Improved COVID Detection with GANs

Yacine Bouaouni, Fayçal REKBI

Deep Learning Project

MATHÉMATIQUES
VISION
APPRENTISSAGE

Abstract

The introduction of deep learning models in medical domain has shown that the accuracy of detecting COVID-19 patients using chest X-rays is very encouraging. We present a method for generating synthetic chest X-ray (CXR) images by implementing a model based on the auxiliary generative classification network (ACGAN) to increase the amount of medical images and improve COVID detection .

Introduction

Motivation

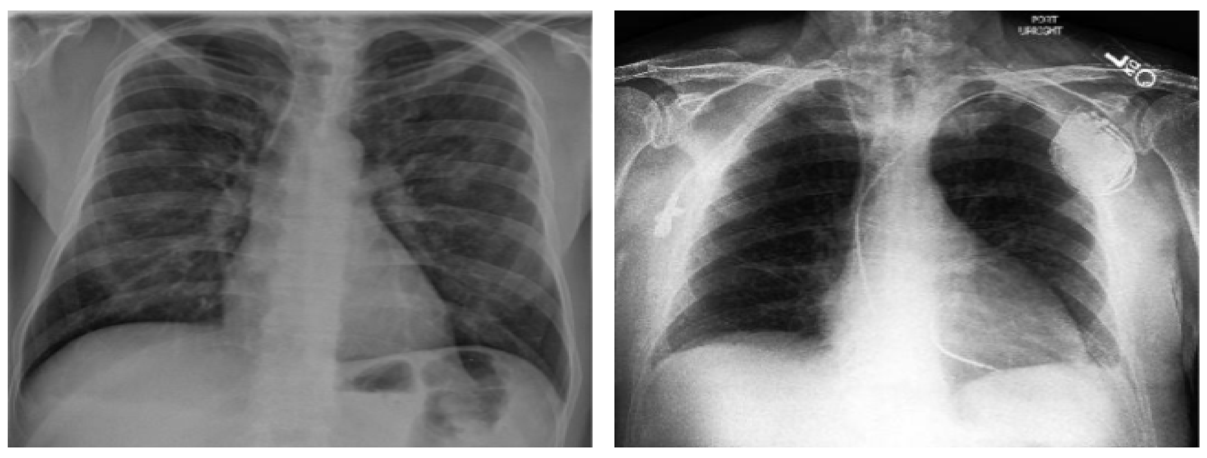
- Data quantity limitations in the medical imaging domain
- Data augmentation with geometric transformation failed
- Overfitting on small datasets.

Problem definition

We present a method to generate synthetic Chest X-Ray (CXR) images for improving COVID detection with GANs.

Dataset

The dataset contains Chest X-Ray and CT images of patients which are positive or suspected of COVID-19 and negative patients.

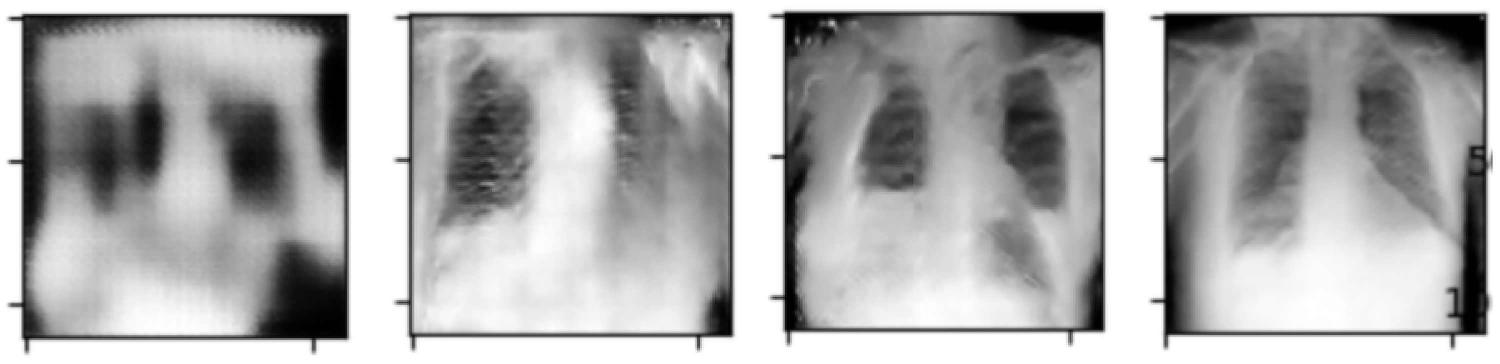


COVID (left) and Non COVID (right) sample image.

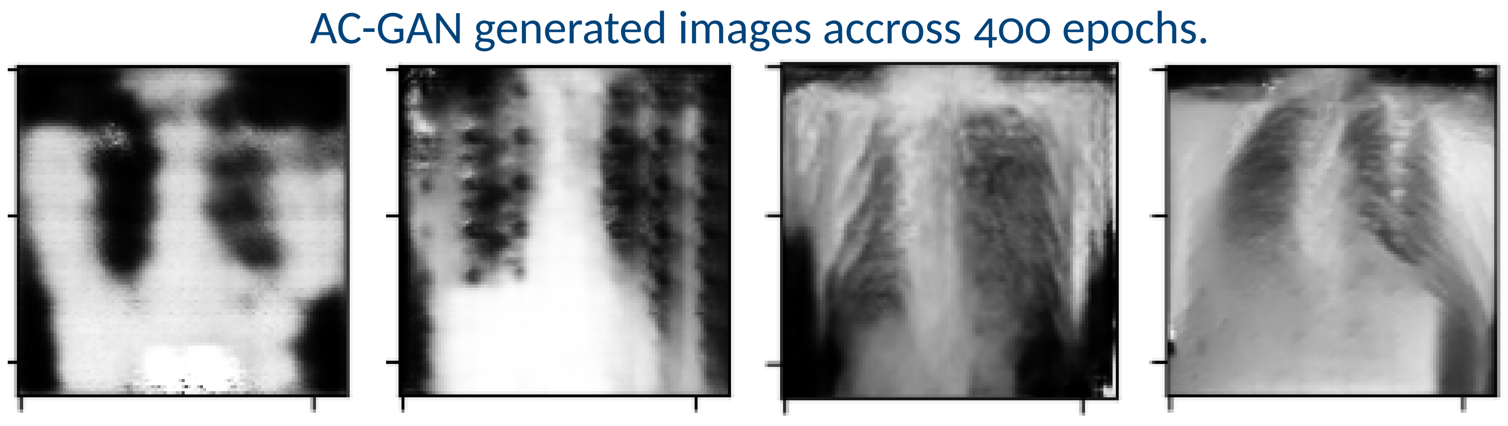
Contribution

- We developped an AcGAN and use the datasets mentioned to generate new X-ray images using our GAN.
- We benchmarked two classifications models based on CNNs and ViT.

Results



AC-GAN generated images accross 400 epochs.



DC-GAN generated images accross 400 epochs.

Model based GANs

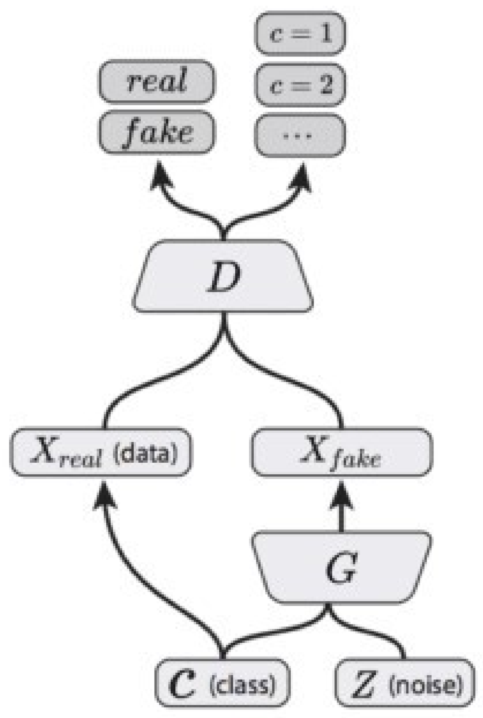
The objective of GAN is to generate realistic, i.e. plausible data according to a probability distribution of the real data $P(X)$. Obviously, this distribution is unknown and we simply have examples of data drawn according to this distribution $D = \{x_i \sim P(X)\}_{i=[\![1 \cdots N]\!]}$, the training examples of our dataset.

DC-GAN

Deep Convolutional Generative Adversarial Network is a type of GANs that uses convolutional layers to generate images. We tested the DC-GAN to generate 112x112 Xray images and made sure to respect the tips to build a stable GAN that were presented in the NIPS 2016 Workshop on Adversarial Training. However, this architecture doesn't benefit from the labels, thus using a GAN that can take advantage of such information would yield more realistic images, an architecture like the AC-GAN.

AC-GAN

The auxiliary classifier GAN is a type of conditional GAN that requires that the discriminator predict the class label of a given image as well as if it's fake or real.



AC-GAN architecture.

- Normalize inputs to the range [-1, 1] and use tanh in the generator output.
- Use mini batches of all real or all fake for calculating batch norm statistics. In this part we have tried many configurations, such as setting the momentum of the batch norm to its default value (0.9) or a low value 0.1, it lead to bad results. However, by taking the momentum equal to 0, we could obtain quite good results.
- Use relu in generator and leaky relu in discriminator except last layer.
- Use smooth upsampling and downsampling operations (e.g. strides).
- Use dropout in train and generation.

Classifier

We used a VGG16 for a binary classification of Covid/Normal Xray images. Training all the layers of the network yields better results then using fine tuning, since the pretrained VGG was done on natural images.

Dataset	Original Dataset A	Augmented Dataset
Train set	0.99	0.99
Test set	0.84	0.875

Discussion & Improvements

GAN

- Train the network for more than 430 epochs (In the original paper, CovidGAN was trained for 2000 epochs).
- Use the Frechet Inception Distance (FID) to evaluate the AC-GAN and DC-GAN with a numerical metric.
- Use VGG16 feature extractor trained on Xray images to compute FID-like metric to avoid using inception net which was pretrained on natural images.

Classifier

- Explore other architectures.
- Use a pre-trained model on medical images.