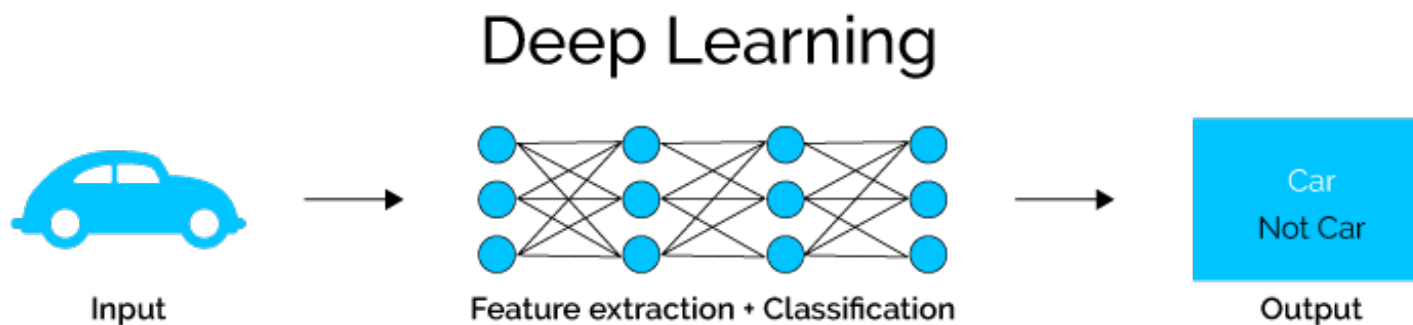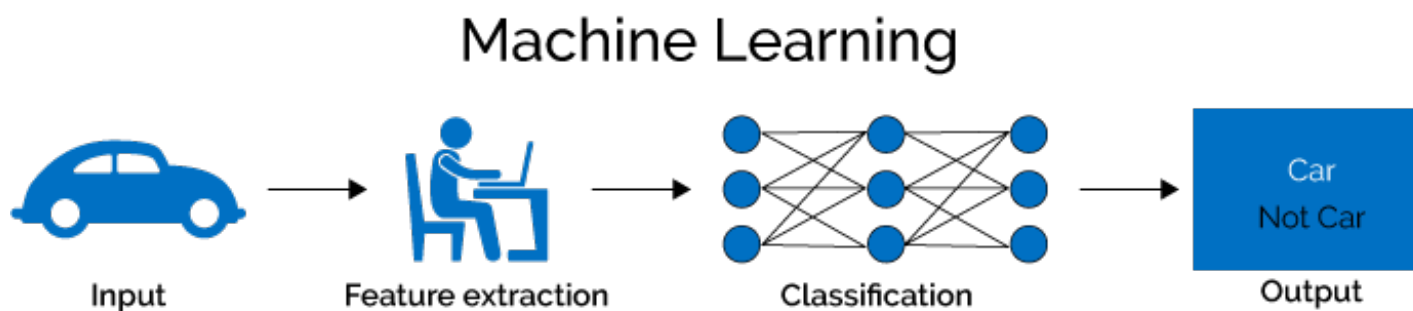# *Deep Learning*

Nima Sedaghat
University of Freiburg

Outline

- Classical Machine Learning vs. Deep Learning

- The Rapid Evolution of Deep Learning

- Deep Learning and Types of Supervision

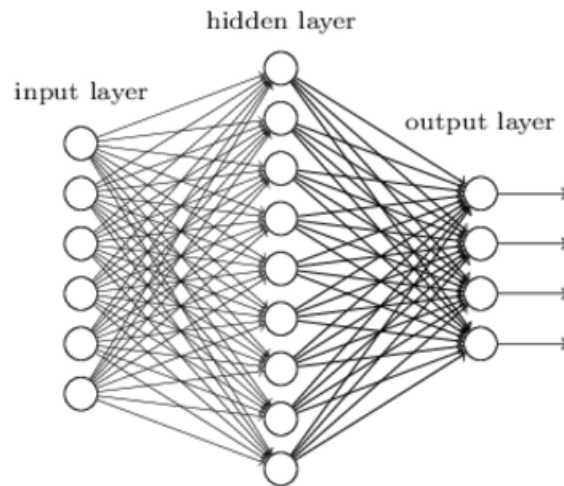# Classical Machine Learning vs. Deep Learning

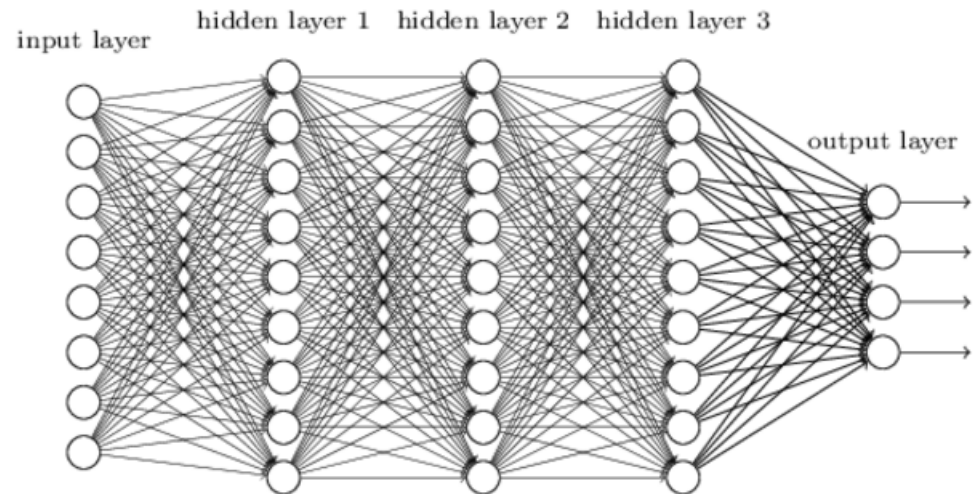# From Hand-Crafted Features to Representation Learning

Why didn't we do it before?

We needed to go deeper: more parameters, more sophisticated features
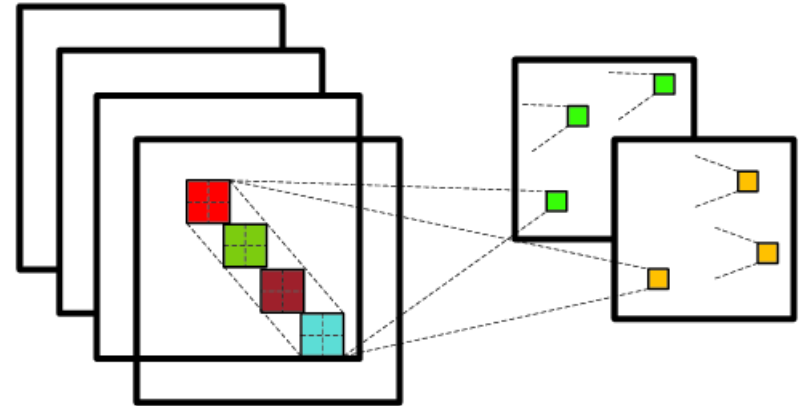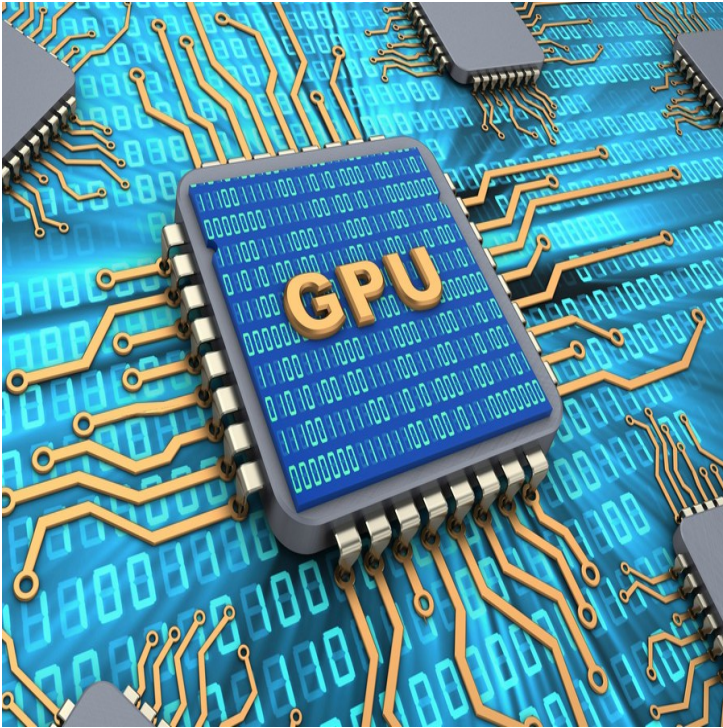

"Non-deep" feedforward neural network

Deep neural network

It would take forever to tell a cat from a dog!
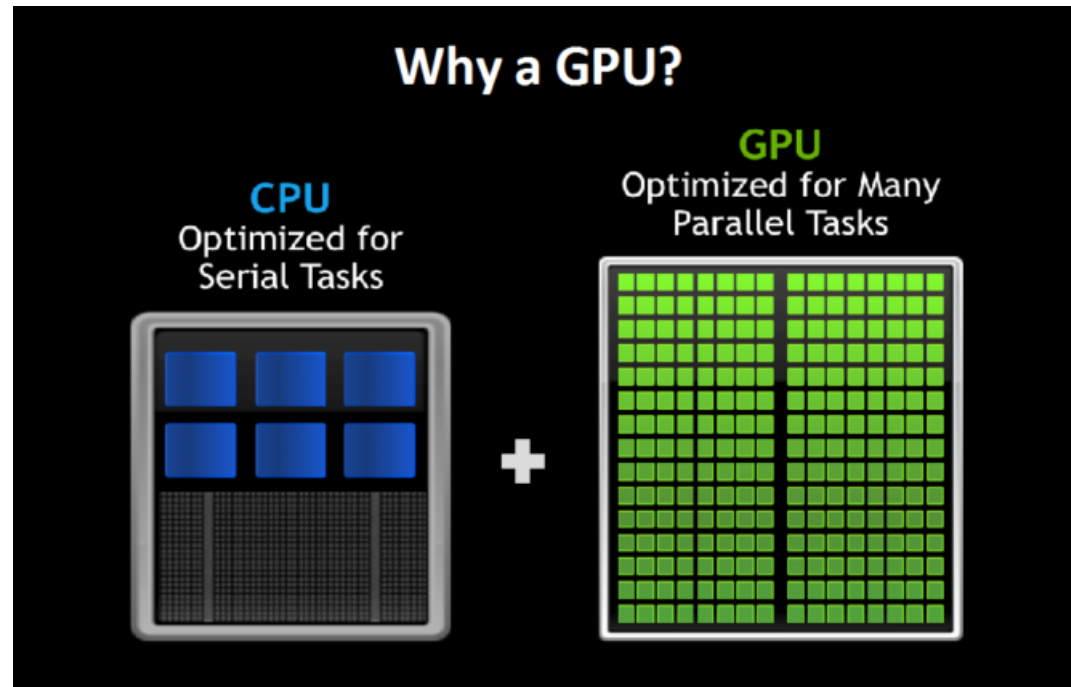
What made it possible?

Convolutional Layers

GPU: Graphical Processing Unit

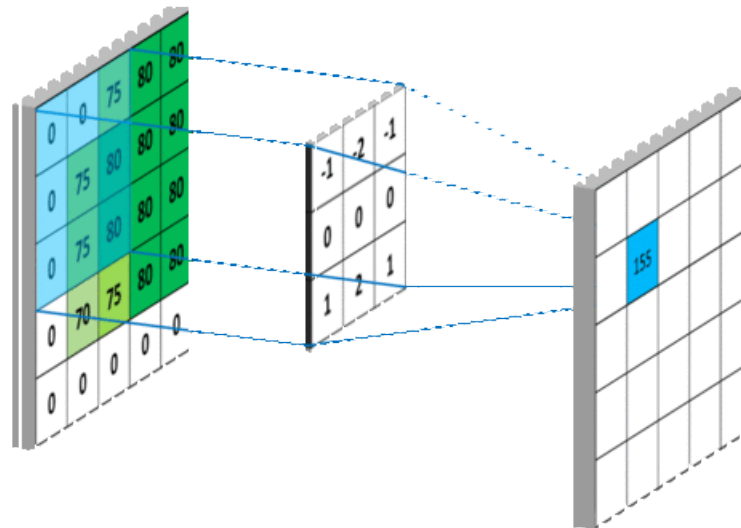https://www.wikihow.com/Connect-an-External-TV-Tuner-Card-to-a-Desktop
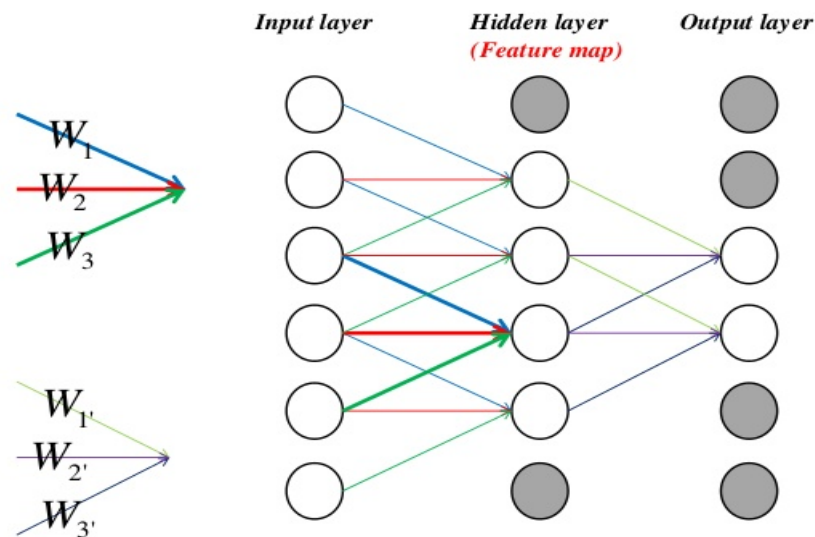
GPU: Graphical Processing Unit

Convolutional Layers

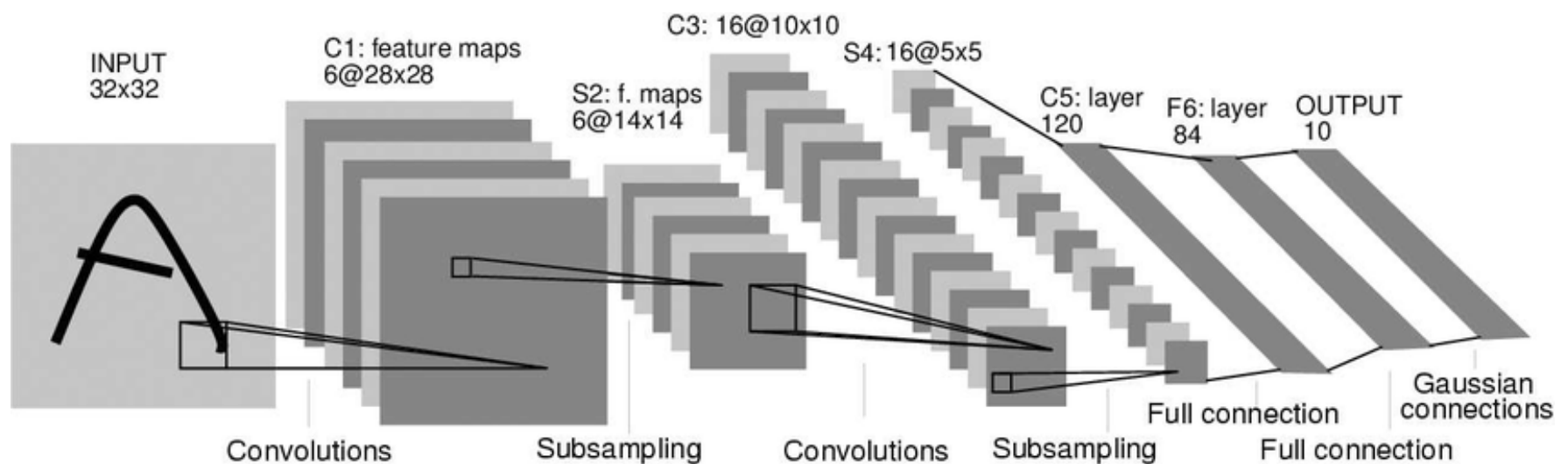https://www.analyticsindiamag.com/convolutional-neural-network-image-classification-overview
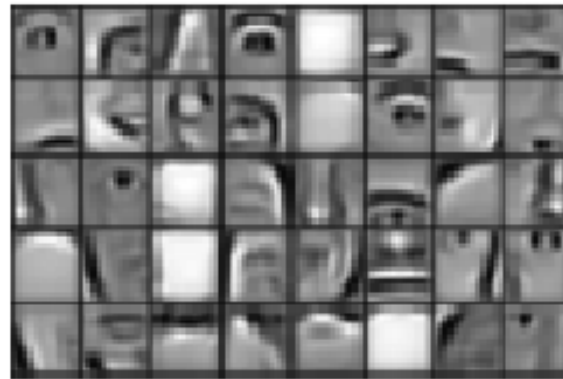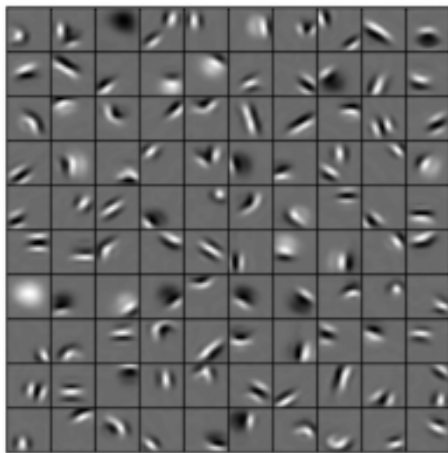
Why Convolutional Layers help?

"Shared Weights"

Seongwon Hwang, "Convolutional Neural Network (CNN) presentation from theory to code in Theano"
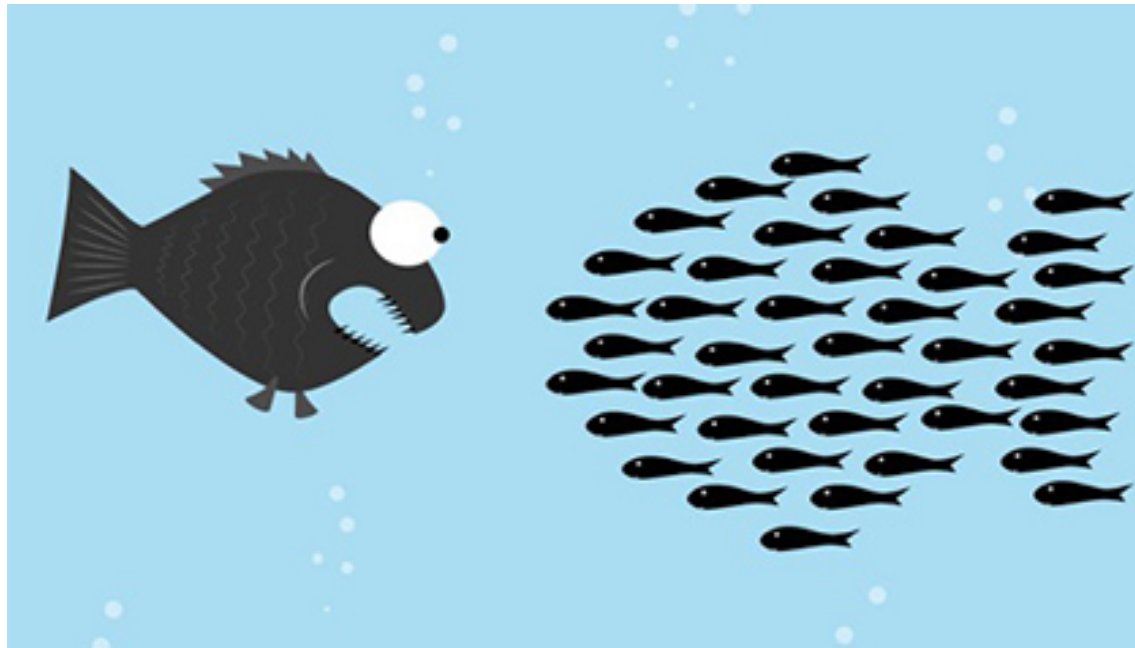
Deep ConvNets

Hierarchical
Representation Learning

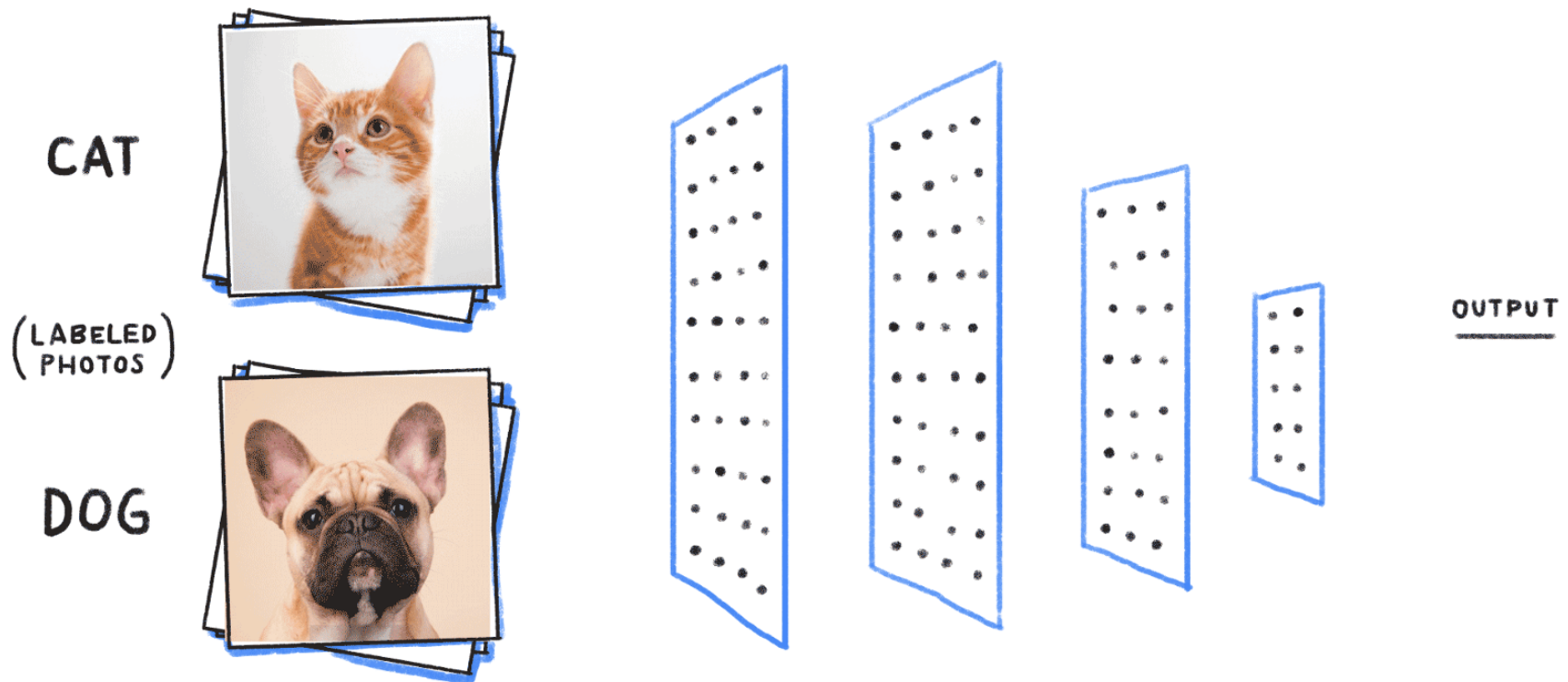# On the Importance of Data

On the Importance of Data

Small Dataset ➝ over-fitting

It's a cat

The Rapid Evolution of Deep Learning

Classification

https://becominghuman.ai/building-an-image-classifier-using-deep-learning-in-python-totally-from-a-beginners-perspective-be8dbaf22dd8

Classification

- Question: examples from other domains?
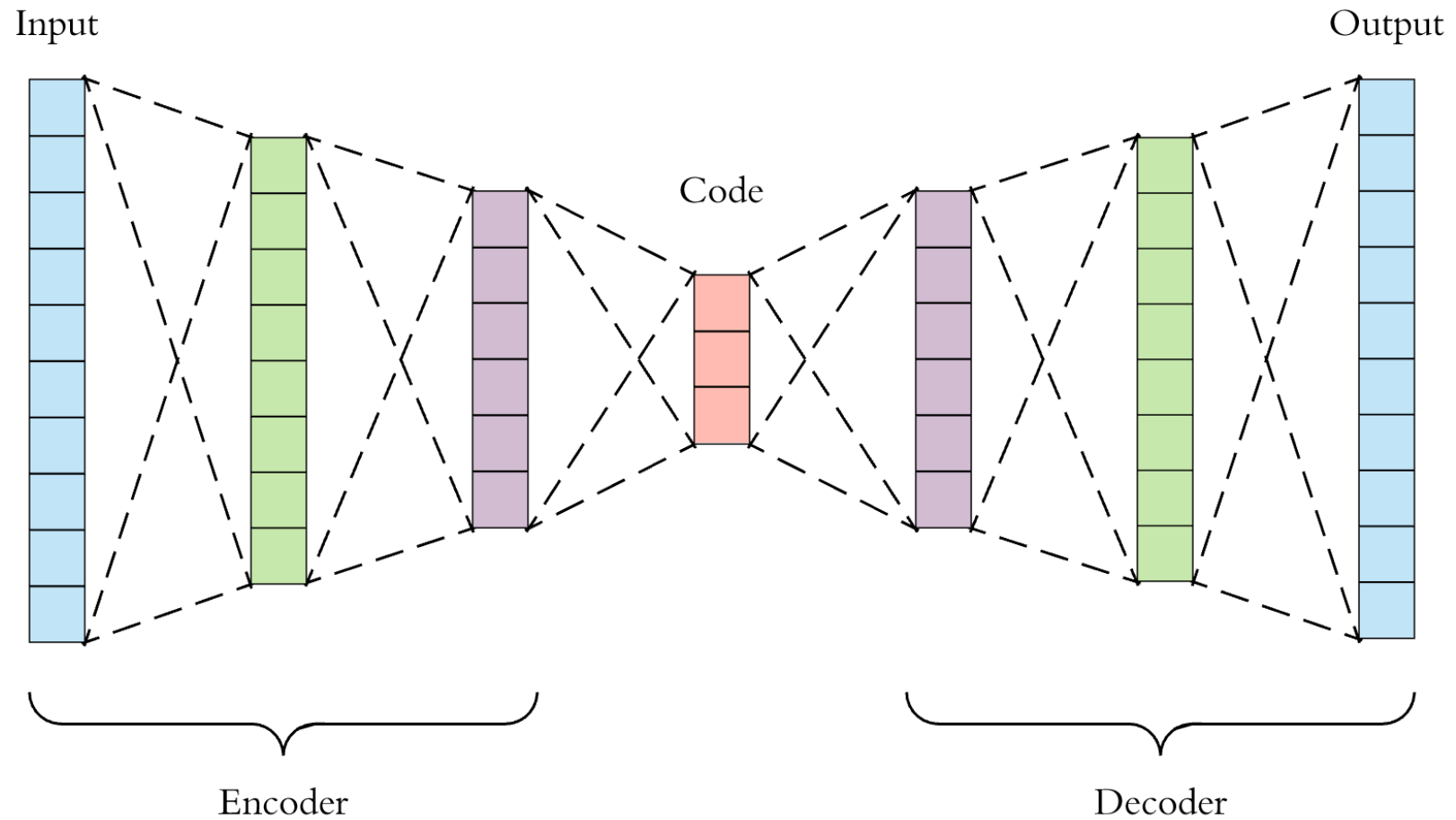
  (E.g. Astronomy)

Regression

Sedaghat, Brox, "Unsupervised Generation of a Viewpoint Annotated Car Dataset from Videos"
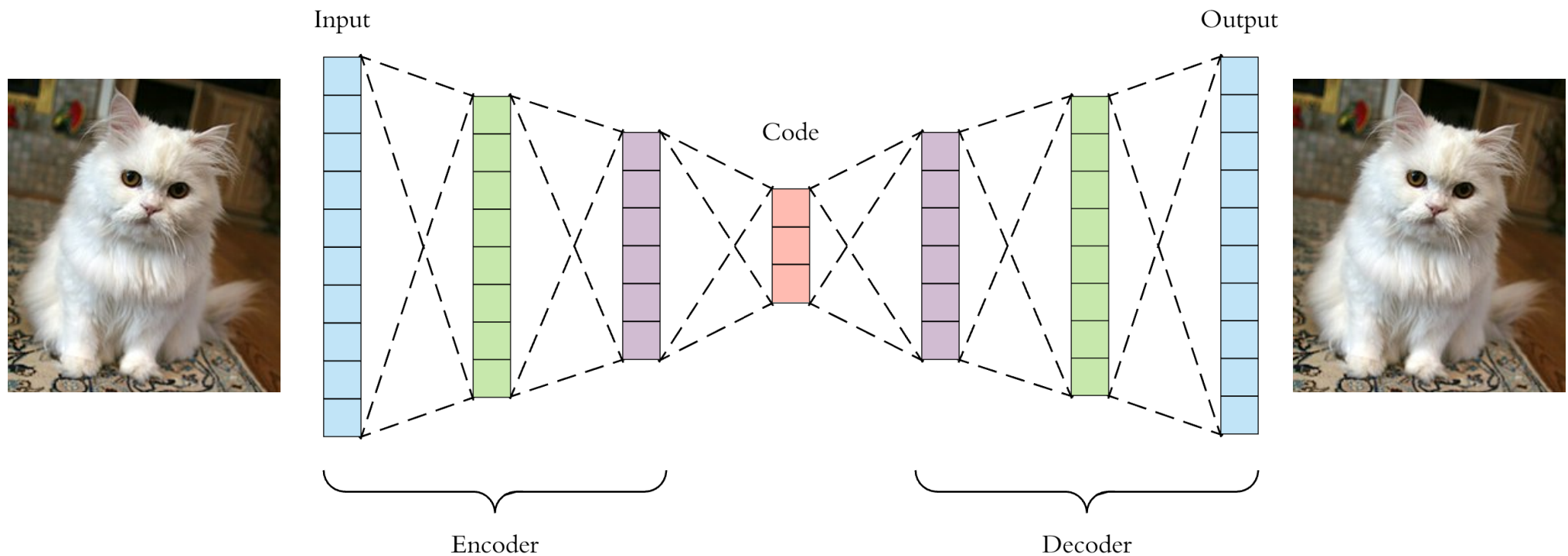
Regression

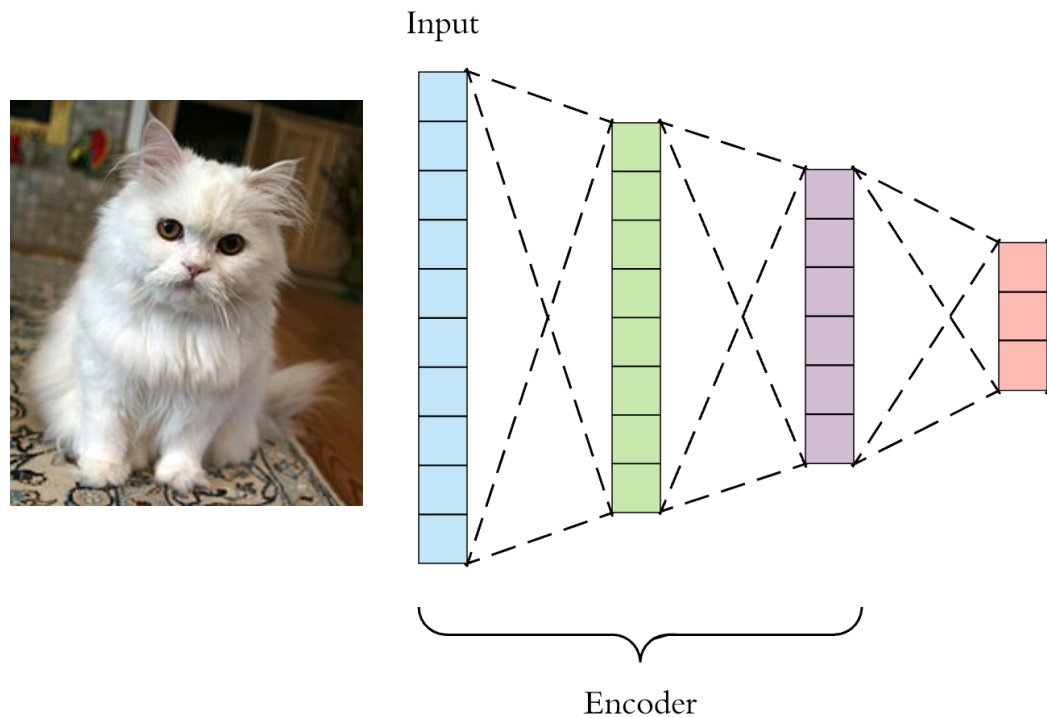- Question: What examples can you think of in Sky/Earth?
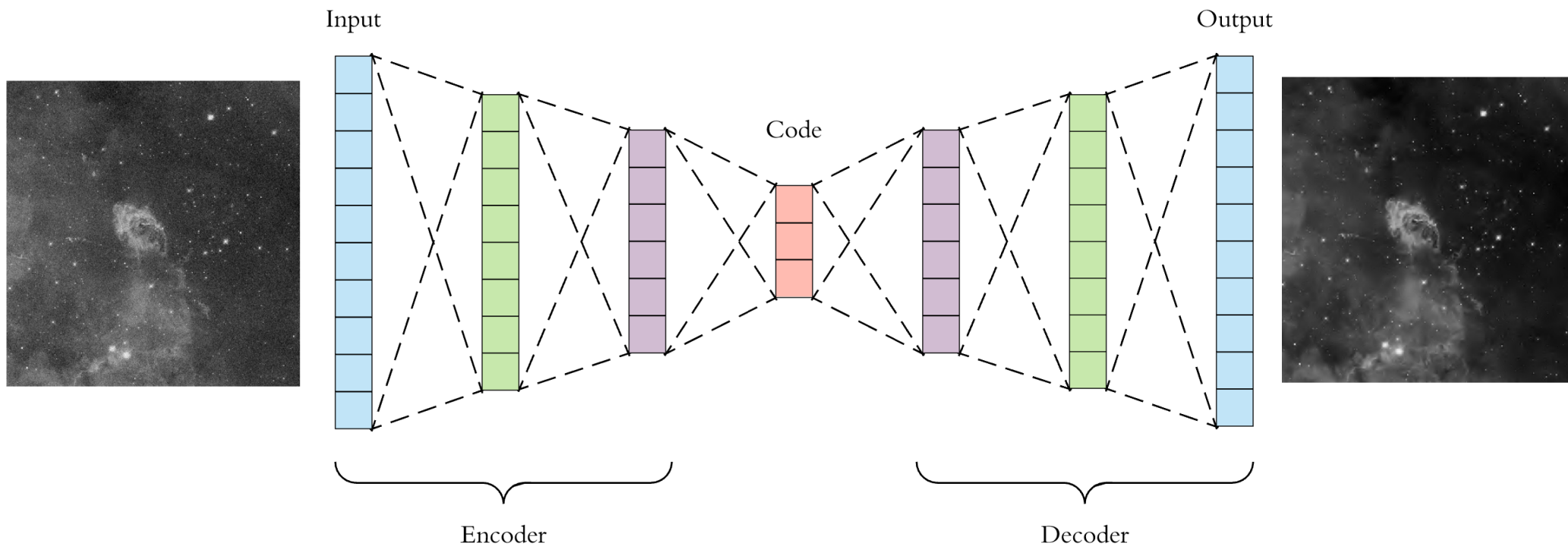
Encoder-Decoder Networks

E.g. Auto-Encoder

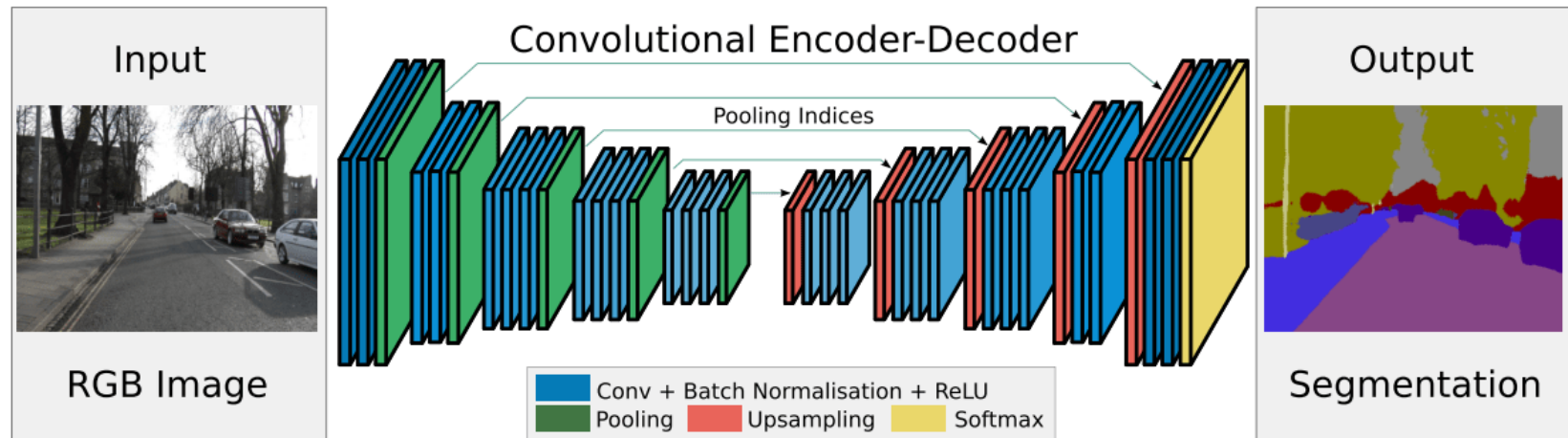# Why an Auto-Encoder?

Input

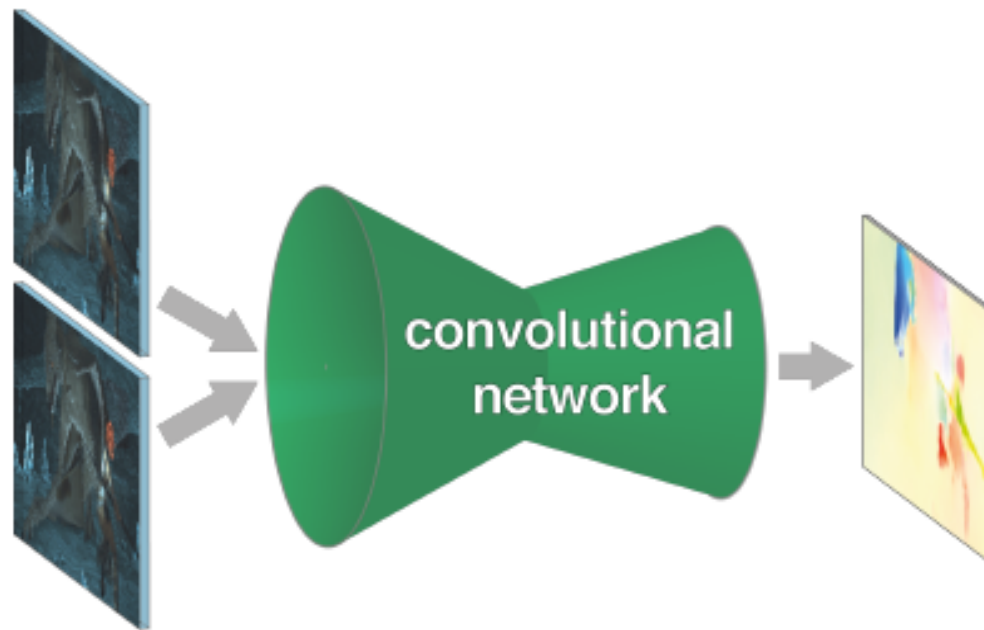Encoder

E.g. De-noising

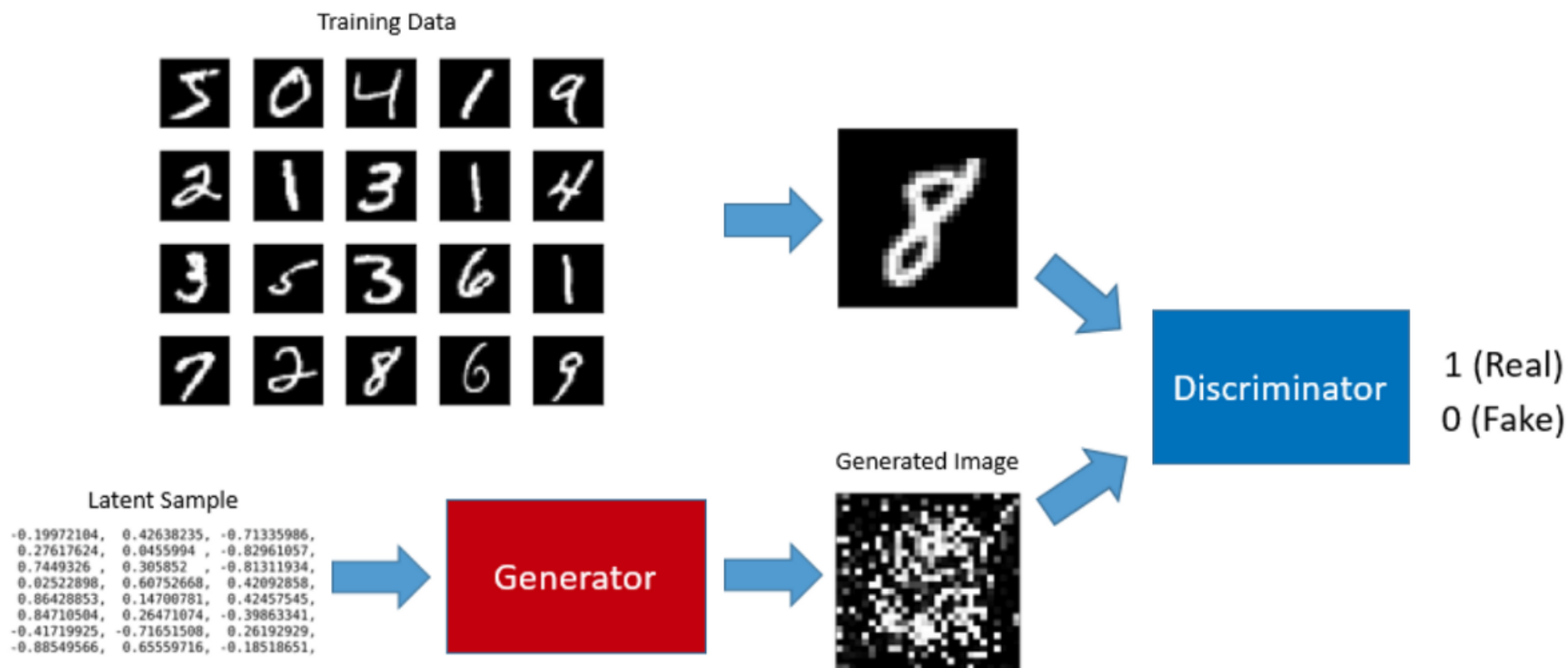Question: How would you train this?

E.g. Segmentation
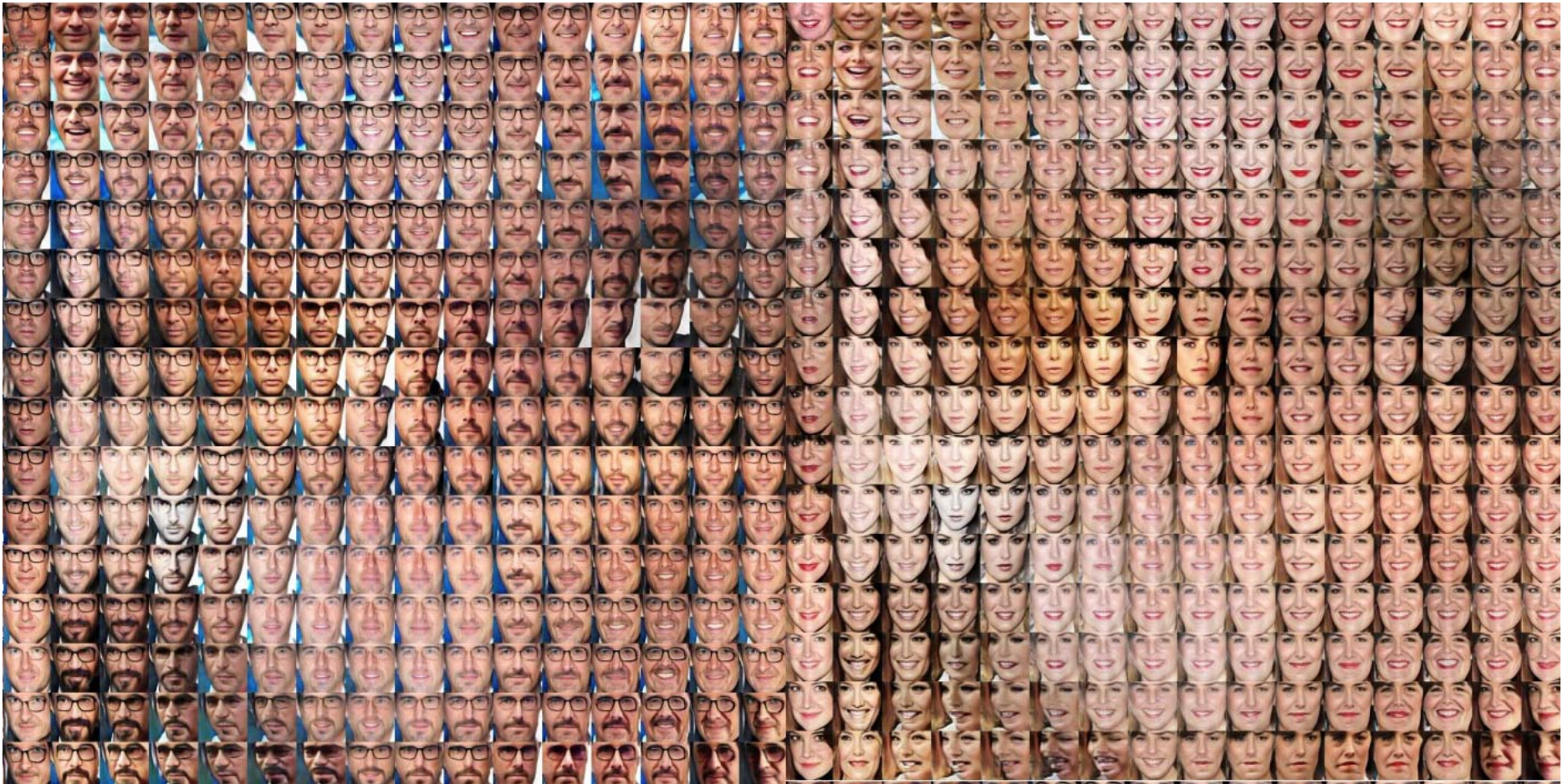
E.g. Optical Flow (Motion) Estimation

Generative Adversarial Network (GAN)

https://towardsdatascience.com/understanding-generative-adversarial-networks-4dafc963f2ef

GAN Use-case example

Antreas Antoniou et al., "Data Augmentation Generative Adversarial Networks"

Deep Learning and Types of Supervision

Deep Learning and Types of Supervision

- Fully Supervised Learning

- Unsupervised/Self-Supervised Learning

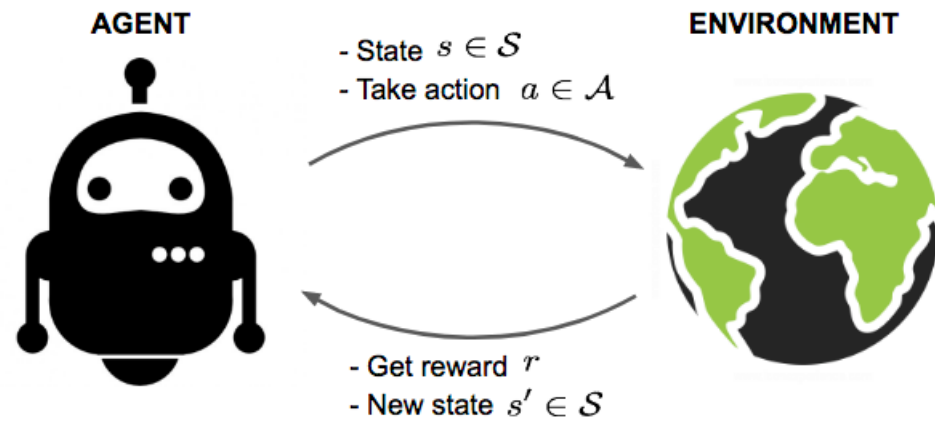- Reinforcement Learning

- (Imitation Learning)

Fully Supervised Learning

- During Training: Input AND Output
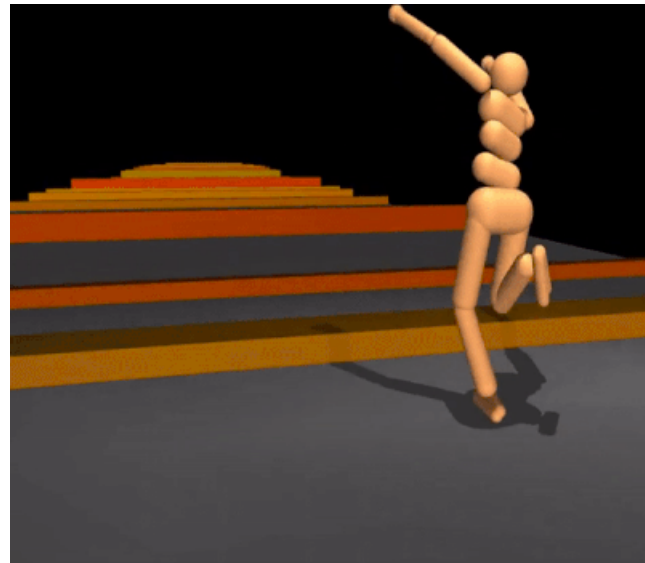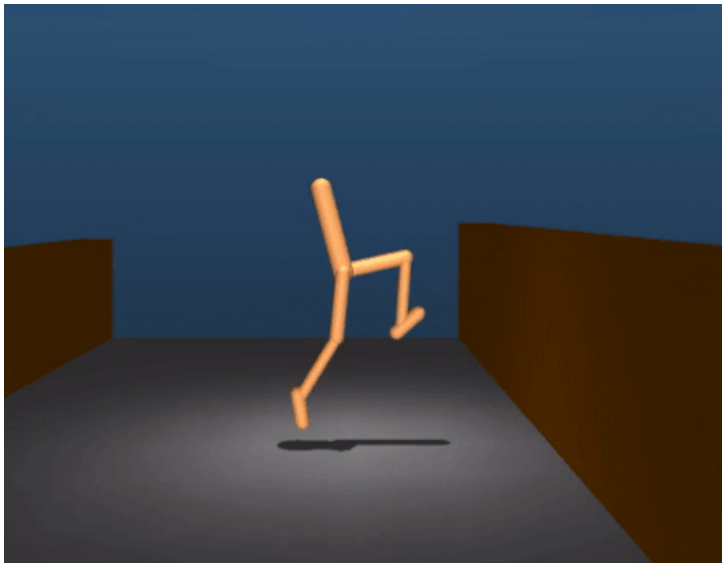
     Labels

     Annotations

Unsupervised/Self-supervised Learning

- No Labels

- No "unsupervised task" such as clustering

- Use self-supervision instead
  - Auto-encoder
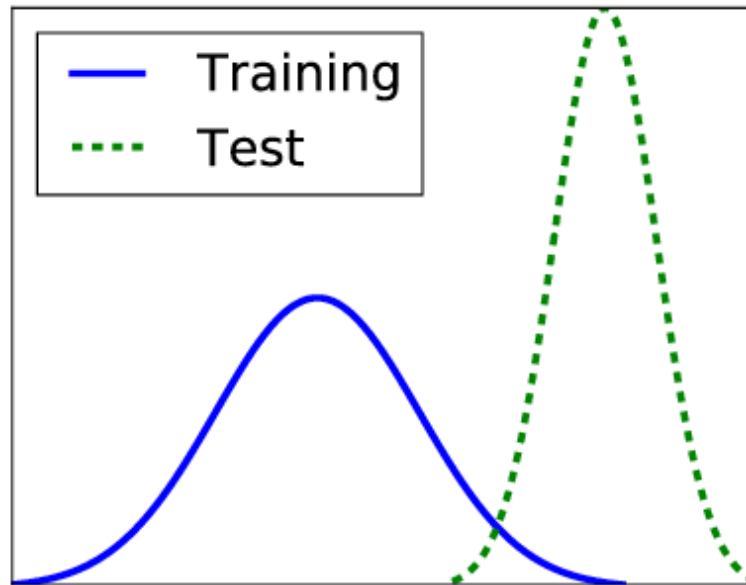 - Denoising
  - Jigsaw-puzzle
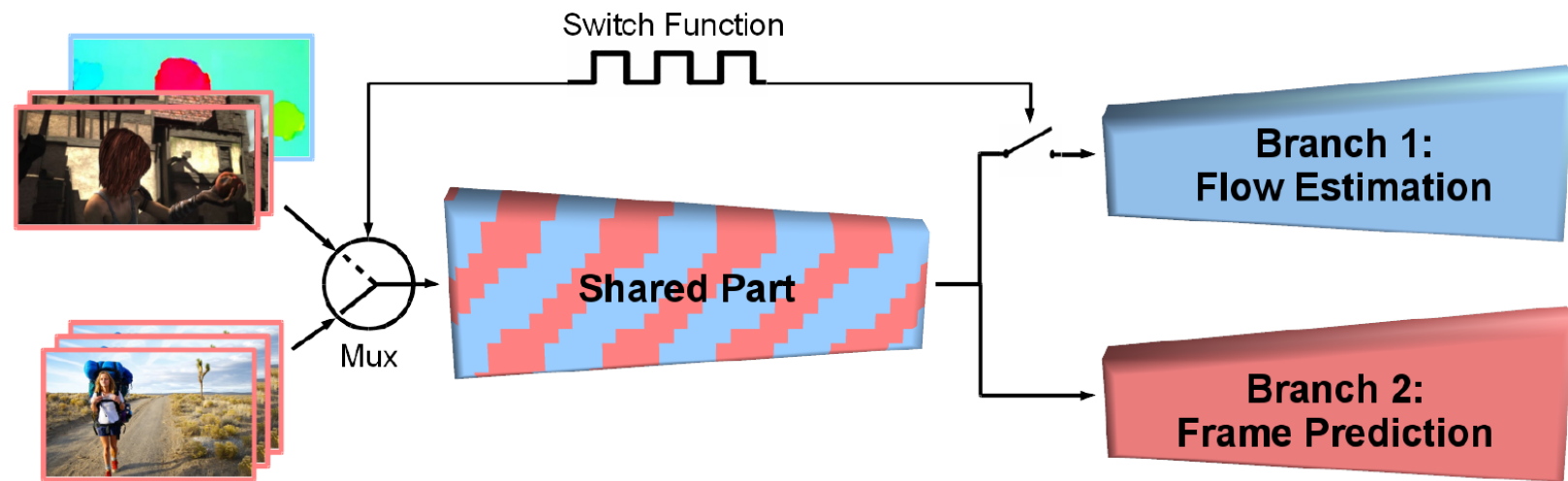 - ...

Reinforcement Learning

AGENT   ENVIRONMENT

- State $s \in \mathcal{S}$
- Take action $a \in \mathcal{A}$

- Get reward r
- New state $s' \in \mathcal{S}$

Reinforcement Learning

Google DeepMind's RL
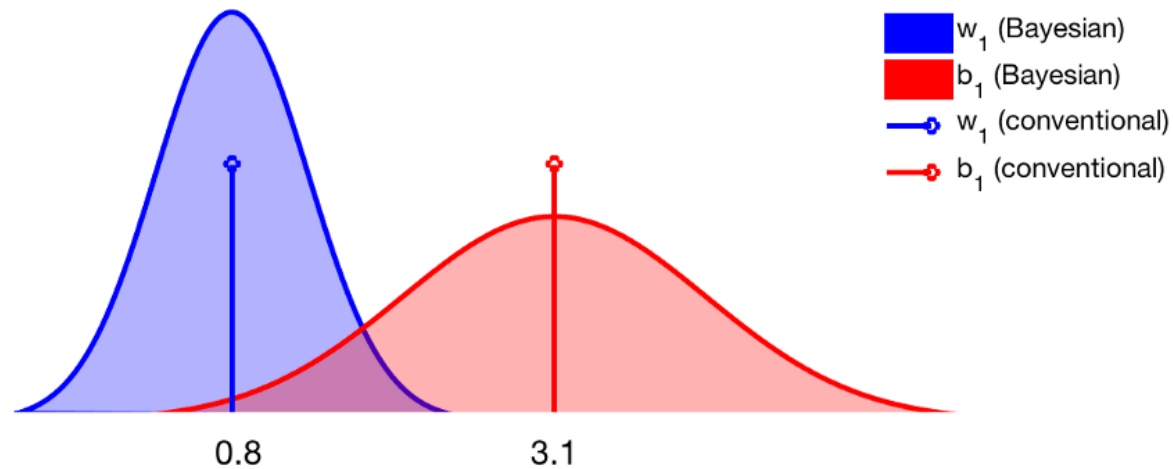
Covariate Shift and Domain Adaptation

Covariate Shift and Domain Adaptation

Hybrid Learning of Optical Flow and Next Frame Prediction to Boost Optical Flow in the Wild.
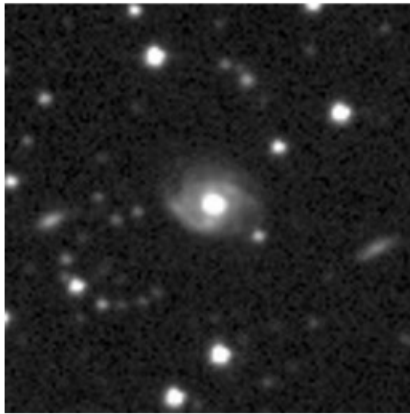Nima Sedaghat, Zolfaghari M., Brox T.

Probabilistic Networks

$$p(w|x,y) = \frac{p(x,y|w)p(w)}{\int p(y|x,w)p(w)dw}$$
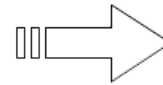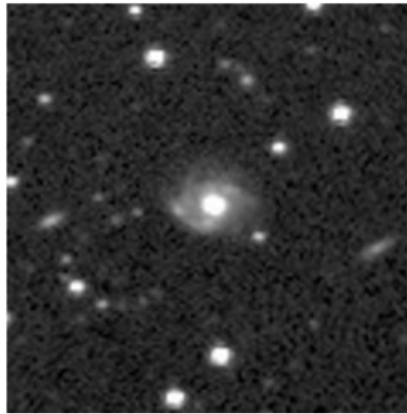
Application Example: **TransiNet**

Reference Image   Science Image   Ideal output