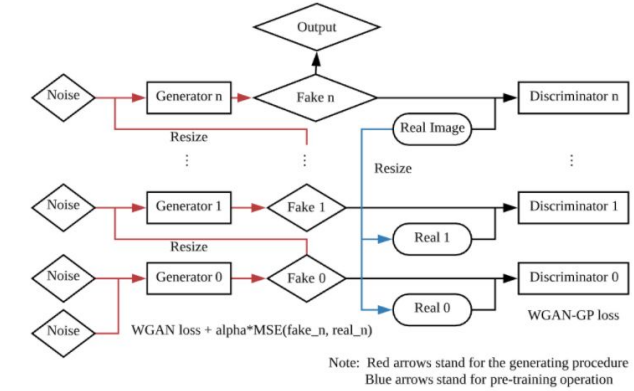
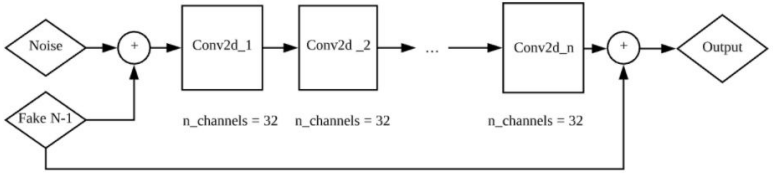
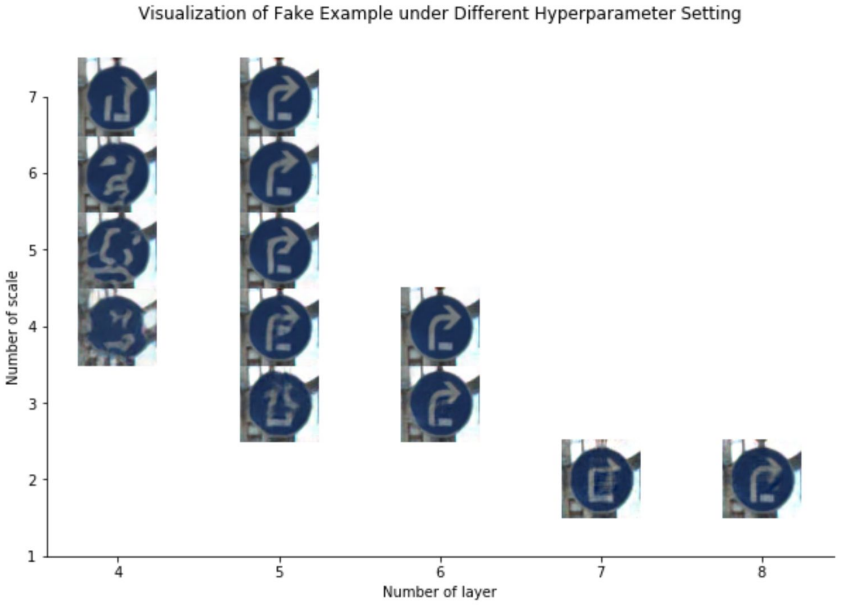
GAN data augmentation approach in extremely imbalanced dataset

Aiden Zhang(zz2699), Zelin Li(zl2848), Yihao Li(yl4326)

Architecture Hyperparameters Tuning



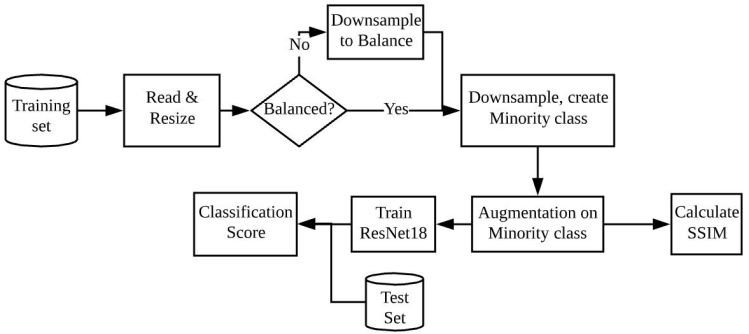




Workflow

- Task 1: Image Classification
  - Dataset:
    - MNIST (10*6000*28*28*3)
    - CIFAR10 (10*5000*32*32*3)
    - GTSRB(42*150*56*56*3 after downsampling)
  - Augmentation Engine:
    - SinGAN
    - Imgaug (geometric transformation)
    - BAGAN
  - Classification Engine: ResNet18

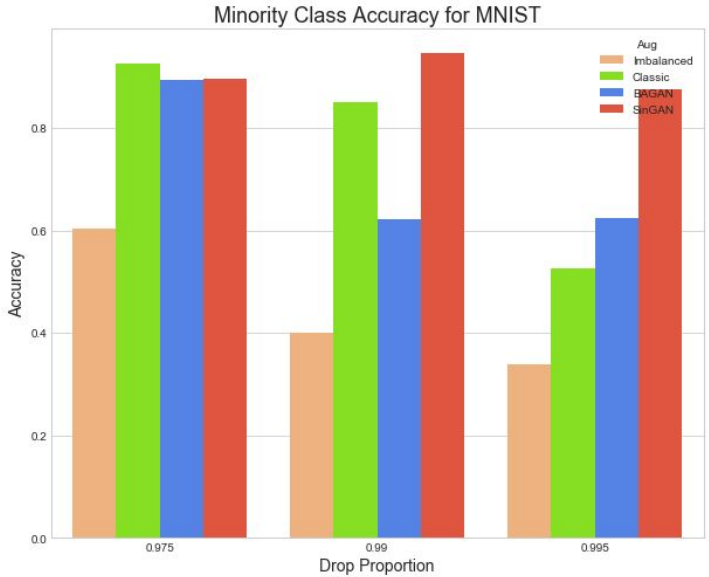
- Task 2: Structural Similarity index (SSIM)
  - 0-1 index, the higher, the more two graphs are similar
  - The average in-class SSIM: average SSIM of 1000 random pairs from augmented minority class

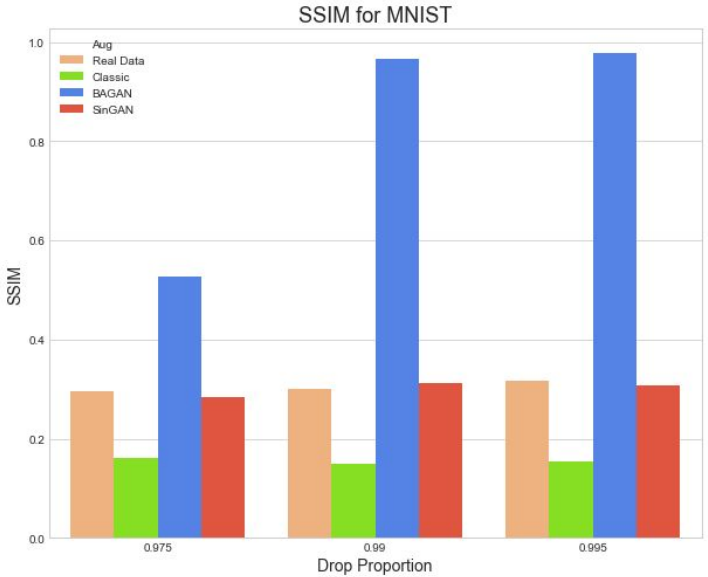


MNIST

Tag: artificial handwriting, fixed composition, relatively dynamic in actual shape(writing style).

Sample size per class: 6000
Drop ratio: 97.5%, 99%, 99.5%



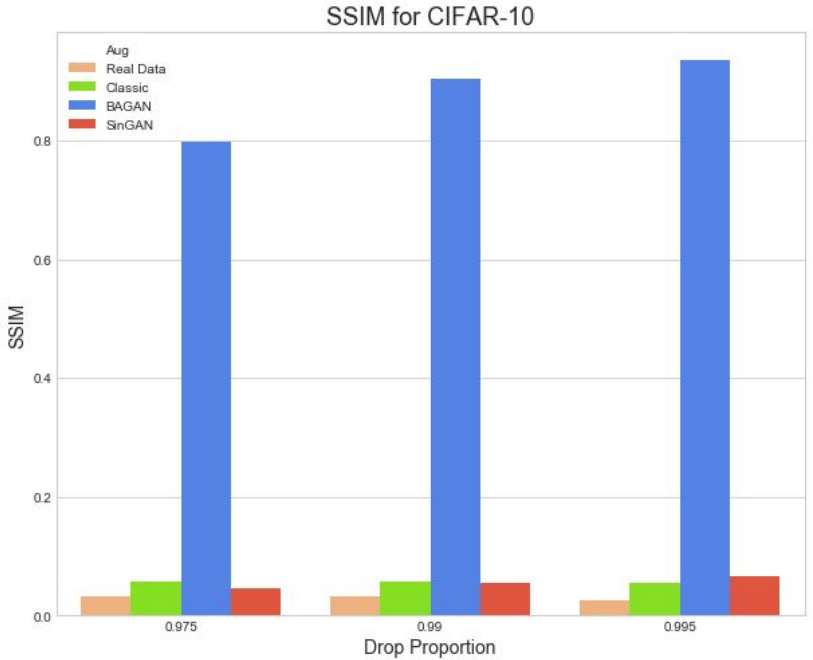


CIFAR-10

Tag: Natural object picture, dynamic in both shape and composition
Sample size per class: 5000
Drop ratio: 97.5%, 99%, 99.5%

Table 3: Minority Class Accuracy for CIFAR-10 dataset

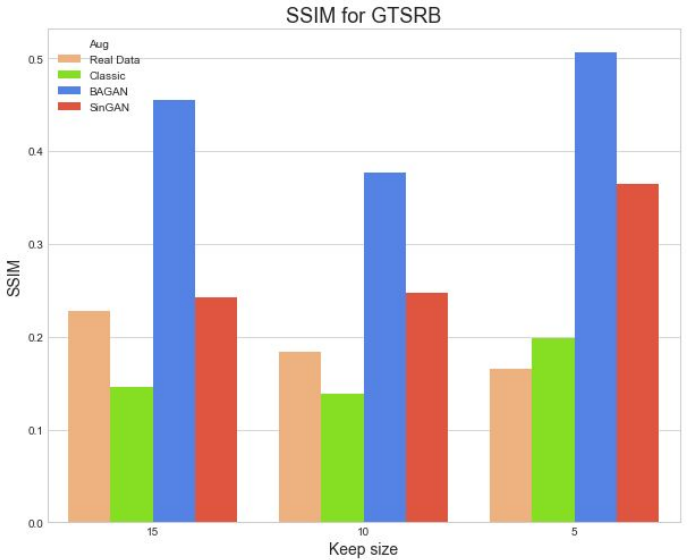
Method	97.5%drop	99%drop	99.5%drop
imbalanced data set	0.002	0	0
geometric transform	0.021	0.015	0.117
BAGAN aug	0.001	0	0
SinGAN aug	0.031	0.003	0.001
full dataset	0.7026		



GTSRB

Tag: Natural object picture, fixed in shape and composition, different light condition

Sample size per class: 150
Drop ratio: 90%(15 left), 93.3%(10 left), 96.7%(5 left)



Conclusion

Given an extremely imbalanced dataset:

- ➔ **When the composition of the image is generally fixed**: SinGAN's performance can be on par with or even better than other state-of-the-art GAN augmentation techniques
- ➔ **For datasets with more variant composition**: as other GAN techniques will fail, SinGAN will not be as efficient as well.
- ➔ By its structure, the data generated by SinGAN **inherits the diversity of the input data**, which is an advantageous point when compared with some of its GAN counterparts like BAGAN.