BourGAN:
Generative Networks with Metric Embeddings

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COLUMBIA UNIVERSITY
IN THE CITY OF NEW YORK

Mode Collapse in GAN

When we train a GAN on MNIST...

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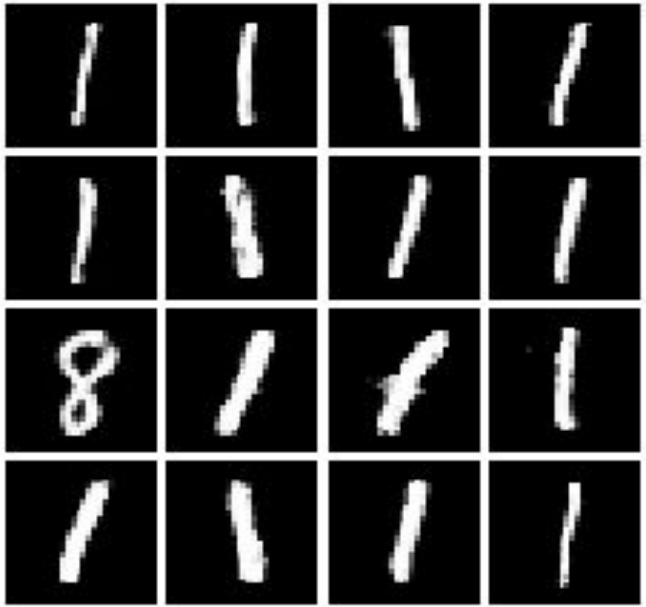

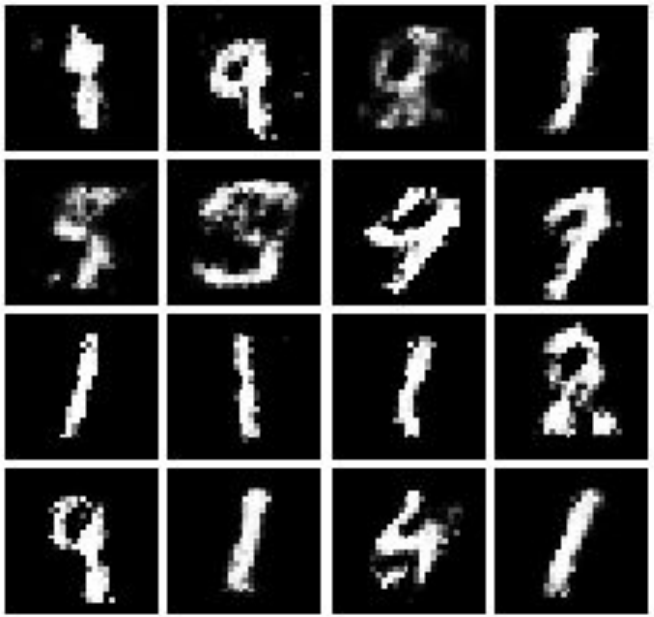

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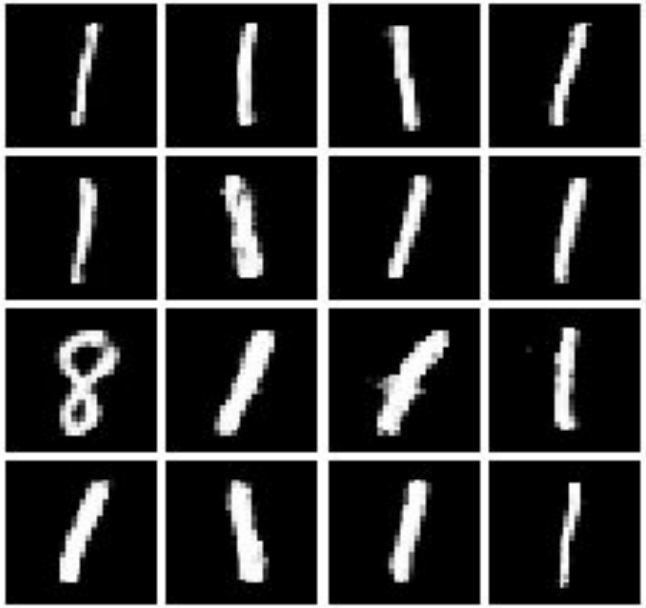
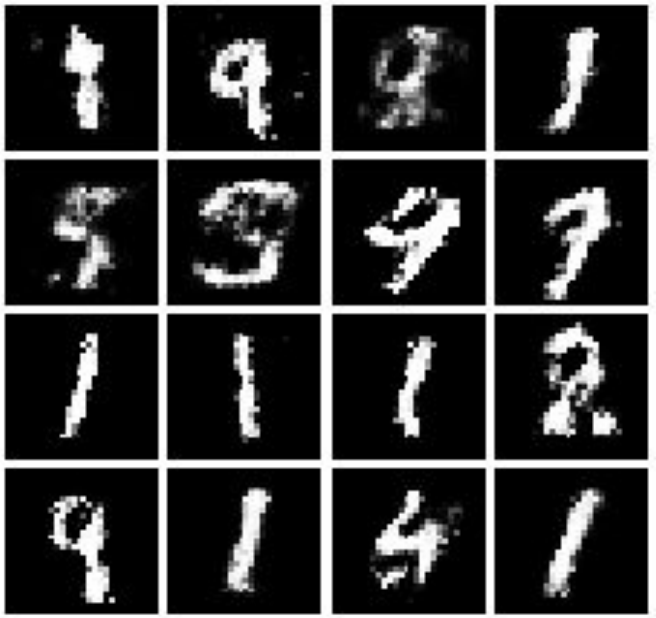
When we train a GAN on MNIST...



Missing Modes



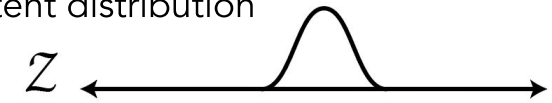
Unwanted Data

Why would mode collapse happen?

Missing Modes

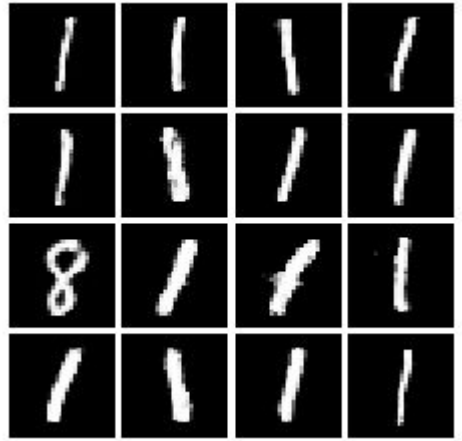
Real distribution

Latent distribution

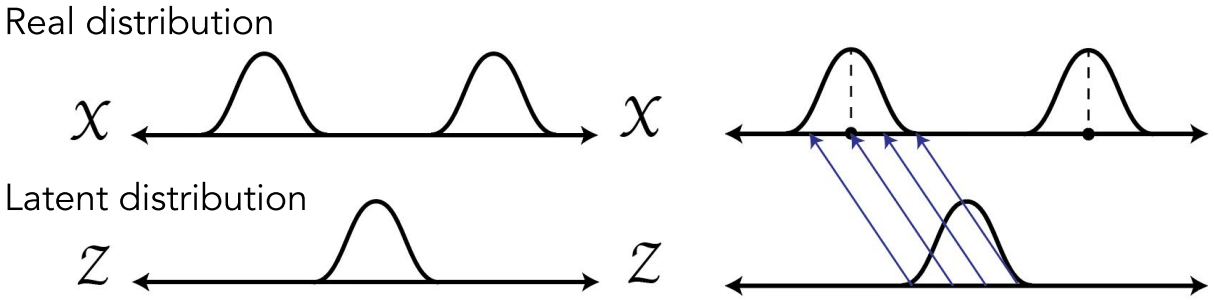


Why would mode collapse happen?

Generated Samples on MNIST



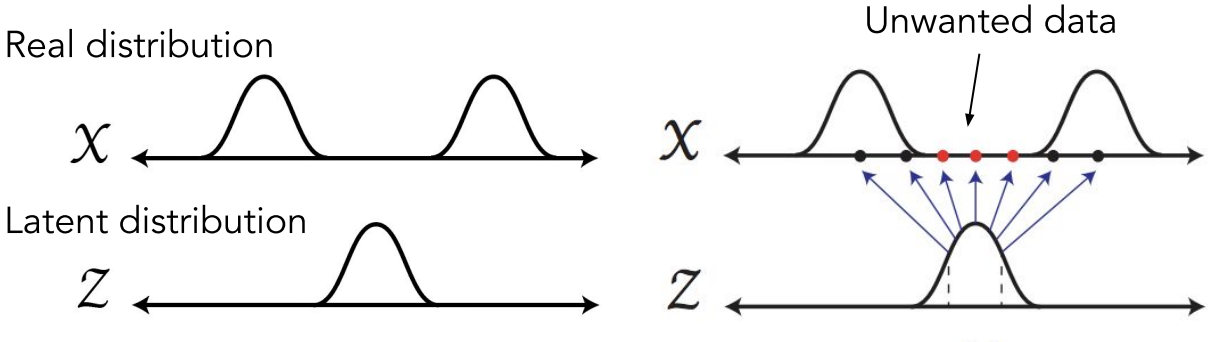
Missing Modes



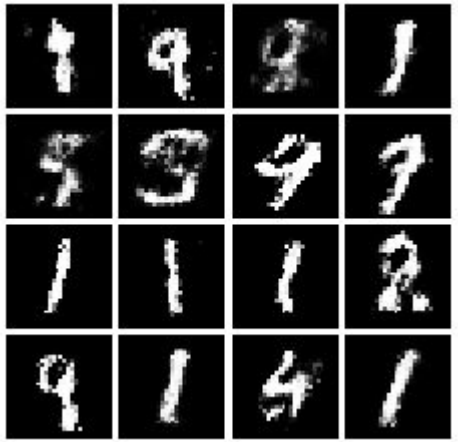
The discriminator can be fooled by generating a subset of data from real distribution.

Why would mode collapse happen?

Unwanted Data



Generated Samples on MNIST

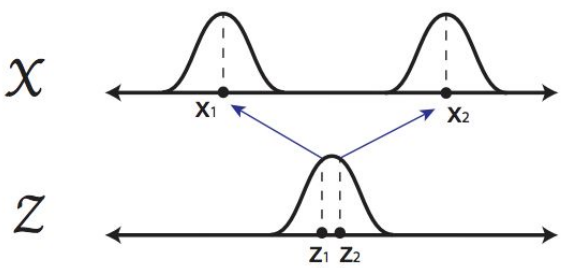


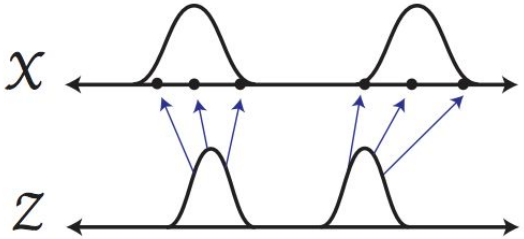
Unwanted data between two modes might be generated.

Large gradients cause the network unstable and hard to train.

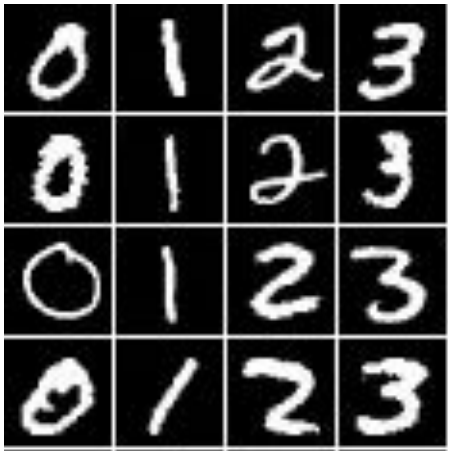
Our Approach

Sampling from Gaussian mixture model





Generated Samples on MNIST



No missing mode 😀

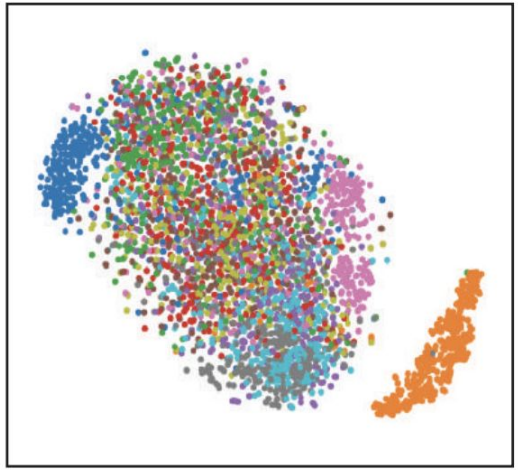
No unwanted data 😀

How to construct the Gaussian mixture?

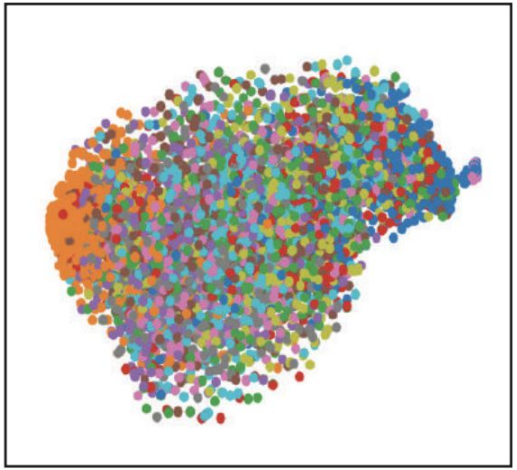
Mode: A Geometric Structure

Modes are defined on a certain distance metric.

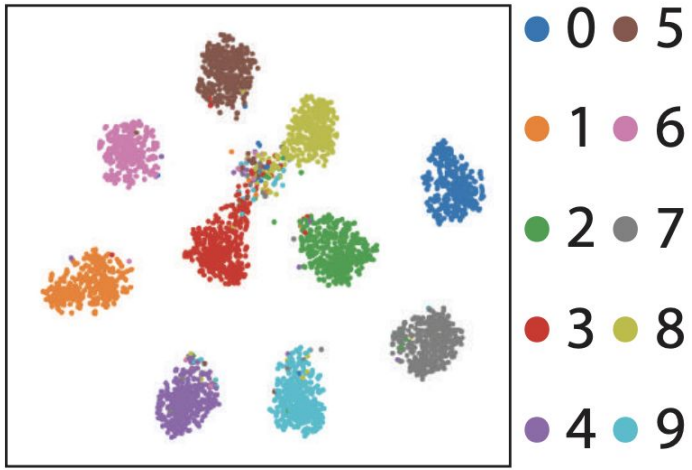
t-SNE visualization of MNIST for different metric



ℓ_2 distance



EMD distance

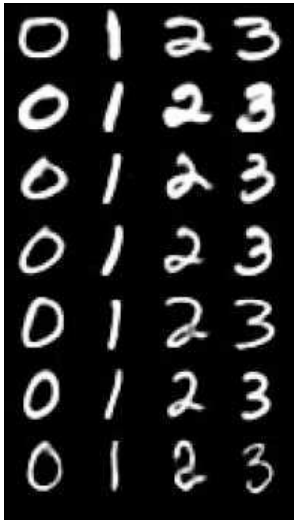


"Classifier" distance

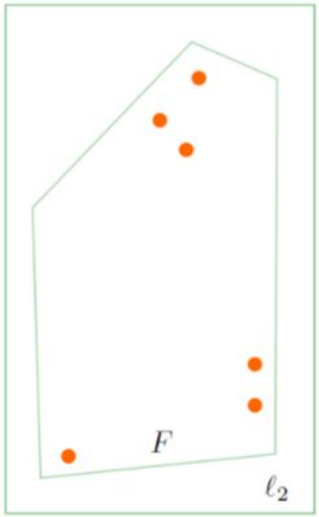
Locating Gaussian Centers

Bourgain's Theorem: an algorithm that embeds data points in an arbitrary metric space into ℓ_2 space with a *bounded* amount of distortion.

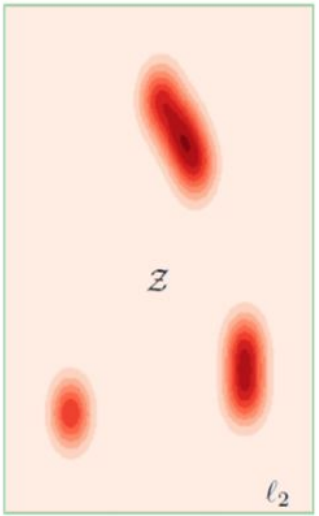
Image space



Latent space

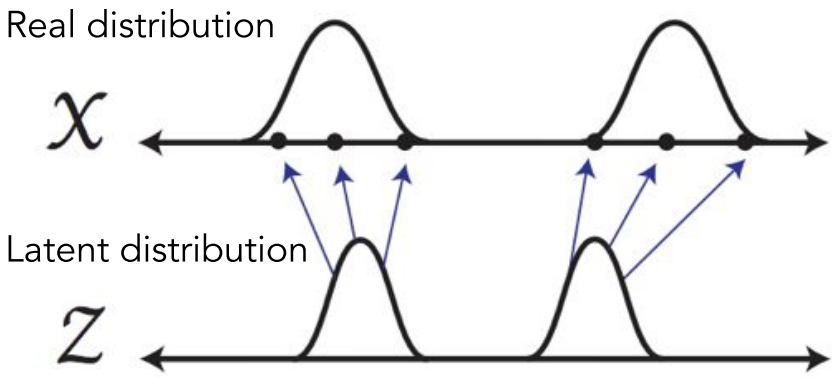


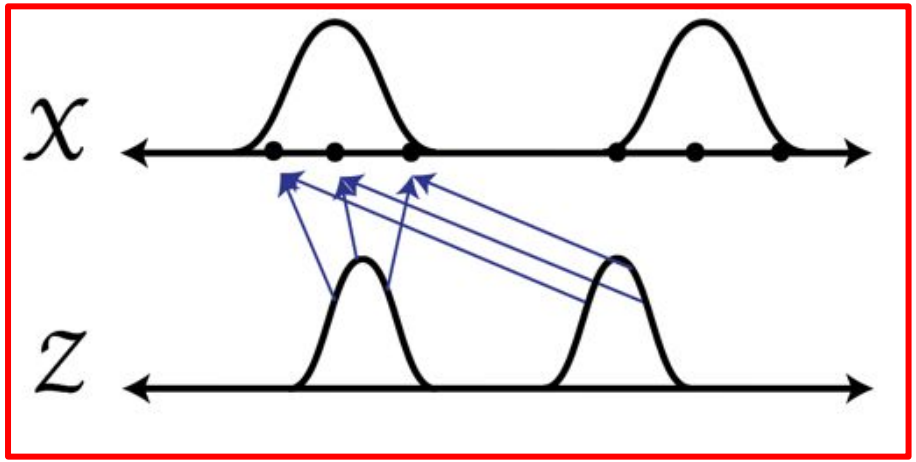
Latent space GMM



Missing Modes

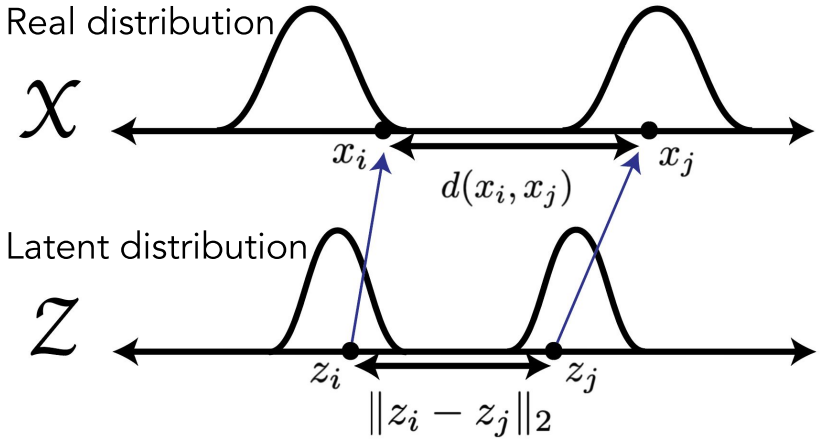
Yet, it is possible to miss certain modes.

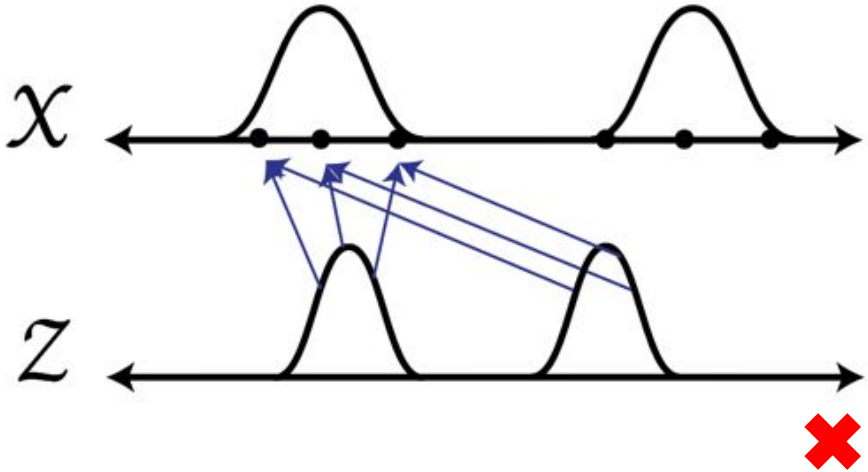




Our Solution: Encourage Distance Preservation

Distance constraint: $\|z_i - z_j\|_2 = d(x_i, x_j)$





Theoretical Results

Wasserstein distance

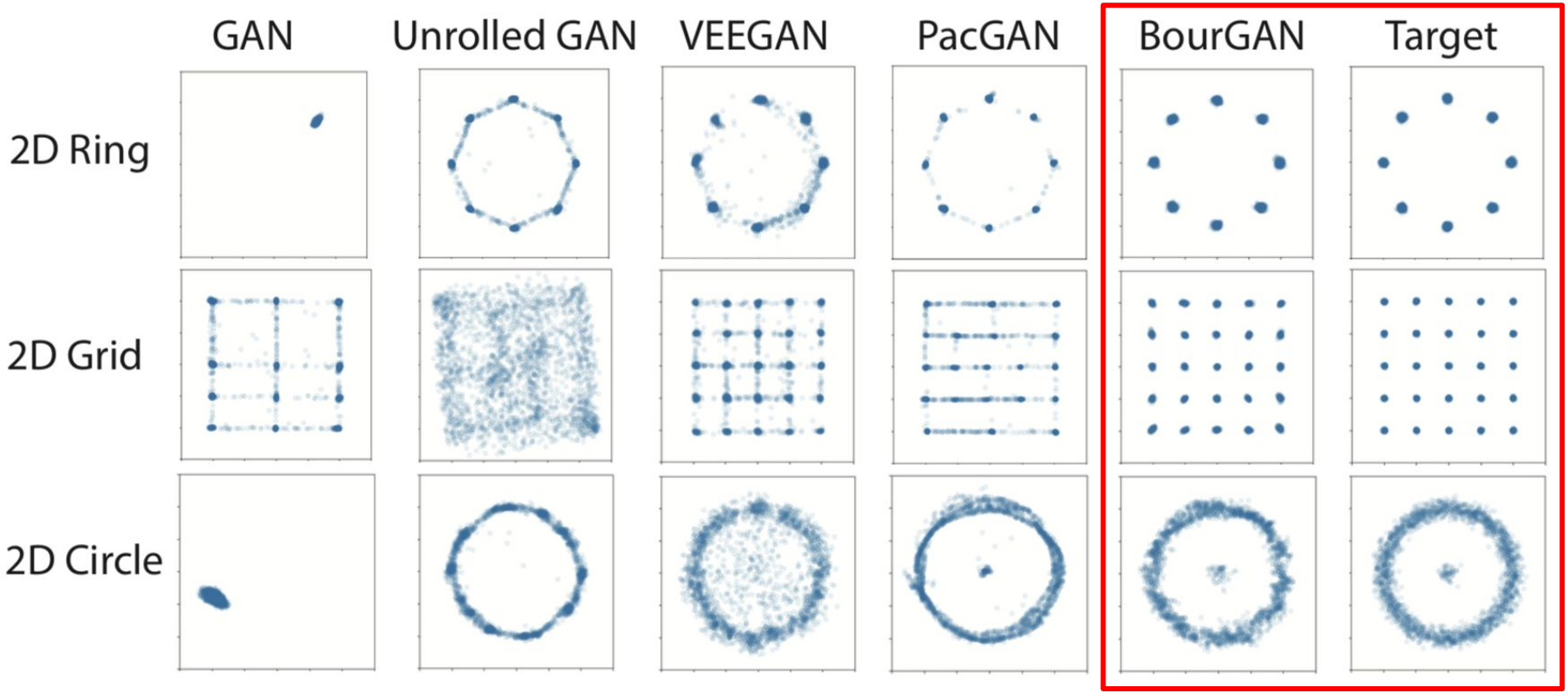
Pairwise distance distribution of generated data

$$W(P, \hat{P}) \leq O(\log \log \log \lambda)$$

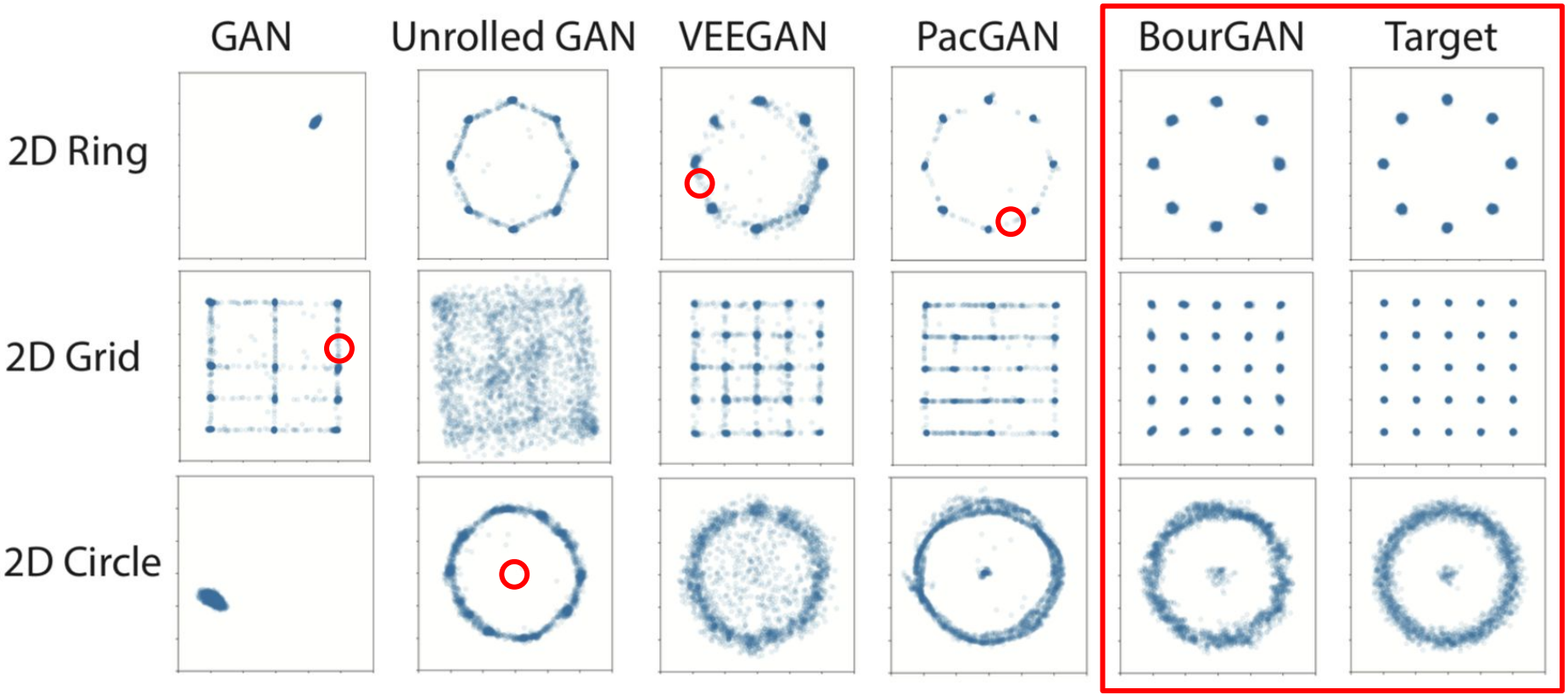
Pairwise distance distribution of real data

A constant related to real distribution

Experimental Results

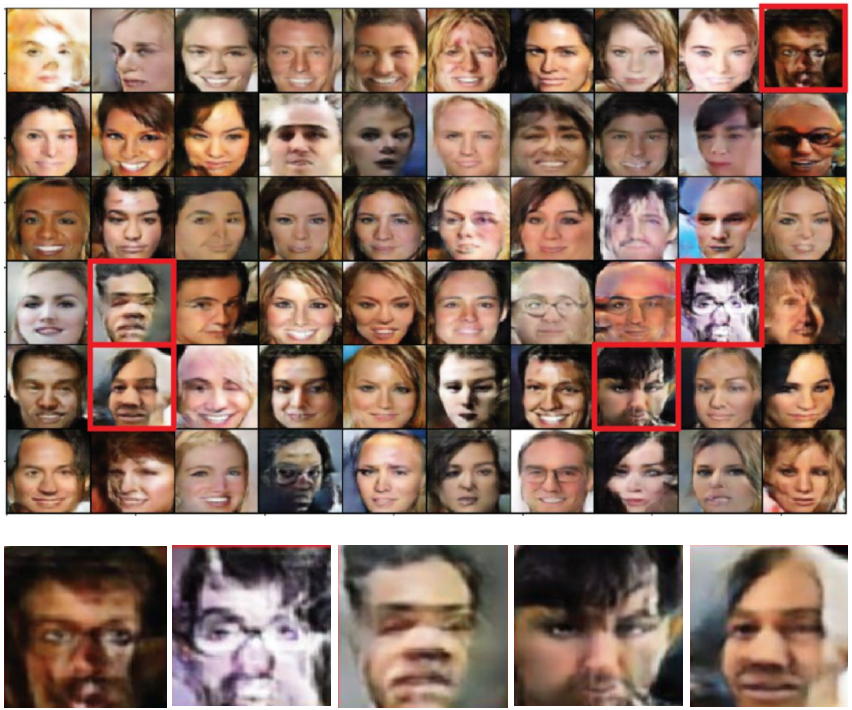


Experimental Results

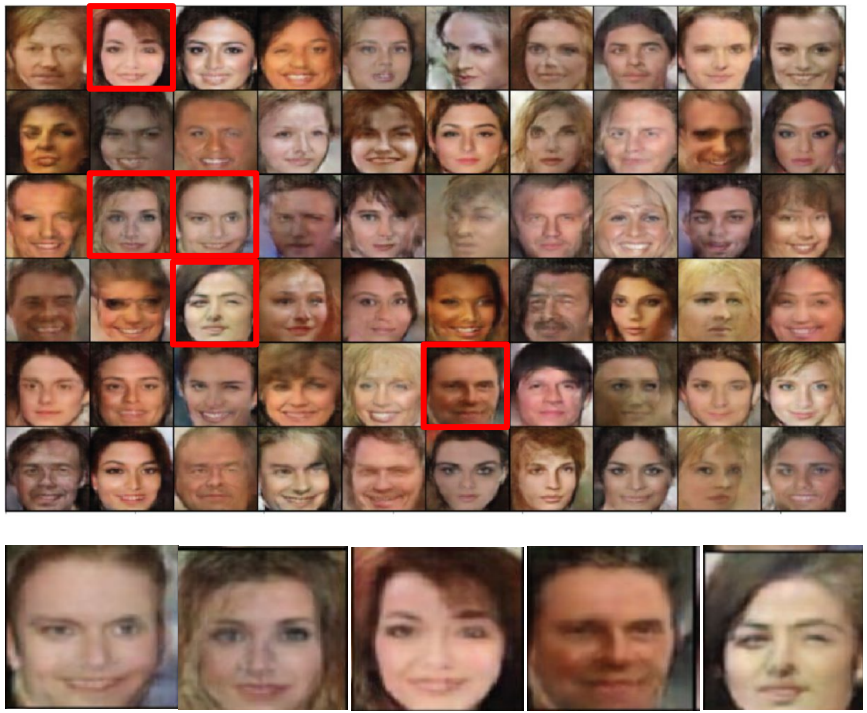


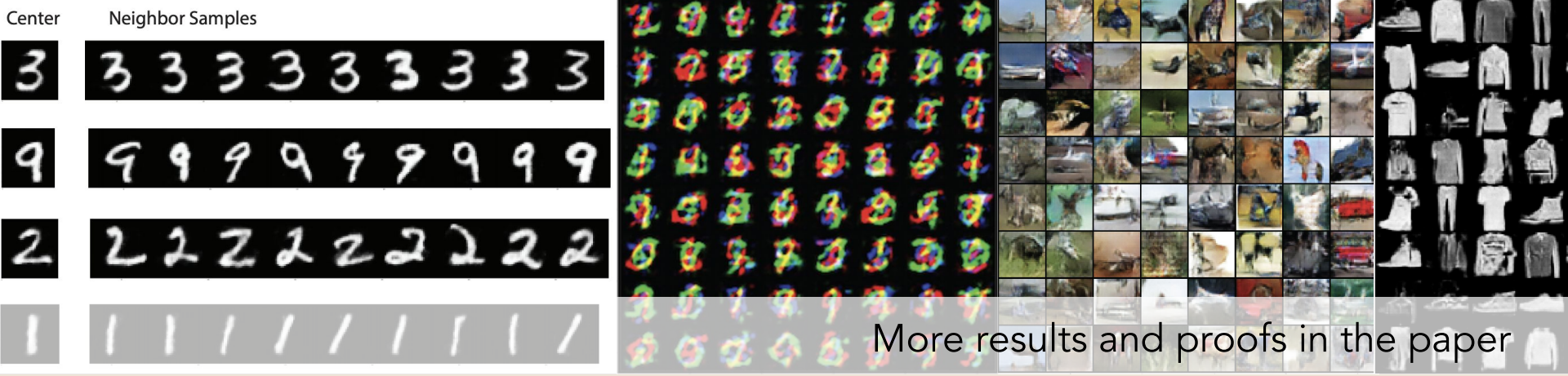
Experimental Results

DCGAN



BourGAN





Poster #17

Tue Dec 4th 05:00 -- 07:00 PM @ Room 210 & 230 AB #17

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