VAE: Variational Autoencoder

Probabilistic generative model with latent distribution

Input
Data x

→

🧠 **Encoder**
Learns distribution

→

🎲 **Latent Space**
Probabilistic representation

| μ (mean) | σ^2 (var) |

→

🔮 **Decoder**
Generate from z

→

Output
Reconstructed $\hat{x}$

Loss = Reconstruction Loss + KL Divergence

📊 Minimize reconstruction error   •   📐 Regularize to Gaussian prior
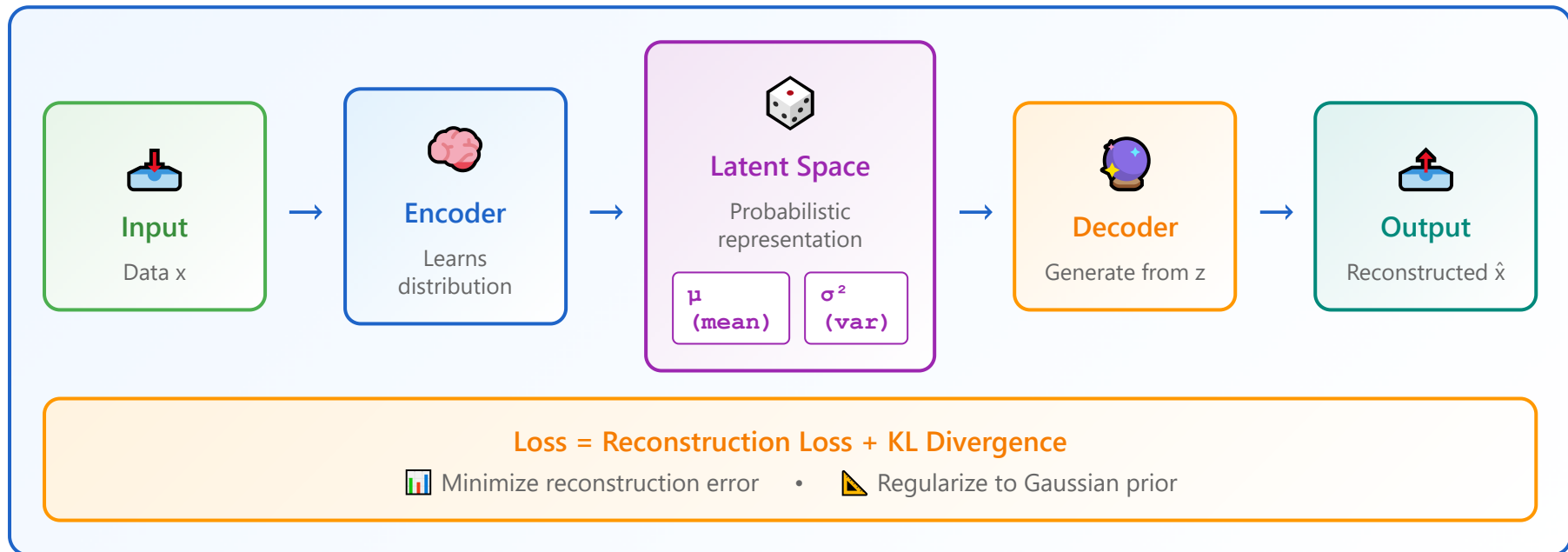
🔑 Key Concepts

🎯 **Probabilistic:** Distribution over latent space

⚡ **Reparameterization:** Enables backpropagation

🌊 **Generation:** Sample latent → new data

🎯 Applications

🖼️ Image generation

📊 Data augmentation

Semi-supervised learning