Lesson 3: Latent Space Rules Everything Around Me

3.1 Representing Images as Tensors

3.2 Desiderata for Computer Vision

3.3 Features of Convolutional Neural Networks

3.4 Working with Images in Python

3.5 The FashionMNIST Dataset

3.6 Convolutional Neural Networks in PyTorch

3.7 Components of a Latent Variable Model (LVM)

3.8 The Humble Autoencoder

3.9 Defining an Autoencoder with PyTorch

Lesson 3: Latent Space Rules Everything Around Me

3.10 Setting up a Training Loop

3.11 Inference with an Autoencoder

3.12 Look Ma, No Features!

3.13 Adding Probability to Autoencoders (VAE)

3.14 Variational Inference: Not Just for Autoencoders

3.15 Transforming an Autoencoder into a VAE

3.16 Training a VAE with PyTorch

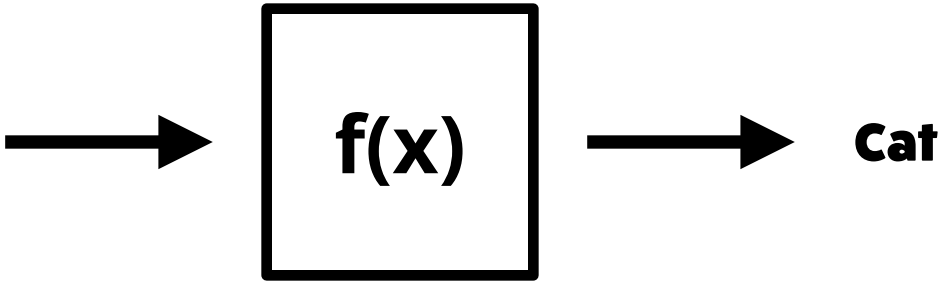
3.17 Exploring Latent Space

3.18 Latent Space Interpolation and Attribute Vectors

3.1

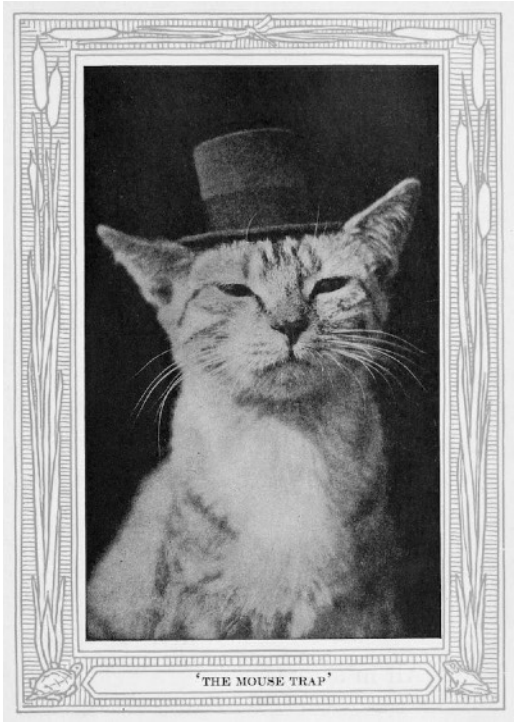
Representing Images as Tensors

How Machines Create



Source: Kittens and Cats: A First Reader (1911)

Representing Greyscale Images



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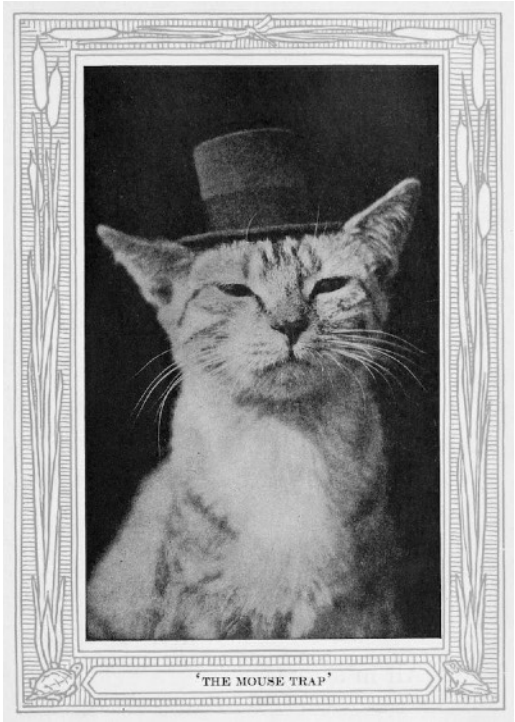
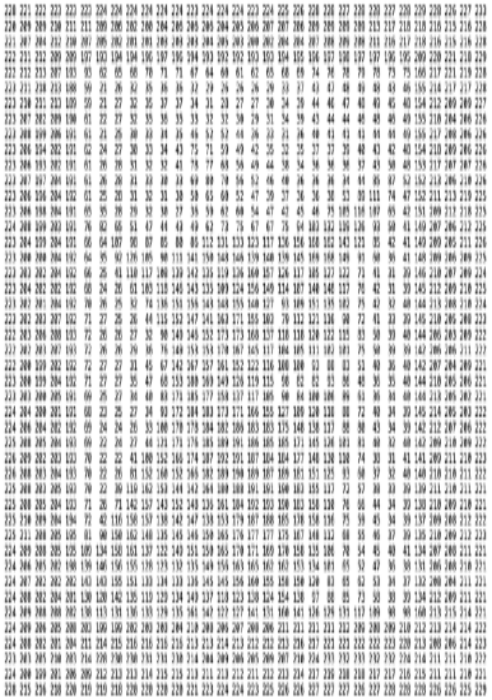
233	0	17	254
255	6	3	223
250	9	11	242
251	247	245	232

Representing Greyscale Images



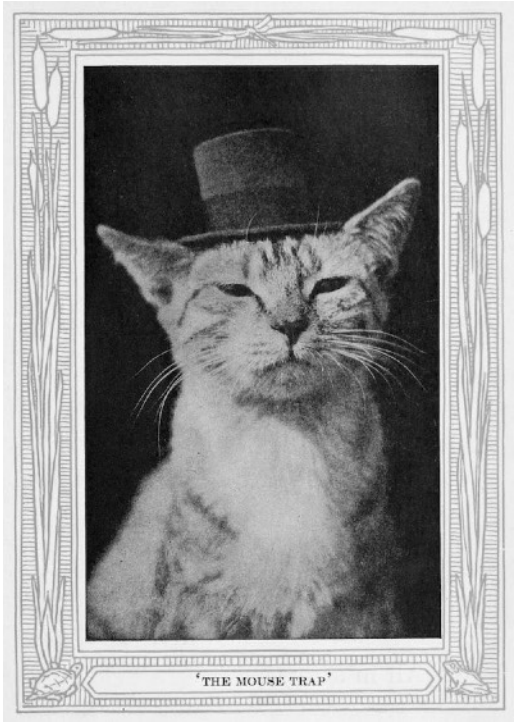


Pearson

Image dtypes

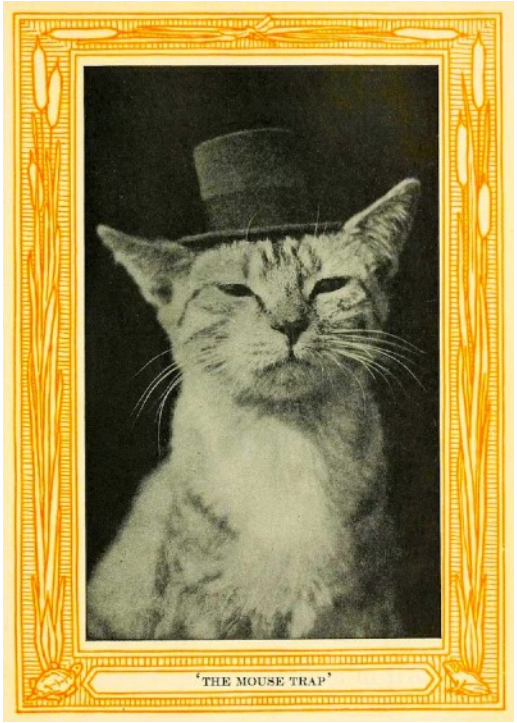
dtype	Range
uint8	0 to 255
float	(-1 to 1) or (0 to 1)
int8	-128 to 127
int32	-2^{31} to $(-2^{31} - 1)$

Representing Greyscale Images



245	238	222	255
233	0	17	254
255	6	3	223
250	9	11	242
251	247	245	232

Representing Color Images



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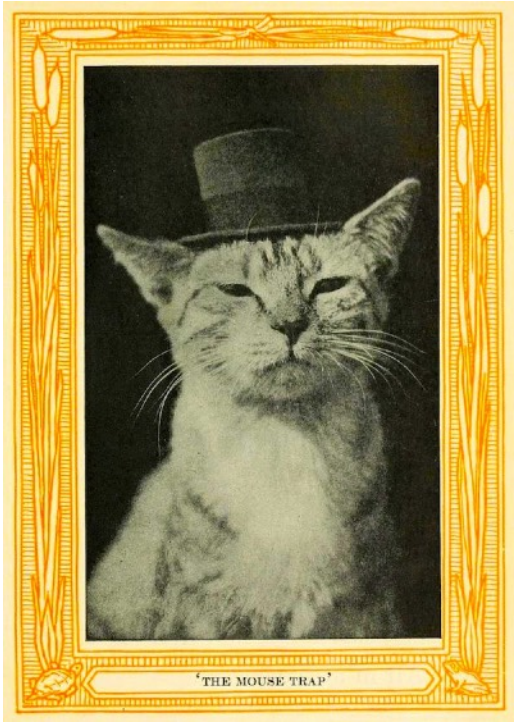
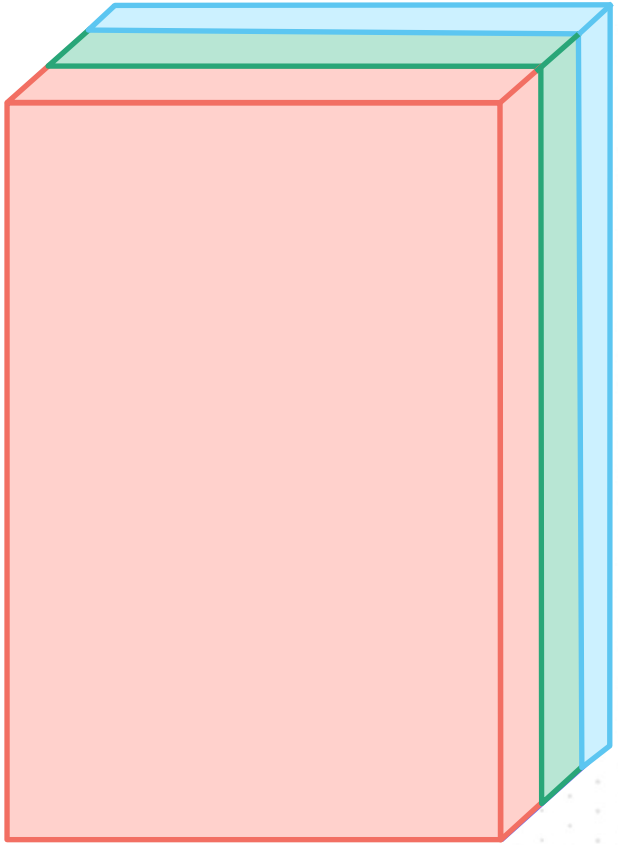
Pearson

Representing Color Images





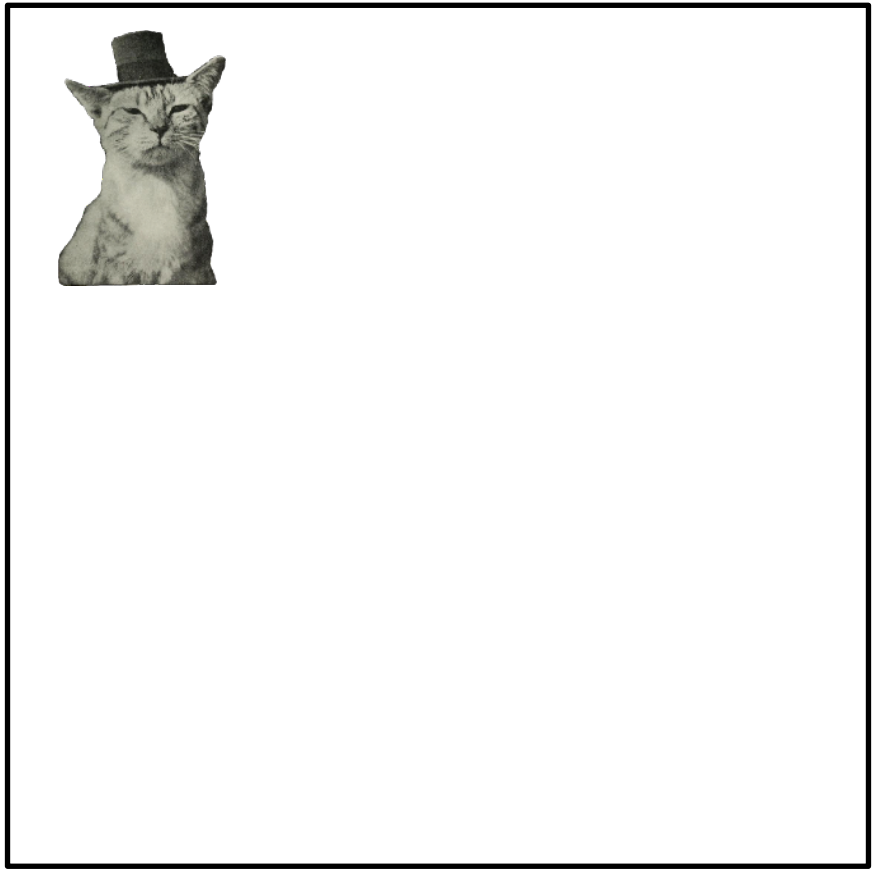
3.2

Desiderata for Computer Vision

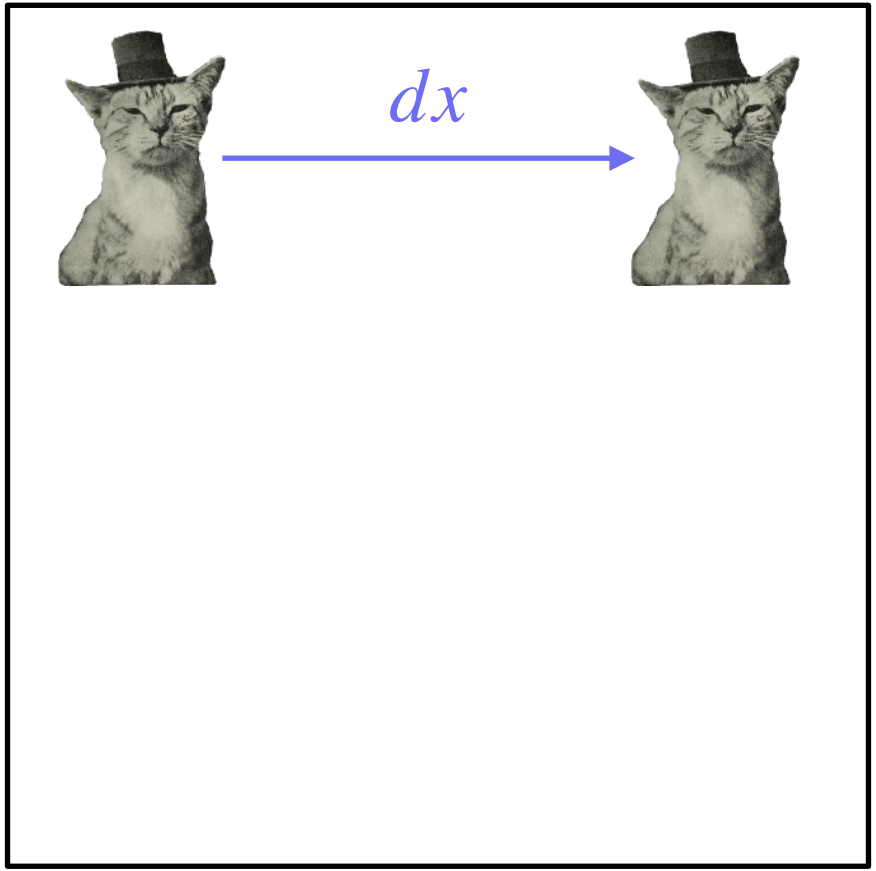
Goal

How can we design a neural network that exhibits translation invariance and locality when modeling images?

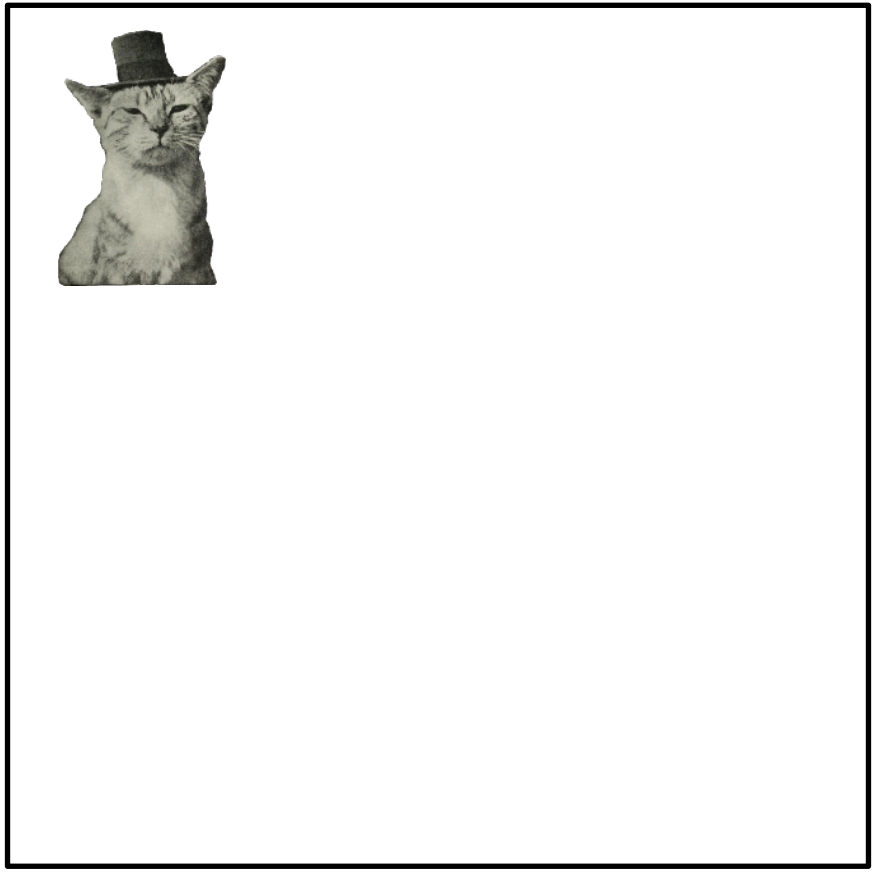
Translation Invariance



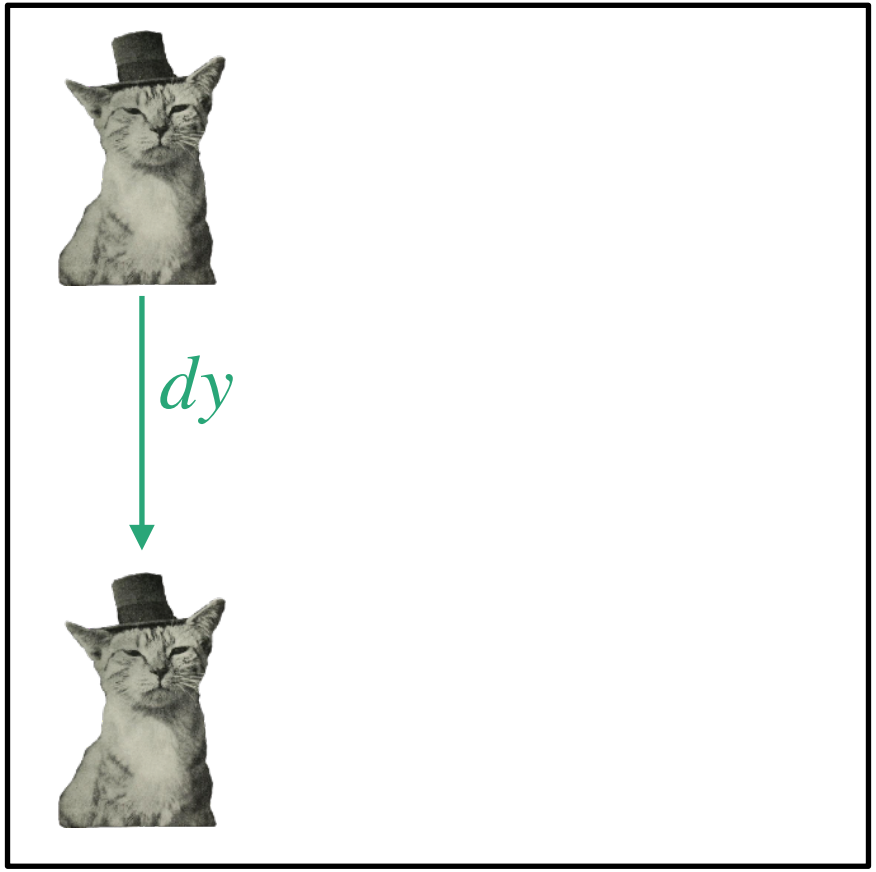
Translation Invariance



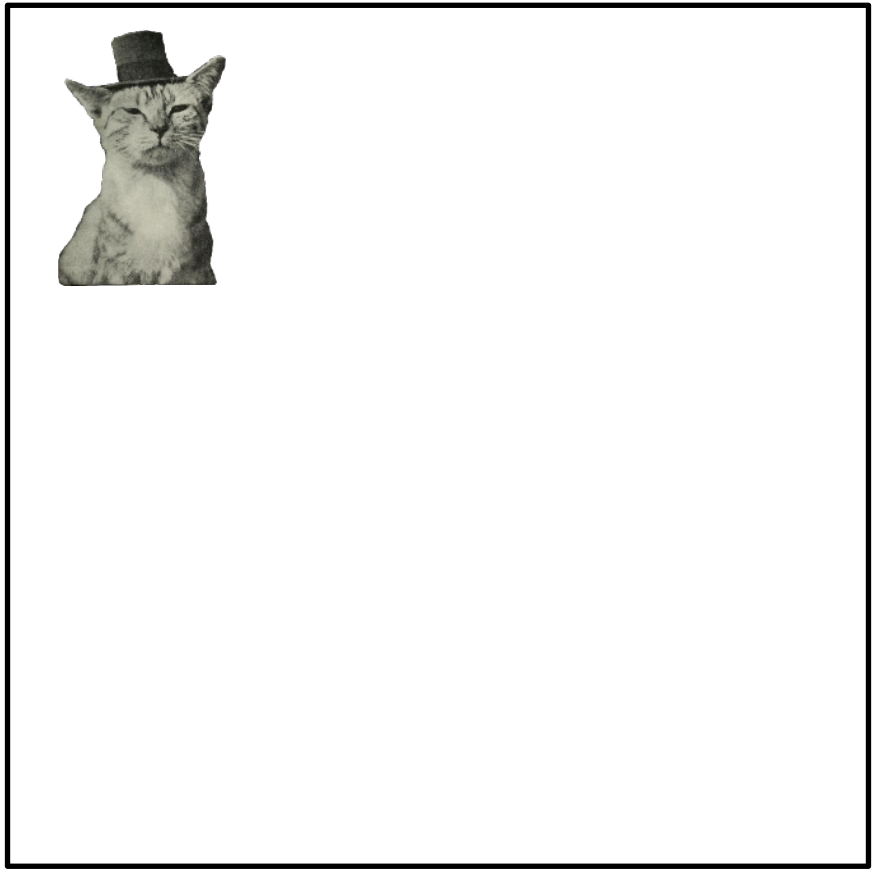
Translation Invariance



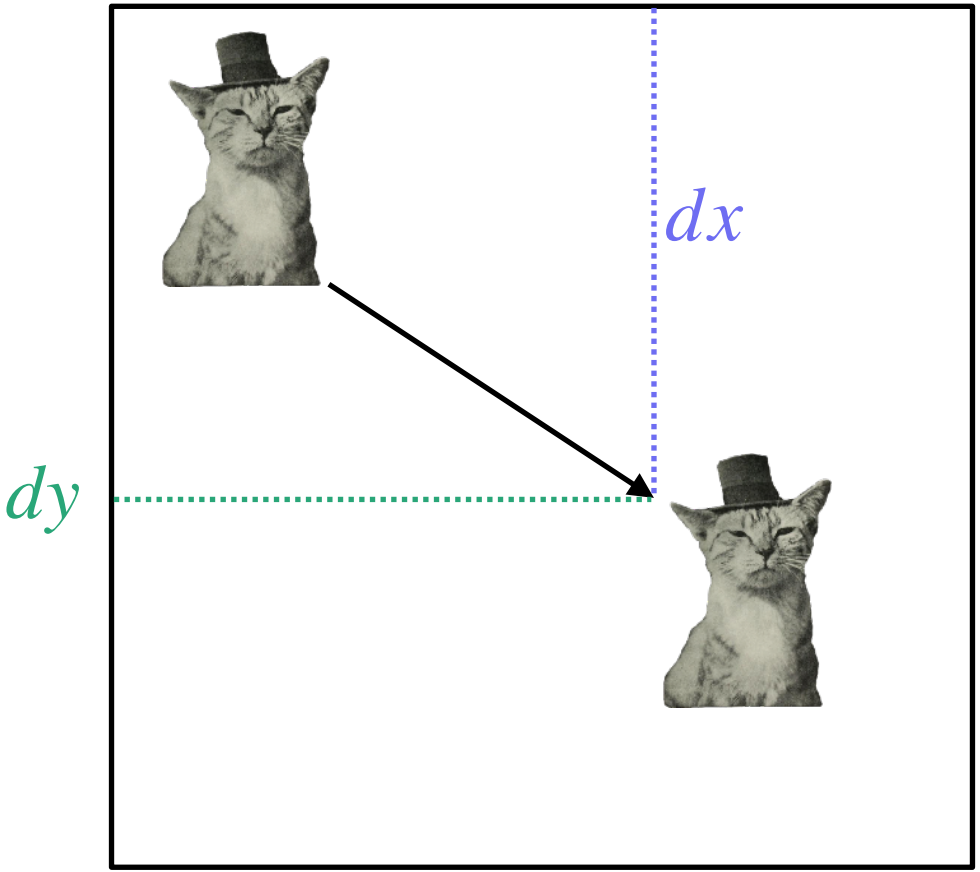
Translation Invariance



Translation Invariance



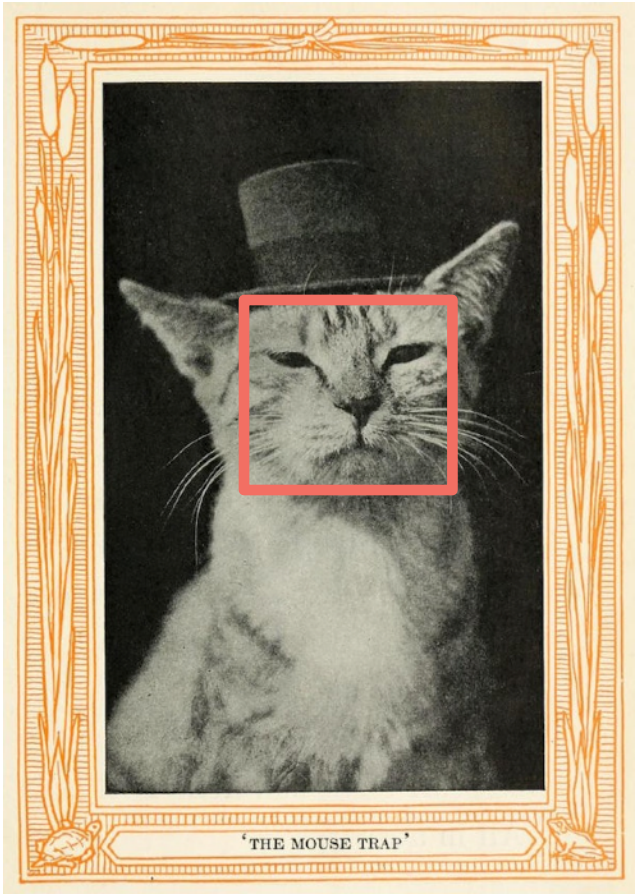
Translation Invariance



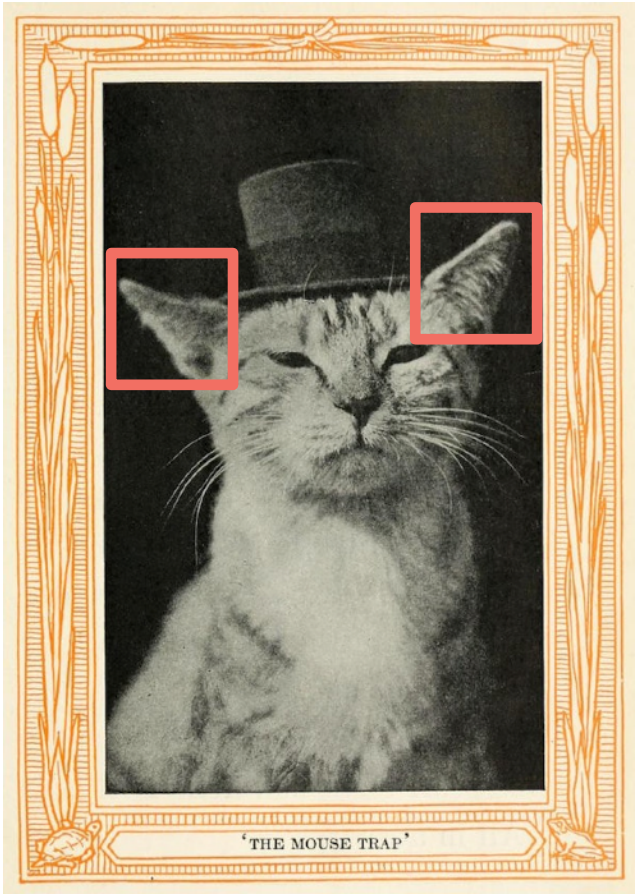
Locality

Pearson

Locality



Locality



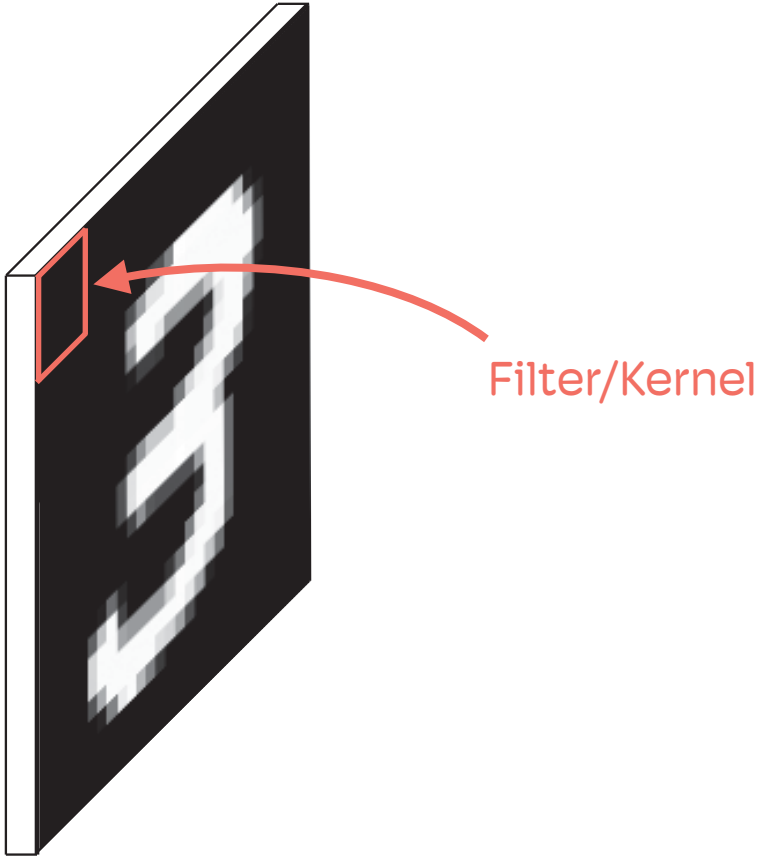
3.3

Features of Convolutional Neural Networks

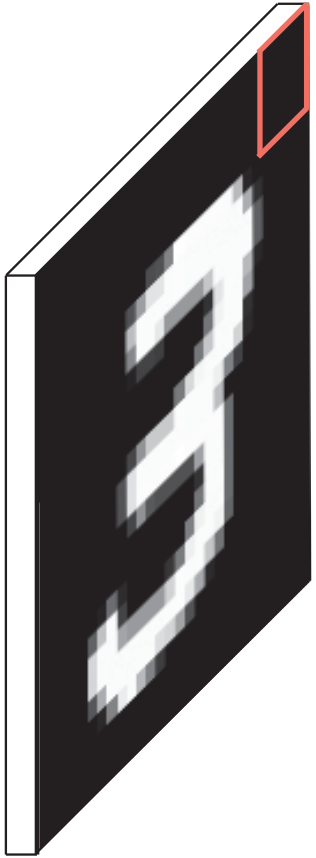
Convolutional Neural Networks

- **Local Receptive Fields**
- **Shared Weights**
- **Pooling**

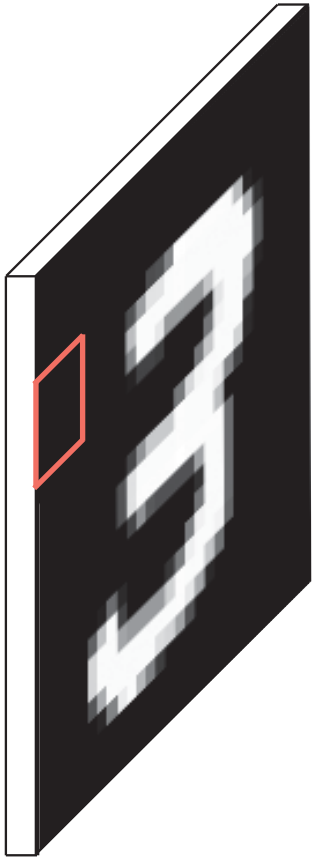
Convolutional Neural Networks



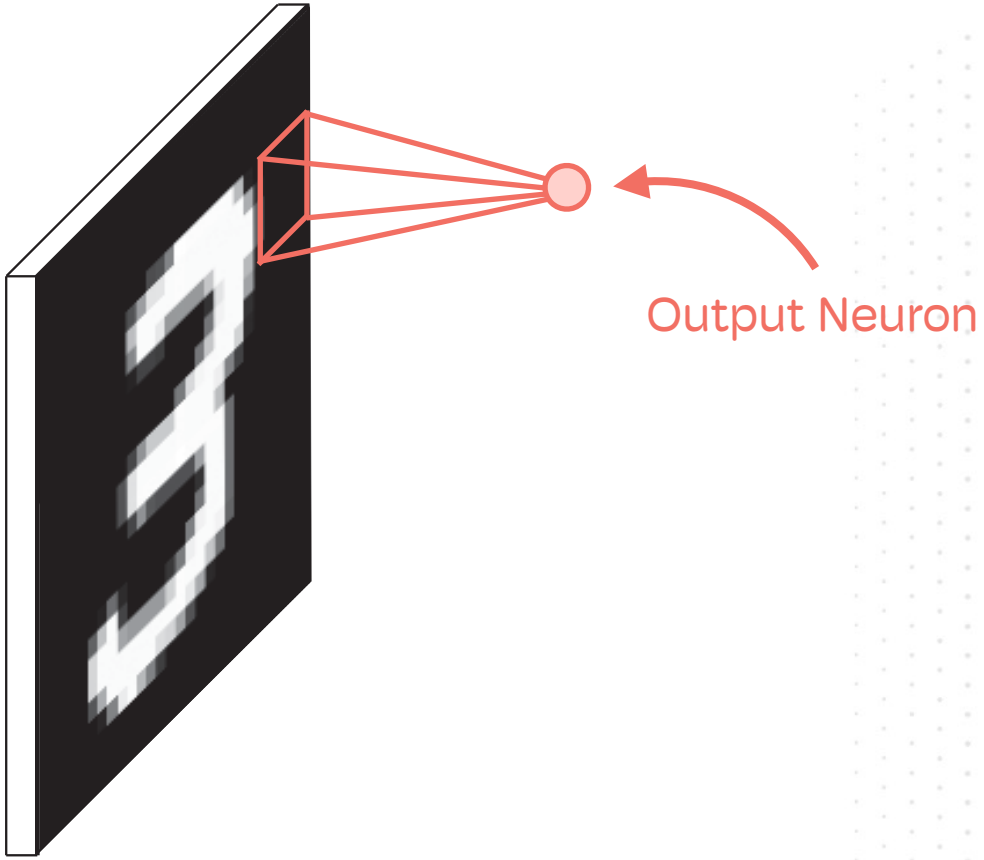
Convolutional Neural Networks



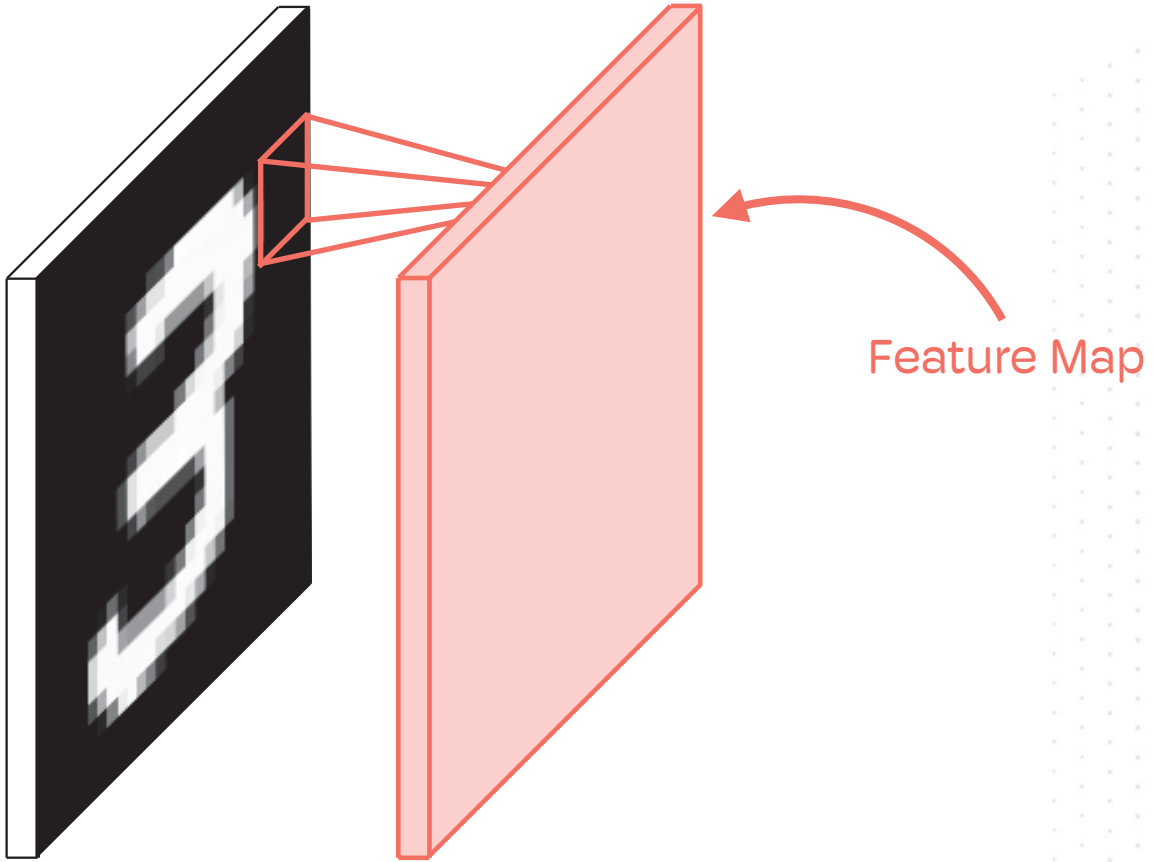
Convolutional Neural Networks



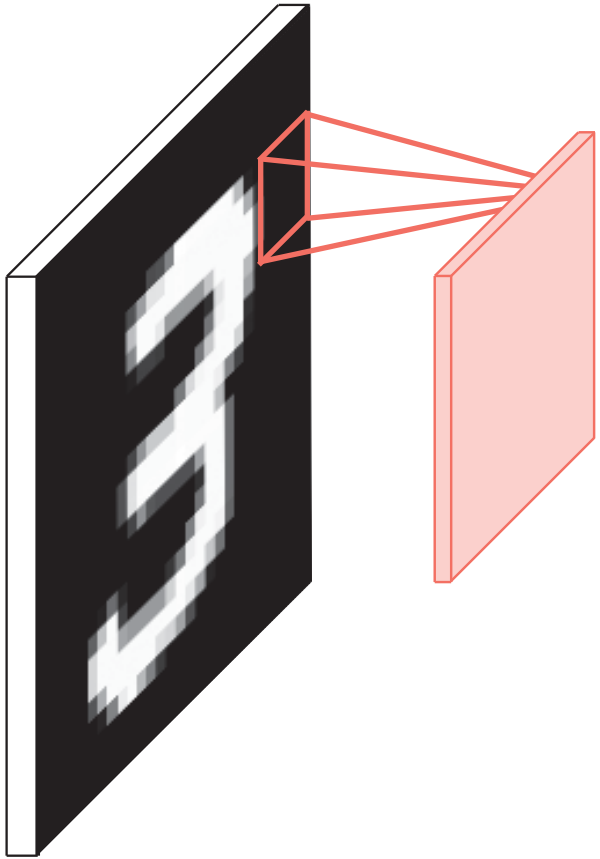
Convolutional Neural Networks



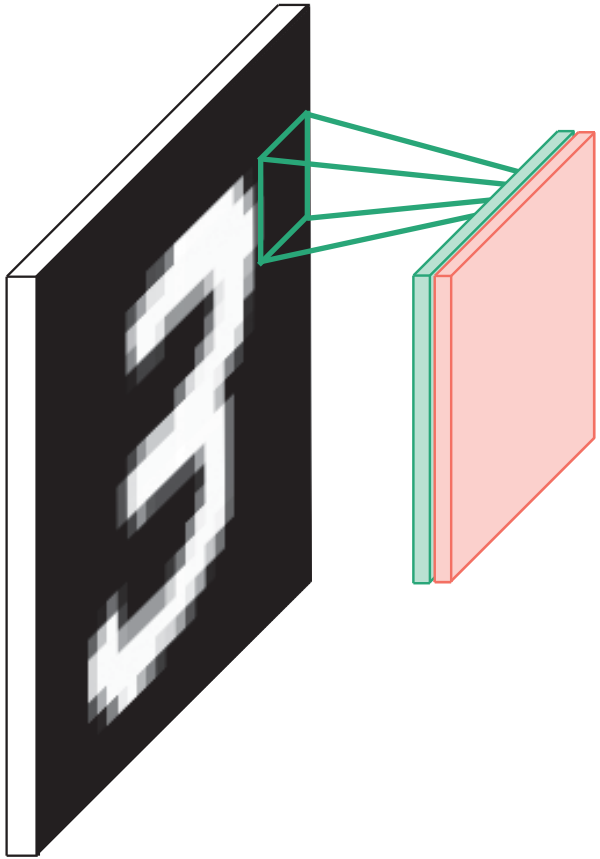
Convolutional Neural Networks



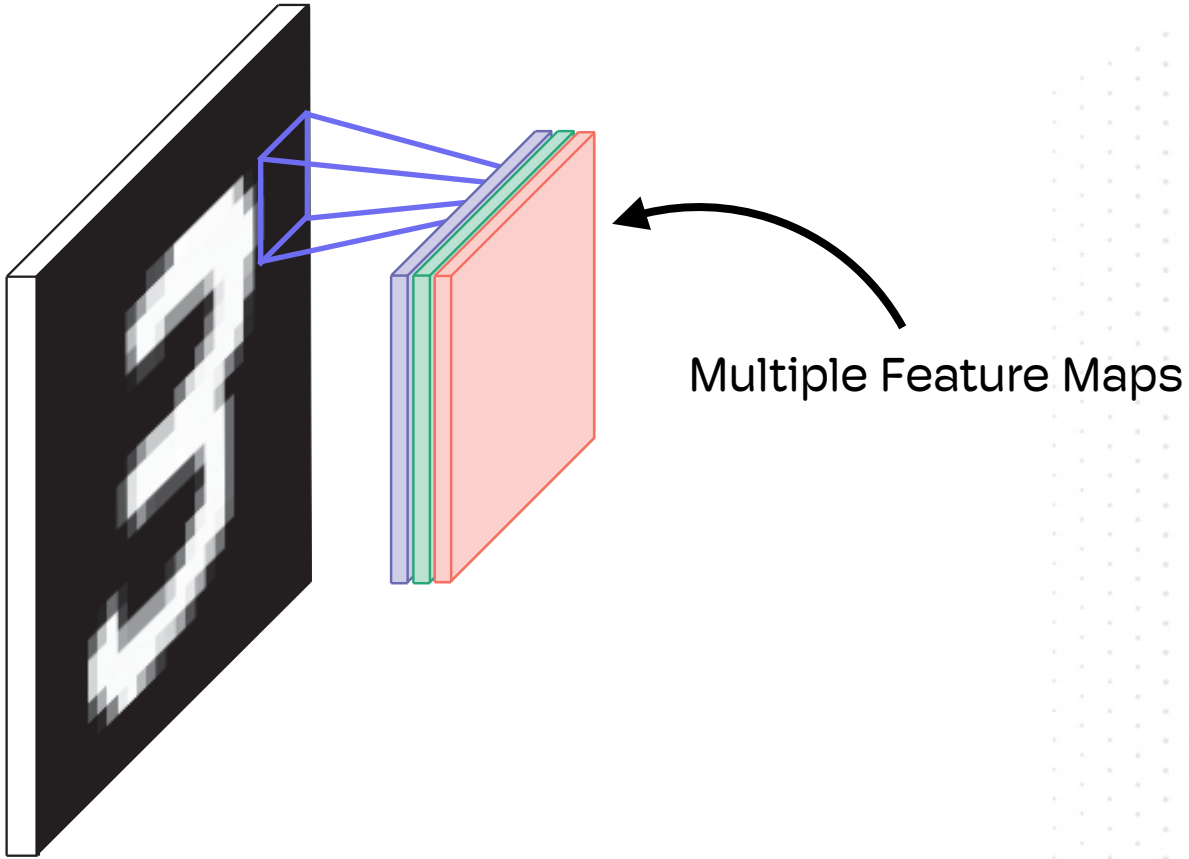
Convolutional Neural Networks



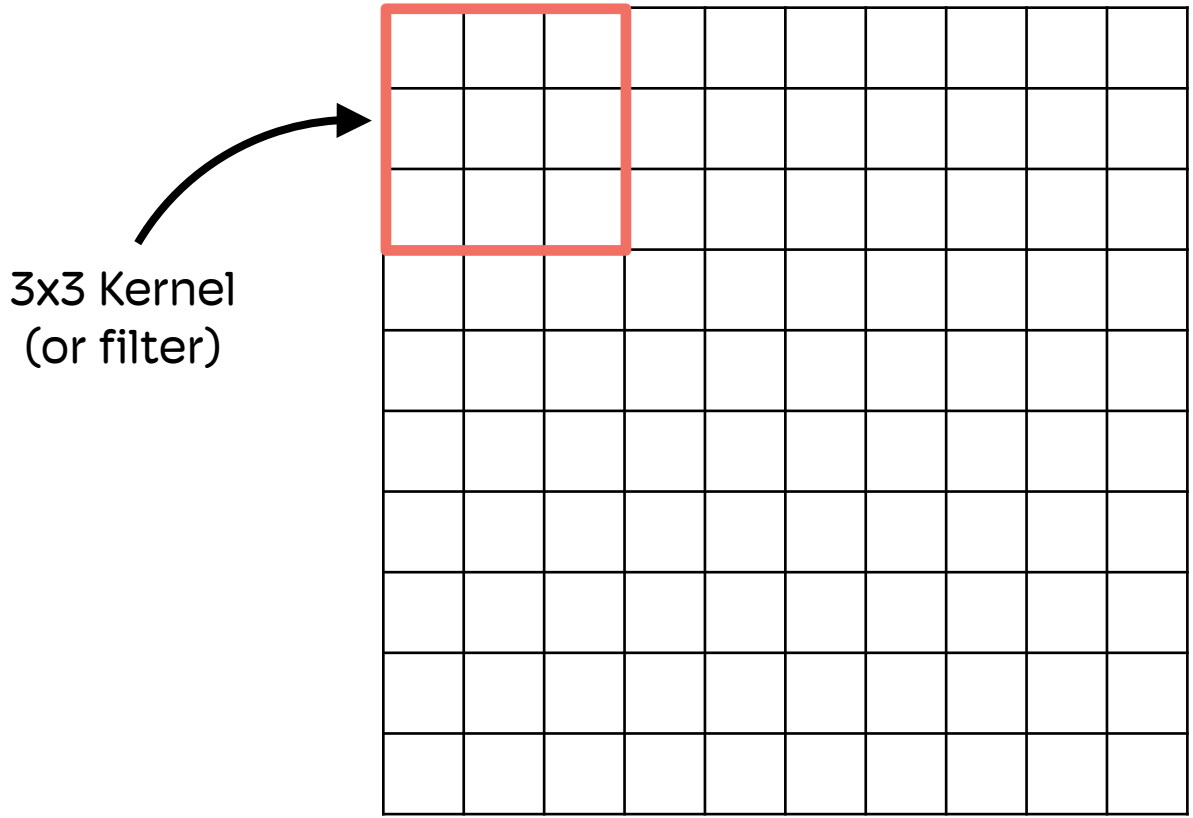
Convolutional Neural Networks



Convolutional Neural Networks

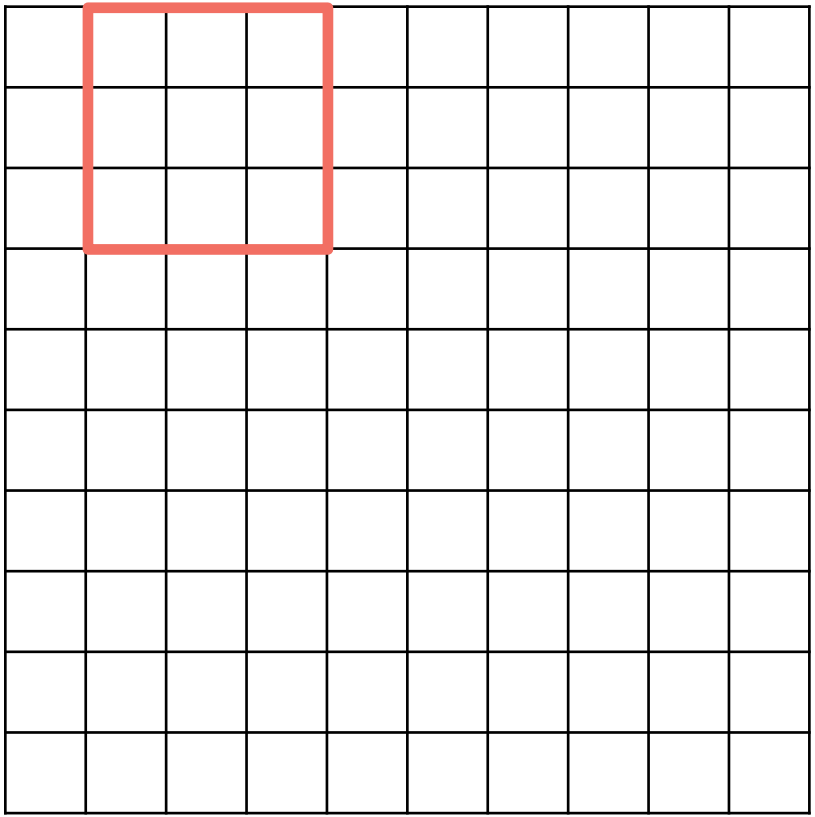


Convolutional “arithmetic”



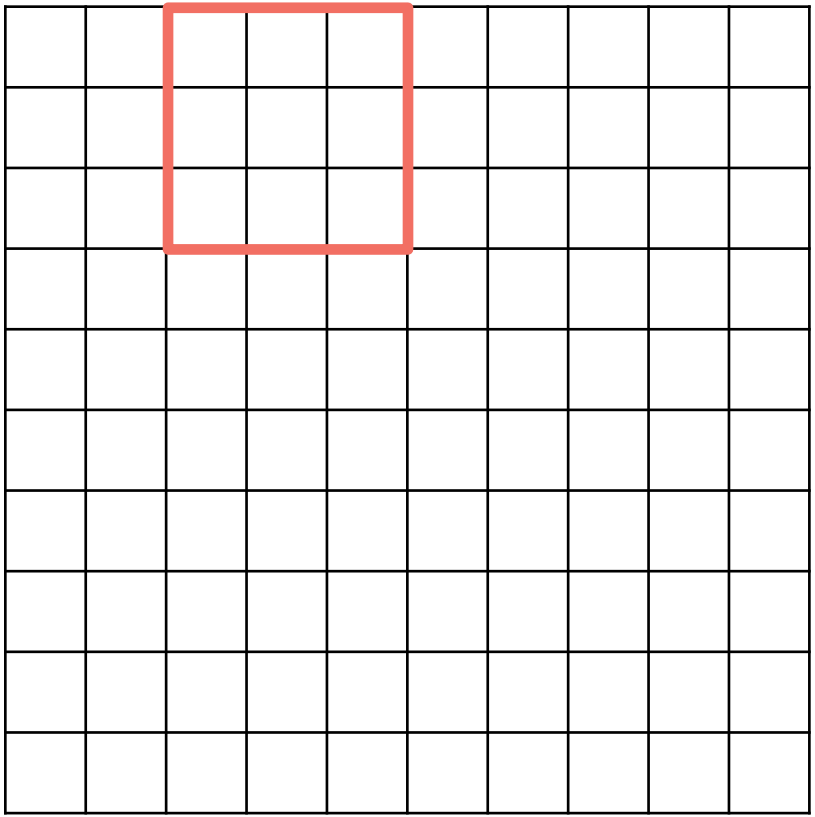
Stride Length

Stride 1



Stride Length

Stride 1



Stride Length

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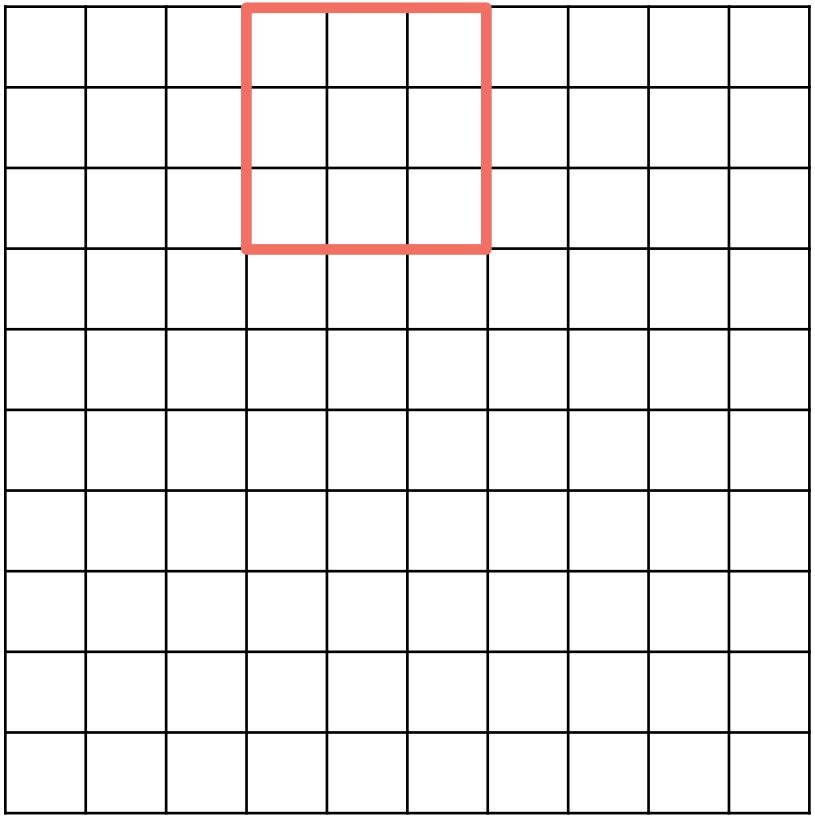
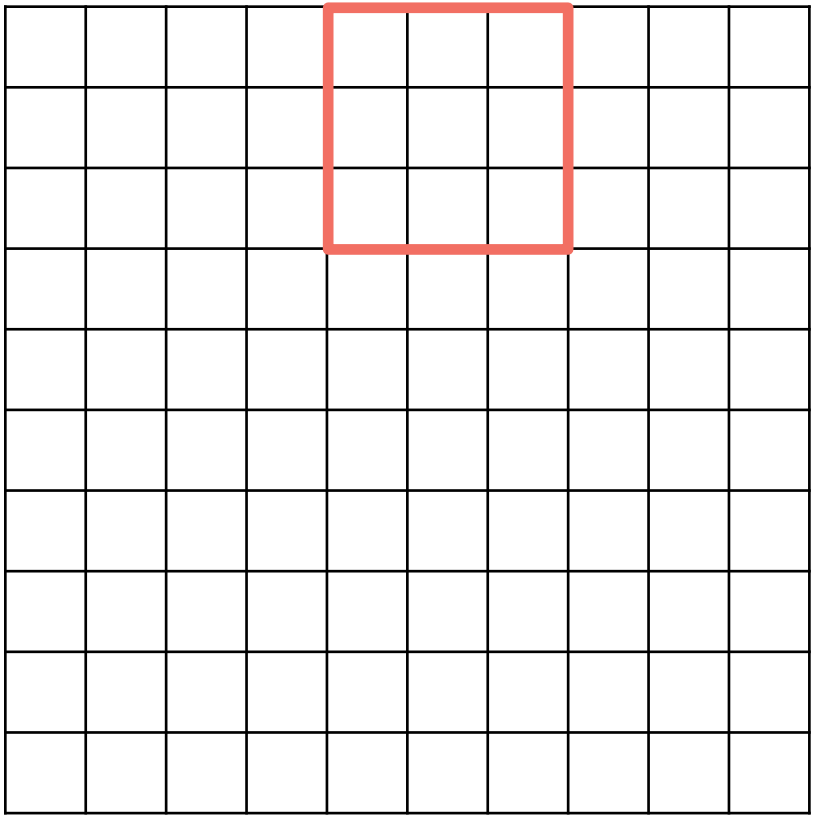


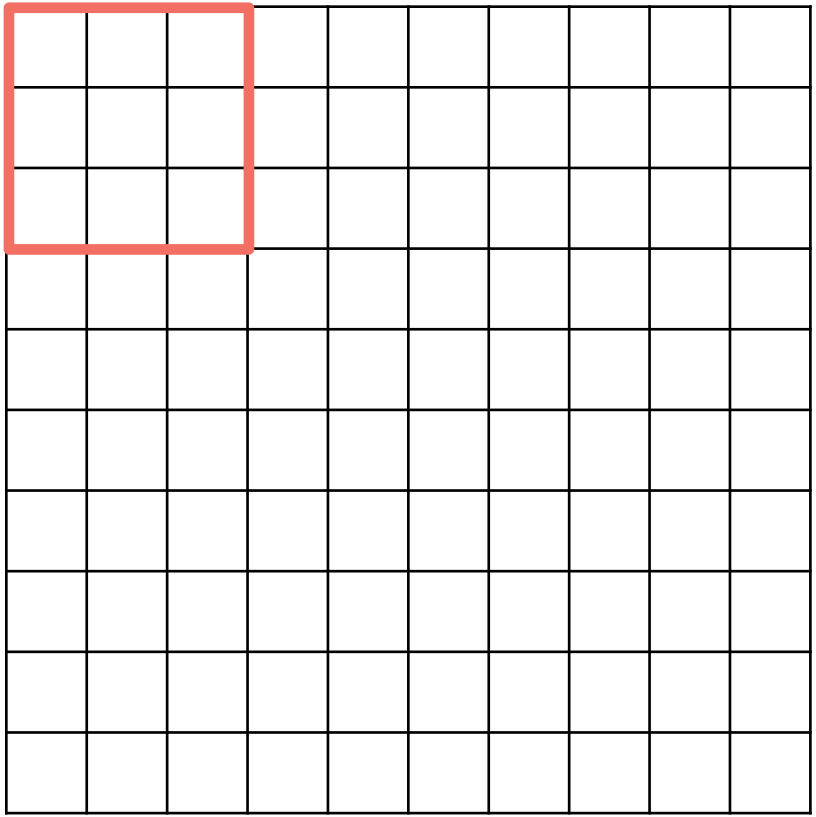
Stride Length

Stride 1



Stride Length

Stride 2



Stride Length

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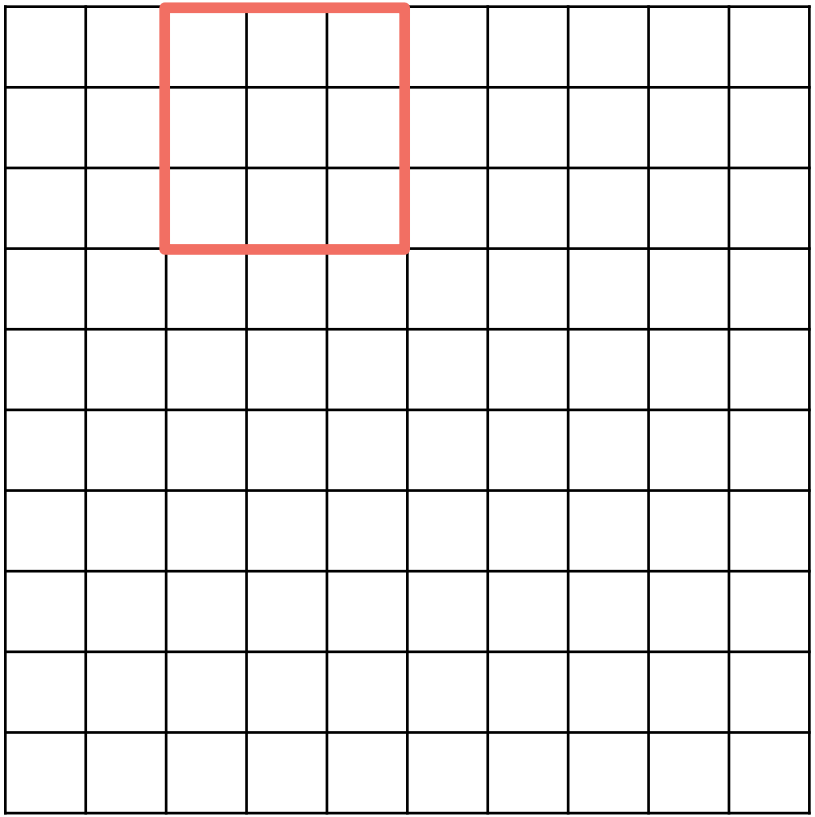

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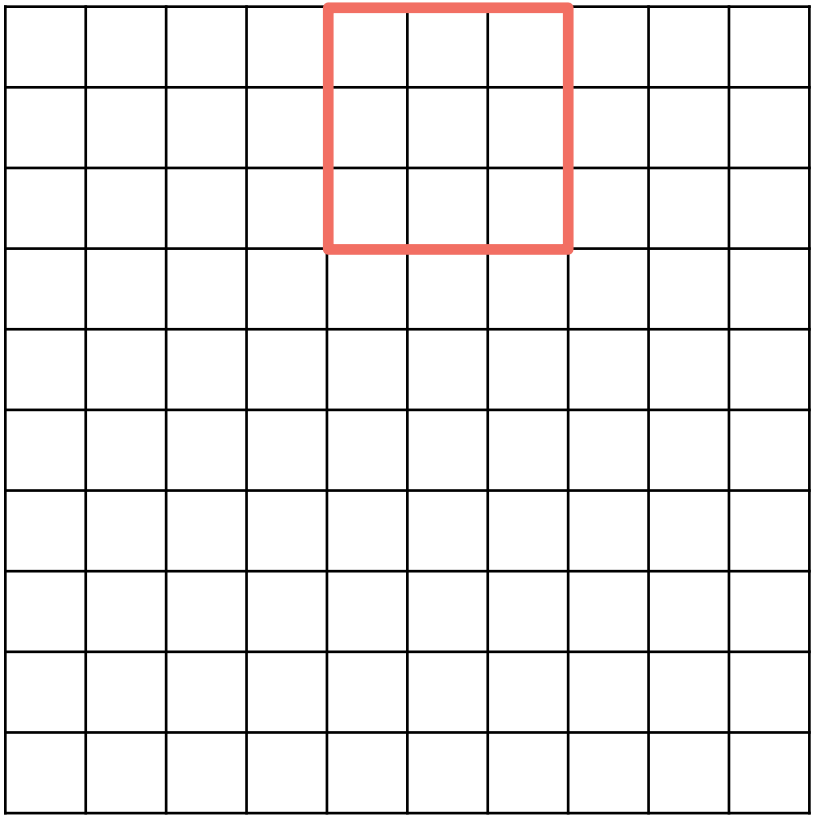

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Padding

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3.4

Working with Images in Python

Live Coding

3.5

The FashionMNIST Dataset

Live Coding

3.6

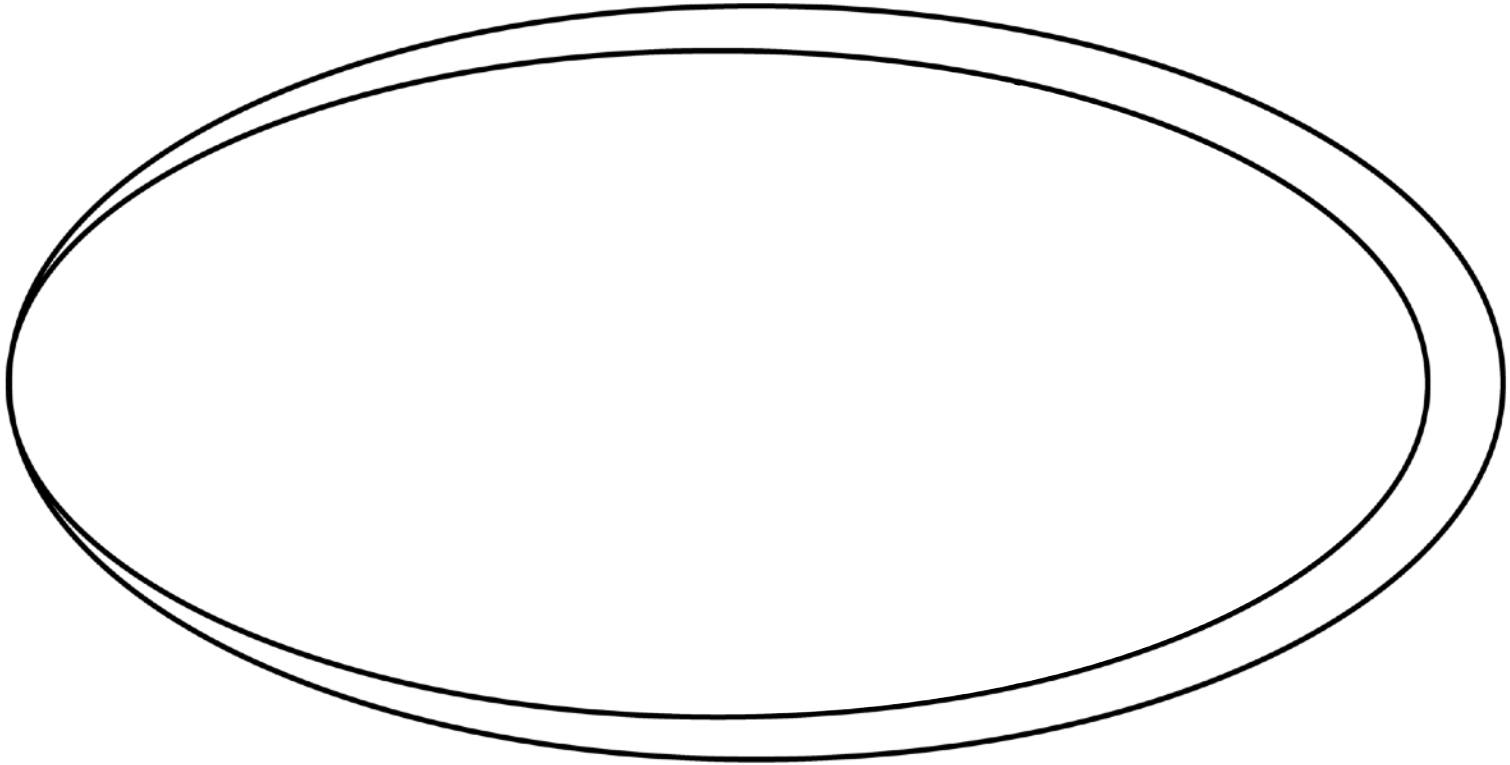
Convolutional Neural Networks in PyTorch

Live Coding

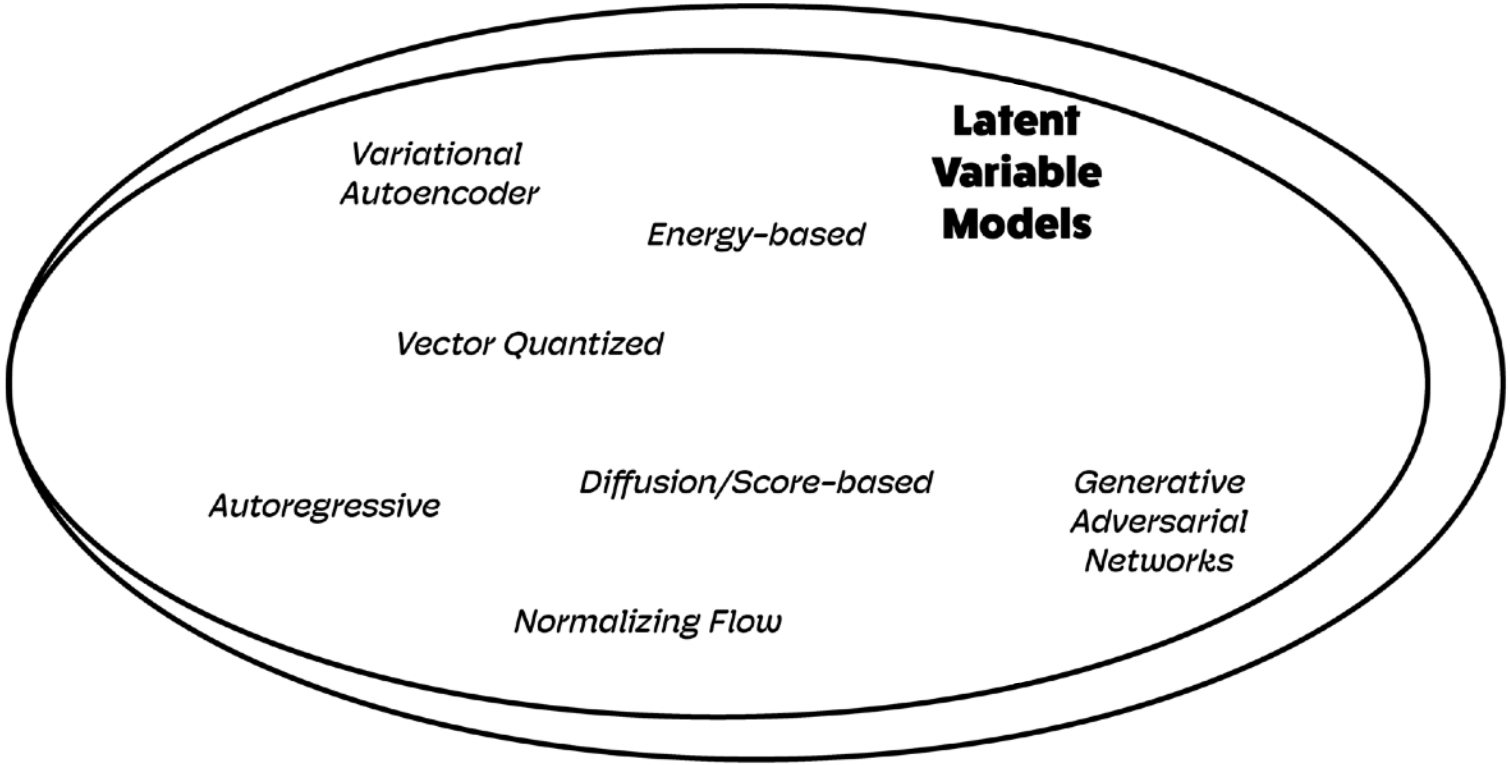
3.7

Components of a Latent Variable Model (LVM)

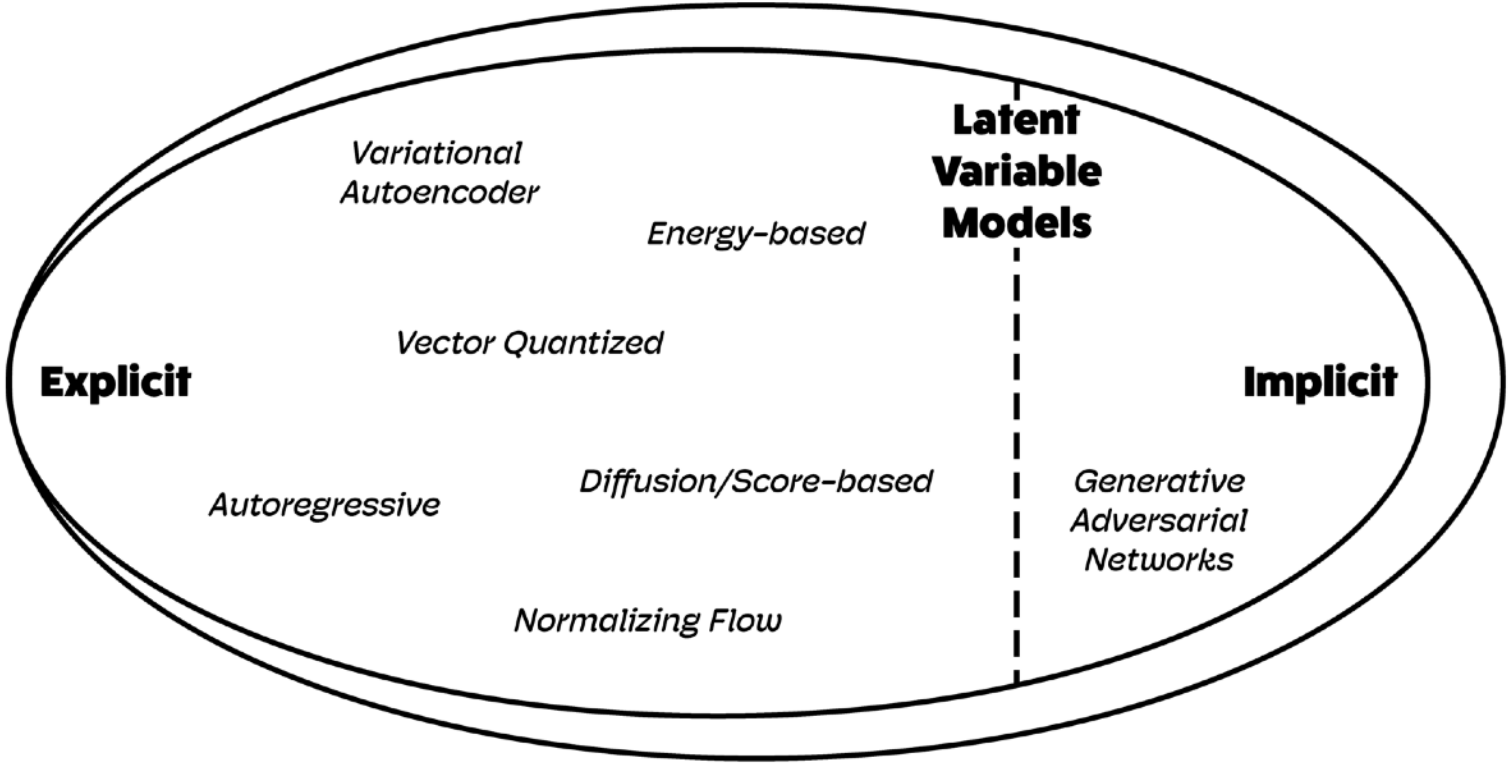
Generative Models



Generative Models



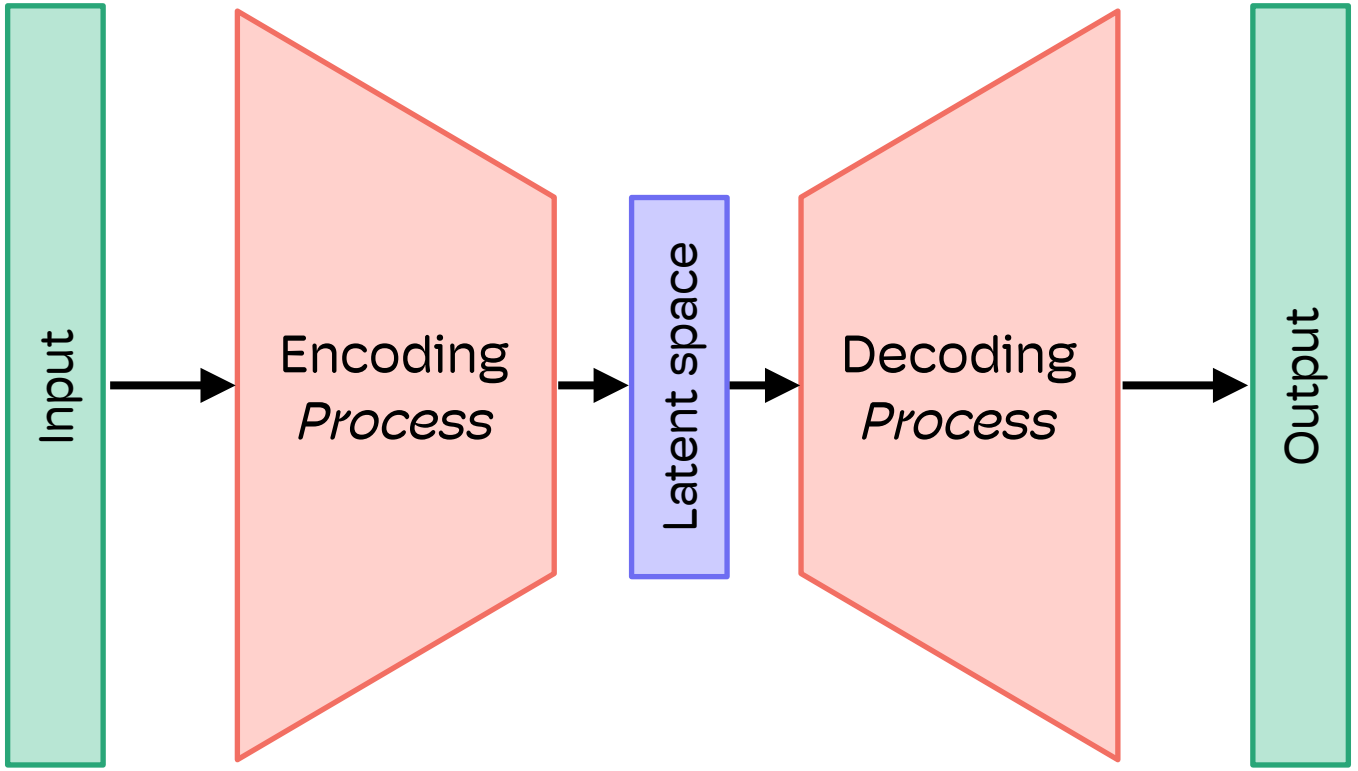
Generative Models



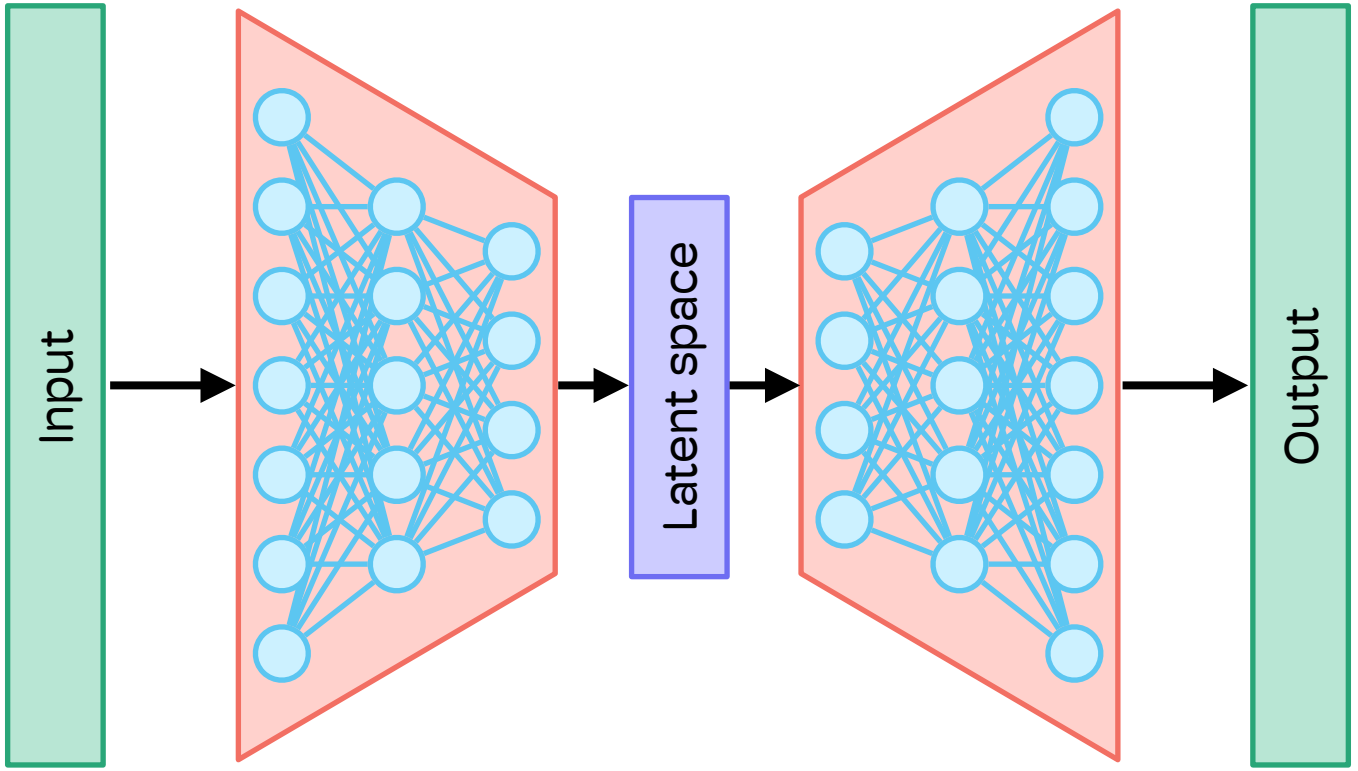
Components of a Latent Variable Model (LVM)

- Encoding
- Latent Representation
- Decoding

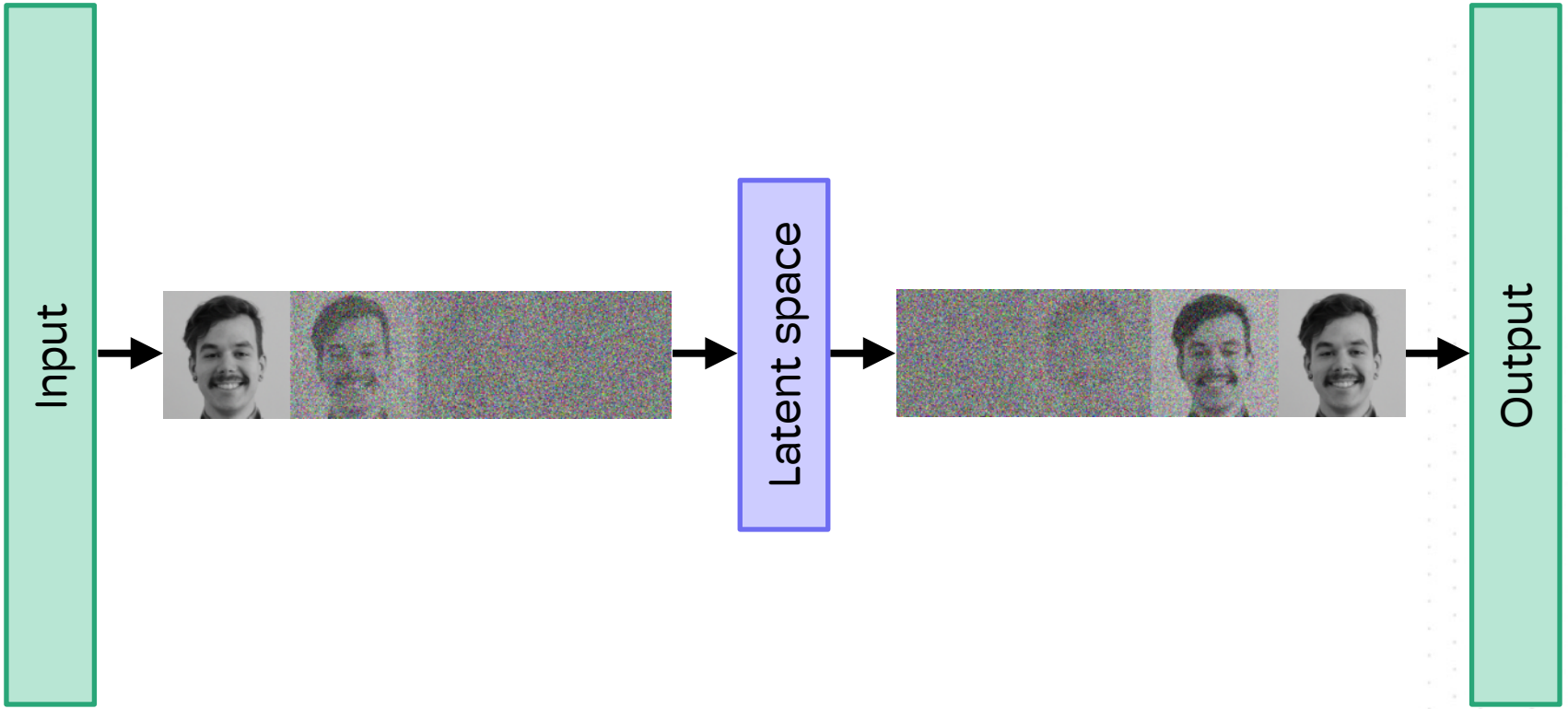
Components of a Latent Variable Model (LVM)



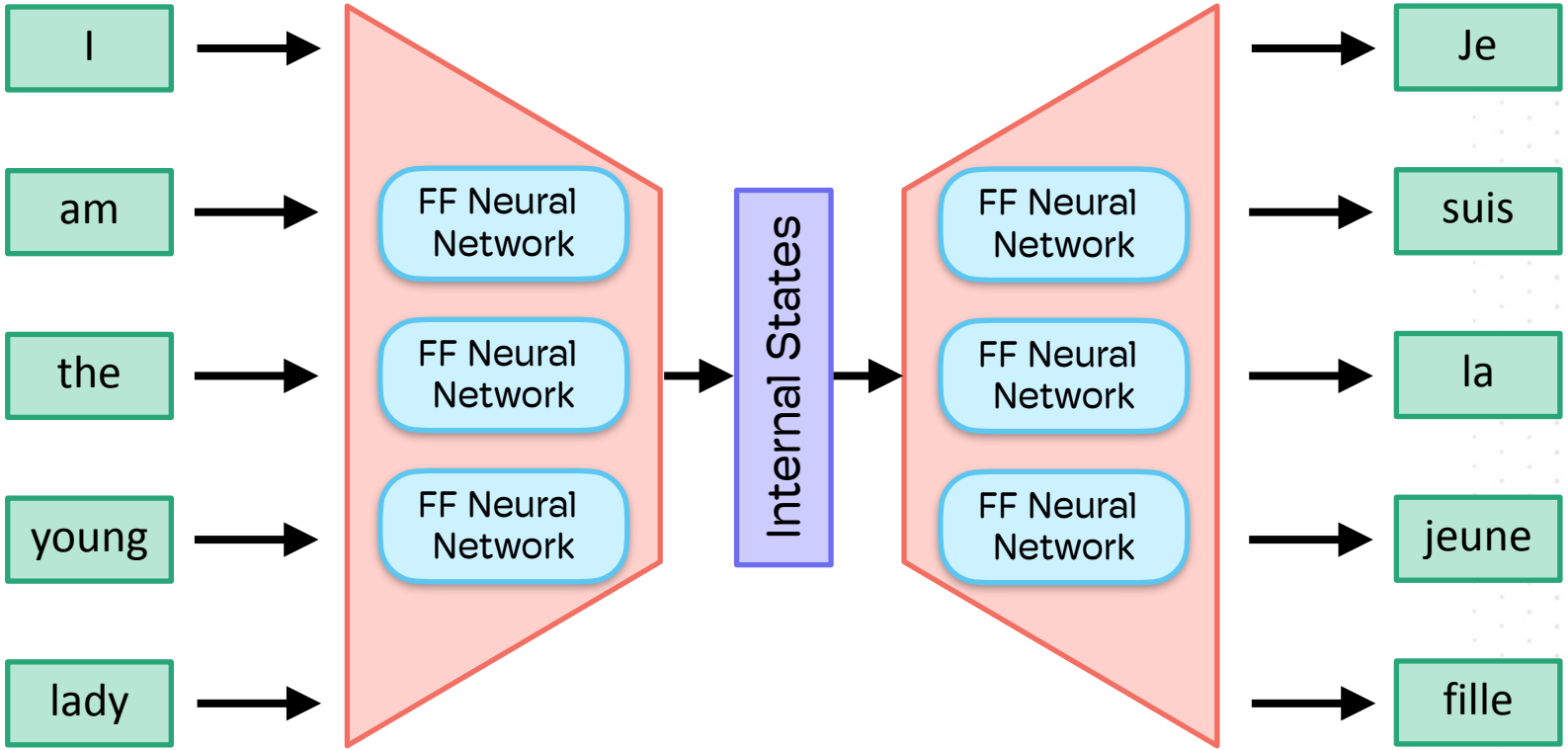
Variational Autoencoder



Diffusion Model



Transformer

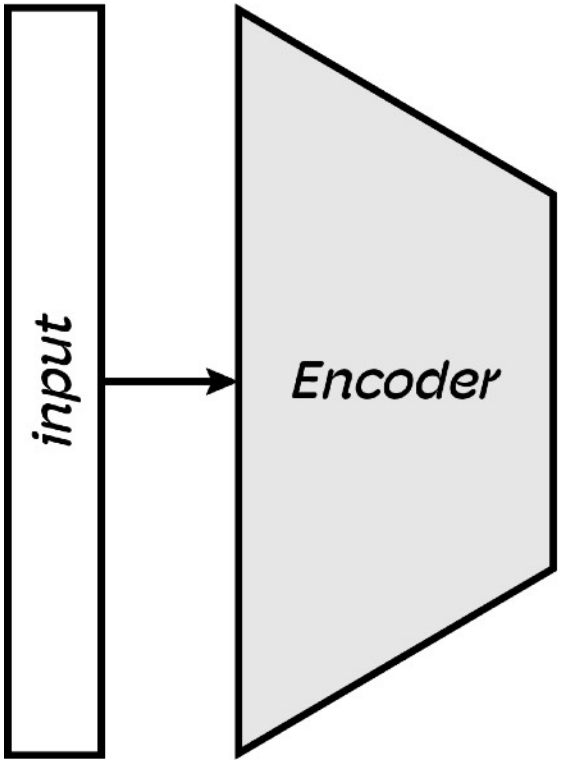


3.8

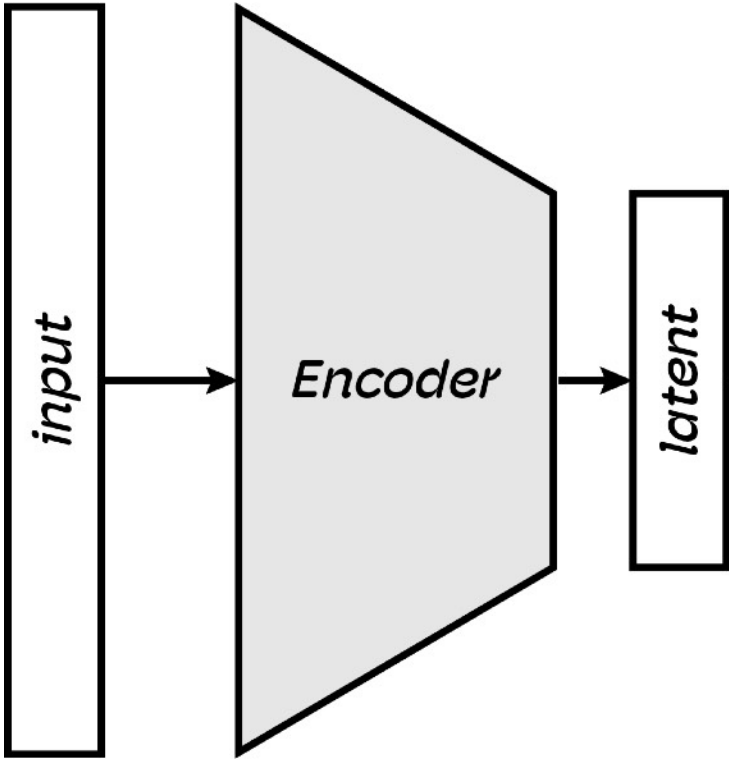
The Humble Autoencoder

Autoencoders

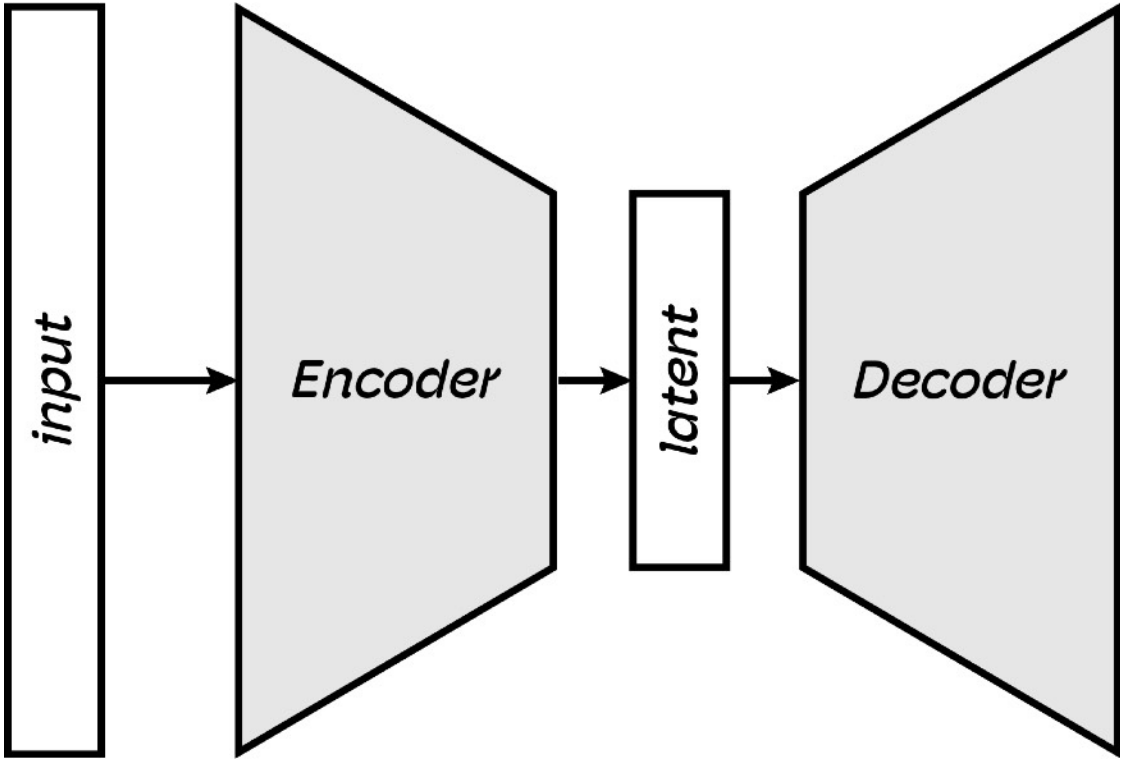
Autoencoders



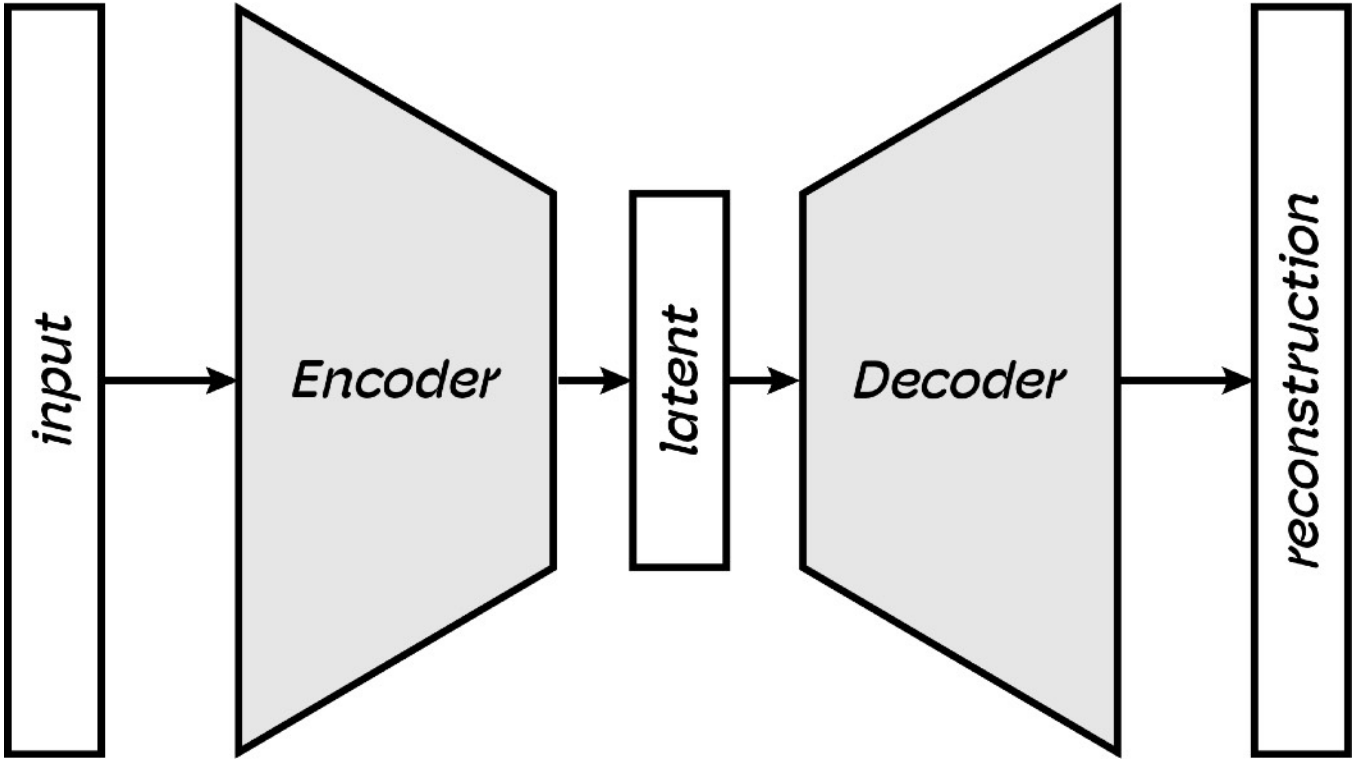
Autoencoders



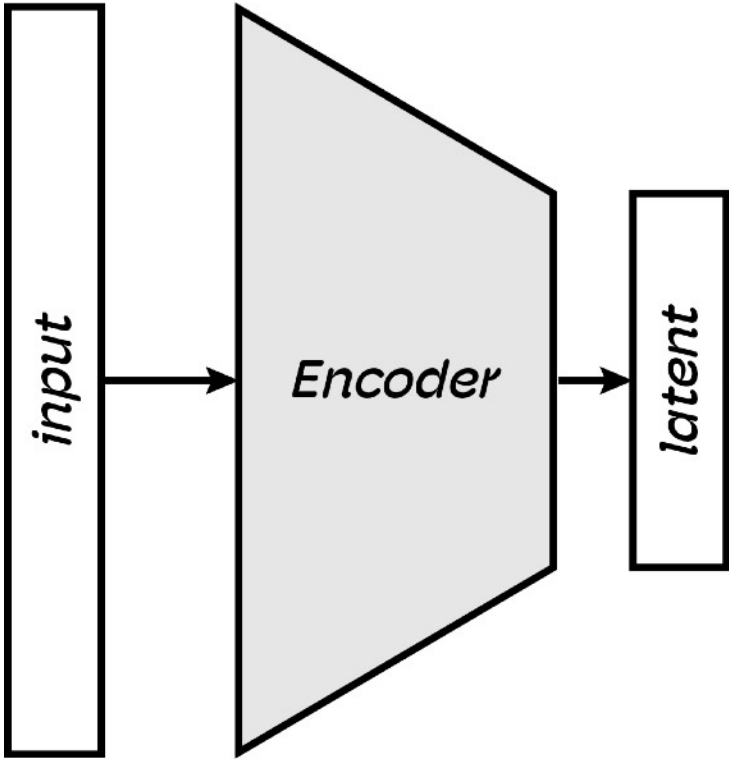
Autoencoders



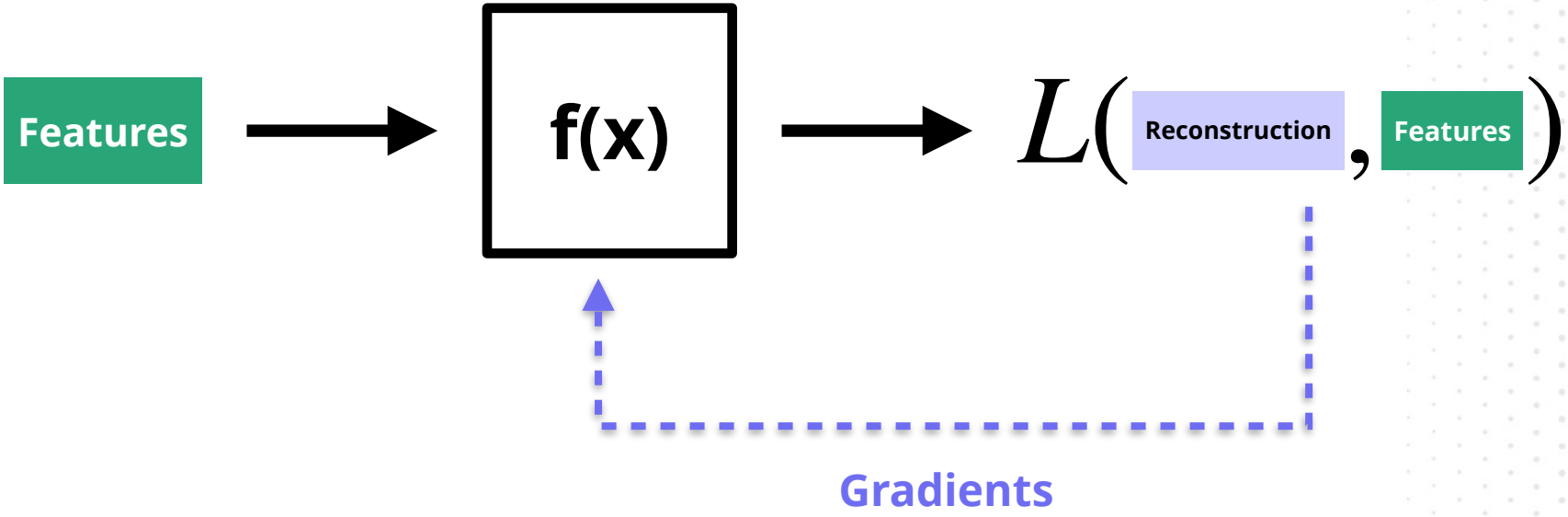
Autoencoders



Autoencoders



Autoencoders



3.9

Defining an Autoencoder with PyTorch

Live Coding

3.10

Setting up a Training Loop

Live Coding

3.11

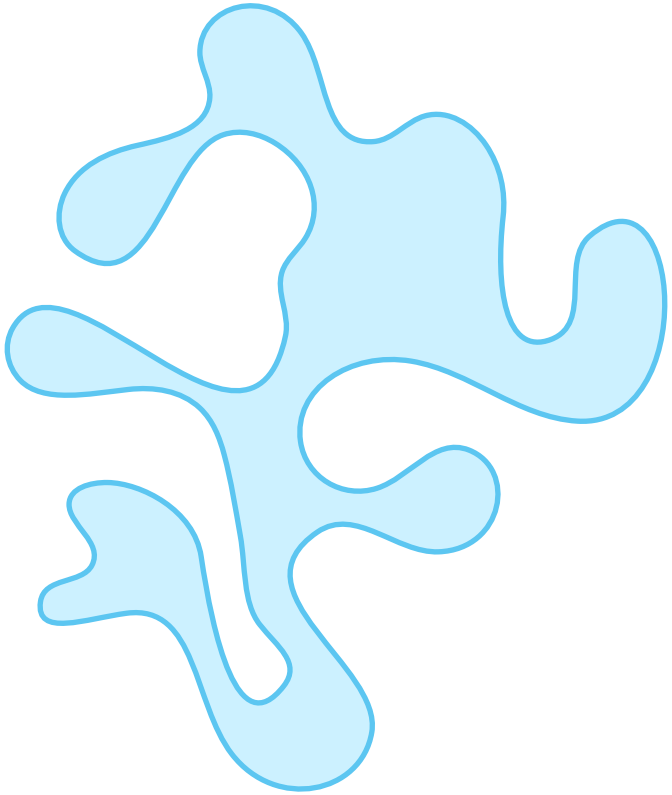
Inference with an Autoencoder

Live Coding

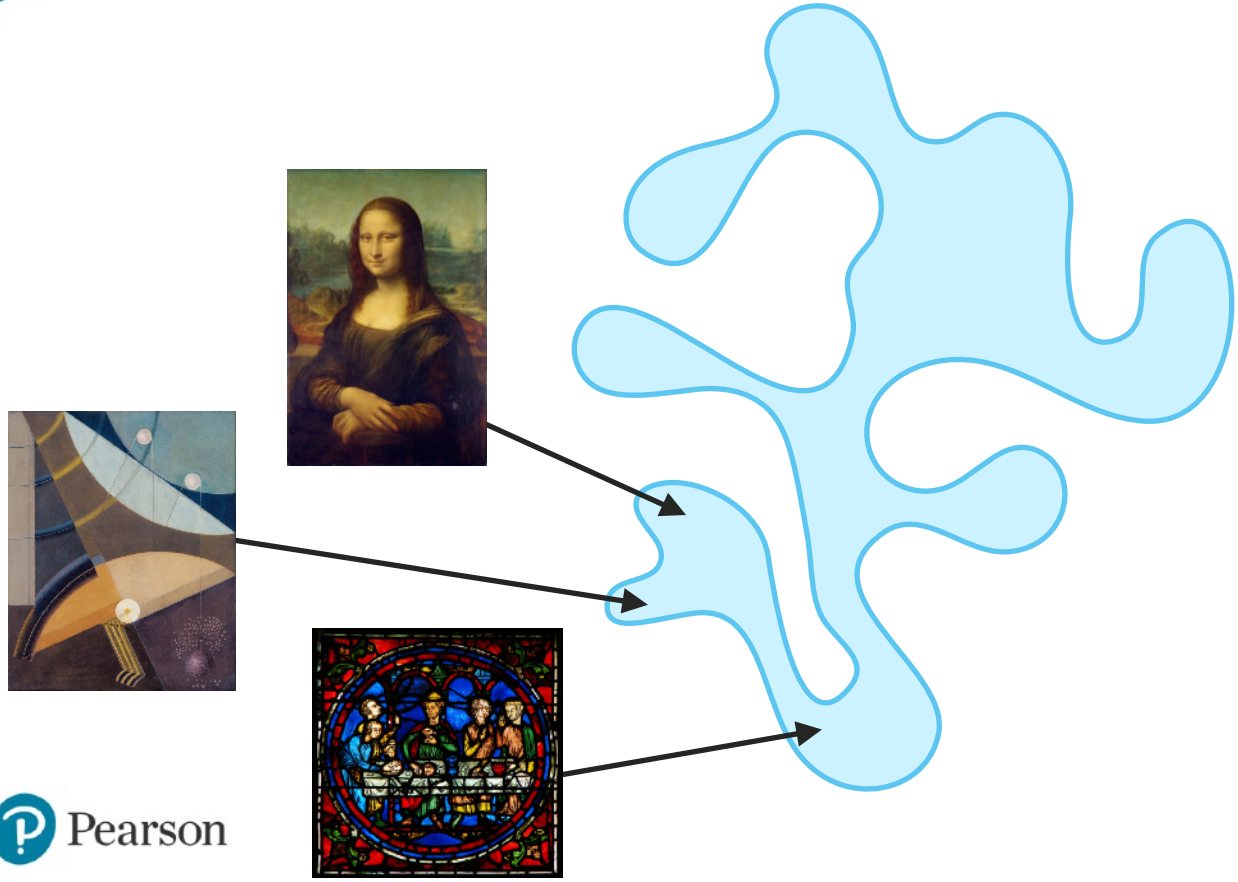
3.12

Look Ma, No Features!

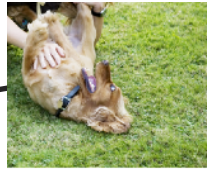
Natural Image Manifold



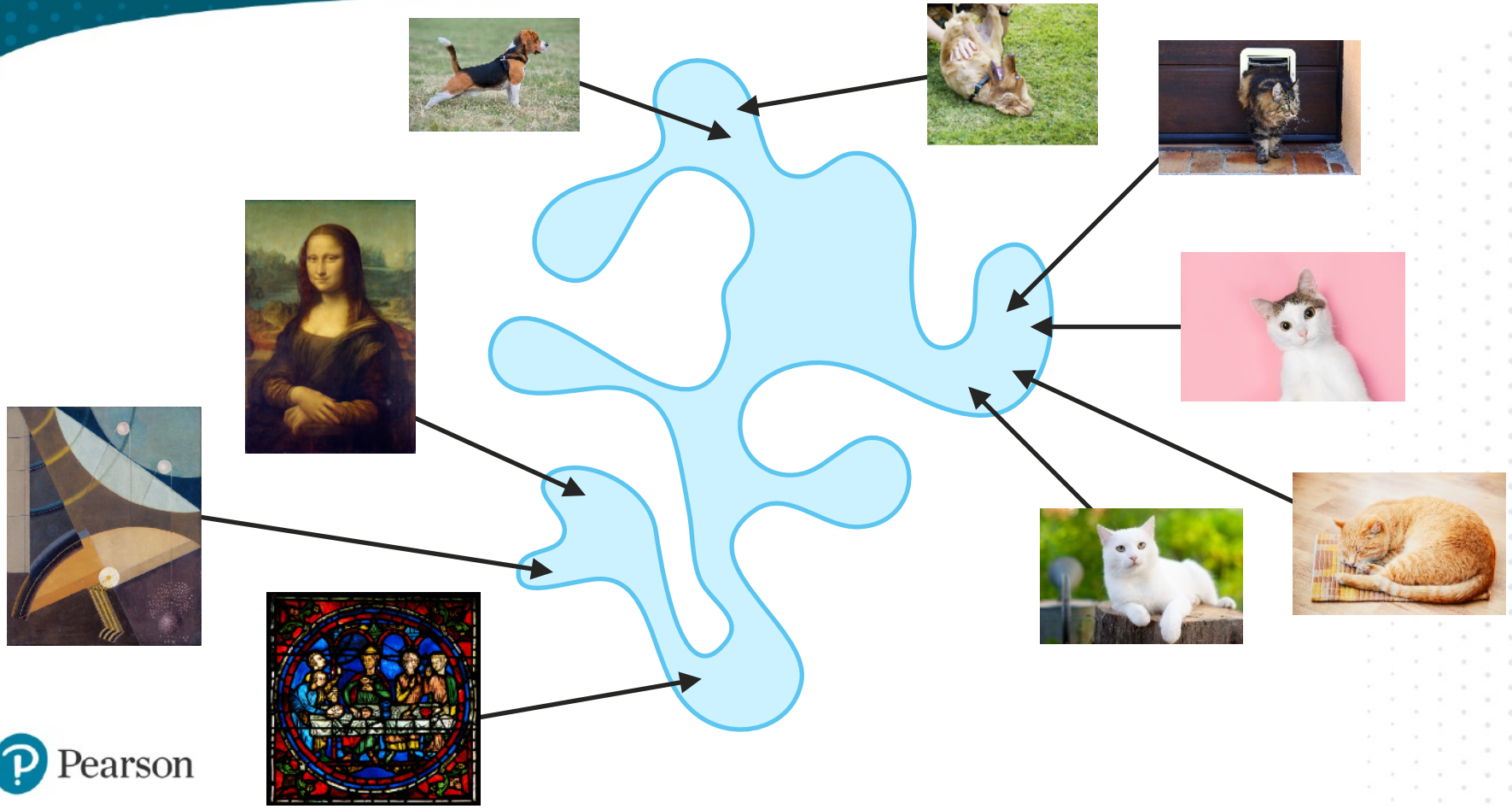
Natural Image Manifold



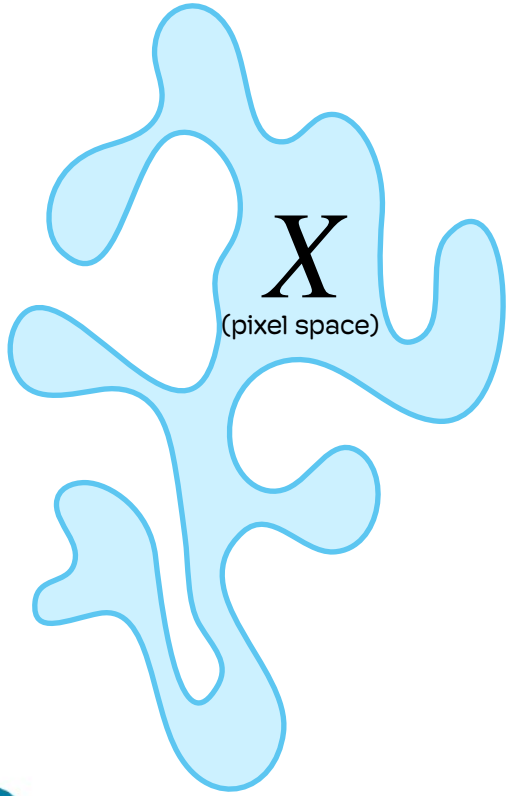
Natural Image Manifold

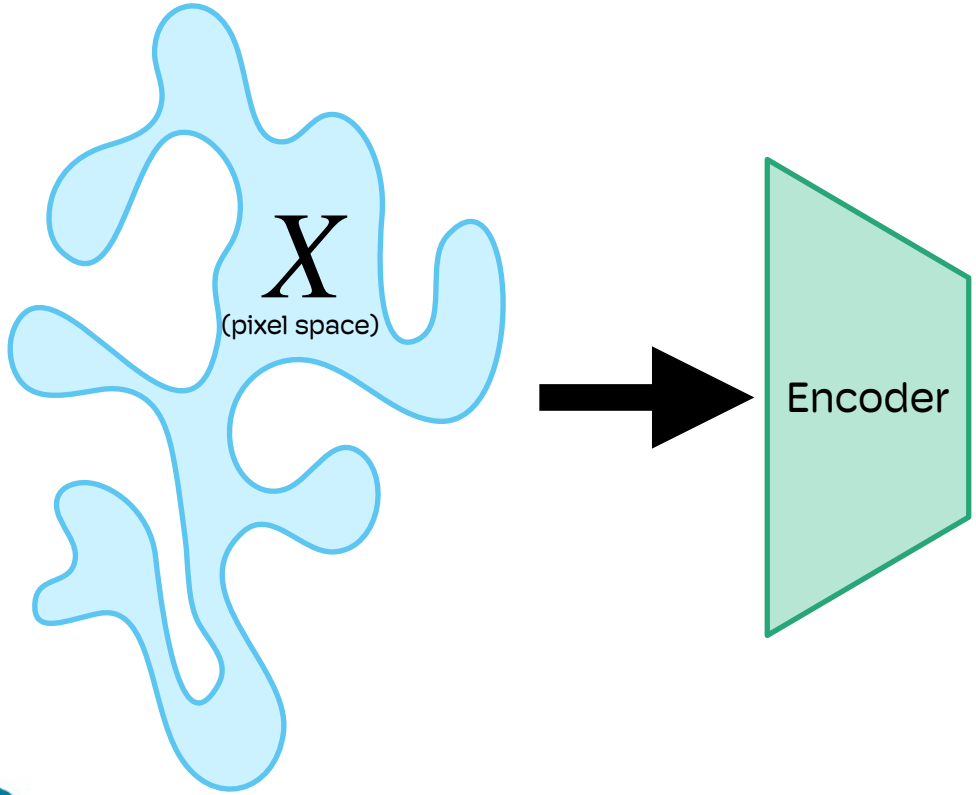

Natural Image Manifold



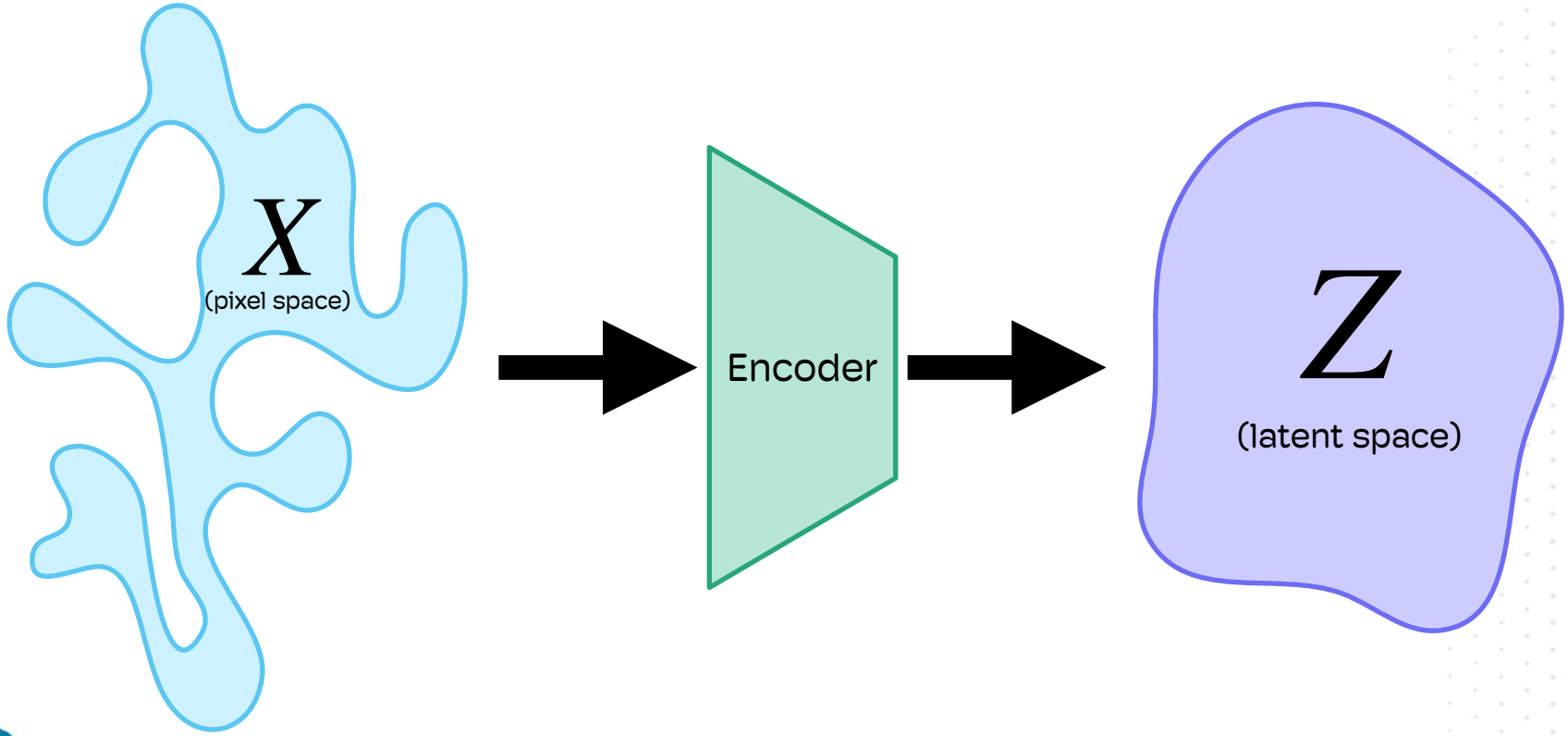
Natural Image Manifold



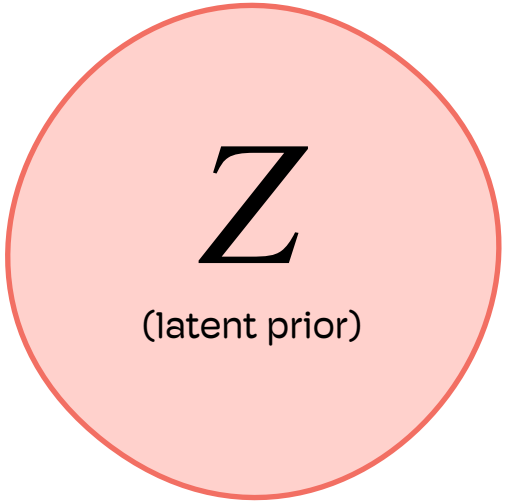
Natural Image Manifold



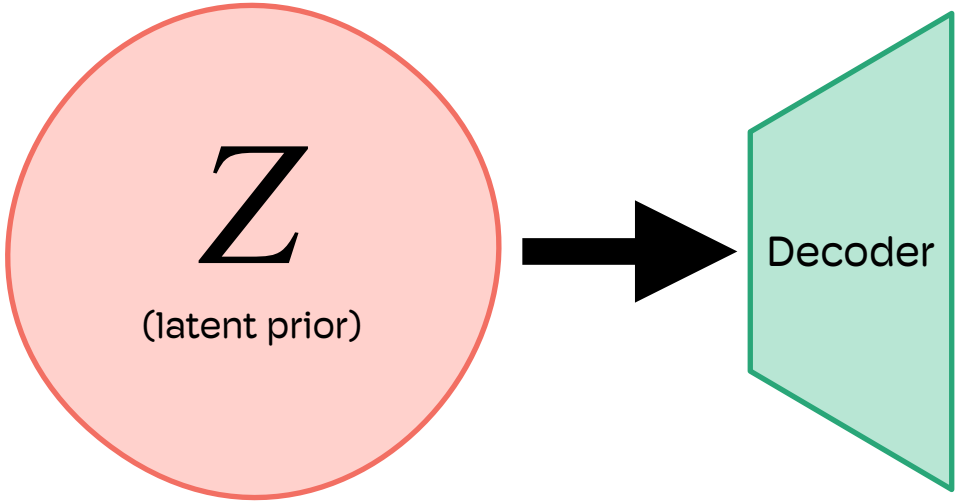
Natural Image Manifold



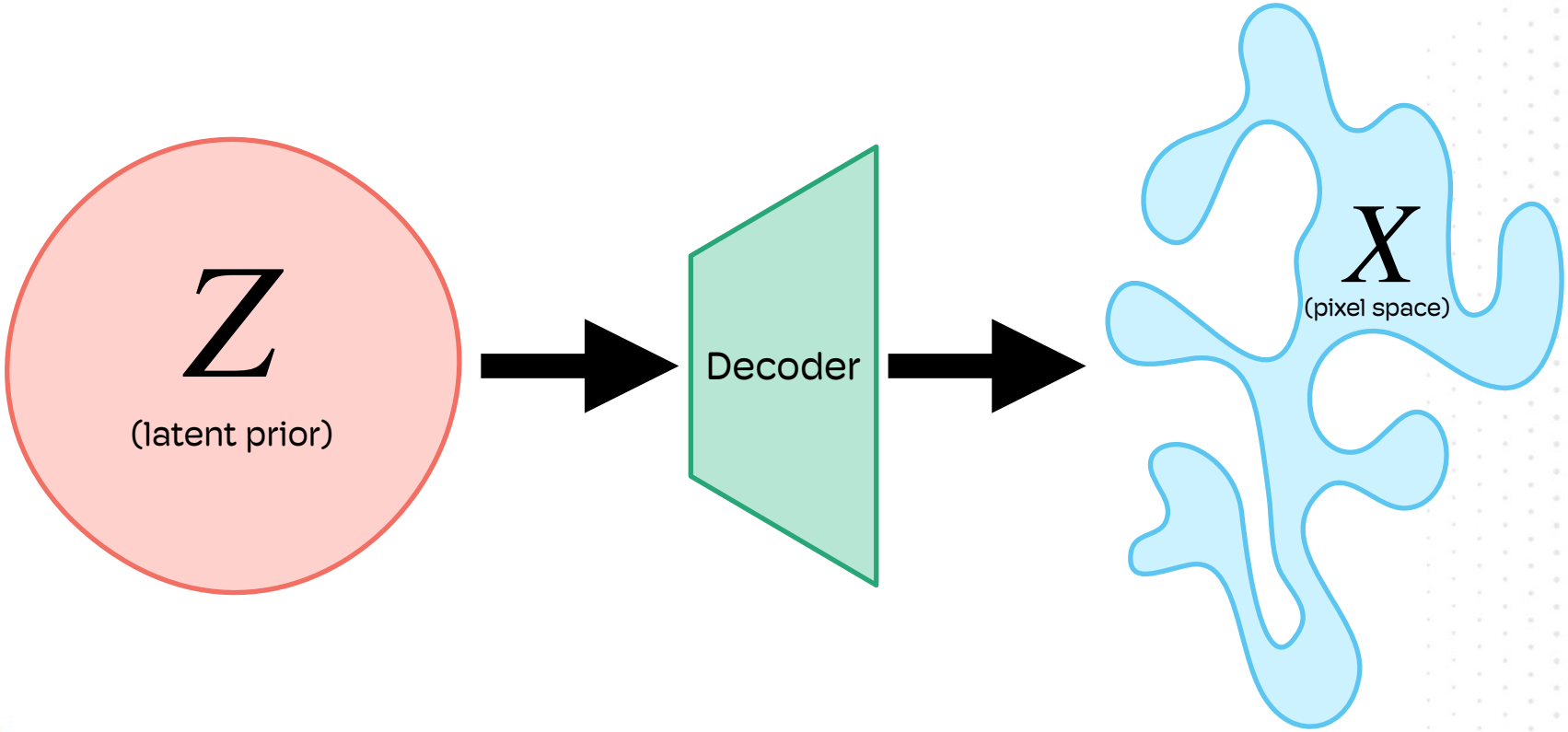
Natural Image Manifold



Natural Image Manifold



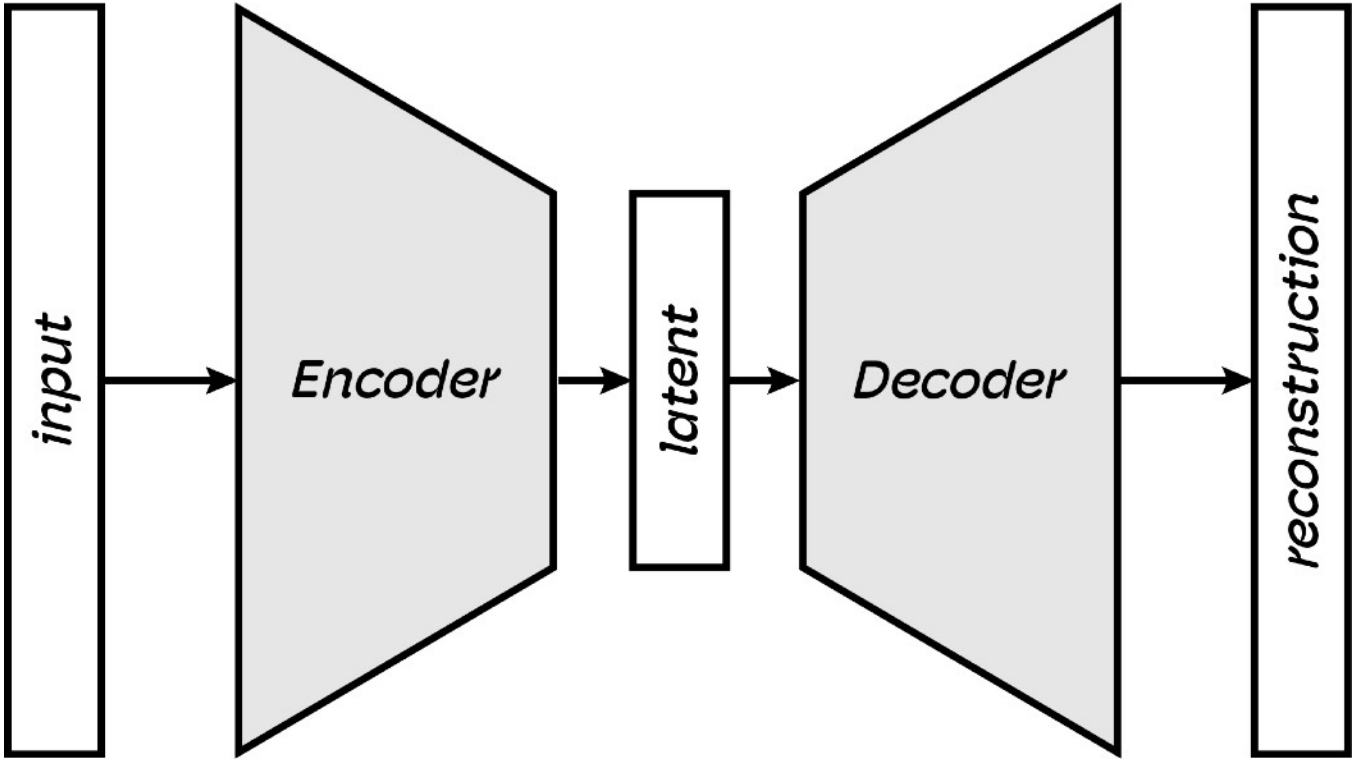
Natural Image Manifold



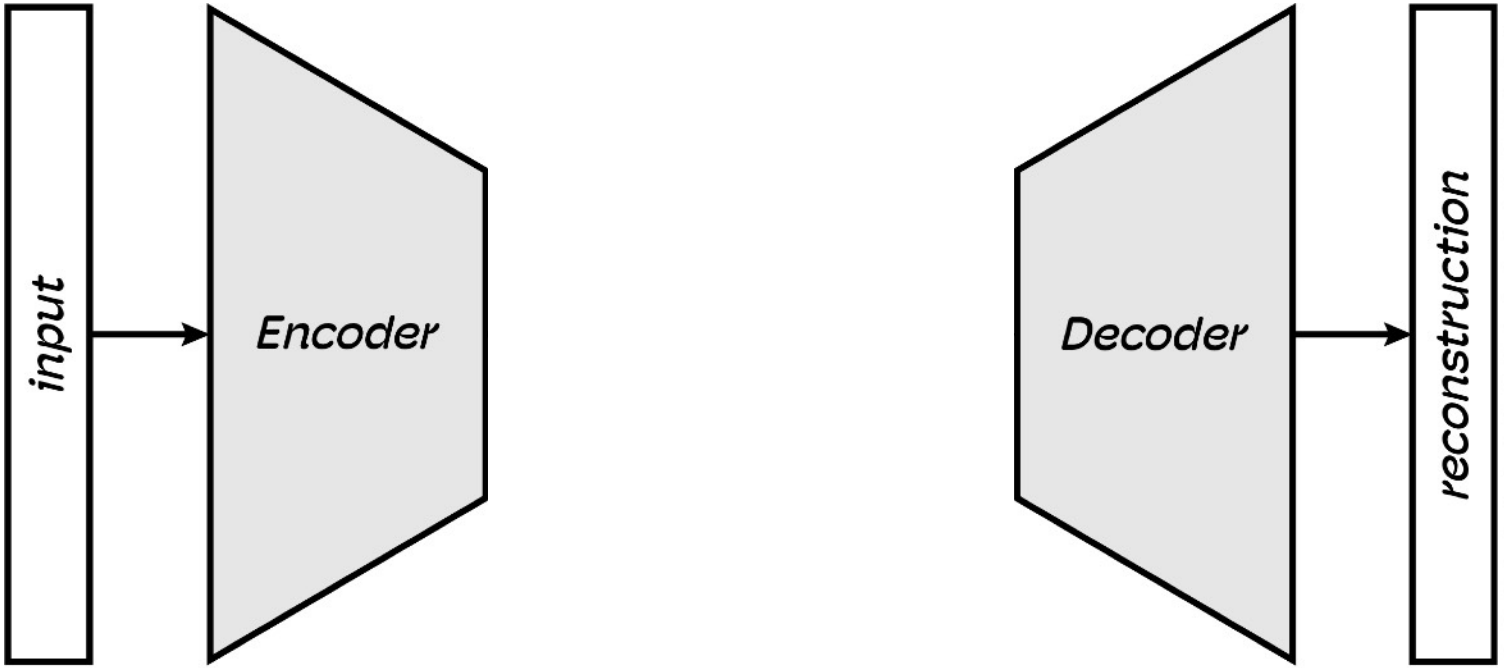
3.13

Adding Probability to Autoencoders (VAE)

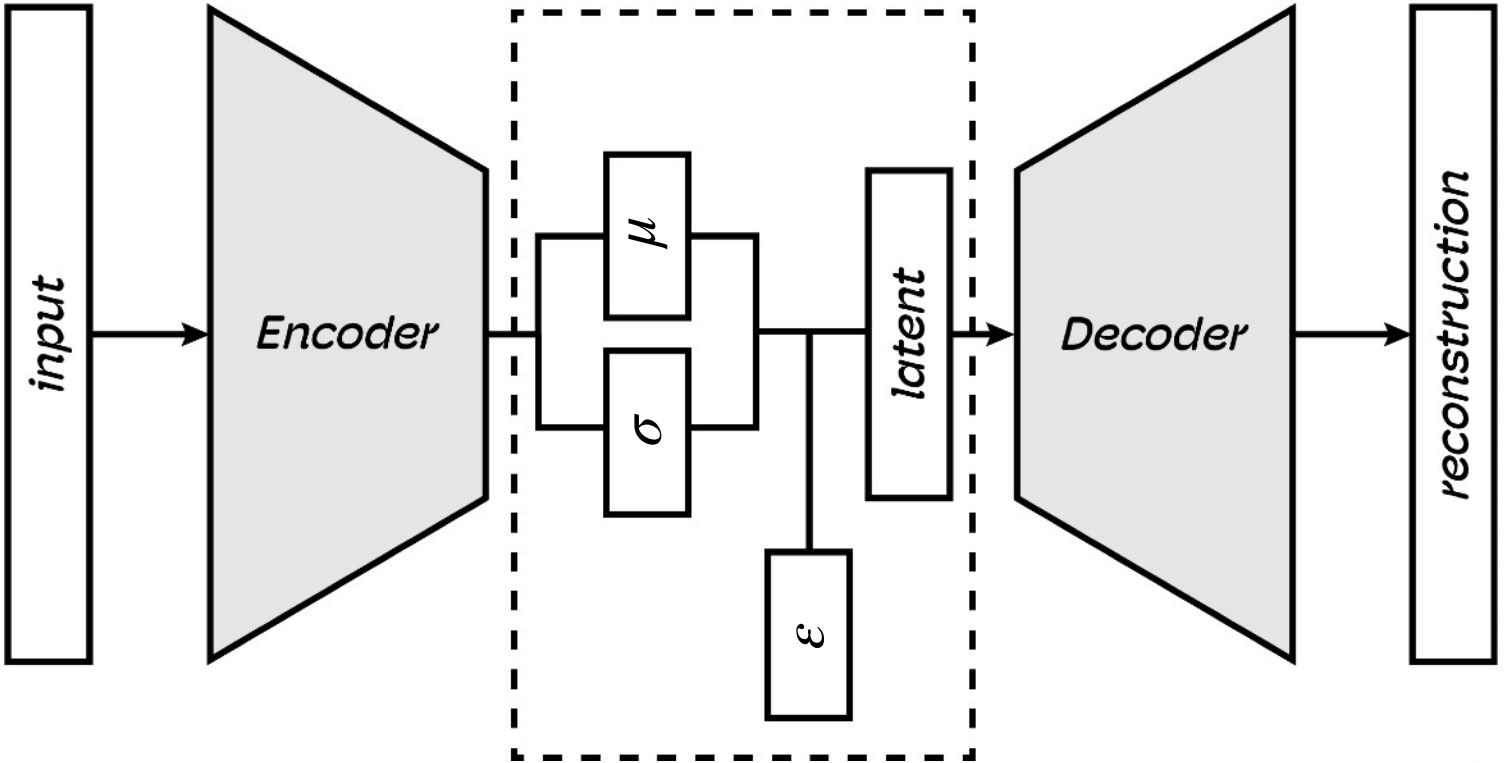
Autoencoders



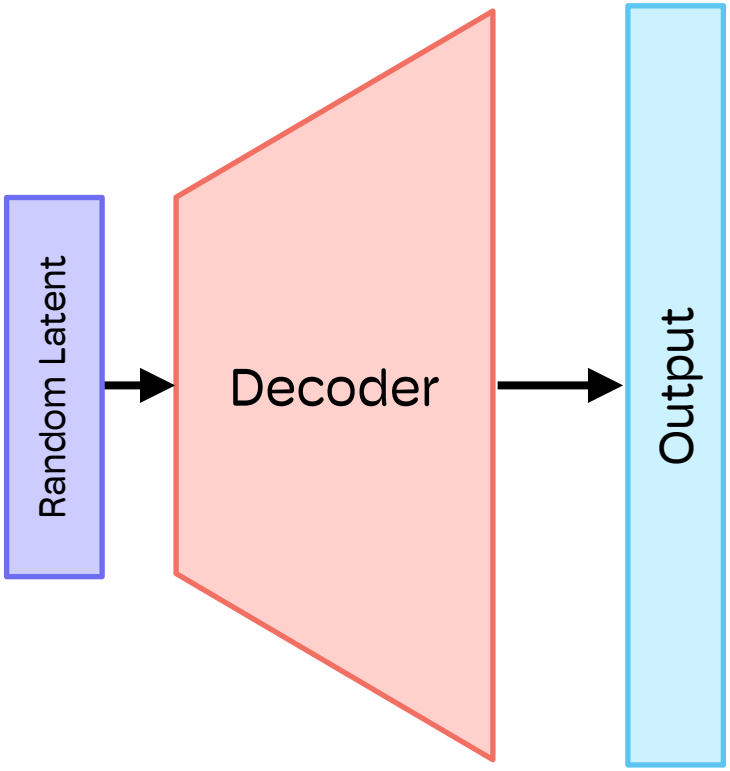
Variational Autoencoders (VAE)



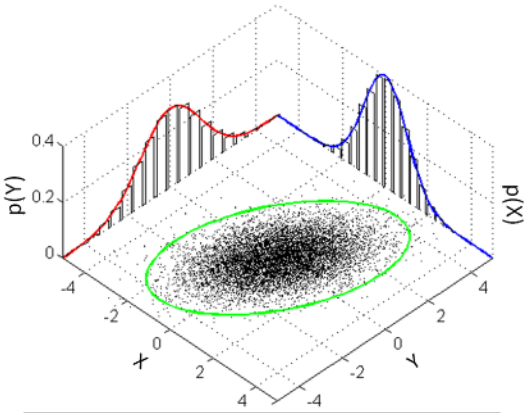
Variational Autoencoders (VAE)

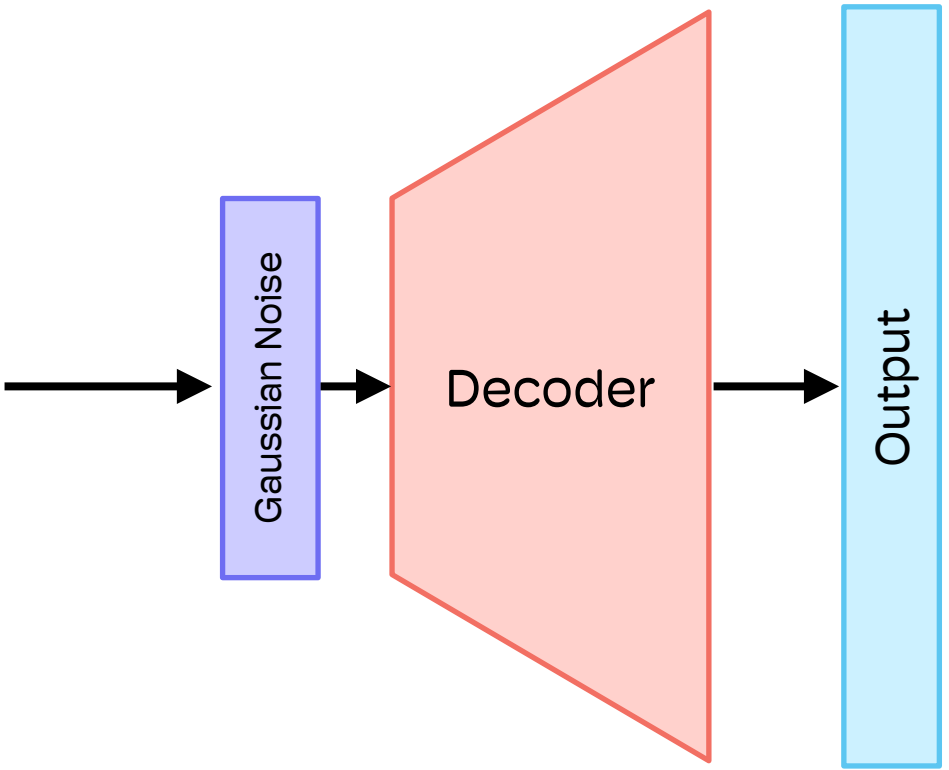


Generation



Generation





3.14

Variational Inference: Not Just for Autoencoders

Live Lecture

3.15

Transforming an Autoencoder into a VAE

Live Coding

3.16

Training a VAE with PyTorch

Live Coding

3.17

Exploring Latent Space

Live Coding

3.18

Latent Space Interpolation and Attribute Vectors

Live Coding