DIMENSIONALITY REDUCTION WITH ADVERSARIAL NETWORKS

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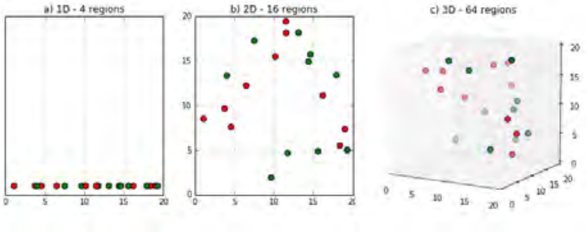
DIMENSIONALITY REDUCTION
// PRINCIPLE



- Reduce effect of curse of dimensionality
- High-dimensional structured data $\rightarrow$ low-dimensional feature vectors

DIMENSIONALITY REDUCTION
// STANDARD ALGORITHMS

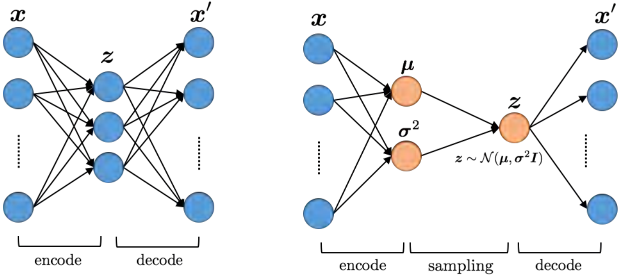
- PCA
- NMF
- T-sne

T-SNE on MNIST handwritten digits dataset

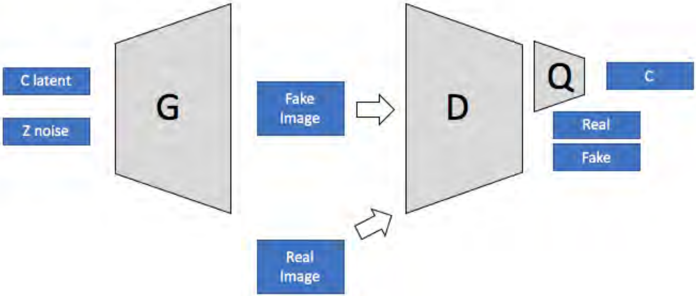
Advantage

good mathematical interpretation

DIMENSIONALITY REDUCTION



DIMENSIONALITY REDUCTION
// INFOGAN



ADVERSARIAL APPROACH
// F-DIVERGENCE AND DISTANCE

- KL-divergence

$$KL(\mathbb{P}, \mathbb{Q}) = \int P(x) log(\frac{P(x)}{Q(x)}) d\mu x$$

- Jensen-Shannon divergence

$$JS(\mathbb{P}, \mathbb{Q})) = KL(\mathbb{P}, \mathbb{Q}) + KL(\mathbb{Q}, \mathbb{P})$$

- Wasserstein distance

$$W(\mathbb{P}, \mathbb{Q}) = \inf_{\gamma \in \Pi(\mathbb{P}, \mathbb{Q})} \mathop{\mathbb{E}}_{x,y \sim \gamma} \parallel x - y \parallel$$

Computation

Can be estimated through the optimization of a neural network

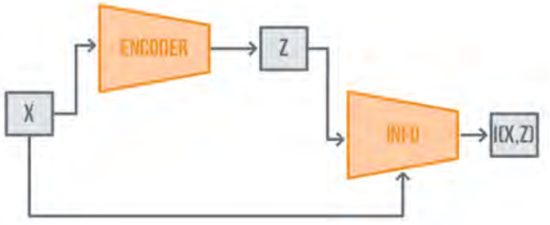
ADVERSARIAL APPROACH
// MUTUAL INFORMATION

- Mutual information : Quantifies the dependence of two random variables

$$I(X,Z) = D(\mathbb{P}_{XZ}||\mathbb{P}_X \otimes \mathbb{P}_Z)$$

Dimensionality reduction

Find Z a low-dimensional representation of X that maximizes $I(X,Z)$

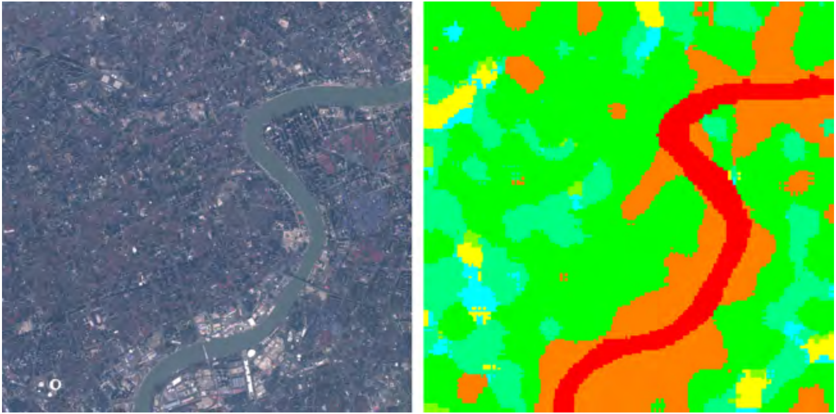


ADVERSARIAL APPROACH
// DISENTANGLED REPRESENTATION

- Disentangled representation : feature vectors that encode complementary information
  - Example : separate colors and number in an low-dimensional feature vector
  - Semi-supervised
  - Algorithm based on adversarial maximization and minimization of mutual information between the different representations

DISENTANGLED REPRESENTATION
// TOY EXAMPLE

DISENTANGLED REPRESENTATION
// SENTINEL 2 EXAMPLE



- Adversarial approach
  - Can deal with structured high-dimensional data
  - Interpretation in terms of mutual information
  - Disentangled representation
  - Successful application in satellite image analysis

- Limits :
  - Adversarial optimization can be difficult