1.3. Unsupervised Learning and Reinforcement Learning

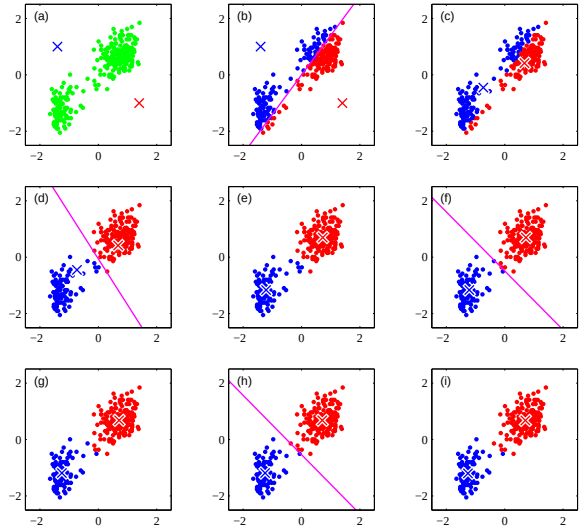
Lecture based on "Dive into Deep Learning" **http://D2L.AI** (Zhang et al., 2020)

Prof. Dr. Christoph Lippert

Digital Health & Machine Learning

(k-means) Clustering

- Find subgroups in the data based on x only.
- Represent each cluster by the mean value of members.
- Example applications:
  - Find subgroups of patients with similar symptoms
  - Find genes with similar gene-expression patterns

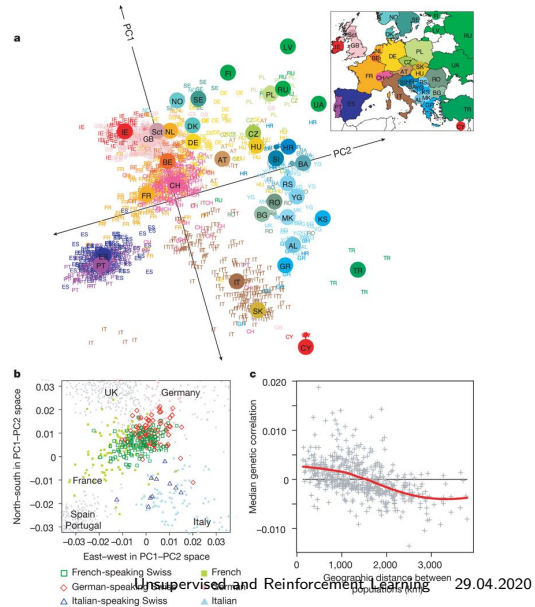


Representation learning

Principal Components Analysis

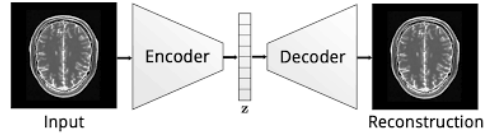
Project high-dimensional (large D) x on principal axes of variation (i.e. principal components).
Example applications:

- Determine population structure from genetic markers (SNPs)
- Data visualization



Representation learning

Autoencoders



Use pair of neural networks (encoder and decoder) to learn a numeric embedding z of x.

- encoder predicts z from x
- decoder predicts x from z

Example applications:

- Learn numeric embedding
- Compression
- De-noising
- Data visualization

embedding z

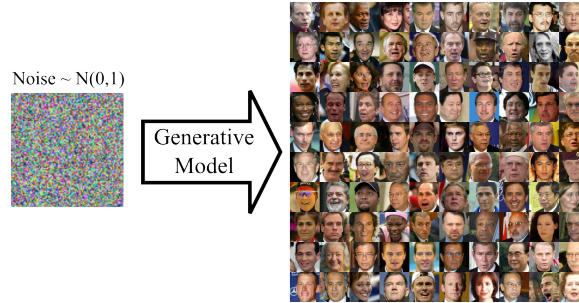
Generative Models

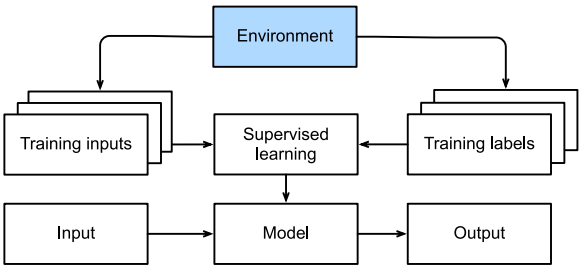
Models:

- Variational Autoencoders
- Generative adversarial networks

Applications:

- Image synthesis
- Image super-resolution (MRI, microscopy)
- Probabilistic modeling





How do we expect the environment to behave?

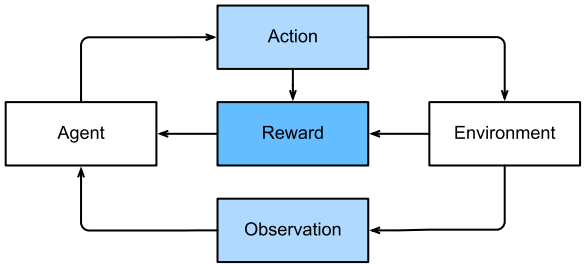
Does it ...

- Remember what we did previously?
- Want to help us, e.g., a user reading text into a speech recognizer?
- Want to beat us, i.e., an adversarial setting like spam filtering (against spammers) or playing a game (vs an opponent)?
- Not care?
- Have shifting dynamics

  Does future data always resemble the past or do the patterns change over time?

  - naturally
  - in response to our tools?

Reinforcement learning



Deep reinforcement learning applies deep neural networks to RL.

- **deep Q-network** that beat humans at Atari games using only the visual input
- **AlphaGo** dethroned the world champion at Go

Summary

- Unsupervised Learning
  - Clustering
  - Representation Learning
  - Generative Models
- Interacting with the environment