Barcelona Supercomputing Center
Centro Nacional de Supercomputación

HIGH PERFORMANCE ARTIFICIAL INTELLIGENCE

Deep Learning - MAI

Foundation Models

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Traditional DL

- Task oriented (aka supervised learning)
  - Optimize to solve one task
  - Use a set of labeled data <input,desired output> (cost!)
  - Struggles w/ generalization
  - Data selection bias

Back to the essence of DL

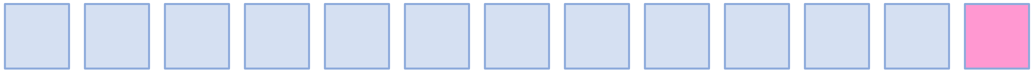
- Representation Learning
  - Use unlabeled data <input>
  - Optimize to learn the distribution of data
  - No labeling cost, less biases, more reusable
- Two main learning objectives
  - Also Siamese, GANs, ...

Masked learning

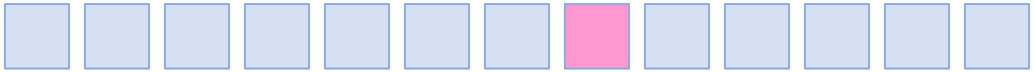
- Learn to reconstruct
  - Remove parts of the data
  - Add noise to the data

Masked for text

- ❖ Next token prediction (GPT) aka “Autoregressive”



- ❖ Masked language modeling (BERT)

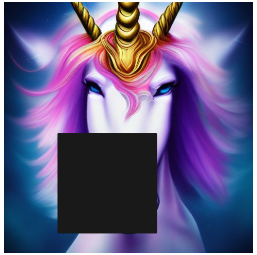


Context 🟦

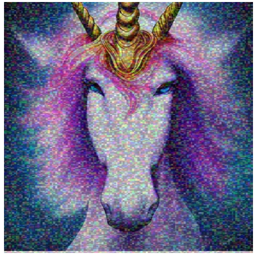
Prediction 🟪

Masked for images

- Patching



- Diffusion



Contrastive learning

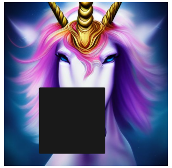
- Contrastive
  - Learn to contextualize / Spread things properly
  - Tranformations which are
    - Not disruptive for the modality
    - Highly disruptive for the data values

Contrastive learning

- Color

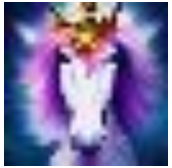
- Rotation

- Patching/ Cropping



- Jigsaw

- Resolution



Next step: Multimodality

- Image

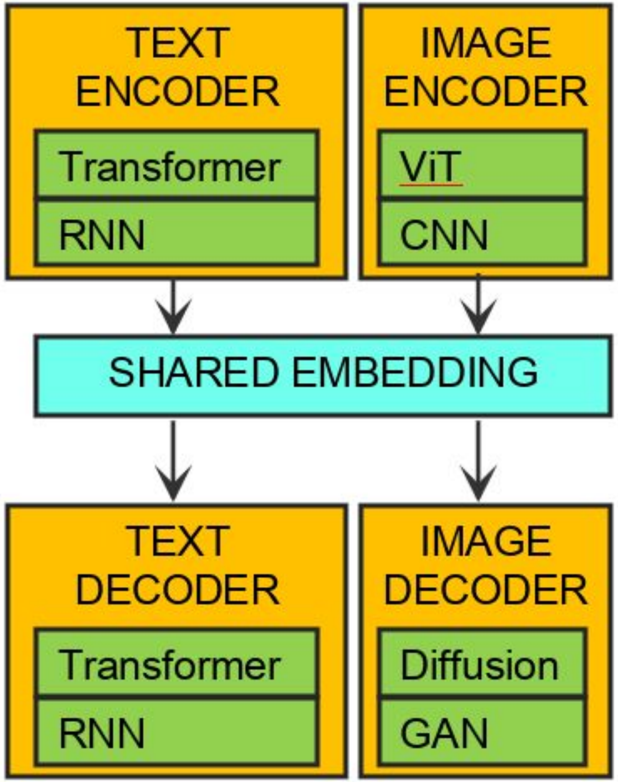
- Text “A majestic unicorn. Front shot. Magic light.”
- Sound
- Graph representation, 3D structure, …

Foundation models

- With SSL we can scale to billions of samples
  - Entire data modalities represented
  - Zero-shot generalization
  - No direct supervised application
  - Generative model fest

A simple architecture

- Data oriented (storage & compute)
- Multimodal by design
- In inference, unplug modalities
- The *shared embedding*
- LLM as shared embedding
    - Everything as LLM tokens



Big players

- OpenAI (Microsoft)
  - GPT(text), codex (code), whisper (voice), CLIP(txt+img), DALL-E (txt+img)
- DeepMind (Google)
  - Gato (agents), Chinchilla (txt), Sparrow (chat), FLAN (txt), LaMBDA, Bard
- Meta AI (Facebook)
  - Galactica (papers, retracted), LLaMA (txt), LLaVA
- Hugging Face (USA company)
  - Repo & cloud. *BigScience* initiative (Jean Zay - IDRIS/GENCI/CNRS), Bloom (txt)

Emerging players

- stability.ai (UK company)
  - StableDiffusion (img+txt), open model movement
- EleutherAI (non-profit)
  - The Pile (txt dataset), GPT-J (txt), GPT-Neo (txt)
- LAION (non-profit)
  - LAION-5B (txt/img dataset), OpenAssistant (ongoing, chat)
- moz://a + Mozilla.ai (non-profit?) Deepspeech, TTS
- **Stanford** (HAI, Alpaca), DAIR (non-profit), CohereAI (non-profit), ...