



Generating Images with GANs

Raghav Bali

Image Sources:

AICAN, *Permutations*, 2017. Image: AICAN.io — Ahmed Elgammal | Edmond de Belamy, from *La Famille de Belamy* ([link](#)) | <https://thispersondoesnotexist.com/>

Agenda

👤 About Me

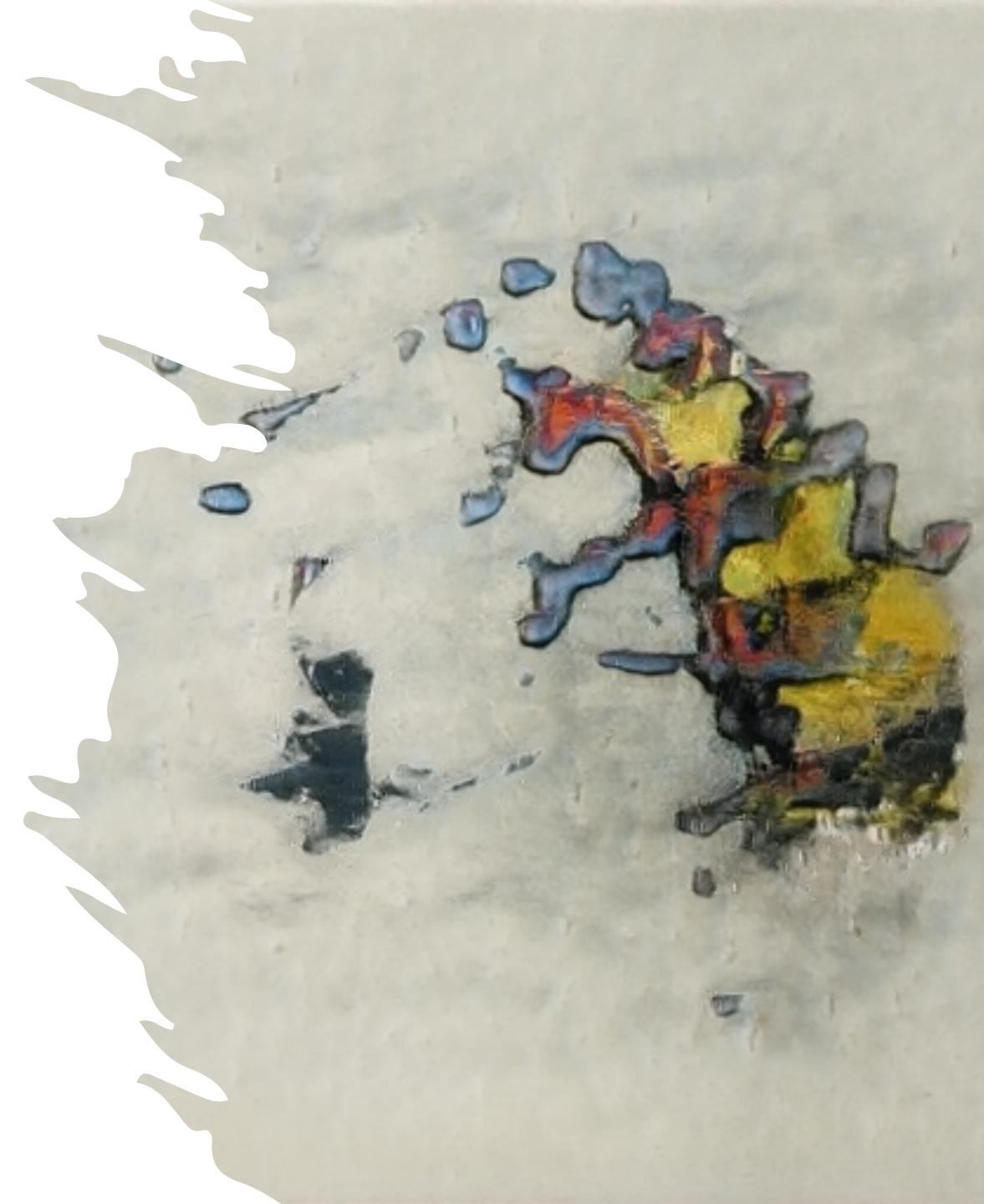
- Machine Learning Landscape
- Generative Modeling
- Generative Adversarial Networks

💻 Generate Images : Hands-on

- Challenges
- Q/A
- Give-away

Image Sources:

- [https://thisartworkdoesnotexist .com/](https://thisartworkdoesnotexist.com/)



Raghav Bali

- Senior Data Scientist at Optum(United HealthGroup)
- A decade's experience involving research & development of enterprise level solutions based on Machine Learning, Deep Learning and Natural Language Processing for real world use-cases.



Optum
2017 - Present



Intel
2015 - 2017



American Express
2014 - 2015

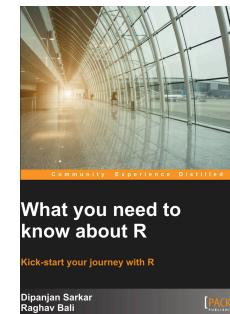
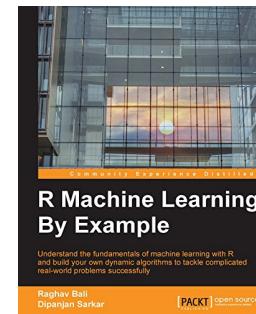
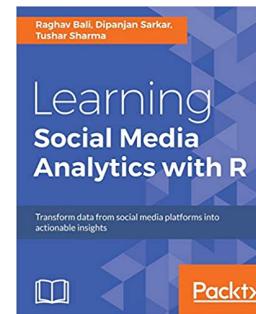
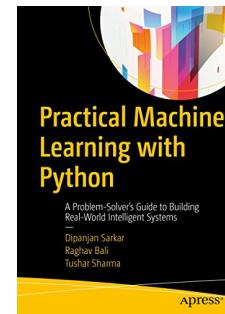
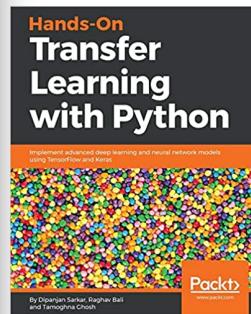
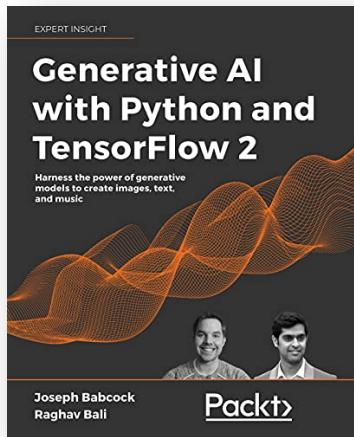
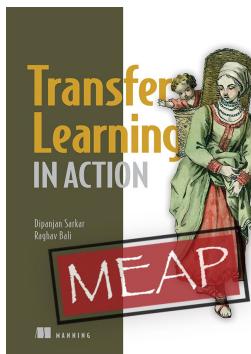


International
Institute of Information
Technology Bangalore
IIIT Bangalore
2012 - 2014

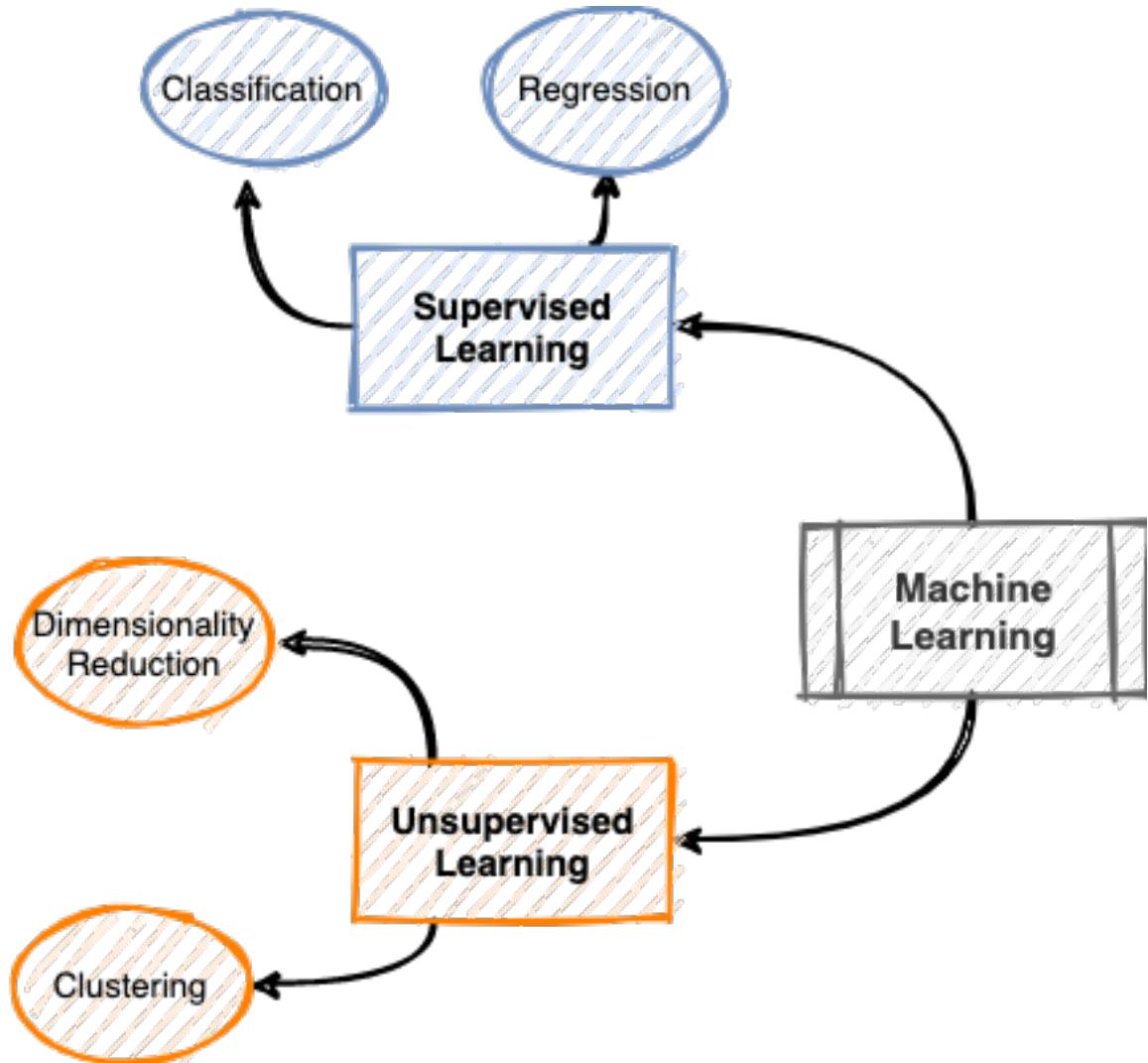


Raghav Bali : Publications

- Talks/Workshops at leading conferences such as Analytics Vidhya, SpringBoard, ODSC, etc.
- Patents: 7 patents in the field of healthcare, deep learning, machine learning and NLP
- Papers
 - CAIAC 2021, EASTER: Simplifying Text Recognition using only 1D Convolutions
 - CAIAC 2021, A Simple and Interpretable Predictive Model for Healthcare
 - Preprint, Exclusion and Inclusion--A model agnostic approach to feature importance in DNNs
 - IEEE SmartData 2016, Real Time Failure Prediction of Load Balancers and Firewalls
- Books

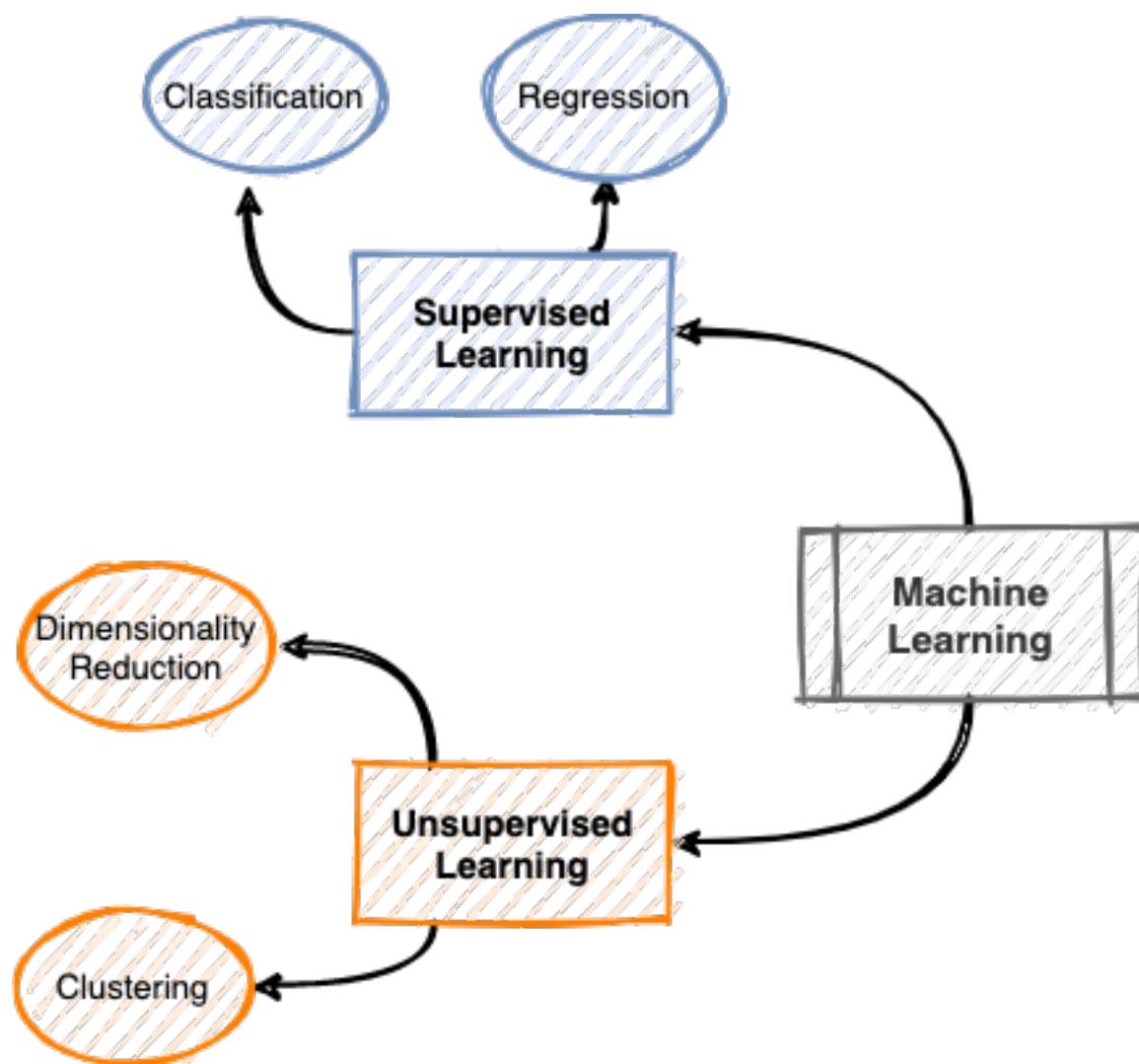


Machine Learning Landscape

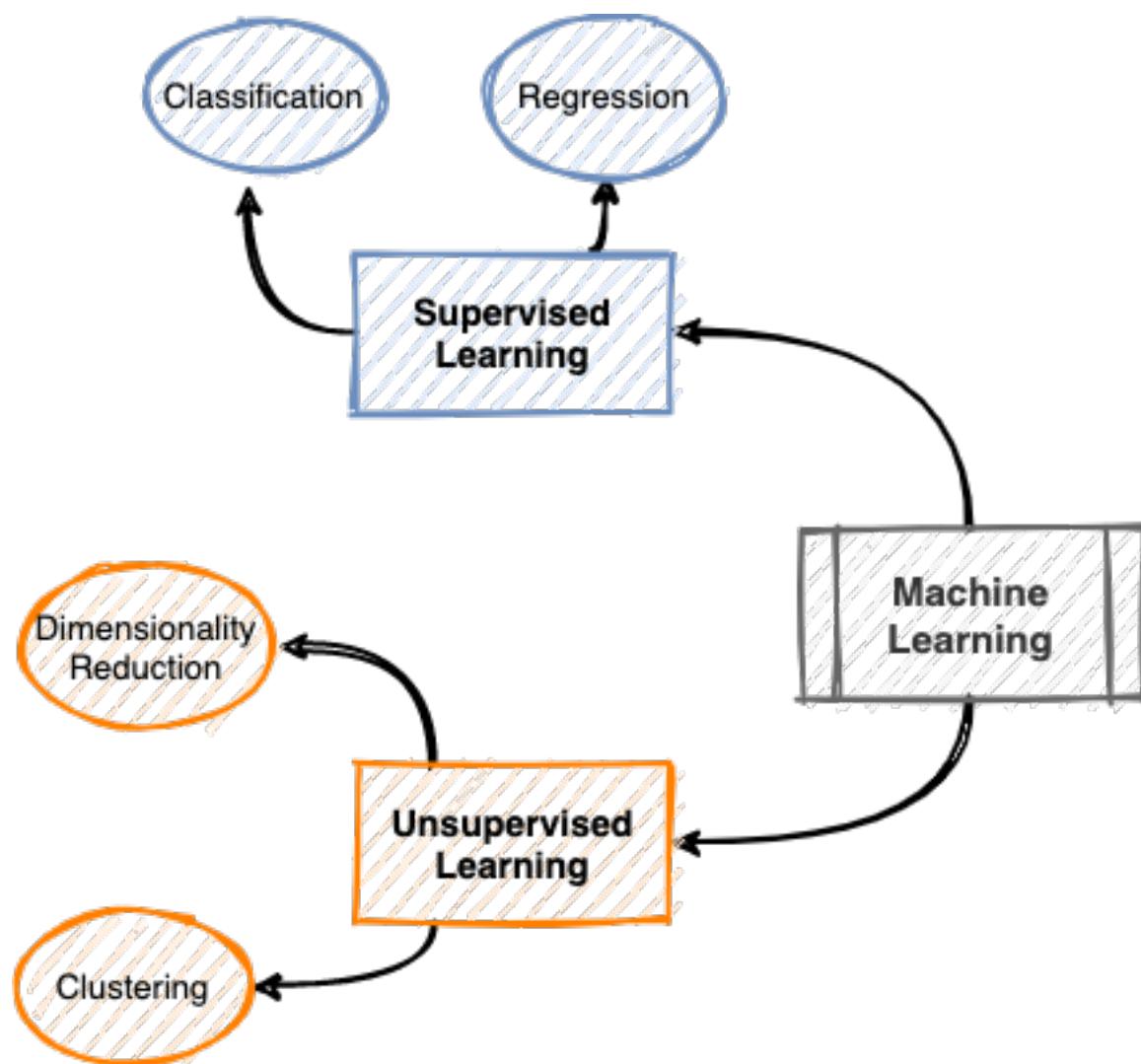


- **Supervised**
 - Regression
 - Classification
- **Unsupervised**
 - Clustering
 - Dimensionality Reduction

Machine Learning Landscape



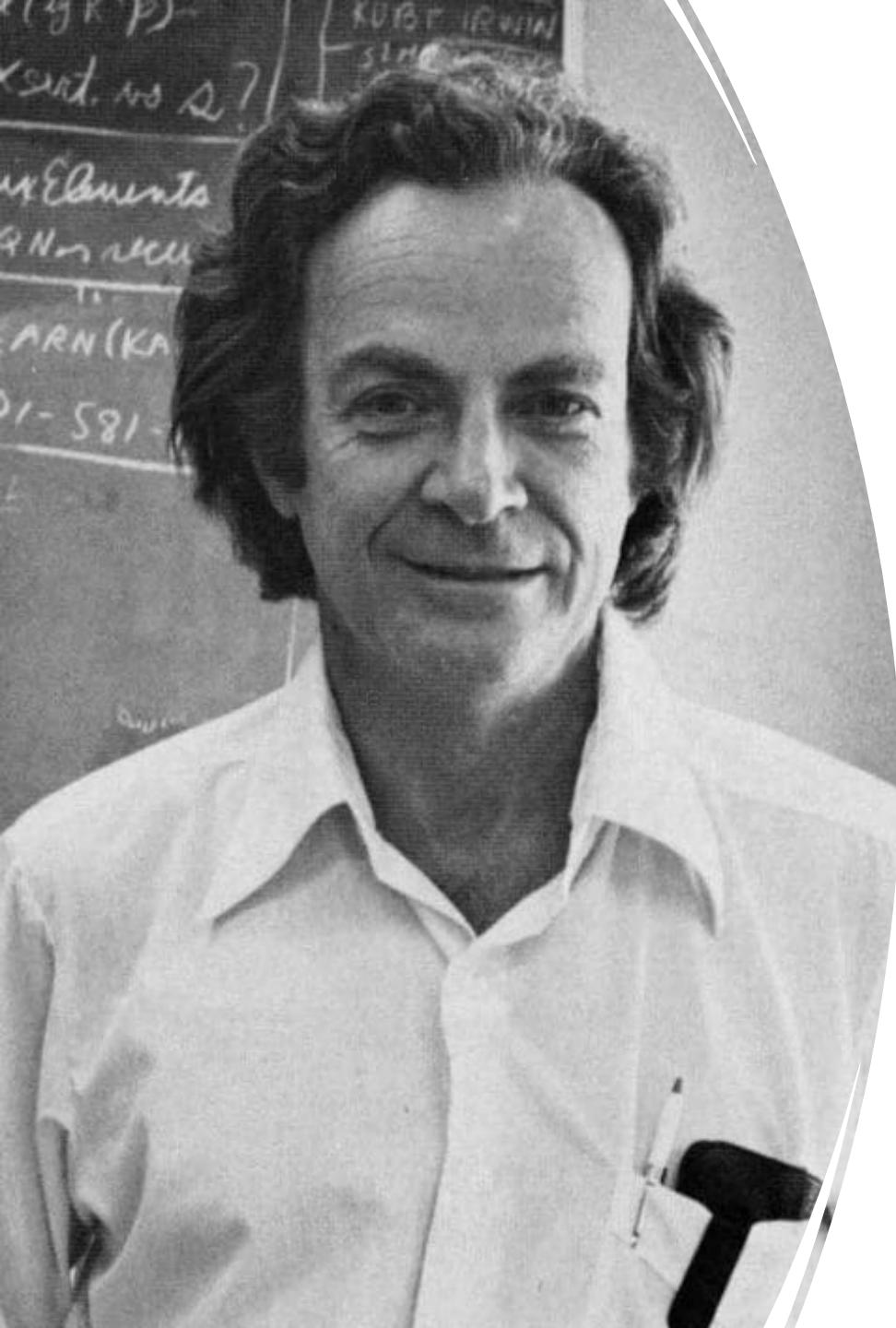
- **Supervised**
 - Regression
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 - **Unsupervised**
 - Clustering
 - Dimensionality Reduction
- Discriminative Modeling**



Machine Learning Landscape

- **Supervised**
 - Regression
 - Classification
 - **Unsupervised**
 - Clustering
 - Dimensionality Reduction
- Discriminative Modeling

Is there something called
Generative Modeling?



Generative Modeling

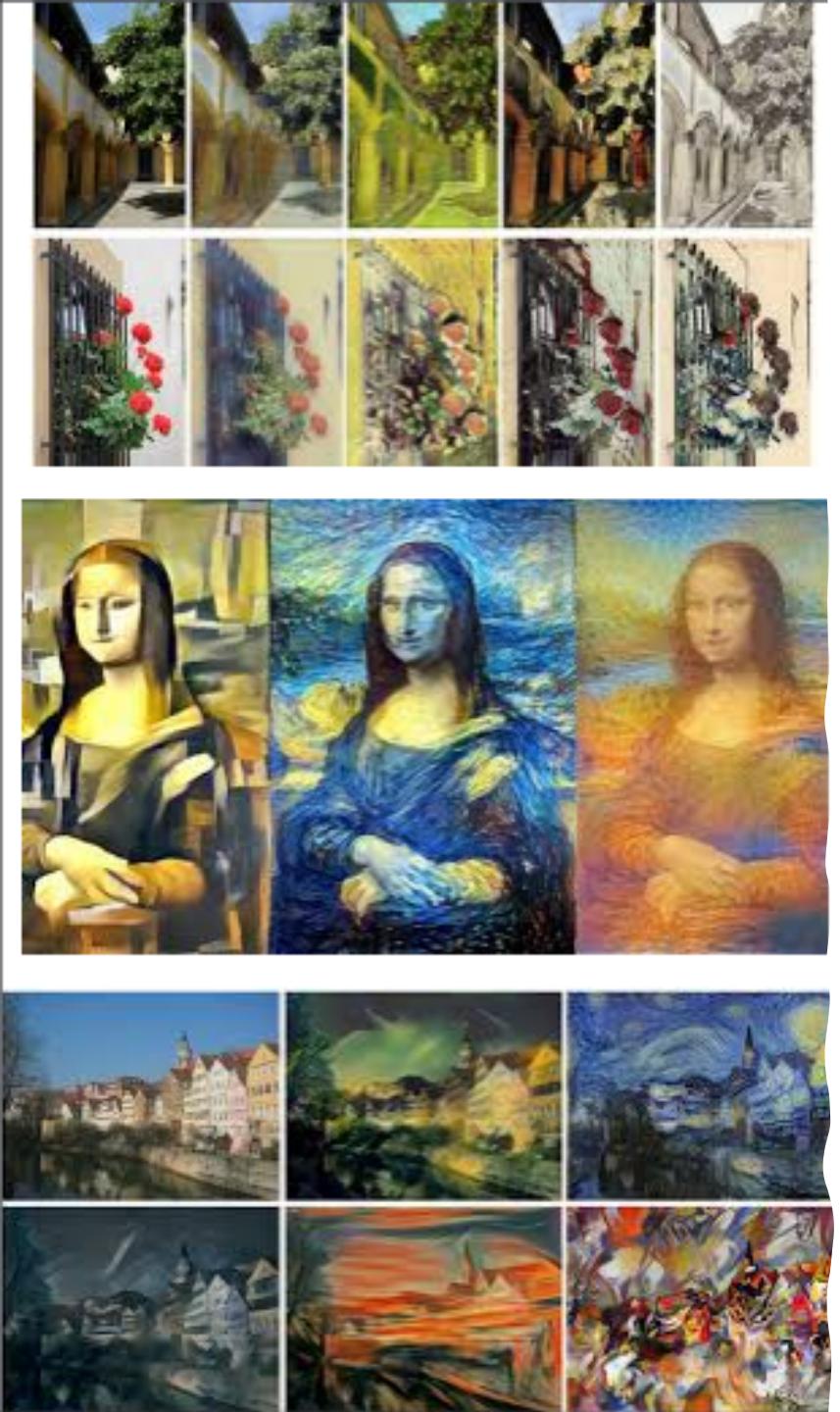
“What I cannot create, I do not understand”

- Richard Feynman

Generative Modeling

- Generative models are a class of models in the unsupervised machine learning space
- These help us model the underlying distributions responsible for generating the dataset under consideration

“There is tremendous amount of data easily accessible in most cases. Generative models analyze and understand such datasets”

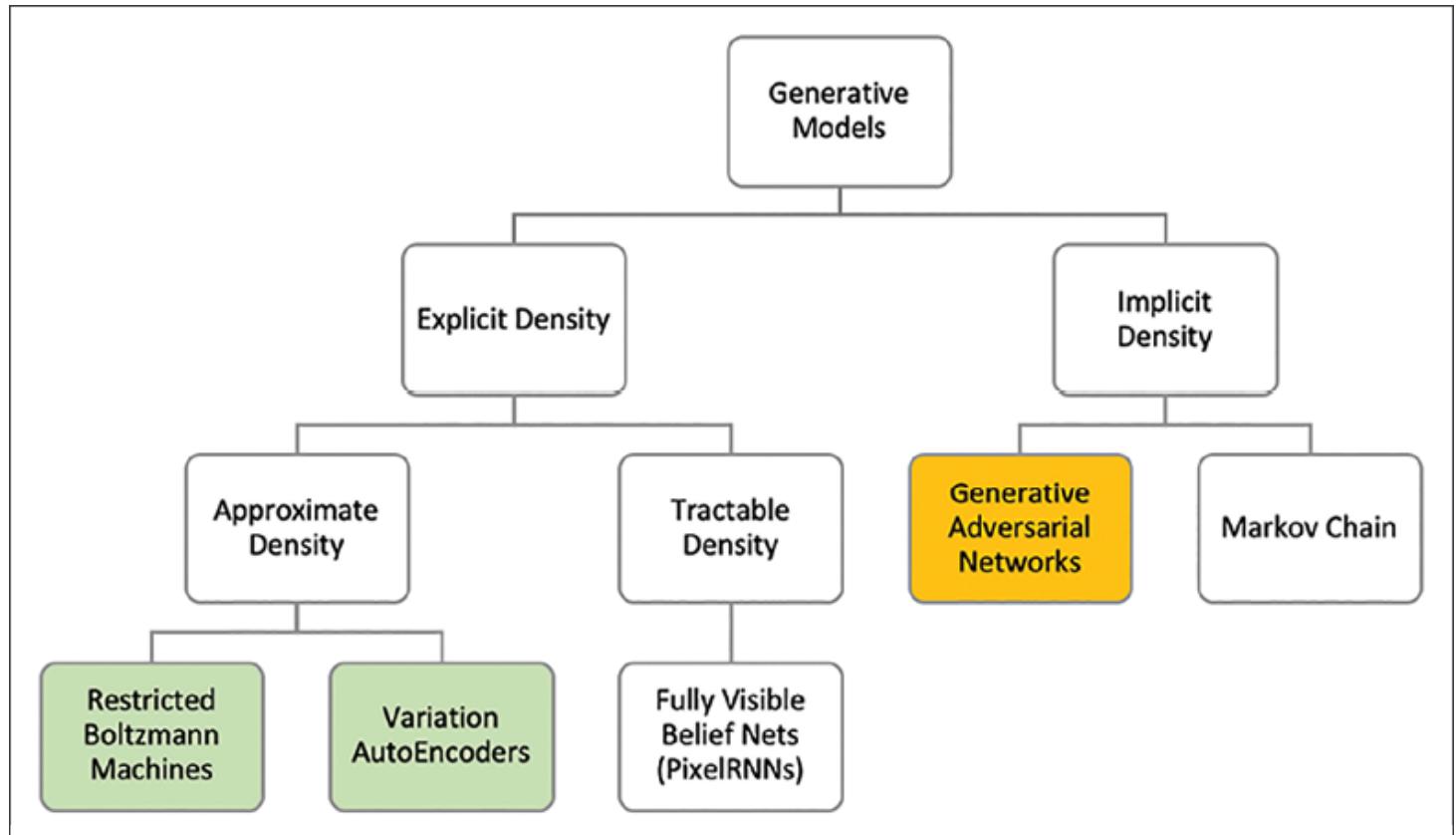


Generative Modeling: Applications

- Productive Applications
 - Image Denoising
 - In-painting
 - Super-resolution
 - Music generation
 - Text generation
 - Style transfers... and many more
- Malicious Applications
 - Pornography & Identity theft
 - Fake-News/Misinformation spread

Generative Modeling: Topology

- Explicit Density
 - Define an underlying probability distribution function, $p\theta$
 - Objective is to increase the maximum likelihood of sampling from this distribution
- Implicit Density
 - Define methods to draw samples from underlying probability distribution function (without defining it explicitly)



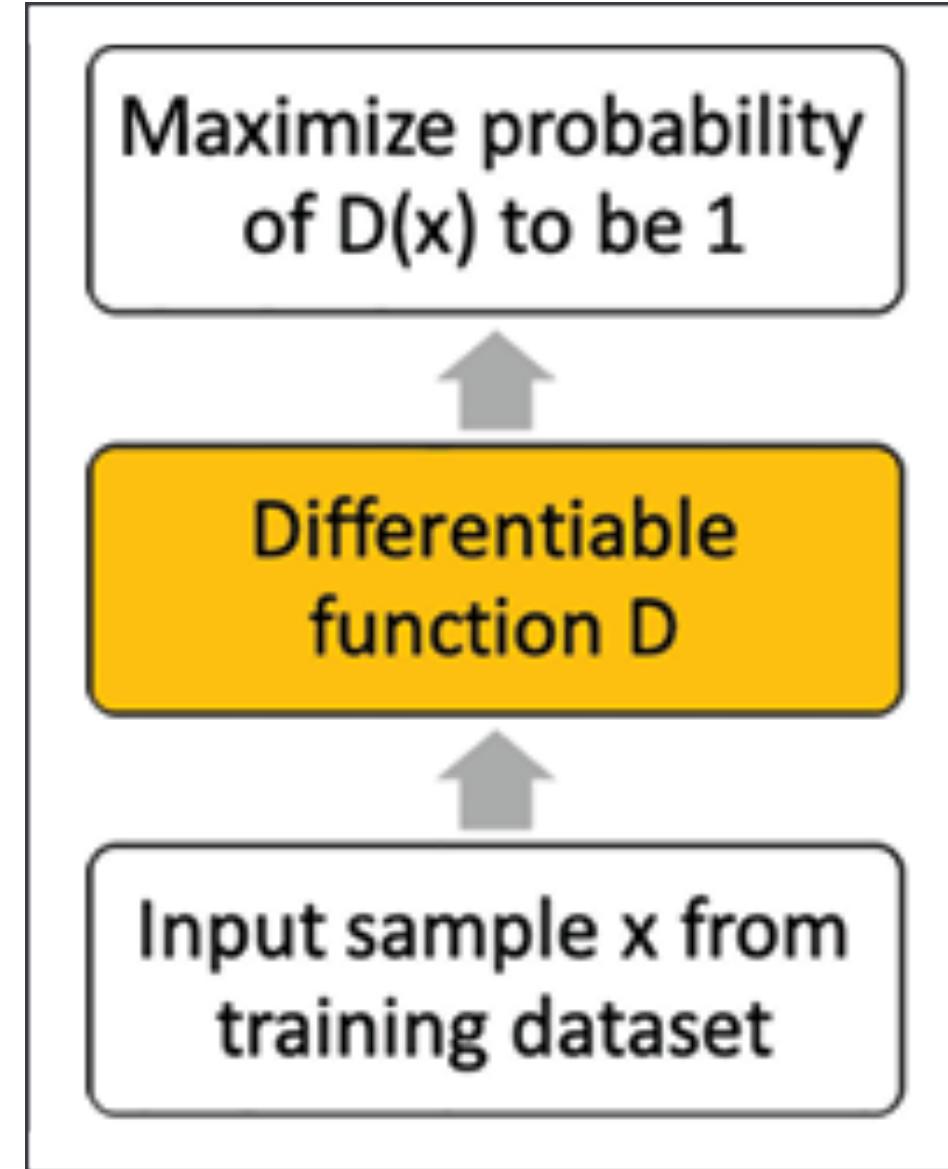
Generative Adversarial Networks

- GANs are implicit density functions which sample directly from the underlying distribution.
- They do this by defining a two-player game of adversaries.
- The adversaries compete against each other under well-defined reward functions and each player tries to maximize its rewards

“Discriminator Vs Generator”

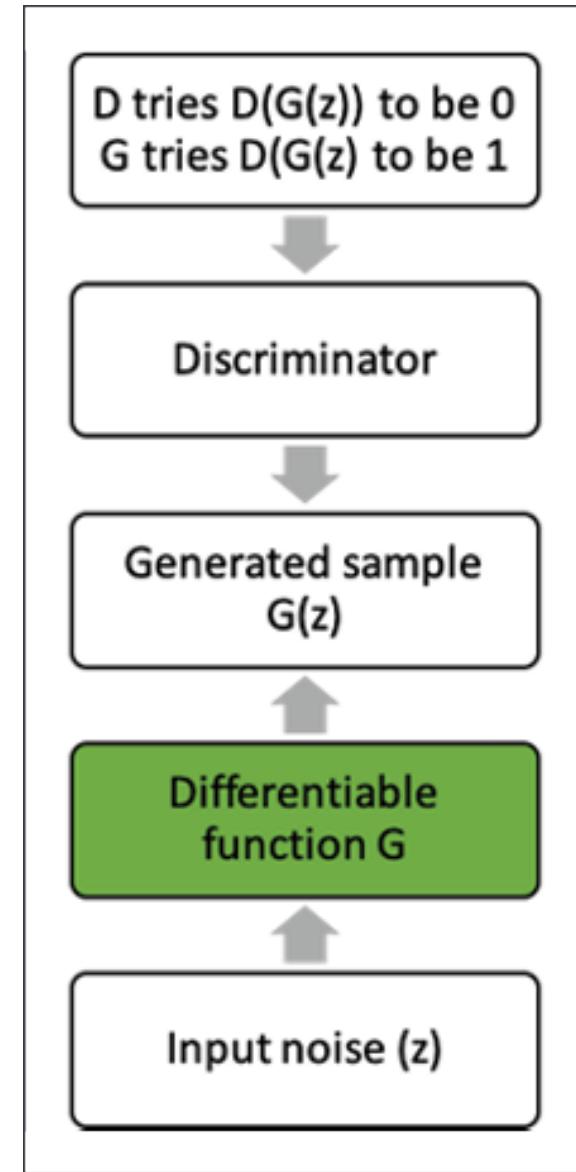
GAN: Discriminator

- This model represents a differentiable function that tries to maximize a probability of 1 for samples drawn from the training distribution.
- The discriminator is also used to classify whether the output from the generator is real or fake.
- We denote the discriminator model as D and its output as $D(x)$.



GAN: Generator

- This model generates samples that are intended to resemble the samples from our training set.
- The model takes random unstructured noise as input (typically denoted as z) and tries to create a varied set of outputs.
- We denote the generator as G and its output as $G(z)$.
- We typically use a lower-dimensional z as compared to the dimension of the original data, x , that is, $z_{dim} \leq x_{dim}$



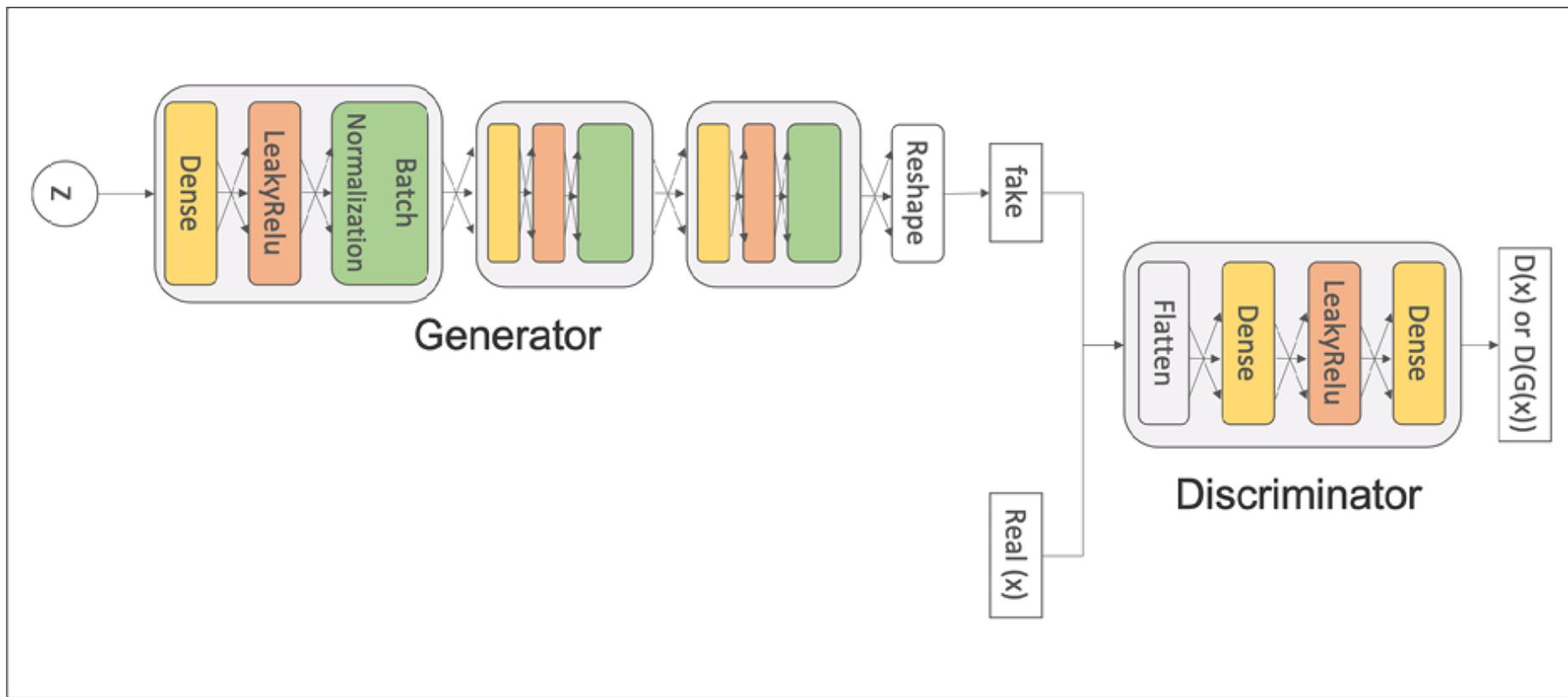
GAN: Training

- Training a GAN is like playing this game of two adversaries.
- More formally, this is termed as the minimax game, where the value function $V(G, D)$ is described as follows:

$$\min_G \max_D V(G, D) = E_{x \sim p_{data}} \log \log D(x) + E_{z \sim p_z} \log \log (1 - D(G(z)))$$

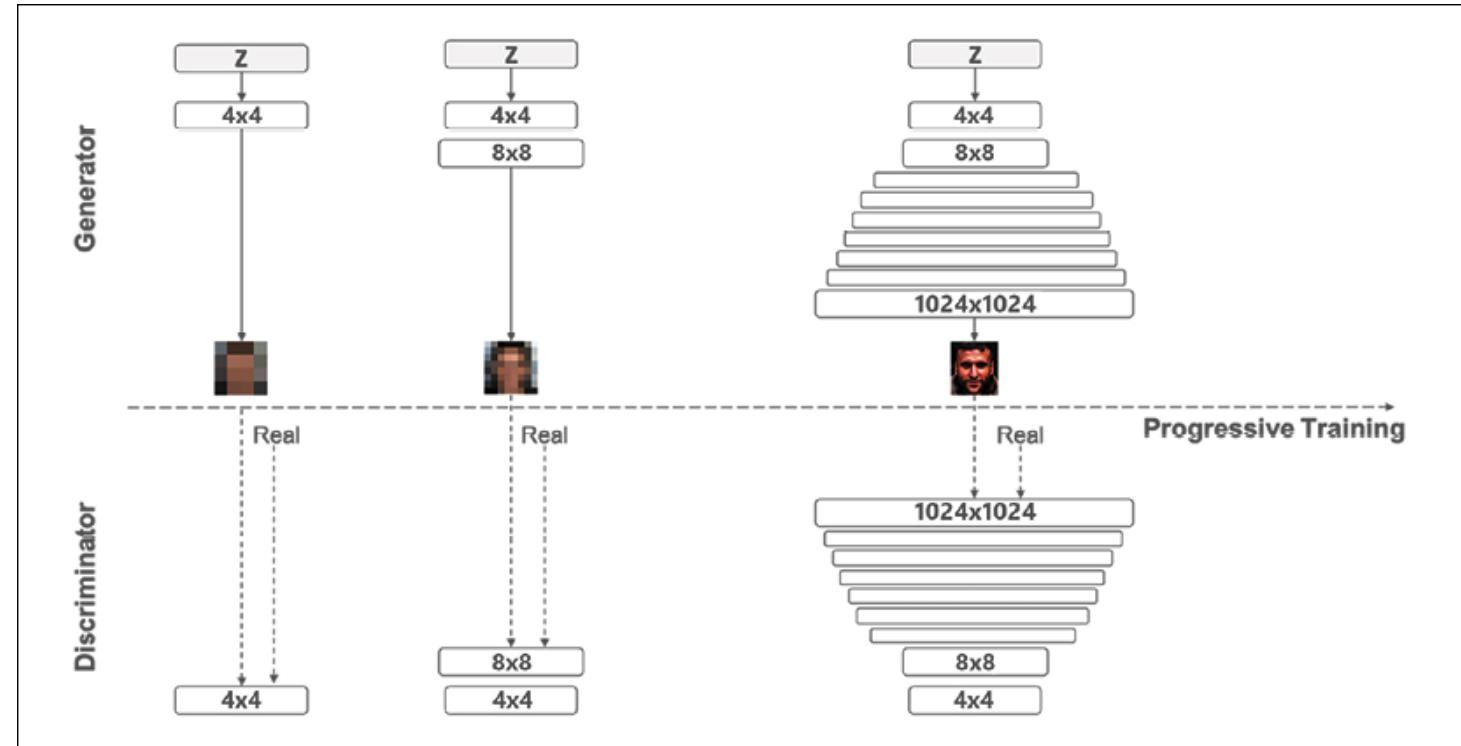
Hands-on: 1

- Vanilla GAN
- Hello World with MNIST



GAN: Progressive GAN

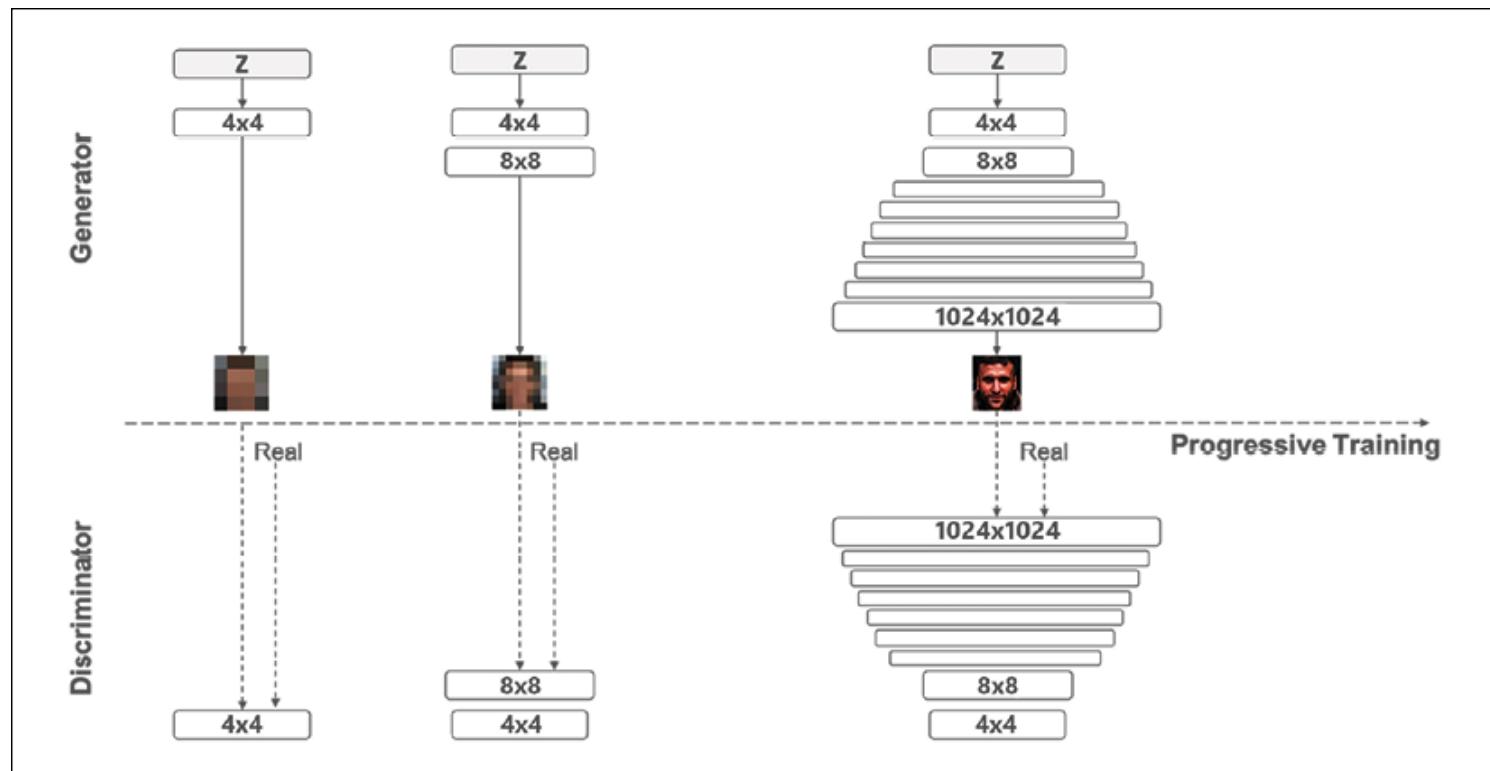
- Generating high resolution images is hard
- Typical engineering solution to solve hard problems *is to break it into smaller feasible ones*
- Instead of training a GAN to directly generate high resolution images, **progressively** increase its output resolution
- Results in :
 - Faster training
 - Lesser memory
 - High resolution/quality output



Source: Karras, T., Aila, T., Laine, S., Lehtinen, J. (2017). *Progressive Growing of GANs for Improved Quality, Stability, and Variation*. arXiv:1710.10196. <https://arxiv.org/abs/1710.10196>

Hands-on: 2

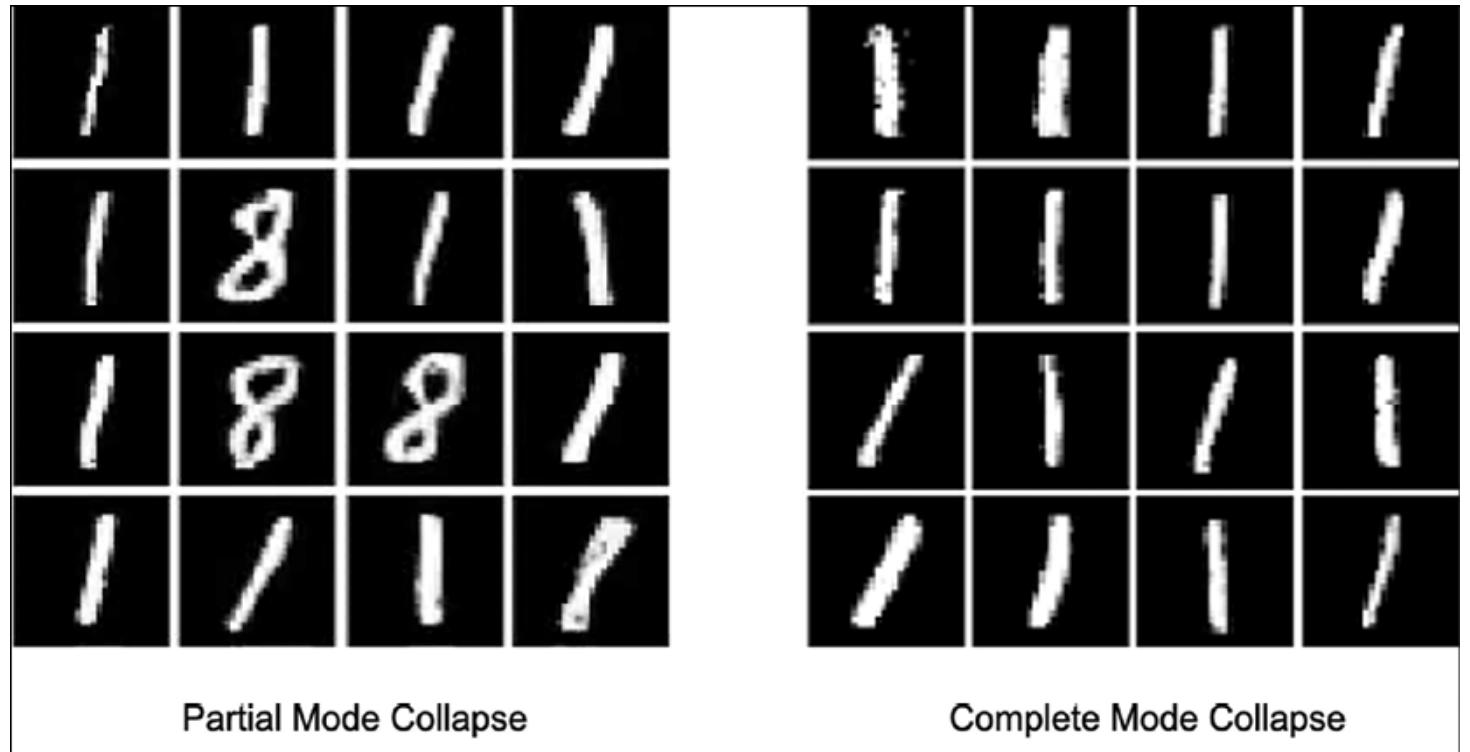
- Progressive GAN
- TF-Hub

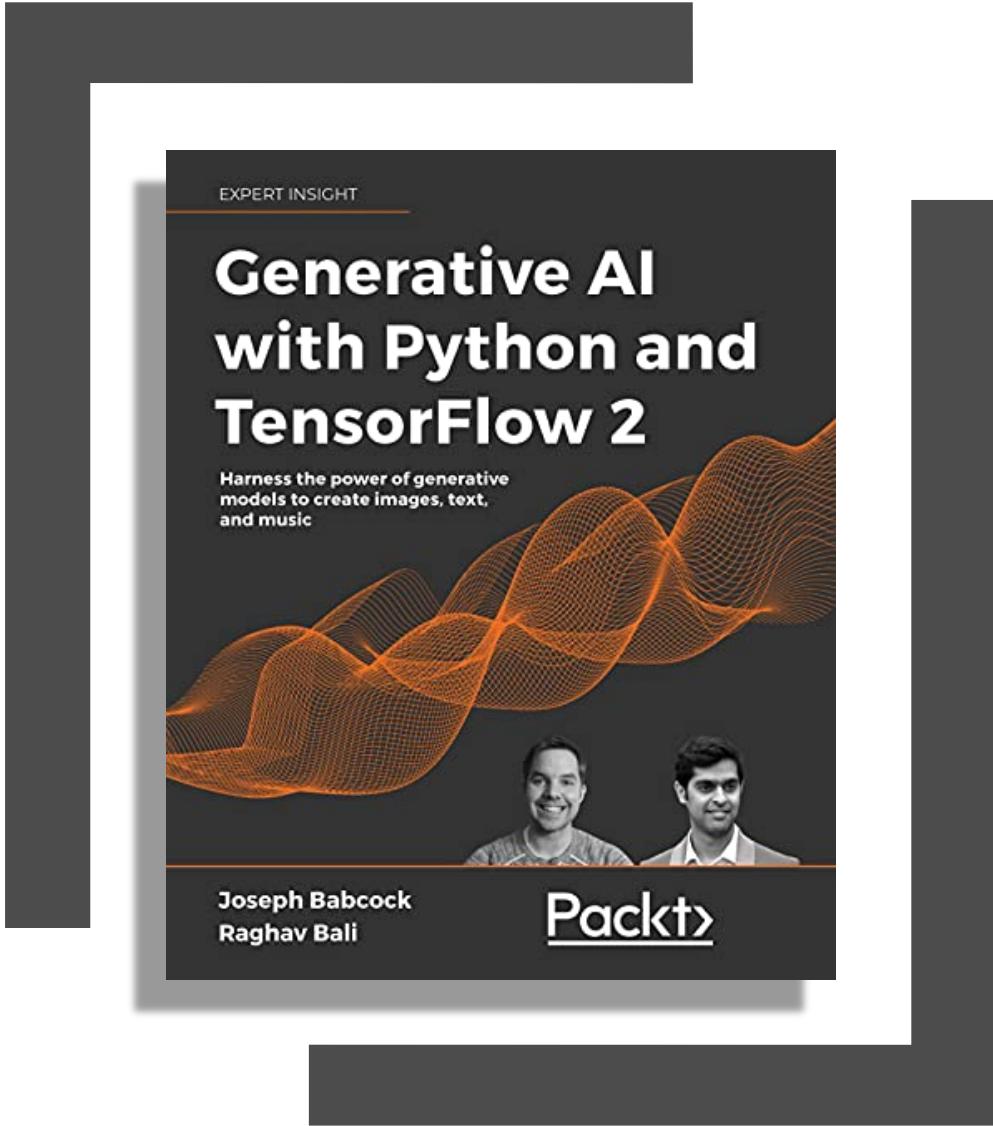


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Challenges

- Training Instability
- Mode Collapse
- Uninformative Loss





Q/A

For more such interesting and usable generative models, refer to
"Generative AI with python and TensorFlow 2"

Give-Away



HARD-COPIES



E-BOOKS



WINNER'S LIST WILL
BE ANNOUNCED
SHORTLY

EXPERT INSIGHT

Generative AI with Python and TensorFlow 2

Harness the power of generative models to create images, text, and music

Joseph Babcock
Raghav Bali

Packt