# Generative Adversarial Networks (Part 1)

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Introduction to Generative Adversarial Networks (GANs)

- ❖ GANs consist of two subnetworks: the **Generator** (G) and the **Discriminator** (D).
- ❖ These networks have opposing objectives, making them adversaries.
- ❖ The Generator creates fake data to deceive the Discriminator into believing it is real.
- ❖ The Discriminator evaluates data to determine if it is real or generated by the Generator.
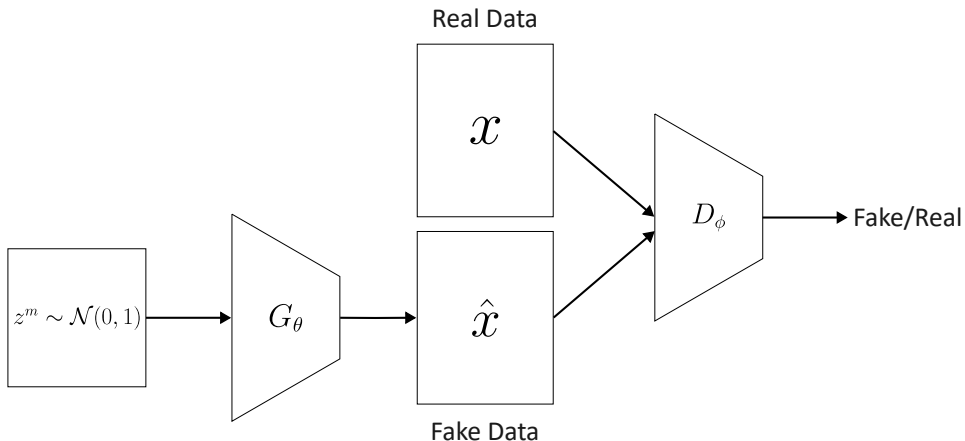
Components of GANs

❖ The Generator (G) takes a latent space vector $z \in \mathbb{R}^m$ and generates an output resembling real data.

❖ Typically, each latent variable is sampled from a Gaussian distribution, i.e., $z_i \sim \mathcal{N}(0, 1)$.

❖ The Discriminator (D) performs a classification task.

❖ If the input $x \in \mathbb{R}^d$ is real, the label is $y = 1$. If the input is generated by G, the label is $y = 0$.

Loss Functions for Generator and Discriminator

❖ The Generator (G) is unaffected by the Discriminator's (D) evaluation of real data.

❖ For fake data, G aims to have D classify it as real, indicating successful deception.

$$\mathcal{L}_G = \mathbb{E}_{z \sim \mathcal{N}(0,1)} \left[\text{loss} \left(D \left(G \left(z \right) \right), 1 - y \right) \right]$$

❖ The Discriminator (D) uses all training data to define the real class, and any output from G belongs to the fake class.

$$\mathcal{L}_D = \mathbb{E}_{x \sim Data} \left[\text{loss} \left(D \left(x \right), y \right) \right] + \mathbb{E}_{z \sim \mathcal{N}(0,1)} \left[\text{loss} \left(D \left(G \left(z \right) \right), y \right) \right]$$