

# A survey of deep learning based network anomaly detection

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### Anomaly Detection in Deep Learning\*\*

Anomaly detection in deep learning involves identifying unusual or unexpected patterns in data by leveraging powerful neural networks. These networks learn to recognize normal patterns in the data and flag deviations from these patterns as anomalies.

### Network Anomaly Detection Examples

- Detecting network intrusions by identifying abnormal traffic patterns.
- Monitoring system logs to detect malicious activity or performance degradation.

### Anomaly Detection in Machine Learning Example

- Predicting fraud in financial transactions by identifying unusual spending patterns.

### Anomaly Detection System of a Network Identified

- Intrusion detection systems that monitor network traffic for malicious or unauthorized activity.
- Log analysis tools that search system logs for anomalies and security breaches.

### Can AI Detect Anomalies?

Yes, AI, through machine learning and deep learning algorithms, can identify anomalies by examining patterns in data and flagging deviations from the norm.

### Three Basic Approaches to Anomaly Detection

- **Supervised Anomaly Detection:** Trains a model on labeled data that includes both normal and anomalous data.
- **Unsupervised Anomaly Detection:** Assumes that most data points are normal and identifies anomalies based on statistical deviations.
- **Semi-Supervised Anomaly Detection:** Combines elements of both supervised and unsupervised approaches.

### Best Algorithm for Anomaly Detection

The best algorithm depends on the specific context and dataset. Some common algorithms include:

- **Isolation Forest:** Isolates anomalous data points by creating random partitions of the data.
- **Local Outlier Factor (LOF):** Computes the local density of data points to identify outliers.
- **Autoencoders:** Neural networks that reconstruct input data and measure anomalies based on the reconstruction error.

### Anomaly Detection in 5G Networks

In 5G networks, anomaly detection identifies deviations from normal network behavior, such as sudden changes in traffic patterns or signal quality.

### Anomaly Detection in Real Life Example

- Detecting fraudulent credit card transactions by analyzing spending patterns.
- Monitoring manufacturing processes to identify equipment malfunctions or defects.

## Techniques for Anomaly Detection

- Statistical methods (e.g., z-score, interquartile range)
- Machine learning algorithms (e.g., K-nearest neighbors, support vector machines)
- Deep learning networks (e.g., autoencoders, recurrent neural networks)

## Anomaly Detection in IoT Data

In the Internet of Things (IoT), anomaly detection monitors IoT sensors for unusual or unexpected events to ensure device health and data integrity.

## Anomaly Detection in Python

In Python, libraries such as scikit-learn and PyOD provide tools for implementing anomaly detection algorithms.

## Anomaly Based Detection Example

- Identifying fraudulent insurance claims by analyzing past claims data and flagging claims that deviate significantly from the norm.

## Why is Anomaly Detection Hard?

Anomaly detection is challenging due to the following factors:

- **Rare Occurrence of Anomalies:** Anomalous events are usually rare, making it difficult to collect enough data for training.
- **Context Dependency:** The definition of an anomaly can vary depending on the context and application.
- **Noise and Ambiguity:** Real-world data often contains noise and ambiguity, which can obscure anomalies.

## Challenges of Anomaly Detection

- High false positive rates
- Difficulty in detecting novel or rare anomalies

- Real-time detection and response
- Scalability to large datasets

## Purpose of Anomaly Detection

Anomaly detection aims to:

- Identify potentially harmful or suspicious events
- Prevent system failures or security breaches
- Improve decision-making by providing insights into data patterns

## Difference Between Outlier and Anomaly Detection

Outlier detection focuses on identifying extreme or unusual data points, while anomaly detection aims to detect patterns that deviate significantly from the norm. Anomalies can be both outliers and non-outliers (e.g., unexpected patterns in sequential data).

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