Three-dimentional Convolution Neural Network based Encrypted Traffic Classifier for Wireless Communications

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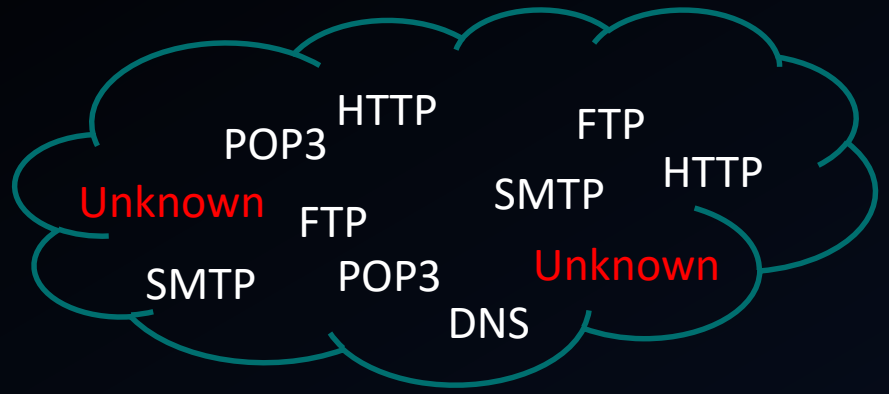
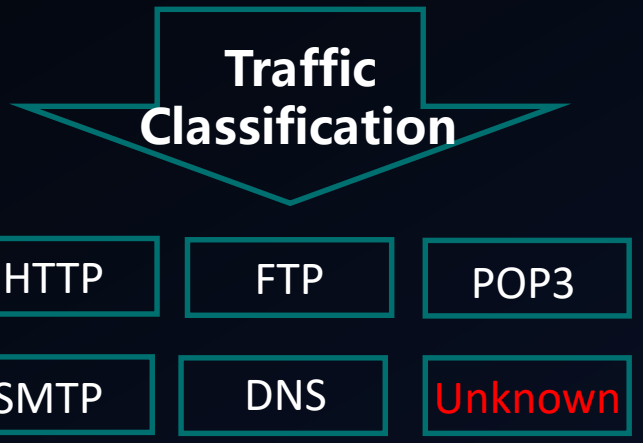
Outline

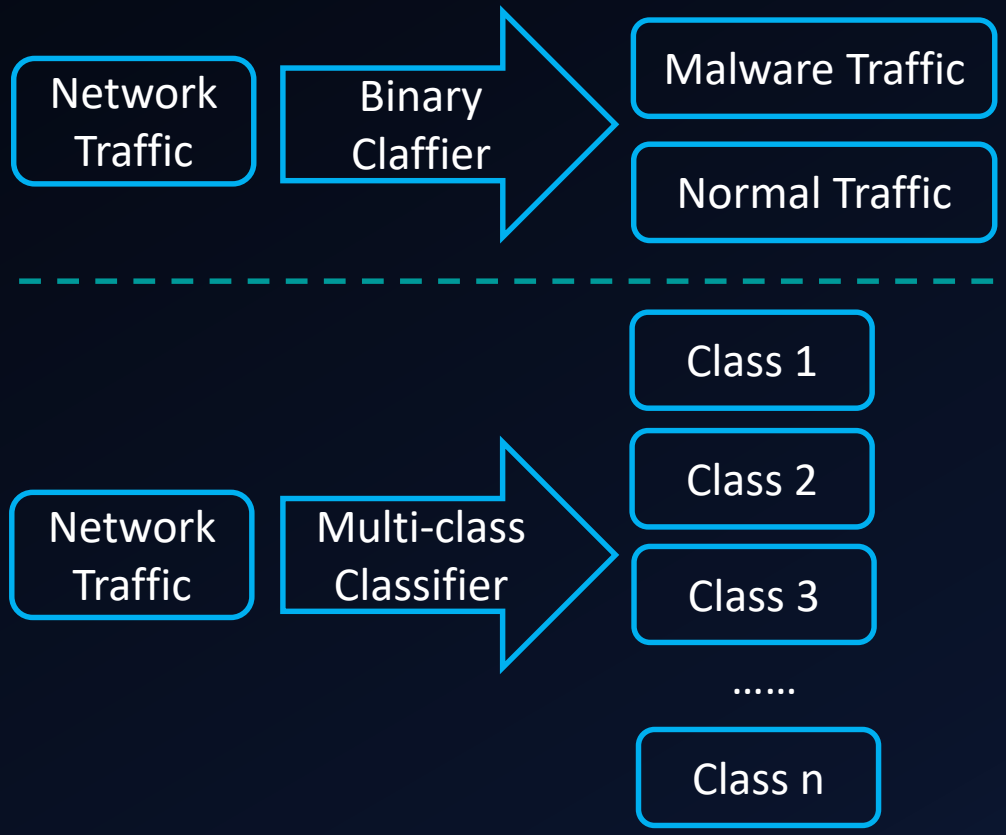
- Traffic Classification
- Preprocessing
- 3D CNN Classifier
- Simulation

I Traffic Classification

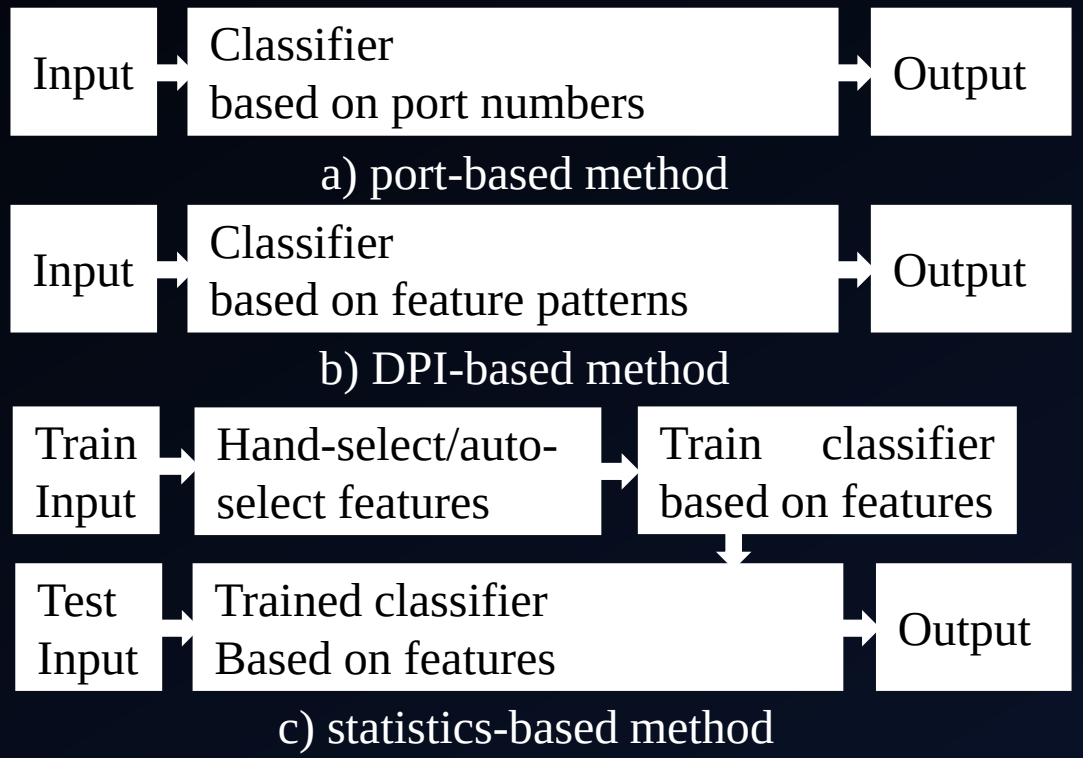
Traffic Classification







Traffic Classification

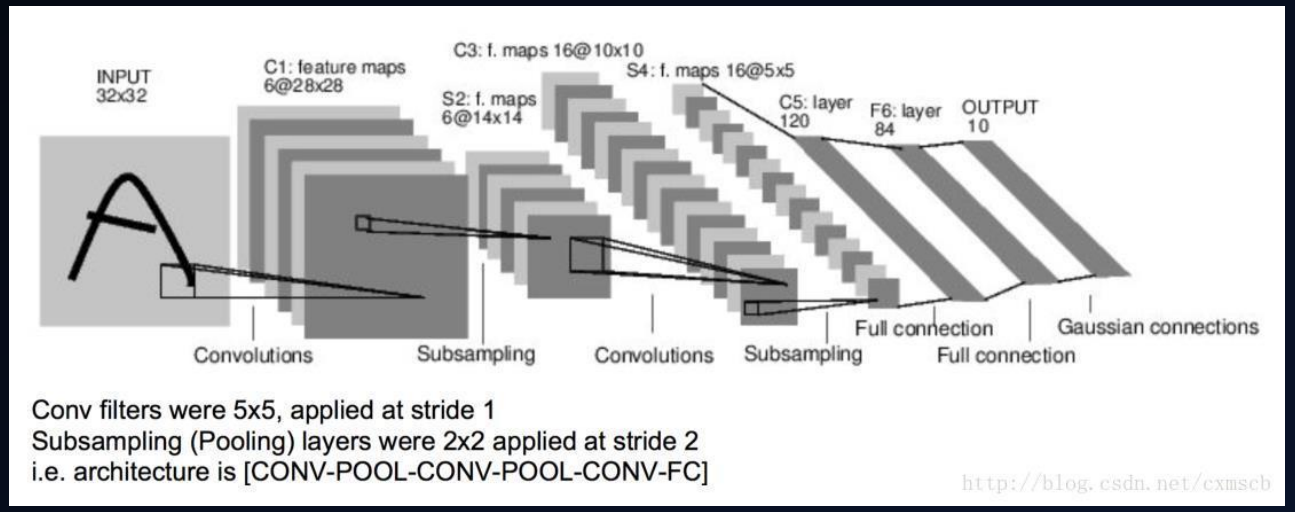


Methods of network traffic classification

II Preprocessing

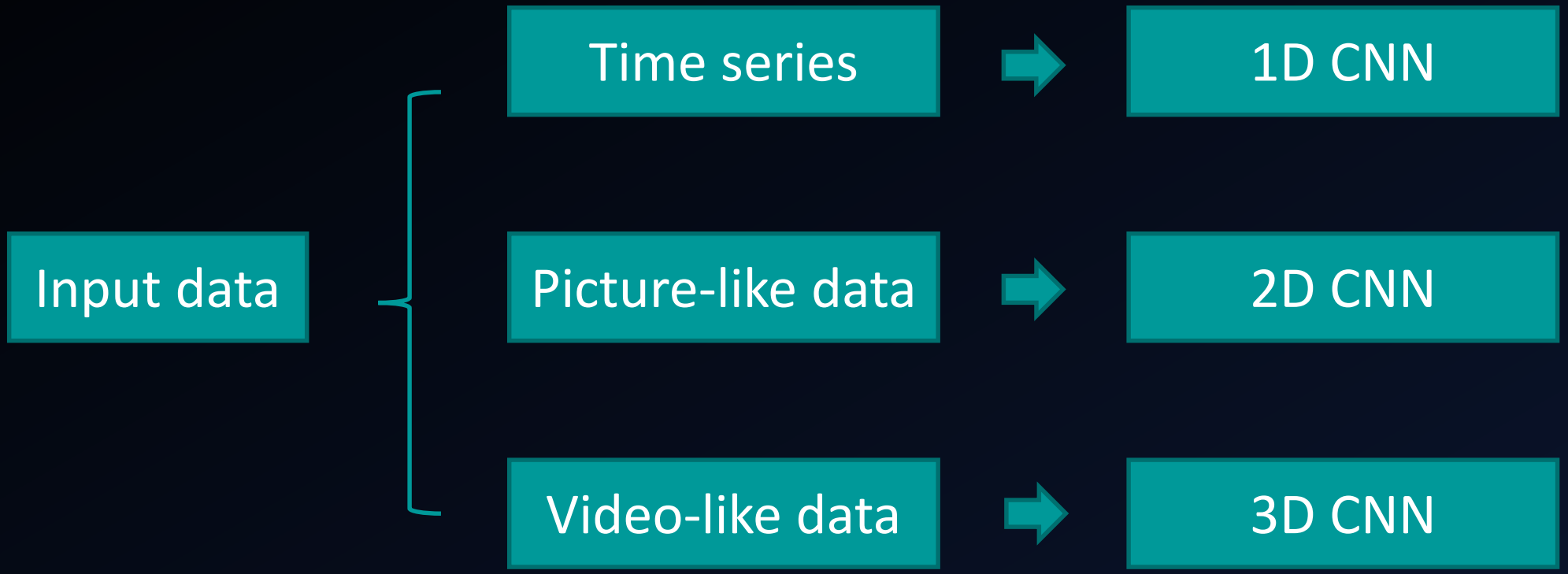
Preprocessing

- Convolution Neural Network
  - Convolutional layer
  - Pooling layer
  - Fully-connected layer
  - Output layer
- Main Application
  - Computer Vision
- Features
  - Sparse connection
  - Weight sharing
  - Multi feature graph

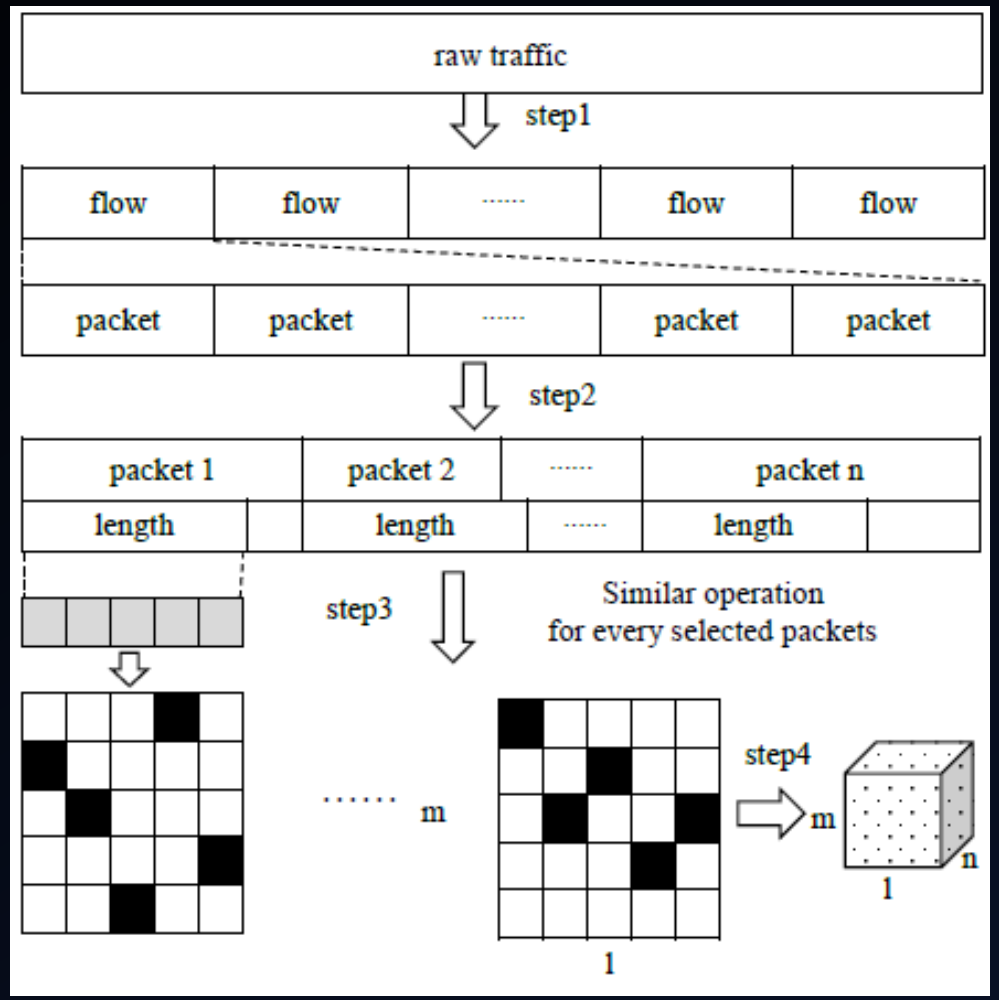


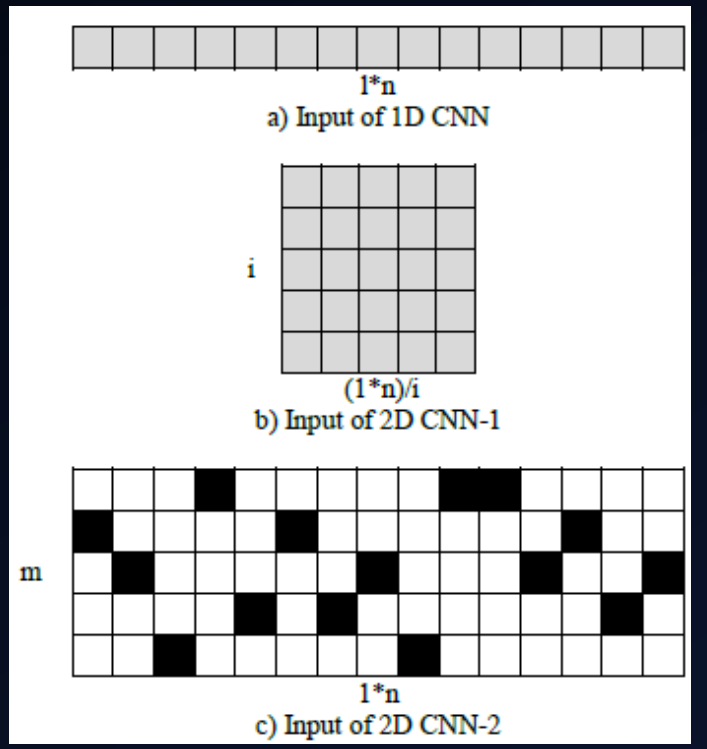
LeNet-5

Preprocessing



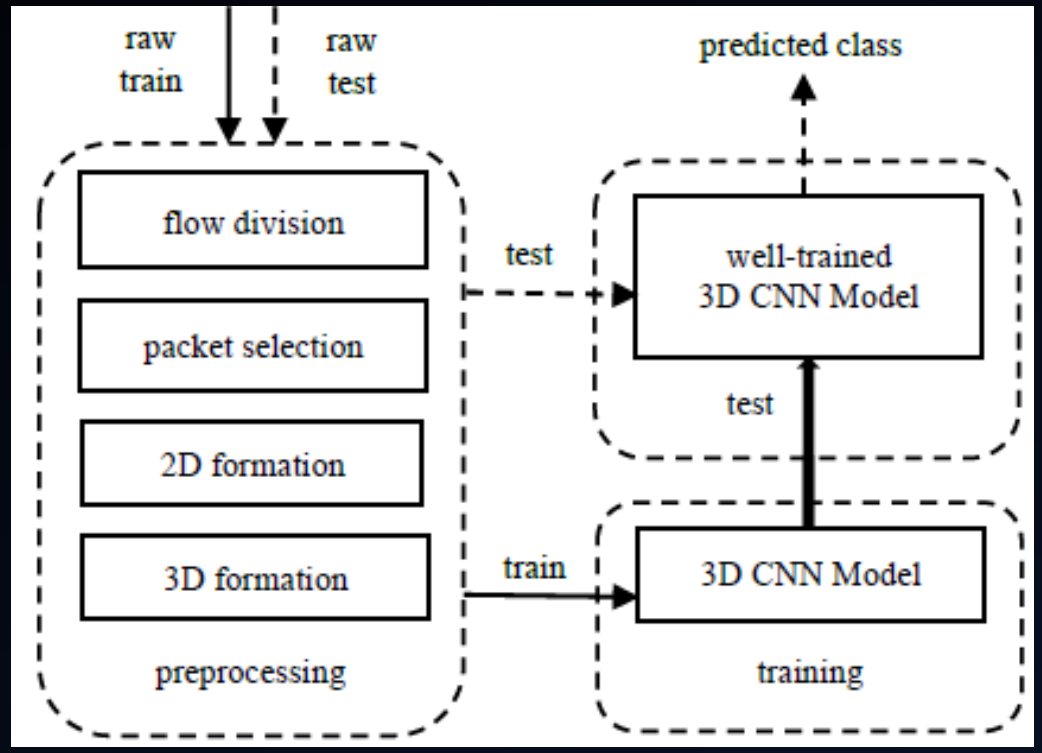
Preprocessing

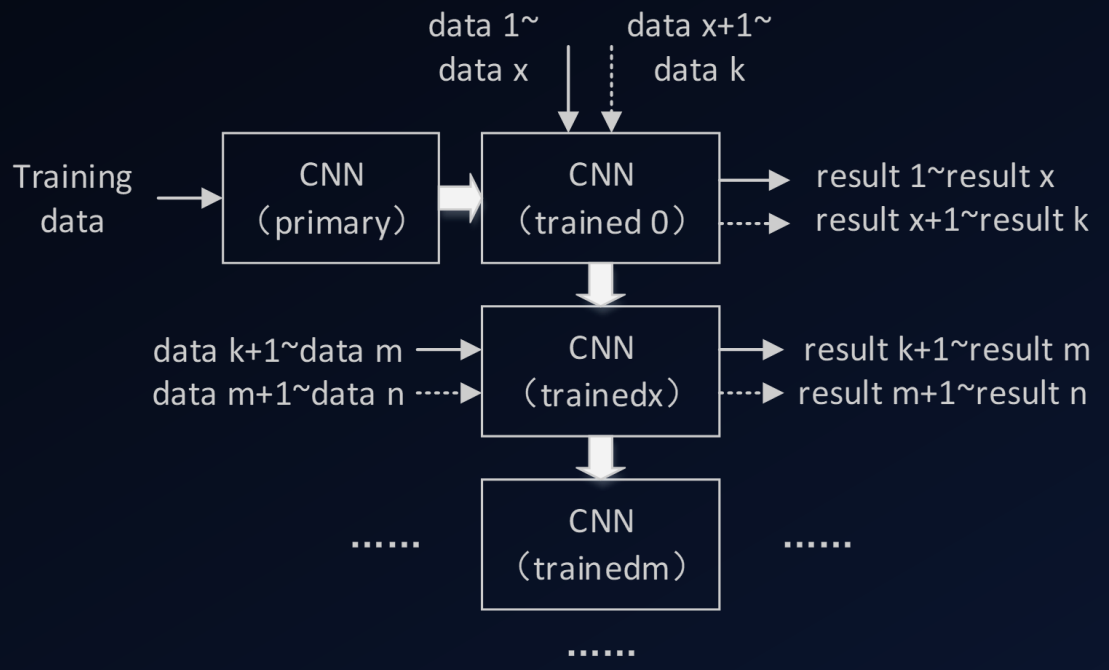




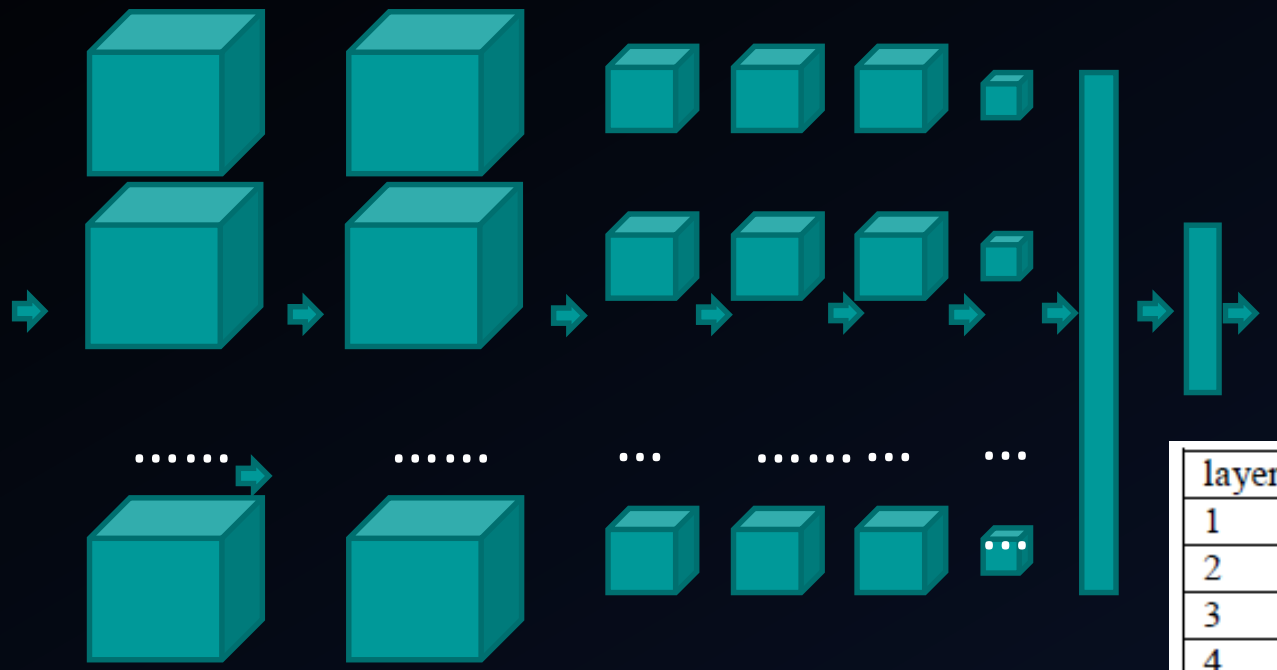
III 3D CNN Classifier

3D CNN Classifier





3D CNN Classifier



layer	type	filter	output
1	conv+Relu	3*3*3*32	28*28*16*32
2	conv+Relu	3*3*3*32	28*28*16*32
3	max pooling	2*2*1	14*14*16*32
4	conv+Relu	3*3*3*64	14*14*16*64
5	conv+Relu	3*3*3*64	14*14*16*64
6	max pooling	2*2*2	7*7*8*64
7	dense	-	1024
8	dense	-	10
9	softmax	-	10

IV Simulation

Simulation

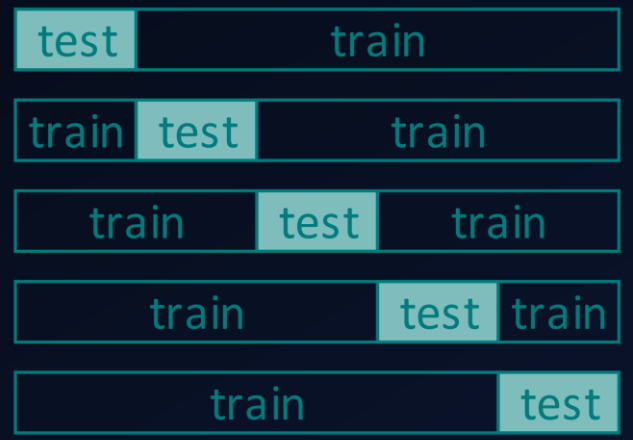
Normal Traffic						Malware Traffic			
BitTorrent	Gmail	MySQL	Outlook	Weibo	Htbot	Neris	Nsis-ay	Shifu	Virut

Dataset : part of USTC-TFC2016(raw)

- real traffic collected by CTU researchers
- simulated traffic collected by IXIA BPS

Experimental frameworks : Keras and Tensorflow

Five-fold cross-validation



Simulation

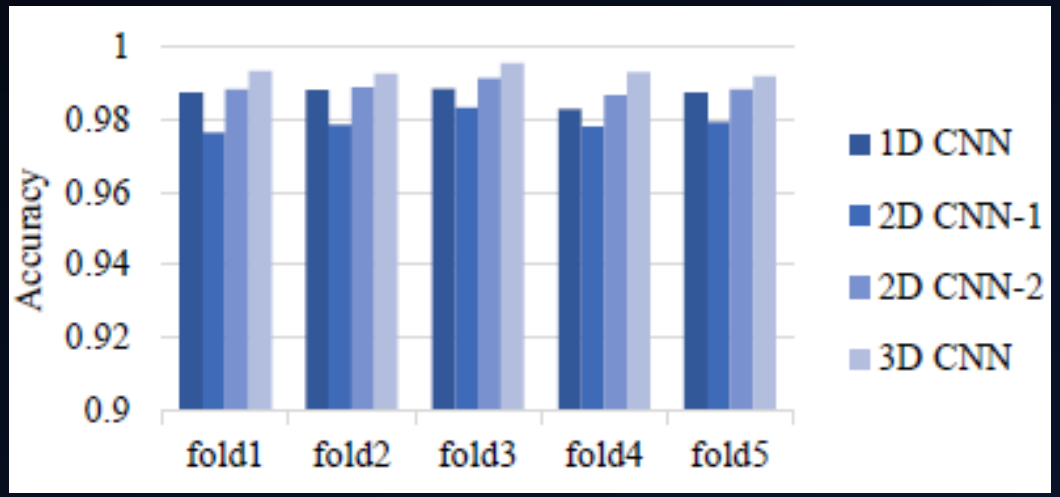
Parameters Selection

Learning rate & Optimizer:

optimizer \ learning rate	0.001	0.0001
GradientDescentOptimizer	98.73%	86.02%
AdamOptimizer	10.52%	99.77%

Packets per flow : 16
Training time : 40 epoch
Cost function : cross entropy
Mini-batch size : 50

Accuracy



CNN-1 : cut according to fixed length
CNN-2 : one-hot encoding of 1D data

Simulation

Evaluation Criterion

Classified as →	X	$\bar{X}$
X	TP	FN
$\bar{X}$	FP	TN

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Precision = \frac{TP}{TP + FP}$$

$$Recall = \frac{TP}{TP + FN}$$

$$F1 = 2\frac{Precision \times Recall}{Precision + Recall}$$

class	precision	recall	F1
BitTorrent	1	0.9962	0.9981
Gmail	0.9898	0.9898	0.9898
MySQL	1	1	1
Outlook	0.9888	0.9925	0.9906
Weibo	1	1	1
Htbot	0.9954	1	0.9977
Neris	0.9433	0.9659	0.9545
Nsis-ay	1	0.9952	0.9976
Shifu	1	0.9971	0.9985
Virut	0.9515	0.927	0.9391

Thank you!