Intrusion Detection System Based on Network Port Statistics Using Multilayer Perceptron and Deep Learning Approaches

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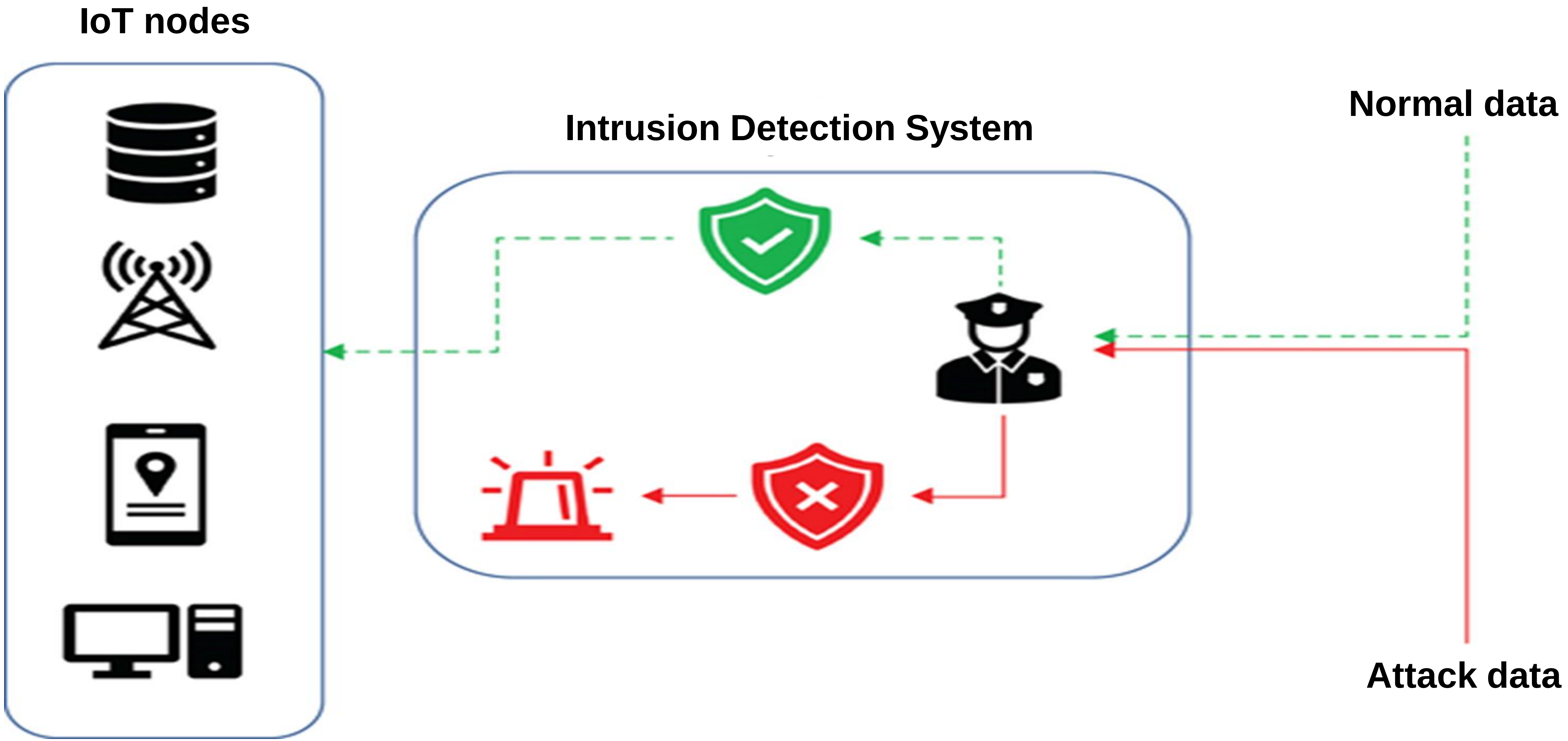
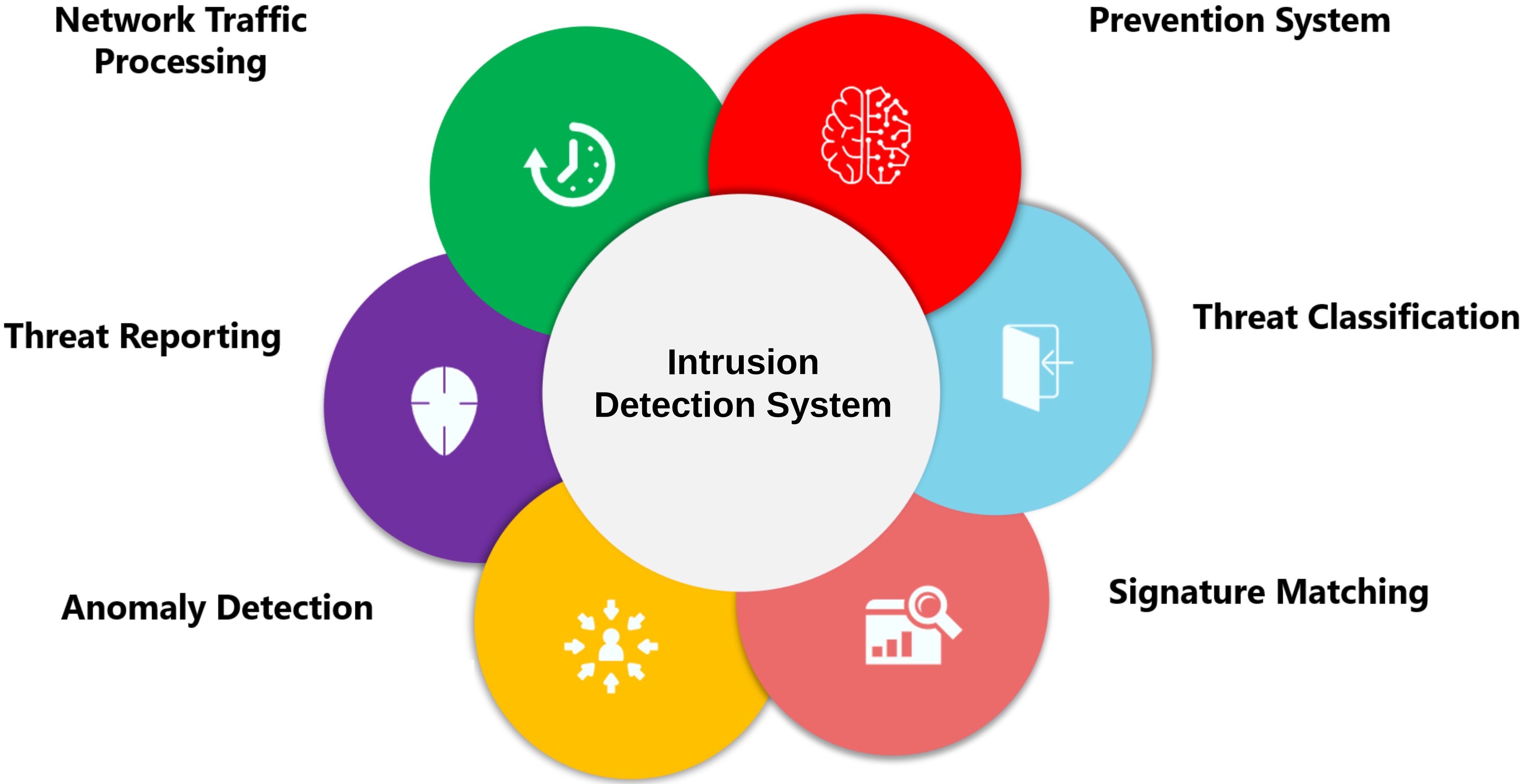
Problem Statement



Motivation & Objectives



Related Works

Author(s)	Dataset	Proposed Methods	Year	Accuracy
Jing et al.	UNSW-NB15	SVM along with a novel scaling strategy.	2019	85.99%
Rai et al.	NSL-KDD	C4.5 decision tree	2018	79.53%
Shettar et al.	KDD Cup'99	A hybrid model combining chaotic neural networks and MLP	2021	84.77%
Atef et al.	CICIDS2017	Comparison between KNN and DNN	2020	DNN-96.42%, KNN-90.91%
Dogukan et al.		Comparison of DL and ML methods utilizing CNN and SVM.	2021	CNN-97.8%, SVM-69.79%
Jiyeon et al.	CICIDS2018	A comparative analysis for IDS using CNN and RNN for DoS attacks.	2019	CNN-96.77% RNN-82.84%

Dataset

Intrusion detection dataset:

- UNR-IDD dataset
- Based on network port statistics
- 37412 total samples
- 34 features
- Five attack types

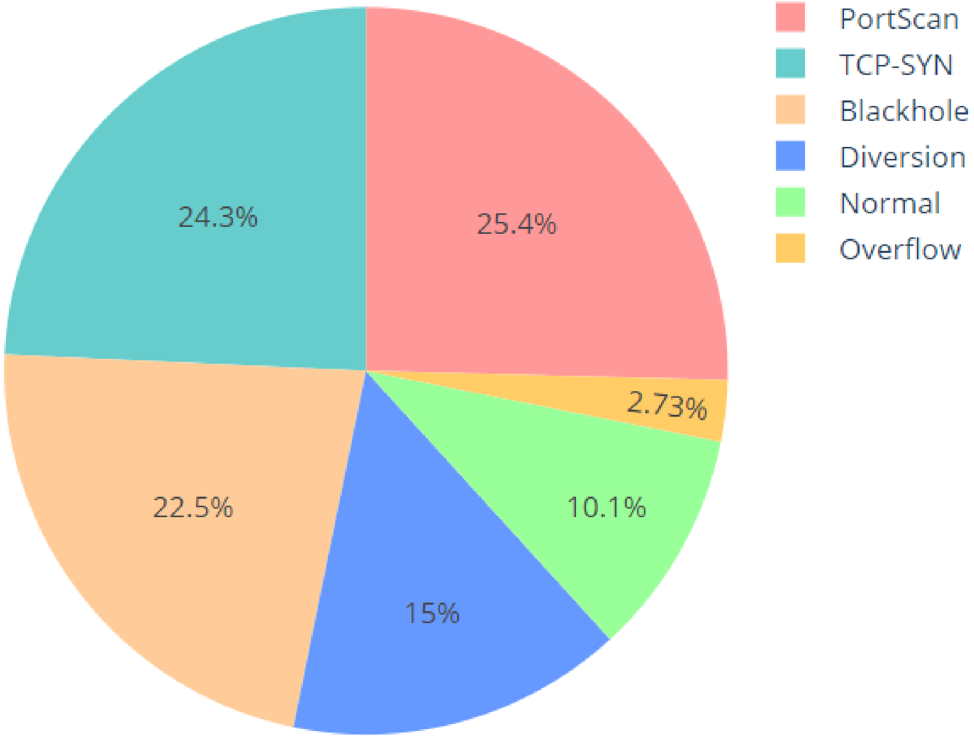
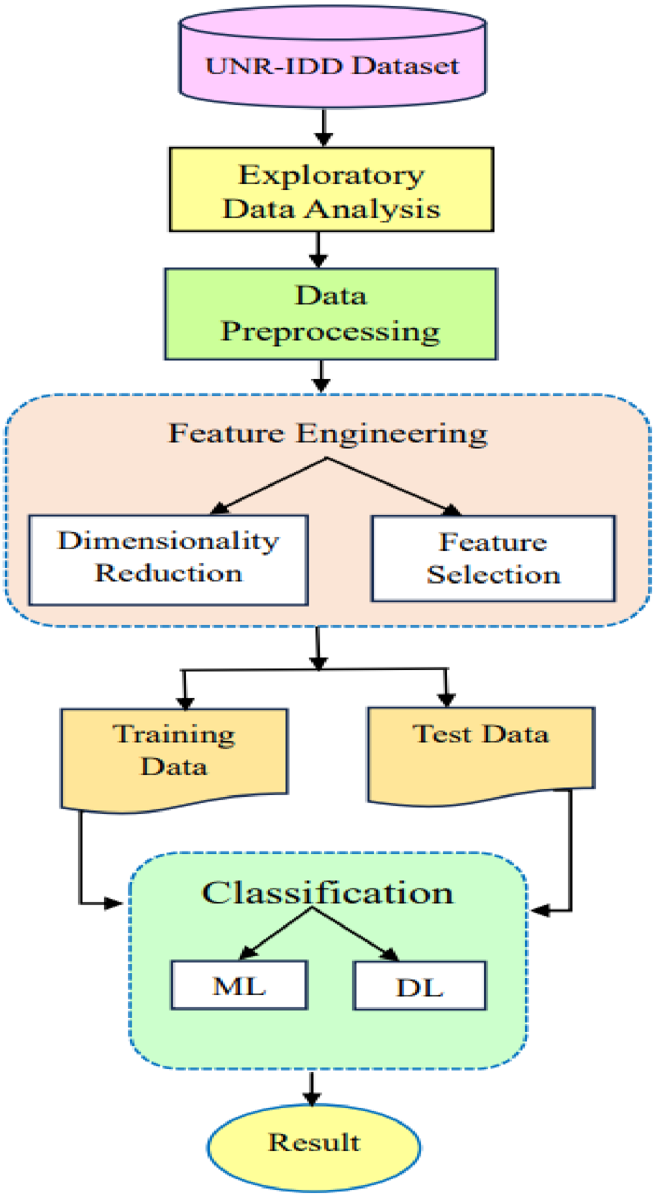


Fig: Attack Distribution in the Dataset

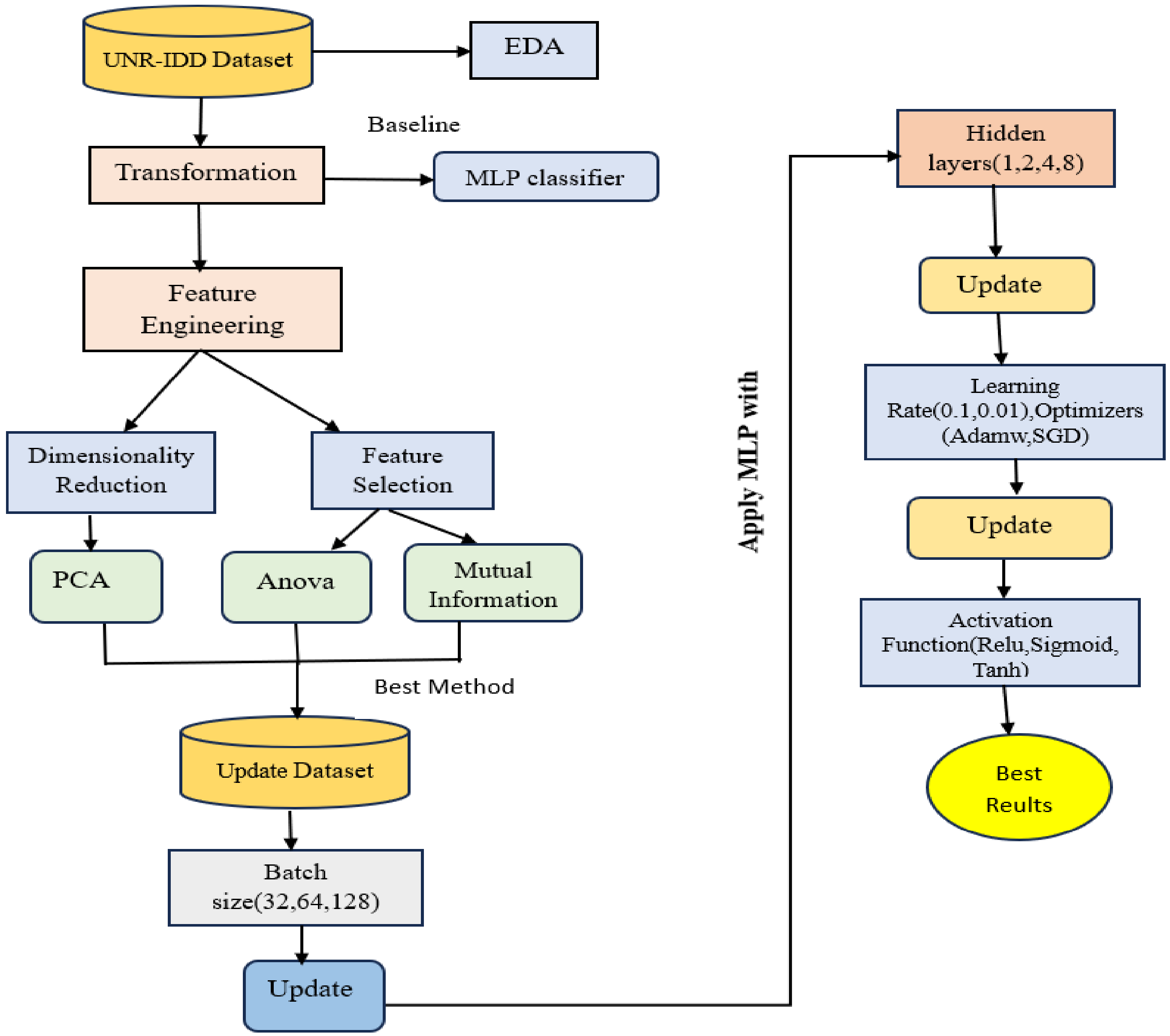
Methodology

- General Architecture for IDS



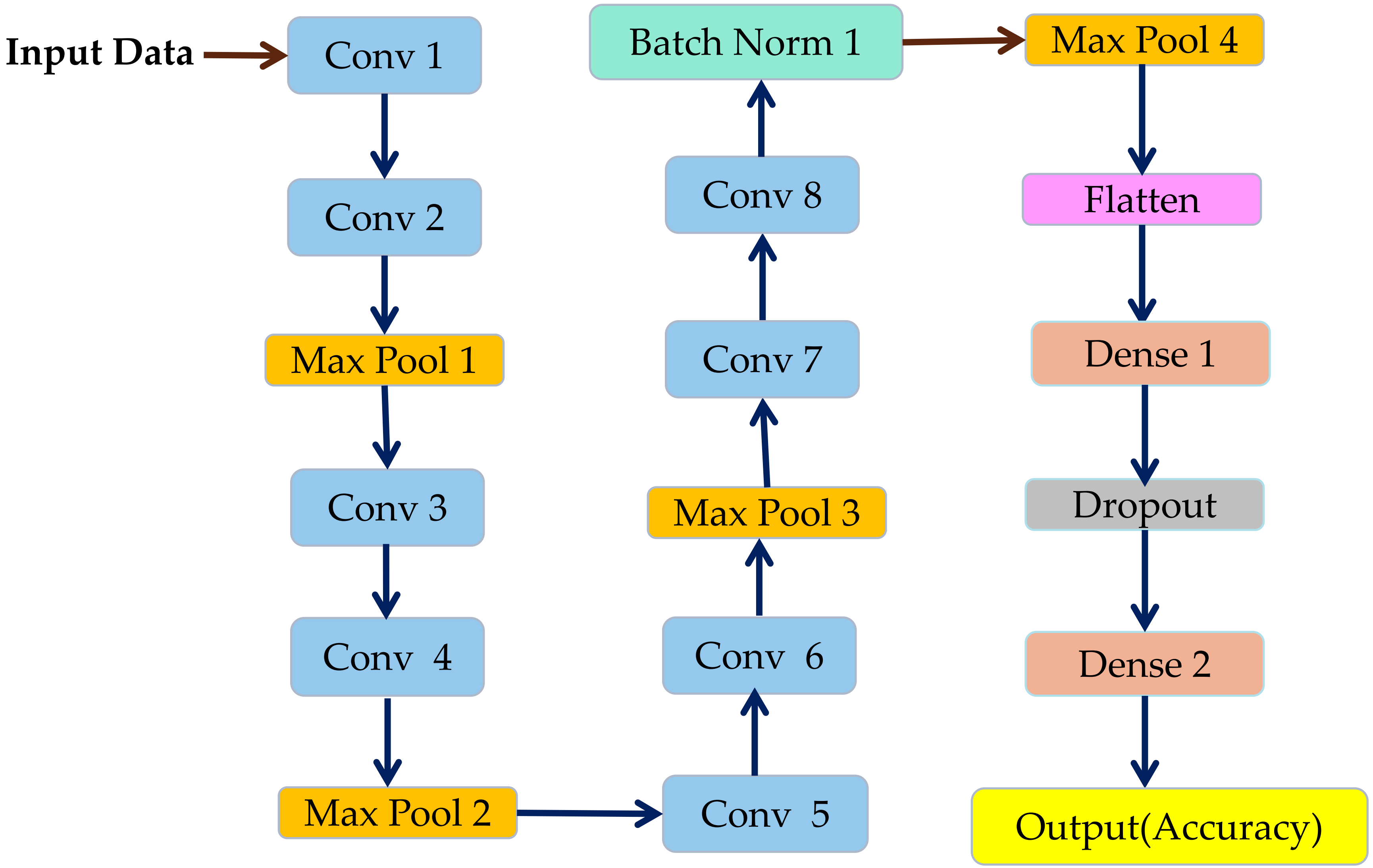
MLP

- Approach 1



CNN

- **Approach 2**



Evaluation Result

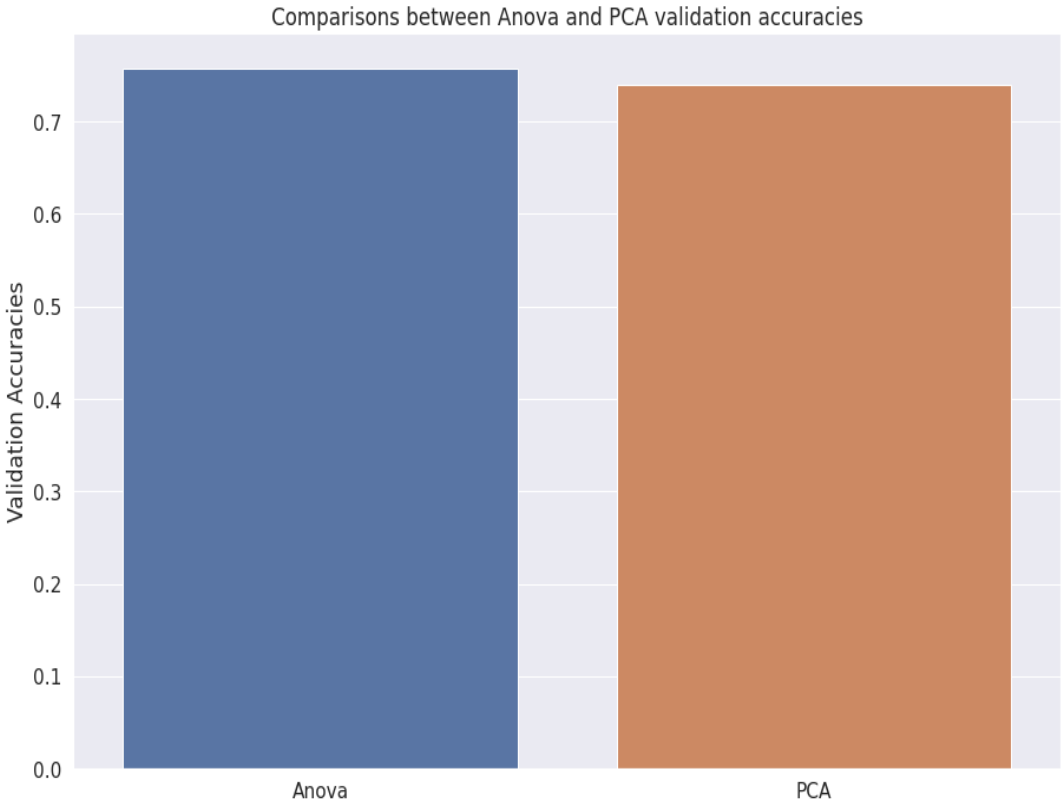
Evaluation Result on Machine Learning Algorithms

ML Algorithms	Accuracy	Precision	Recall	F1-score
Decision Tree	0.71	0.73	0.75	0.70
Support Vector Machine	0.69	0.73	0.68	0.69
Naive Bayes	0.61	0.68	0.61	0.62
KNN	0.67	0.69	0.65	0.67

Evaluation Result(MLP)

Comparative result of feature engineering techniques

PCA	ANOVA	Mutual Information
72.94%	74.68%	73.79%

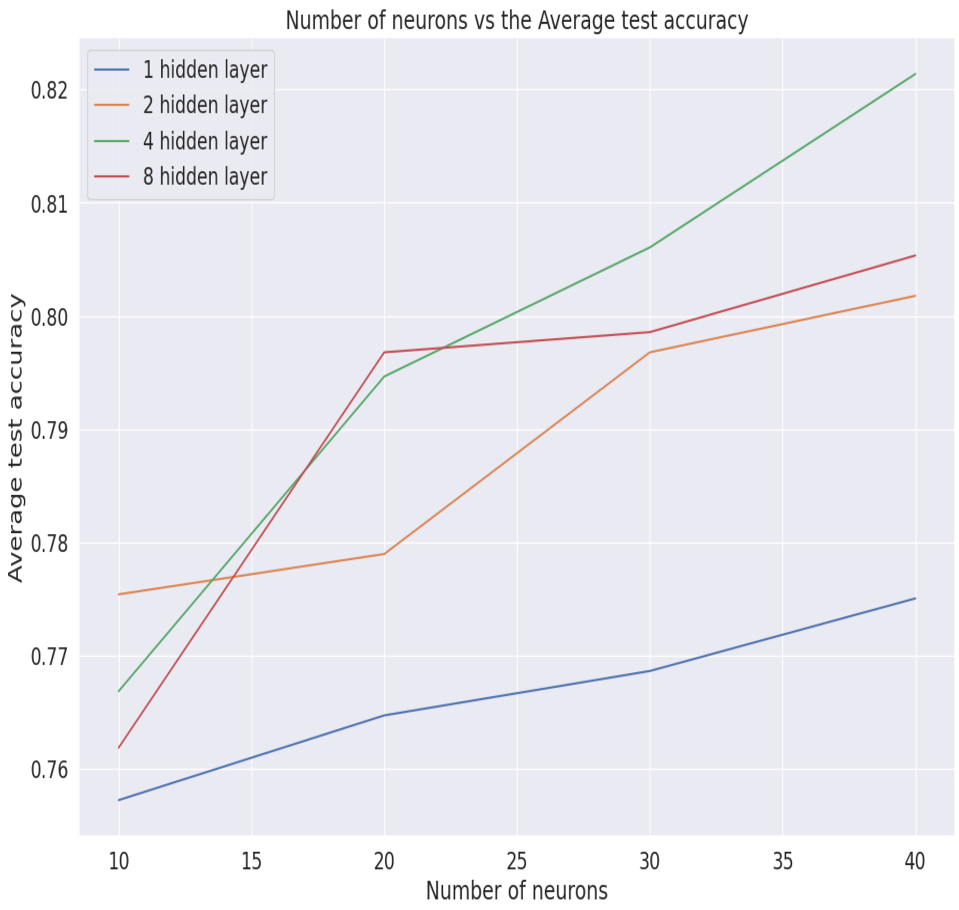


Evaluation Results for Hyperparameter Tuning

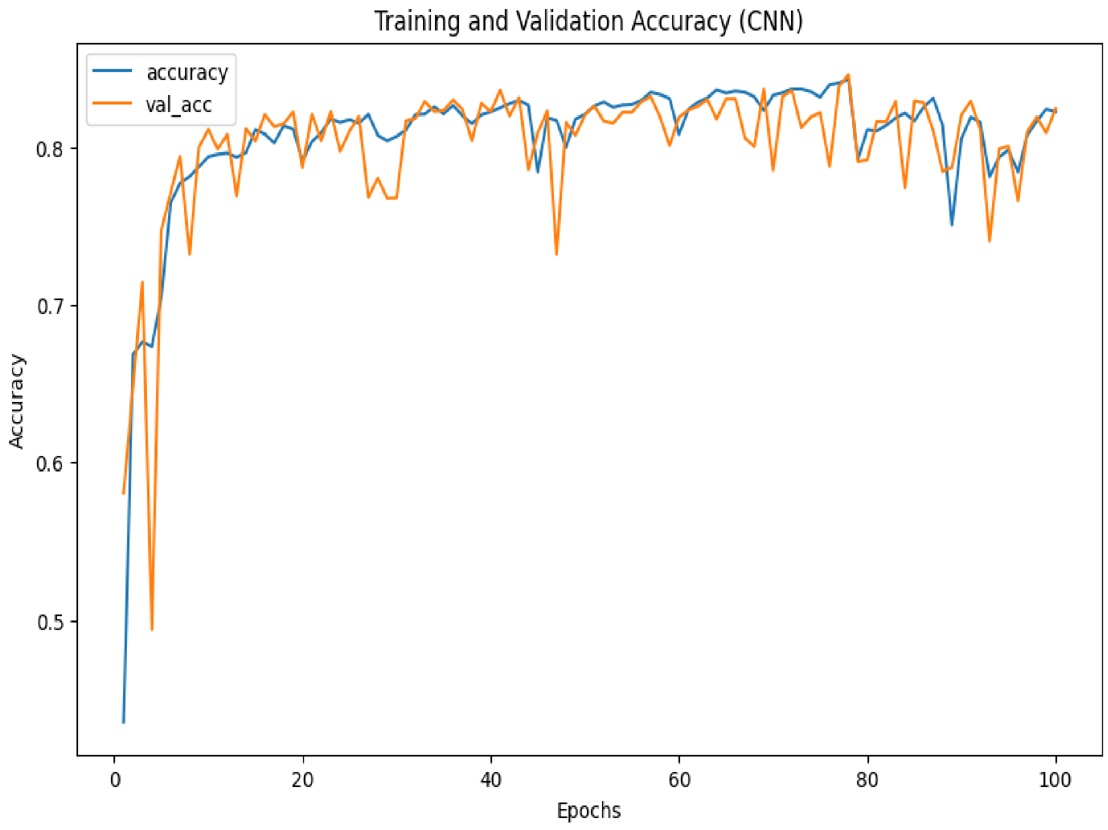
Batch Size	Training Accuracy	Test Accuracy	Validation Accuracy
32	0.720122	0.729055	0.723707
64	**0.717067**	**0.730837**	**0.729055**
128	0.711722	0.718360	0.705882

Learning Rate With Optimizers	Training Accuracy	Test Accuracy	Validation Accuracy
AdamW_LR=0.1	0.667048	0.677361	0.695187
SGD 0.1_LR=0.1	0.791321	0.791443	0.803921
AdamW_LR=0.01	**0.820924**	**0.802139**	**0.821746**
SGD 0.1_LR=0.01	0.772050	0.754010	0.757575

Activation Function	Training Accuracy	Test Accuracy	Validation Accuracy
Relu	0.802587	0.814616	0.818181
LeakyRelu	**0.825888**	**0.837790**	**0.816399**
Sigmoid	0.788850	0.782531	0.791443
Tanh	0.772192	0.802139	0.770623



Evaluation Result(CNN)



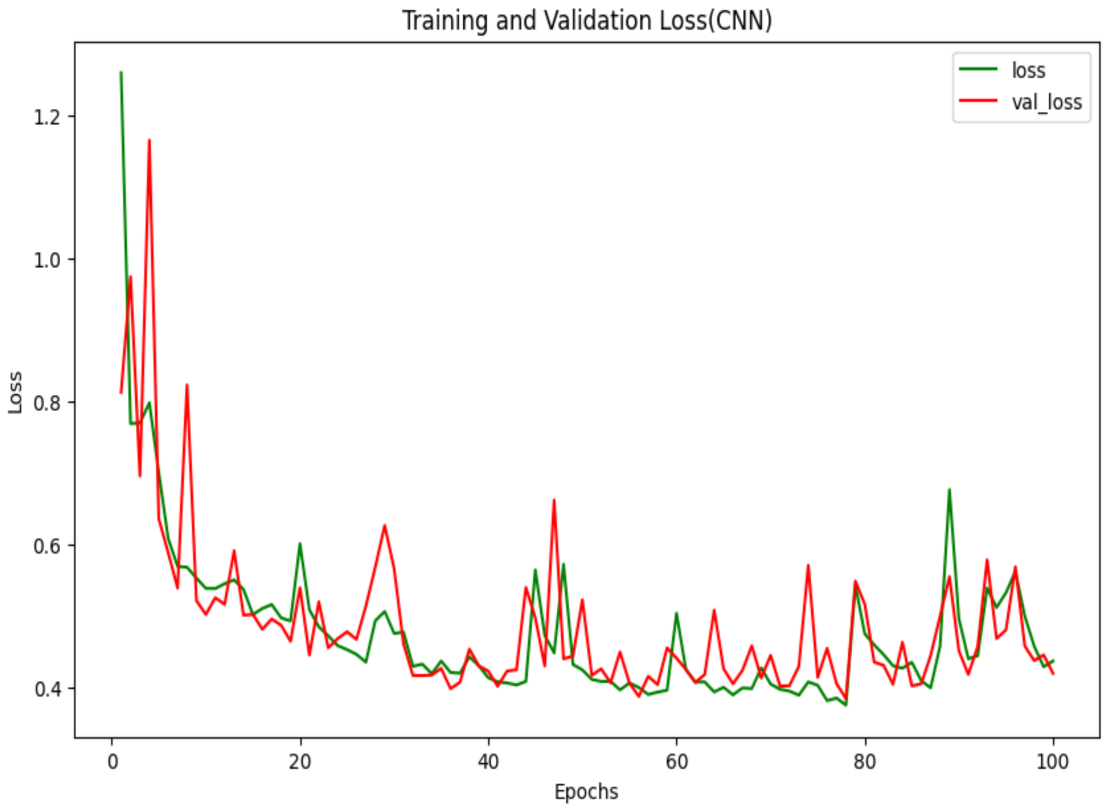


Fig: Graph for model’s Accuracy and Loss

Comparative Result With ML and DL Model

Methods	Accuracy
Decision Tree	71%
SVM	69%
Naïve Bayes	61%
KNN	67%
MLP(Tapadhir et al.)	66%
MLP (Proposed method)	**83%**
CNN	**85.7%**

Conclusion & Future Work

Conclusion:

- We proposed a network port statistics based enhanced Intrusion Detection system, unveiling the potential of MLP and CNN.
- This finding highlights the effectiveness of deep learning approaches in outperforming the conventional ML approaches for the UNR-IDD dataset.

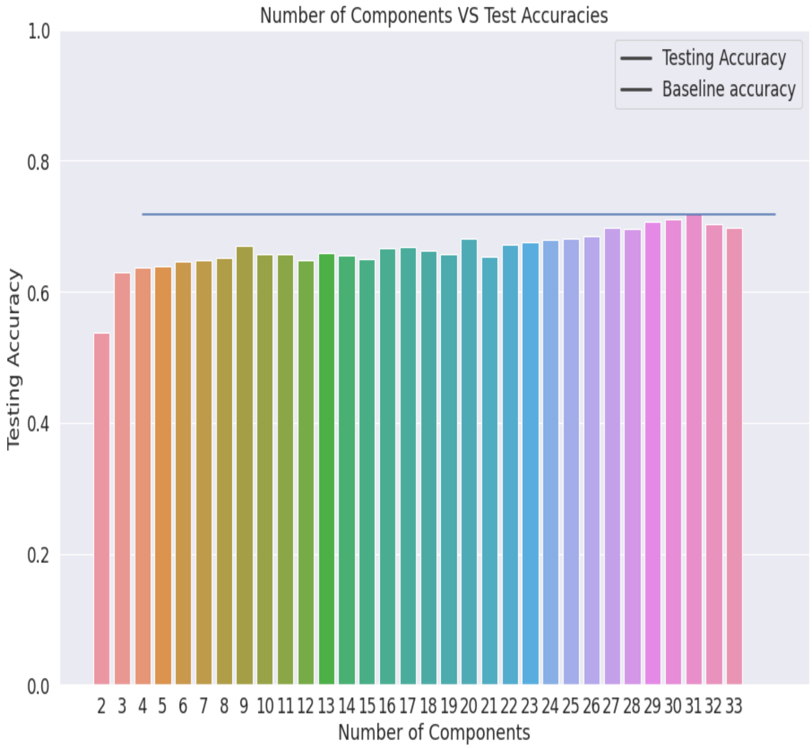
Future Work:

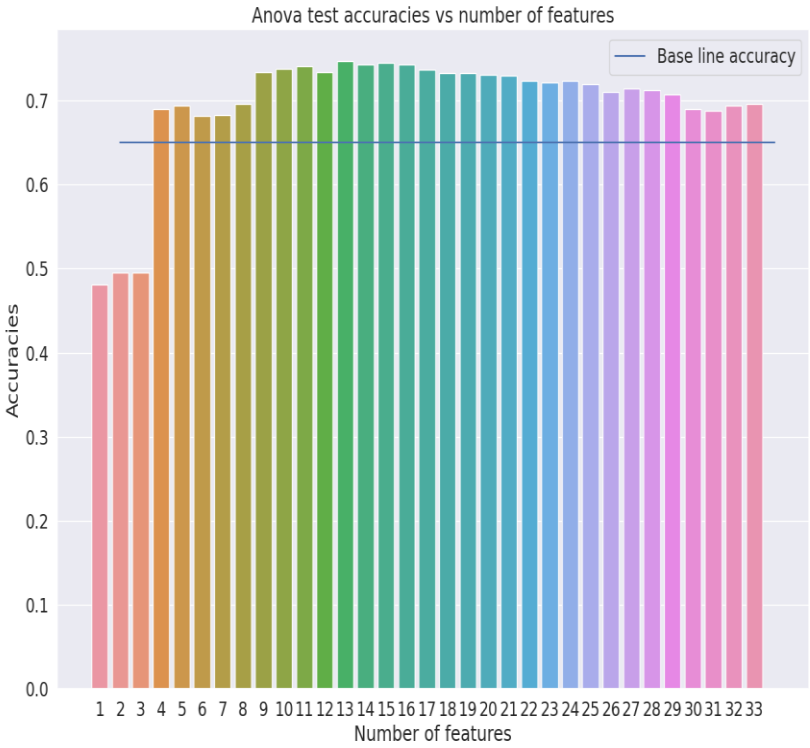
- Frameworks including GAN, RNN, or more sophisticated designs including Transformers will be taken into consideration for further study.
- To work with real-time network data for the model’s effectiveness.

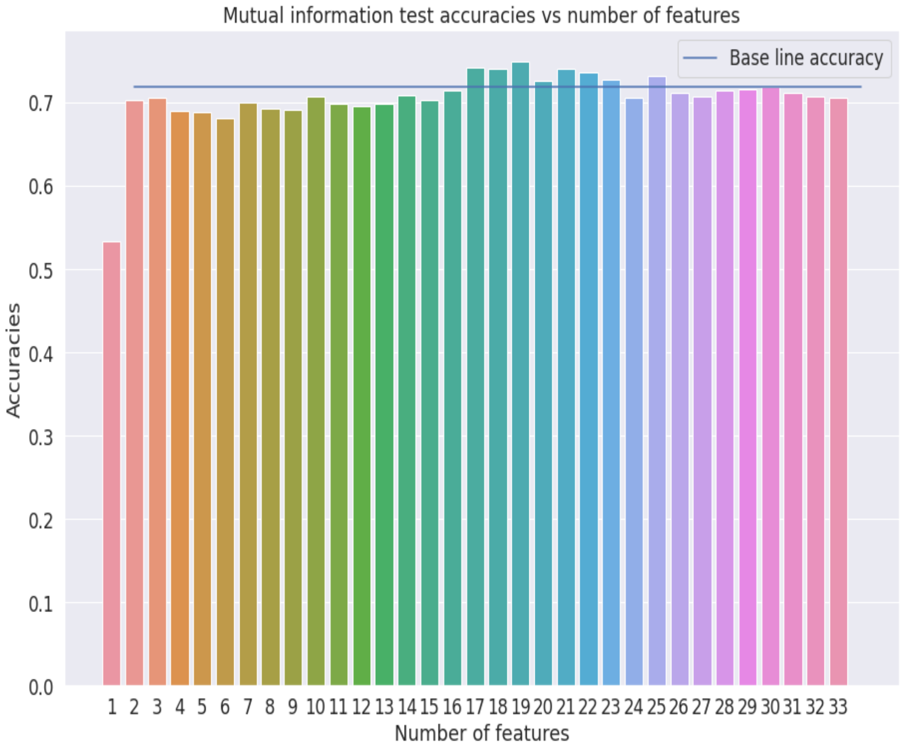
References

- Das, Tapadhir, et al. "UNR-IDD: Intrusion Detection Dataset using Network Port Statistics." *2023 IEEE 20th Consumer Communications & Networking Conference (CCNC)*. IEEE, 2023. [1]
- https://www.kaggle.com/datasets/tapadhirdas/unridd-intrusion-detection-dataset [2]

Backup Slide







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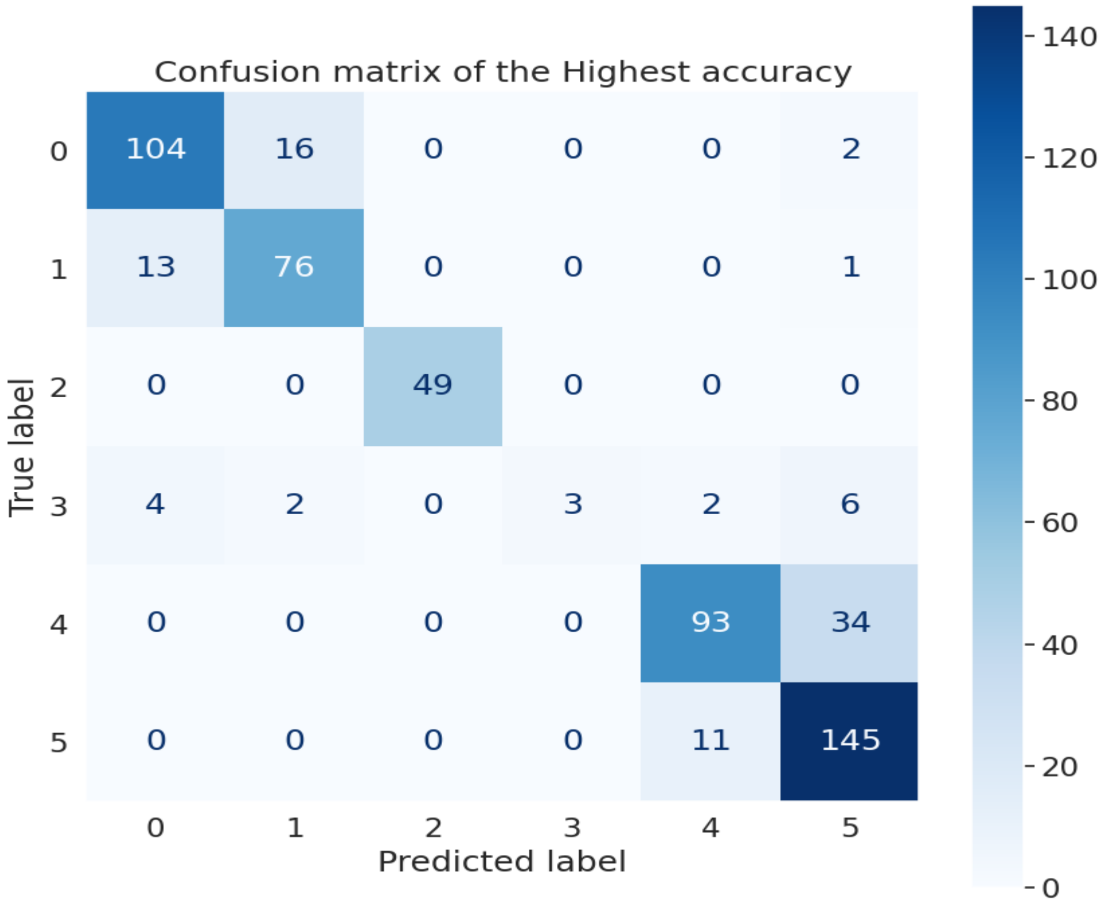
Hidden Layer With Neurons	Training Accuracy	Test Accuracy	Validation Accuracy
1_10	0.766705	0.771836	0.780749
1_20	0.787323	0.791444	0.789661
1_30	0.788087	0.782531	0.796791
1_40	0.794578	0.784314	0.803922
2_10	0.787705	0.789661	0.798574
2_20	0.791905	0.778966	0.793226
2_30	0.794960	0.796791	0.796791
2_40	0.803360	0.796791	0.809269
4_10	0.788851	0.796791	0.811052
4_20	0.801451	0.811052	0.791444
4_30	0.835815	0.811052	0.834225
4_40	**0.841924**	**0.837790**	**0.825312**
8_10	0.782741	0.795009	0.803922
8_20	0.793433	0.800357	0.816399
8_30	0.799160	0.800357	0.809269
8_40	0.824208	0.825312	0.809982



Thank you