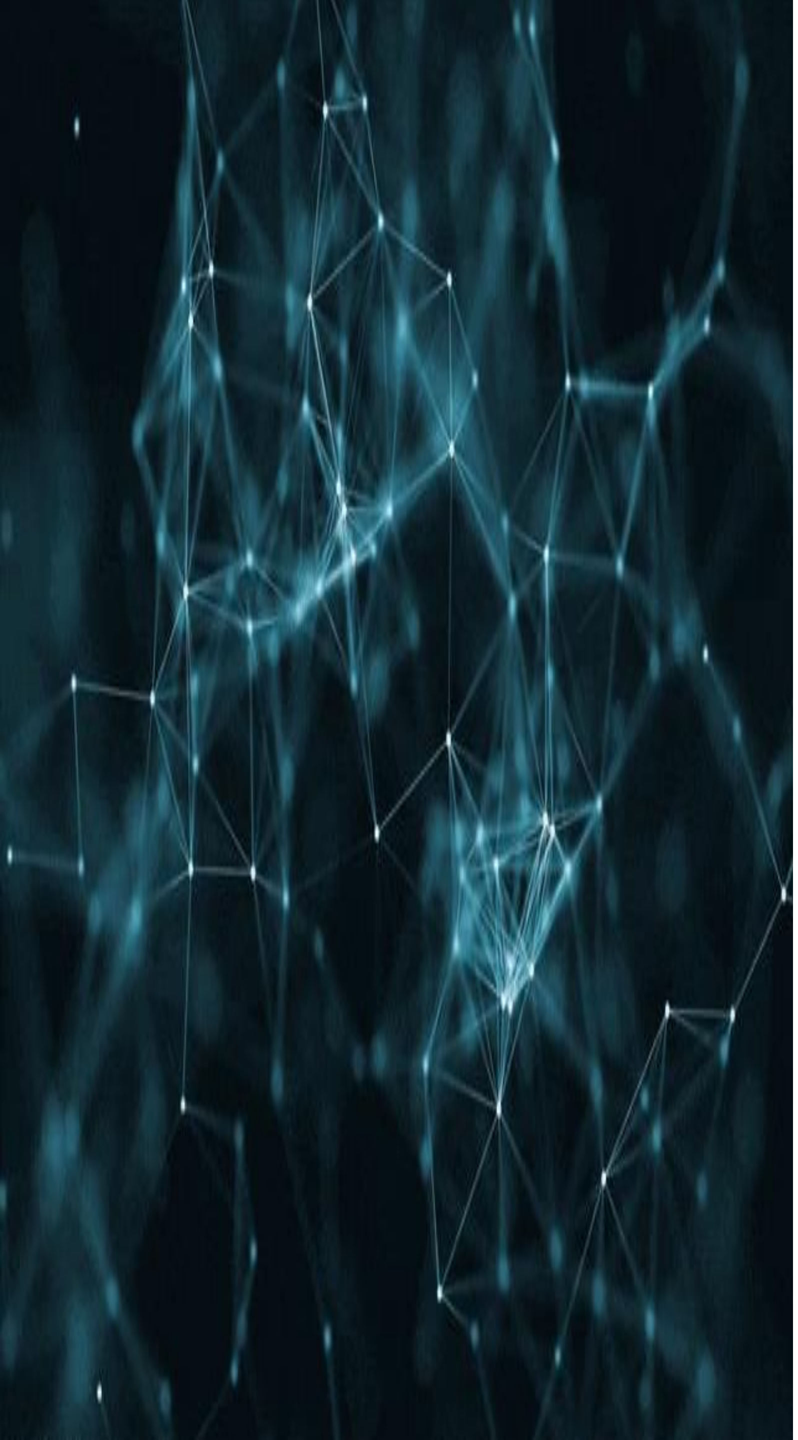
Generative Adversarial Networks

Shobhit

Software Engineer, Qualcomm

IIT Bhubaneswar, India



Agenda

- Game
- Generative modelling
- Coolest applications
- GANs components and its architecture
- GANs training
- Difficulties during training
- Use case

(Shobhit)

Let’s Play Game - Identify Real or Fake One

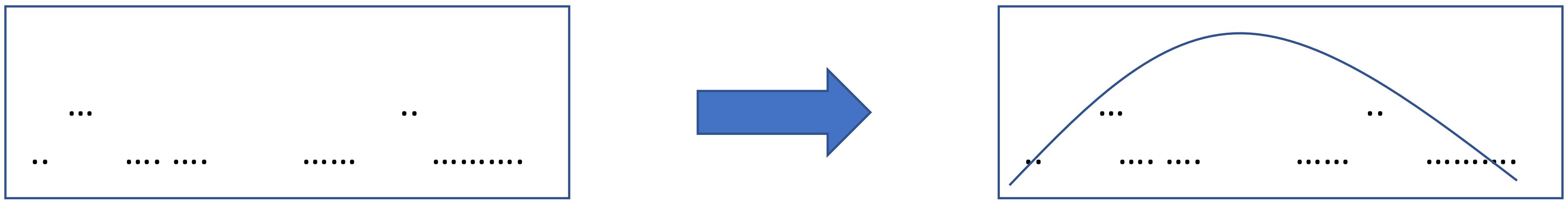



Generated From StyleGAN2

These People Don’t Exist

(Shobhit)

Generative Modelling – Density Estimation



(Shobhit)

Generative Modelling – Sample Generation

Celeb A dataset

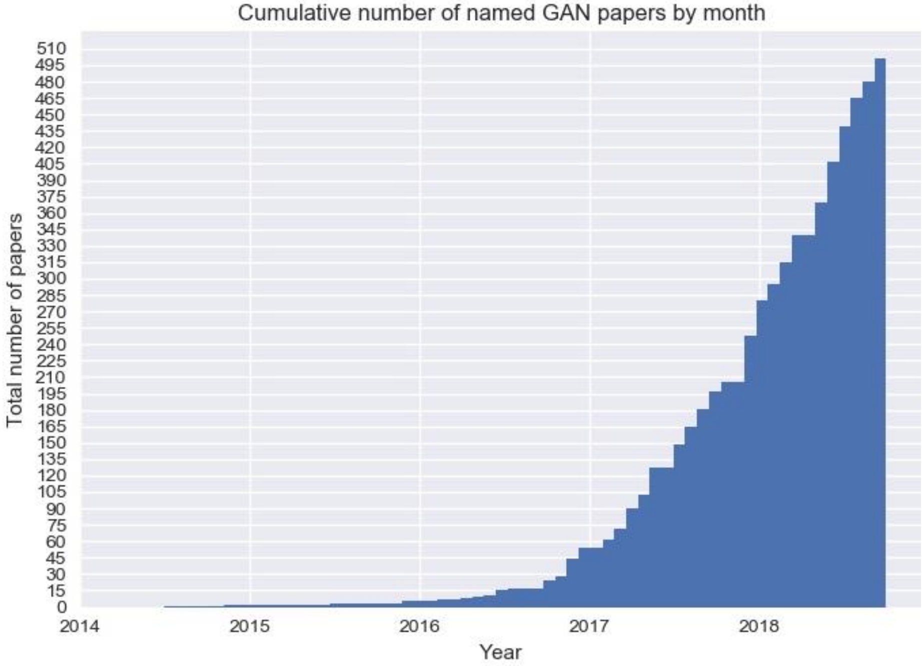
Generated Images

Tero Karras et.al. (2018). Progressive Growing of GANs for Improved Quality, Stability, and Variation.

(Shobhit)

Inventor of GANs – Ian Goodfellow

Ian Goodfellow @goodfellow_ian · Jan 15, 2019
4.5 years of GAN progress on face generation. arxiv.org/abs/1406.2661 arxiv.org/abs/1511.06434 arxiv.org/abs/1606.07536 arxiv.org/abs/1710.10196 arxiv.org/abs/1812.04948

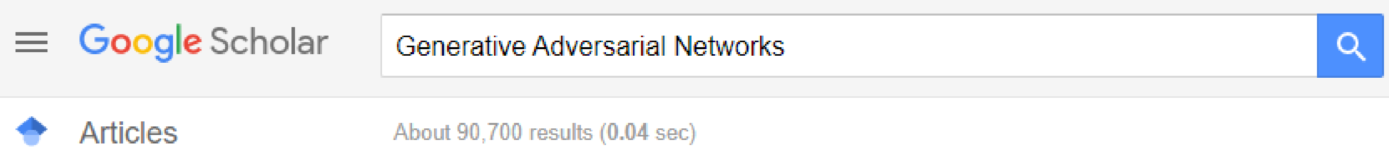


https://github.com/hindupuravinash/the-gan-zoo

Ian Goodfellow @goodfellow_ian · Jul 12, 2019
I'm in Fortune's 40 under 40:

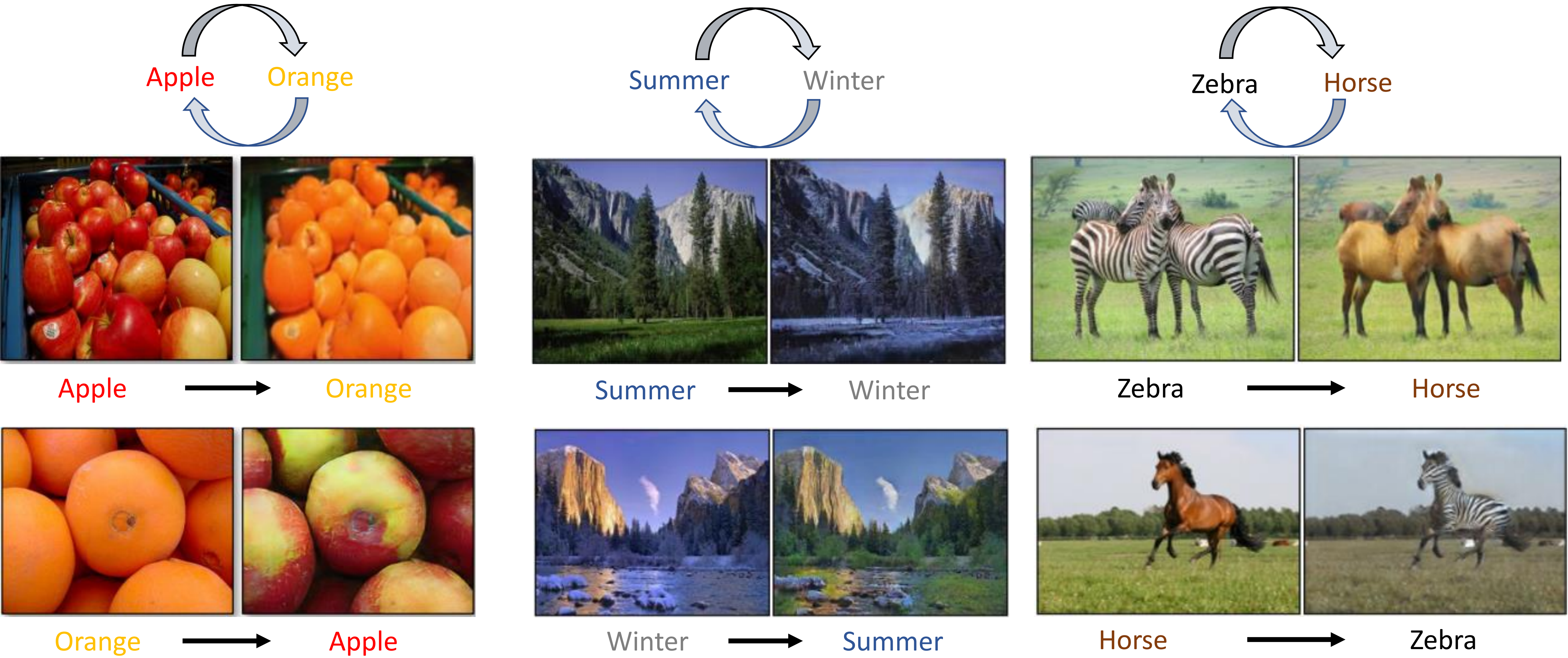
Ian Goodfellow
Industry: A.I. As one of the youngest and most respected A.I. researchers in the world, Ian Goodfellow has kept busy pushing the frontiers of de...
fortune.com

Around 33,300 citation is on original paper of GANs



(Shobhit)

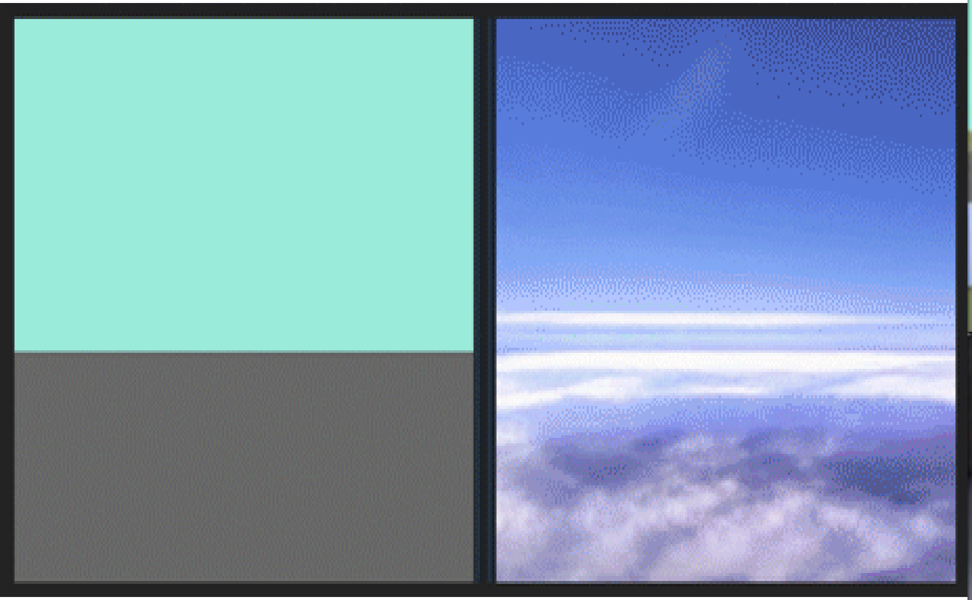
Coolest Application – CycleGAN



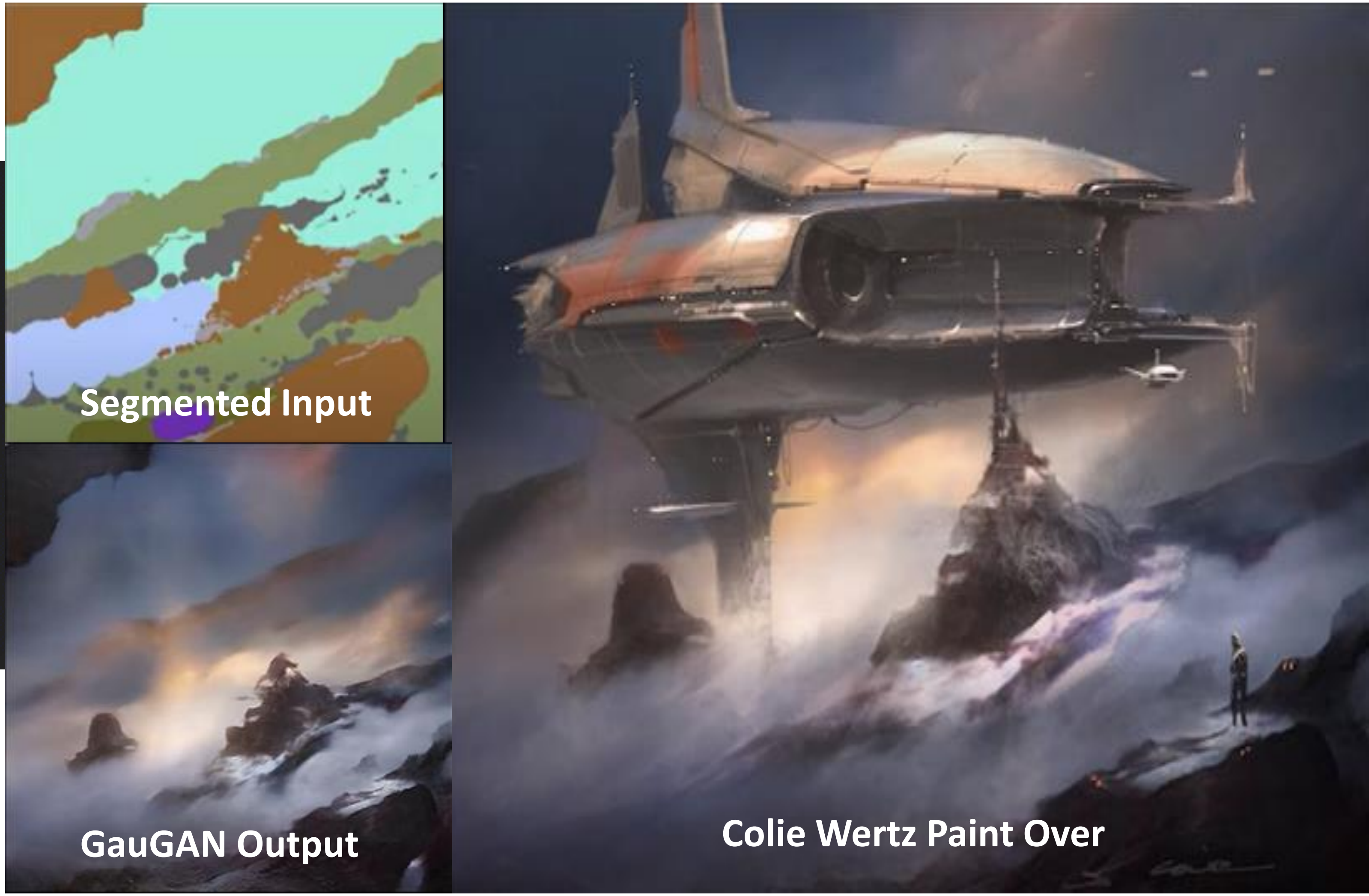
Zhu, Jun-Yan, et al(2020). 'Unpaired Image-to-Image Translation Using Cycle-Consistent Adversarial Networks'.

(Shobhit)

Coolest Application – Nvidia GauGAN



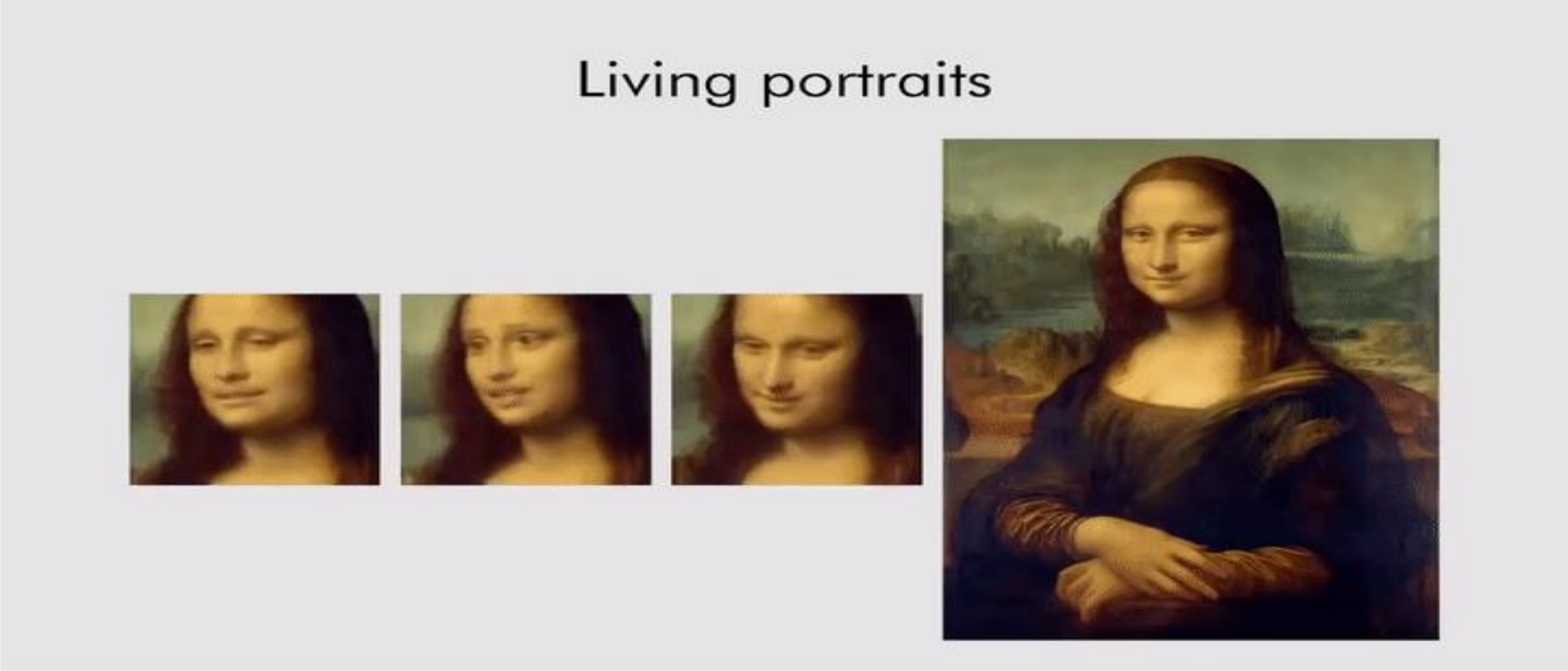
http://nvidia-research-mingyuliu.com/gaugan/



Colie Wertz, Senior Concept Artist Rogue one: A Starwars story, Bumblebee, Captain America: Civil Wars

(Shobhit)

Coolest Application



Zakharov, Egor, et al.(2019) “Few-shot adversarial learning of realistic neural talking head models”

(Shobhit)

Companies Using GANs

(Shobhit)

Why GANs

- Simulate all possible future plans
- Missing Values
- Realistic generation tasks
- Avoids Multi-modal outputs
- Data Augmentations

(Shobhit)

GANs Components

Generator

It will generate Fakes data that looks like Real

It is like a Art Forger

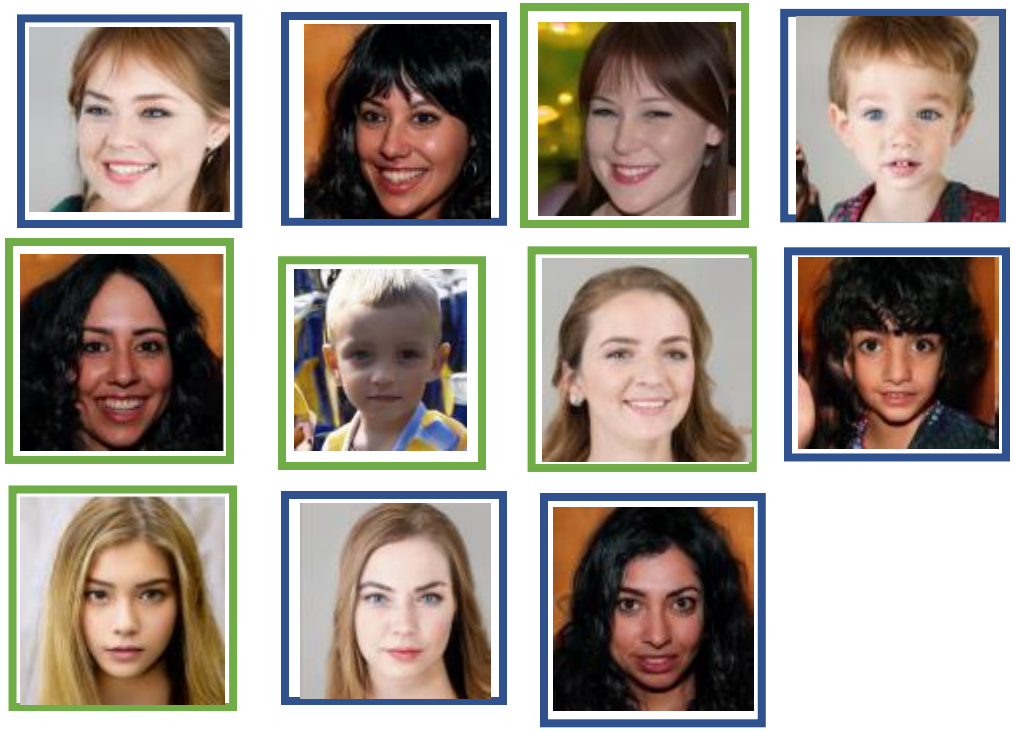
Discriminator

It will learn to distinguish Real from Fake

It is like a Art Inspector

Real

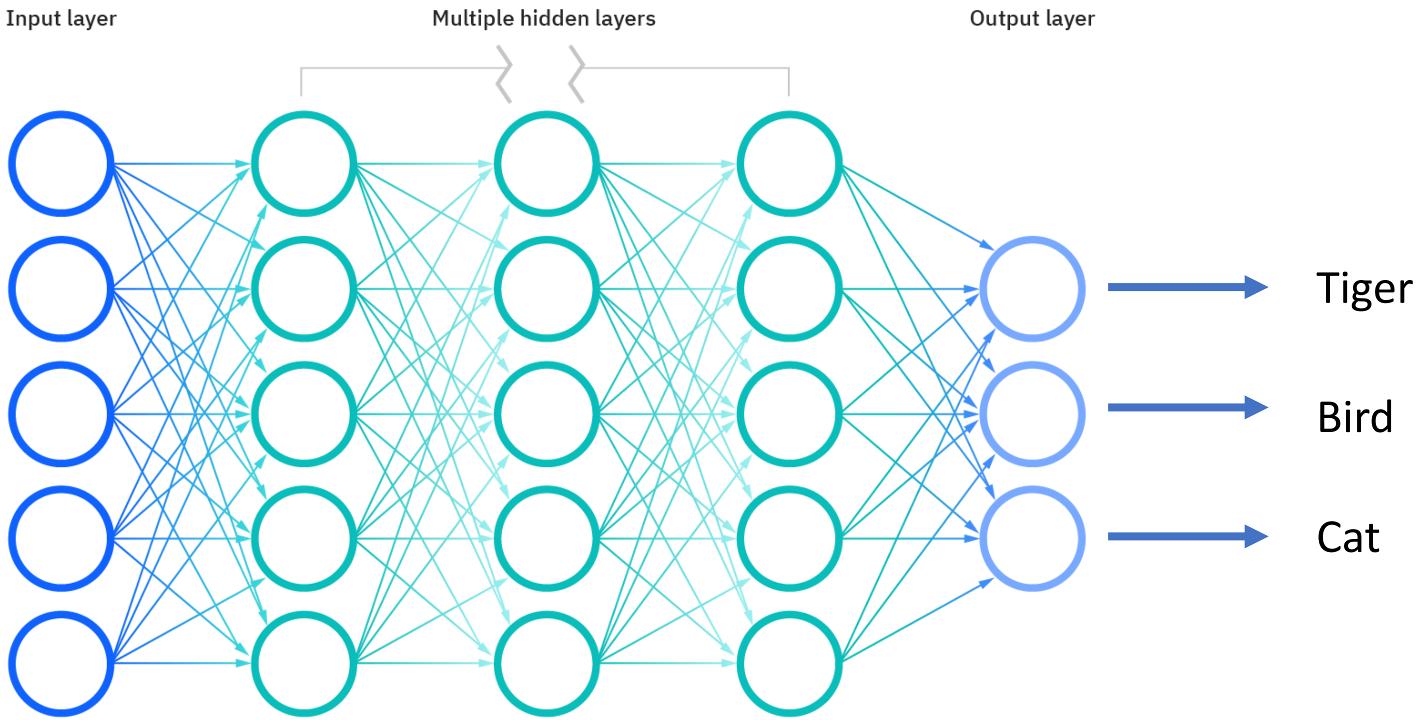
Fake



(Shobhit)

Discriminator - Classifiers

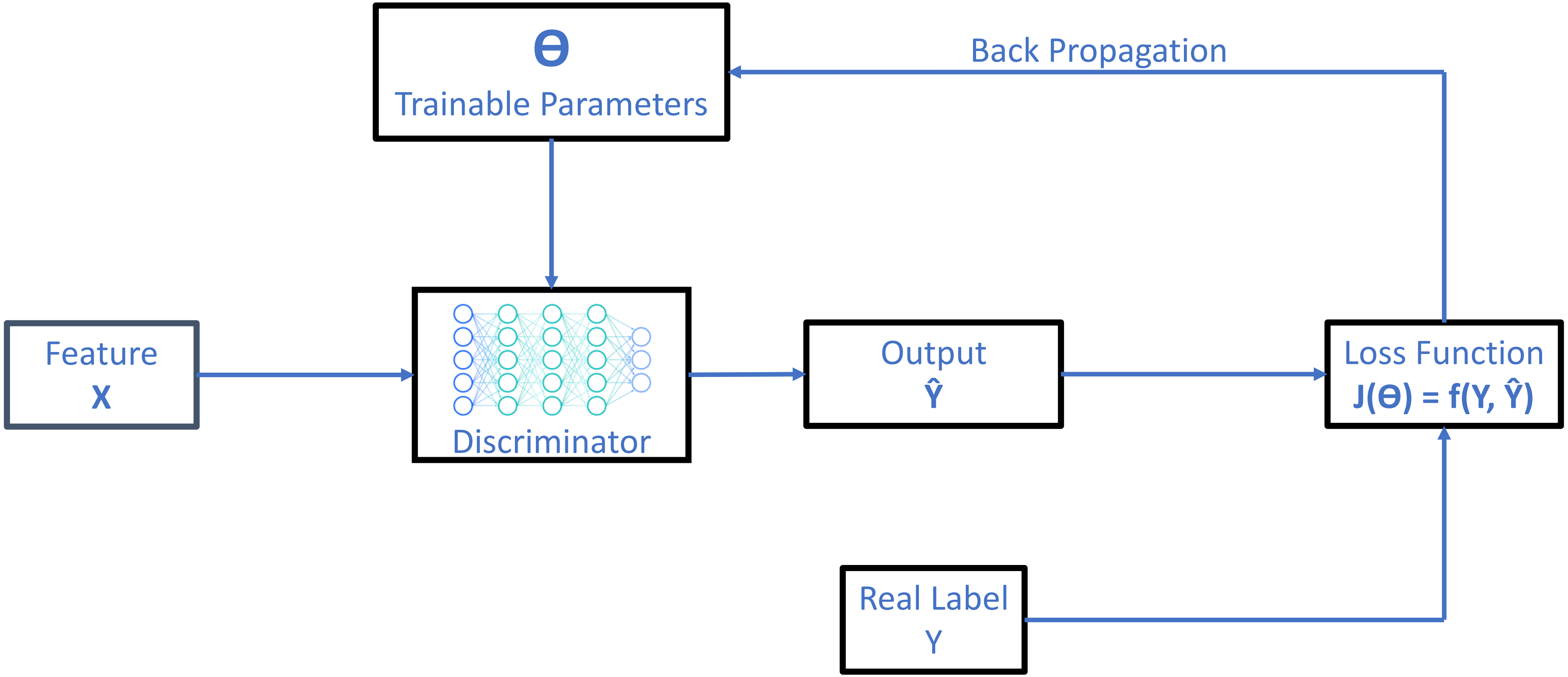
Ref: ImageNet



Ref: IBM

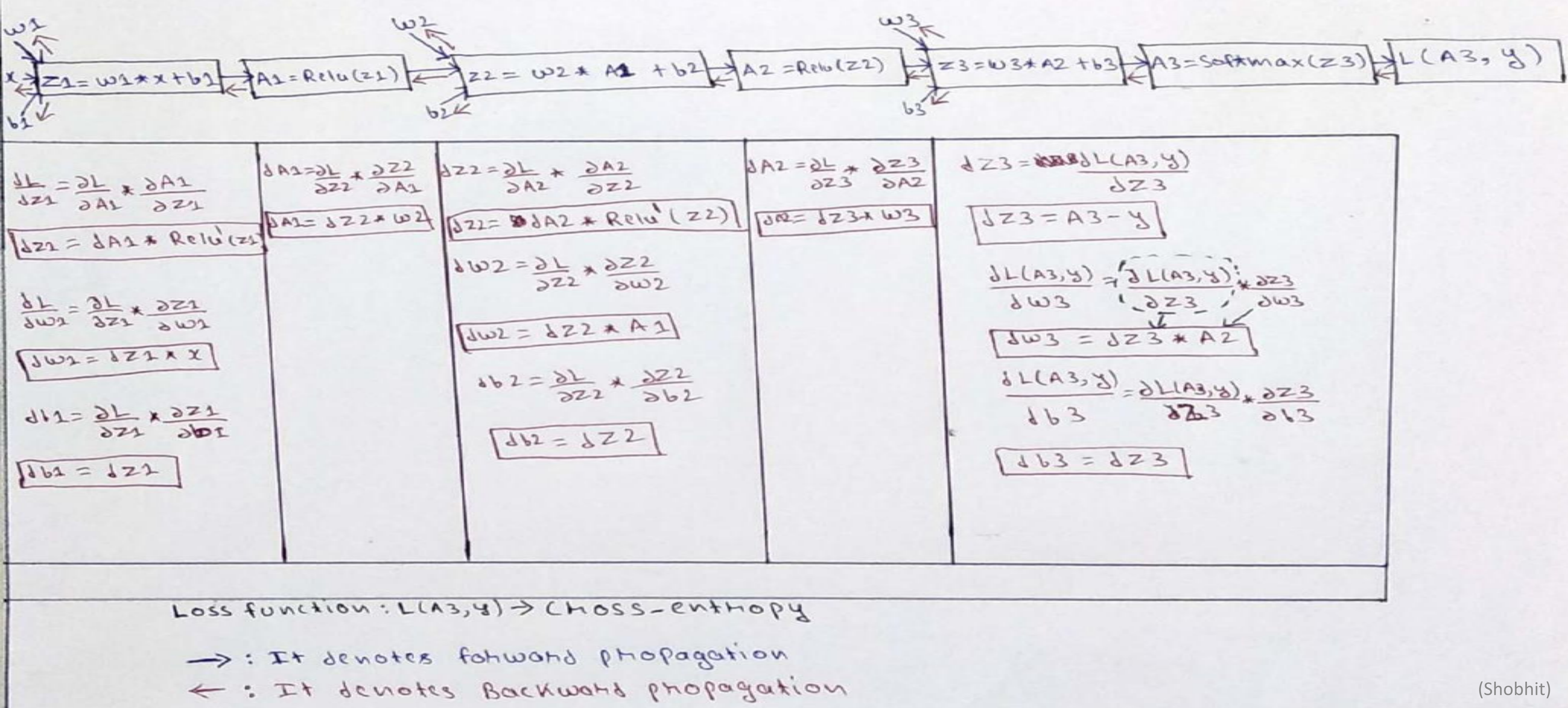
(Shobhit)

Discriminator - Training



(Shobhit)

Back Propagation Example



(Shobhit)

Discriminator - Probability

$$P(\hat{Y}|X) = \frac{P(\hat{Y} \cap X)}{P(X)}$$

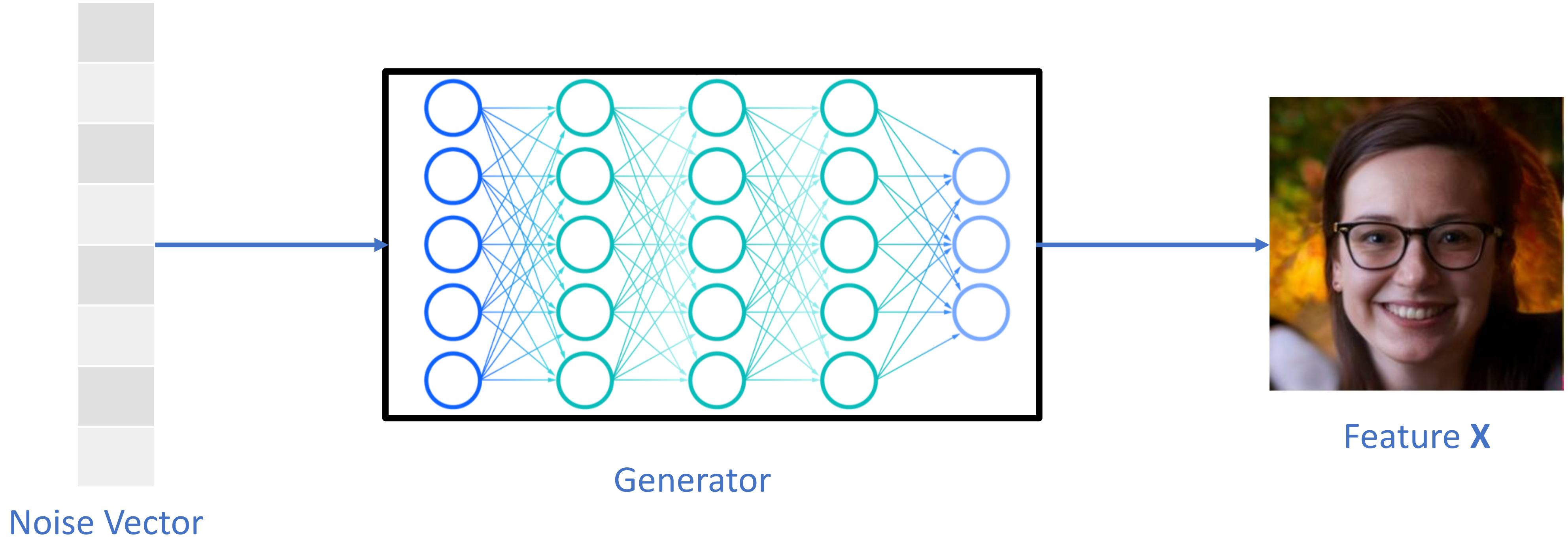
Ŷ -> Predicted Class

X -> Features

$$P(Real/Fake|$$  $$)$$

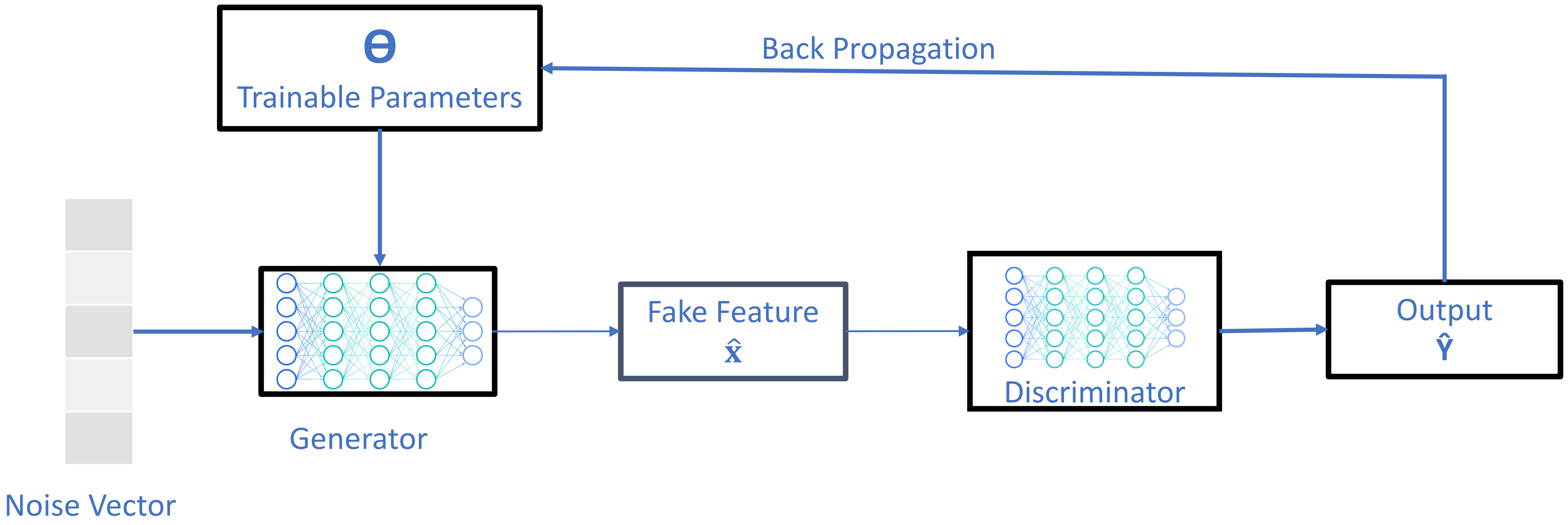
(Shobhit)

Generator



(Shobhit)

Generator - Training



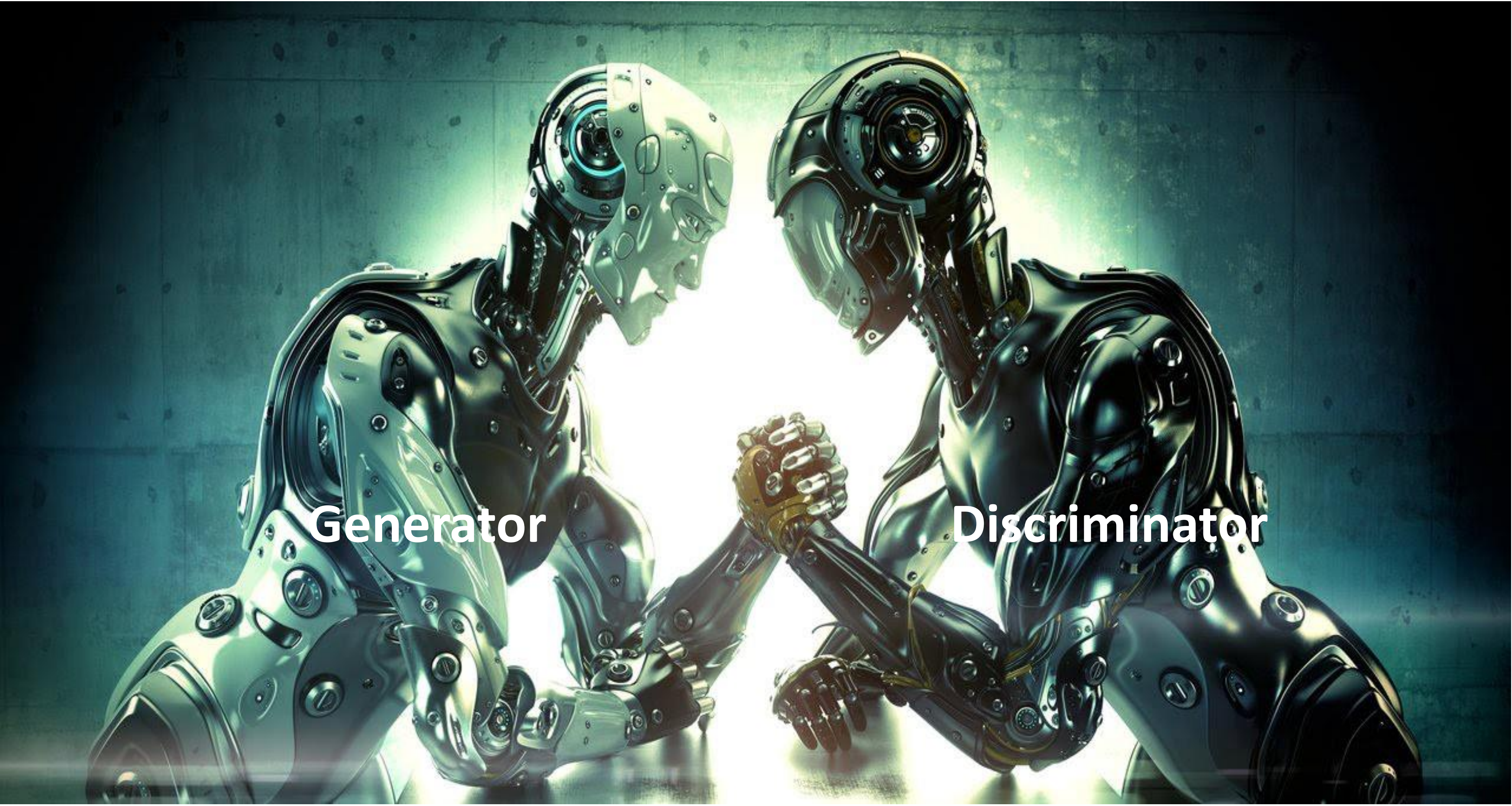
(Shobhit)

Generator - Probability

$P($  $|Human)$

$P($  $)$ -> Generate possible faces

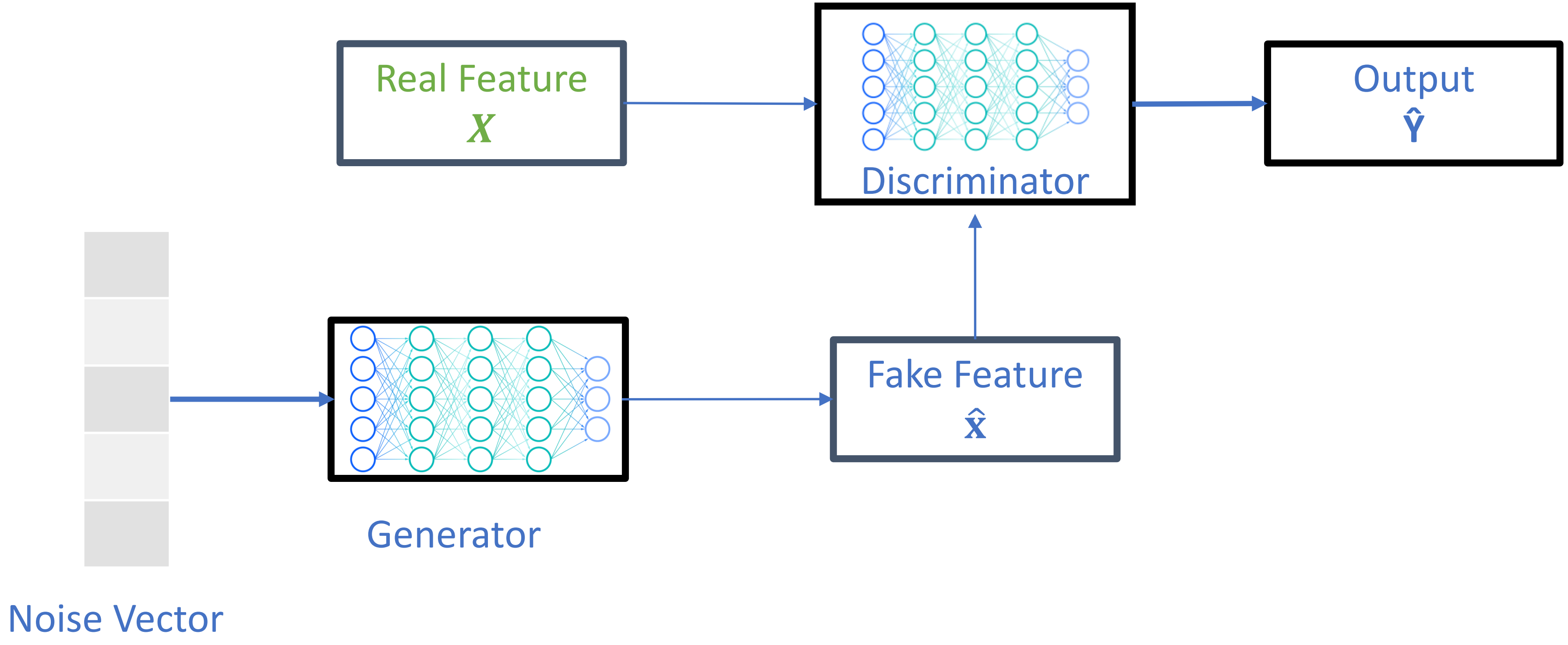
(Shobhit)



https://www.deviantart.com/ociacia/art/Robotic-Arm-Wrestling-437570457

(Shobhit)

GAN - Model



(Shobhit)

Loss Function Example – Binary Cross Entropy

$$J(\theta) = -\frac{1}{m}\sum_{i=1}^{m}[y^{(i)}\ \log h\big(x^{(i)},\theta\big) + \big(1 - y^{(i)}\big)\log(1\ - h\big(x^{(i)},\theta\big))]$$

Average Loss over whole batch

Prediction

Labels

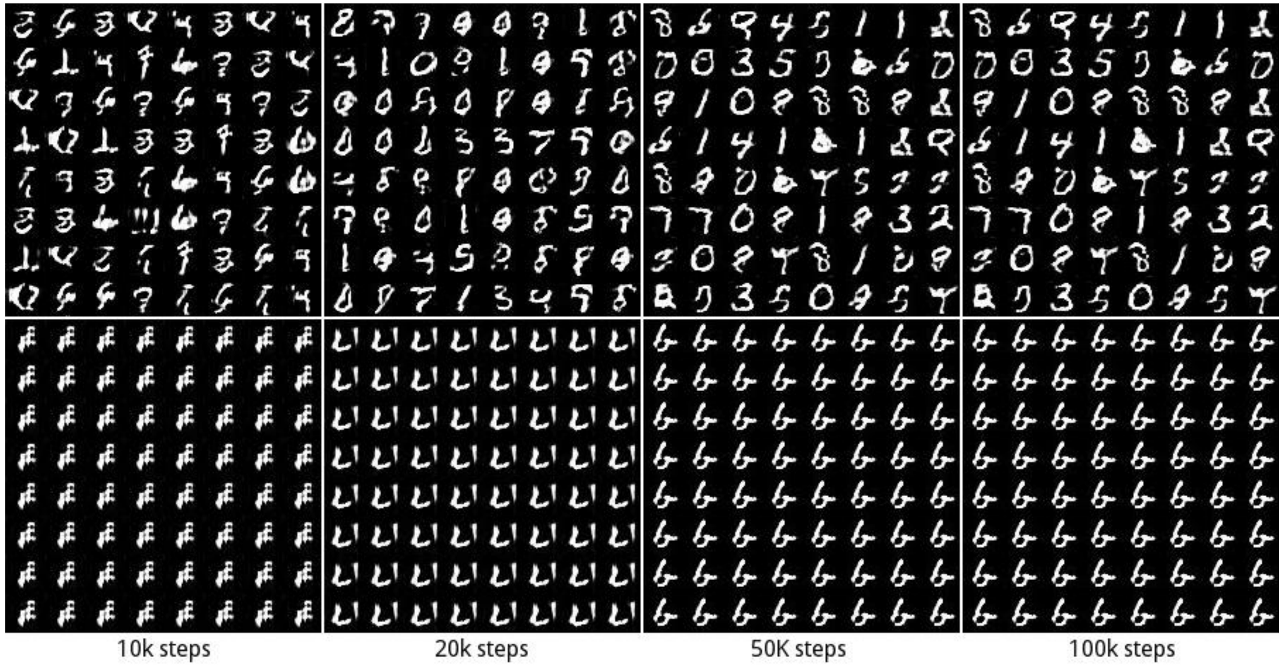
Features

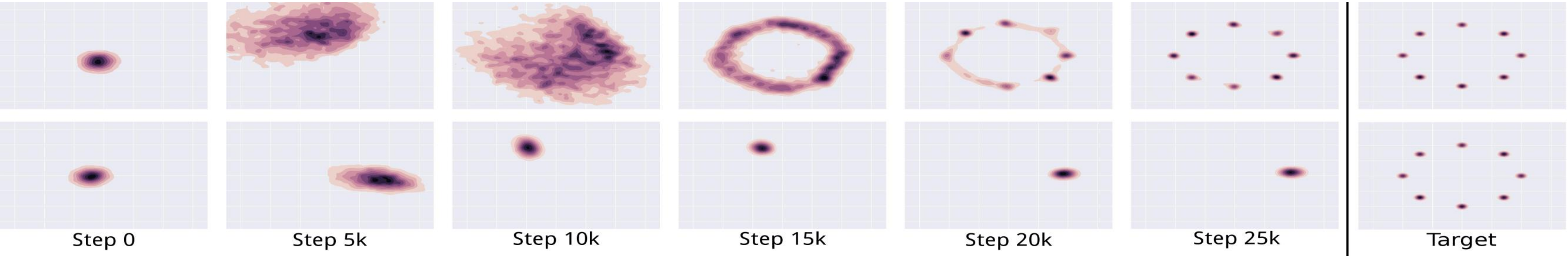
Parameters

(Shobhit)

Difficulties - Training

- Non Convergence
- Mode Collapse





Metz, Luke, et al.(2016) "Unrolled Generative Adversarial Networks."

(Shobhit)

Major Types of GANS

- Conditional GAN
- InfoGAN
- DCGAN
- StackGAN
- Wasserstein GANs(WGAN)

(Shobhit)

My Contributions to the Projects of GANs Domain

(Shobhit)

Use Case1 – Malware Detection

- **Domain** : Novel Malware Generation and Detection
- **Paper** : Shobhit and P. Bera, "ModCGAN: A Multimodal Approach to Detect New Malware," 2021 International IEEE Cyber Science, Ireland
- **Youtube Link** : https://www.youtube.com/watch?v=6-iwKgrKyPY

(Shobhit)

Use Case 2 : Image Sequence Generation from Text

Ground Truth

Generated Images

Story

The park was empty.	Many people entered the park.	After sometime, animals entered.	There were many children who were playing.	There was a food truck near it.

Links – Applications of GANs Enjoy!

- http://nvidia-research-mingyuliu.com/vid2vid-cameo/
- http://nvidia-research-mingyuliu.com/ganimal
- http://nvidia-research-mingyuliu.com/gaugan
- https://www.nvidia.com/research/inpainting/index.html
- https://www.wombo.ai/

(Shobhit)

Summary

- GANs are generative models that are implemented using two stochastic neural network modules: **Generator** and **Discriminator**.
- **Generator** tries to generate samples from random noise as input
- **Discriminator** tries to distinguish the samples from Generator and samples from the real data distribution.
- Both networks are trained adversarially to fool the other component. In this process, both models become better at their respective tasks.
- Can be trained using back-propagation for Neural Network based Generator/ Discriminator functions.
- Sharper images can be generated.
- Faster to sample from the model distribution: *single* forward pass generates a *single* sample.

Questions

&

Thank You

(Shobhit)