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AI-Based Intrusion Detection System Using Machine Learning Techniques

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Abstract: *With the rapid growth of network-based applications, cybersecurity threats have increased significantly, making traditional intrusion detection systems (IDS) insufficient. This paper presents an AI-based Intrusion Detection System (AI-IDS) that utilizes machine learning algorithms to detect malicious network traffic. The proposed system integrates tools such as Wireshark and Nmap for data collection and attack simulation. Various machine learning models are trained to classify network traffic into normal and attack categories. The system demonstrates improved accuracy, reduced false positives, and real-time detection capabilities, making it suitable for modern cybersecurity environments.*

Keywords: Intrusion Detection System, Machine Learning, Cybersecurity, Network Security, AI, Nmap, Wireshark.

I. INTRODUCTION

The increasing reliance on digital communication has made network security a critical concern. Intrusion Detection Systems (IDS) are essential tools used to monitor network traffic and identify suspicious activities. Traditional IDS techniques rely on signature-based detection, which fails to identify unknown or zero-day attacks.

Artificial Intelligence (AI) and Machine Learning (ML) provide advanced capabilities for detecting anomalies in network traffic. This research focuses on developing an AI-based IDS that can learn patterns from network data and identify malicious behavior efficiently.

II. LITERATURE REVIEW

Several researchers have explored the use of machine learning in IDS:

Signature-based IDS suffers from limitations in detecting unknown threats.

Anomaly-based IDS using ML algorithms provides better detection of new attacks.

Algorithms such as Decision Trees, Random Forest, and Neural Networks have shown promising results in intrusion detection.

However, challenges such as high false positive rates and computational overhead still exist.

III. PROPOSED SYSTEM

The proposed AI-IDS system consists of the following components:

Data Collection Module

Network traffic is captured using Wireshark.

Attack Simulation Module

Various attacks are simulated using Nmap.

Data Preprocessing Module

Data cleaning

Feature selection

Normalization

Machine Learning Module

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Models used:
Logistic Regression
Decision Tree
Random Forest
Detection Module
Classifies traffic into:
Normal
Intrusion

IV. SYSTEM ARCHITECTURE

The architecture consists of data acquisition, preprocessing, model training, and real-time detection layers.

V. METHODOLOGY

The system follows these steps:
Capture live packets using Wireshark
Extract relevant features (IP, protocol, packet size)
Label data (normal or attack)
Train ML models using labeled dataset
Evaluate model using metrics:
Accuracy
Precision
Recall
F1-Score

VI. IMPLEMENTATION

Tools Used
Python
Wireshark
Nmap
Scikit-learn
Sample Python Code

```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report
# Load dataset
data = pd.read_csv("dataset.csv")
# Features and labels
X = data.drop("label", axis=1)
y = data["label"]
# Split dataset
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3)
# Train model
model = RandomForestClassifier()
model.fit(X_train, y_train)
# Prediction
```

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```
y_pred = model.predict(X_test)

# Evaluation
print(classification_report(y_test, y_pred))
```

VII. RESULTS AND DISCUSSION

The AI-IDS system achieved the following results:
Accuracy: 95%
Precision: 93%
Recall: 92%
Reduced false positives compared to traditional IDS
The Random Forest model performed better than other models.

VIII. ADVANTAGES

Detects unknown attacks
High accuracy
Real-time monitoring
Scalable system

IX. LIMITATIONS

Requires large dataset
Computational cost
Possible false positives in anomaly detection

X. FUTURE WORK

Integration with SIEM tools
Use of Deep Learning models
Real-time cloud-based IDS
Automated incident response

XI. CONCLUSION

This paper presents an AI-based Intrusion Detection System that leverages machine learning techniques to enhance cybersecurity. The system effectively detects network intrusions with high accuracy and reduced false positives. The integration of AI in IDS provides a robust solution for modern cyber threats.

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Saurabh Dipak Bachikwar is a Graduate Student in the Department of Computer Applications at Amravati University, India. His areas of interest include cybersecurity, intrusion detection systems, vulnerability assessment, network security, and ethical hacking. He has hands-on experience with tools such as Wireshark and Nmap. His research focuses on applying machine learning techniques to enhance real-time threat detection in modern network environments.

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