Enhance Credit Card Fraud Detection Using Generative AI

Course: CSC 496 – Graduation Project
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What is Fraud Detection?

process of identifying and preventing unauthorized or suspicious activities, especially in financial transactions like credit card payments.

Problem Statement

- Fraud cases are extremely rare .
- Severe class imbalance in data.
- Traditional models struggle to detect rare cases.
- High chance of false positives or missed fraud.

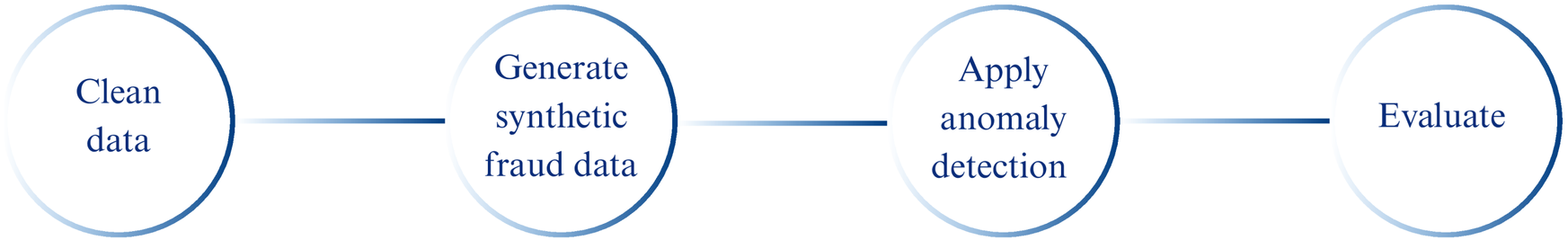
Goals & Objectives

The goal is to build an intelligent system that can accurately detect credit card fraud and reduce false alarms, especially in cases where fraudulent transactions are very rare.

Objectives:

- Review related research
- Use a public credit card transaction dataset.
- Generate synthetic fraud data using GANs.
- Apply models
- Evaluate performance

Our Solution



Class Imbalance

Class Imbalance Problem

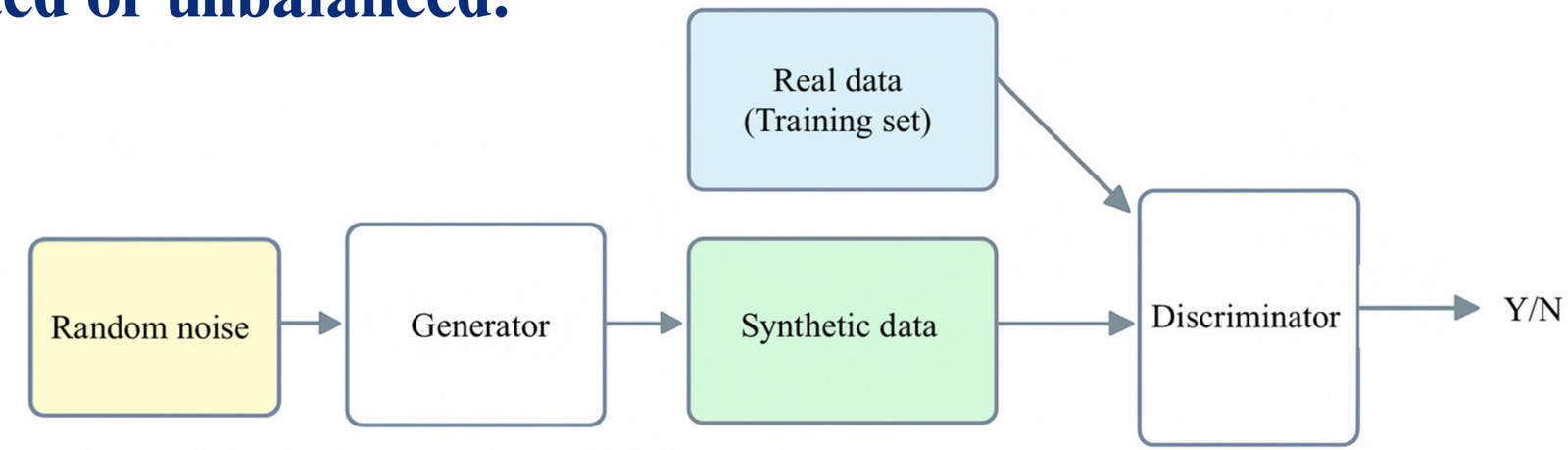
- Most credit card transactions are normal.
- Fraud cases are very rare
- This imbalance makes it hard for models to learn fraud patterns.
- Exists in many fields

Role of Generative AI

- We use GANs to generate synthetic fraud data
- This helps balance the dataset and improve detection.

Generative Adversarial Networks (GANs):

- **Two parts:**
  - Generator: creates synthetic data.
  - Discriminator: checks if it's real or not.
- **Useful when data is limited or unbalanced.**



VAE & Diffusion Models

Variational Autoencoder (VAE)

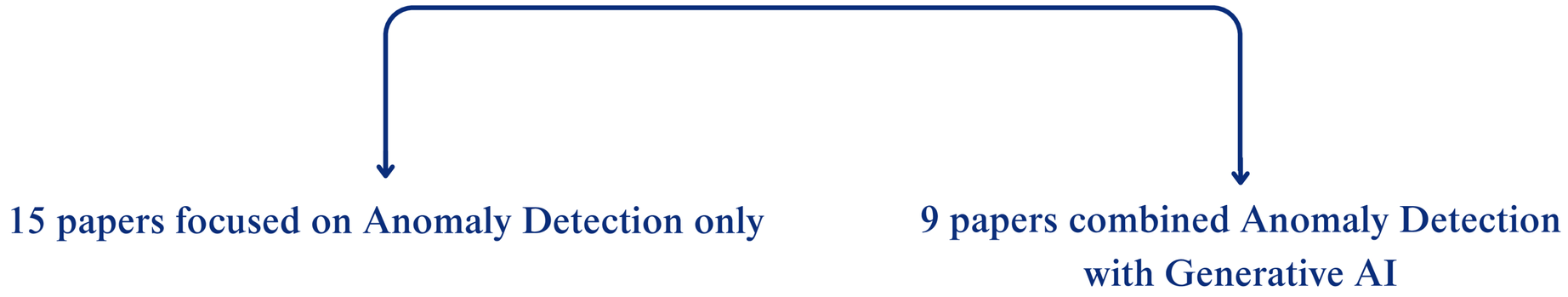
- Generates varied and realistic fraud data
- Learns patterns to avoid duplication

Diffusion Models:

- Add and remove noise to create synthetic samples
- More stable than GANs, with better accuracy

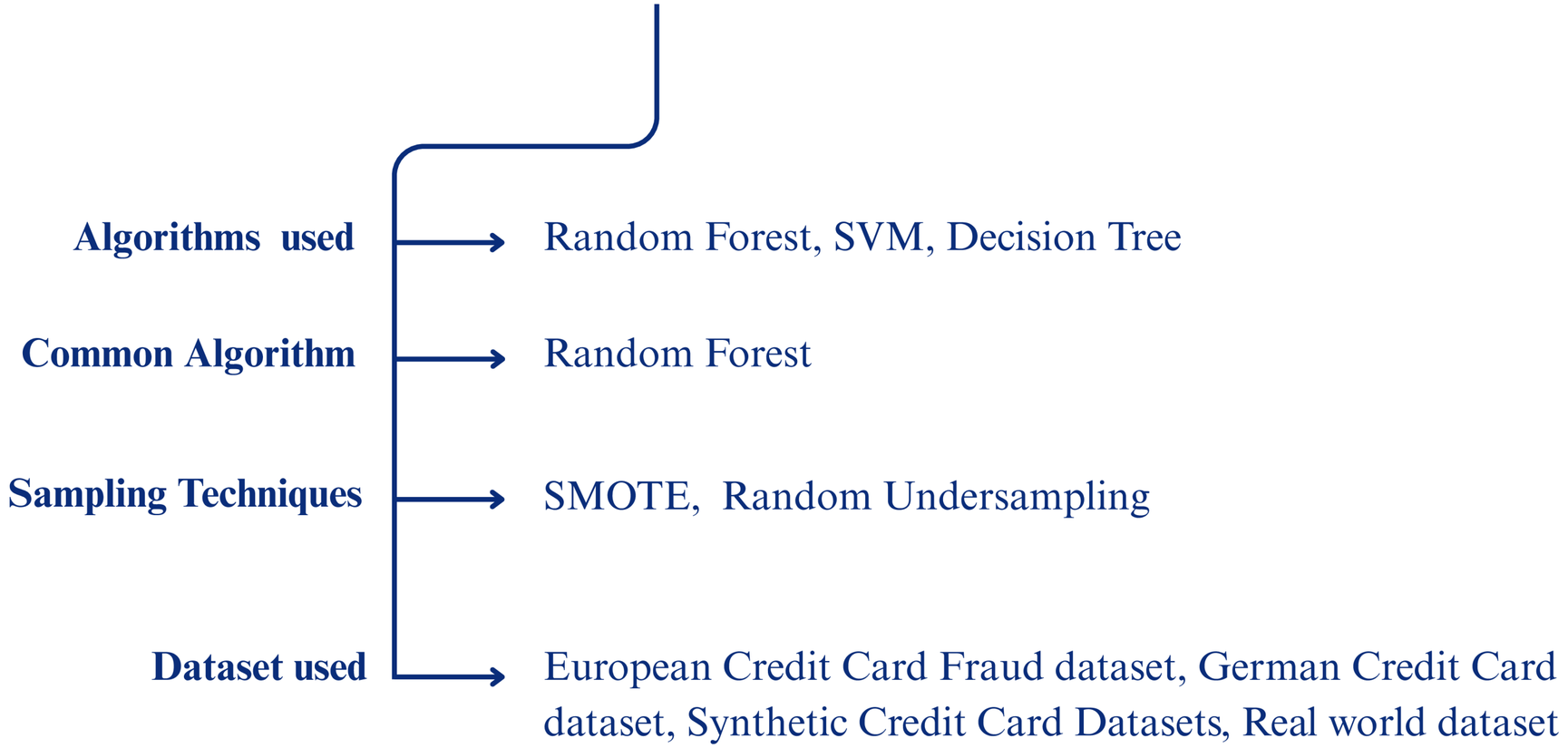
Literature review

We reviewed and compared a total of 24 papers on credit card fraud detection



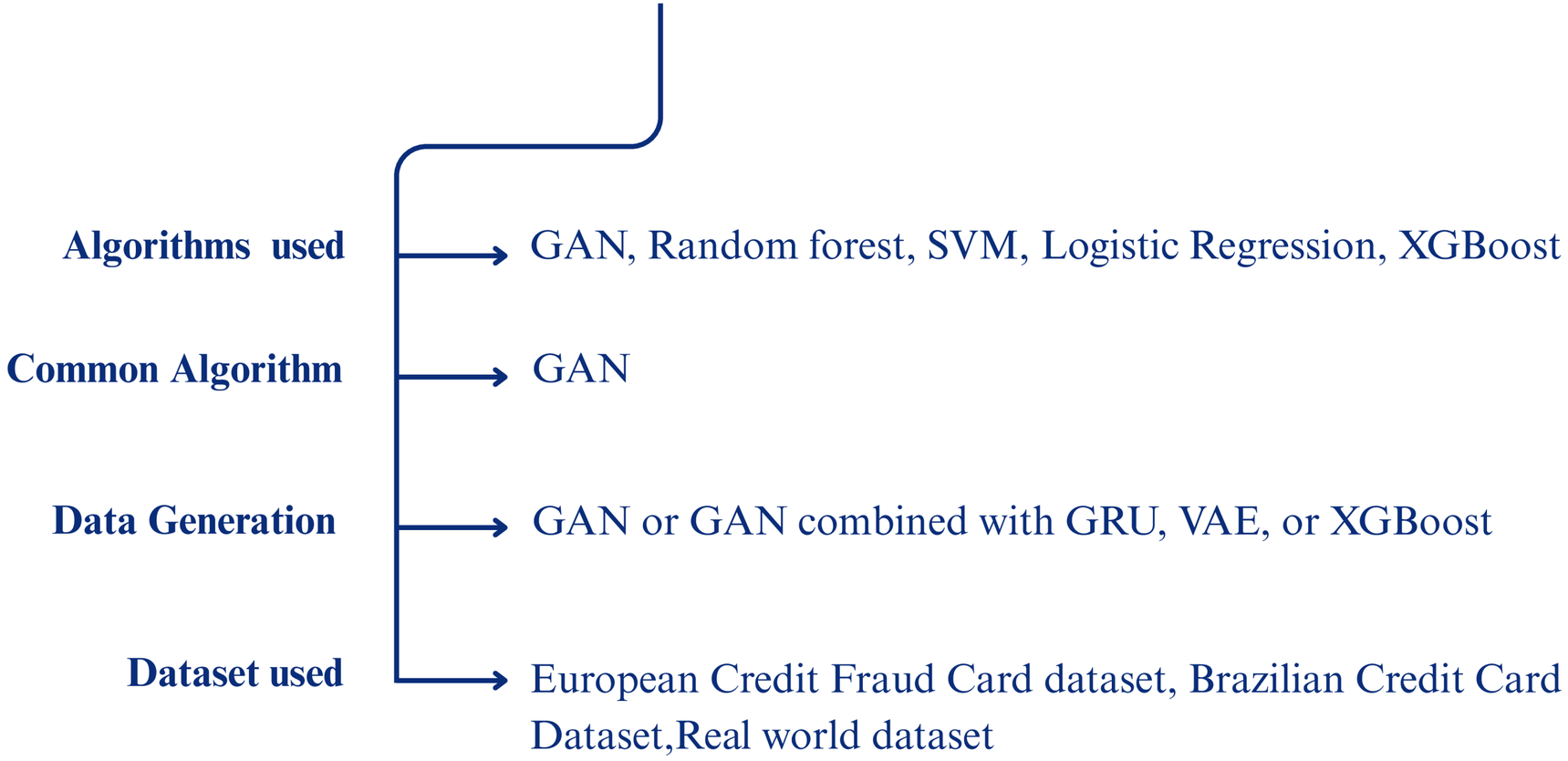
Literature review

Anomaly Detection Studies



Literature review

- **Anomaly Detection + Generative AI Studies**



Dataset overview

➢ European Credit Card Fraud

Feature	Type	Description
Time	Numerical	Time in seconds since the first transaction
Amount	Numerical	Value of the transaction in euros
V1 to V28	Numerical	PCA-transformed anonymous features
Class	Categorical	Target label: 0 = normal, 1 = fraud

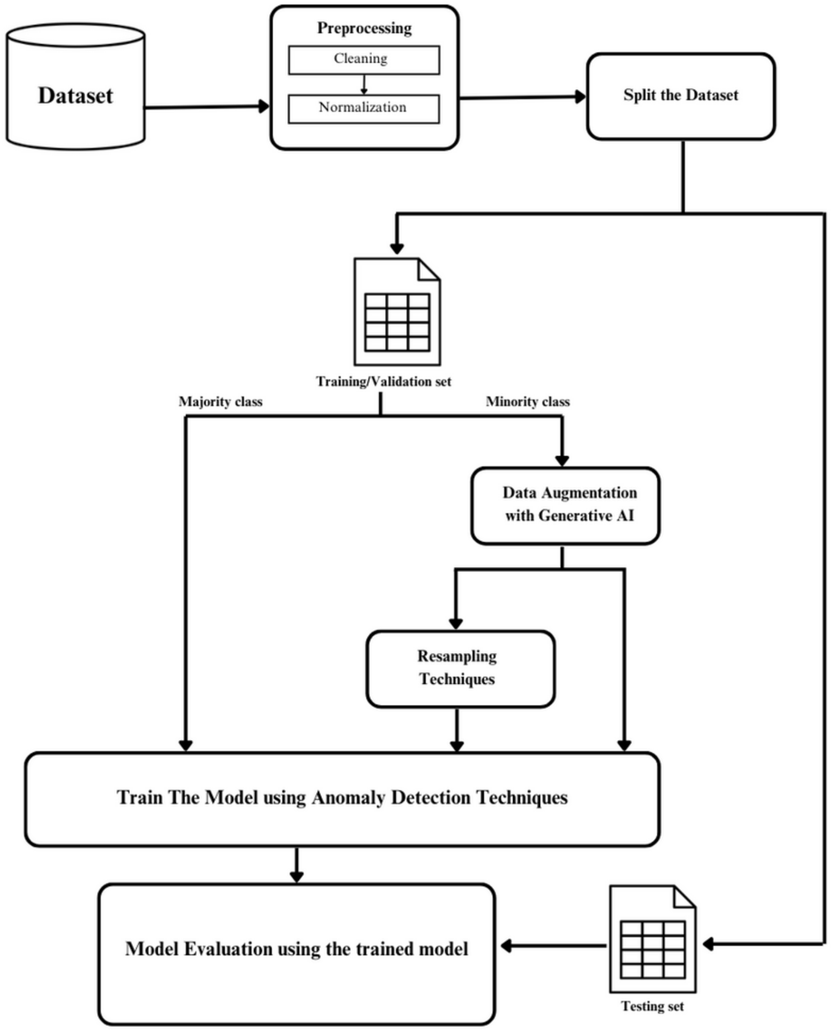
Dataset overview

European Credit Card Fraud

Total transactions: 284,807 | Fraud cases: 492 (0.17%)

	Time	V1	.....	V28	Amount	Class
1	0	-1.3598071336738		-0.0210530534538215	149.62	0
	⋮					
284,807	17279	-0.53341252200504		0.0136489143320671	217	0

Overview of the Methodology

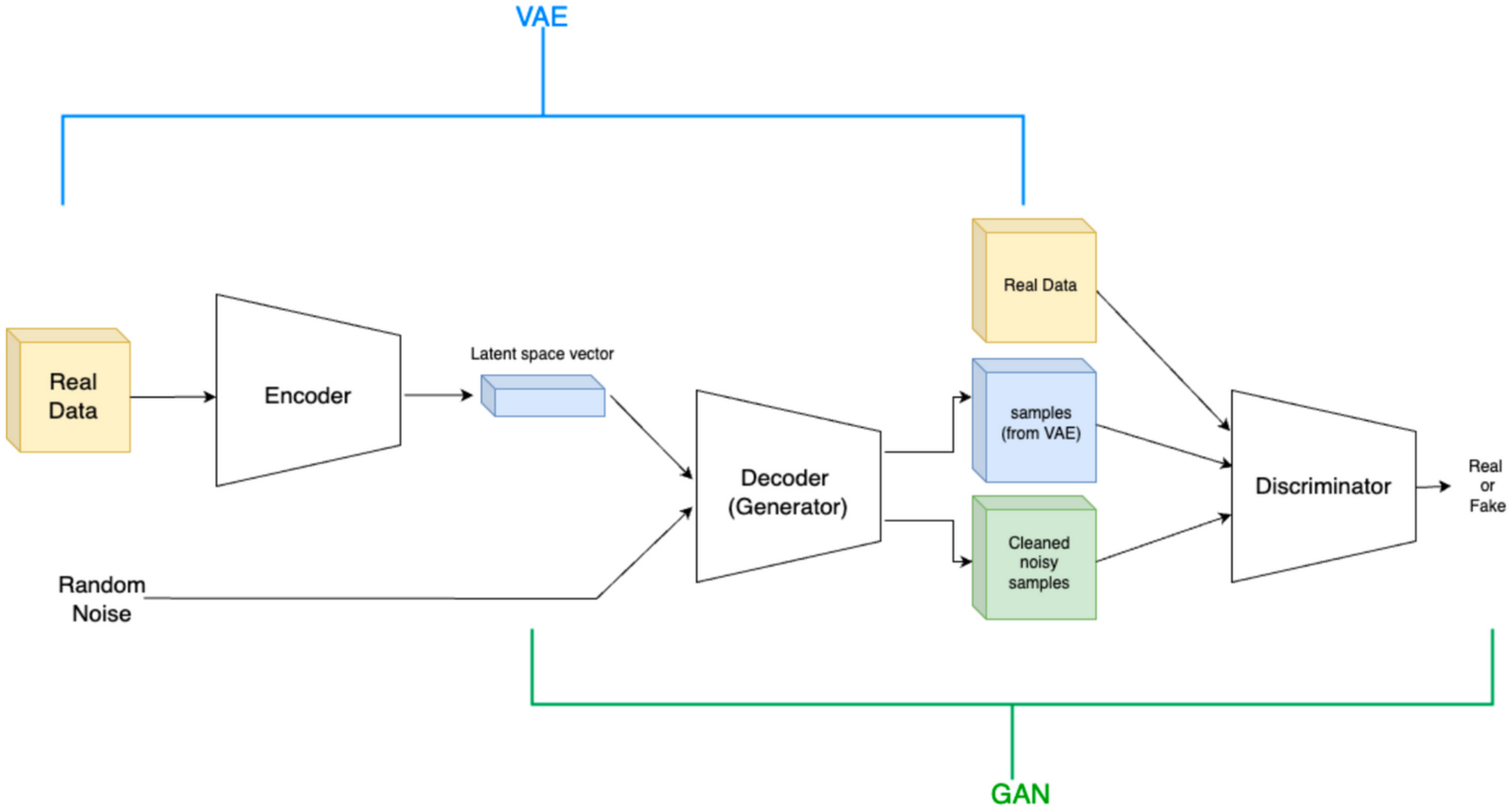


Key Components:

- Preprocessing
- Data Division
- Data Augmentation
- Resampling Technique
- Anomaly Detection
- Model Evaluation

Data Augmentation with Generative AI

- VAE-GAN Model

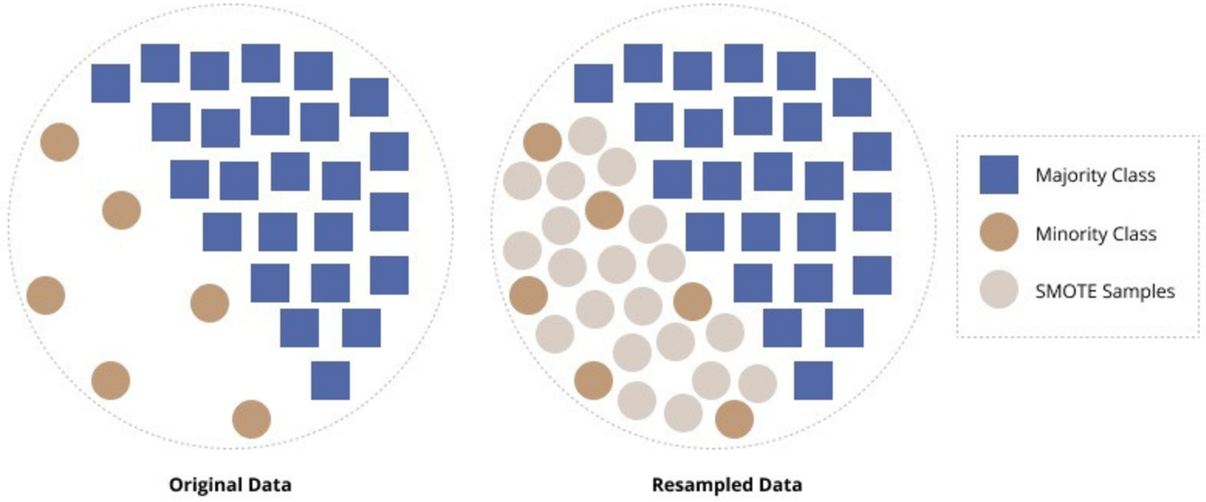


Resampling Technique

➢ SMOTE stands for Synthetic Minority Over-sampling Technique.

Instead of duplicating existing fraud cases, SMOTE generates new synthetic samples by:

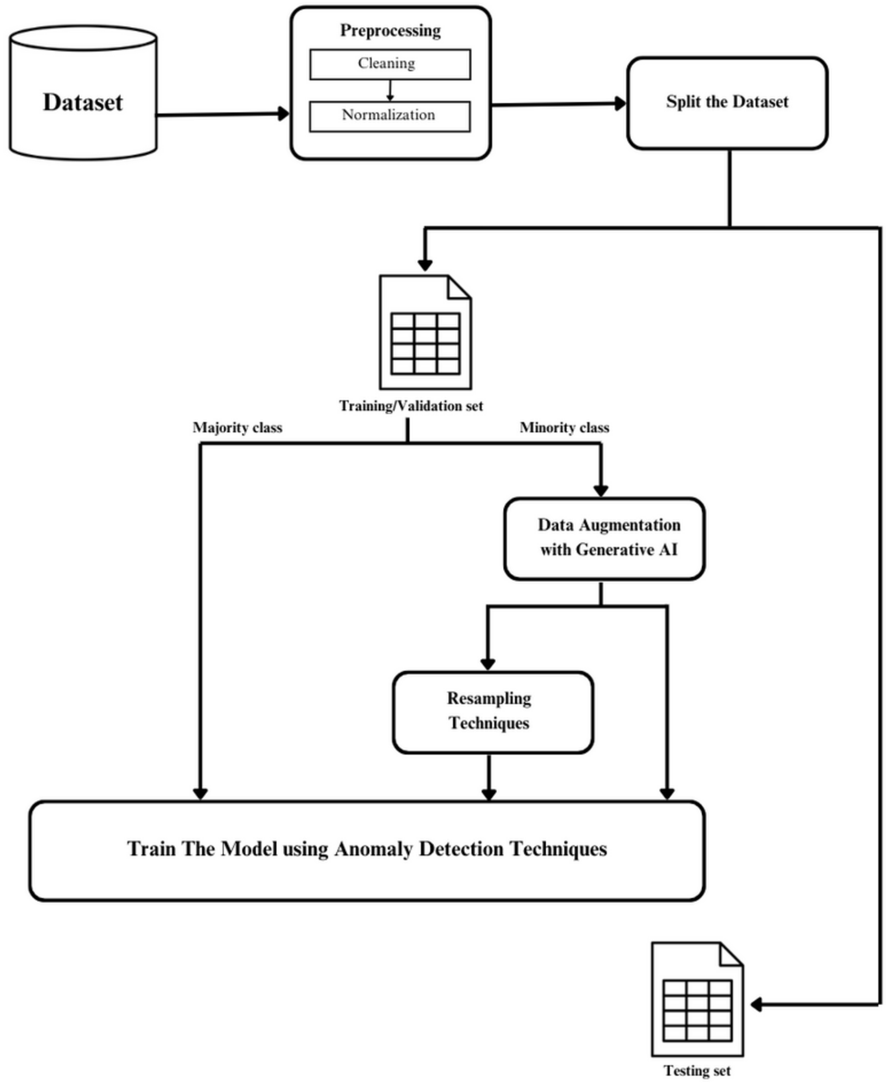
- Selecting a real minority (fraud) sample.
- Finding its nearest neighbors within the fraud class.
- Interpolating between them to create a new, realistic point.



Data Augmentation with Generative AI & SMOTE

Why Combine VAE-GAN + SMOTE ?

- VAE-GAN covers the global patteens.
- SMOTE strengthens local consistency and continuity.
- Together, they create a balanced, diverse, and well structured dataset.



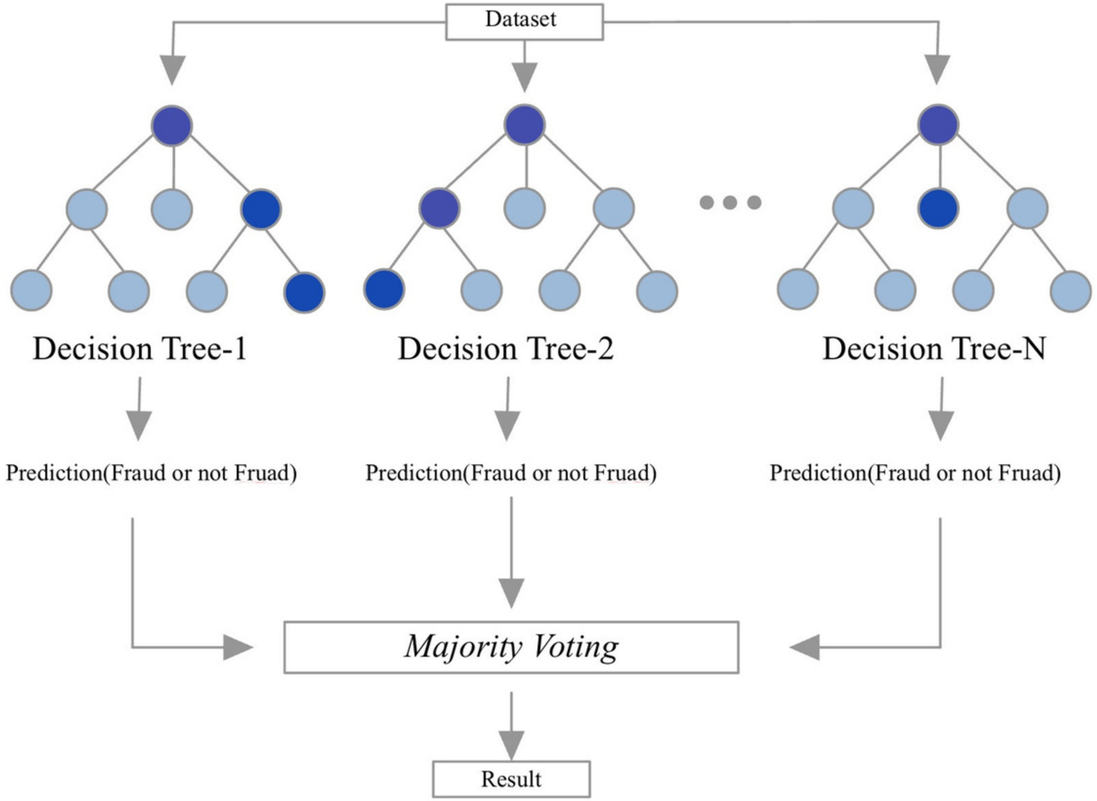
We will compare both approaches:

- VAE-GAN alone
- VAE-GAN + SMOTE

Model Training Using Anomaly detection techniques

Random Forest (Supervised Learning)

- Combines multiple decision trees using majority voting to improve prediction accuracy.
- Trained on labeled data to classify transactions.



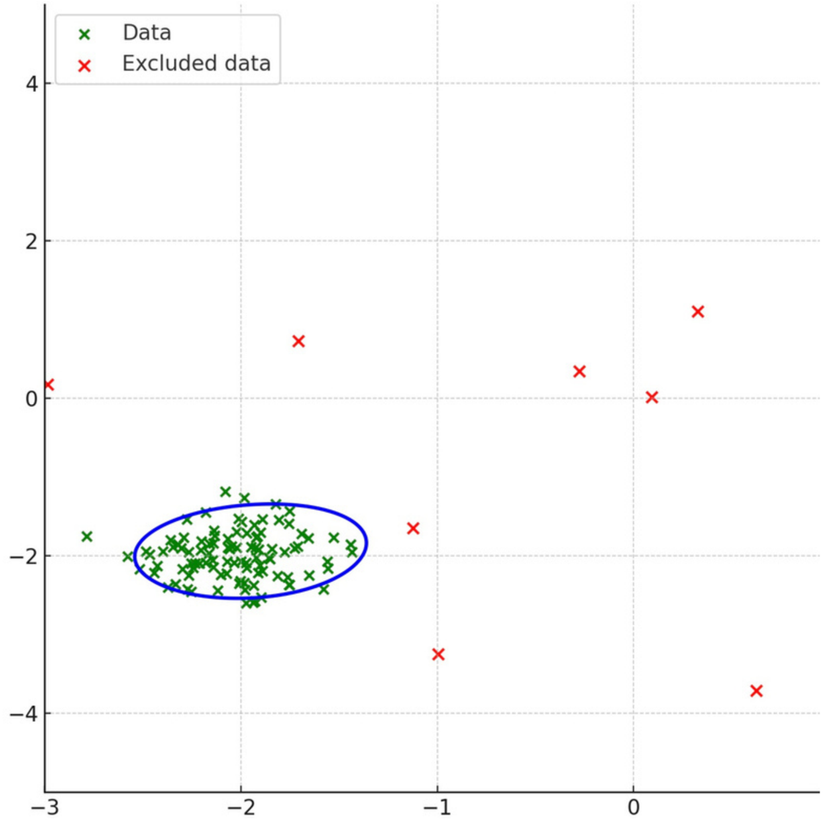
Strengths:

- Handles large, complex datasets.
- Resistant to overfitting.
- Provides high accuracy and interpretability.

Model Training Using Anomaly detection techniques

One-Class SVM (Unsupervised Learning)

- Trained using only the normal data.
- Learns a boundary that encapsulates normal behavior in feature space.



Strengths:

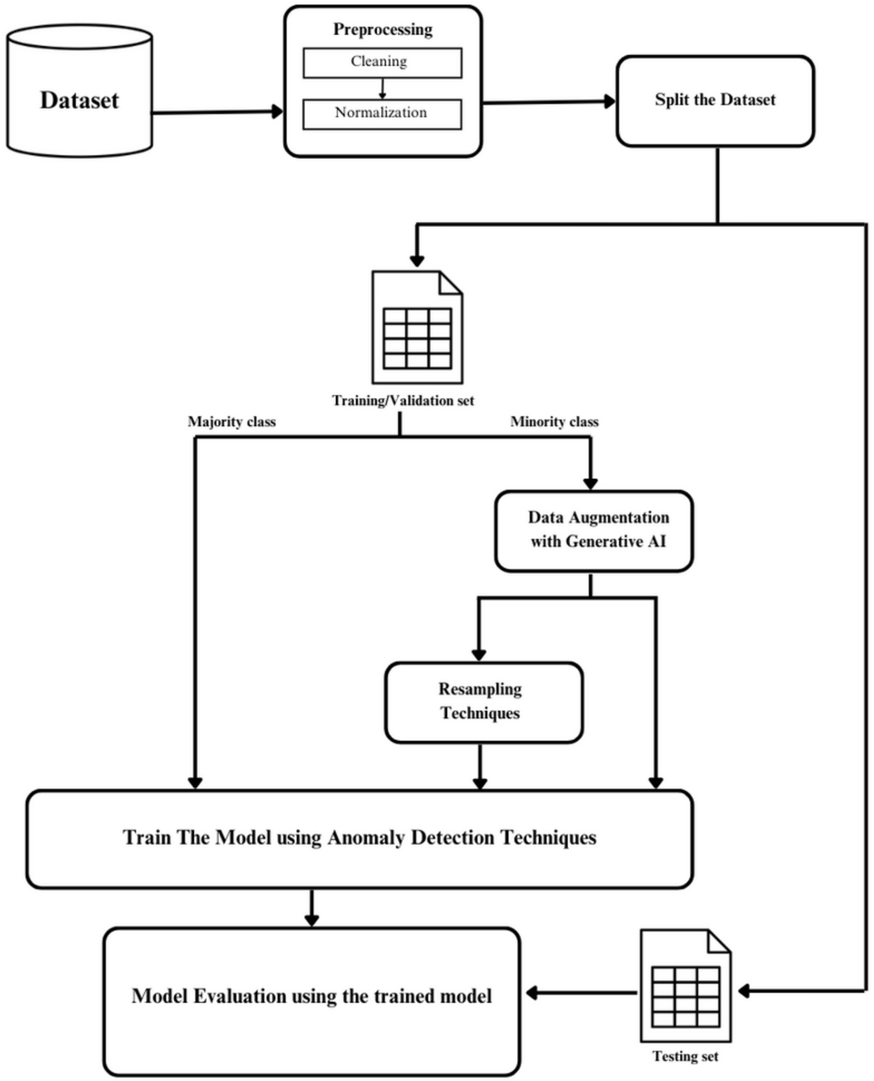
- Useful when fraud labels are scarce or unreliable.
- Detects novel or unexpected fraud patterns.

Both models are trained on the augmented and resampled dataset

Evaluating Model Performance

Evaluation Strategy

- The trained models are assessed using a separate testing set that was not seen during training.
- This ensures a fair and unbiased evaluation of how well the models perform in real-world conditions.



Evaluating Model Performance

- **Evaluation Metrices**

Accuracy

Precision

Recall

F1-Score

Experimental Design

➢ Tools & Libraries

we might use Google Colab as our development environment

Conclusion

AI-BASED FRAUD DETECTION CAN IMPROVE ACCURACY AND EFFICIENCY

MODELS LIKE VAE-GAN HELP CREATE HIGH-QUALITY SYNTHETIC FRAUD SAMPLES.

COMBINING SYNTHETIC DATA WITH CLASSICAL MODELS BOOSTS PERFORMANCE IN IMBALANCED DATASETS.

supports better fraud detection, less loss, more trust.

Thank You.

Any Questions ?