add(Dense(10, activation='softmax'))

         # компиляция
         model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy'])

         return model
```

Создал атаку

```
[ ]  backdoor = PoisoningAttackBackdoor(add_pattern_bd)
     example_target = np.array([0, 0, 0, 0, 0, 0, 0, 0, 0, 1])
     pdata, plabels = backdoor.poison(x_test, y=example_target)
     plt.imshow(pdata[0].squeeze())
```

```
<matplotlib.image.AxesImage at 0x788455d415d0>
```



Определил целевой класс атаки и создал модель

```
[ ]  targets = to_categorical([9], 10)[0]
```

Создал модель

```
[ ]  model = KerasClassifier(create_model())
     proxy = AdversarialTrainerMadryPGD(KerasClassifier(create_model()), nb_epochs=10, eps=0.15, eps_step=0.001)
     proxy.fit(x_train, y_train)
```

```
Precompute adv samples: 100% 1/1 [00:00<00:00, 65.75it/s]
Adversarial training epochs: 100% 10/10 [01:56<00:00, 11.18s/it]
```

Выполним атаку

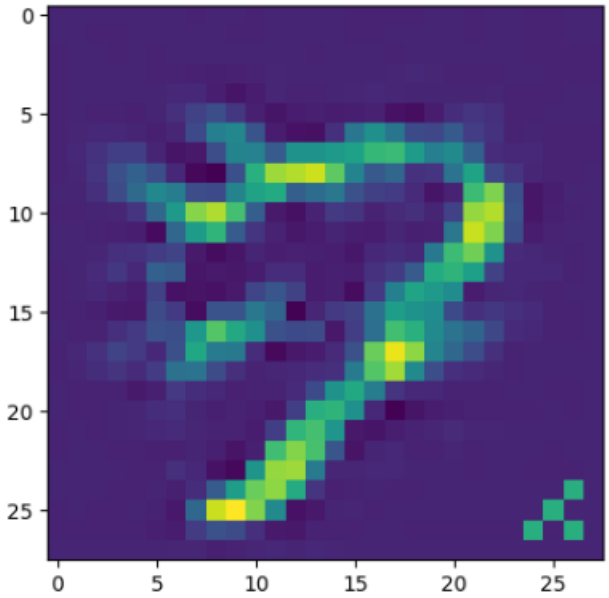
```
attack = PoisoningAttackCleanLabelBackdoor(backdoor=backdoor, proxy_classifier=proxy.get_classifier(),
                                           target=targets,pp_poison=percent_poison, norm=2, eps=5,
                                           eps_step=0.1, max_iter=200)
pdata, plabels = attack.poison(x_train, y_train)
```

```
PGD - Random Initializations: 100% 1/1 [00:00<00:00, 1.07it/s]
PGD - Random Initializations: 100% 1/1 [00:00<00:00, 1.09it/s]
PGD - Random Initializations: 100% 1/1 [00:00<00:00, 1.03it/s]
PGD - Random Initializations: 100% 1/1 [00:00<00:00, 1.06it/s]
PGD - Random Initializations: 100% 1/1 [00:00<00:00, 1.06it/s]
PGD - Random Initializations: 100% 1/1 [00:00<00:00, 1.09it/s]
PGD - Random Initializations: 100% 1/1 [00:00<00:00, 1.02it/s]
PGD - Random Initializations: 100% 1/1 [00:00<00:00, 1.04it/s]
PGD - Random Initializations: 100% 1/1 [00:01<00:00, 1.09s/it]
PGD - Random Initializations: 100% 1/1 [00:01<00:00, 1.26s/it]
PGD - Random Initializations: 100% 1/1 [00:00<00:00, 1.22it/s]
```

Создал отравленные примеры данных и отобразил одно из отравленных

```
poisoned = pdata[np.all(plabels == targets, axis=1)]
poisoned_labels = plabels[np.all(plabels == targets, axis=1)]
print(len(poisoned))
idx = 0
plt.imshow(poisoned[idx].squeeze())
print(f"Label: {np.argmax(poisoned_labels[idx])}")
```

```
1003
Label: 9
```



Обучил модель на отравленных данных и сделал тест на чистой модели

```
[ ]  model.fit(pdata, plabels, nb_epochs=10)
```

Тест на чистой модели

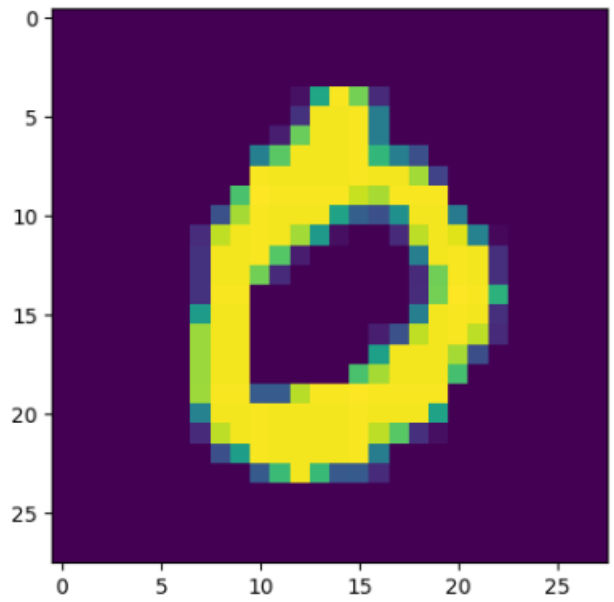
```
[ ]  clean_preds = np.argmax(model.predict(x_test), axis=1)
     clean_correct = np.sum(clean_preds == np.argmax(y_test, axis=1))
     clean_total = y_test.shape[0]
     clean_acc = clean_correct / clean_total

     print("\nClean test set accuracy: %.2f%%" % (clean_acc * 100))
```

```
Clean test set accuracy: 97.79%
```

Выполнил проверку работы модели в обычных условиях на чистых данных

как отравленная модель классифицирует чистую

```
[ ]  c = 0 # class to display
     i = 0 # image of the class to display
     c_idx = np.where(np.argmax(y_test, 1) == c)[0][i] # index of the image in clean arrays
     plt.imshow(x_test[c_idx].squeeze())
     plt.show()
     clean_label = c
     print("Prediction: " + str(clean_preds[c_idx]))
```

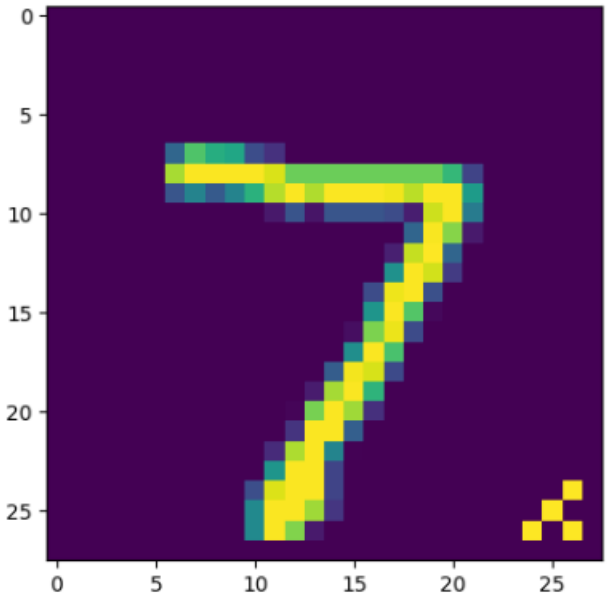



```
Prediction: 0
```

Выявил результат атаки на модель

```
not_target = np.logical_not(np.all(y_test == targets, axis=1))
px_test, py_test = backdoor.poison(x_test[not_target], y_test[not_target])
poison_preds = np.argmax(model.predict(px_test), axis=1)
poison_correct = np.sum(poison_preds == np.argmax(y_test[not_target],
axis=1))
poison_total = poison_preds.shape[0]
poison_acc = poison_correct / poison_total

print("\nPoison test set accuracy: %.2f%%" % (poison_acc * 100))

c = 0 # index to display
plt.imshow(px_test[c].squeeze())
plt.show()
clean_label = c

print("Prediction: " + str(poison_preds[c]))
```

```
Poison test set accuracy: 0.37%
```




```
Prediction: 9
```