# weighted-ddqn-stableb2-ddqnparms-2.5e6

## March 27, 2022

### 0.0.1 Exploration

```
[1]: |git clone https://github.com/openai/baselines.git
     %cd baselines
     !pip install -e .
     !pip install stable-baselines
     !pip install --upgrade tensorflow==1.14.0
     !pip install gym
    fatal: destination path 'baselines' already exists and is not an empty
    directory.
    /project/baselines
    Obtaining file:///project/baselines
    Requirement already satisfied: gym<0.16.0,>=0.15.4 in
    /opt/conda/lib/python3.7/site-packages (from baselines==0.1.6) (0.15.7)
    Requirement already satisfied: scipy in /opt/conda/lib/python3.7/site-packages
    (from baselines==0.1.6) (1.4.1)
    Requirement already satisfied: tqdm in /opt/conda/lib/python3.7/site-packages
    (from baselines==0.1.6) (4.46.1)
    Requirement already satisfied: joblib in /opt/conda/lib/python3.7/site-packages
    (from baselines==0.1.6) (0.15.1)
    Requirement already satisfied: cloudpickle in /opt/conda/lib/python3.7/site-
    packages (from baselines==0.1.6) (1.2.2)
    Requirement already satisfied: click in /opt/conda/lib/python3.7/site-packages
    (from baselines==0.1.6) (7.1.2)
    Requirement already satisfied: opency-python in /opt/conda/lib/python3.7/site-
    packages (from baselines==0.1.6) (4.5.5.64)
    Requirement already satisfied: six in /opt/conda/lib/python3.7/site-packages
    (from gym<0.16.0,>=0.15.4->baselines==0.1.6) (1.15.0)
    Requirement already satisfied: numpy>=1.10.4 in /opt/conda/lib/python3.7/site-
    packages (from gym<0.16.0,>=0.15.4->baselines==0.1.6) (1.18.5)
    Requirement already satisfied: pyglet<=1.5.0,>=1.4.0 in
    /opt/conda/lib/python3.7/site-packages (from
    gym<0.16.0,>=0.15.4->baselines==0.1.6) (1.5.0)
    Requirement already satisfied: future in /opt/conda/lib/python3.7/site-packages
    (from pyglet<=1.5.0,>=1.4.0->gym<0.16.0,>=0.15.4->baselines==0.1.6) (0.18.2)
    Installing collected packages: baselines
      Attempting uninstall: baselines
```

```
Found existing installation: baselines 0.1.6
   Uninstalling baselines-0.1.6:
      Successfully uninstalled baselines-0.1.6
 Running setup.py develop for baselines
Successfully installed baselines
Requirement already satisfied: stable-baselines in
/opt/conda/lib/python3.7/site-packages (2.10.2)
Requirement already satisfied: opency-python in /opt/conda/lib/python3.7/site-
packages (from stable-baselines) (4.5.5.64)
Requirement already satisfied: joblib in /opt/conda/lib/python3.7/site-packages
(from stable-baselines) (0.15.1)
Requirement already satisfied: numpy in /opt/conda/lib/python3.7/site-packages
(from stable-baselines) (1.18.5)
Requirement already satisfied: gym[atari,classic_control]>=0.11 in
/opt/conda/lib/python3.7/site-packages (from stable-baselines) (0.15.7)
Requirement already satisfied: cloudpickle>=0.5.5 in
/opt/conda/lib/python3.7/site-packages (from stable-baselines) (1.2.2)
Requirement already satisfied: matplotlib in /opt/conda/lib/python3.7/site-
packages (from stable-baselines) (3.2.1)
Requirement already satisfied: scipy in /opt/conda/lib/python3.7/site-packages
(from stable-baselines) (1.4.1)
Requirement already satisfied: pandas in /opt/conda/lib/python3.7/site-packages
(from stable-baselines) (1.0.4)
Requirement already satisfied: six in /opt/conda/lib/python3.7/site-packages
(from gym[atari,classic_control]>=0.11->stable-baselines) (1.15.0)
Requirement already satisfied: pyglet<=1.5.0,>=1.4.0 in
/opt/conda/lib/python3.7/site-packages (from
gym[atari,classic_control]>=0.11->stable-baselines) (1.5.0)
Requirement already satisfied: atari-py~=0.2.0; extra == "atari" in
/opt/conda/lib/python3.7/site-packages (from
gym[atari,classic_control]>=0.11->stable-baselines) (0.2.9)
Requirement already satisfied: Pillow; extra == "atari" in
/opt/conda/lib/python3.7/site-packages (from
gym[atari,classic_control]>=0.11->stable-baselines) (7.1.2)
Requirement already satisfied: cycler>=0.10 in /opt/conda/lib/python3.7/site-
packages (from matplotlib->stable-baselines) (0.10.0)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in
/opt/conda/lib/python3.7/site-packages (from matplotlib->stable-baselines)
(2.4.7)
Requirement already satisfied: python-dateutil>=2.1 in
/opt/conda/lib/python3.7/site-packages (from matplotlib->stable-baselines)
(2.8.1)
Requirement already satisfied: kiwisolver>=1.0.1 in
/opt/conda/lib/python3.7/site-packages (from matplotlib->stable-baselines)
(1.2.0)
Requirement already satisfied: pytz>=2017.2 in /opt/conda/lib/python3.7/site-
packages (from pandas->stable-baselines) (2020.1)
Requirement already satisfied: future in /opt/conda/lib/python3.7/site-packages
```

```
(from pyglet<=1.5.0,>=1.4.0->gym[atari,classic_control]>=0.11->stable-baselines)
(0.18.2)
Requirement already up-to-date: tensorflow==1.14.0 in
/opt/conda/lib/python3.7/site-packages (1.14.0)
Requirement already satisfied, skipping upgrade: termcolor>=1.1.0 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (1.1.0)
Requirement already satisfied, skipping upgrade: numpy<2.0,>=1.14.5 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (1.18.5)
Requirement already satisfied, skipping upgrade: tensorboard<1.15.0,>=1.14.0 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (1.14.0)
Requirement already satisfied, skipping upgrade: tensorflow-
estimator<1.15.0rc0,>=1.14.0rc0 in /opt/conda/lib/python3.7/site-packages (from
tensorflow==1.14.0) (1.14.0)
Requirement already satisfied, skipping upgrade: wheel>=0.26 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (0.34.2)
Requirement already satisfied, skipping upgrade: keras-preprocessing>=1.0.5 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (1.1.2)
Requirement already satisfied, skipping upgrade: six>=1.10.0 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (1.15.0)
Requirement already satisfied, skipping upgrade: gast>=0.2.0 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (0.3.3)
Requirement already satisfied, skipping upgrade: google-pasta>=0.1.6 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (0.2.0)
Requirement already satisfied, skipping upgrade: astor>=0.6.0 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (0.8.1)
Requirement already satisfied, skipping upgrade: keras-applications>=1.0.6 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (1.0.8)
Requirement already satisfied, skipping upgrade: grpcio>=1.8.6 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (1.29.0)
Requirement already satisfied, skipping upgrade: protobuf>=3.6.1 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (3.11.4)
Requirement already satisfied, skipping upgrade: absl-py>=0.7.0 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (0.9.0)
Requirement already satisfied, skipping upgrade: wrapt>=1.11.1 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (1.12.1)
Requirement already satisfied, skipping upgrade: werkzeug>=0.11.15 in
/opt/conda/lib/python3.7/site-packages (from
tensorboard<1.15.0,>=1.14.0->tensorflow==1.14.0) (1.0.1)
Requirement already satisfied, skipping upgrade: setuptools>=41.0.0 in
/opt/conda/lib/python3.7/site-packages (from
tensorboard<1.15.0,>=1.14.0->tensorflow==1.14.0) (47.1.1.post20200529)
Requirement already satisfied, skipping upgrade: markdown>=2.6.8 in
/opt/conda/lib/python3.7/site-packages (from
tensorboard<1.15.0,>=1.14.0->tensorflow==1.14.0) (3.2.2)
Requirement already satisfied, skipping upgrade: h5py in
/opt/conda/lib/python3.7/site-packages (from keras-
applications>=1.0.6->tensorflow==1.14.0) (2.10.0)
Requirement already satisfied, skipping upgrade: importlib-metadata;
```

```
python_version < "3.8" in /opt/conda/lib/python3.7/site-packages (from
    markdown>=2.6.8->tensorboard<1.15.0,>=1.14.0->tensorflow==1.14.0) (1.6.1)
    Requirement already satisfied, skipping upgrade: zipp>=0.5 in
    /opt/conda/lib/python3.7/site-packages (from importlib-metadata; python_version
    < "3.8"->markdown>=2.6.8->tensorboard<1.15.0,>=1.14.0->tensorflow==1.14.0)
    Requirement already satisfied: gym in /opt/conda/lib/python3.7/site-packages
    (0.15.7)
    Requirement already satisfied: scipy in /opt/conda/lib/python3.7/site-packages
    (from gym) (1.4.1)
    Requirement already satisfied: six in /opt/conda/lib/python3.7/site-packages
    (from gym) (1.15.0)
    Requirement already satisfied: pyglet<=1.5.0,>=1.4.0 in
    /opt/conda/lib/python3.7/site-packages (from gym) (1.5.0)
    Requirement already satisfied: numpy>=1.10.4 in /opt/conda/lib/python3.7/site-
    packages (from gym) (1.18.5)
    Requirement already satisfied: cloudpickle~=1.2.0 in
    /opt/conda/lib/python3.7/site-packages (from gym) (1.2.2)
    Requirement already satisfied: future in /opt/conda/lib/python3.7/site-packages
    (from pyglet <= 1.5.0, >= 1.4.0 -> gym) (0.18.2)
[2]: import os
     import time
     import gym
     import random
     import numpy as np
     import pandas as pd
     from tensorflow import keras
     from tensorflow.keras import layers
     from stable_baselines.deepq.policies import MlpPolicy
     from stable_baselines.common.vec_env.dummy_vec_env import DummyVecEnv
     from stable_baselines import deepq
     from stable_baselines import bench
     from stable_baselines import logger
     import tensorflow as tf
     from baselines.common.tf_util import make_session
    /opt/conda/lib/python3.7/site-
    packages/tensorflow/python/framework/dtypes.py:516: FutureWarning: Passing
    (type, 1) or '1type' as a synonym of type is deprecated; in a future version of
    numpy, it will be understood as (type, (1,)) / '(1,)type'.
      _np_qint8 = np.dtype([("qint8", np.int8, 1)])
    /opt/conda/lib/python3.7/site-
    packages/tensorflow/python/framework/dtypes.py:517: FutureWarning: Passing
    (type, 1) or '1type' as a synonym of type is deprecated; in a future version of
```

```
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_quint8 = np.dtype([("quint8", np.uint8, 1)])
/opt/conda/lib/python3.7/site-
packages/tensorflow/python/framework/dtypes.py:518: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  np gint16 = np.dtype([("gint16", np.int16, 1)])
/opt/conda/lib/python3.7/site-
packages/tensorflow/python/framework/dtypes.py:519: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_quint16 = np.dtype([("quint16", np.uint16, 1)])
/opt/conda/lib/python3.7/site-
packages/tensorflow/python/framework/dtypes.py:520: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint32 = np.dtype([("qint32", np.int32, 1)])
/opt/conda/lib/python3.7/site-
packages/tensorflow/python/framework/dtypes.py:525: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
 np_resource = np.dtype([("resource", np.ubyte, 1)])
/opt/conda/lib/python3.7/site-
packages/tensorboard/compat/tensorflow_stub/dtypes.py:541: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint8 = np.dtype([("qint8", np.int8, 1)])
/opt/conda/lib/python3.7/site-
packages/tensorboard/compat/tensorflow_stub/dtypes.py:542: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_quint8 = np.dtype([("quint8", np.uint8, 1)])
/opt/conda/lib/python3.7/site-
packages/tensorboard/compat/tensorflow_stub/dtypes.py:543: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  np qint16 = np.dtype([("qint16", np.int16, 1)])
/opt/conda/lib/python3.7/site-
packages/tensorboard/compat/tensorflow_stub/dtypes.py:544: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_quint16 = np.dtype([("quint16", np.uint16, 1)])
/opt/conda/lib/python3.7/site-
packages/tensorboard/compat/tensorflow_stub/dtypes.py:545: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint32 = np.dtype([("qint32", np.int32, 1)])
/opt/conda/lib/python3.7/site-
```

```
packages/tensorboard/compat/tensorflow_stub/dtypes.py:550: FutureWarning:
    Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
    version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
      np_resource = np.dtype([("resource", np.ubyte, 1)])
    /opt/conda/lib/python3.7/site-packages/stable baselines/ init .py:33:
    UserWarning: stable-baselines is in maintenance mode, please use [Stable-
    Baselines3 (SB3)](https://github.com/DLR-RM/stable-baselines3) for an up-to-date
    version. You can find a [migration guide](https://stable-
    baselines3.readthedocs.io/en/master/guide/migration.html) in SB3 documentation.
      "stable-baselines is in maintenance mode, please use [Stable-Baselines3
    (SB3)](https://github.com/DLR-RM/stable-baselines3) for an up-to-date version.
    You can find a [migration guide] (https://stable-
    baselines3.readthedocs.io/en/master/guide/migration.html) in SB3 documentation."
[3]: data = pd.read_csv("/project/datasets/clean-ids-collection/cic-ddos2019/clean/
      \hookrightarrowcicddos2019.csv")
     data.head(5)
[3]:
        Protocol
                                    Timestamp Flow Duration Total Fwd Packets \
               0 2018-11-03 09:18:16.964447
     0
                                                   114456999
                                                                              45
     1
               0 2018-11-03 09:18:18.506537
                                                   114347504
                                                                              56
     2
               6 2018-11-03 09:18:18.610576
                                                    36435473
                                                                               6
     3
                  2018-11-03 09:18:18.610579
                                                    36434705
                                                                               6
     4
                  2018-11-03 09:18:18.610581
                                                    36434626
                                                                               6
        Total Backward Packets Fwd Packets Length Total Bwd Packets Length Total
     0
                                                                                 0.0
                             0
                                                      0.0
                             0
                                                      0.0
                                                                                 0.0
     1
     2
                             2
                                                    116.0
                                                                                92.0
     3
                             2
                                                                                92.0
                                                    116.0
     4
                             2
                                                    116.0
                                                                                92.0
        Fwd Packet Length Max Fwd Packet Length Min Fwd Packet Length Mean
     0
                          0.0
                                                  0.0
                                                                      0.000000
     1
                          0.0
                                                  0.0
                                                                      0.000000
     2
                         46.0
                                                  6.0
                                                                     19.333334 ...
     3
                         46.0
                                                  6.0
                                                                     19.333334
     4
                         46.0
                                                  6.0
                                                                     19.333334
        Fwd Seg Size Min
                         Active Mean Active Std Active Max Active Min
     0
                            8185.5835
                                         28337.111
                                                       98168.0
                                                                        3.0
                       0
                                                                        4.0
     1
                           35028.4180
                                        121314.914
                                                      420255.0
     2
                      20
                                             0.000
                           62416.0000
                                                       62416.0
                                                                    62416.0
     3
                      20
                           62413.0000
                                             0.000
                                                       62413.0
                                                                    62413.0
     4
                      20
                           62409.0000
                                             0.000
                                                       62409.0
                                                                    62409.0
```

Idle Min

Label

Idle Max

Idle Mean

Idle Std

```
0
   9529897.0 351582.62 10001143.0
                                     9048097.0 Benign
1
   9493930.0 351541.10
                        9978130.0
                                    8820294.0 Benign
2 36373056.0
                   0.00 36373056.0
                                    36373056.0
                                               {\tt Benign}
3 36372292.0
                   0.00 36372292.0
                                    36372292.0 Benign
4 36372216.0
                   0.00 36372216.0
                                    36372216.0 Benign
```

[5 rows x 69 columns]

# [4]: data.info() data.describe()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 138007 entries, 0 to 138006
Data columns (total 69 columns):

#	Column	Non-Null Count	Dtype
0	Protocol	138007 non-null	int64
1	Timestamp	138007 non-null	object
2	Flow Duration	138007 non-null	int64
3	Total Fwd Packets	138007 non-null	int64
4	Total Backward Packets	138007 non-null	int64
5	Fwd Packets Length Total	138007 non-null	float64
6	Bwd Packets Length Total	138007 non-null	float64
7	Fwd Packet Length Max	138007 non-null	float64
8	Fwd Packet Length Min	138007 non-null	float64
9	Fwd Packet Length Mean	138007 non-null	float64
10	Fwd Packet Length Std	138007 non-null	float64
11	Bwd Packet Length Max	138007 non-null	float64
12	Bwd Packet Length Min	138007 non-null	float64
13	Bwd Packet Length Mean	138007 non-null	float64
14	Bwd Packet Length Std	138007 non-null	float64
15	Flow Bytes/s	138007 non-null	float64
16	Flow Packets/s	138007 non-null	float64
17	Flow IAT Mean	138007 non-null	float64
18	Flow IAT Std	138007 non-null	float64
19	Flow IAT Max	138007 non-null	float64
20	Flow IAT Min	138007 non-null	float64
21	Fwd IAT Total	138007 non-null	float64
22	Fwd IAT Mean	138007 non-null	float64
23	Fwd IAT Std	138007 non-null	float64
24	Fwd IAT Max	138007 non-null	float64
25	Fwd IAT Min	138007 non-null	float64
26	Bwd IAT Total	138007 non-null	float64
27	Bwd IAT Mean	138007 non-null	float64
28	Bwd IAT Std	138007 non-null	float64
29	Bwd IAT Max	138007 non-null	
30	Bwd IAT Min	138007 non-null	float64

```
Bwd Packets/s
 35
                                138007 non-null
                                                  float64
 36
     Packet Length Min
                                138007 non-null
                                                  float64
     Packet Length Max
                                138007 non-null
                                                  float64
 38
     Packet Length Mean
                                138007 non-null
                                                  float64
     Packet Length Std
 39
                                138007 non-null
                                                  float64
 40
     Packet Length Variance
                                138007 non-null
                                                  float64
 41
     FIN Flag Count
                                138007 non-null
                                                  int64
 42
     SYN Flag Count
                                138007 non-null
                                                  int64
     RST Flag Count
                                138007 non-null
 43
                                                  int64
 44
     PSH Flag Count
                                138007 non-null
                                                  int64
 45
     ACK Flag Count
                                138007 non-null
                                                  int64
                                138007 non-null
     URG Flag Count
 46
                                                  int64
 47
     ECE Flag Count
                                138007 non-null
                                                  int64
 48
     Down/Up Ratio
                                138007 non-null
                                                  float64
 49
     Avg Packet Size
                                138007 non-null
                                                  float64
 50
     Avg Fwd Segment Size
                                138007 non-null
                                                  float64
     Avg Bwd Segment Size
 51
                                138007 non-null
                                                  float64
     Subflow Fwd Packets
 52
                                138007 non-null
                                                  int64
     Subflow Fwd Bytes
                                138007 non-null
                                                  int64
     Subflow Bwd Packets
 54
                                138007 non-null
                                                  int64
 55
     Subflow Bwd Bytes
                                138007 non-null
                                                  int64
 56
     Init Fwd Win Bytes
                                138007 non-null
                                                  int64
     Init Bwd Win Bytes
 57
                                138007 non-null
                                                  int64
 58
     Fwd Act Data Packets
                                138007 non-null
                                                  int64
 59
     Fwd Seg Size Min
                                138007 non-null
                                                  int64
     Active Mean
                                138007 non-null
                                                  float64
     Active Std
                                138007 non-null
                                                  float64
 61
 62
     Active Max
                                138007 non-null
                                                  float64
 63
     Active Min
                                138007 non-null
                                                  float64
     Idle Mean
                                138007 non-null
 64
                                                  float64
 65
     Idle Std
                                138007 non-null
                                                  float64
 66
     Idle Max
                                138007 non-null
                                                  float64
 67
     Idle Min
                                138007 non-null
                                                  float64
    Label
                                138007 non-null
                                                  object
dtypes: float64(45), int64(22), object(2)
memory usage: 72.7+ MB
             Protocol
                       Flow Duration
                                       Total Fwd Packets
count
       138007.000000
                         1.380070e+05
                                           138007.000000
mean
            11.592050
                         1.035663e+07
                                                13.812169
                        2.853154e+07
std
             5.607782
                                                70.298079
min
             0.000000
                         1.000000e+00
                                                 1.000000
25%
             6.000000
                         1.178000e+03
                                                 2.000000
```

138007 non-null

138007 non-null

138007 non-null

138007 non-null

int64

int64

int64

float64

31 Fwd PSH Flags

Fwd Header Length

Bwd Header Length

Fwd Packets/s

32

33

34

[4]:

```
50%
           17.000000
                        2.489200e+04
                                                3.000000
75%
           17.000000
                        2.999380e+06
                                                8.000000
max
           17.000000
                        1.199987e+08
                                            20444.000000
       Total Backward Packets
                                Fwd Packets Length Total
                 138007.000000
                                             1.380070e+05
count
                                             4.019830e+03
                      6.636576
mean
std
                     99.503208
                                             5.151998e+04
min
                      0.000000
                                             0.000000e+00
25%
                                             1.800000e+01
                      0.000000
50%
                      2.000000
                                             8.600000e+01
75%
                      2.000000
                                             2.064000e+03
                  31700.000000
max
                                             1.526642e+07
       Bwd Packets Length Total
                                  Fwd Packet Length Max
                                                           Fwd Packet Length Min
                                           138007.000000
                                                                   138007.000000
count
                    1.380070e+05
                    5.102600e+03
                                              249.273218
                                                                       132.853515
mean
std
                    1.880790e+05
                                              419.156188
                                                                       234.493611
min
                    0.000000e+00
                                                0.000000
                                                                         0.00000
25%
                    0.000000e+00
                                                6.000000
                                                                         0.000000
50%
                    0.000000e+00
                                               43.000000
                                                                        30.000000
                    1.660000e+02
                                              440.000000
75%
                                                                       152.000000
                    5.842950e+07
                                            32120.000000
                                                                     2131.000000
max
                                Fwd Packet Length Std
       Fwd Packet Length Mean
count
                 138007.000000
                                         138007.000000
mean
                    161.376744
                                             37.345936
std
                    241.043532
                                            116.216344
min
                      0.00000
                                              0.000000
25%
                      6.000000
                                              0.000000
50%
                     39.000000
                                              0.000000
75%
                    349.500000
                                             14.433757
                   3015.290500
                                           2221.556200
max
       Fwd Act Data Packets
                              Fwd Seg Size Min
                                                                  Active Std
                                                  Active Mean
               138007.000000
                                   1.380070e+05
                                                 1.380070e+05
                                                                1.380070e+05
count
                   10.525227
                                 -1.175840e+07
                                                 7.345821e+04
                                                                3.066152e+04
mean
                   62.973954
                                   1.112129e+08
                                                 5.176193e+05
                                                                2.392317e+05
std
min
                    0.000000
                                  -1.408238e+09
                                                 0.000000e+00
                                                                0.00000e+00
25%
                                   2.000000e+01
                                                 0.000000e+00
                    1.000000
                                                                0.000000e+00
50%
                    1.000000
                                   2.000000e+01
                                                 0.000000e+00
                                                                0.000000e+00
75%
                    5.000000
                                   2.000000e+01
                                                 0.000000e+00
                                                                0.00000e+00
                18766.000000
                                   1.480000e+03
                                                 4.050800e+07
                                                                1.100562e+07
max
         Active Max
                        Active Min
                                        Idle Mean
                                                        Idle Std
                                                                       Idle Max
       1.380070e+05
                      1.380070e+05
                                     1.380070e+05
                                                   1.380070e+05
                                                                  1.380070e+05
count
mean
       1.140858e+05
                      5.479838e+04
                                     3.445620e+06
                                                   3.282404e+05
                                                                  3.770891e+06
```

```
6.900226e+05
                    4.802156e+05
                                  1.157949e+07 2.158705e+06 1.230392e+07
std
       0.000000e+00
                    0.000000e+00
                                  0.000000e+00 0.000000e+00 0.000000e+00
min
25%
       0.000000e+00
                    0.000000e+00
                                  0.000000e+00 0.000000e+00 0.000000e+00
50%
       0.000000e+00
                    0.000000e+00
                                  0.000000e+00 0.000000e+00 0.000000e+00
75%
       0.000000e+00
                    0.000000e+00 0.000000e+00 0.000000e+00 0.000000e+00
       4.050800e+07
                    4.050800e+07 1.192194e+08 6.961402e+07 1.192194e+08
max
           Idle Min
count 1.380070e+05
       3.153606e+06
mean
std
       1.120812e+07
      0.000000e+00
min
25%
      0.000000e+00
50%
      0.000000e+00
75%
      0.000000e+00
max
       1.192194e+08
[8 rows x 67 columns]
```

Preprocessing done by Laurens D'Hooge

### 0.1 Creating the model

- Build an agent to classify network flow automatically
- Feed a packet that gets classified
- Want the classification to be equal to the label

```
[5]: def balancing_dataset_sampler_df(df, train_frac=0.2, val_frac=0.1, test_frac=0.
      \rightarrow7):
         col = df.columns[-1]
         cols = df.columns[:-1]
         vc = df[col].value_counts()
         n = vc.iloc[-1]
         m = vc.iloc[0]
         initial_cut = df.loc[df[col] == vc.index[0]].sample(n=int(m-n),__
      →replace=False)
         df = df.drop(index=initial cut.index)
         train_df = df.groupby(col).apply(lambda x: x.sample(n=int(n*train_frac),_
      →replace=False))
         train_df.reset_index(level=0, inplace=True, drop=True)
         df = df.drop(index=train_df.index)
         validation_df = df.groupby(col).apply(lambda x: x.sample(n=int(n*val_frac),__
      →replace=False))
         validation_df.reset_index(level=0, inplace=True, drop=True)
```

```
df = df.drop(index=validation_df.index)

test_df = df.groupby(col).apply(lambda x: x.sample(n=int(n*test_frac),_u
replace=False))

test_df.reset_index(level=0, inplace=True, drop=True)

df = df.drop(index=test_df.index)

return train_df[cols], train_df[col], validation_df[cols],_u
validation_df[col], test_df[cols], test_df[col]

data.drop('Timestamp', inplace=True, axis=1)
print(data['Label'].value_counts())
data['Label'] = data['Label'].astype('object')
atk idx = data.loc[data['Label'] != "Benign"].index
```

```
[6]: data.drop('Timestamp', inplace=True, axis=1)
    print(data['Label'].value_counts())
    data['Label'] = data['Label'].astype('object')
    atk_idx = data.loc[data['Label'] != "Benign"].index
    data.loc[atk_idx, 'Label'] = 1.0
    data.loc[data.index.difference(atk_idx), 'Label'] = 0.0
    data['Label'] = data['Label'].astype(dtype=np.float32)

x_train, y_train, x_val, y_val, x_test, y_test = ___
    ⇒balancing_dataset_sampler_df(data, train_frac=0.9, val_frac=0.0, test_frac=0.
    ⇒1)
```

```
95095
Benign
DrDoS_NTP
                  13687
TFTP
                  13027
Syn
                   6713
UDP
                   2158
MSSQL
                   1763
DrDoS_UDP
                   1174
UDP-lag
                   1097
                    927
DrDoS_MSSQL
DrDoS DNS
                    552
                    484
LDAP
DrDoS SSDP
                    413
DrDoS SNMP
                    392
                    215
Portmap
DrDoS_LDAP
                    174
NetBIOS
                     73
DrDoS_NetBIOS
                     51
                     10
UDPLag
WebDDoS
                      2
Name: Label, dtype: int64
```

```
[7]: print("Training")
    print(x_train.shape)
    print(y_train.shape)
    print("Validation")
```

```
print(x_val.shape)
      print(y_val.shape)
      print("Testing")
      print(x_test.shape)
      print(y_test.shape)
     Training
     (77240, 67)
     (77240,)
     Validation
     (0, 67)
     (0,)
     Testing
     (8582, 67)
     (8582,)
 [8]: # all attacks
      # attacks_dict = {
      #
             'Benign': 0,
             'Portmap': 1,
      #
      #
             'NetBIOS': 2,
      #
             'LDAP': 3,
      #
             'MSSQL': 4,
      #
             'UDP': 5,
      #
             'UDPLag': 6,
             'Syn': 7,
      #
      #
             'DrDoS_NTP': 8,
      #
             'DrDoS_DNS': 9,
      #
             'DrDoS_LDAP': 10,
      #
             'DrDoS_MSSQL': 11,
      #
             'DrDoS NetBIOS': 12,
             'DrDoS_SNMP': 13,
      #
             'DrDoS_SSDP': 14,
      #
      #
             'DrDoS_UDP': 15,
      #
             'UDP-lag': 16,
      #
             'WebDDoS': 17,
      #
             'TFTP': 18,
      # }
 [9]: \# x\_train = np.expand\_dims(x\_train, -1)
      \# x\_test = np.expand\_dims(x\_test, -1)
      \# x_val = np.expand_dims(x_val, -1)
[10]: \# y_train = np.expand_dims(y_train, -1)
      \# y_test = np.expand_dims(y_test, -1)
[11]: print(x_train.shape)
```

```
(77240, 67)
```

```
[12]: print(x_train.index)
      print(y_train.index)
      y_train = y_train.to_frame()
      y_test = y_test.to_frame()
     Int64Index([ 37323, 90895, 15959, 59102, 63247, 102774, 125740, 90005,
                  55681, 99643,
                 105901, 77033, 12024, 78476, 116078, 119216, 70932, 74577,
                  17529, 110995],
                dtype='int64', length=77240)
                                 15959, 59102, 63247, 102774, 125740, 90005,
     Int64Index([ 37323, 90895,
                  55681, 99643,
                 105901, 77033, 12024, 78476, 116078, 119216, 70932, 74577,
                  17529, 110995],
                dtype='int64', length=77240)
[13]: # custom keys -> replace by index
      x_train = x_train.set_index([pd.Index(range (0, len(x_train)))])
      y_train = y_train.set_index([pd.Index(range (0, len(y_train)))])
      x_test = x_test.set_index([pd.Index(range (0, len(x_test)))])
      y_test = y_test.set_index([pd.Index(range (0, len(y_test)))])
[14]: print(x_train.index)
      print(y_train.index)
     RangeIndex(start=0, stop=77240, step=1)
     RangeIndex(start=0, stop=77240, step=1)
[15]: print(y_train)
            Label
     0
              0.0
     1
              0.0
     2
              0.0
     3
              0.0
     4
              0.0
     77235
              1.0
     77236
              1.0
     77237
              1.0
     77238
              1.0
     77239
              1.0
```

```
[77240 rows x 1 columns]
```

```
[16]: print(y_train.iloc[17162,:])

Label    0.0
Name: 17162, dtype: float32

[17]: print(y_train.index)
    print(x_train.index)

RangeIndex(start=0, stop=77240, step=1)
    RangeIndex(start=0, stop=77240, step=1)
```

#### 0.1.1 Custom environment

```
[18]: class IdsEnv(gym.Env):
          def __init__(self, images_per_episode=1, dataset=(x_train, y_train),_
       →random=True):
              # Actions we can take, classify as malicious or non-malicious (later_
       →also the correct attack)
              # change to 19 if detectiong all different attacks
              self.action_space = gym.spaces.Discrete(2)
              # All the features we have, 67 features and 1 label. Label should not _{f L}
       \rightarrow be included
              self.observation_space = gym.spaces.Box(low=float('-inf'),__
       →high=float('inf'), shape=(67,))
              self.images_per_episode = images_per_episode
              self.step_count = 0
              self.x, self.y = dataset
              self.random = random
              self.dataset_idx = 0
          def step(self, action):
              done = False
              reward = int(action == self.expected_action)
              obs = self._next_obs()
              self.step_count += 1
              if self.step_count >= self.images_per_episode:
                  done = True
              return obs, reward, done, {}
          def _next_obs(self):
              if self.random:
```

```
next_obs_idx = random.randint(0, len(self.x) - 1)
    self.expected_action = int(self.y.iloc[next_obs_idx,:])
    obs = self.x.iloc[next_obs_idx,:]

else:
    obs = self.x.iloc[self.dataset_idx]
    self.expected_action = int(self.y.iloc[self.dataset_idx])

self.dataset_idx += 1
    if self.dataset_idx >= len(self.x):
        raise StopIteration()

return obs

def reset(self):
    self.step_count = 0

obs = self._next_obs()
    return obs
```

Train classifier using dqn

```
[19]: def ids_dqn():
            logger.configure(dir=os.path.join(os.getcwd(),'Training/Logs/ids_dqn'),u
      → format_strs=['stdout', 'tensorboard'])
          env = IdsEnv(images_per_episode=4096)
            env = bench.Monitor(env, logger.get dir())
          model = deepq.DQN(
              MlpPolicy,
              env,
              verbose=1,
              learning_rate=0.00025,
              buffer_size=1000000,
              learning_starts=50000,
              batch_size=32,
              gamma=0.99,
              train_freq=4,
              target_network_update_freq=30000, # 10k to 30k
              exploration_fraction=0.01, # 0.1 to 0.01
              exploration_initial_eps=1.0,
              exploration_final_eps=0.05,
              total_timesteps=int(2.5e6),
              log_interval=10
          )
```

```
model.save('ddqn_stableb2_ids.pkl')
  env.close()

return model

start_time = time.time()
dqn_model = ids_dqn()
print("DQN Training Time:", time.time() - start_time)
```

WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/stable\_baselines/common/tf\_util.py:191: The name tf.ConfigProto is deprecated. Please use tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/stable\_baselines/common/tf\_util.py:200: The name tf.Session is deprecated. Please use tf.compat.v1.Session instead.

WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/stable\_baselines/deepq/dqn.py:129: The name tf.train.AdamOptimizer is deprecated. Please use tf.compat.v1.train.AdamOptimizer instead.

WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/stable\_baselines/deepq/build\_graph.py:358: The name tf.variable\_scope is deprecated. Please use tf.compat.v1.variable\_scope instead.

WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/stable\_baselines/deepq/build\_graph.py:359: The name tf.placeholder is deprecated. Please use tf.compat.v1.placeholder instead.

WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/stable\_baselines/deepq/build\_graph.py:139: The name tf.get\_variable is deprecated. Please use tf.compat.v1.get\_variable instead.

WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/stable\_baselines/deepq/policies.py:109: flatten (from tensorflow.python.layers.core) is deprecated and will be removed in a future version.

Instructions for updating:

Use keras.layers.flatten instead.

WARNING:tensorflow:Entity <bound method Flatten.call of <tensorflow.python.layers.core.Flatten object at 0x7f5d94930e50>> could not be transformed and will be executed as-is. Please report this to the AutgoGraph team. When filing the bug, set the verbosity to 10 (on Linux, `export AUTOGRAPH\_VERBOSITY=10`) and attach the full output. Cause: converting <bound method Flatten.call of <tensorflow.python.layers.core.Flatten object at 0x7f5d94930e50>>: AttributeError: module 'gast' has no attribute 'Num'

Ox7f5d9490fbd0>>: AssertionError: Bad argument number for Name: 3, expecting 4 WARNING: Entity <bound method Dense.call of <tensorflow.python.layers.core.Dense

method Dense.call of <tensorflow.python.layers.core.Dense object at

```
object at 0x7f5d9490fbd0>> could not be transformed and will be executed as-is.
Please report this to the AutgoGraph team. When filing the bug, set the
verbosity to 10 (on Linux, `export AUTOGRAPH_VERBOSITY=10`) and attach the full
output. Cause: converting <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f5d9490fbd0>>: AssertionError:
Bad argument number for Name: 3, expecting 4
WARNING:tensorflow:Entity <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f5d9a598550>> could not be
transformed and will be executed as-is. Please report this to the AutgoGraph
team. When filing the bug, set the verbosity to 10 (on Linux, `export
AUTOGRAPH VERBOSITY=10`) and attach the full output. Cause: converting <bound
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<tensorflow.python.layers.core.Dense object at 0x7f5d9a598550>>: AssertionError:
Bad argument number for Name: 3, expecting 4
WARNING:tensorflow:Entity <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f5d94930f10>> could not be
transformed and will be executed as-is. Please report this to the AutgoGraph
team. When filing the bug, set the verbosity to 10 (on Linux, `export
AUTOGRAPH_VERBOSITY=10`) and attach the full output. Cause: converting <bound
method Dense.call of <tensorflow.python.layers.core.Dense object at
0x7f5d94930f10>>: AssertionError: Bad argument number for Name: 3, expecting 4
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<tensorflow.python.layers.core.Dense object at 0x7f5d94930f10>>: AssertionError:
Bad argument number for Name: 3, expecting 4
```

```
WARNING:tensorflow:From /opt/conda/lib/python3.7/site-
packages/stable_baselines/deepq/build_graph.py:149:
add_dispatch_support.<locals>.wrapper (from tensorflow.python.ops.array_ops) is
deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:Entity <bound method Flatten.call of
<tensorflow.python.layers.core.Flatten object at 0x7f5d9478fbd0>> could not be
transformed and will be executed as-is. Please report this to the AutgoGraph
team. When filing the bug, set the verbosity to 10 (on Linux, `export
AUTOGRAPH VERBOSITY=10`) and attach the full output. Cause: converting <bound
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WARNING:tensorflow:Entity <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f5d9480ad90>> could not be
transformed and will be executed as-is. Please report this to the AutgoGraph
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<tensorflow.python.layers.core.Dense object at 0x7f5d9480ad90>>: AssertionError:
Bad argument number for Name: 3, expecting 4
WARNING:tensorflow:Entity <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f5d94812610>> could not be
transformed and will be executed as-is. Please report this to the AutgoGraph
team. When filing the bug, set the verbosity to 10 (on Linux, `export
AUTOGRAPH_VERBOSITY=10`) and attach the full output. Cause: converting <bound
method Dense.call of <tensorflow.python.layers.core.Dense object at
0x7f5d94812610>>: AssertionError: Bad argument number for Name: 3, expecting 4
WARNING: Entity <bound method Dense.call of <tensorflow.python.layers.core.Dense
object at 0x7f5d94812610>> could not be transformed and will be executed as-is.
Please report this to the AutgoGraph team. When filing the bug, set the
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output. Cause: converting <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f5d94812610>>: AssertionError:
Bad argument number for Name: 3, expecting 4
```

```
WARNING:tensorflow:Entity <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f5d9488bb90>> could not be
transformed and will be executed as-is. Please report this to the AutgoGraph
team. When filing the bug, set the verbosity to 10 (on Linux, `export
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0x7f5d9488bb90>>: AssertionError: Bad argument number for Name: 3, expecting 4
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<tensorflow.python.layers.core.Dense object at 0x7f5d9488bb90>>: AssertionError:
Bad argument number for Name: 3, expecting 4
WARNING:tensorflow:Entity <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f5d94880210>> could not be
transformed and will be executed as-is. Please report this to the AutgoGraph
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WARNING:tensorflow:From /opt/conda/lib/python3.7/site-packages/stable\_baselines/deepq/build\_graph.py:449: The name tf.summary.merge\_all is deprecated. Please use tf.compat.v1.summary.merge\_all instead.

% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes	5     1   20
mean 100 episode reward   steps	2.21e+03     77824
<pre>  % time spent exploring   episodes   mean 100 episode reward   steps</pre>	5     30     2.25e+03     118784
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes	5     50

<u>.</u>	2.2e+03     200704
<u>.</u>	5     60     2.21e+03     241664
· ·	5
· ·	5     80     2.29e+03     323584
· ·	5
<u>.</u>	5     100     2.38e+03     405504
% time spent exploring   episodes   mean 100 episode reward   steps	5
<u>.</u>	5     120     2.51e+03     487424
% time spent exploring   episodes	5     130

mean 100 episode reward   steps	2.58e+03     528384
% time spent exploring   episodes   mean 100 episode reward   steps	5     140     2.67e+03     569344
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5     170     2.99e+03     692224
% time spent exploring   episodes   mean 100 episode reward   steps	5
episodes	5     190     3.15e+03     774144
% time spent exploring   episodes   mean 100 episode reward   steps	5     200     3.21e+03     815104
% time spent exploring   episodes	5     210

mean 100 episode reward	3.27e+03
steps	856064
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring	5
episodes	230
mean 100 episode reward	3.37e+03
steps	937984
% time spent exploring	5
episodes	240
mean 100 episode reward	3.41e+03
steps	978944
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring	5
episodes	270
mean 100 episode reward	3.46e+03
steps	1101824
% time spent exploring	5
episodes	280
mean 100 episode reward	3.47e+03
steps	1142784
% time spent exploring   episodes	5     290

mean 100 episode reward   steps	3.48e+03     1183744
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes	5     370

<u>.</u>	3.51e+03     1511424
episodes   mean 100 episode reward	5
· ·	5
· · · · · · · · · · · · · · · · · · ·	5
· ·	5
<u>.</u>	5     420     3.52e+03     1716224
% time spent exploring   episodes   mean 100 episode reward   steps	5     430     3.52e+03     1757184
<u>.</u>	5     440     3.52e+03     1798144
% time spent exploring   episodes	5     450

mean 100 episode reward   steps	3.52e+03     1839104
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5     520     3.39e+03     2125824
% time spent exploring   episodes	5     530

mean 100 episode reward   steps	3.33e+03     2166784
% time spent exploring   episodes   mean 100 episode reward   steps	5     540     3.28e+03     2207744
% time spent exploring   episodes   mean 100 episode reward   steps	5     550     3.22e+03     2248704
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes   mean 100 episode reward   steps	5
% time spent exploring   episodes	5     610

```
| mean 100 episode reward | 3.25e+03 |
     | steps
                | 2494464 |
     DQN Training Time: 12524.102679491043
[20]: def ids_dqn_eval(dqn_model):
         attempts, correct = 0,0
         env = IdsEnv(images_per_episode=1, dataset=(x_test, y_test), random=False)
         try:
             while True:
                  obs, done = env.reset(), False
                  while not done:
                     obs, rew, done, _ = env.step(dqn_model.predict(obs)[0])
                     attempts += 1
                     if rew > 0:
                         correct += 1
         except StopIteration:
             print()
             print('validation done...')
             print('Accuracy: {0}%'.format((float(correct) / attempts) * 100))
      ids_dqn_eval(dqn_model)
     /opt/conda/lib/python3.7/site-packages/gym/logger.py:30: UserWarning: WARN:
     Box bound precision lowered by casting to float32
       warnings.warn(colorize('%s: %s'%('WARN', msg % args), 'yellow'))
```

validation done...

Accuracy: 86.75990675990676%