Latent space representation

by GANgsters
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Introduction

I. **First approaches**

II. Cluster based method : **ClusterGAN**

III. **Results and improvements**

Problem Setting

Standard Generative Adversarial Networks minimax objective :

$$\mathcal{L}_{adv} = \min_{\Theta_G} \max_{\Theta_D} \; \mathbb{E}_{x \sim P_x^r} \left[q(D(x)) \right] + \mathbb{E}_{z \sim P_z} \left[q(1 - D(G(z))) \right]$$

where *q(.)* = *log* for the Vanilla GAN

Two main drawbacks:

- **mode collapse** → we try enforcing mode diversity explicitly
- non-convergence

Perceptual Loss

Intuition: increase the **precision** by changing the loss as follows

$$\mathcal{L}_{adv} + \beta_p \cdot \mathcal{L}_{\text{perceptual}}$$

with

$$\mathcal{L}_{\text{perceptual}}(x, \hat{x}) = \sum_{l=1}^{L} \lambda_l \left\| \phi_l(x) - \phi_l(\hat{x}) \right\|_2^2$$

we use VGG16 to extract the feature maps

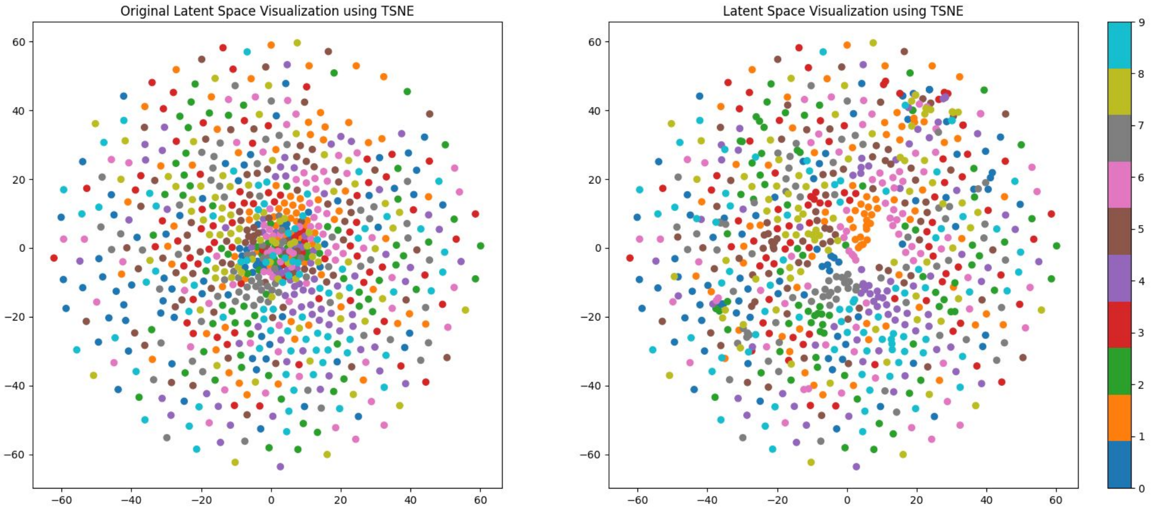
Results : slightly increased precision - strong decrease in **FID** value
Method is **over-killing** for the MNIST dataset

Non conclusive method → next : clustering based approach

Latent Space Exploration

Trained a classifier to retrieve labels (94% accuracy)

Performed **gradient ascent** on z



→ “explicitly” encode the class label in the latent space via **clustering**

ClusterGAN

Generator and **encoder** loss:

$$\mathcal{L}_{GE} = \mathcal{L}_{adv} + \beta_n \cdot \mathcal{L}_{zn} + \beta_c \cdot \mathcal{L}_{zc}$$

with

$$\mathcal{L}_{zn} = \|z_n - E(G(z))_n\|_2^2$$

$$\mathcal{L}_{zc} = -\sum_{i=1}^{10} z_{c,i} \log(E(G(z))_{c,i})$$

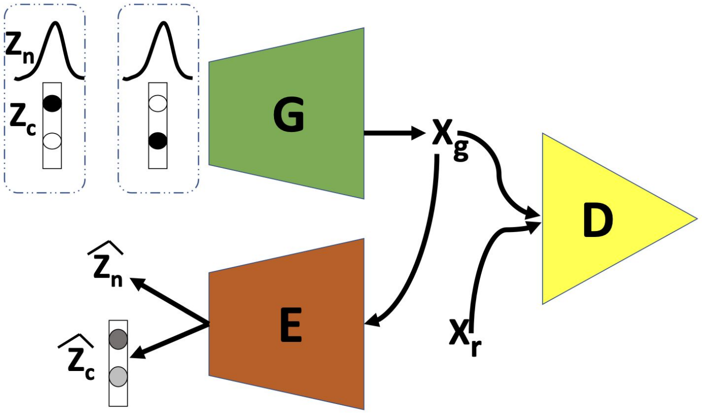
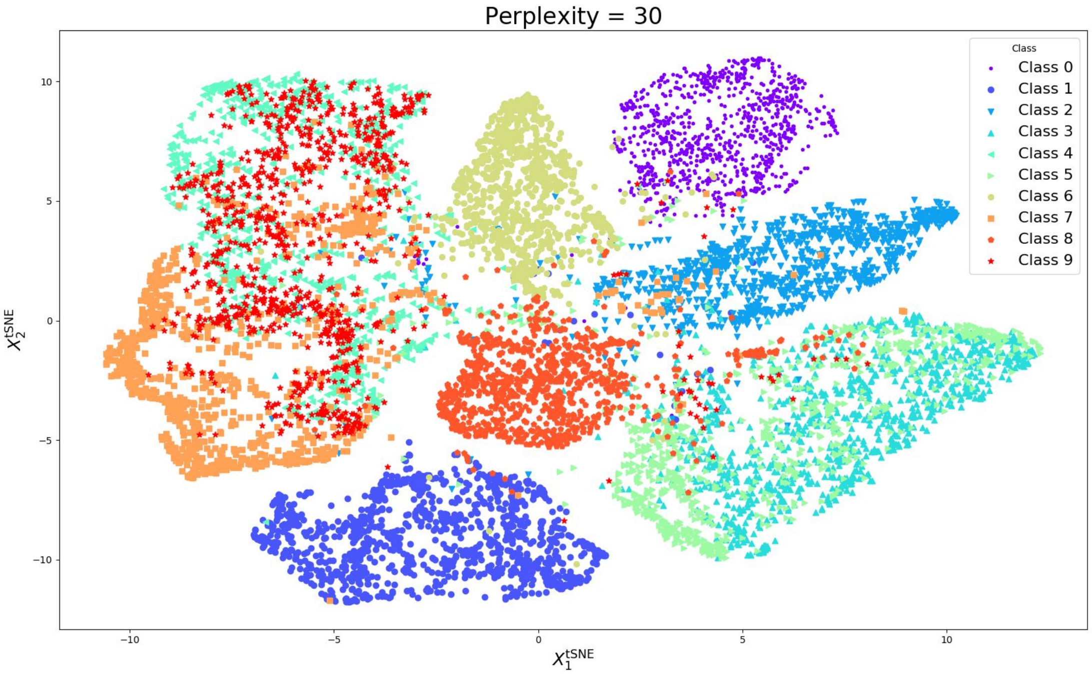


Figure 1: ClusterGAN Architecture

and the standard adversarial loss for the **discriminator**

Clustering Results



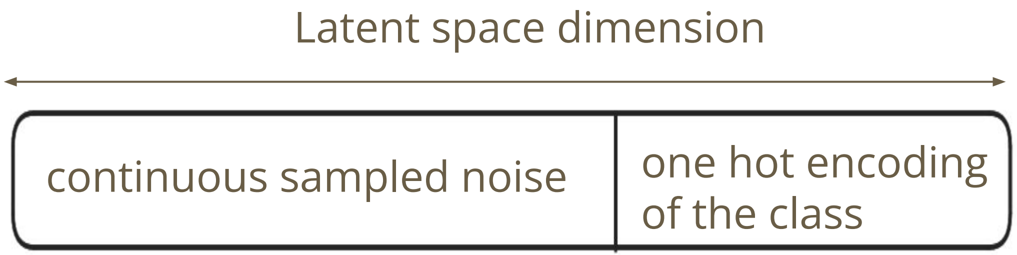
Improving the model

- **Recall**

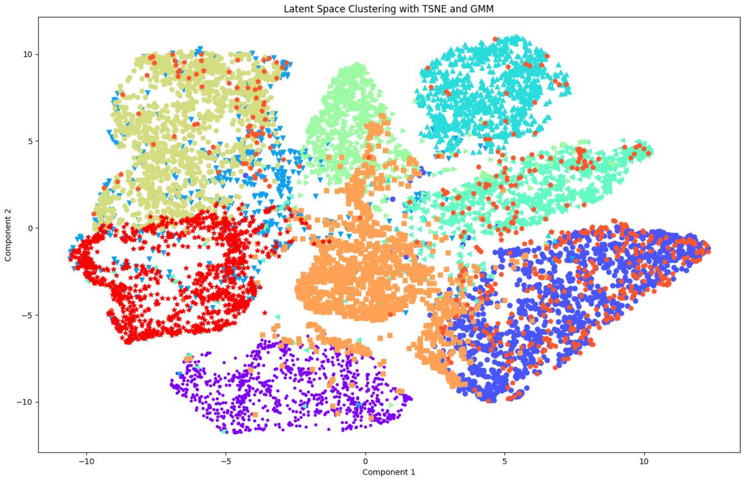
⇒ focus on each specific **mode**

✘ limited to fixed modes

✔ continuous Gaussian in the latent space mitigates coverage of the data distribution



- **GMM:** clustered the latent space



Results and Analysis

Metrics	FID	Precision	Recall
ClusterGAN (d=20)	**9.60**	**0.77**	**0.32**
ClusterGAN (d=100)	9.66	0.76	0.31
ClusterGAN (d=200)	12.61	0.65	0.41

Table 1: Metrics over the ClusterGAN model with different latent space dimensions

Metrics	FID	Precision	Recall
VanillaGAN	15.13	0.62	0.47
ClusterGAN (GMM)	14.0	0.8636	0.14
ClusterGAN	9.60	0.77	0.32
ClusterGAN with IR	10.06	0.76	0.33

Table 2: Metrics over the different models with d=20

Thank you for listening !

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