Vector Quantized Variational Autoencoder

Winter 2025

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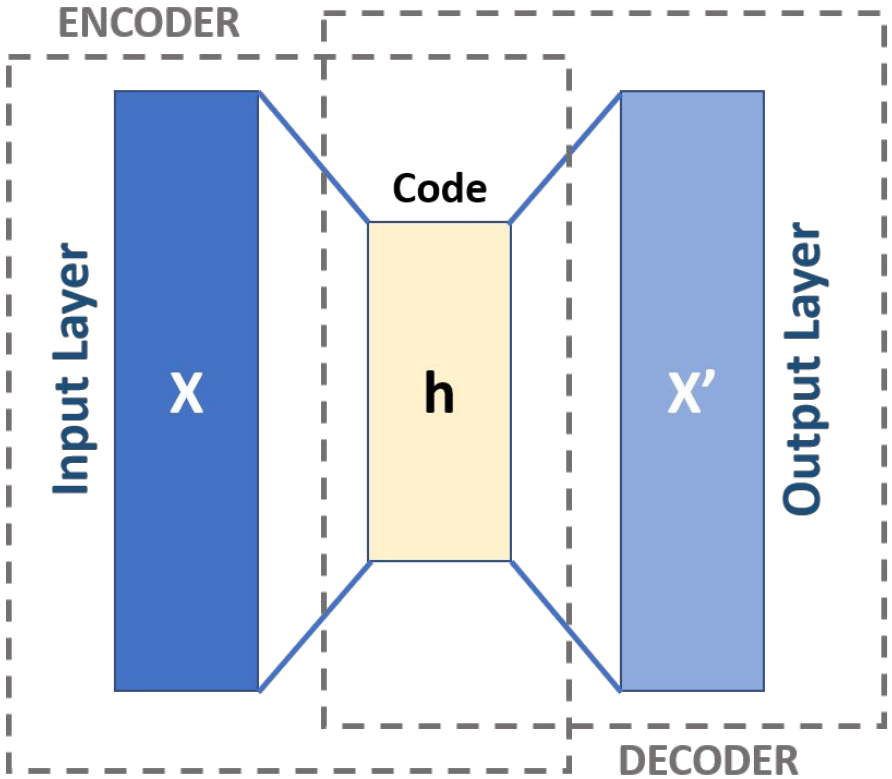
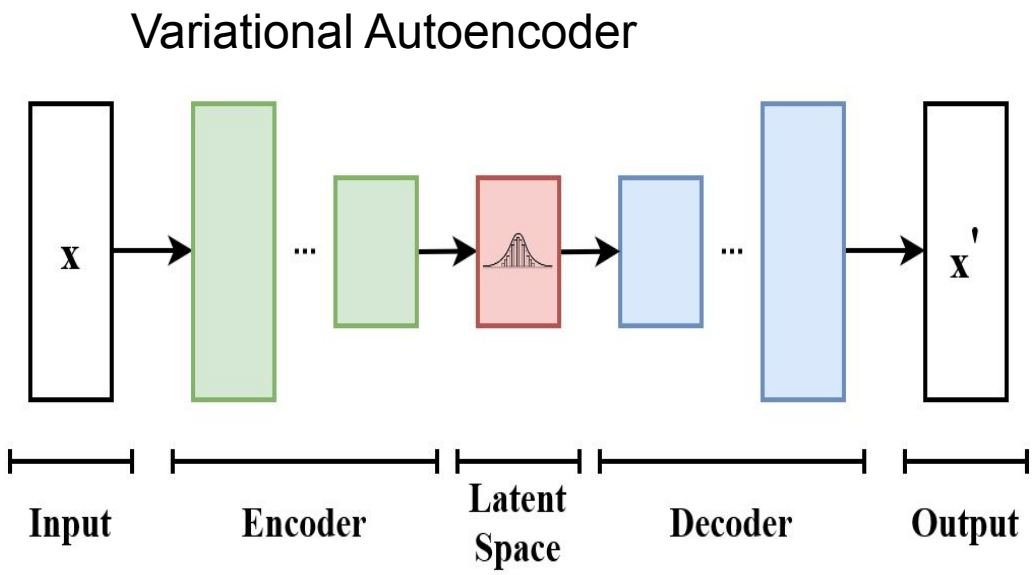
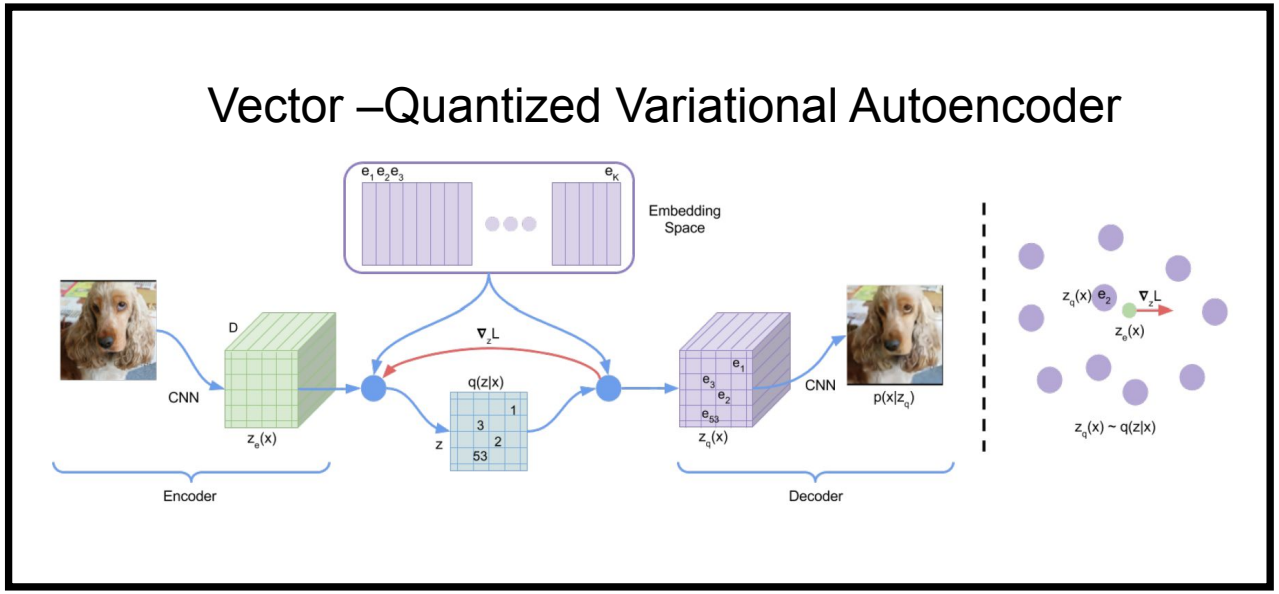
What are autoencoders?

- Autoencoders are a type of artificial neural network (ANN) that compress and reconstruct data. They are an unsupervised machine learning (ANN) that can learn powerful statistics from any dataset.



Different types of autoencoders

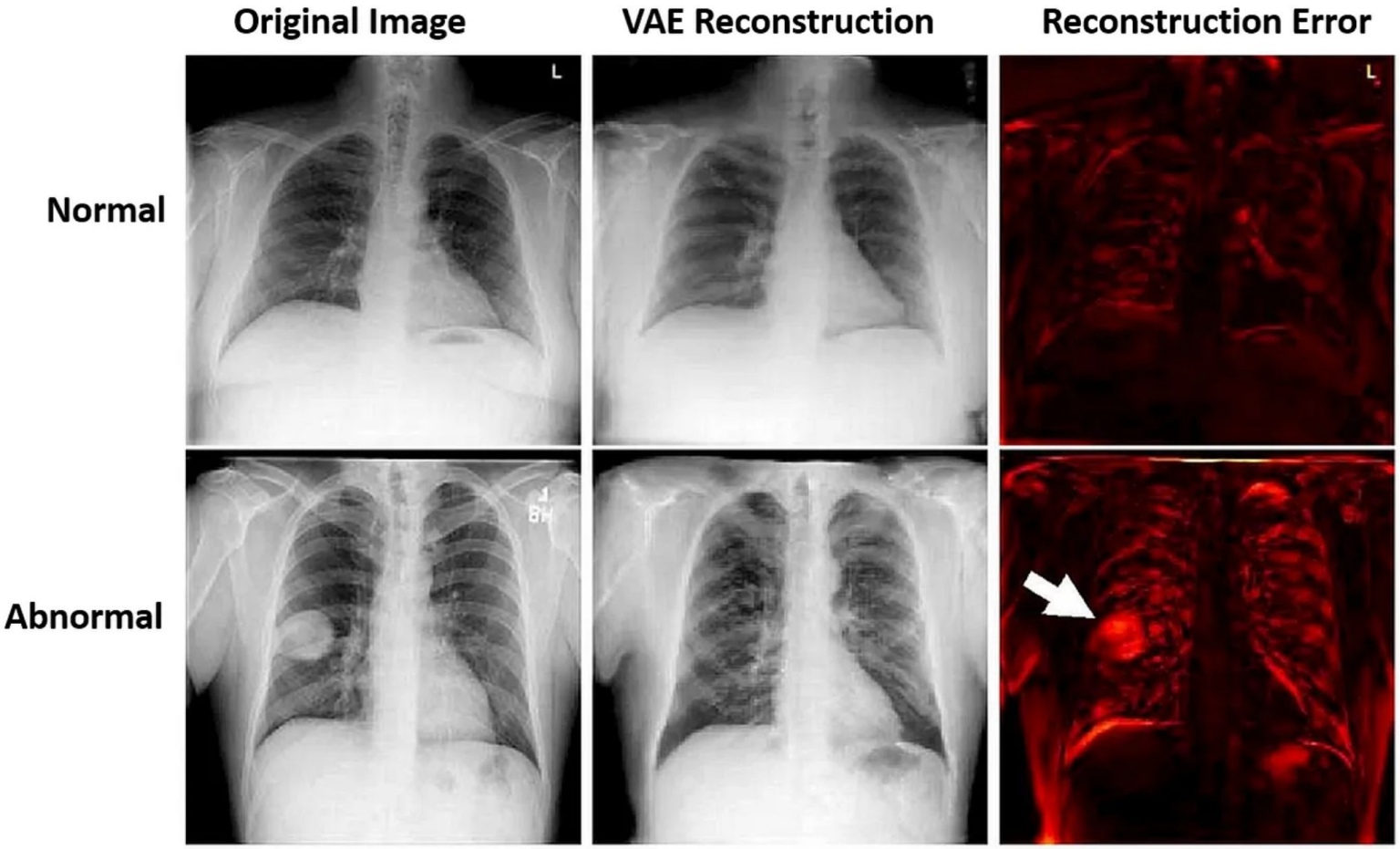




What are autoencoders used for?

- **Data compression**: Autoencoders can compress data to make it easier to store and transmit.
- **Image denoising**: Autoencoders can remove noise from images.
- **Anomaly detection**: Autoencoders can identify unusual activity in data, such as in financial markets.
- **Feature learning**: Autoencoders can extract important features from data, which can be used in computer vision, natural language processing, and more.
- **Image inpainting**: Autoencoders can fill in missing pixels in images.
- **Information retrieval**: Autoencoders can help users search for images based on their content.

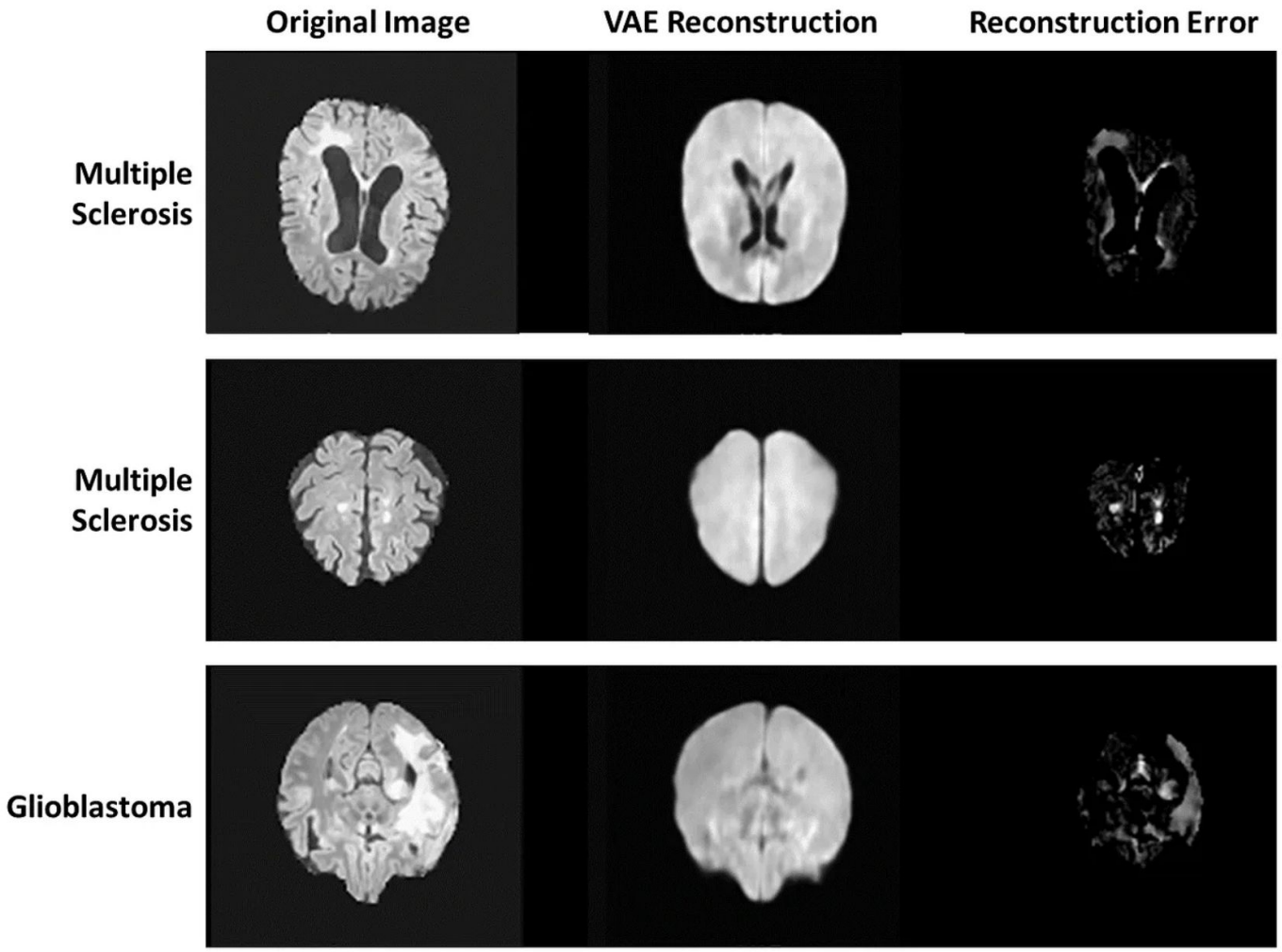
Autoencoders in anomaly detection



Anomaly detection on chest radiograph, with a lung mass on the abnormal image

Demeusy, 2024

Autoencoders in anomaly detection

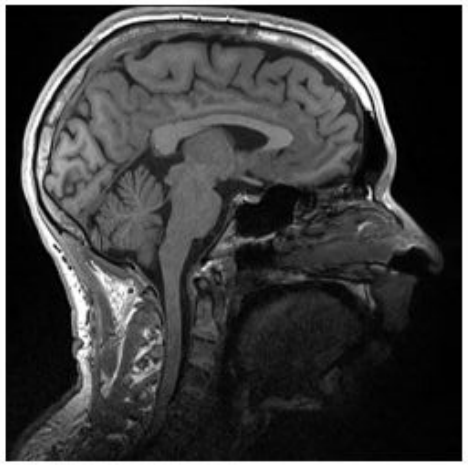


MRI, VAE reconstruction and error reconstruction

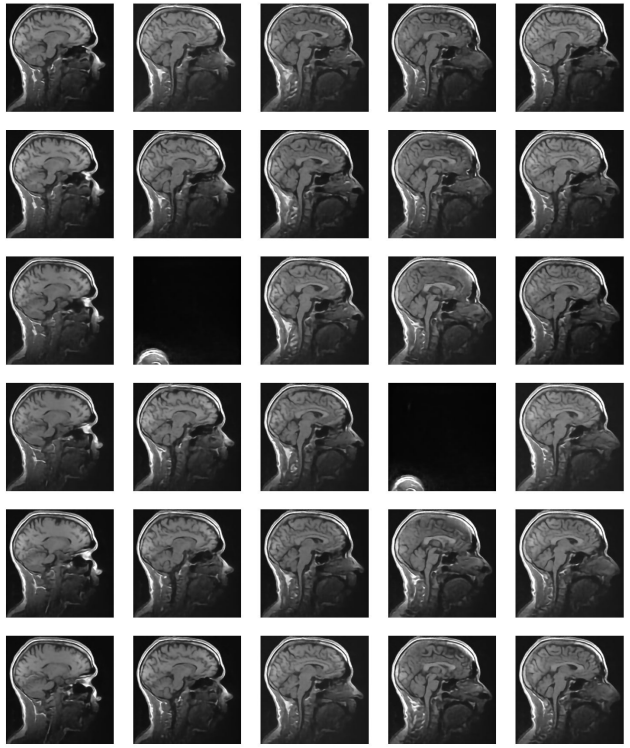
Demeusy, 2024

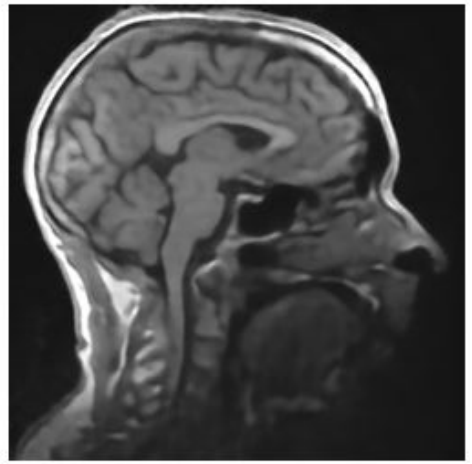
Indiv Dataset

- Used IXI_Dataset:
  - Nearly 600 MR images from normal, healthy subjects
  - T1 images
- Converted the 3D scans to **76,800** 2D slices
- Trained a VQVAE model on the slices
- It successfully reconstructed the unseen individuals from Indiv's:



Indiv's T1 scans





VQVAE reconstructions

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Quick Test!

Binary Classifier: Cats vs Dogs

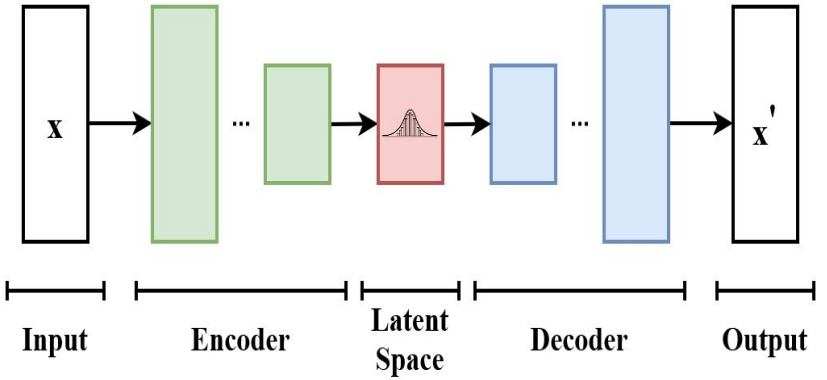
Large training dataset for VQVAE (5k?)

Test set for VQVAE & Train for cats vs dogs classifier (100)

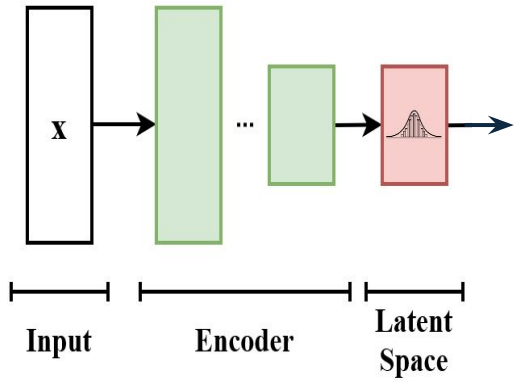
Test set for cats vs dogs classifier (N=15000)

Train a vqvae on large cats and dogs dataset

(analogous to IXI T1 dataset)

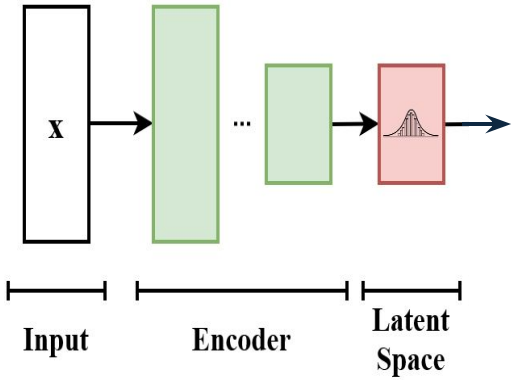


(IndivRobotics)



Save quantized output to numpy file

1)



Save quantized output to numpy file (e.g. 002_cat.npy)

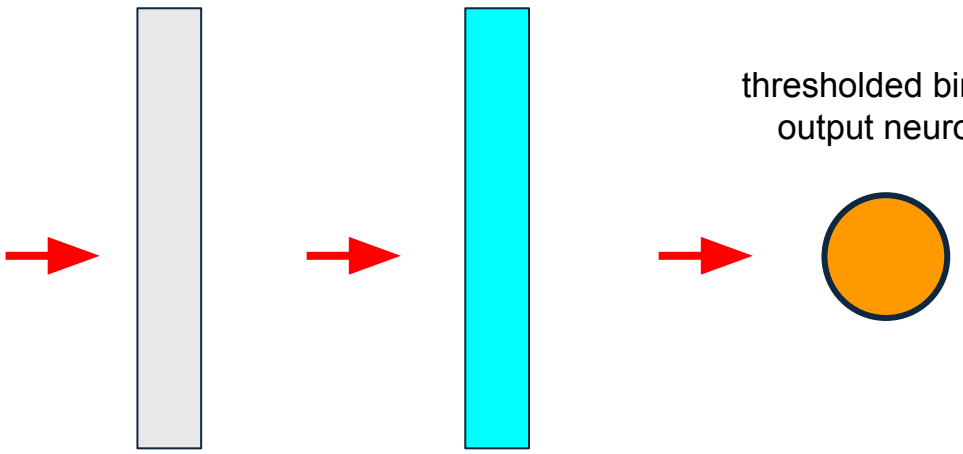
frozen weights

learnable weights

2)

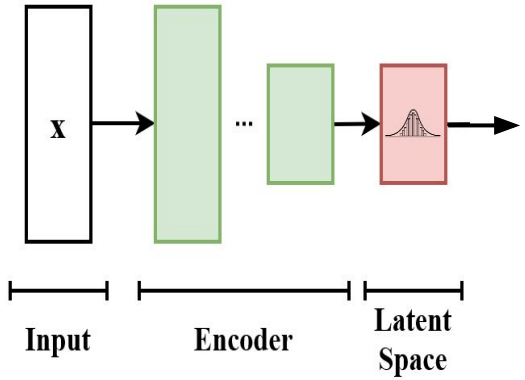
Frozen Weights

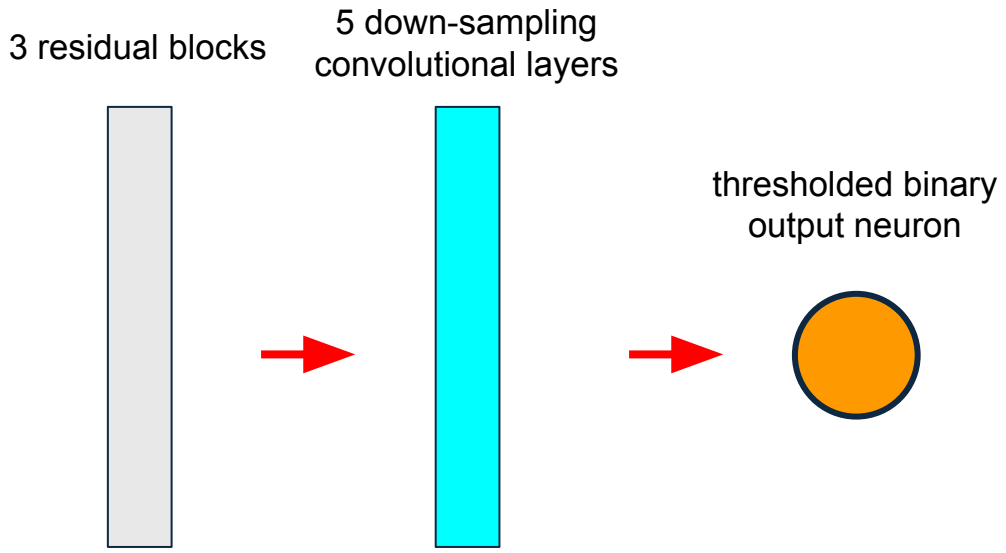
Load numpy file in a different script



Viable alternative (all-in-one script)

1)





frozen weights

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