

# Image Enhancement Using Deep Learning

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# Introduction

**Image enhancement** - Adjusting images to make them more suitable for display or analysis

**Super-resolution** - Artificially increasing the level of detail on blurry or low-quality images



# Applications

Face Recognition



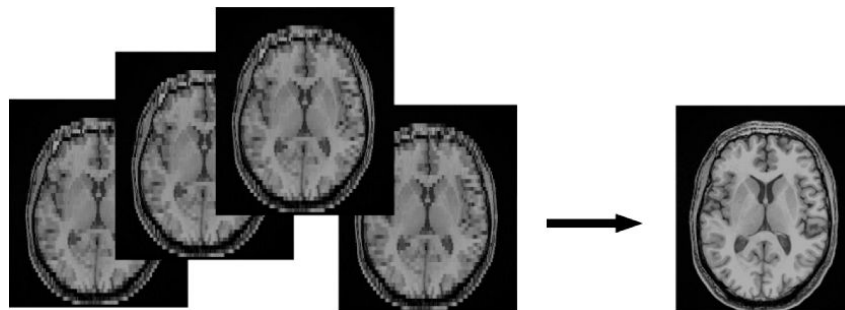
Satellite Mapping



License Plate OCR

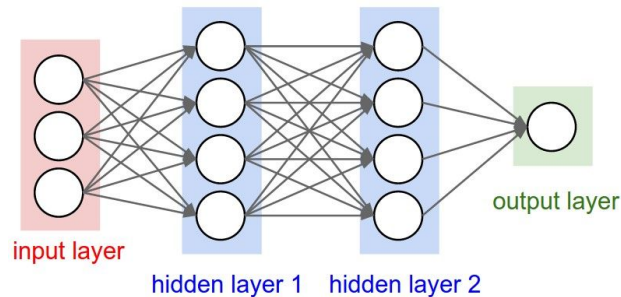


Medical Imaging

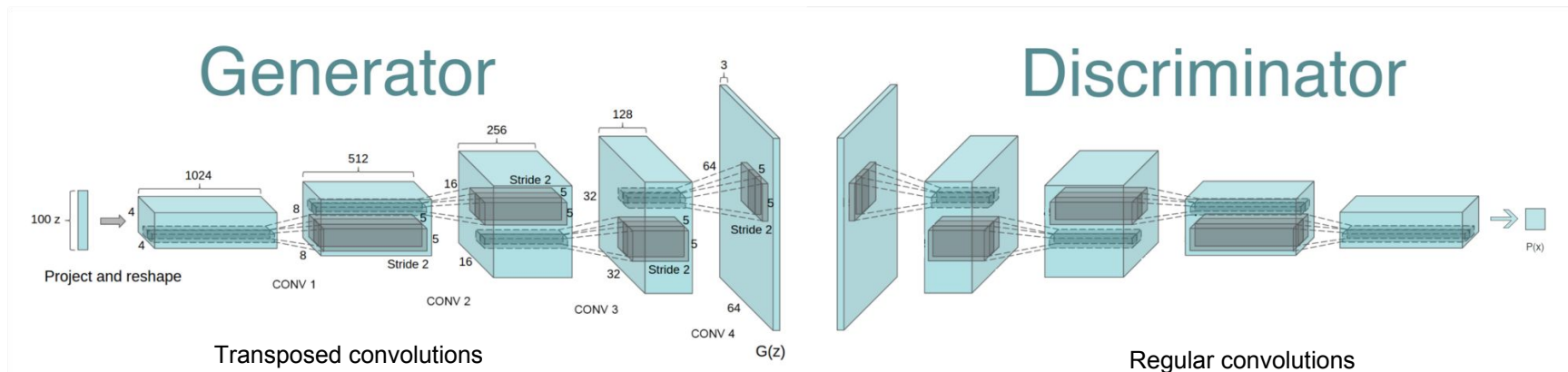


# Methods

- Traditional
  - Data-independent, no training required
    - Usually based on fast fourier transforms
    - Forensic software, Adobe Photoshop
- Deep learning
  - Data-dependent, needs training
    - Convolutional neural networks
    - Variational autoencoders
    - **Generative adversarial networks**



# Generative Adversarial Networks (GAN)

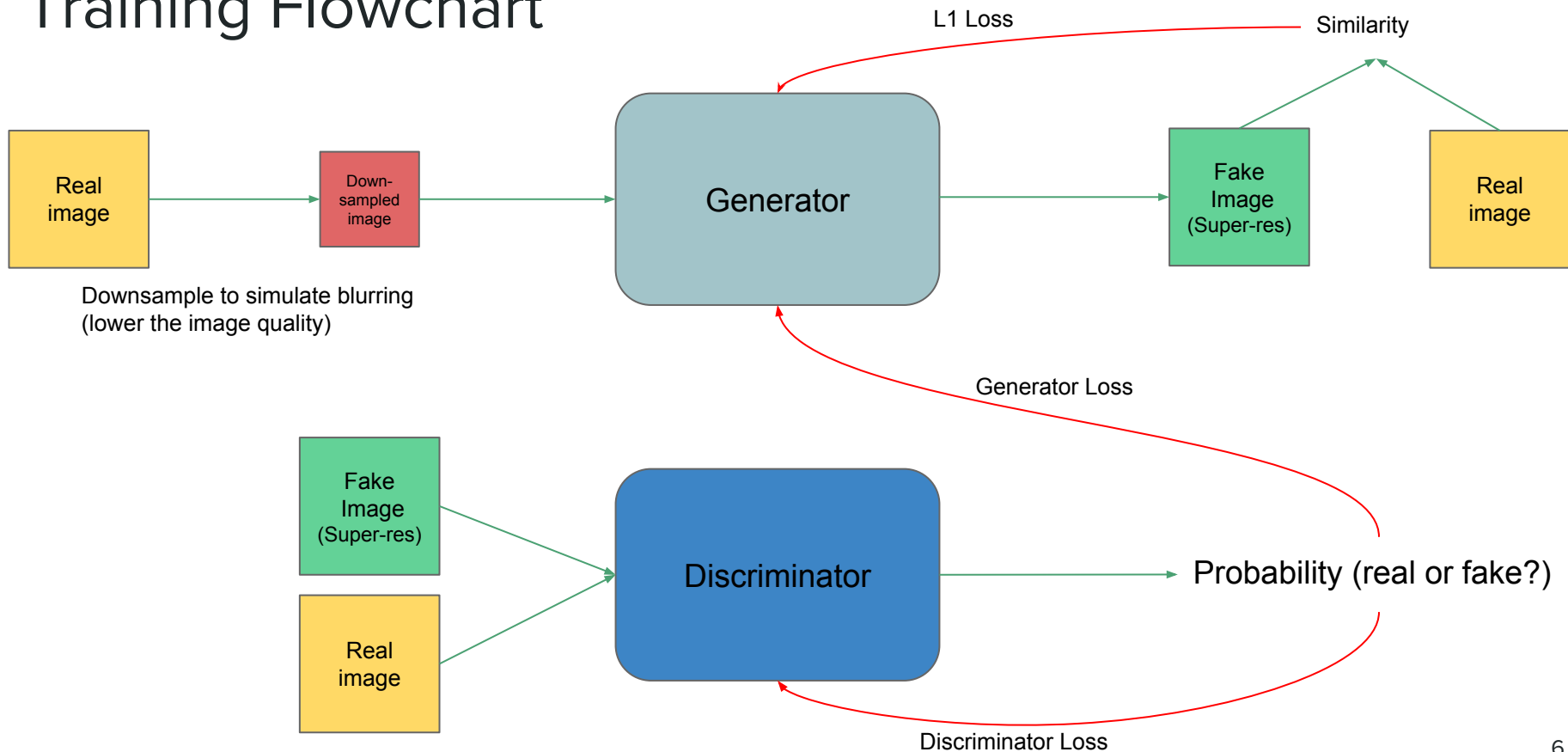


Learns to create fake images that can fool the Discriminator

Learns to distinguish between real and fake images

Goal is to create super-resolution images that look as real as possible and similar to the original image

# Training Flowchart



# Training Notes

- Multiple loss functions to optimize and balance
  - Generator L1 loss
    - How much does the generated image matches the original
  - Generator Cross-entropy loss
    - How realistic the generated image looks (can it fool the Discriminator?)
  - Discriminator loss
    - How well the discriminator correctly classifies an image as real or fake
- Training will fail if the Discriminator overpowers Generator
  - Discriminator provides no useful information for Generator to learn
  - Very common problem with GANs
  - Must optimize hyperparameters or alter the model architecture
- Decent results achieved after several thousand iterations

# Dataset

## MNIST Digits

60k images



16x16 pixels  
Downsampled to 4x4

## Celebrity Faces

200k images



64x64 pixels  
Downsampled to 16x16

## Flowers

8k images

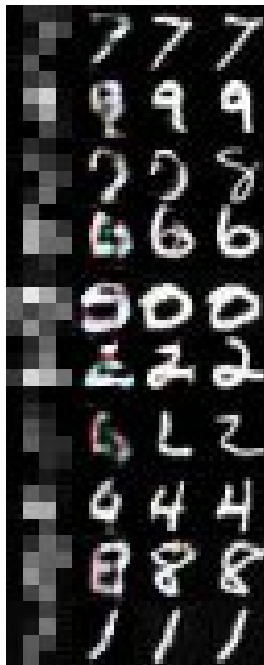




# Results

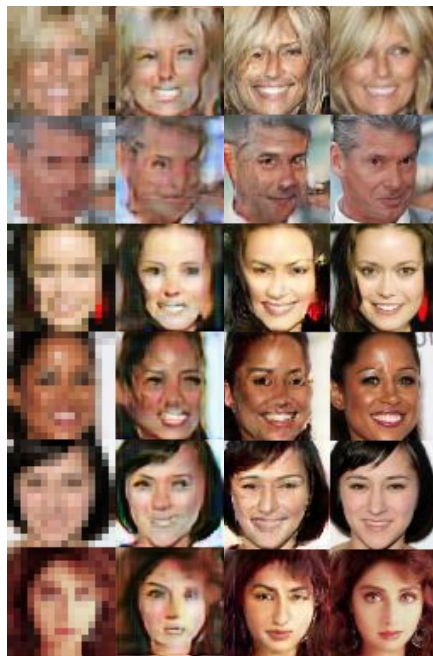
## Digits

4x4 | 1k iterations | 20k iterations | Truth



## Faces

16x16 | 1k iterations | 8k iterations | Truth



## Flowers

16x16 | 1k iterations | 5k iterations | Truth



# References

- Unsupervised Representation Learning with Deep Convolutional Generative Adversarial Networks - <https://arxiv.org/abs/1511.06434>
- [http://www.mathcs.emory.edu/~nagy/courses/fall06/ID\\_lecture1.pdf](http://www.mathcs.emory.edu/~nagy/courses/fall06/ID_lecture1.pdf)
- A hybrid MLP-PNN architecture for fast image superresolution - [https://www.researchgate.net/publication/1957977\\_A\\_hybrid\\_MLP-PNN\\_architecture\\_for\\_fast\\_image\\_superresolution](https://www.researchgate.net/publication/1957977_A_hybrid_MLP-PNN_architecture_for_fast_image_superresolution)
- <https://www.mathworks.com/discovery/image-enhancement.html>
- <https://people.mpi-inf.mpg.de/~kkim/supres/supres.htm>
- A PCA-Based Super-Resolution Algorithm For Short Image Sequences - <https://arxiv.org/ftp/arxiv/papers/1201/1201.3821.pdf>
- <http://www.ifp.illinois.edu/~jyang29/papers/chap1.pdf>
- <https://github.com/david-gpu/srez>
- <https://github.com/reedscot/icml2016>