# ML_Final_Project_tsk9863_rv2205

May 17, 2022

## 1 ECE-GY 6143 - Machine Learning Project

### 1.1 Analyzing impacts of Attacks and Counters on Image Classifiers

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## 2 Installation

[ ]:
```
#flickrapi
!pip install flickrapi
```

```
Requirement already satisfied: flickrapi in /usr/local/lib/python3.7/dist-
packages (2.4.0)
Requirement already satisfied: requests-toolbelt>=0.3.1 in
/usr/local/lib/python3.7/dist-packages (from flickrapi) (0.9.1)
Requirement already satisfied: requests-oauthlib>=0.4.0 in
/usr/local/lib/python3.7/dist-packages (from flickrapi) (1.3.1)
Requirement already satisfied: requests>=2.2.1 in /usr/local/lib/python3.7/dist-
packages (from flickrapi) (2.23.0)
Requirement already satisfied: six>=1.5.2 in /usr/local/lib/python3.7/dist-
packages (from flickrapi) (1.15.0)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.7/dist-packages (from requests>=2.2.1->flickrapi)
(2021.10.8)
Requirement already satisfied: chardet<4,>=3.0.2 in
/usr/local/lib/python3.7/dist-packages (from requests>=2.2.1->flickrapi) (3.0.4)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in
/usr/local/lib/python3.7/dist-packages (from requests>=2.2.1->flickrapi)
(1.24.3)
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-
packages (from requests>=2.2.1->flickrapi) (2.10)
Requirement already satisfied: oauthlib>=3.0.0 in /usr/local/lib/python3.7/dist-
packages (from requests-oauthlib>=0.4.0->flickrapi) (3.2.0)
```

[ ]:
```
# Adversarial Robustness Toolbox
import sys
!{sys.executable} -m pip install adversarial-robustness-toolbox==1.5.1␣
↪tensorflow==2.3.1 Keras==2.4.3 matplotlib==3.3.2 ipywidgets==7.6.3
```

```
Requirement already satisfied: adversarial-robustness-toolbox==1.5.1 in
/usr/local/lib/python3.7/dist-packages (1.5.1)
Requirement already satisfied: tensorflow==2.3.1 in
/usr/local/lib/python3.7/dist-packages (2.3.1)
Requirement already satisfied: Keras==2.4.3 in /usr/local/lib/python3.7/dist-
packages (2.4.3)
Collecting matplotlib==3.3.2
  Using cached matplotlib-3.3.2-cp37-cp37m-manylinux1_x86_64.whl (11.6 MB)
Requirement already satisfied: ipywidgets==7.6.3 in
/usr/local/lib/python3.7/dist-packages (7.6.3)
Requirement already satisfied: scipy>=1.4.1 in /usr/local/lib/python3.7/dist-
packages (from adversarial-robustness-toolbox==1.5.1) (1.4.1)
Requirement already satisfied: statsmodels in /usr/local/lib/python3.7/dist-
packages (from adversarial-robustness-toolbox==1.5.1) (0.10.2)
Requirement already satisfied: mypy in /usr/local/lib/python3.7/dist-packages
(from adversarial-robustness-toolbox==1.5.1) (0.950)
Requirement already satisfied: tqdm in /usr/local/lib/python3.7/dist-packages
(from adversarial-robustness-toolbox==1.5.1) (4.64.0)
Requirement already satisfied: six in /usr/local/lib/python3.7/dist-packages
(from adversarial-robustness-toolbox==1.5.1) (1.15.0)
Requirement already satisfied: numpy in /usr/local/lib/python3.7/dist-packages
(from adversarial-robustness-toolbox==1.5.1) (1.18.5)
Requirement already satisfied: scikit-learn==0.23.*,>=0.22.2 in
/usr/local/lib/python3.7/dist-packages (from adversarial-robustness-
toolbox==1.5.1) (0.23.2)
Requirement already satisfied: setuptools in /usr/local/lib/python3.7/dist-
packages (from adversarial-robustness-toolbox==1.5.1) (57.4.0)
Requirement already satisfied: resampy in /usr/local/lib/python3.7/dist-packages
(from adversarial-robustness-toolbox==1.5.1) (0.2.2)
Requirement already satisfied: Pillow in /usr/local/lib/python3.7/dist-packages
(from adversarial-robustness-toolbox==1.5.1) (7.1.2)
Requirement already satisfied: pydub in /usr/local/lib/python3.7/dist-packages
(from adversarial-robustness-toolbox==1.5.1) (0.25.1)
Requirement already satisfied: ffmpeg-python in /usr/local/lib/python3.7/dist-
packages (from adversarial-robustness-toolbox==1.5.1) (0.2.0)
Requirement already satisfied: cma in /usr/local/lib/python3.7/dist-packages
(from adversarial-robustness-toolbox==1.5.1) (3.2.2)
Requirement already satisfied: opt-einsum>=2.3.2 in
/usr/local/lib/python3.7/dist-packages (from tensorflow==2.3.1) (3.3.0)
Requirement already satisfied: absl-py>=0.7.0 in /usr/local/lib/python3.7/dist-
packages (from tensorflow==2.3.1) (1.0.0)
Requirement already satisfied: tensorflow-estimator<2.4.0,>=2.3.0 in
/usr/local/lib/python3.7/dist-packages (from tensorflow==2.3.1) (2.3.0)
Requirement already satisfied: google-pasta>=0.1.8 in
/usr/local/lib/python3.7/dist-packages (from tensorflow==2.3.1) (0.2.0)
Requirement already satisfied: h5py<2.11.0,>=2.10.0 in
/usr/local/lib/python3.7/dist-packages (from tensorflow==2.3.1) (2.10.0)
Requirement already satisfied: keras-preprocessing<1.2,>=1.1.1 in
```

```
/usr/local/lib/python3.7/dist-packages (from tensorflow==2.3.1) (1.1.2)
Requirement already satisfied: wrapt>=1.11.1 in /usr/local/lib/python3.7/dist-
packages (from tensorflow==2.3.1) (1.14.1)
Requirement already satisfied: termcolor>=1.1.0 in
/usr/local/lib/python3.7/dist-packages (from tensorflow==2.3.1) (1.1.0)
Requirement already satisfied: grpcio>=1.8.6 in /usr/local/lib/python3.7/dist-
packages (from tensorflow==2.3.1) (1.46.1)
Requirement already satisfied: wheel>=0.26 in /usr/local/lib/python3.7/dist-
packages (from tensorflow==2.3.1) (0.37.1)
Requirement already satisfied: astunparse==1.6.3 in
/usr/local/lib/python3.7/dist-packages (from tensorflow==2.3.1) (1.6.3)
Requirement already satisfied: gast==0.3.3 in /usr/local/lib/python3.7/dist-
packages (from tensorflow==2.3.1) (0.3.3)
Requirement already satisfied: protobuf>=3.9.2 in /usr/local/lib/python3.7/dist-
packages (from tensorflow==2.3.1) (3.17.3)
Requirement already satisfied: tensorboard<3,>=2.3.0 in
/usr/local/lib/python3.7/dist-packages (from tensorflow==2.3.1) (2.8.0)
Requirement already satisfied: pyyaml in /usr/local/lib/python3.7/dist-packages
(from Keras==2.4.3) (3.13)
Requirement already satisfied: kiwisolver>=1.0.1 in
/usr/local/lib/python3.7/dist-packages (from matplotlib==3.3.2) (1.4.2)
Requirement already satisfied: certifi>=2020.06.20 in
/usr/local/lib/python3.7/dist-packages (from matplotlib==3.3.2) (2021.10.8)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.3 in
/usr/local/lib/python3.7/dist-packages (from matplotlib==3.3.2) (3.0.9)
Requirement already satisfied: python-dateutil>=2.1 in
/usr/local/lib/python3.7/dist-packages (from matplotlib==3.3.2) (2.8.2)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.7/dist-
packages (from matplotlib==3.3.2) (0.11.0)
Requirement already satisfied: traitlets>=4.3.1 in
/usr/local/lib/python3.7/dist-packages (from ipywidgets==7.6.3) (5.2.0)
Requirement already satisfied: jupyterlab-widgets>=1.0.0 in
/usr/local/lib/python3.7/dist-packages (from ipywidgets==7.6.3) (1.1.0)
Requirement already satisfied: nbformat>=4.2.0 in /usr/local/lib/python3.7/dist-
packages (from ipywidgets==7.6.3) (5.4.0)
Requirement already satisfied: ipython>=4.0.0 in /usr/local/lib/python3.7/dist-
packages (from ipywidgets==7.6.3) (5.5.0)
Requirement already satisfied: ipykernel>=4.5.1 in
/usr/local/lib/python3.7/dist-packages (from ipywidgets==7.6.3) (4.10.1)
Requirement already satisfied: widgetsnbextension~=3.5.0 in
/usr/local/lib/python3.7/dist-packages (from ipywidgets==7.6.3) (3.5.2)
Requirement already satisfied: threadpoolctl>=2.0.0 in
/usr/local/lib/python3.7/dist-packages (from scikit-
learn==0.23.*,>=0.22.2->adversarial-robustness-toolbox==1.5.1) (3.1.0)
Requirement already satisfied: joblib>=0.11 in /usr/local/lib/python3.7/dist-
packages (from scikit-learn==0.23.*,>=0.22.2->adversarial-robustness-
toolbox==1.5.1) (1.1.0)
Requirement already satisfied: tornado>=4.0 in /usr/local/lib/python3.7/dist-
```

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packages (from ipykernel>=4.5.1->ipywidgets==7.6.3) (5.1.1)
Requirement already satisfied: jupyter-client in /usr/local/lib/python3.7/dist-
packages (from ipykernel>=4.5.1->ipywidgets==7.6.3) (5.3.5)
Requirement already satisfied: simplegeneric>0.8 in
/usr/local/lib/python3.7/dist-packages (from ipython>=4.0.0->ipywidgets==7.6.3)
(0.8.1)
Requirement already satisfied: pexpect in /usr/local/lib/python3.7/dist-packages
(from ipython>=4.0.0->ipywidgets==7.6.3) (4.8.0)
Requirement already satisfied: pygments in /usr/local/lib/python3.7/dist-
packages (from ipython>=4.0.0->ipywidgets==7.6.3) (2.6.1)
Requirement already satisfied: prompt-toolkit<2.0.0,>=1.0.4 in
/usr/local/lib/python3.7/dist-packages (from ipython>=4.0.0->ipywidgets==7.6.3)
(1.0.18)
Requirement already satisfied: decorator in /usr/local/lib/python3.7/dist-
packages (from ipython>=4.0.0->ipywidgets==7.6.3) (4.4.2)
Requirement already satisfied: pickleshare in /usr/local/lib/python3.7/dist-
packages (from ipython>=4.0.0->ipywidgets==7.6.3) (0.7.5)
Requirement already satisfied: typing-extensions in
/usr/local/lib/python3.7/dist-packages (from
kiwisolver>=1.0.1->matplotlib==3.3.2) (4.2.0)
Requirement already satisfied: fastjsonschema in /usr/local/lib/python3.7/dist-
packages (from nbformat>=4.2.0->ipywidgets==7.6.3) (2.15.3)
Requirement already satisfied: jsonschema>=2.6 in /usr/local/lib/python3.7/dist-
packages (from nbformat>=4.2.0->ipywidgets==7.6.3) (4.3.3)
Requirement already satisfied: jupyter-core in /usr/local/lib/python3.7/dist-
packages (from nbformat>=4.2.0->ipywidgets==7.6.3) (4.10.0)
Requirement already satisfied: pyrsistent!=0.17.0,!=0.17.1,!=0.17.2,>=0.14.0 in
/usr/local/lib/python3.7/dist-packages (from
jsonschema>=2.6->nbformat>=4.2.0->ipywidgets==7.6.3) (0.18.1)
Requirement already satisfied: attrs>=17.4.0 in /usr/local/lib/python3.7/dist-
packages (from jsonschema>=2.6->nbformat>=4.2.0->ipywidgets==7.6.3) (21.4.0)
Requirement already satisfied: importlib-metadata in
/usr/local/lib/python3.7/dist-packages (from
jsonschema>=2.6->nbformat>=4.2.0->ipywidgets==7.6.3) (4.11.3)
Requirement already satisfied: importlib-resources>=1.4.0 in
/usr/local/lib/python3.7/dist-packages (from
jsonschema>=2.6->nbformat>=4.2.0->ipywidgets==7.6.3) (5.7.1)
Requirement already satisfied: zipp>=3.1.0 in /usr/local/lib/python3.7/dist-
packages (from importlib-
resources>=1.4.0->jsonschema>=2.6->nbformat>=4.2.0->ipywidgets==7.6.3) (3.8.0)
Requirement already satisfied: wcwidth in /usr/local/lib/python3.7/dist-packages
(from prompt-toolkit<2.0.0,>=1.0.4->ipython>=4.0.0->ipywidgets==7.6.3) (0.2.5)
Requirement already satisfied: requests<3,>=2.21.0 in
/usr/local/lib/python3.7/dist-packages (from
tensorboard<3,>=2.3.0->tensorflow==2.3.1) (2.23.0)
Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.7/dist-
packages (from tensorboard<3,>=2.3.0->tensorflow==2.3.1) (3.3.7)
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in
```

```
/usr/local/lib/python3.7/dist-packages (from
tensorboard<3,>=2.3.0->tensorflow==2.3.1) (1.8.1)
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in
/usr/local/lib/python3.7/dist-packages (from
tensorboard<3,>=2.3.0->tensorflow==2.3.1) (0.4.6)
Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0 in
/usr/local/lib/python3.7/dist-packages (from
tensorboard<3,>=2.3.0->tensorflow==2.3.1) (0.6.1)
Requirement already satisfied: google-auth<3,>=1.6.3 in
/usr/local/lib/python3.7/dist-packages (from
tensorboard<3,>=2.3.0->tensorflow==2.3.1) (1.35.0)
Requirement already satisfied: werkzeug>=0.11.15 in
/usr/local/lib/python3.7/dist-packages (from
tensorboard<3,>=2.3.0->tensorflow==2.3.1) (1.0.1)
Requirement already satisfied: rsa<5,>=3.1.4 in /usr/local/lib/python3.7/dist-
packages (from google-auth<3,>=1.6.3->tensorboard<3,>=2.3.0->tensorflow==2.3.1)
(4.8)
Requirement already satisfied: pyasn1-modules>=0.2.1 in
/usr/local/lib/python3.7/dist-packages (from google-
auth<3,>=1.6.3->tensorboard<3,>=2.3.0->tensorflow==2.3.1) (0.2.8)
Requirement already satisfied: cachetools<5.0,>=2.0.0 in
/usr/local/lib/python3.7/dist-packages (from google-
auth<3,>=1.6.3->tensorboard<3,>=2.3.0->tensorflow==2.3.1) (4.2.4)
Requirement already satisfied: requests-oauthlib>=0.7.0 in
/usr/local/lib/python3.7/dist-packages (from google-auth-
oauthlib<0.5,>=0.4.1->tensorboard<3,>=2.3.0->tensorflow==2.3.1) (1.3.1)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in
/usr/local/lib/python3.7/dist-packages (from pyasn1-modules>=0.2.1->google-
auth<3,>=1.6.3->tensorboard<3,>=2.3.0->tensorflow==2.3.1) (0.4.8)
Requirement already satisfied: idna<3,>=2.5 in /usr/local/lib/python3.7/dist-
packages (from requests<3,>=2.21.0->tensorboard<3,>=2.3.0->tensorflow==2.3.1)
(2.10)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in
/usr/local/lib/python3.7/dist-packages (from
requests<3,>=2.21.0->tensorboard<3,>=2.3.0->tensorflow==2.3.1) (1.24.3)
Requirement already satisfied: chardet<4,>=3.0.2 in
/usr/local/lib/python3.7/dist-packages (from
requests<3,>=2.21.0->tensorboard<3,>=2.3.0->tensorflow==2.3.1) (3.0.4)
Requirement already satisfied: oauthlib>=3.0.0 in /usr/local/lib/python3.7/dist-
packages (from requests-oauthlib>=0.7.0->google-auth-
oauthlib<0.5,>=0.4.1->tensorboard<3,>=2.3.0->tensorflow==2.3.1) (3.2.0)
Requirement already satisfied: notebook>=4.4.1 in /usr/local/lib/python3.7/dist-
packages (from widgetsnbextension~=3.5.0->ipywidgets==7.6.3) (5.3.1)
Requirement already satisfied: Send2Trash in /usr/local/lib/python3.7/dist-
packages (from notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3)
(1.8.0)
Requirement already satisfied: nbconvert in /usr/local/lib/python3.7/dist-
packages (from notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3)
```

```
(5.6.1)
Requirement already satisfied: ipython-genutils in
/usr/local/lib/python3.7/dist-packages (from
notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3) (0.2.0)
Requirement already satisfied: jinja2 in /usr/local/lib/python3.7/dist-packages
(from notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3) (2.11.3)
Requirement already satisfied: terminado>=0.8.1 in
/usr/local/lib/python3.7/dist-packages (from
notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3) (0.13.3)
Requirement already satisfied: pyzmq>=13 in /usr/local/lib/python3.7/dist-
packages (from jupyter-client->ipykernel>=4.5.1->ipywidgets==7.6.3) (22.3.0)
Requirement already satisfied: ptyprocess in /usr/local/lib/python3.7/dist-
packages (from
terminado>=0.8.1->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3)
(0.7.0)
Requirement already satisfied: future in /usr/local/lib/python3.7/dist-packages
(from ffmpeg-python->adversarial-robustness-toolbox==1.5.1) (0.16.0)
Requirement already satisfied: MarkupSafe>=0.23 in
/usr/local/lib/python3.7/dist-packages (from
jinja2->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3) (2.0.1)
Requirement already satisfied: mypy-extensions>=0.4.3 in
/usr/local/lib/python3.7/dist-packages (from mypy->adversarial-robustness-
toolbox==1.5.1) (0.4.3)
Requirement already satisfied: tomli>=1.1.0 in /usr/local/lib/python3.7/dist-
packages (from mypy->adversarial-robustness-toolbox==1.5.1) (2.0.1)
Requirement already satisfied: typed-ast<2,>=1.4.0 in
/usr/local/lib/python3.7/dist-packages (from mypy->adversarial-robustness-
toolbox==1.5.1) (1.5.3)
Requirement already satisfied: defusedxml in /usr/local/lib/python3.7/dist-
packages (from
nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3)
(0.7.1)
Requirement already satisfied: mistune<2,>=0.8.1 in
/usr/local/lib/python3.7/dist-packages (from
nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3)
(0.8.4)
Requirement already satisfied: bleach in /usr/local/lib/python3.7/dist-packages
(from nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3)
(5.0.0)
Requirement already satisfied: testpath in /usr/local/lib/python3.7/dist-
packages (from
nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3)
(0.6.0)
Requirement already satisfied: entrypoints>=0.2.2 in
/usr/local/lib/python3.7/dist-packages (from
nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3) (0.4)
Requirement already satisfied: pandocfilters>=1.4.1 in
/usr/local/lib/python3.7/dist-packages (from
nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ipywidgets==7.6.3)
(1.5.0)
Requirement already satisfied: webencodings in /usr/local/lib/python3.7/dist-
packages (from bleach->nbconvert->notebook>=4.4.1->widgetsnbextension~=3.5.0->ip
ywidgets==7.6.3) (0.5.1)
Requirement already satisfied: numba>=0.32 in /usr/local/lib/python3.7/dist-
packages (from resampy->adversarial-robustness-toolbox==1.5.1) (0.51.2)
Requirement already satisfied: llvmlite<0.35,>=0.34.0.dev0 in
/usr/local/lib/python3.7/dist-packages (from numba>=0.32->resampy->adversarial-
robustness-toolbox==1.5.1) (0.34.0)
Requirement already satisfied: patsy>=0.4.0 in /usr/local/lib/python3.7/dist-
packages (from statsmodels->adversarial-robustness-toolbox==1.5.1) (0.5.2)
Requirement already satisfied: pandas>=0.19 in /usr/local/lib/python3.7/dist-
packages (from statsmodels->adversarial-robustness-toolbox==1.5.1) (1.3.5)
Requirement already satisfied: pytz>=2017.3 in /usr/local/lib/python3.7/dist-
packages (from pandas>=0.19->statsmodels->adversarial-robustness-toolbox==1.5.1)
(2022.1)
Installing collected packages: matplotlib
  Attempting uninstall: matplotlib
    Found existing installation: matplotlib 3.1.3
    Uninstalling matplotlib-3.1.3:
      Successfully uninstalled matplotlib-3.1.3
ERROR: pip's dependency resolver does not currently take into account all
the packages that are installed. This behaviour is the source of the following
dependency conflicts.
yellowbrick 1.4 requires scikit-learn>=1.0.0, but you have scikit-learn 0.23.2
which is incompatible.
albumentations 0.1.12 requires imgaug<0.2.7,>=0.2.5, but you have imgaug 0.2.9
which is incompatible.
Successfully installed matplotlib-3.3.2
```

```
[ ]: !python -m pip uninstall matplotlib
     !pip install matplotlib==3.1.3
```

```
Found existing installation: matplotlib 3.3.2
Uninstalling matplotlib-3.3.2:
  Would remove:
    /usr/local/lib/python3.7/dist-packages/matplotlib-3.3.2-py3.7-nspkg.pth
    /usr/local/lib/python3.7/dist-packages/matplotlib-3.3.2.dist-info/*
    /usr/local/lib/python3.7/dist-packages/matplotlib/*
    /usr/local/lib/python3.7/dist-packages/mpl_toolkits/axes_grid/*
    /usr/local/lib/python3.7/dist-packages/mpl_toolkits/axes_grid1/*
    /usr/local/lib/python3.7/dist-packages/mpl_toolkits/axisartist/*
    /usr/local/lib/python3.7/dist-packages/mpl_toolkits/mplot3d/*
    /usr/local/lib/python3.7/dist-packages/mpl_toolkits/tests/*
    /usr/local/lib/python3.7/dist-packages/pylab.py
Proceed (y/n)? y
  Successfully uninstalled matplotlib-3.3.2
Collecting matplotlib==3.1.3
  Using cached matplotlib-3.1.3-cp37-cp37m-manylinux1_x86_64.whl (13.1 MB)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in
/usr/local/lib/python3.7/dist-packages (from matplotlib==3.1.3) (3.0.9)
Requirement already satisfied: cycler>=0.10 in /usr/local/lib/python3.7/dist-
packages (from matplotlib==3.1.3) (0.11.0)
Requirement already satisfied: python-dateutil>=2.1 in
/usr/local/lib/python3.7/dist-packages (from matplotlib==3.1.3) (2.8.2)
Requirement already satisfied: kiwisolver>=1.0.1 in
/usr/local/lib/python3.7/dist-packages (from matplotlib==3.1.3) (1.4.2)
Requirement already satisfied: numpy>=1.11 in /usr/local/lib/python3.7/dist-
packages (from matplotlib==3.1.3) (1.18.5)
Requirement already satisfied: typing-extensions in
/usr/local/lib/python3.7/dist-packages (from
kiwisolver>=1.0.1->matplotlib==3.1.3) (4.2.0)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.7/dist-
packages (from python-dateutil>=2.1->matplotlib==3.1.3) (1.15.0)
Installing collected packages: matplotlib
ERROR: pip's dependency resolver does not currently take into account all

the packages that are installed. This behaviour is the source of the following

dependency conflicts.

yellowbrick 1.4 requires scikit-learn>=1.0.0, but you have scikit-learn 0.23.2

which is incompatible.

albumentations 0.1.12 requires imgaug<0.2.7,>=0.2.5, but you have imgaug 0.2.9

which is incompatible.
Successfully installed matplotlib-3.1.3
```

[ ]:
```
# Install ImageNet stubs:
!{sys.executable} -m pip install git+https://github.com/nottombrown/
 ↪imagenet_stubs
```

```
Collecting git+https://github.com/nottombrown/imagenet_stubs
  Cloning https://github.com/nottombrown/imagenet_stubs to /tmp/pip-req-
build-x27s6ybq
  Running command git clone -q https://github.com/nottombrown/imagenet_stubs
/tmp/pip-req-build-x27s6ybq
```

## 3 Utility functions

[ ]:
```
import matplotlib.pyplot as plt

def makegraph(acc_dict, title):

  names = list(acc_dict.keys())
  values = list(acc_dict.values())
  plt.xlabel("%")
  plt.ylabel("accuracy")
  plt.title(title)

  plotfig = plt.plot(names,values, linewidth=2.0)
```

## 4 Code

[ ]:
```
import flickrapi
import urllib.request
import matplotlib.pyplot as plt
import numpy as np
import skimage.io
import skimage.transform
import requests
from io import BytesIO
from PIL import Image


# For SSIM
from skimage import metrics

# For PCA
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.decomposition import PCA
import cv2
from scipy.stats import stats
import matplotlib.image as mpimg
from PIL import Image as im


# Load basic dependencies:
import warnings
warnings.filterwarnings('ignore')

%matplotlib inline
```

```
import matplotlib.pyplot as plt
import sys
import numpy as np

# For Adversarial attacks
# Disable TensorFlow eager execution:
import tensorflow as tf
if tf.executing_eagerly():
    tf.compat.v1.disable_eager_execution()

# Load Keras dependencies:
from keras.applications.resnet50 import ResNet50, preprocess_input
from keras.preprocessing import image

# Load ART dependencies:
from art.estimators.classification import KerasClassifier
from art.attacks.evasion import ProjectedGradientDescent
from art.defences.preprocessor import SpatialSmoothing
from art.utils import to_categorical
from art.attacks.evasion import FastGradientMethod

import imagenet_stubs
from imagenet_stubs.imagenet_2012_labels import name_to_label, label_to_name


%matplotlib inline
```

```
[ ]: # see the flickr demo on where to get keys.
     api_key = u'17e77d77492197f4c429bfd3cdd6fbfe41'  # use your Key
     api_secret = u'8cdd8092ad79460bfe'  # Use your secret
     flickr = flickrapi.FlickrAPI(api_key, api_secret)
```

```
[ ]: import warnings
     import os

     dir_name = 'test'
     dir_exists = os.path.isdir(dir_name)
     if not dir_exists:
         os.mkdir(dir_name)
         print("Making directory %s" % dir_name)
     else:
         print("Will store images in directory %s" % dir_name)
```

```
Will store images in directory test
```

```
[ ]: classes =␣
      ↪['golden_retriever','persian_cat','ambulance','school_bus','traffic_light']
```

```
[ ]: for i in classes:

       dir_folder = os.path.join(os.getcwd(),'test',i)
       dir_exists = os.path.isdir(dir_folder)
       if not dir_exists:
           os.mkdir(dir_folder)
           print("Making directory %s" % dir_folder)
       else:
           print("Will store images in directory %s" % dir_folder)
```

```
Will store images in directory /content/test/golden_retriever
Will store images in directory /content/test/persian_cat
Will store images in directory /content/test/ambulance
Will store images in directory /content/test/school_bus
Will store images in directory /content/test/traffic_light
```

```
[ ]: n_images = 500

     for _ in classes:
       keyword = _
       dir_name = _
       photos = flickr.walk(text=keyword, tag_mode='all',␣
      ↪tags=keyword,extras='url_c',\
                          sort='relevance',per_page=100)

       i = 0
       nrow = 224
       ncol = 224
       for photo in photos:
           url=photo.get('url_c')
           if not (url is None):

               # Create a file from the URL
               # This may only work in Python3
               response = requests.get(url)
               file = BytesIO(response.content)

               # Read image from file
               im = skimage.io.imread(file)

               # Resize images
               im1 = skimage.transform.resize(im,(nrow,ncol),mode='constant')

               # Convert to uint8, suppress the warning about the precision loss
               with warnings.catch_warnings():
                   warnings.simplefilter("ignore")
                   im2 = skimage.img_as_ubyte(im1)
```

```
          # Save the image

          local_name = '{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.
↪format('test',dir_name,keyword, i)
          skimage.io.imsave(local_name, im2)
          if i%100 == 0:
            print("Downloaded: ",local_name)
          i = i + 1
      if (i >= n_images):
          break
```

[ ]:
```
#!zip -r /content/project_data.zip /content/test
# Drive link: https://drive.google.com/file/d/1mdvke76_2fybm6J00g2qJ-2e5a20zPvY/
↪view?usp=sharing
```

## 5 Image classification

[ ]:
```
#Loading pretrained deep network
import tensorflow as tf
tf.config.list_physical_devices('GPU')
```

[ ]:
```
[PhysicalDevice(name='/physical_device:GPU:0', device_type='GPU')]
```

[ ]:
```
from tensorflow.keras import applications
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras import optimizers
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dropout, Flatten, Dense
from keras.applications.vgg16 import VGG16
from keras.applications.vgg16 import preprocess_input
from keras.applications.vgg16 import decode_predictions

from keras.preprocessing.image import load_img
from keras.preprocessing.image import img_to_array
```

[ ]:
```
import numpy as np
import matplotlib.pyplot as plt
```

[ ]:
```
#clear keras session
import tensorflow.keras.backend as K
K.clear_session()
```

[ ]:
```
#Set the dimensions of the input image
nrow = 150
ncol = 150
```

```
input_shape = (nrow,ncol,3)
```

[ ]:
```
def predictlabel(model):
  label = []
  yhat=[]
  res= dict()
  for i in classes:
    for d in range(n_images):
      image = load_img('{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d))
      image = img_to_array(image)
      image = image.reshape(1,image.shape[0],image.shape[1],image.shape[2])
      image = preprocess_input(image)
      yhat = model.predict(image)
      l = decode_predictions(yhat)
      # print(l[0][0][1])
      res['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)] = l[0][0][1]
  return res
```

[ ]:
```
from keras.applications.resnet import ResNet50

# Performing image classification for original images
model1 = ResNet50()
resresnet = predictlabel(model1)
model = VGG16()
resvgg = predictlabel(model)
```

```
WARNING:tensorflow:From /usr/local/lib/python3.7/dist-
packages/tensorflow/python/keras/engine/training_v1.py:2070: Model.state_updates
(from tensorflow.python.keras.engine.training) is deprecated and will be removed
in a future version.
Instructions for updating:
This property should not be used in TensorFlow 2.0, as updates are applied
automatically.
Downloading data from https://storage.googleapis.com/download.tensorflow.org/dat
a/imagenet_class_index.json
40960/35363 [==================================] - 0s 0us/step
Downloading data from https://storage.googleapis.com/tensorflow/keras-
applications/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels.h5
553467904/553467096 [==============================] - 4s 0us/step
```

## 6 Adversarial attacks

[ ]:
```
from art.preprocessing.preprocessing import Preprocessor

class ResNet50Preprocessor(Preprocessor):
    def __call__(self, x, y=None):
        return preprocess_input(x.copy()), y

    def estimate_gradient(self, x, gradient):
        return gradient[..., ::-1]

model = ResNet50(weights='imagenet')
# Create the ART preprocessor and classifier wrapper:
preprocessor = ResNet50Preprocessor()
classifier = KerasClassifier(clip_values=(0, 255), model=model,␣
 ↪preprocessing=preprocessor)
```

[ ]:
```
# Create a new folder to store the adversarial samples
os.mkdir("adversarial_samples")
```

[ ]:
```
adv_images = []
fgsm_pred = {}
pgd_pred = {}

def adversarial_attack():
  p_ssim, f_ssim = 0, 0
  for i in classes:
    for d in range(n_images):
        file = '{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)
        im = image.load_img(file, target_size=(224, 224))
        im = image.img_to_array(im)
        if d == 0:
          adv_images.append([im])
        m = np.expand_dims(im, axis=0)
        m = np.array(m)

        # Creating PGD and FGSM class
        pgd = ProjectedGradientDescent(classifier, targeted=False, max_iter=10,␣
 ↪eps_step=1, eps=5)
        fgsm = FastGradientMethod(classifier, eps=0.5)

        # Generating new adversarial images
        pgd_img = pgd.generate(m)
        fgsm_img = fgsm.generate(m)

        # Predicting adversarially attacked images
        yhat_pgd = model1.predict(pgd_img)
        yhat_fgsm = model1.predict(fgsm_img)

        label1 = decode_predictions(yhat_pgd)[0][0][1]
        label2 = decode_predictions(yhat_fgsm)[0][0][1]
        p_ssim += metrics.structural_similarity(im, pgd_img[0],␣
↪multichannel=True)
        f_ssim += metrics.structural_similarity(im, fgsm_img[0],␣
↪multichannel=True)

        pgd_pred[file] = label1
        fgsm_pred[file] = label2

        # Saving the adversarial samples to a new folder
        cv2.imwrite('adversarial_samples/' + i + str(d) + '_pgd_.jpeg',␣
↪pgd_img[0])
        cv2.imwrite('adversarial_samples/' + i + str(d) + '_fgsm_.jpeg',␣
↪fgsm_img[0])

  print("PGD SSIM:",p_ssim/(len(classes)*n_images))
  print("FGSM SSIM:",f_ssim/(len(classes)*n_images))
  #return pgd_pred, fgsm_pred
```

[ ]:
```
def adv_acc(f, p):
   f_score, p_score = 0,0
   for i in classes:
    for d in range(n_images):
        file = '{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)
        if resresnet[file] == fgsm_pred[file]:
          f_score += 1
        if resresnet[file] == pgd_pred[file]:
          p_score += 1

   print("FGSM accuracy:", f_score/(len(classes)*n_images))
   print("PGD accuracy:", p_score/(len(classes)*n_images))
```

[ ]:
```
adversarial_attack()
adv_acc(fgsm_pred, pgd_pred)
```

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PGD - Iterations:   0%|          | 0/10 [00:00<?, ?it/s]
PGD - Random Initializations:   0%|          | 0/1 [00:00<?, ?it/s]
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PGD - Random Initializations:   0%|          | 0/1 [00:00<?, ?it/s]
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PGD - Random Initializations:   0%|          | 0/1 [00:00<?, ?it/s]
PGD - Iterations:   0%|          | 0/10 [00:00<?, ?it/s]
PGD - Random Initializations:   0%|          | 0/1 [00:00<?, ?it/s]
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PGD - Random Initializations:   0%|          | 0/1 [00:00<?, ?it/s]
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PGD - Random Initializations:   0%|          | 0/1 [00:00<?, ?it/s]
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PGD - Iterations:   0%|          | 0/10 [00:00<?, ?it/s]
PGD - Random Initializations:   0%|          | 0/1 [00:00<?, ?it/s]
PGD - Iterations:   0%|          | 0/10 [00:00<?, ?it/s]
PGD - Random Initializations:   0%|          | 0/1 [00:00<?, ?it/s]
PGD - Iterations:   0%|          | 0/10 [00:00<?, ?it/s]
PGD - Random Initializations:   0%|          | 0/1 [00:00<?, ?it/s]
PGD - Iterations:   0%|          | 0/10 [00:00<?, ?it/s]
PGD - Random Initializations:   0%|          | 0/1 [00:00<?, ?it/s]
PGD - Iterations:   0%|          | 0/10 [00:00<?, ?it/s]
PGD - Random Initializations:   0%|          | 0/1 [00:00<?, ?it/s]
PGD - Iterations:   0%|          | 0/10 [00:00<?, ?it/s]
PGD SSIM: 0.8114246111901547
FGSM SSIM: 0.9460959274785238
FGSM accuracy: 0.24
PGD accuracy: 0.05
```

## 7 Random noise

```
[ ]: import random
     import torchvision.transforms as transforms
     total_pixels=224*224*3

     noise_ssim = []
     noise_images = []
     def noise(n_percent,model):
       label = []
       yhat=[]
       res_attack= dict()
       ssim = 0
       for i in classes:
         for d in range(n_images):

             image = load_img('{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d))
             image = img_to_array(image)
             image = image.reshape(image.shape[0],image.shape[1],image.shape[2])

             att=image.copy()

             # Select a random pixel and replace it with a random pixel intensity
             for r in range(0,total_pixels*n_percent//100):
               r1=random.randint(0,224-1)
               r2=random.randint(0,224-1)
               r3=random.randint(0,3-1)
               r4=random.randint(0,255)
               att[r1][r2][r3]=r4

             if d == 0:
               noise_images.append([att])

             # Computing SSIM score
             ssim += metrics.structural_similarity(image, att, multichannel=True)
             att=att.reshape(1,image.shape[0],image.shape[1],image.shape[2])
             att = preprocess_input(att)

             yhatattack = model.predict(att)
             lattack = decode_predictions(yhatattack)
             res_attack['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)] =␣
      ↪lattack[0][0][1]
```

```
  ssim /= (len(classes)*n_images)
  noise_ssim.append(ssim)

  #print("OUTPUT OF NOISE:", res_attack)
  return res_attack
```

[ ]:
```
# Computing accuracy for noisy images

noise_vgg = dict()
noise_resnet = dict()
noise_acc_vgg = {}
noise_acc_resnet = {}
def find_noise_acc(n_percent_list):
  for n_percent in n_percent_list:
    scorevgg = 0
    scoreresnet = 0
    noise_vgg = noise(n_percent,model)
    noise_resnet = noise(n_percent,model1)

    for i in classes:
      for d in range(n_images):
        if resvgg['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)] ==␣
 ↪noise_vgg['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)]:
          scorevgg+=1
        if resresnet['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)] ==␣
 ↪noise_resnet['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)]:
          scoreresnet+=1
    noise_acc_vgg[n_percent] = scorevgg / len(resvgg.keys())
    noise_acc_resnet[n_percent] = scoreresnet / len(resresnet.keys())

  return noise_acc_vgg,noise_acc_resnet
```

[ ]:
```
noise_acc_vgg,noise_acc_resnet = find_noise_acc([0,10,20,30,40])
```

## 8 PCA

[ ]:
```
from PIL import Image as im

pca_ssim = {}
res_pca = {}
pca_images = []

def pca(ncomp, model):
    ssim = 0
    for i in classes:
        for d in range(n_images):
            img = cv2.cvtColor(cv2.imread('{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.
↪format('test',i,i,d)), cv2.COLOR_BGR2RGB)

            blue,green,red = cv2.split(img)

            # Normalization
            df_blue = blue/255
            df_green = green/255
            df_red = red/255

            # Fitting PCA
            pca_b = PCA(n_components=ncomp)
            pca_b.fit(df_blue)
            trans_pca_b = pca_b.transform(df_blue)
            pca_g = PCA(n_components=ncomp)
            pca_g.fit(df_green)
            trans_pca_g = pca_g.transform(df_green)
            pca_r = PCA(n_components=ncomp)
            pca_r.fit(df_red)
            trans_pca_r = pca_r.transform(df_red)

            # Reconstructing the original image
            b_arr = pca_b.inverse_transform(trans_pca_b)
            g_arr = pca_g.inverse_transform(trans_pca_g)
            r_arr = pca_r.inverse_transform(trans_pca_r)

            # Merging RGB channels to form a single image
            img_reduced= (cv2.merge((b_arr, g_arr, r_arr)))
            if d == 0:
              pca_images.append([img_reduced])
            # Computing SSIM
            ssim += metrics.structural_similarity(img, img_reduced,␣
↪multichannel=True)

            data = im.fromarray(img_reduced, 'RGB')
            data = data.resize((224,224))
            image = img_to_array(data)
            # reshape data for the model
            image = image.reshape((1, image.shape[0], image.shape[1], image.
↪shape[2]))
            # prepare the image for the VGG model
            image = preprocess_input(image)
            yhat = model.predict(image)
            # convert the probabilities to class labels
            label = decode_predictions(yhat)
            # retrieve the most likely result, e.g. highest probability
            label = label[0][0][1]

            res_pca['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)] =␣
↪label

    ssim /= (len(classes)*n_images)
    pca_ssim[ncomp] = ssim
    return res_pca
```

[ ]:
```
pca_acc_vgg = {}
pca_acc_resnet = {}

def pca_acc(comp_list):
  for c in comp_list:
    scorevgg = 0
    scoreresnet = 0
    pca_vgg = pca(c,model)
    pca_resnet = pca(c,model1)

    for i in classes:
      for d in range(n_images):
        if resvgg['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)] ==␣
↪pca_vgg['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)]:
          scorevgg+=1
        if resresnet['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)] ==␣
↪pca_resnet['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)]:
          scoreresnet+=1
    pca_acc_vgg[c] = scorevgg / len(resvgg.keys())
    pca_acc_resnet[c] = scoreresnet / len(resresnet.keys())

  return pca_acc_vgg, pca_acc_resnet
```

[ ]:
```
pca_acc_vgg, pca_acc_resnet = pca_acc([50,100,200])
```

[ ]:
```

```

## 9 Blurring images

[ ]:
```
n_images = 20
```

[ ]:
```
import cv2

blur_images = []
```

```
# Blurring images with a (k,k) kernel
def blur(k):
      res_blur = dict()
      vgg_blur = dict()
      for i in classes:
        for d in range(n_images):
            image = cv2.imread('{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.
 ↪format('test',i,i,d))
            blurImg = cv2.blur(image,(k,k))
            blurImg = cv2.resize(blurImg,(224, 224))
            blurImg = img_to_array(blurImg)
            blurImg = blurImg.reshape((1, blurImg.shape[0], blurImg.shape[1],␣
 ↪blurImg.shape[2]))
            blurImg = preprocess_input(blurImg)
            if d == 0:
              blur_images.append(blurImg)


            yhatblurr = model1.predict(blurImg)
            lblur = decode_predictions(yhatblurr)
            res_blur['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)] =␣
 ↪lblur[0][0][1]

            yhatblurr = model.predict(blurImg)
            lblur = decode_predictions(yhatblurr)
            vgg_blur['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)] =␣
 ↪lblur[0][0][1]

      return res_blur, vgg_blur
```

[ ]:
```
# Calculating accuracy for blurry images

def blur_calc(k_list):
  blur_resnet = dict()
  blur_vgg = dict()
  for k in k_list:
    scorevgg = 0
    scoreresnet = 0
    res_blur, vgg_blur = blur(k)
    for i in classes:
      for d in range(n_images):

          if resresnet['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)] ==␣
 ↪res_blur['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)]:
            scoreresnet+=1
```

```
        if resvgg['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)] ==␣
↪vgg_blur['{0:s}/{1:s}/{2:s}_{3:04d}.jpg'.format('test',i,i,d)]:
          scorevgg+=1

    blur_resnet[k] = scoreresnet / len(resresnet.keys())
    blur_vgg[k] = scorevgg / len(resresnet.keys())

  return blur_resnet, blur_vgg
```

[ ]:
```
blur_resnet, blur_vgg = blur_calc([1,2,3,4])
```

## 10 Displaying the results

## 11 Adversarial images

[ ]:
```
imgs = []
for i in range(len(adv_images)):
  imgs.append(adv_images[i][0])

_, axs = plt.subplots(1, 5, figsize=(17, 17))
axs = axs.flatten()
for img, ax in zip(imgs, axs):
    ax.imshow(img/255)
plt.show()
```

## 12 PCA images

[ ]:
```
imgs = []
for i in range(len(adv_images)):
  imgs.append(pca_images[i][0])

_, axs = plt.subplots(1, 5, figsize=(17, 17))
axs = axs.flatten()
for img, ax in zip(imgs, axs):
    ax.imshow(img)
plt.show()
```

```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
```

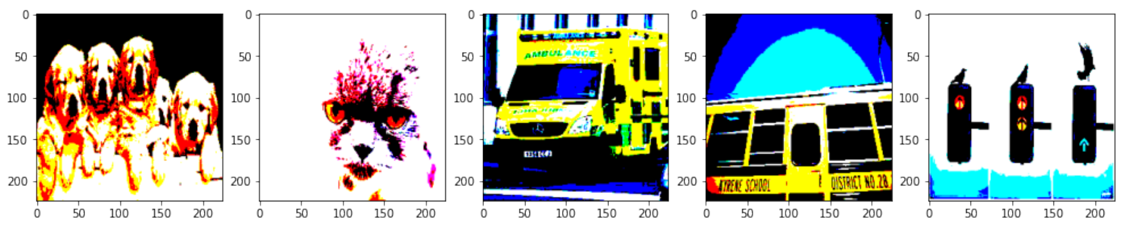
```
[ ]:
```

## 13 Noise images

```
[ ]: imgs = []
     for i in range(len(adv_images)):
       imgs.append(noise_images[i][0])

     _, axs = plt.subplots(1, 5, figsize=(17, 17))
     axs = axs.flatten()
     for img, ax in zip(imgs, axs):
         ax.imshow(img)
     plt.show()
```

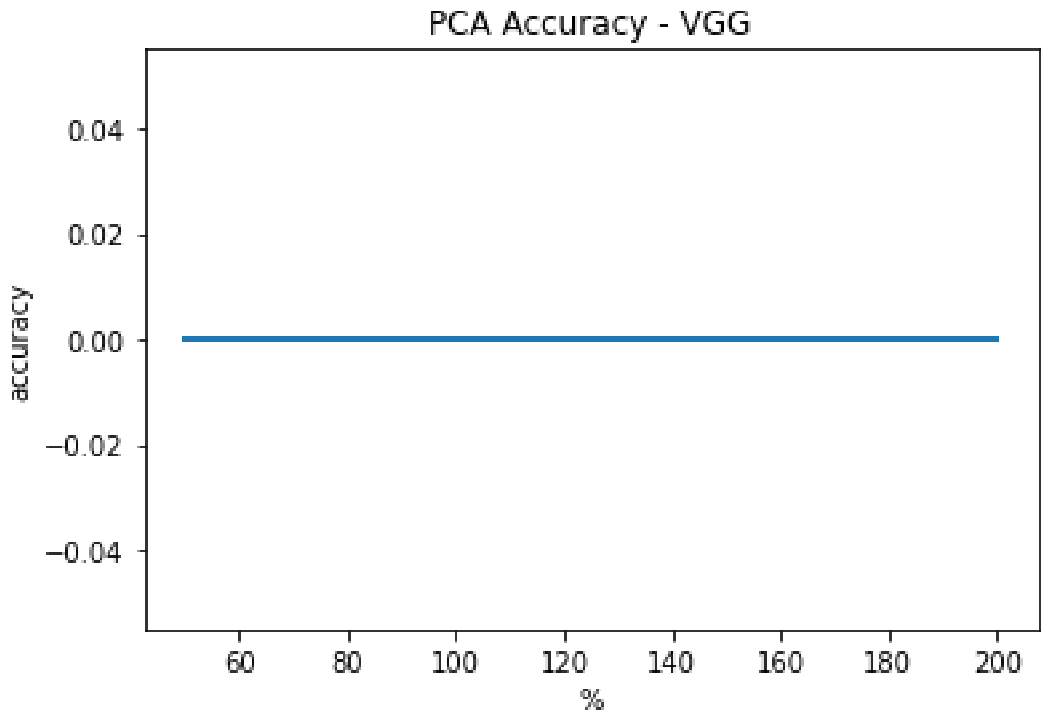
```
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
Clipping input data to the valid range for imshow with RGB data ([0..1] for
floats or [0..255] for integers).
```



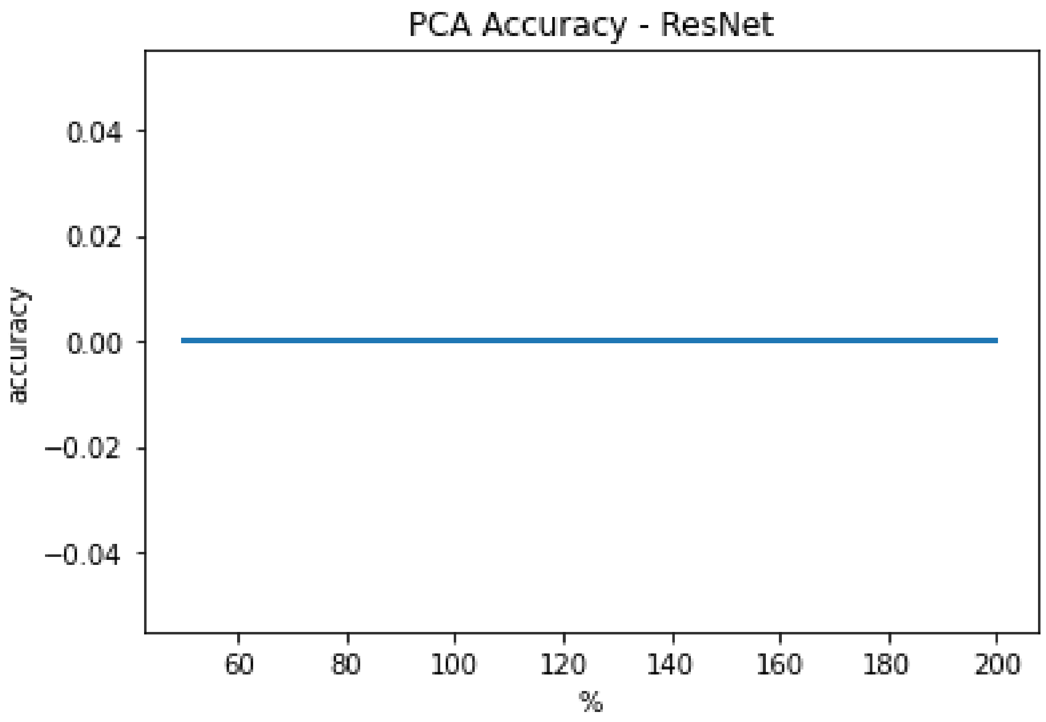
## 14 Accuracy Graphs

## 15 PCA

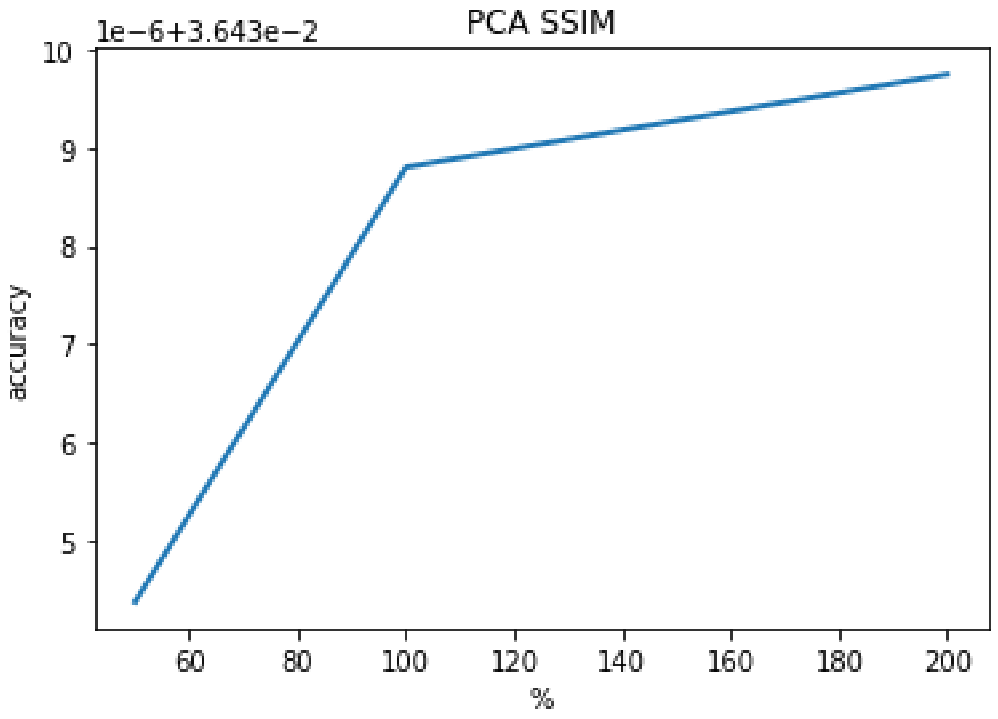
```
[ ]: makegraph(pca_acc_vgg, "PCA Accuracy - VGG")
```



```
[ ]: makegraph(pca_acc_resnet, "PCA Accuracy - ResNet")
```

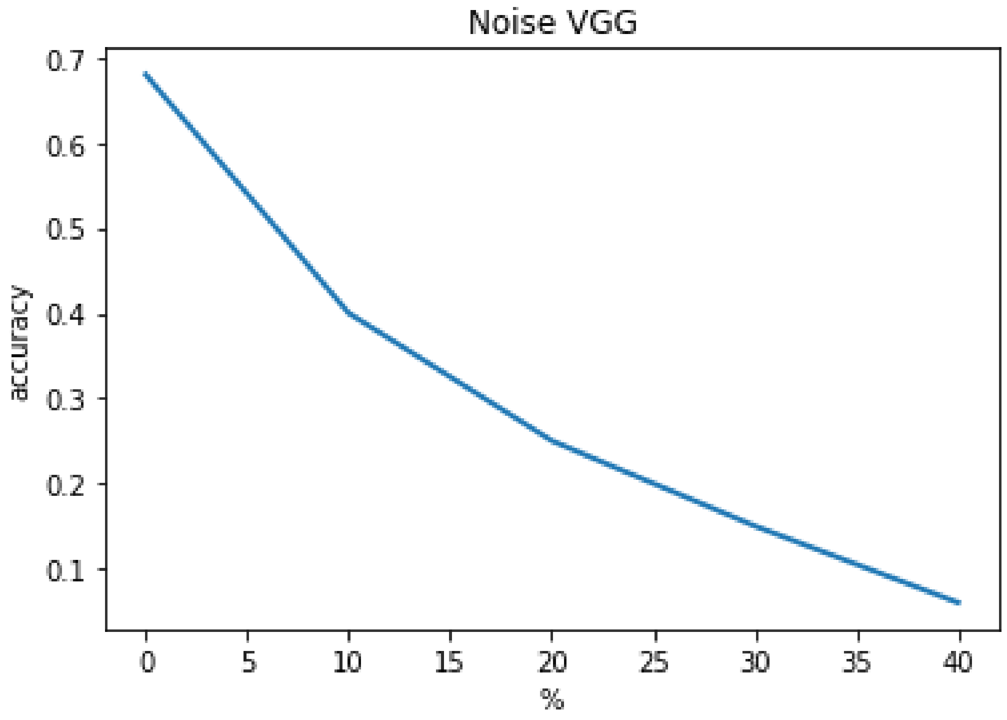


```
[ ]: makegraph(pca_ssim, "PCA SSIM")
```

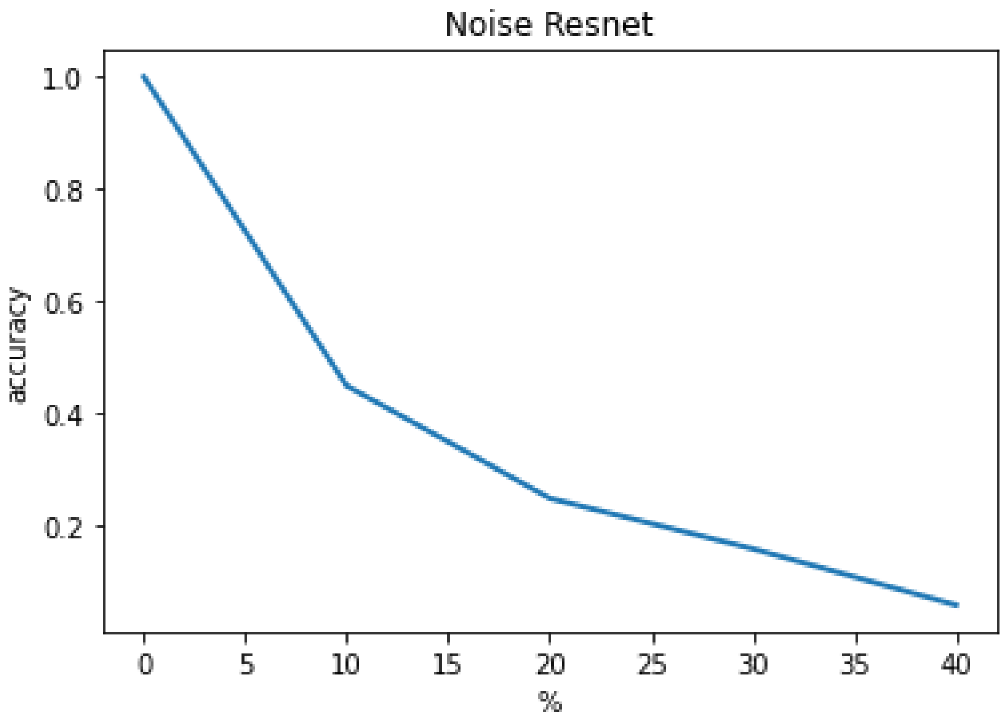


## 16 Noise

```
[ ]: makegraph(noise_acc_vgg, "Noise VGG")
```

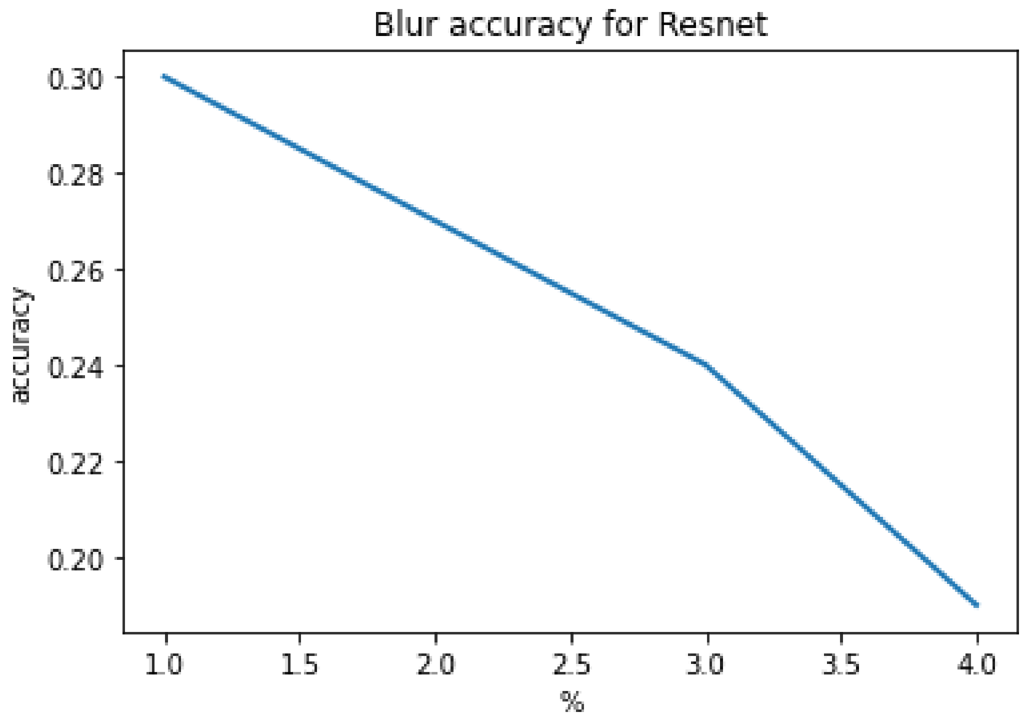


```
[ ]: makegraph(noise_acc_resnet, "Noise Resnet")
```

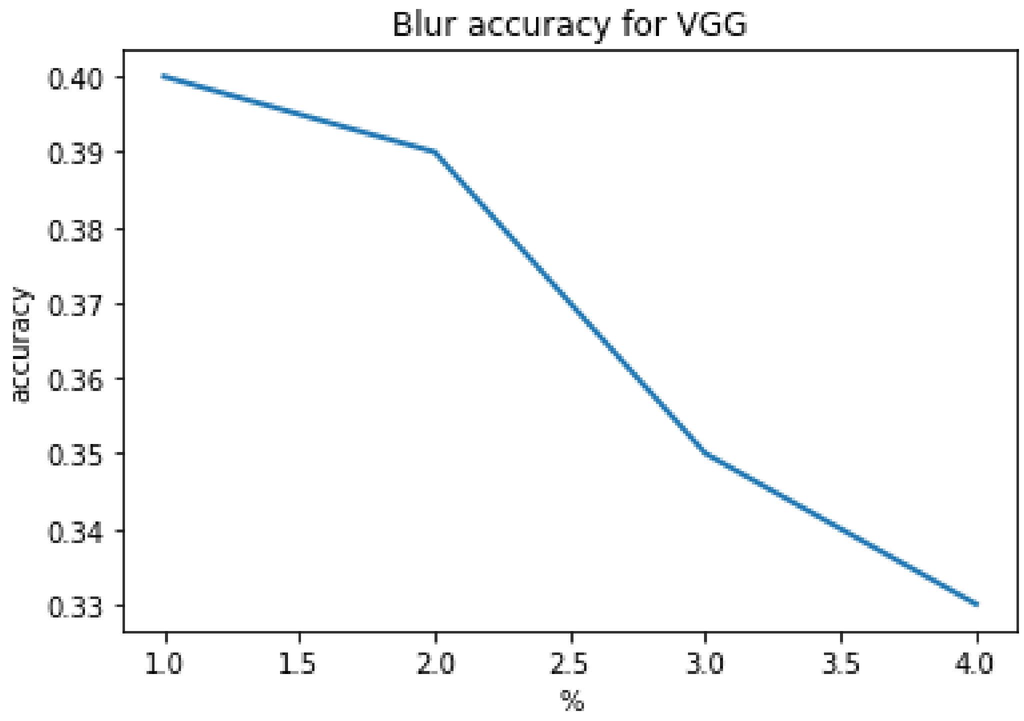


## 17 Blur

```
[ ]: makegraph(blur_resnet, "Blur accuracy for Resnet")
```



[ ]:
```
makegraph(blur_vgg, "Blur accuracy for VGG")
```



## 18 Results

1. Our idea was, to use PCA to reduce the dimensions of adversarially attacked images and to check if the new generated image still had an effect of the attack. According to our experiments, PCA retains the visual features of the image but completely changes the structure of the images internally which can fool the classifiers easily. Thus, if the images are to be used for any ML process, the images should not be compressed using PCA. Methods like JPEG Compression could perform better

2. Our idea was to blur adversarially attacked images to supress the effect of the attacks, however blurring didn't help much as it blurred the image too much.

3. Adversarial attacks produce images that are visually very similar to the original images and in fact have a very high SSIM score as well. In order to improve the model's classification towards adversarial attacks, the models should be trained with adversarial samples to improve its robustness

4. PGD is more powerful than FGSM according to the results. The more accuracy is significantly less on images attacked by PGD and the SSIM score for PGD images is still relatively high

5. In many cases it was observed that ResNet outperforms VGG which was expected.

6. A new dataset containing adversarial images can be generated using the code segments provided. This can help in training and testing new models.

```
[ ]:
```