

# **BusinessPredicting Kubernetes Cluster Issues Using Machine Learning**



# Overview

- Introduction 01
- Common Issues in Kubernetes Clusters 02
- Machine Learning for Predicting Kubernetes Issues 03
- Implemented Machine Learning Models 04
- Model Training and Evaluation 05
- Conclusion and Future Scope 06

GUIDEWIRE



# Introduction

## What is Kubernetes?

Kubernetes is an open-source container orchestration platform.  
Automates deployment, scaling, and operations of applications.  
Ensures application availability and scalability.



# Why Predict Kubernetes Issues?

- Downtime leads to financial losses and inefficiencies.
- Helps prevent system failures before they occur.
- Improves system reliability and reduces manual troubleshooting.



“

**GUIDEWIRE**

# Common Issues in Kubernetes Clusters

## Node Failures



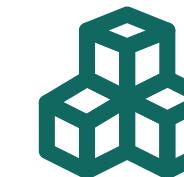
- Nodes going offline disrupt workloads.
- Causes include hardware failures or resource exhaustion.

## Pod Failures



- Containers may crash due to memory leaks or CPU overutilization.
- Insufficient resource allocation leads to pod evictions.

## Networking Failures



- DNS resolution issues prevent inter-service communication.
- Misconfigured network policies block traffic.

## Persistent Storage Issues



- Improperly mounted volumes cause data loss.
- Storage class misconfigurations lead to unavailability.

## Misconfigurations and Security Vulnerabilities



- Incorrect YAML configurations cause deployment failures.
- Security misconfigurations expose services to attacks.

# Machine Learning for Predicting Kubernetes Issues

## How AI Helps in Issue Prediction

Analyzes historical logs and metrics to detect patterns.

- Predicts failures before they occur using trained models.
- Enables proactive remediation instead of reactive fixes.

## Data Sources for ML-based Prediction

- Kubernetes Metrics Server: CPU, Memory usage, Node stats.
- Prometheus & Grafana: Time-series monitoring.
- ELK Stack (Elasticsearch, Logstash, Kibana): Log analysis.

# Implemented Machine Learning Models

## How AI Helps in Issue Prediction

01

### Random Forest Classifier

Works well with high-dimensional  
Kubernetes data.

- Reduces overfitting by using multiple decision trees.
- Handles both categorical and numerical variables.

02

### Long Short-Term Memory (LSTM)

- A type of recurrent neural network (RNN) designed for sequence-based data.
- Effective in identifying patterns from time-series Kubernetes metrics.
- Captures long-term dependencies in system behavior for accurate anomaly detection.

# Model Training and Evaluation

01

## Data Preprocessing

Extracts features from Kubernetes logs.

- Splits dataset into training and testing sets (80%-20%).
- Normalizes numerical data for better model performance.

02

## Training Process

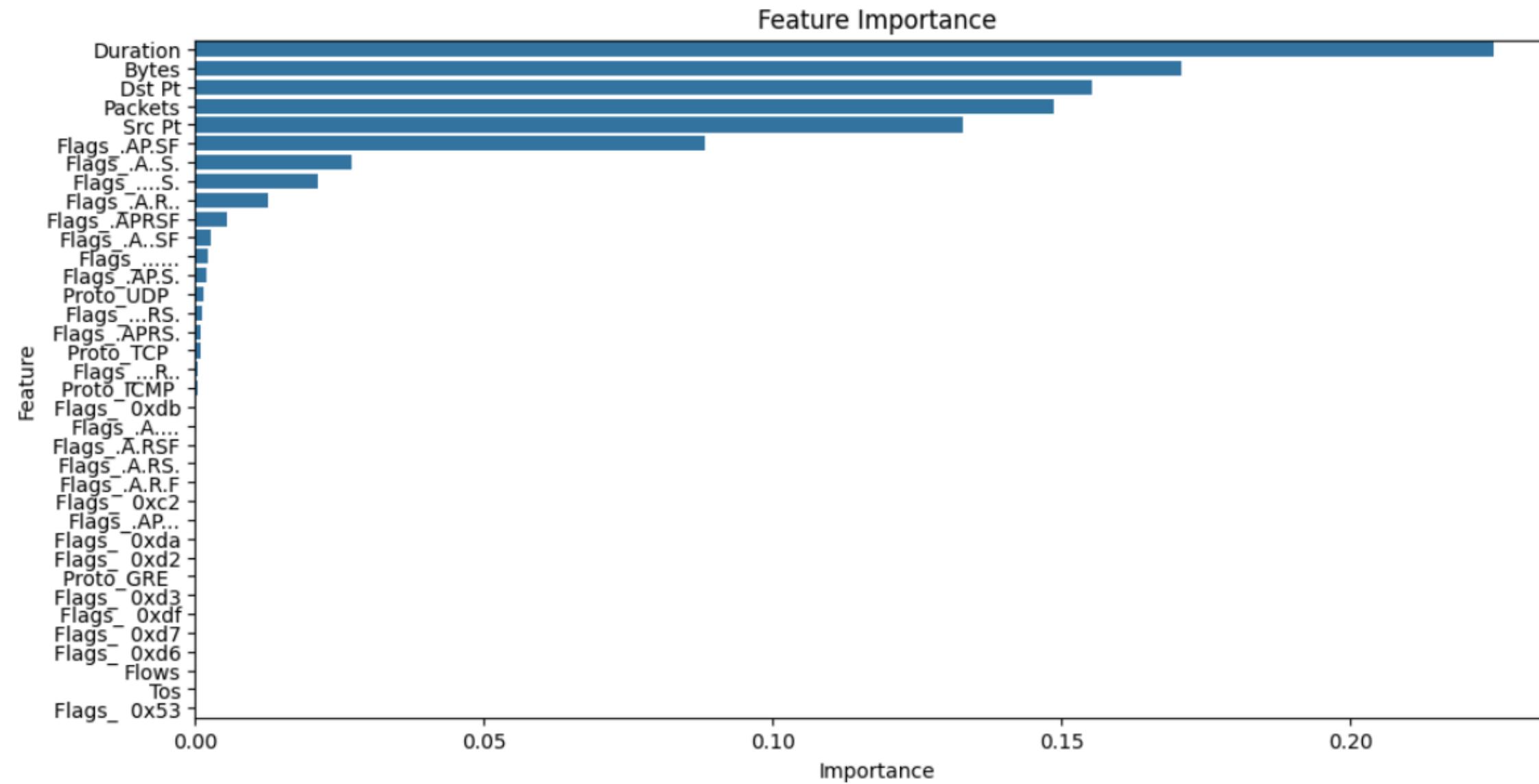
- **RandomForestClassifier** trained with 100 decision trees.
- **Long Short-Term Memory (LSTM)** optimized using log-loss evaluation

03

## Model Evaluation Metrics

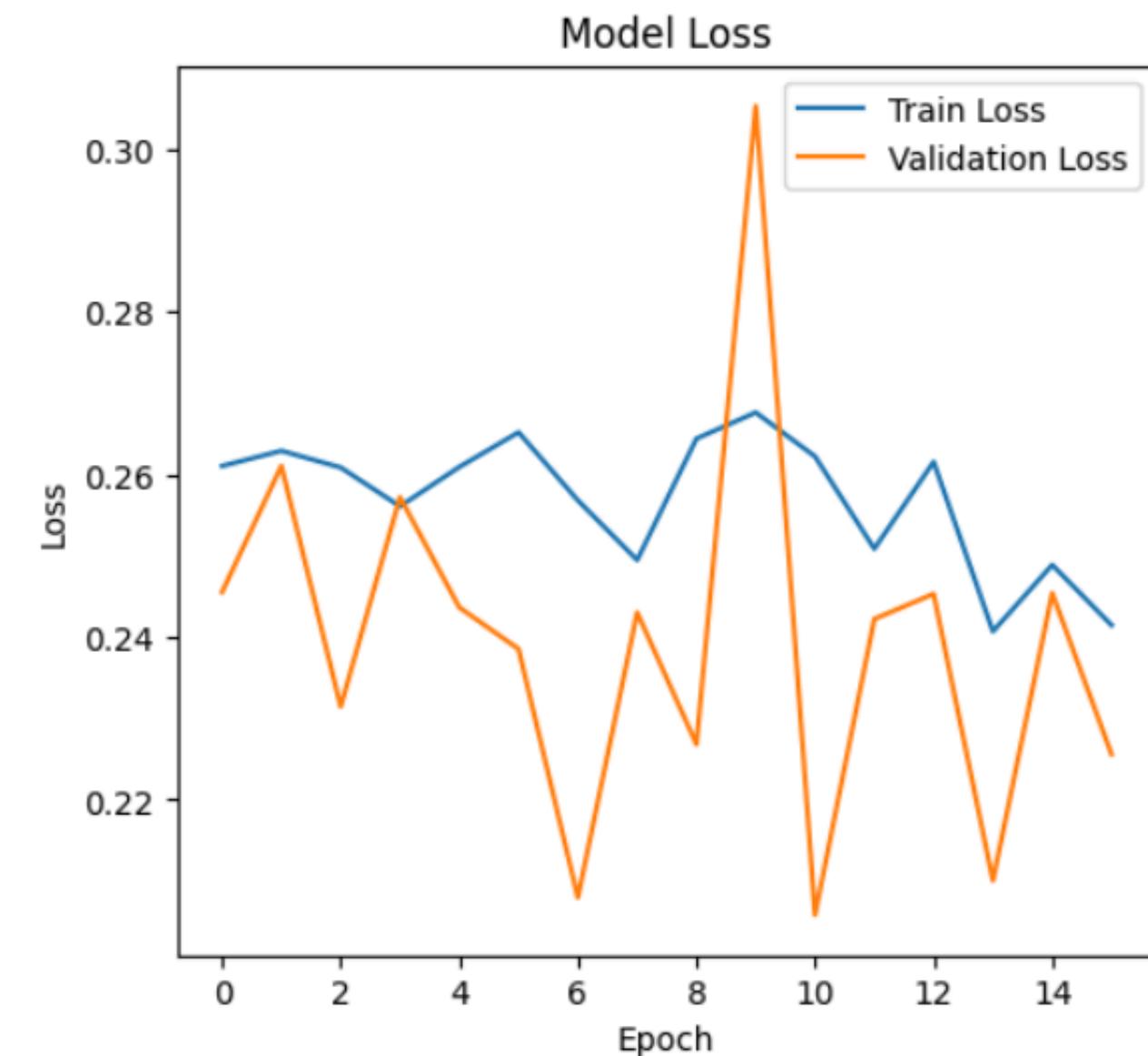
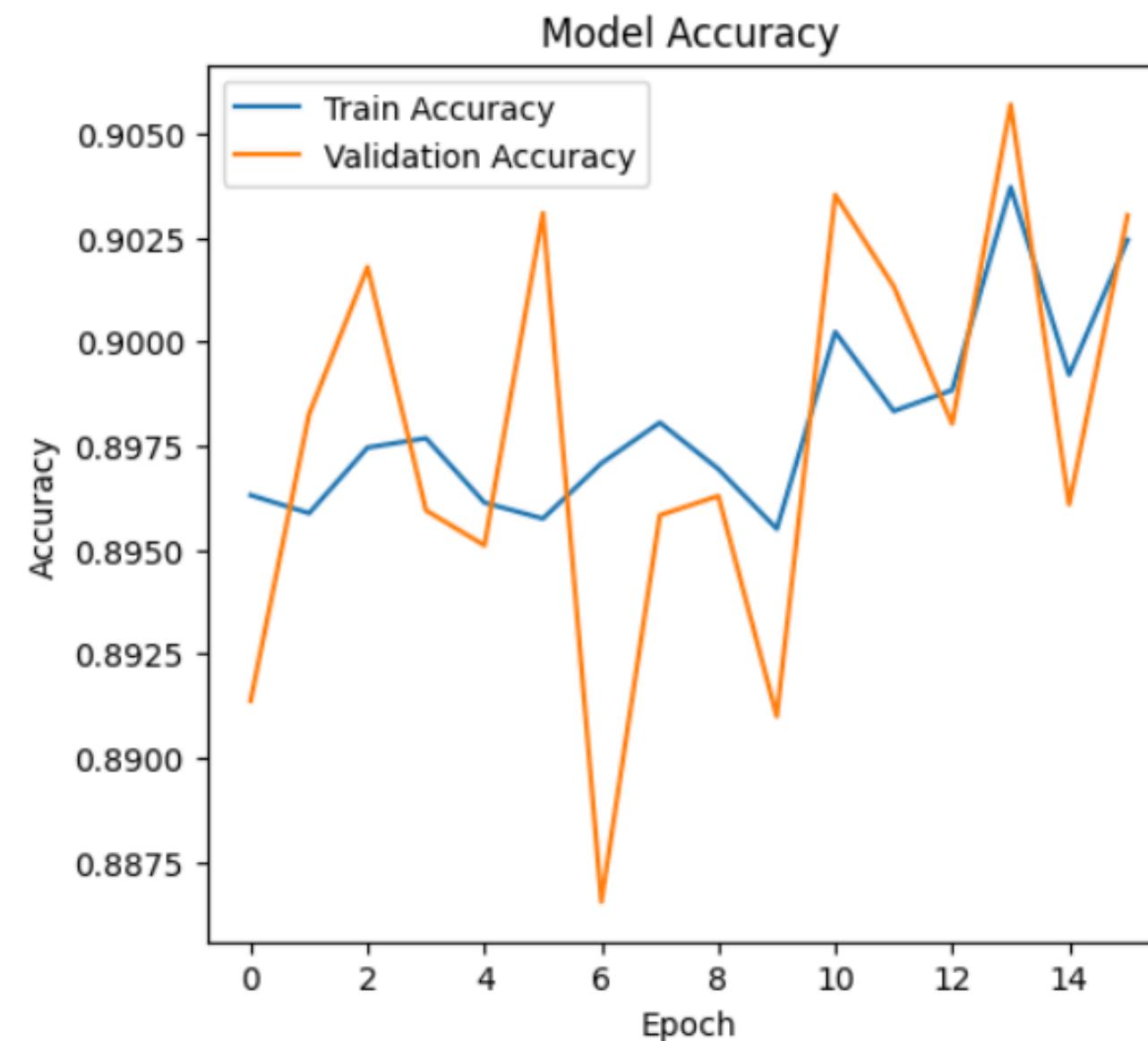
- **Accuracy Score:** Measures model correctness.
- **Precision & Recall:** Ensures high anomaly detection rate.
- **Confusion Matrix:** Analyzes true vs. false predictions.

# Feature Importance



- Extracts feature importance values from `clf.feature_importances_` (suggesting a tree-based model like Decision Tree, Random Forest, or XGBoost).
- Creates a DataFrame mapping feature names (`X_train.columns`) to their importance scores.
- Sorts the features by importance in descending order.
- Plots a bar chart using Seaborn and Matplotlib to visualize the most significant features.

# Accuracy and Loss



# Conclusion and Future Scope

## Benefits of AI-driven Kubernetes Monitoring

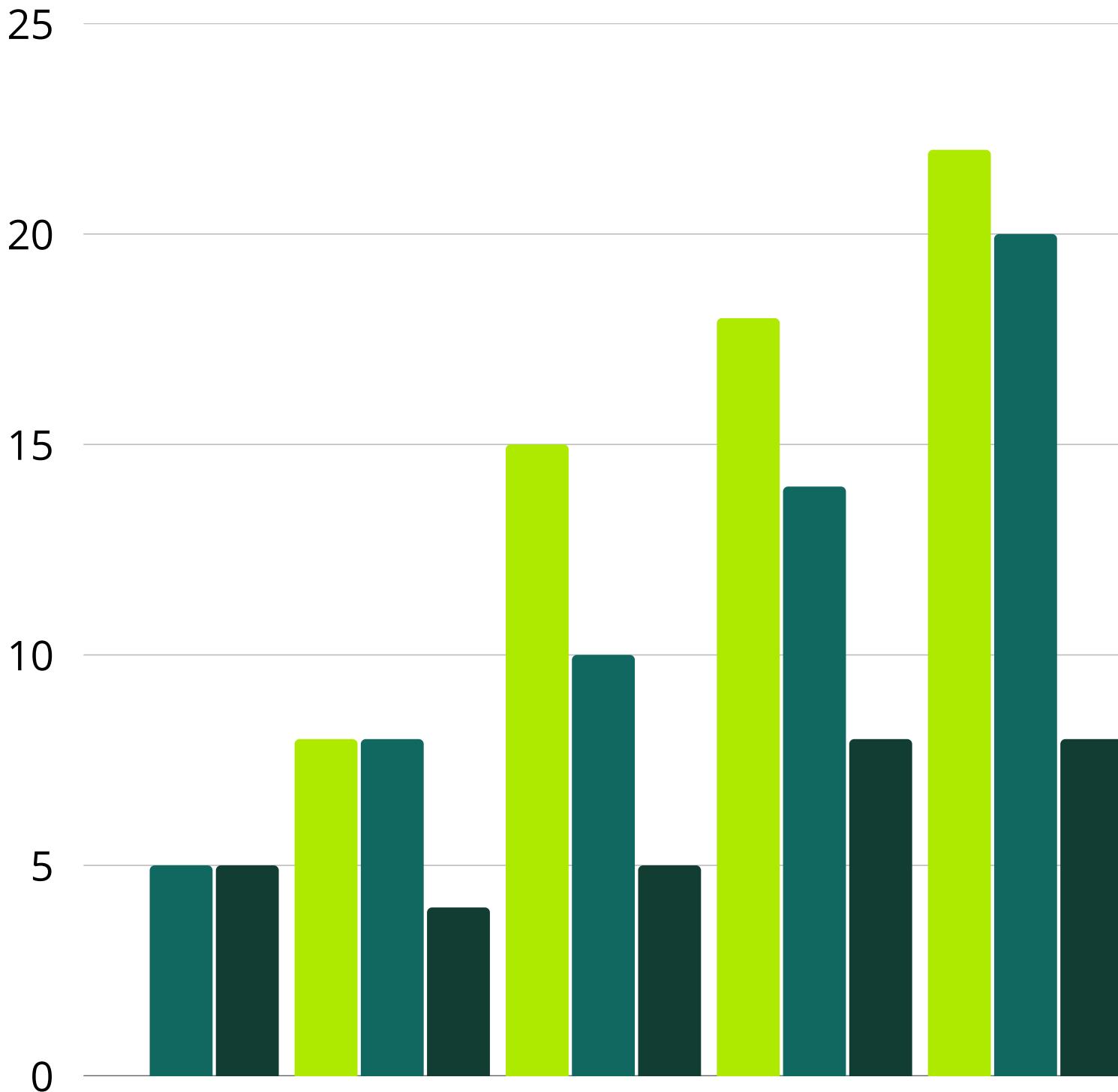
Reduces system downtime through proactive issue resolution.

- Enhances resource allocation by detecting anomalies.
- Improves security by predicting potential vulnerabilities.

## Future Scope

AI-powered self-healing Kubernetes clusters.

- Advanced deep learning models for real-time anomaly detection.
- Integration with cloud-native security frameworks for enhanced resilience.





Thank you