Generative Adversarial Networks for Time Series

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Contents

Evaluation Metrics for GAN

Evaluation metrics ensure that synthetic data closely resembles real data in terms of realism and feature distribution.

- **Qualitative evaluation:** Human visual inspection of the generated data.
- **Quantitative evaluation:** Use of metrics associated with statistical measures used for time series analytics

Evaluation Metrics Used

1. **Discriminative Score:**

- A recurrent neural network (RNN) is trained to distinguish between real and GAN-generated synthetic time-series data.
- The metric evaluates how well the RNN performs by measuring the difference between its accuracy and 50%, indicating how distinguishable the synthetic data is from real data.

Evaluation Metrics Used

2. Predictive Score:

- A recurrent neural network (RNN) is trained using synthetic data to predict the next step in a time series.
- The metric evaluates how well this model performs on real data by calculating the mean absolute error (MAE), indicating the accuracy of the synthetic data in replicating real-world patterns.

Frequently used Metrics

Distance-Based Evaluation Metrics:

- **Euclidean Distance**: Measures the straight-line distance between corresponding points in real and synthetic datasets.
- **Kullback-Leibler (KL) Divergence:** Quantifies how much one probability distribution diverges from a second, expected probability distribution.
- **Wasserstein Distance:** Also known as Earth Mover's Distance, it measures the minimum effort required to transform the distribution of synthetic data into that of the real data.

Similarity-Based Evaluation Metrics:

- **Cosine Similarity:** Compares the orientation of the vectors in a multi-dimensional space.
- **Jaccard Similarity:** Compares the similarity between two sets by dividing the intersection of the sets by the union of the sets.

Other Frequently used Metrics

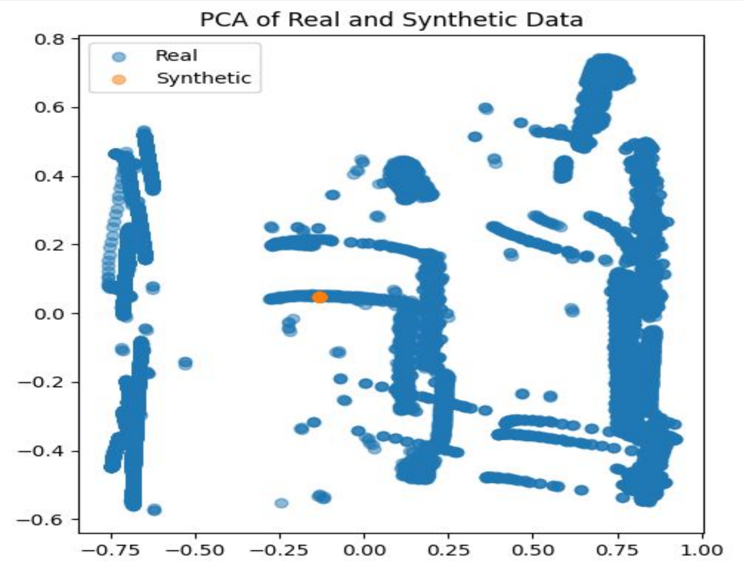
1. **Inception Scores (IS)**: Calculated by generating synthetic data samples and passing them through a pre-trained neural network (typically an Inception model) to classify the samples. The score evaluates two key aspects: Confidence and Diversity.

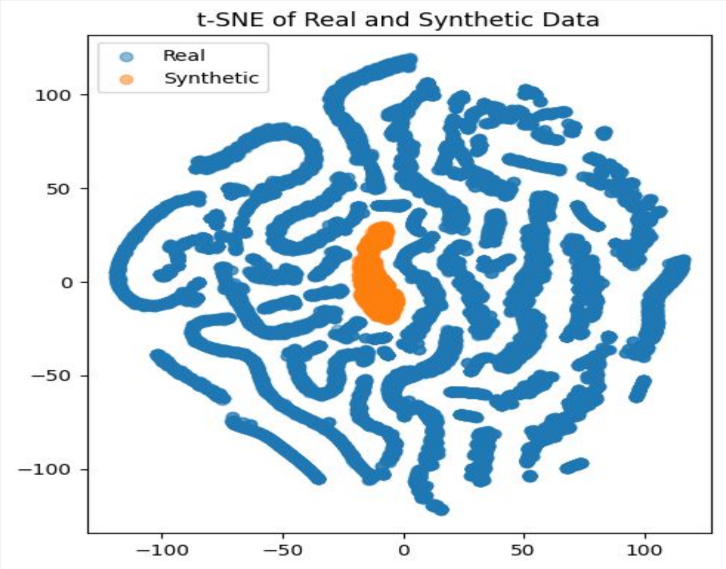
2. **Fréchet Distances**: Measure the similarity between two distributions by calculating the Wasserstein distance, commonly used to compare real and generated data distributions.

3. **Fréchet Inception Distances (FID)**: Compare the distributions of real and generated data by calculating the Fréchet Distance between feature representations extracted from a pre-trained Inception model, capturing both the quality and diversity of the generated data.

Transformer GAN - Evaluation Results

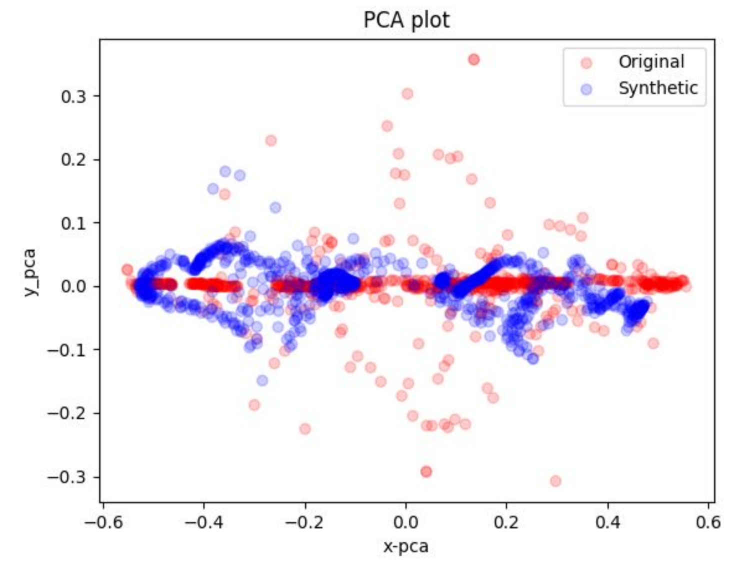
Results for
10k Iterations

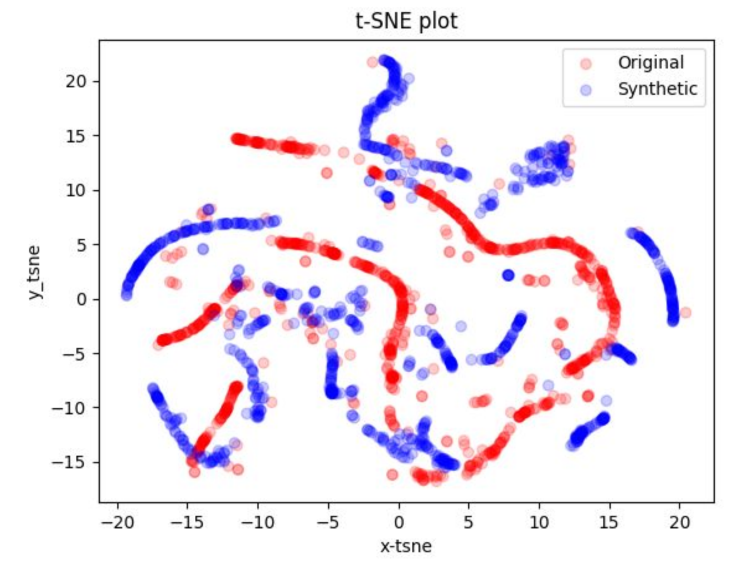




TimeGAN - Results for LSTM

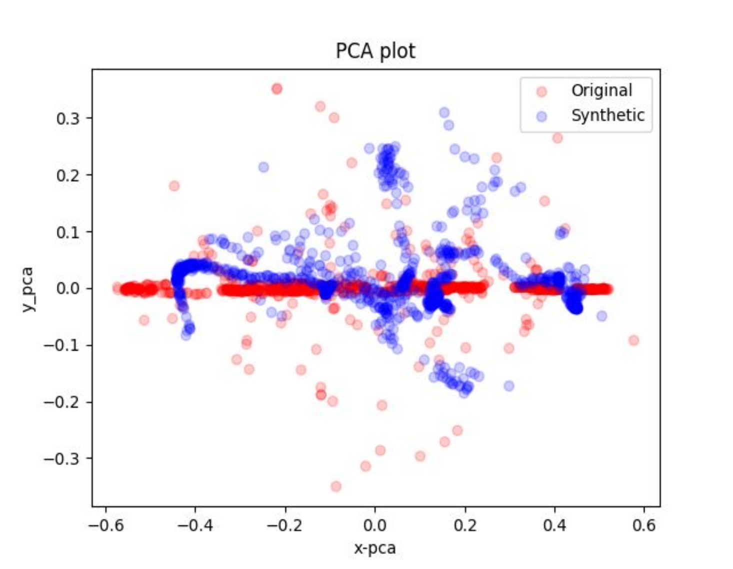
Results for 10k Iterations

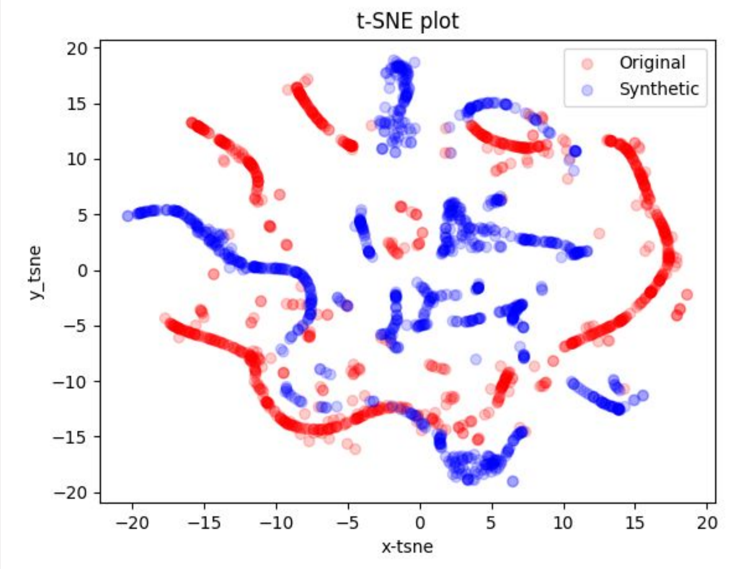




TimeGAN - Results for LSTM

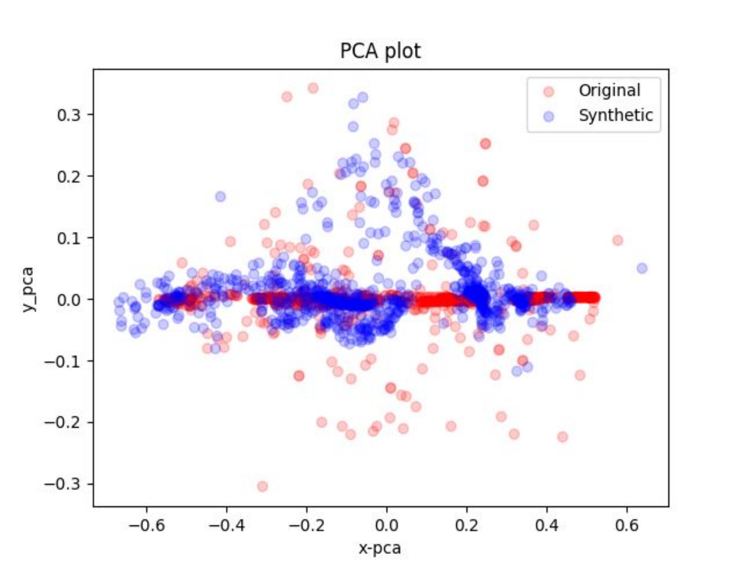
Results for
25k Iterations

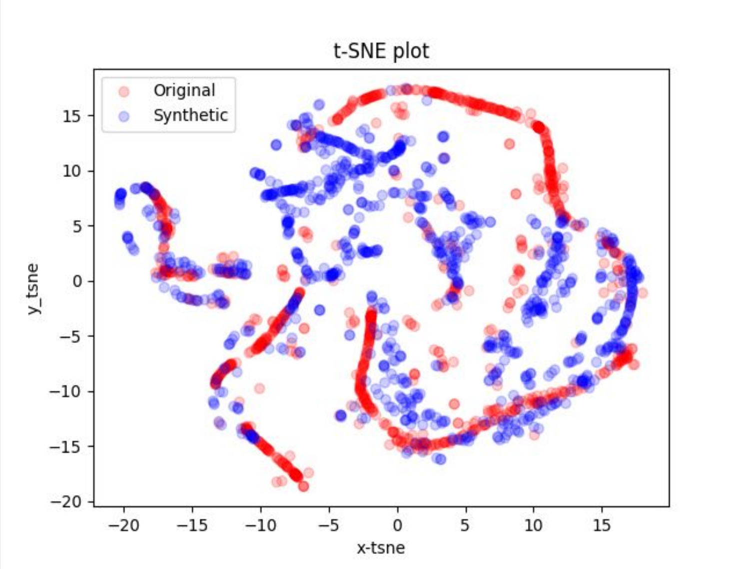




TimeGAN - Results for GRU

Results for
10k Iterations





Way Forward

1. **Comparing the results** of TimeGAN, TransformerGAN and WGAN by a common evaluation metric.

2. **Implementing a common evaluation metric** for time series data and which is suitable for the provided CNC dataset.

3. Develop simple and **interactive visualizations** to compare the real and generated time-series data.

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Thank You For Your Attention!

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