

CLASSIFICATION OF VIDEO STREAMS BASED ON VARIOUS DEEP LEARNING AND ML APPROACHES

Presented By : Navnit & Papry

Concordia University | 2024

INTRODUCTION

1

Due to exponential amount of traffic released by video streaming based application, ISPs face the problem of fairness amongst other non-streaming based traffic, which leads to data losses and poor QoS amongst the users.

2

Modern video streaming applications, network traffic patterns have become increasingly complex, requiring robust methods for efficient classification and management.

3

Classification of this data in real-time can be used by ISPs to alleviate this problem by providing policies based on classification result and will help in providing fairness.

OUR CONTRIBUTION

1

We propose a data pre-processing technique that incorporates domain-specific information to enhance feature differentiation and improve classification accuracy.

2

We introduce a window-based approach for partitioning time-series data, enabling its transformation into image representations suitable for Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) networks for classification tasks..

3

Showcasing the capabilities of CNN + LSTM based approaches in effectively understanding inter - and intra - traffic features between various packets for Multi Class Classification.

4

We present the results of applying well-known machine learning algorithms on the transformed data, highlighting the most relevant features for optimal classification performance.

DATASET USED

4

5G Traffic Datasets

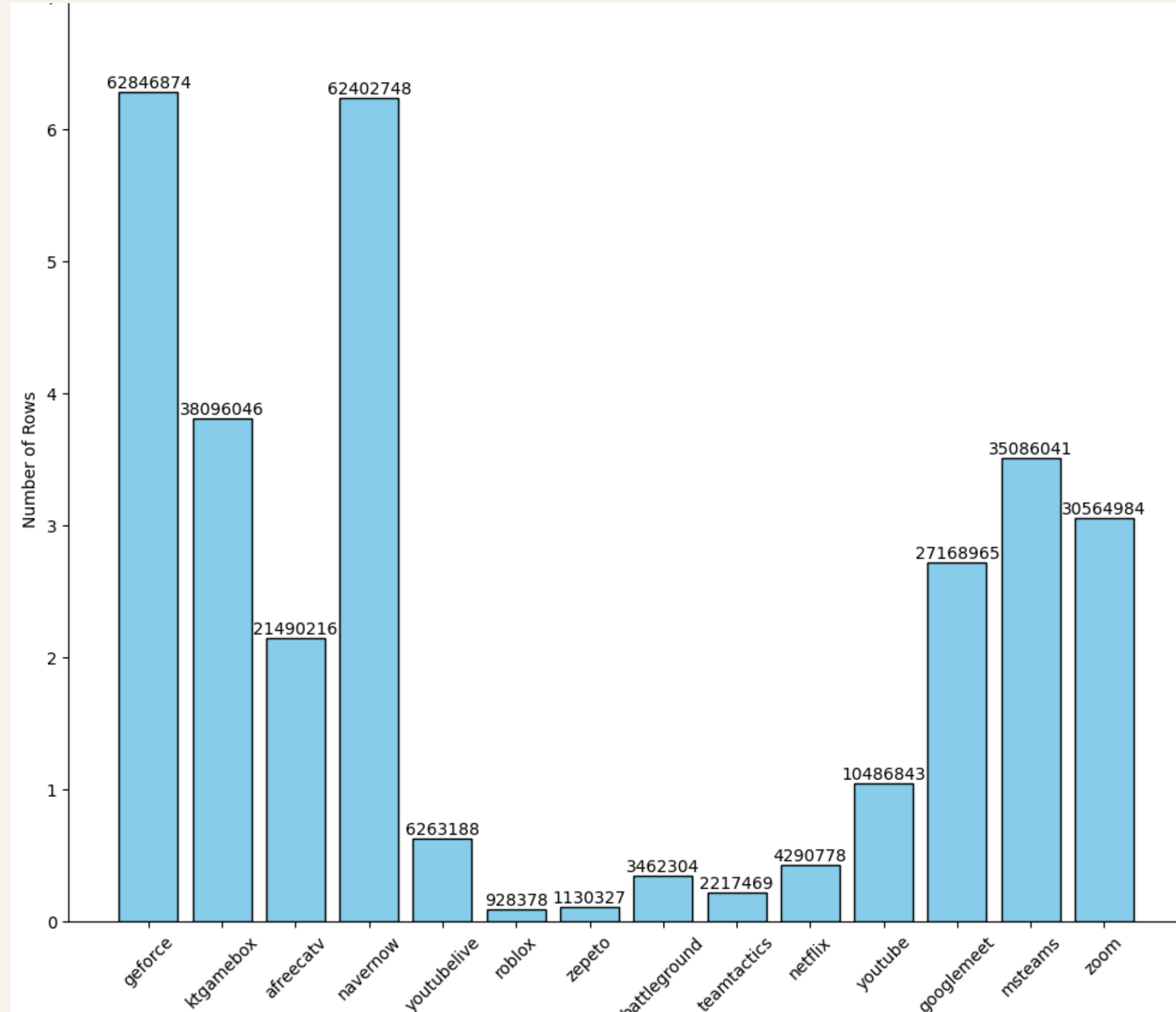
We created a 5G dataset by measuring 5G traffic directly from a major mobile operator in South Korea. The model name of the mobile terminal used for traffic measurement is the Samsung Galaxy A90 5G,

IEEE DataPort / Oct 3, 2023

Type	Application	Protocol	Duration and Size
Live Streaming	YouTube Live	GQUIC	20h 19m 38s File size: 0.73GB
	AfreecaTV	TCP	20h 14m 00s File size: 4.06GB
	Naver NOW	TCP	33h 50m 34s File size: 12.48GB
Stored Streaming	YouTube	QUIC	22h 59m 51s File size: 1.12GB
	Netflix	TCP	24h 43m 02s File size: 0.74GB
	Amazon Prime Video	TCP	32h 39m 10s File size: 1.54GB
Video Conferencing	Zoom	UDP	26h 12m 53s File size: 3.36GB
	MS Teams	UDP	28h 17m 27s File size: 3.71GB
	Google Meet	UDP	24h 01m 40s File size: 4.41GB
Metaverse	Zepeto	TCP	15h 28m 36s File size: 0.16GB
	Roblox	RakNet	25h 04m 11s File size: 0.11GB
Online Game	Teamfight Tactics	UDP	13h 46m 53s File size: 0.24GB
	Battleground	UDP	16h 02m 57s File size: 0.38GB
Game Streaming	GeForce Now	UDP	12h 26m 21s File size: 7.05GB
	KT GameBox	UDP	12h 23m 26s File size: 4.36GB

PACKETS / APPLICATION

5

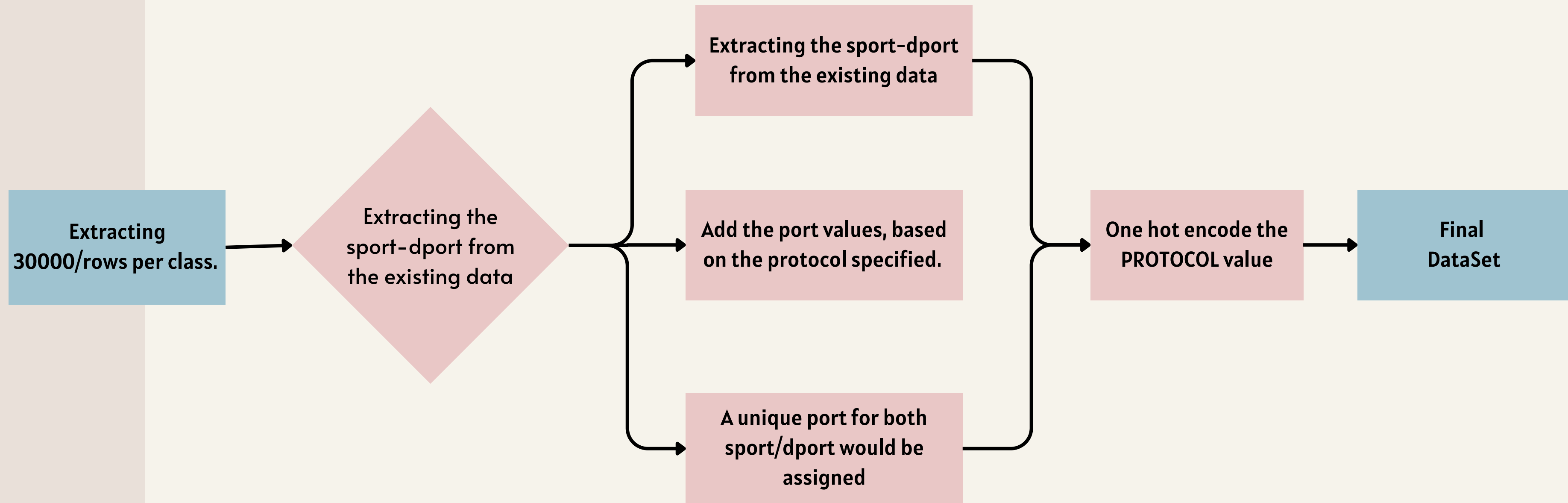


PRE-PROCESSING



FOR ML MODELS

7



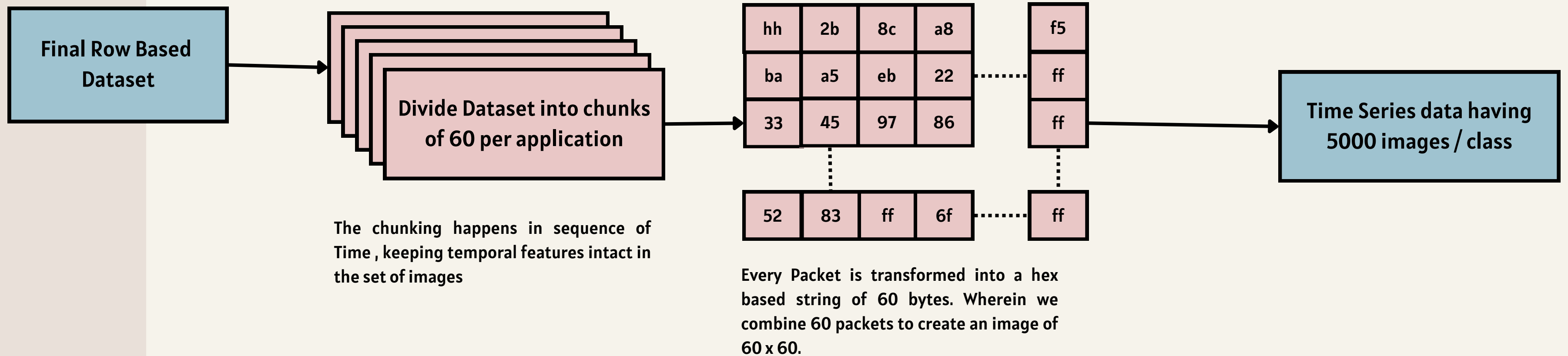
EFFECTIVE FEATURES

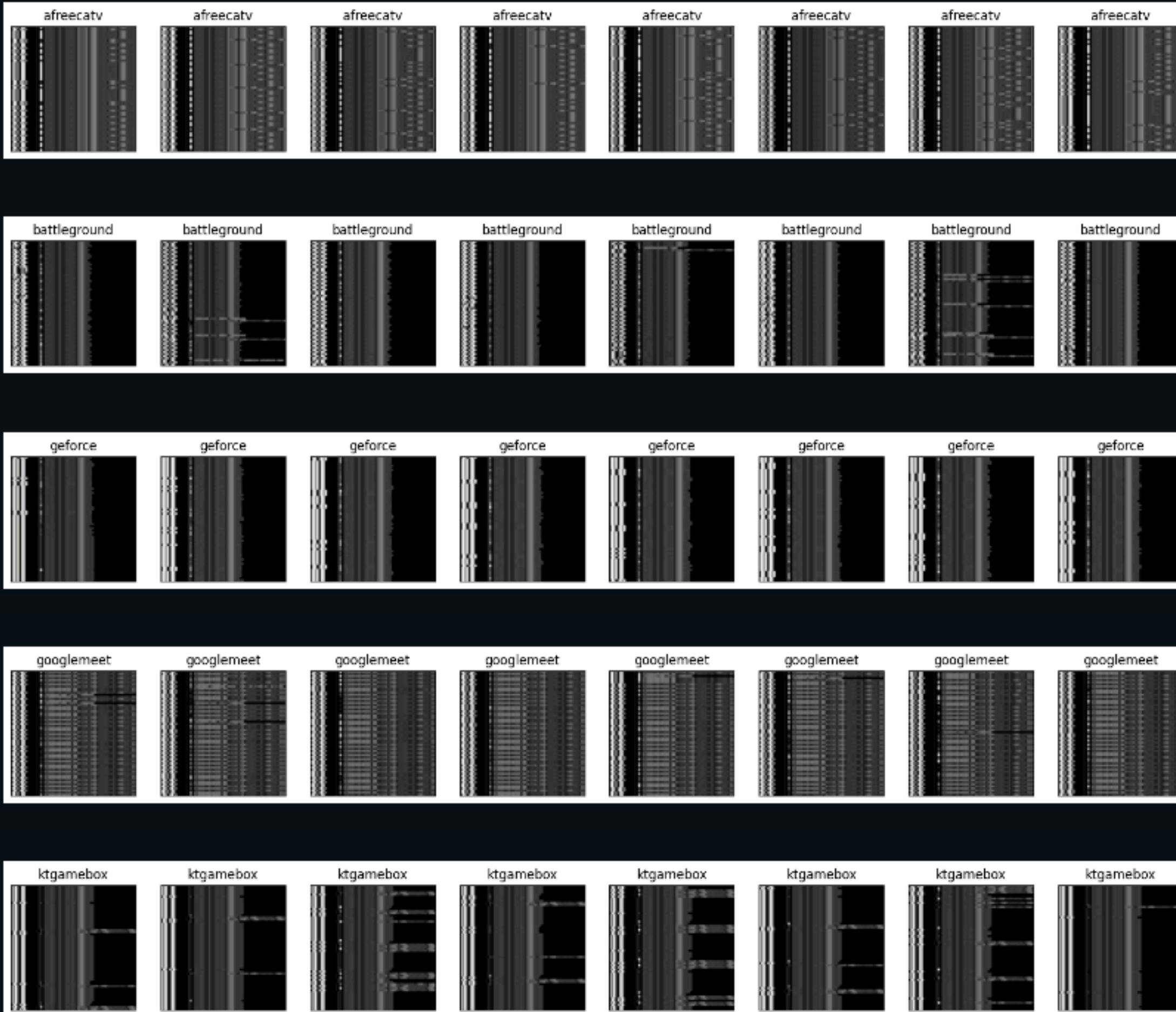
8

Source	Destination	Length	sport	dport
protocol len	P_CLASSIC-STUN		P_CLTP	P_DB-LSP
P_DNS	P_DCP-AF	P_HTTP/JSO	P_SSL	P_TLSv1
P_DTLSv1.2	P_GQUIC	P_HCrt	P_HTTP N	P_MANOLITO
P_Pathport	P_QUIC	P_R-GOOSE	P_RTCP	P_RakNet
P_SSLv2	P_STUN	P_TCP	P_TFTP	P_THRIFT
P_TLSv1.2	P_TLSv1.3	P_UDP		

CNN & LSTM

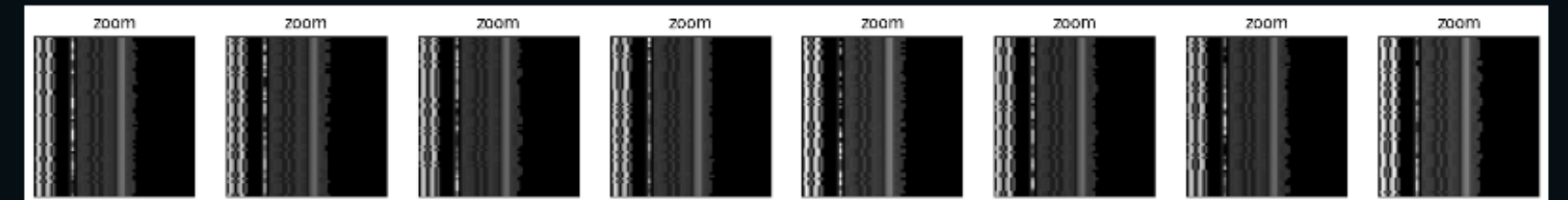
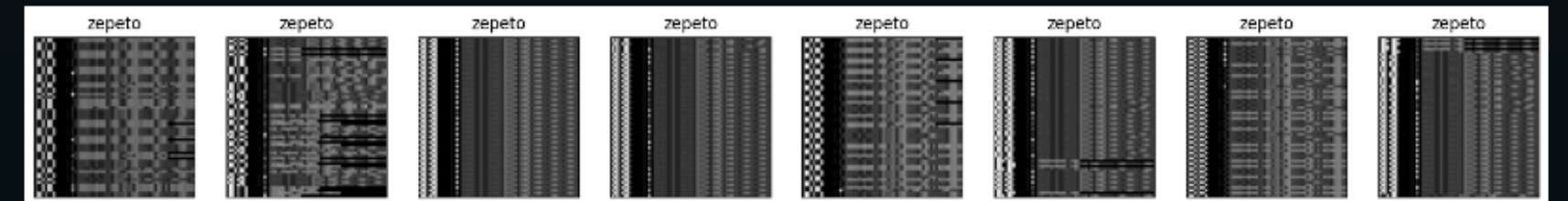
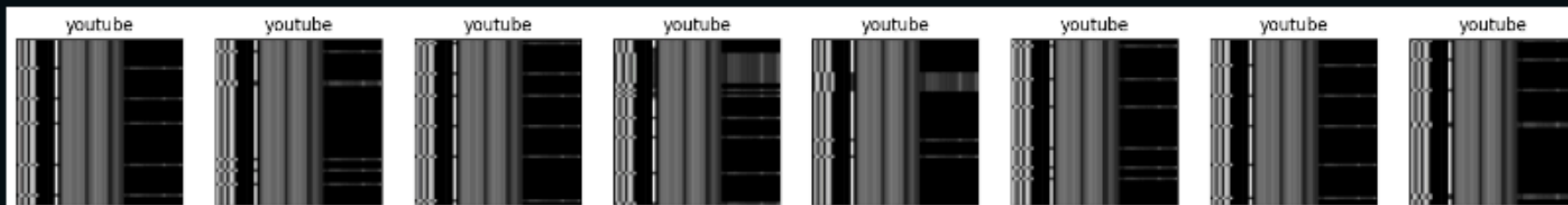
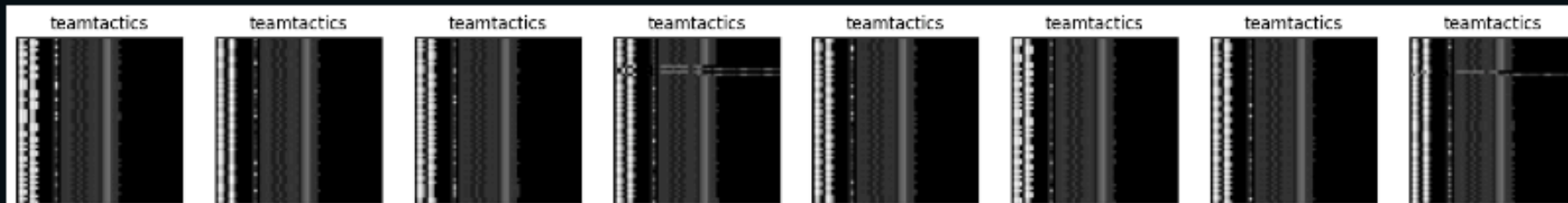
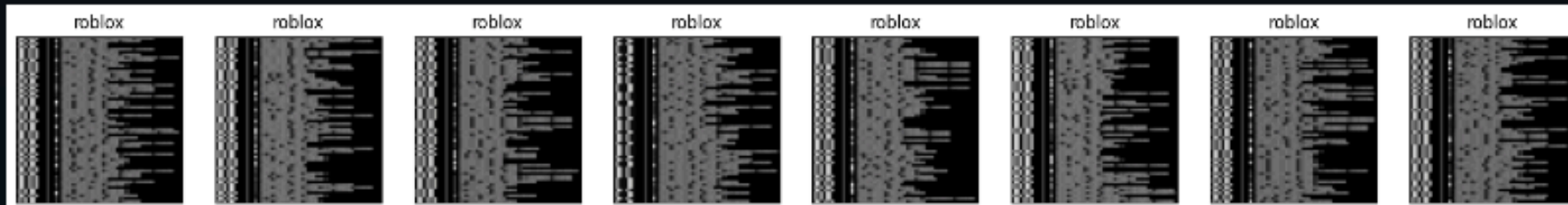
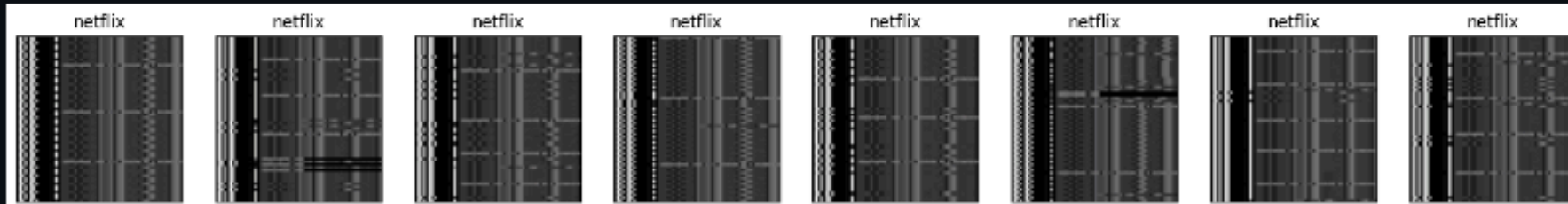
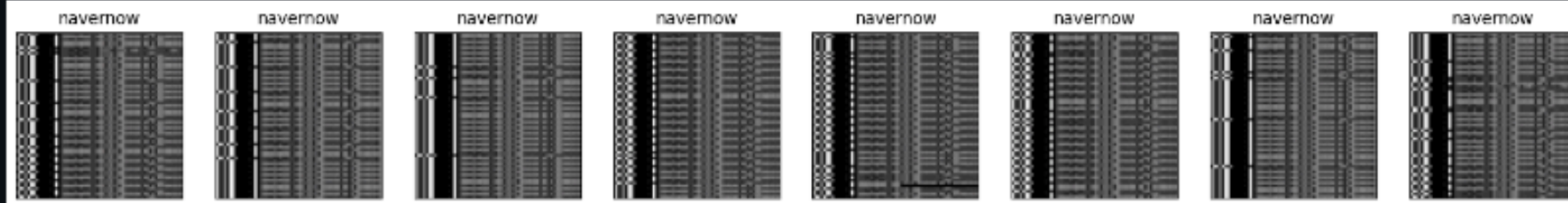
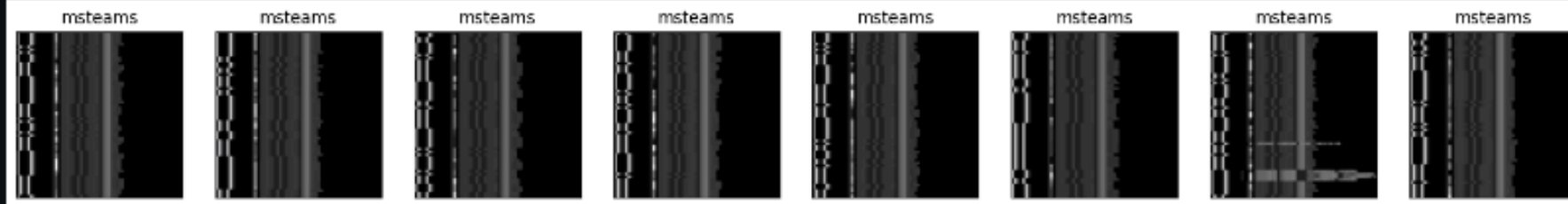
9





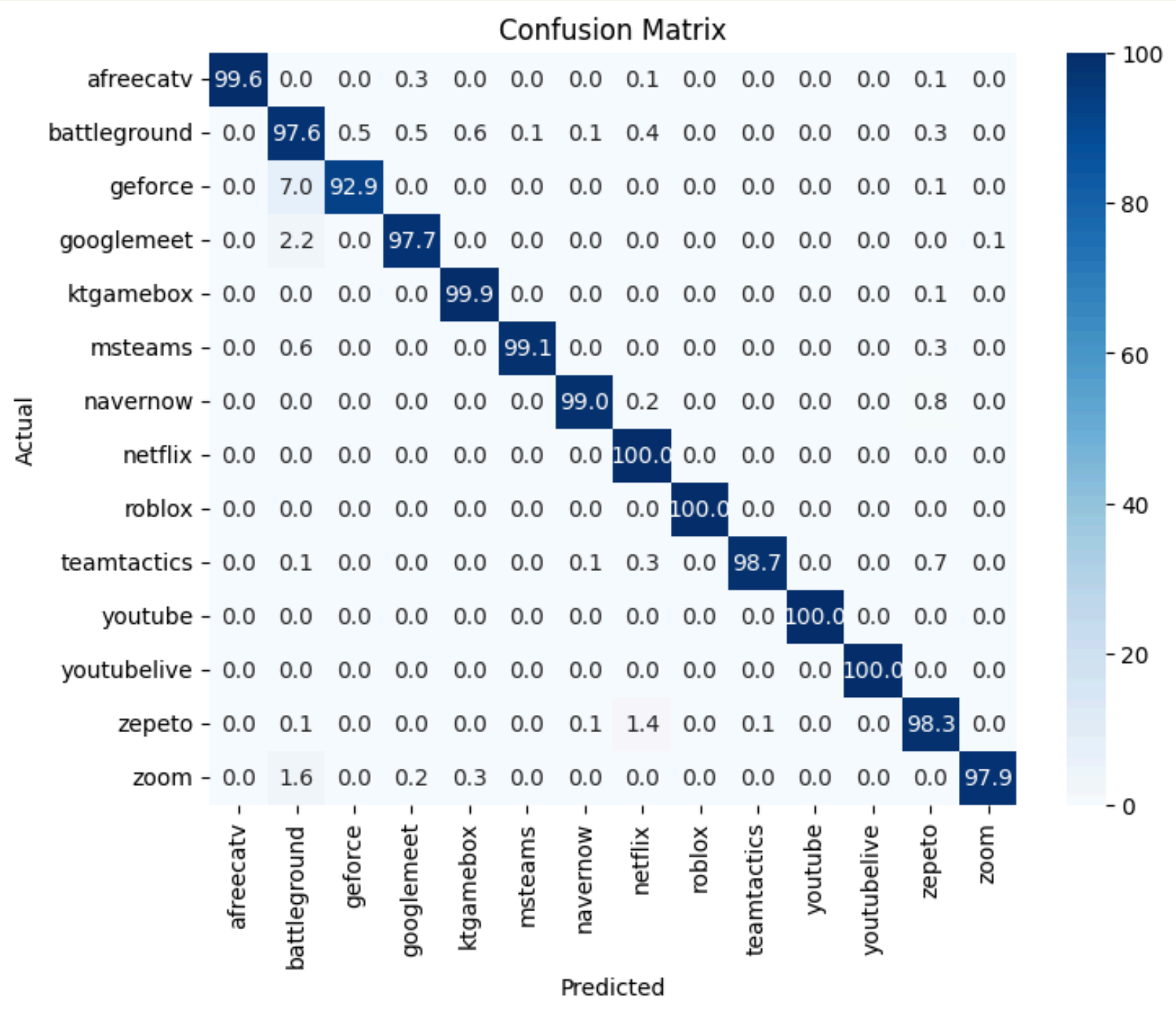
Generated Images Per Application





RESULTS

DECISION TREE



```

accuracy 0.9861630591630591
Classes: ['afreecatv' 'battleground' 'geforce' 'googlemeet' 'ktgamebox' 'msteams'
'navernow' 'netflix' 'roblox' 'teamtactics' 'youtube' 'youtubelive'
'zepeto' 'zoom']

```

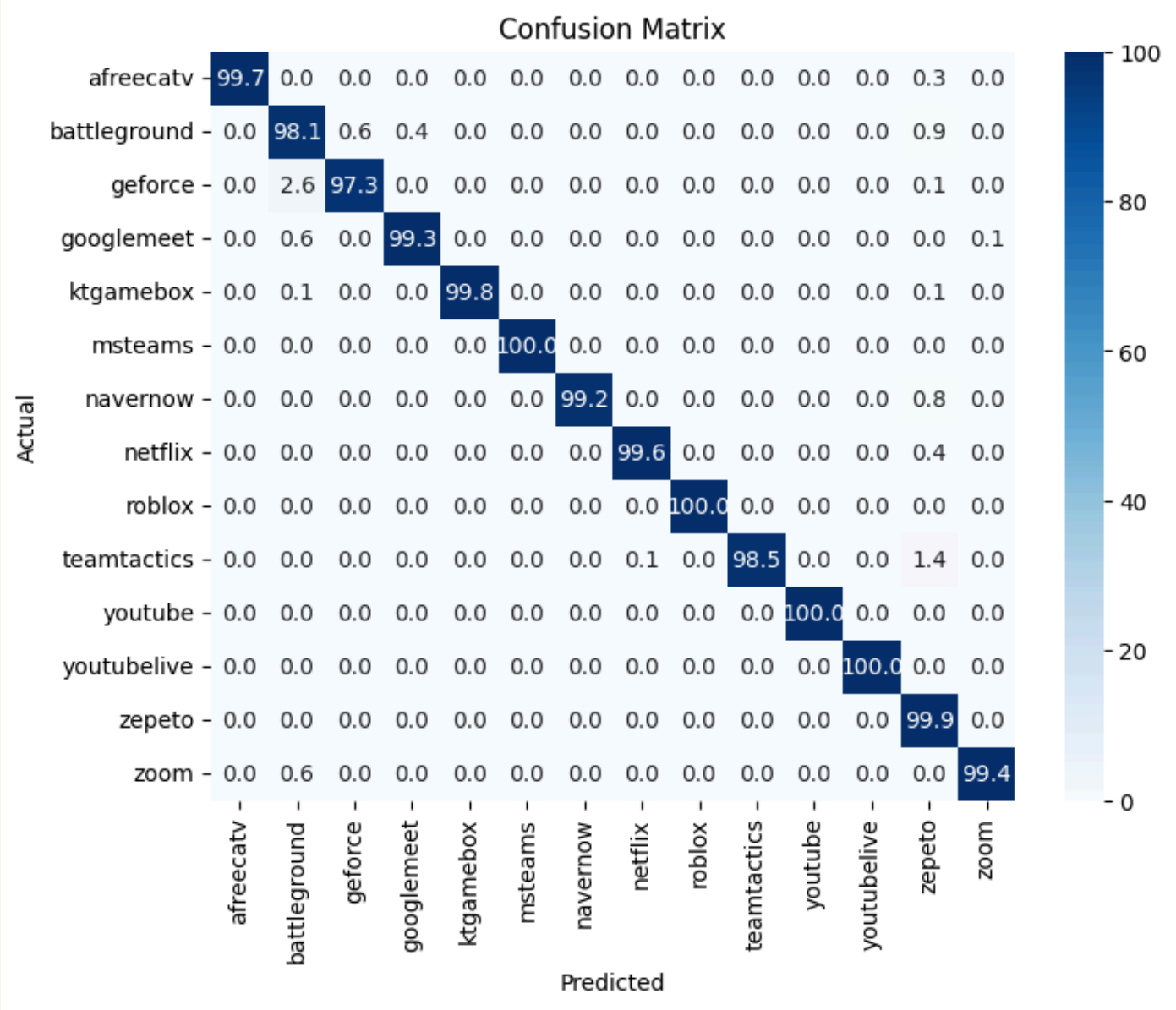
	precision	recall	f1-score	support
afreecatv	1.00	1.00	1.00	99097
battleground	0.89	0.98	0.93	98853
geforce	0.99	0.93	0.96	98782
googlemeet	0.99	0.98	0.98	99377
ktgamebox	0.99	1.00	1.00	98729
msteams	1.00	0.99	0.99	98510
navernow	1.00	0.99	0.99	99077
netflix	0.98	1.00	0.99	99125
roblox	1.00	1.00	1.00	99006
teamtactics	1.00	0.99	0.99	99235
youtube	1.00	1.00	1.00	99380
youtubelive	1.00	1.00	1.00	98538
zepeto	0.98	0.98	0.98	99296
zoom	1.00	0.98	0.99	98995
accuracy			0.99	1386000
macro avg	0.99	0.99	0.99	1386000
weighted avg	0.99	0.99	0.99	1386000

```

Saving the model
Saved the model

```

RANDOM FOREST



```
accuracy 0.9934191919191919
Classes: ['afreecatv' 'battleground' 'geforce' 'googlemeet' 'ktgamebox' 'msteams'
'navernow' 'netflix' 'roblox' 'teamtactics' 'youtube' 'youtubelive'
'zepeto' 'zoom']
```

	precision	recall	f1-score	support
afreecatv	1.00	1.00	1.00	99263
battleground	0.96	0.98	0.97	98921
geforce	0.99	0.97	0.98	99204
googlemeet	1.00	0.99	0.99	98672
ktgamebox	1.00	1.00	1.00	99305
msteams	1.00	1.00	1.00	99140
navernow	1.00	0.99	1.00	98835
netflix	1.00	1.00	1.00	99203
roblox	1.00	1.00	1.00	99079
teamtactics	1.00	0.99	0.99	99024
youtube	1.00	1.00	1.00	99084
youtubelive	1.00	1.00	1.00	98953
zepeto	0.96	1.00	0.98	98438
zoom	1.00	0.99	1.00	98879
accuracy			0.99	1386000
macro avg	0.99	0.99	0.99	1386000
weighted avg	0.99	0.99	0.99	1386000

ML BASED MODEL RESULTS

15

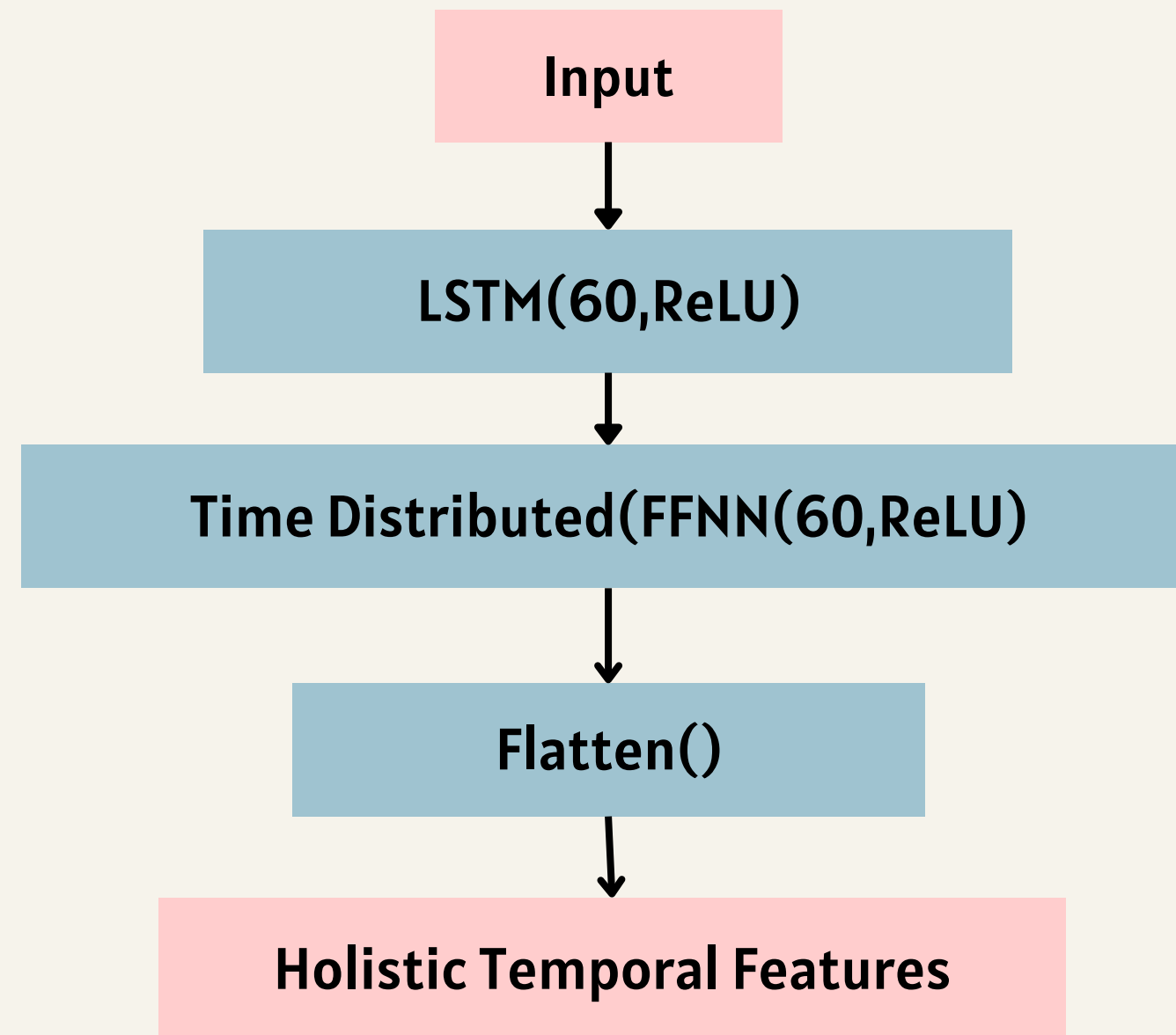
Model Name	F1	Precision	Recall	Accuracy
Decision Tree	0.99	0.99	0.99	0.98
Random Forest	0.99	0.99	0.99	0.99

CNN + LSTM

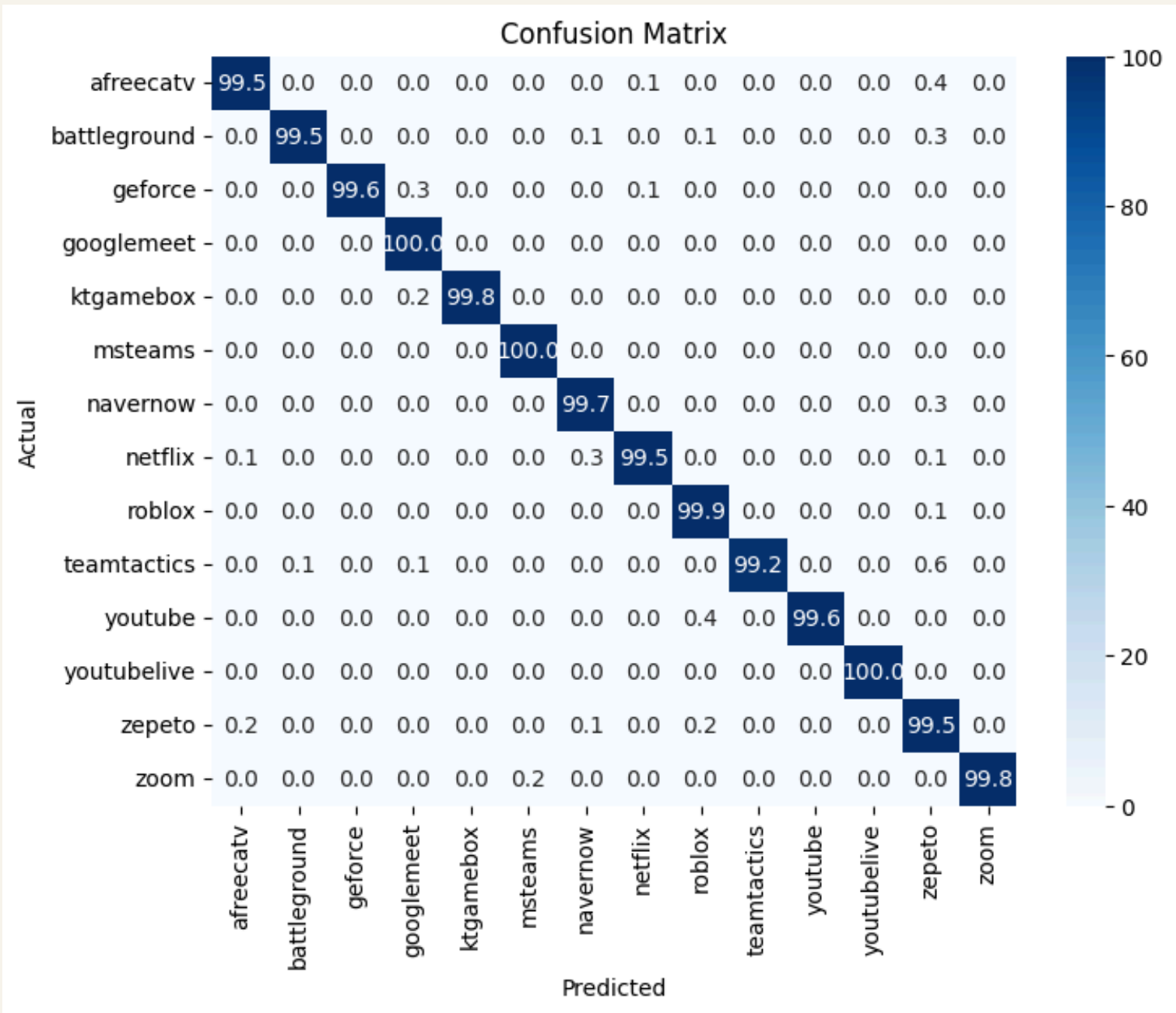


LSTM-TD(FFNN)

17

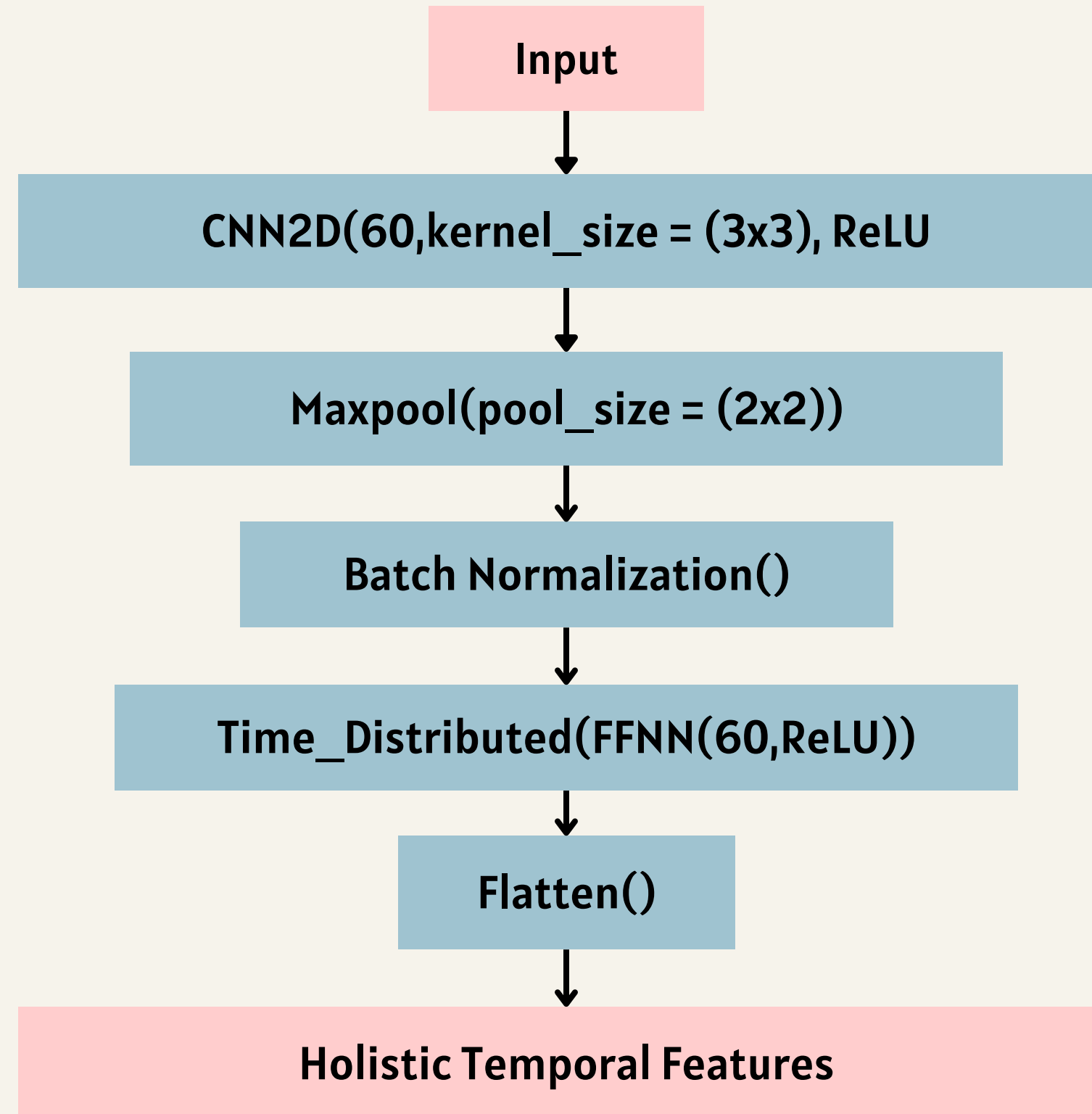


LSTM-TD(FFNN)

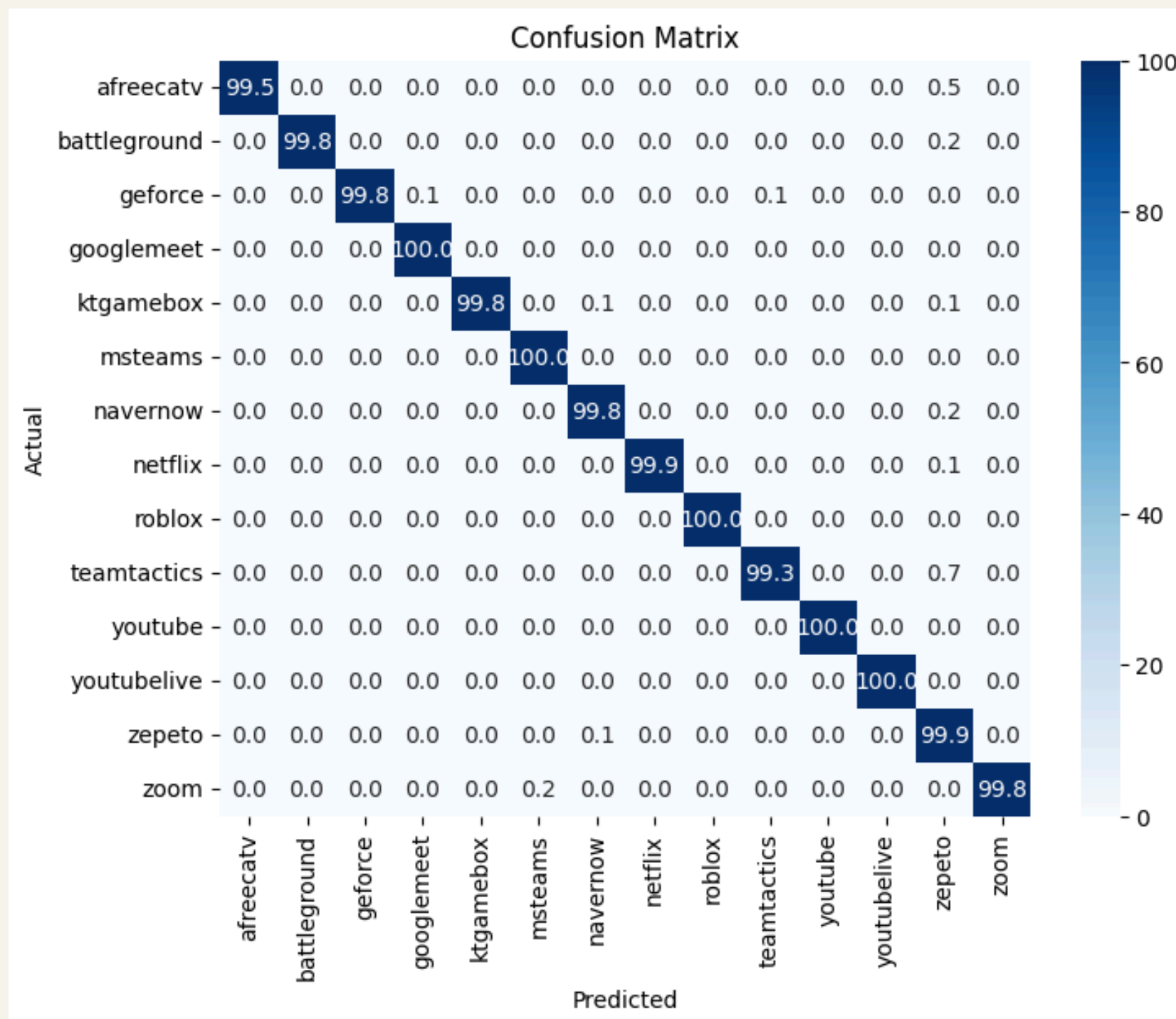


... accuracy 0.9968571428571429				
	precision	recall	f1-score	support
afreecatv	1.00	0.99	1.00	1000
battleground	1.00	0.99	1.00	1000
geforce	1.00	1.00	1.00	1000
googlemeet	0.99	1.00	1.00	1000
ktgamebox	1.00	1.00	1.00	1000
msteams	1.00	1.00	1.00	1000
navernow	1.00	1.00	1.00	1000
netflix	1.00	0.99	1.00	1000
roblox	0.99	1.00	1.00	1000
teamtactics	1.00	0.99	1.00	1000
youtube	1.00	1.00	1.00	1000
youtubelive	1.00	1.00	1.00	1000
zepeto	0.98	0.99	0.99	1000
zoom	1.00	1.00	1.00	1000
accuracy			1.00	14000
macro avg	1.00	1.00	1.00	14000
weighted avg	1.00	1.00	1.00	14000

CNN-TD(FFNN)



CNN-TD(FFNN)

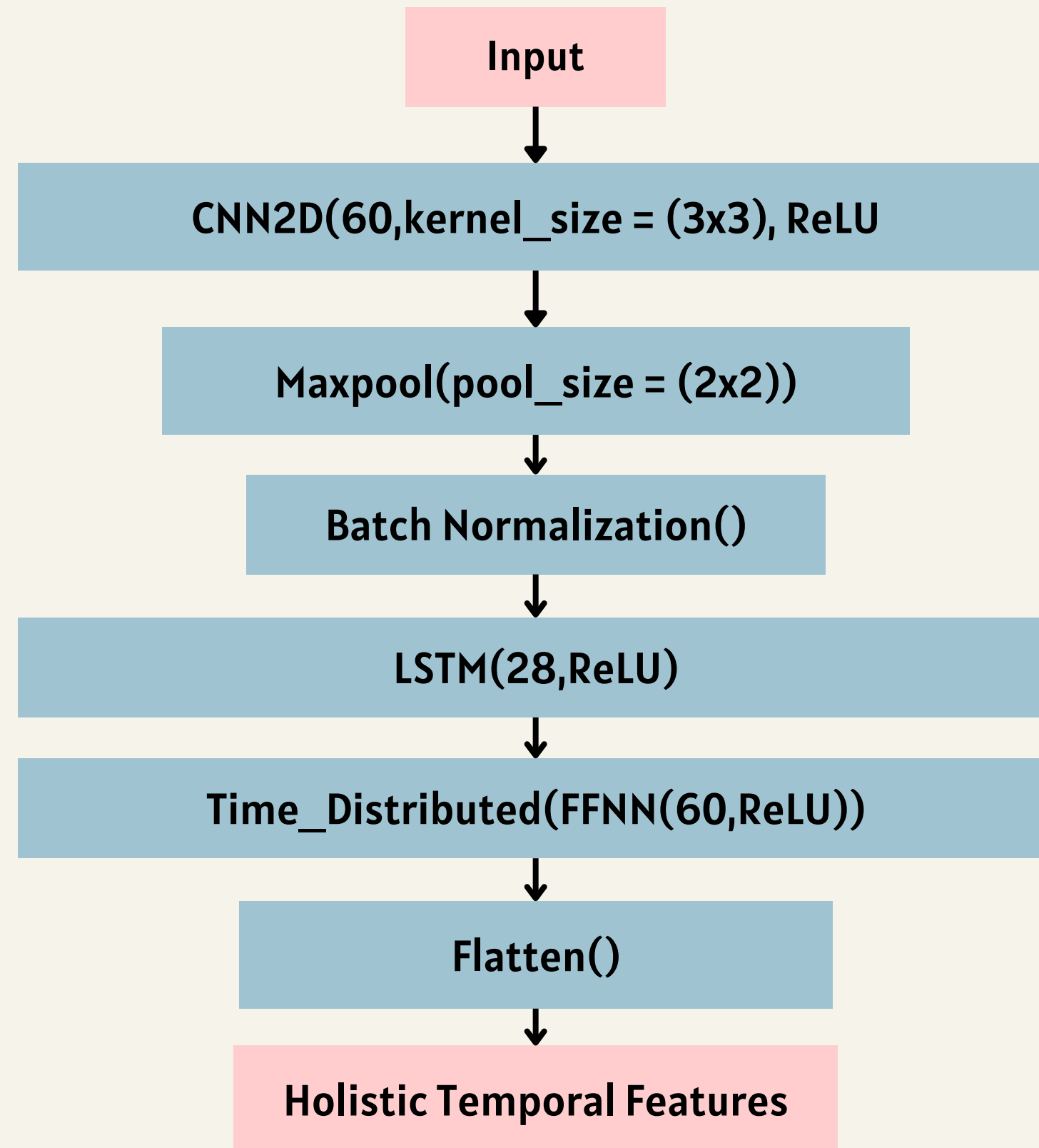


```
.. accuracy 0.9982857142857143
```

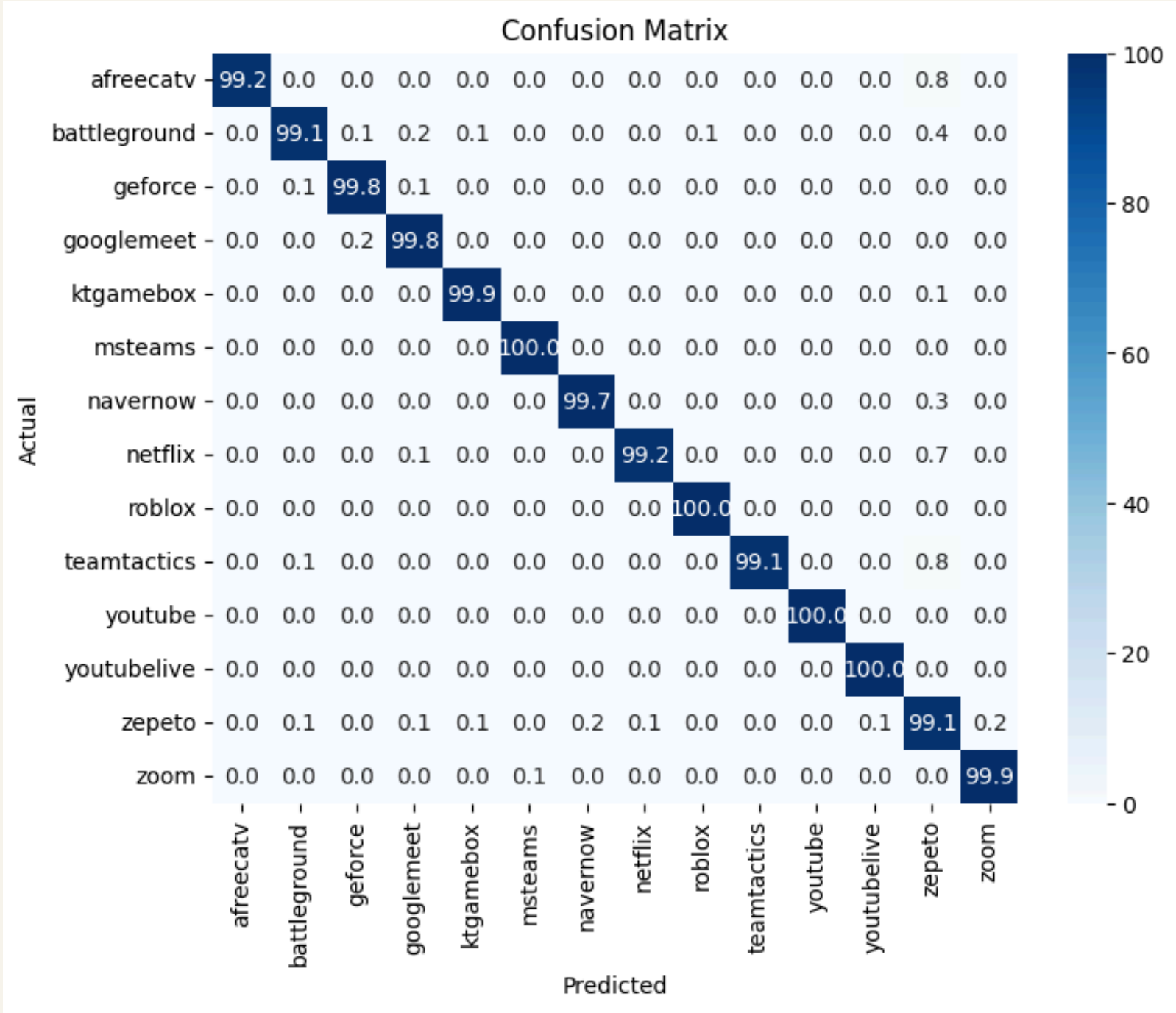
	precision	recall	f1-score	support
afreecatv	1.00	0.99	1.00	1000
battleground	1.00	1.00	1.00	1000
geforce	1.00	1.00	1.00	1000
googlemeet	1.00	1.00	1.00	1000
ktgamebox	1.00	1.00	1.00	1000
msteams	1.00	1.00	1.00	1000
navernow	1.00	1.00	1.00	1000
netflix	1.00	1.00	1.00	1000
roblox	1.00	1.00	1.00	1000
teamtactics	1.00	0.99	1.00	1000
youtube	1.00	1.00	1.00	1000
youtubelive	1.00	1.00	1.00	1000
zepeto	0.98	1.00	0.99	1000
zoom	1.00	1.00	1.00	1000
accuracy			1.00	14000
macro avg	1.00	1.00	1.00	14000
weighted avg	1.00	1.00	1.00	14000

CNN-LSTM-TD(FFNN)

21



CNN-LSTM-TD(FFNN)



```
... accuracy 0.9962857142857143
      precision    recall  f1-score   support

    afreecatv         1.00      0.99      1.00       1000
    battleground         1.00      0.99      0.99       1000
      geforce         1.00      1.00      1.00       1000
    googlemeet         1.00      1.00      1.00       1000
    ktgamebox         1.00      1.00      1.00       1000
      msteams         1.00      1.00      1.00       1000
    navernow         1.00      1.00      1.00       1000
      netflix         1.00      0.99      1.00       1000
      roblox         1.00      1.00      1.00       1000
    teamtactics         1.00      0.99      1.00       1000
      youtube         1.00      1.00      1.00       1000
    youtubelive         1.00      1.00      1.00       1000
      zepeto         0.97      0.99      0.98       1000
      zoom         1.00      1.00      1.00       1000

   accuracy                   1.00      14000
  macro avg                   1.00      14000
 weighted avg                   1.00      14000
```

CNN & LSTM BASED RESULTS

Model Name	F1	Accuracy	Recall	Precision
CNN-TD(FFNN)	1.00	0.9982	1.00	1.00
LSTM-TD(FFNN)	1.00	0.9968	1.00	1.00
CNN-LSTM-TD(FFNN)	1.00	0.9962	1.00	1.00

FUTURE WORK

- 1** Exploration of Sparse CNN and xLSTM approaches.
- 2** Validation data from different dataset.
- 3** Hyperparameters tuning for ML based models.
- 4** Alternative ways of Data Pre-Processing.

VALIDATION DATA USED

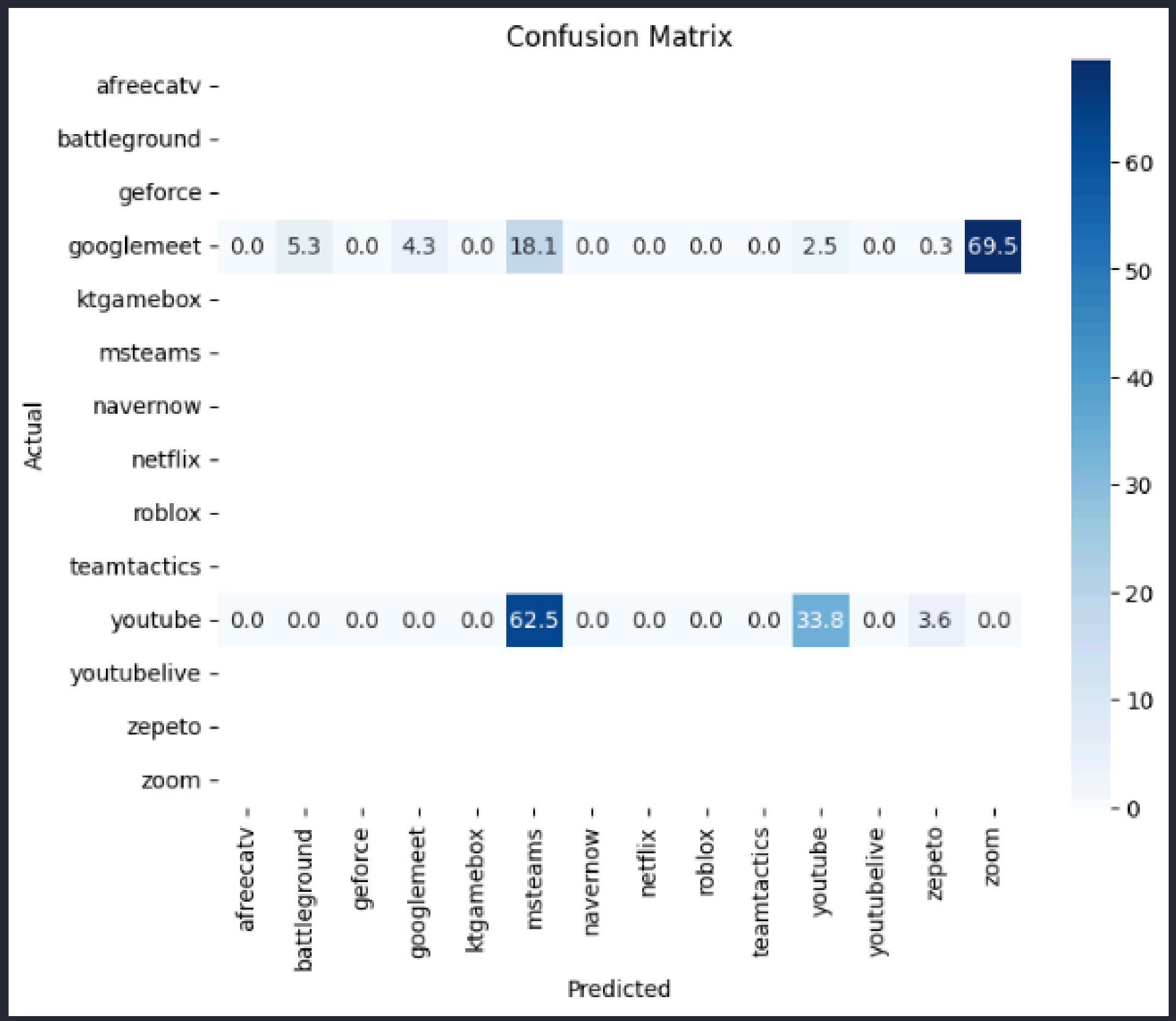
ITC-Net-Blend-60: A Comprehensive Dataset for Robust Network Traffic Classification in Diverse Environments -...

This dataset includes network traffic data from more than 50 Android applications across 5 different scenarios. The applications are consistent in all scenarios, but other factors like location, device, and user vary (se...

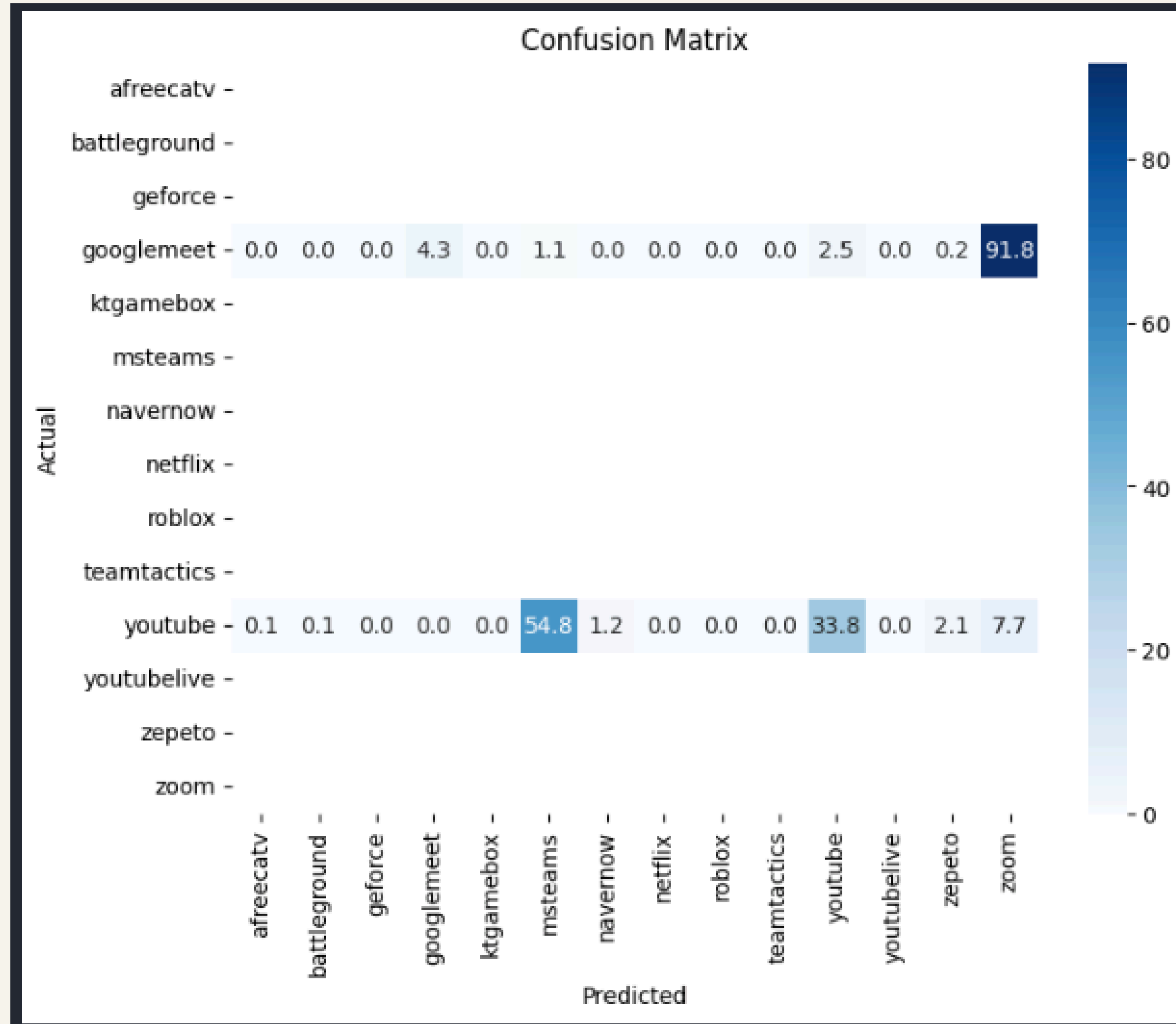
 Mendeley Data / Feb 5, 2024

- 1** We were not able to find the dataset which effectively demonstrates the features of training data.
- 2** We did find data of two of the application, but it only accomodates two types of protocol TCP and UDP.
- 3** Those two applications are Youtube, Google Meet. Hence the validation is only done over these two datasets.

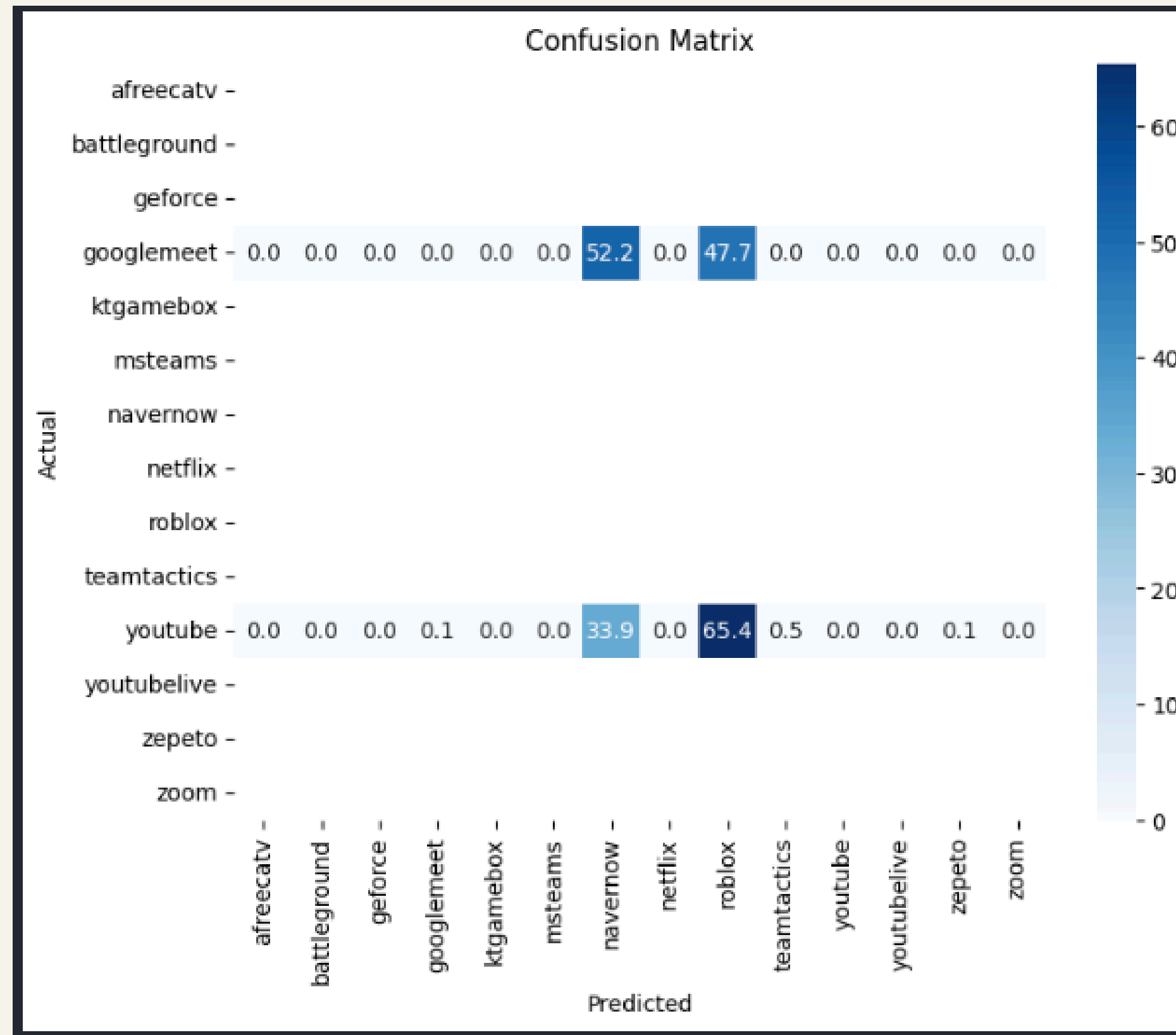
DECISION TREE



RANDOM FOREST



CNN



The background features three vertical stripes on the left: a wide pink stripe, a narrower blue stripe, and a medium-width beige stripe. The rest of the background is a light cream color, decorated with two rectangular grids of small pink dots in the top-right and bottom-right corners.

THANK YOU