

weighted-dqn-1e6-4096-defaultparams

March 27, 2022

0.0.1 Exploration

```
[1]: !git clone https://github.com/openai/baselines.git
      %cd baselines
      !pip install -e .
      !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: opencv-python in /opt/conda/lib/python3.7/site-
packages (from baselines==0.1.6) (4.5.5.64)
Requirement already satisfied: pygame<=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: 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: 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: future in /opt/conda/lib/python3.7/site-packages
(from pygame<=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
Collecting tensorflow==1.14.0
  Using cached tensorflow-1.14.0-cp37-cp37m-manylinux1_x86_64.whl (109.3 MB)
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: 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: 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: 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: 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: 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: 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: 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: wrapt>=1.11.1 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (1.12.1)
Collecting tensorboard<1.15.0,>=1.14.0
  Using cached tensorboard-1.14.0-py3-none-any.whl (3.1 MB)
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: absl-py>=0.7.0 in
/opt/conda/lib/python3.7/site-packages (from tensorflow==1.14.0) (0.9.0)
Collecting tensorflow-estimator<1.15.0rc0,>=1.14.0rc0
  Using cached tensorflow_estimator-1.14.0-py2.py3-none-any.whl (488 kB)
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: setuptools in
/opt/conda/lib/python3.7/site-packages (from
protobuf>=3.6.1->tensorflow==1.14.0) (47.1.1.post20200529)
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: 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: 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: 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)
(3.1.0)
Installing collected packages: tensorboard, tensorflow-estimator, tensorflow
  Attempting uninstall: tensorboard
    Found existing installation: tensorboard 2.2.2
    Uninstalling tensorboard-2.2.2:
      Successfully uninstalled tensorboard-2.2.2
  Attempting uninstall: tensorflow-estimator
    Found existing installation: tensorflow-estimator 2.2.0
    Uninstalling tensorflow-estimator-2.2.0:
      Successfully uninstalled tensorflow-estimator-2.2.0
  Attempting uninstall: tensorflow
    Found existing installation: tensorflow 2.2.0
    Uninstalling tensorflow-2.2.0:
      Successfully uninstalled tensorflow-2.2.0
Successfully installed tensorboard-1.14.0 tensorflow-1.14.0 tensorflow-
estimator-1.14.0
Requirement already satisfied: gym in /opt/conda/lib/python3.7/site-packages
(0.15.7)
Requirement already satisfied: cloudpickle~=1.2.0 in
/opt/conda/lib/python3.7/site-packages (from gym) (1.2.2)
Requirement already satisfied: six in /opt/conda/lib/python3.7/site-packages
(from gym) (1.15.0)
Requirement already satisfied: numpy>=1.10.4 in /opt/conda/lib/python3.7/site-
packages (from gym) (1.18.5)
Requirement already satisfied: scipy in /opt/conda/lib/python3.7/site-packages
(from gym) (1.4.1)
Requirement already satisfied: pygame<=1.5.0,>=1.4.0 in
/opt/conda/lib/python3.7/site-packages (from gym) (1.5.0)
Requirement already satisfied: future in /opt/conda/lib/python3.7/site-packages
(from pygame<=1.5.0,>=1.4.0->gym) (0.18.2)

```

```

[2]: import time
import gym
import random
import numpy as np
import pandas as pd
from tensorflow import keras
from tensorflow.keras import layers

from baselines.ppo2 import ppo2
from baselines.common.vec_env.dummy_vec_env import DummyVecEnv

```

```

from baselines import deepq
from baselines import bench
from 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_qint16 = np.dtype(["qint16", 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])

```

```

[3]: data = pd.read_csv("/project/datasets/clean-ids-collection/cic-ddos2019/clean/
↪cicddos2019.csv")
data.head(5)

```

```

[3]:
  Protocol  Timestamp  Flow Duration  Total Fwd Packets  \
0         0  2018-11-03 09:18:16.964447      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         6  2018-11-03 09:18:18.610579       36434705        6
4         6  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
1                        0                        0.0      0.0
2                        2                      116.0     92.0
3                        2                      116.0     92.0
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	0	8185.5835	28337.111	98168.0	3.0	
1	0	35028.4180	121314.914	420255.0	4.0	
2	20	62416.0000	0.000	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 Mean	Idle Std	Idle Max	Idle Min	Label
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	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	float64
30	Bwd IAT Min	138007	non-null	float64
31	Fwd PSH Flags	138007	non-null	int64
32	Fwd Header Length	138007	non-null	int64
33	Bwd Header Length	138007	non-null	int64
34	Fwd Packets/s	138007	non-null	float64
35	Bwd Packets/s	138007	non-null	float64
36	Packet Length Min	138007	non-null	float64
37	Packet Length Max	138007	non-null	float64
38	Packet Length Mean	138007	non-null	float64
39	Packet Length Std	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
43	RST Flag Count	138007	non-null	int64
44	PSH Flag Count	138007	non-null	int64
45	ACK Flag Count	138007	non-null	int64
46	URG Flag Count	138007	non-null	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
51	Avg Bwd Segment Size	138007	non-null	float64
52	Subflow Fwd Packets	138007	non-null	int64
53	Subflow Fwd Bytes	138007	non-null	int64
54	Subflow Bwd Packets	138007	non-null	int64
55	Subflow Bwd Bytes	138007	non-null	int64
56	Init Fwd Win Bytes	138007	non-null	int64
57	Init Bwd Win Bytes	138007	non-null	int64
58	Fwd Act Data Packets	138007	non-null	int64
59	Fwd Seg Size Min	138007	non-null	int64
60	Active Mean	138007	non-null	float64
61	Active Std	138007	non-null	float64
62	Active Max	138007	non-null	float64
63	Active Min	138007	non-null	float64
64	Idle Mean	138007	non-null	float64
65	Idle Std	138007	non-null	float64
66	Idle Max	138007	non-null	float64
67	Idle Min	138007	non-null	float64
68	Label	138007	non-null	object

dtypes: float64(45), int64(22), object(2)

memory usage: 72.7+ MB

[4]:

	Protocol	Flow Duration	Total Fwd Packets \
count	138007.000000	1.380070e+05	138007.000000
mean	11.592050	1.035663e+07	13.812169
std	5.607782	2.853154e+07	70.298079
min	0.000000	1.000000e+00	1.000000
25%	6.000000	1.178000e+03	2.000000
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 \
count	138007.000000	1.380070e+05
mean	6.636576	4.019830e+03
std	99.503208	5.151998e+04
min	0.000000	0.000000e+00
25%	0.000000	1.800000e+01
50%	2.000000	8.600000e+01
75%	2.000000	2.064000e+03
max	31700.000000	1.526642e+07

	Bwd Packets Length Total	Fwd Packet Length Max	Fwd Packet Length Min \
count	1.380070e+05	138007.000000	138007.000000
mean	5.102600e+03	249.273218	132.853515
std	1.880790e+05	419.156188	234.493611
min	0.000000e+00	0.000000	0.000000
25%	0.000000e+00	6.000000	0.000000
50%	0.000000e+00	43.000000	30.000000
75%	1.660000e+02	440.000000	152.000000
max	5.842950e+07	32120.000000	2131.000000

	Fwd Packet Length Mean	Fwd Packet Length Std ... \
count	138007.000000	138007.000000 ...
mean	161.376744	37.345936 ...
std	241.043532	116.216344 ...
min	0.000000	0.000000 ...
25%	6.000000	0.000000 ...
50%	39.000000	0.000000 ...
75%	349.500000	14.433757 ...
max	3015.290500	2221.556200 ...

	Fwd Act Data Packets	Fwd Seg Size Min	Active Mean	Active Std \
count	138007.000000	1.380070e+05	1.380070e+05	1.380070e+05
mean	10.525227	-1.175840e+07	7.345821e+04	3.066152e+04
std	62.973954	1.112129e+08	5.176193e+05	2.392317e+05
min	0.000000	-1.408238e+09	0.000000e+00	0.000000e+00
25%	1.000000	2.000000e+01	0.000000e+00	0.000000e+00
50%	1.000000	2.000000e+01	0.000000e+00	0.000000e+00

75%	5.000000	2.000000e+01	0.000000e+00	0.000000e+00
max	18766.000000	1.480000e+03	4.050800e+07	1.100562e+07

	Active Max	Active Min	Idle Mean	Idle Std	Idle Max \
count	1.380070e+05	1.380070e+05	1.380070e+05	1.380070e+05	1.380070e+05
mean	1.140858e+05	5.479838e+04	3.445620e+06	3.282404e+05	3.770891e+06
std	6.900226e+05	4.802156e+05	1.157949e+07	2.158705e+06	1.230392e+07
min	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00
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
max	4.050800e+07	4.050800e+07	1.192194e+08	6.961402e+07	1.192194e+08

	Idle Min
count	1.380070e+05
mean	3.153606e+06
std	1.120812e+07
min	0.000000e+00
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.
    ↪7):
    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),
↪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],
↪validation_df[col], test_df[cols], test_df[col]

```

```

[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)

```

Benign	95095
DrDoS_NTP	13687
TFTP	13027
Syn	6713
UDP	2158
MSSQL	1763
DrDoS_UDP	1174
UDP-lag	1097
DrDoS_MSSQL	927
DrDoS_DNS	552
LDAP	484
DrDoS_SSDP	413
DrDoS_SNMP	392
Portmap	215
DrDoS_LDAP	174
NetBIOS	73
DrDoS_NetBIOS	51
UDPLag	10
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
(17164, 67)
(17164,)
Validation
(8582, 67)
(8582,)
Testing
(60076, 67)
(60076,)
```

```
[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)
```

```
[ ]:
```

0.1.1 Custom environment

```
[11]: 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 detecting all different attacks
          self.action_space = gym.spaces.Discrete(2)
          # All the features we have, 67 features and 1 label. Label should not
      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[next_obs_idx])
              obs = self.x[next_obs_idx]

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

```

[12]: def ids_dqn():
    logger.configure(dir=os.path.join(os.getcwd(), 'Training/Logs/ids_dqn'),
        ↪format_strs=['stdout', 'tensorboard'])
    env = IdsEnv(images_per_episode=4096)
    env = bench.Monitor(env, logger.get_dir())

    model = deepq.learn(
        env,
        "mlp",
        total_timesteps=int(1.0e6),
        print_freq=10,
    )

    model.save('dqn_ids.pkl')
    env.close()

    return model

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

```

Logging to ./Training/Logs/ids_dqn

/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'))

WARNING:tensorflow:From /project/baselines/baselines/common/tf_util.py:53: The name tf.get_default_session is deprecated. Please use tf.compat.v1.get_default_session instead.

WARNING:tensorflow:From /project/baselines/baselines/common/tf_util.py:63: The

name tf.ConfigProto is deprecated. Please use tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From /project/baselines/baselines/common/tf_util.py:70: The name tf.InteractiveSession is deprecated. Please use tf.compat.v1.InteractiveSession instead.

WARNING:tensorflow:From /project/baselines/baselines/common/misc_util.py:58: The name tf.set_random_seed is deprecated. Please use tf.compat.v1.set_random_seed instead.

WARNING:tensorflow:From /project/baselines/baselines/deepq/deepq.py:205: The name tf.train.AdamOptimizer is deprecated. Please use tf.compat.v1.train.AdamOptimizer instead.

WARNING:tensorflow:From /project/baselines/baselines/deepq/build_graph.py:176: The name tf.variable_scope is deprecated. Please use tf.compat.v1.variable_scope instead.

WARNING:tensorflow:From /project/baselines/baselines/common/input.py:57: to_float (from tensorflow.python.ops.math_ops) is deprecated and will be removed in a future version.

Instructions for updating:

Use `tf.cast` instead.

WARNING:tensorflow:From /project/baselines/baselines/common/models.py:94: 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 0x7f705c741210>> could not be transformed and will be executed as-is. Please report this to the AutoGraph 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 0x7f705c741210>>: AttributeError: module 'gast' has no attribute 'Num'

WARNING: Entity <bound method Flatten.call of <tensorflow.python.layers.core.Flatten object at 0x7f705c741210>> could not be transformed and will be executed as-is. Please report this to the AutoGraph 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 0x7f705c741210>>: AttributeError: module 'gast' has no attribute 'Num'

WARNING:tensorflow:Entity <bound method Flatten.call of <tensorflow.python.layers.core.Flatten object at 0x7f7058bb5d90>> could not be transformed and will be executed as-is. Please report this to the AutoGraph 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

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method Flatten.call of <tensorflow.python.layers.core.Flatten object at
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WARNING:tensorflow:Entity <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f7051600650>> 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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output. Cause: converting <bound method Dense.call of
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Bad argument number for Name: 3, expecting 4
WARNING:tensorflow:Entity <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f7051602190>> 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
0x7f7051602190>>: AssertionError: Bad argument number for Name: 3, expecting 4
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object at 0x7f7051602190>> could not be transformed and will be executed as-is.
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output. Cause: converting <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f7051602190>>: AssertionError:
Bad argument number for Name: 3, expecting 4
WARNING:tensorflow:From /project/baselines/baselines/deepq/build_graph.py:189:
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 0x7f7051556cd0>> could not be
transformed and will be executed as-is. Please report this to the AutgoGraph
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WARNING:tensorflow:Entity <bound method Flatten.call of
<tensorflow.python.layers.core.Flatten object at 0x7f7051600c10>> could not be
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```



```

0x7f7051600c10>>: AttributeError: module 'gast' has no attribute 'Num'
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Bad argument number for Name: 3, expecting 4
WARNING:tensorflow:Entity <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f70516d7910>> 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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method Dense.call of <tensorflow.python.layers.core.Dense object at
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Bad argument number for Name: 3, expecting 4
WARNING:tensorflow:Entity <bound method Flatten.call of
<tensorflow.python.layers.core.Flatten object at 0x7f70515f36d0>> could not be
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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 0x7f70514e32d0>> 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
0x7f70514e32d0>>: AssertionError: Bad argument number for Name: 3, expecting 4
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output. Cause: converting <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f70514e32d0>>: AssertionError:
Bad argument number for Name: 3, expecting 4
WARNING:tensorflow:Entity <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f7051556290>> 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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Bad argument number for Name: 3, expecting 4
WARNING:tensorflow:Entity <bound method Dense.call of
<tensorflow.python.layers.core.Dense object at 0x7f705163ac10>> could not be
transformed and will be executed as-is. Please report this to the AutgoGraph
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AUTOGRAPH_VERBOSITY=10`) and attach the full output. Cause: converting <bound
method Dense.call of <tensorflow.python.layers.core.Dense object at
0x7f705163ac10>>: AssertionError: Bad argument number for Name: 3, expecting 4
WARNING: Entity <bound method Dense.call of <tensorflow.python.layers.core.Dense
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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 0x7f705163ac10>>: AssertionError:
Bad argument number for Name: 3, expecting 4
WARNING:tensorflow:Entity <bound method Flatten.call of
<tensorflow.python.layers.core.Flatten object at 0x7f7051604350>> could not be
transformed and will be executed as-is. Please report this to the AutgoGraph

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/opt/conda/lib/python3.7/site-packages/numpy/core/fromnumeric.py:3335:

RuntimeWarning: Mean of empty slice.

out=out, **kwargs)

/opt/conda/lib/python3.7/site-packages/numpy/core/_methods.py:161:

RuntimeWarning: invalid value encountered in double_scalars

ret = ret.dtype.type(ret / rcount)

```

-----
| % time spent exploring | 63      |
| episodes               | 10      |
| mean 100 episode reward | 2.38e+03 |
| steps                  | 3.69e+04 |
-----

```

```

-----
| % time spent exploring | 23      |

```

episodes	20	
mean 100 episode reward	2.77e+03	
steps	7.78e+04	

% time spent exploring	2	
episodes	30	
mean 100 episode reward	3.12e+03	
steps	1.19e+05	

% time spent exploring	2	
episodes	40	
mean 100 episode reward	3.32e+03	
steps	1.6e+05	

% time spent exploring	2	
episodes	50	
mean 100 episode reward	3.44e+03	
steps	2.01e+05	

% time spent exploring	2	
episodes	60	
mean 100 episode reward	3.51e+03	
steps	2.42e+05	

% time spent exploring	2	
episodes	70	
mean 100 episode reward	3.57e+03	
steps	2.83e+05	

% time spent exploring	2	
episodes	80	
mean 100 episode reward	3.61e+03	
steps	3.24e+05	

% time spent exploring	2	
episodes	90	
mean 100 episode reward	3.64e+03	
steps	3.65e+05	

% time spent exploring	2	

episodes	100	
mean 100 episode reward	3.66e+03	
steps	4.06e+05	

Saving model due to mean reward increase: None -> 3666.4
 Saving model due to mean reward increase: 3666.4 -> 3701.9
 Saving model due to mean reward increase: 3701.9 -> 3733.6
 Saving model due to mean reward increase: 3733.6 -> 3777.3

% time spent exploring	2	
episodes	110	
mean 100 episode reward	3.8e+03	
steps	4.46e+05	

Saving model due to mean reward increase: 3777.3 -> 3801.8
 Saving model due to mean reward increase: 3801.8 -> 3832.8
 Saving model due to mean reward increase: 3832.8 -> 3850.5
 Saving model due to mean reward increase: 3850.5 -> 3869.6

% time spent exploring	2	
episodes	120	
mean 100 episode reward	3.88e+03	
steps	4.87e+05	

Saving model due to mean reward increase: 3869.6 -> 3878.8
 Saving model due to mean reward increase: 3878.8 -> 3886.9
 Saving model due to mean reward increase: 3886.9 -> 3887.9

% time spent exploring	2	
episodes	130	
mean 100 episode reward	3.89e+03	
steps	5.28e+05	

Saving model due to mean reward increase: 3887.9 -> 3888.2

% time spent exploring	2	
episodes	140	
mean 100 episode reward	3.89e+03	
steps	5.69e+05	

% time spent exploring	2	
episodes	150	
mean 100 episode reward	3.89e+03	
steps	6.1e+05	

% time spent exploring	2	
------------------------	---	--

episodes	160	
mean 100 episode reward	3.88e+03	
steps	6.51e+05	

% time spent exploring	2	
episodes	170	
mean 100 episode reward	3.89e+03	
steps	6.92e+05	

% time spent exploring	2	
episodes	180	
mean 100 episode reward	3.88e+03	
steps	7.33e+05	

% time spent exploring	2	
episodes	190	
mean 100 episode reward	3.88e+03	
steps	7.74e+05	

% time spent exploring	2	
episodes	200	
mean 100 episode reward	3.88e+03	
steps	8.15e+05	

% time spent exploring	2	
episodes	210	
mean 100 episode reward	3.88e+03	
steps	8.56e+05	

% time spent exploring	2	
episodes	220	
mean 100 episode reward	3.88e+03	
steps	8.97e+05	

% time spent exploring	2	
episodes	230	
mean 100 episode reward	3.88e+03	
steps	9.38e+05	

% time spent exploring	2	

episodes	240	
mean 100 episode reward	3.88e+03	
steps	9.79e+05	

 Restored model with mean reward: 3888.2
 DQN Training Time: 6663.2857892513275

```
[13]: 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(obs[None])[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: 94.902953024603%