

Guide to Choosing a Generative AI Model Type

Types of generative AI models

Model	Key features	Applications
Generative adversarial networks (GANs)	<ol style="list-style-type: none">Two competing neural networks: generator and discriminator.The generator learns to create realistic data, while the discriminator learns to distinguish real from fake.The adversarial training process continuously improves both networks.Can be challenging to train and achieve stable results.	<ol style="list-style-type: none">Image generation: faces, landscapes, objectsText generation: poems, code, scriptsVideo generation: realistic videos, animationDrug discovery: generate molecules with intended propertiesMusic generation: composing new songs
Variational autoencoders (VAEs)	<ol style="list-style-type: none">Encode input data into a lower-dimensional latent spaceLearn a probability distribution over the latent spaceDecode samples from the latent space to generate new data pointsFocuses on learning a meaningful representation of the data	<ol style="list-style-type: none">Image compression: efficiently stores and transmits imagesAnomaly detection: identify unusual data pointsDimensionality reduction: compress high-dimensional dataText summarization: generate concise summaries of text documents
Autoregressive models	<ol style="list-style-type: none">Generate data point by point, conditioned on previously generated pointsUse recurrent neural networks (RNNs) or transformers to capture long-term dependenciesCan be computationally expensive for long sequences	<ol style="list-style-type: none">Text generation: realistic and coherent text sequencesMusic generation: generating music that follows genre and styleTime series forecasting: predicting future values of a time seriesImage inpainting: filling in missing parts of an image
Diffusion models	<ol style="list-style-type: none">Start with a simple noise and gradually "de-noise" it into realistic dataUse a U-Net architecture with skip connections to preserve informationCan be more stable and easier to train than GANs, but often slower	<ol style="list-style-type: none">Image generation: high-quality and diverse imagesText generation: coherent and grammatically correct textAudio generation: realistic and musical audioInpainting and denoising: improving the quality of images or audio
Flow-based models	<ol style="list-style-type: none">Transform a simple distribution (Gaussian) into a complex one using invertible transformationsLearn the parameters of these transformations from the dataCan be efficient and accurate for high-dimensional data, but training can be challenging	<ol style="list-style-type: none">Image generation: realistic and diverse imagesDensity estimation: modeling the probability distribution of dataDimensionality reduction: compress high-dimensional dataAnomaly detection: identify unusual data points

Comparison of models on different considerations

Feature	GANs	VAEs	Autoregressive models	Diffusion models	Flow-based models
Data type	Images, text, audio	Images, text, continuous data	Images, text, sequences	Images, text	Images, continuous data
Task objective	High-fidelity generation, data augmentation	Encoding/decoding, representation learning	Sequence generation, text-to-image translation	Image generation, editing, inpainting	Image generation, conditional generation
Quality of samples	High-fidelity, diverse	Often blurry, less realistic	Sharp, high-resolution	High-fidelity, diverse	High-fidelity, controllable
Control over generation	Limited	Moderate	High	Moderate	High
Training complexity	High	Moderate	High	Moderate	High
Interpretability	Low	Moderate	High	Moderate	Low

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