Application Matrix of Families of Generative Models for Computer Vision

Ed Mwanza, PhD candidate Comp. Sci.

July 17, 2023

Table 1: Application Matrix of Families of Generative Models for Computer Vision

	Applications						
	Data Augmentation	Super Resolution	Inpainting	Denoising	Style Transfer	Object Transfiguration	Image Colorization
VAEs	🟢	🔴	🔴	🔴	🔴	🔴	🔴
GANs	🟢	🔴	🔴	🔴	🟢	🟢	🔴
Flow-based Models	🟢	🔴	🔴	🔴	🟡	🟡	🔴
Auto-regressive Models	🟢	🔴	🔴	🔴	🟡	🟡	🔴
Hybrid Models	🟢	🔴	🔴	🔴	🟢	🟢	🔴
Diffusion Models	🟢	🔴	🔴	🔴	🔴	🔴	🔴
Other notable models	🟢	🟢	🟢	🟢	🟢	🟢	🟢

Variational Autoencoders (VAEs)

- Vanilla VAE
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: Vanilla VAE is a basic VAE model that learns a latent representation of data.
- β-VAE
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: β-VAE introduces a regularization term to the VAE's objective function to control disentanglement of latent factors.
- VQ-VAE
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: VQ-VAE uses vector quantization to learn a discrete latent space and enables high-quality image generation.
- VAE-GAN
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: VAE-GAN combines the variational autoencoder (VAE) and generative adversarial network (GAN) frameworks for improved generative modeling.
- CVAE (Conditional VAE)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: CVAE extends the VAE framework to incorporate conditional information for controlled generation.
- DFC-VAE (Disentangled Feature Control VAE)

  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: DFC-VAE introduces mechanisms to disentangle specific features in the latent space for better control over generated outputs.

- HiVAE (Hierarchical VAE)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: HiVAE incorporates hierarchical structure into the VAE framework to capture hierarchical relationships in data.

- VLAE (Variational Lossy Autoencoder)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: VLAE is an extension of the VAE model that allows lossy compression of data by learning multiple latent representations.

- AdaVAE (Adaptive VAE)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: AdaVAE incorporates an adaptive mechanism to dynamically adjust the capacity of the VAE during training.

- SCVAE (Semi-Supervised Conditional VAE)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: SCVAE combines the conditional VAE framework with semi-supervised learning for enhanced modeling of labeled and unlabeled data.

- AAE (Adversarial Autoencoder)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper

  - **Owner**: Company/Group Name
  - **Explanation**: AAE combines the autoencoder and GAN frameworks to achieve unsupervised learning and adversarial training.

Generative Adversarial Networks (GANs)

- Vanilla GAN
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: Vanilla GAN is the original GAN model that consists of a generator and discriminator network.
- DCGAN (Deep Convolutional GAN)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: DCGAN extends the GAN model with deep convolutional networks for more stable training and better image generation.
- CGAN (Conditional GAN)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: CGAN incorporates conditional information into the GAN framework for controlled generation.
- WGAN (Wasserstein GAN)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: WGAN uses Wasserstein distance as the training objective for improved stability and meaningful loss metrics.
- LSGAN (Least Squares GAN)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name

  - **Explanation**: LSGAN replaces the binary GAN loss with a least squares loss for better training dynamics and improved image quality.

- CycleGAN
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: CycleGAN performs image-to-image translation using cycle consistency loss to learn mappings between domains without paired data.

- ProGAN (Progressive GAN)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: ProGAN progressively grows both the generator and discriminator during training to generate high-resolution images.

Flow-based Models

- RealNVP (Real-valued Non-Volume Preserving)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: RealNVP is a flow-based model that models the data distribution with a sequence of invertible transformations.

- Glow
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: Glow is a flow-based model that utilizes invertible 1×1 convolutions to learn a tractable and flexible data distribution.

- FFJORD (Continuous-Time Flows)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name

  - **Explanation**: FFJORD is a flow-based model that leverages continuous-time normalizing flows for efficient and expressive generative modeling.

Auto-regressive Models

- PixelRNN
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: PixelRNN is an auto-regressive model that generates images by modeling the conditional distribution of each pixel given previous pixels.
- PixelCNN
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: PixelCNN is an auto-regressive model that generates images by modeling the joint distribution of all pixels in parallel.
- WaveNet
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: WaveNet is an auto-regressive model primarily used for speech and audio generation, but can also be applied to image generation.

Hybrid Models

- VQ-VAE-2 (Vector Quantized VAE)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: VQ-VAE-2 combines a VAE with vector quantization to learn a discrete latent space representation.
- CVAE-GAN (Conditional VAE-GAN)
  - **Repository Link**: GitHub Repository

  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: CVAE-GAN combines the conditional VAE and GAN frameworks to achieve controlled generation with disentangled latent variables.

- VAE-Glow
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: VAE-Glow combines a VAE with the Glow flow-based model for improved generative modeling.

Diffusion Models

- Noise-Contrastive Estimation (NCE)
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: NCE is a diffusion-based model that estimates the data distribution by contrasting it with a noise distribution.

- Diffusion Probabilistic Models
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: Diffusion probabilistic models use a series of diffusion steps to model the data distribution effectively.

Other notable models

- Adversarial Autoencoders
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: Adversarial Autoencoders combine the adversarial training of GANs with the autoencoder framework for unsupervised learning and generation.

- StyleGAN (Style-Generative Adversarial Network)

  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: StyleGAN generates high-quality images with fine-grained control over the style and attributes of the generated content.

- BigGAN
  - **Repository Link**: GitHub Repository
  - **Paper Link**: Example Paper
  - **Owner**: Company/Group Name
  - **Explanation**: BigGAN is a large-scale GAN model capable of generating high-resolution images with improved diversity and quality.