Lecture 10 – Unsupervised Representation Learning

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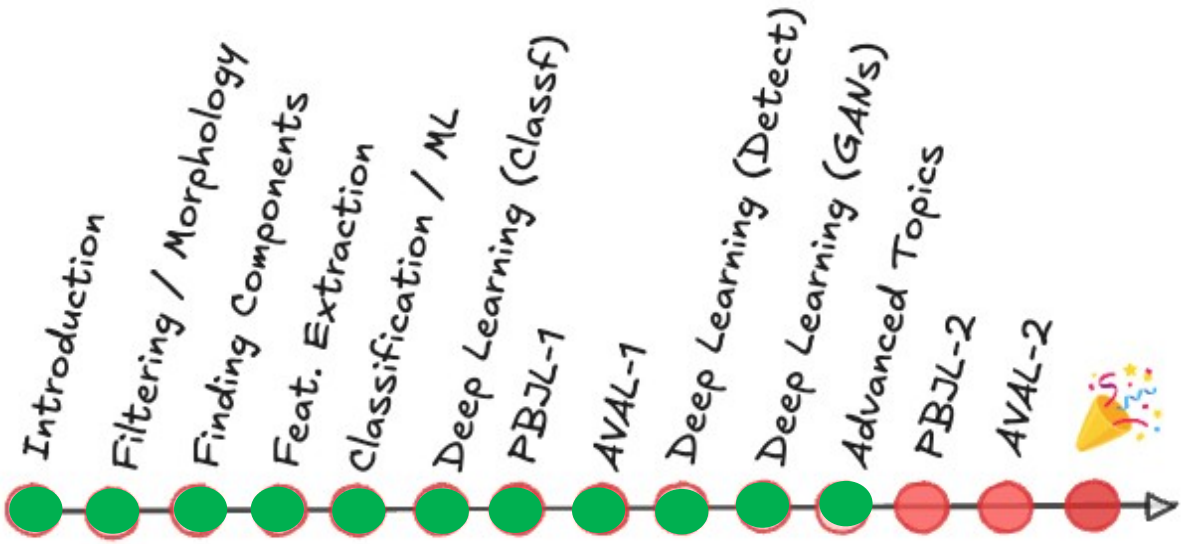
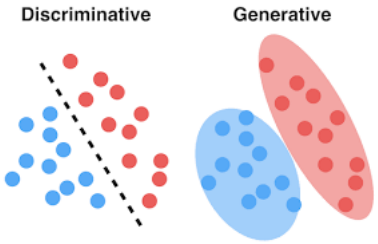
Topics

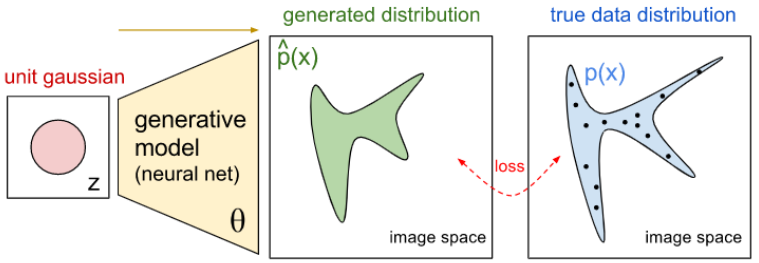
- Review of Lecture 09 – Generative Adversarial Learning
  - DCGAN
  - PIX2PIX
- Deep Unsupervised Representation Learning
  - Latent Representations
  - Auto-Encoders
  - Representation Learning
  - Knowlegde Transfer
- Practice



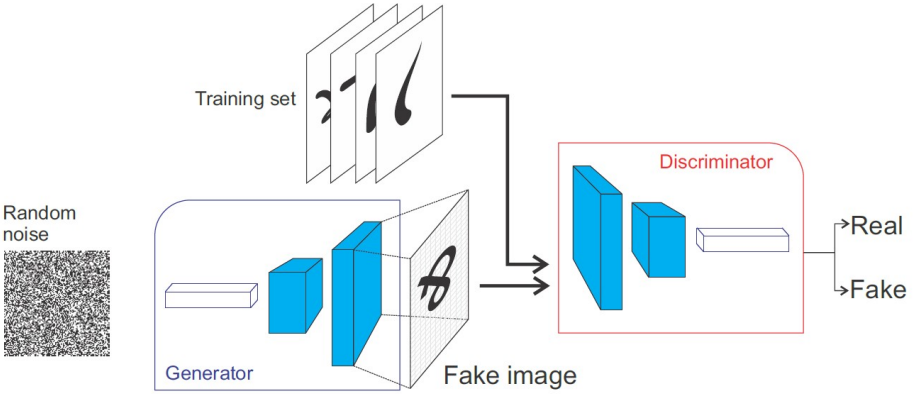
Review Lecture 09 - GANs

- Discriminative vs Generative



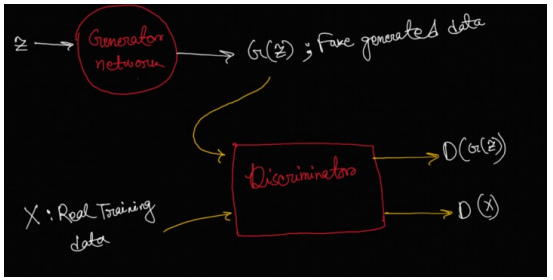


- Deep Generative Networks
  - Generator – Discriminator Architecture



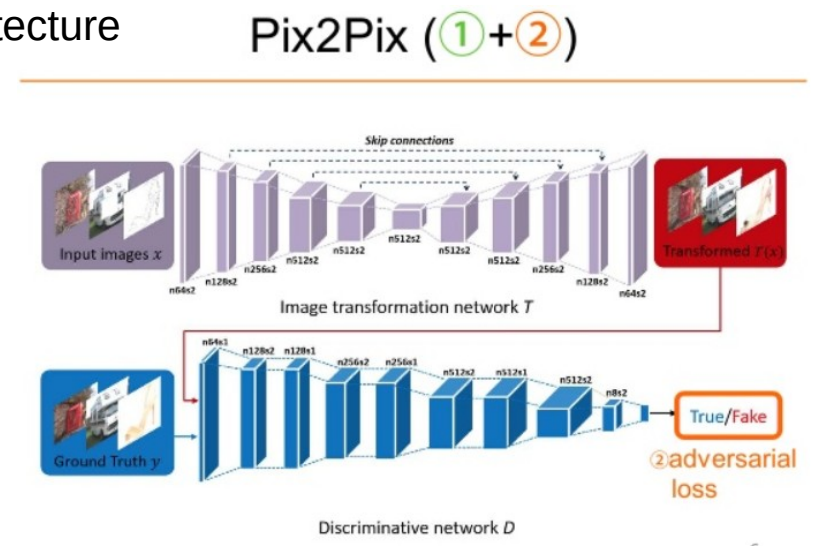
- Generative Loss

$$\min_G \max_D V(D,G) = \mathbb{E}_{x \sim p_{data}}[\log D(x)] + \mathbb{E}_{z \sim p_z(z)}[\log(1 - D(G(z)))]$$

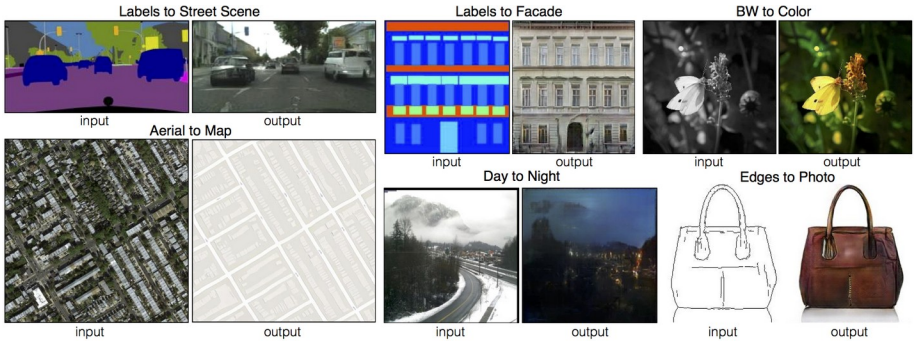


Review Lecture 09 - GANs

- Pix2Pix
  - Encoder-Decoder Architecture



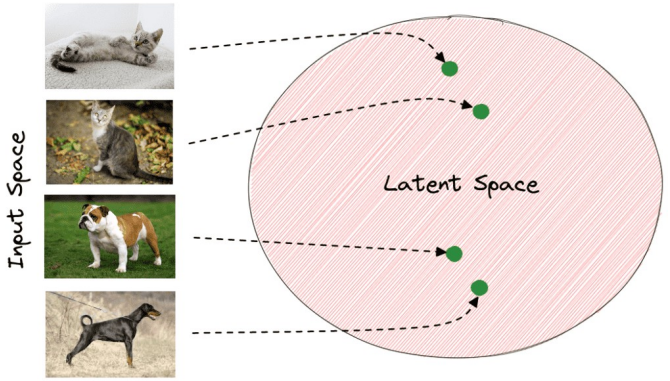
  - Image Translation Task

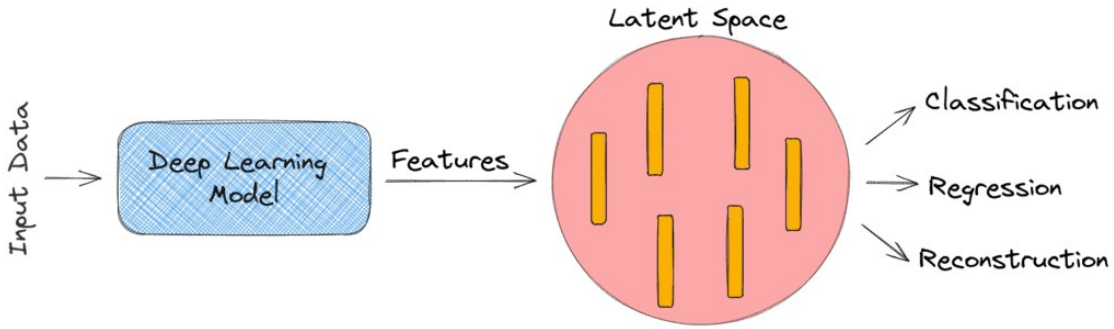


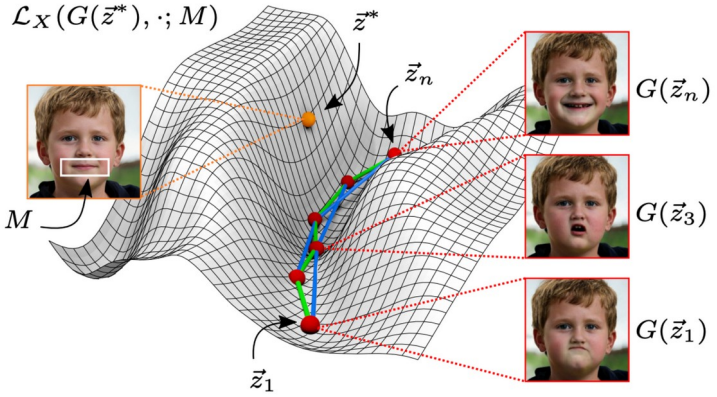
Unsupervised Representation Learning

Representation

- Representation is a feature of data that can entangle and hide more or less the different explanatory factors or variation behind the data
  - Image Embeddings, Token Embeddings (NLP)
  - Latent Space



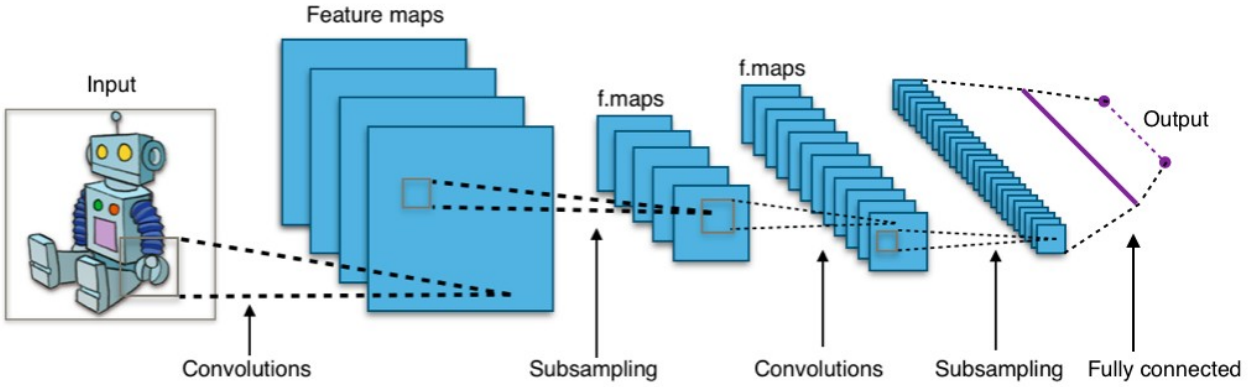




Bengio, Yoshua, Aaron Courville, and Pascal Vincent. "Representation learning: A review and new perspectives." IEEE transactions on pattern analysis and machine intelligence 35.8 (2013): 1798-1828.)

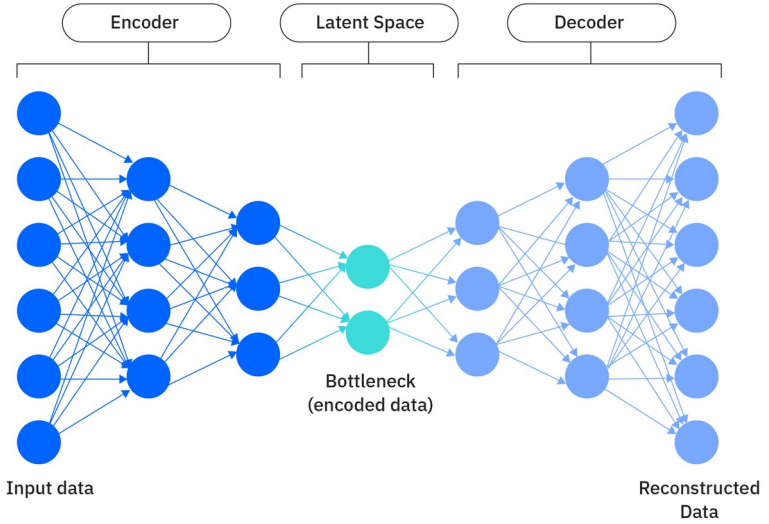
Supervised Learning

- **Supervised approaches** achieve outstanding results in many domains
  - Dependence on **vast annotated datasets**
  - Manual annotation is expensive and time-consuming
  - Limited scalability to new domains or tasks
  - Generalization issues across datasets and environments (overfitting)
  - Need for learning meaningful **representations** without supervision



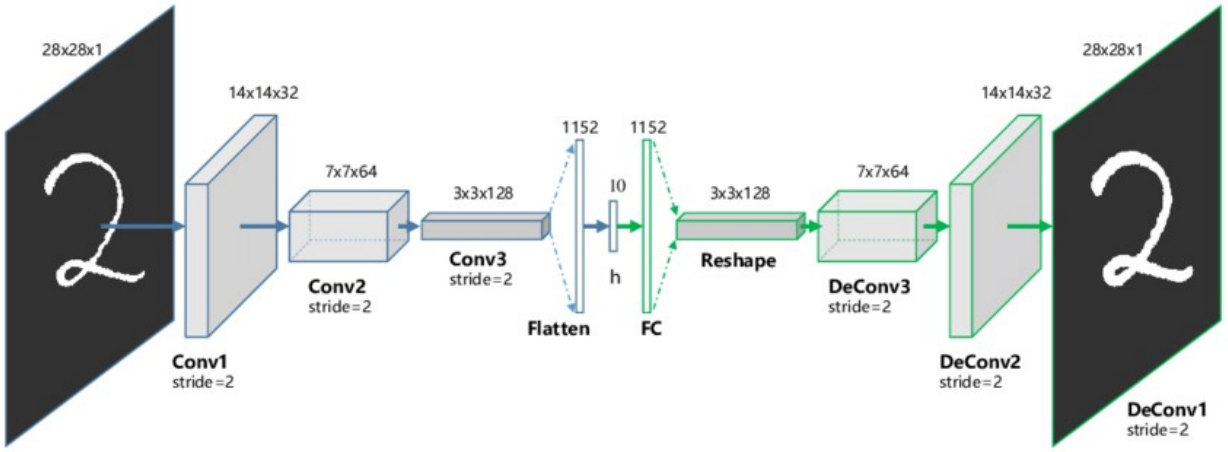
Autoencoders

- Unsupervised Learning
  - Dimensionality Reduction
  - Clustering
  - Denoising
  - Representation Learning



Convolutional Autoencoders

- Encoder – Decoder Architecture
  - Recover the input data
  - MSE Loss (most common, but others are possible)



$$\text{MSE} = \frac{1}{N}\sum_{i=1}^{N}(y_i - \hat{y}_i)^2$$

Semi-Supervised Representation Learning

- Unsupervised Step
  - Auto-Encoder Training
  - Learn Latent Representations
- Feature Extraction
  - Freeze The Encoder
  - Extract Latent Vectors
- Supervised Classifier Training
  - Input: Latent Vectors (Labeled)
  - Fully-Connected, SVM, ...