BSC AI Factory

Generative and Self-Supervised ML

Introduction to Unsupervised DL

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Generative and Self-Supervised ML Course

Instructors

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Materials

Web for the course on https://sites.google.com/view/aifgenml

Motivation

Unsupervised Deep Learning

- Deep learning as other areas of machine learning has also a bias for supervised methods
- Deep learning relies on huge datasets, but there is a limit to how many labels we can obtain efficiently
- Unsupervised methods can benefit of all the data that we can not label and make an impact on supervised tasks
  - We could learn the inherent probability distribution of the data (generative model) as a representation for supervised tasks
  - We can solve unsupervised tasks with data that need semantic understanding of the problem for building representations

Why unsupervised learning is important for AI?

Geoffrey Hinton

(in his 2014 AMA on Reddit)

The brain has about 10^{14} synapses, and we only live for about 10^9 seconds. So we have a lot more parameters than data. This motivates the idea that we must do a lot of unsupervised learning since the perceptual input (including proprioception) is the only place we can get 10^5 dimensions of constraint per second.

Yann LeCunn's LeCake

Y. LeCun

How Much Information is the Machine Given during Learning?

- **"Pure" Reinforcement Learning (cherry)**
  - The machine predicts a scalar reward given once in a while.
  - **A few bits for some samples**
- **Supervised Learning (icing)**
  - The machine predicts a category or a few numbers for each input
  - Predicting human-supplied data
  - **10→10,000 bits per sample**
- **Self-Supervised Learning (cake génoise)**
  - The machine predicts any part of its input for any observed part.
  - Predicts future frames in videos
  - **Millions of bits per sample**

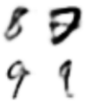
Unsupervised Learning Applications

- Generation of new data from generative models (probability distribution)
- Generation using conditioning (bias the generation with a prior or transfer from one domain to another)
  - Generating speech with different characteristics, generating images from text, image to image translation...
- Information compression from latent representations
- Improve supervised tasks with data embeddings generated from self-supervised pre-training

Image Generation Models Evolution (2012-2025)

2012 2014 2015 2018 2020 2021 2025

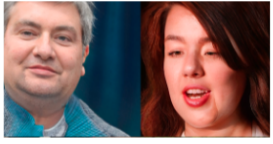
VAEs



GAN

DCGAN

StyleGAN1/2/3/ADA/XL
BigGAN/GigaGAN



SD1.5/2.1/XL/3
FLUX 1/2
DALL-E/2/3, Imagen
Qwen, Hunyuan, HiDream

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AI Factories

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