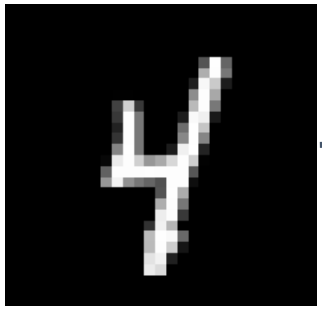
Imaging technologies

– Deep learning –

- Pattern recognition with machine learning -

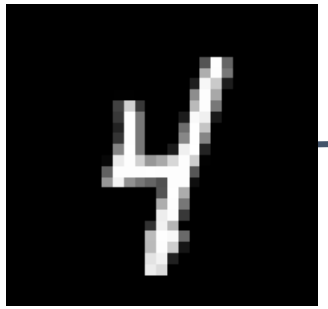
Traditional machine learning approaches:



handcrafted features → classifier → **4**

LBP, PCA, HOG, SIFT, Gabor filters…

Deep “end-to-end” learning:

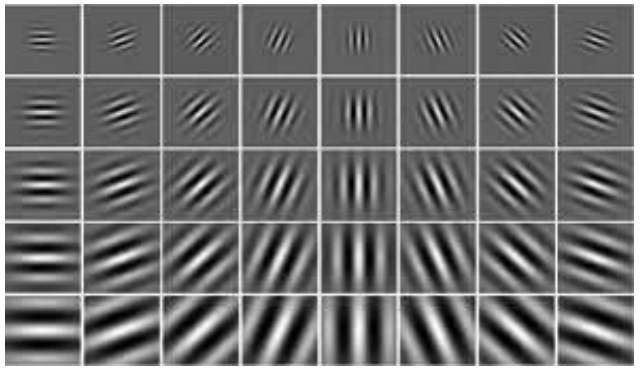


low-level features → high-level features → classifier → **4**

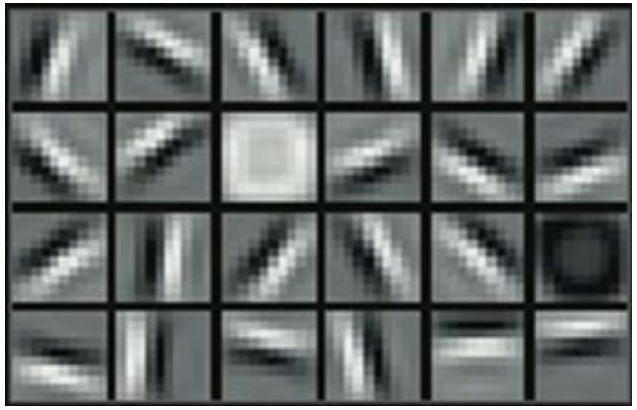
Self-learned feature extraction

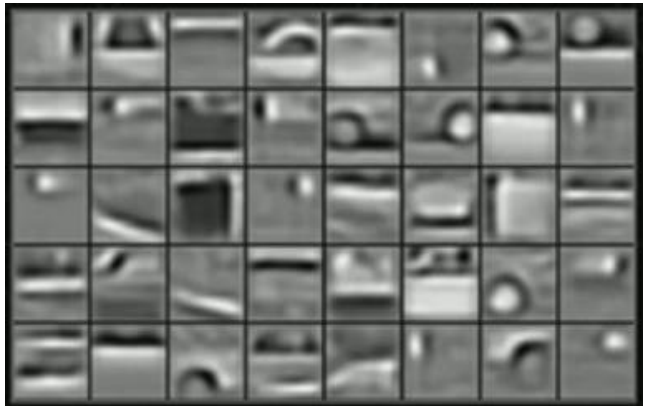
- Pattern recognition with machine learning -

Bank of Gabor filters:



CNN filters for cars *:





low-level features → high-level features

**Lee et al, Unsupervised Learning of Hierarchical Representations with Convolutional Deep Belief Networks*

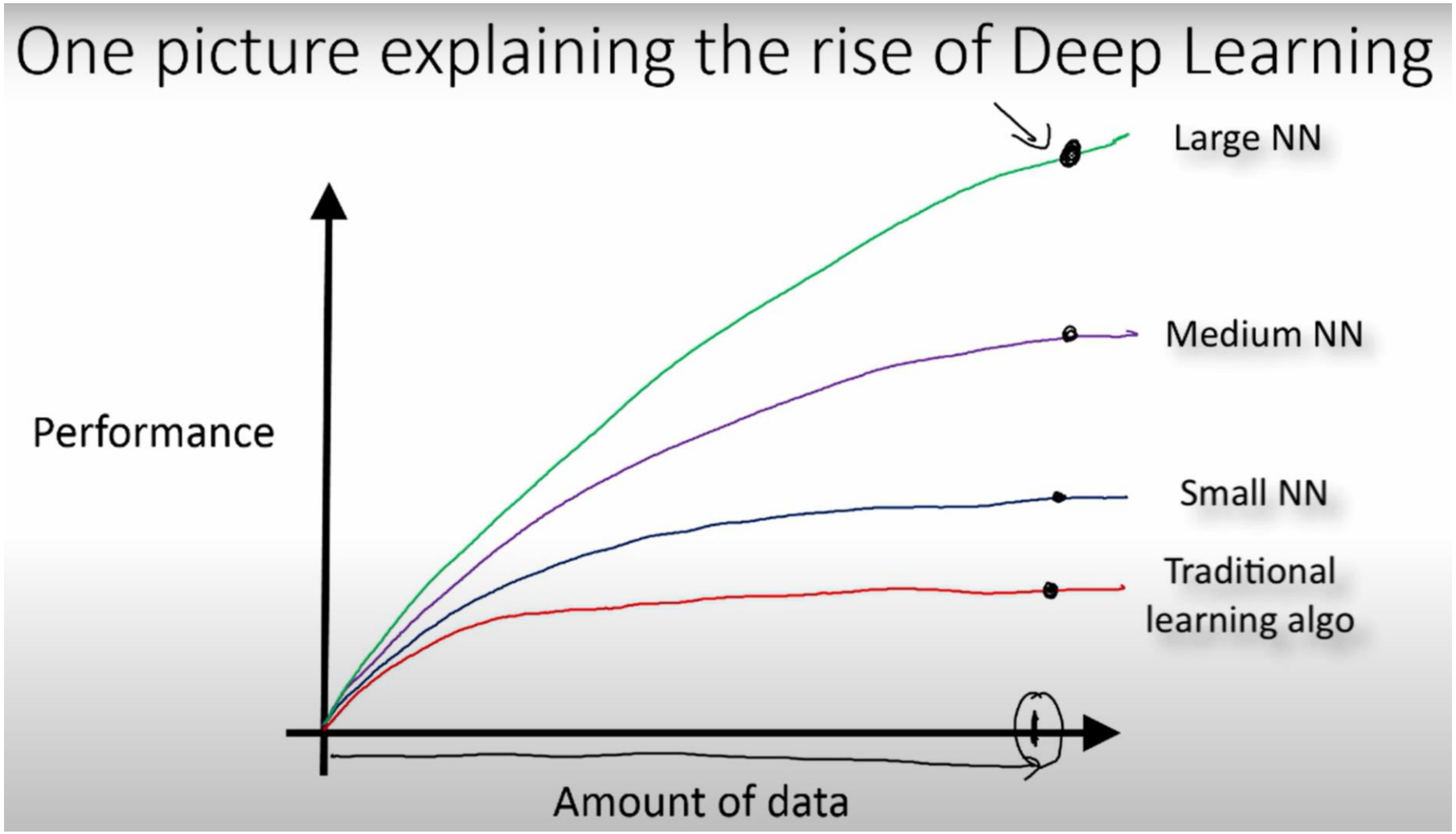
- Beginings of the deep learning era -

Godfathers of deeplearning – all three won Turing award (also known as “Nobel Prize in Computer Science”) in 2019

1986: seminal paper on **backpropagation** - Hinton et al., Learning representations by back-propagating errors
1989: one of the **first neural networks for pattern recognition** was introduced in LeCun et al., Backpropagation applied to handwritten zip code recognition.
1998: **neural networks beat traditional approaches** in some tasks – LeCun and Bengio et al., Gradient-based learning applied to document recognition

- Deep vs. shallow learning -

Andrew Ng,
*Founder of **DeepLearning.AI**,*
*Co-Founder of **Coursera** and*
Professor at Stanford University



**YouTube: Andrew Ng, How scale is enabling deep learning*

- Benchmarks in image classificication-

ImageNet-1K dataset: 1.281.167 annotated images. Since 2010 the dataset is used in the ImageNet Large Scale Visual Recognition Challenge (ILSVRC), a benchmark in image classification and object detection.

goldfish

coffee

shark

butterfly

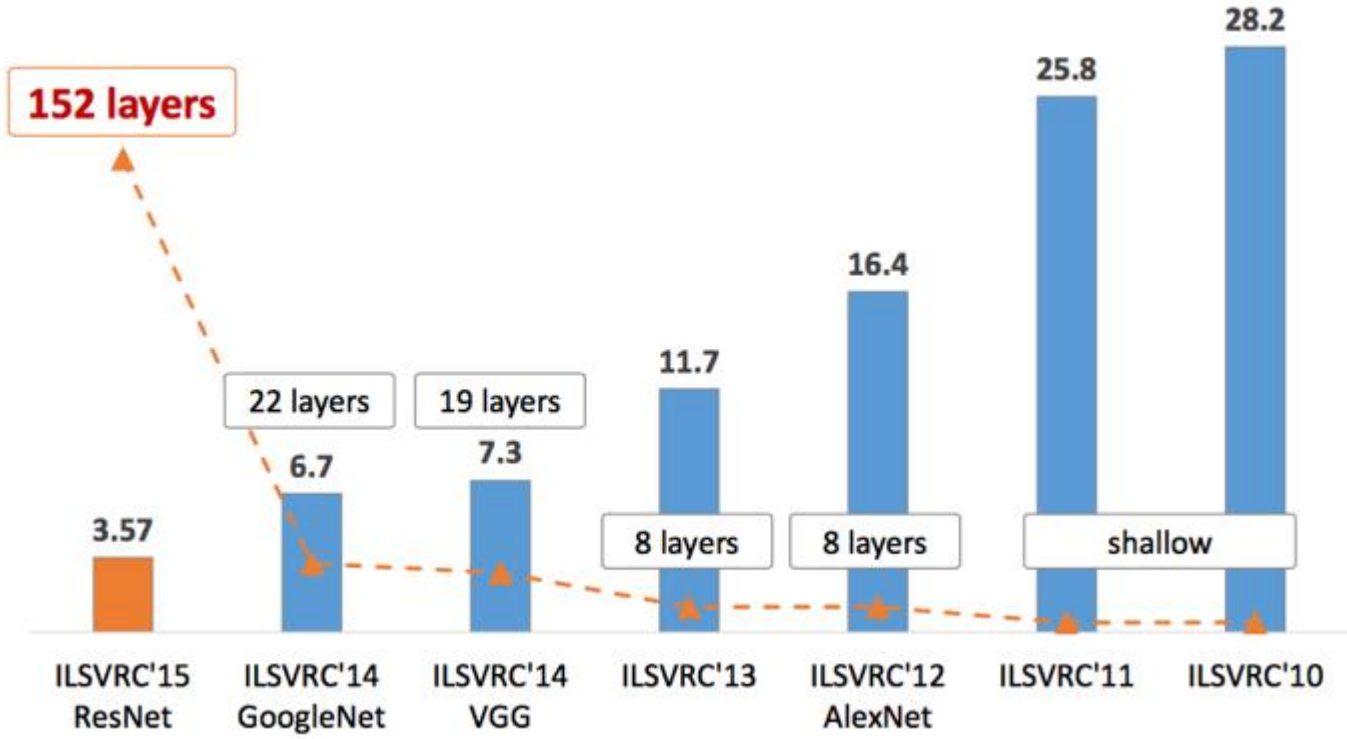
ladybag

.

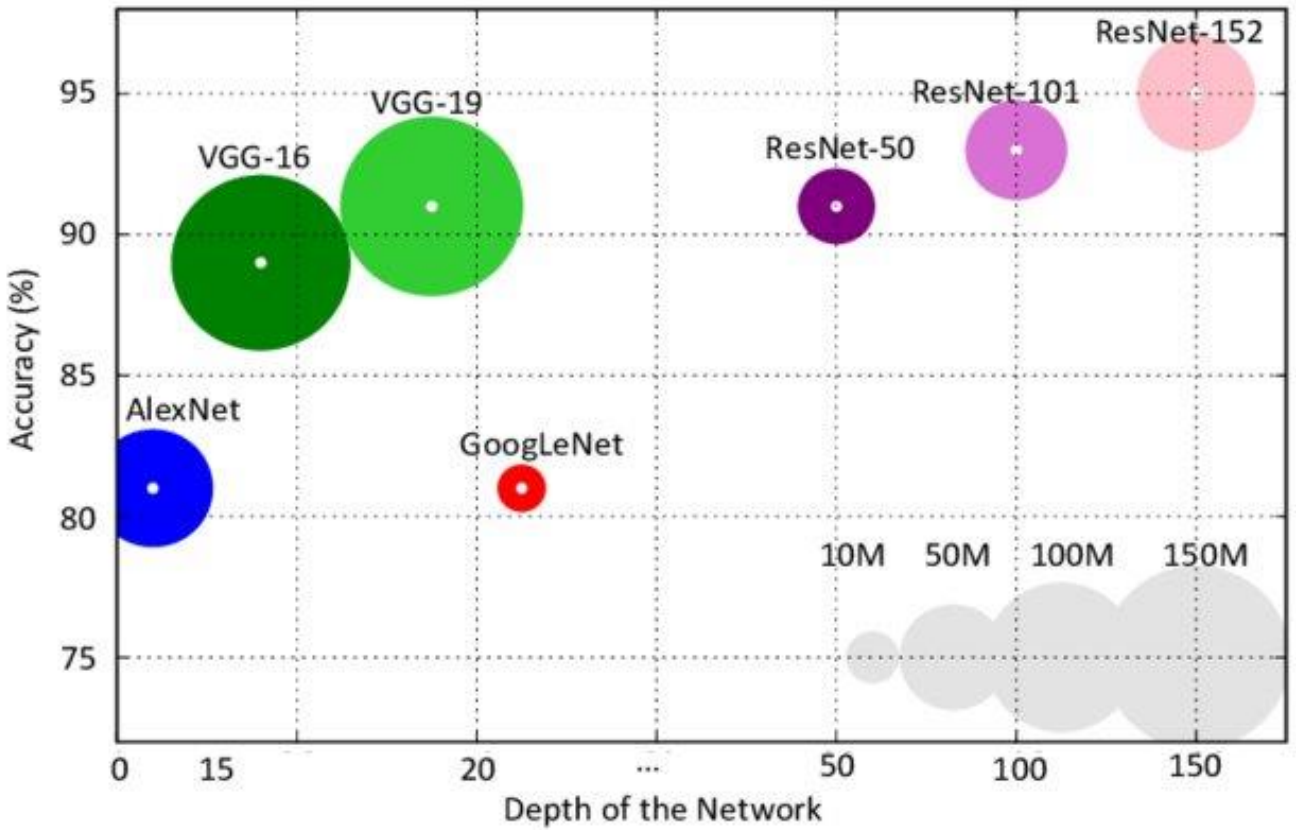
.

.

1000 classes of different objects



- Classification accuracy vs. model complexity -

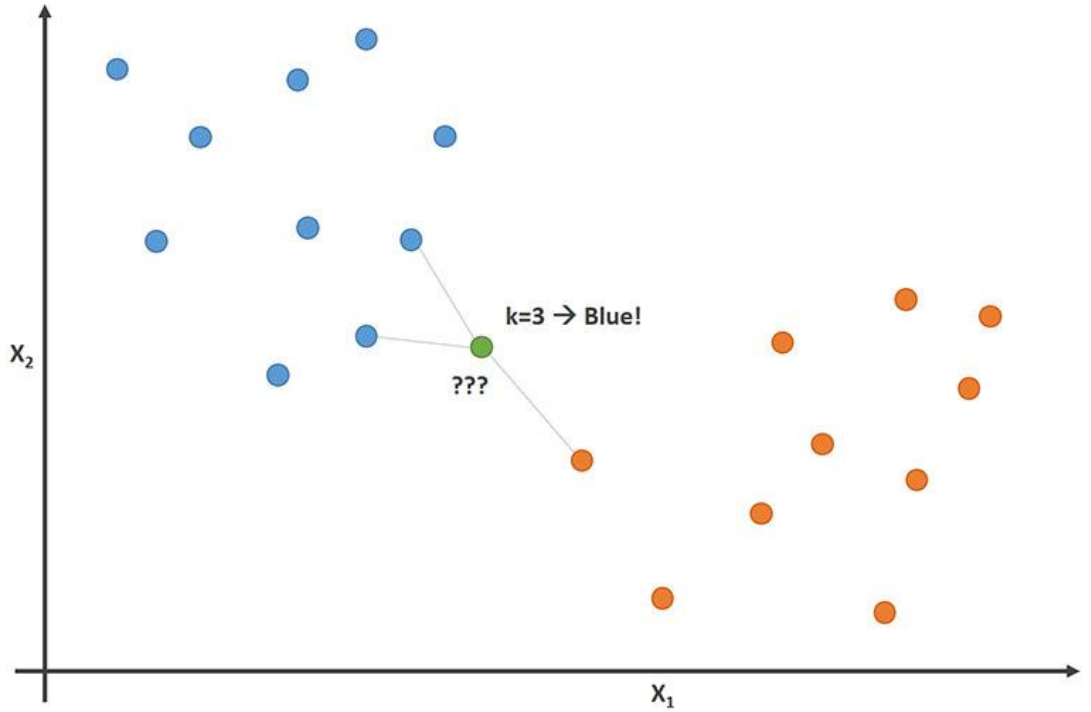


**__ChatGPT__ (chatting bot) has 175 billion parameters*

**Mohammadi et al., Transfer Learning for Clinical Sleep Pose Detection Using a Single 2D IR Camera*

- Types of machine learning algorithms -

- ***Supervised* learning**
  - models are trained with labelled data
- *Unsupervised* learning
  - data is unlabelled
- *Semi-supervised* learning
  - data is only partly labelled
- *Self-supervised* learning
  - labels are generated by the model



• traditional algorithms: Nearest Neighbor, Linear Regression, Logistic Regression, Decision Trees, Support Vector Machine (SVM)…

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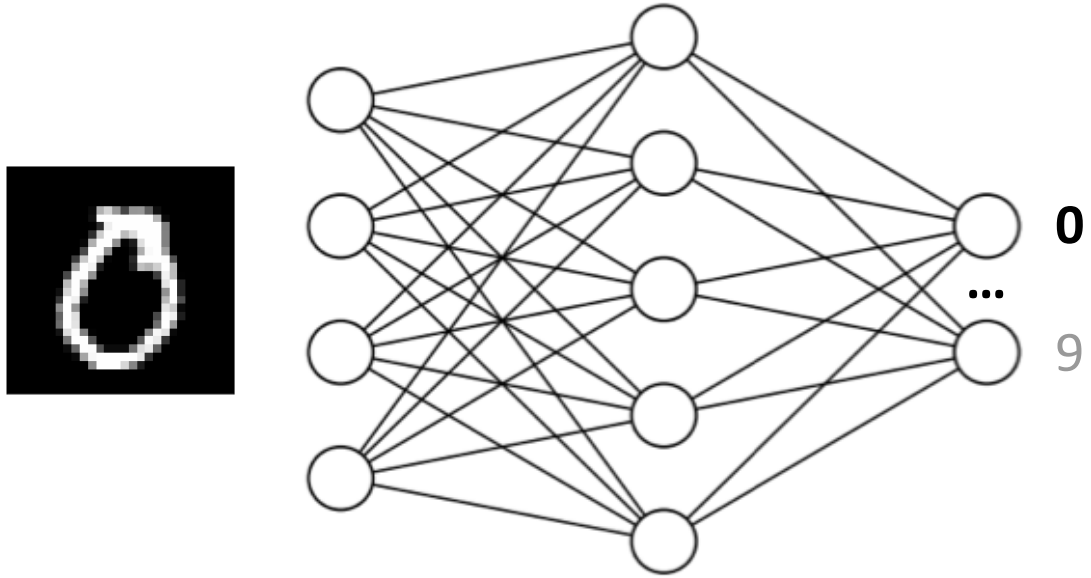

• deep learning methods: NN classifiers, NN segmentation with pixelwise annotations…

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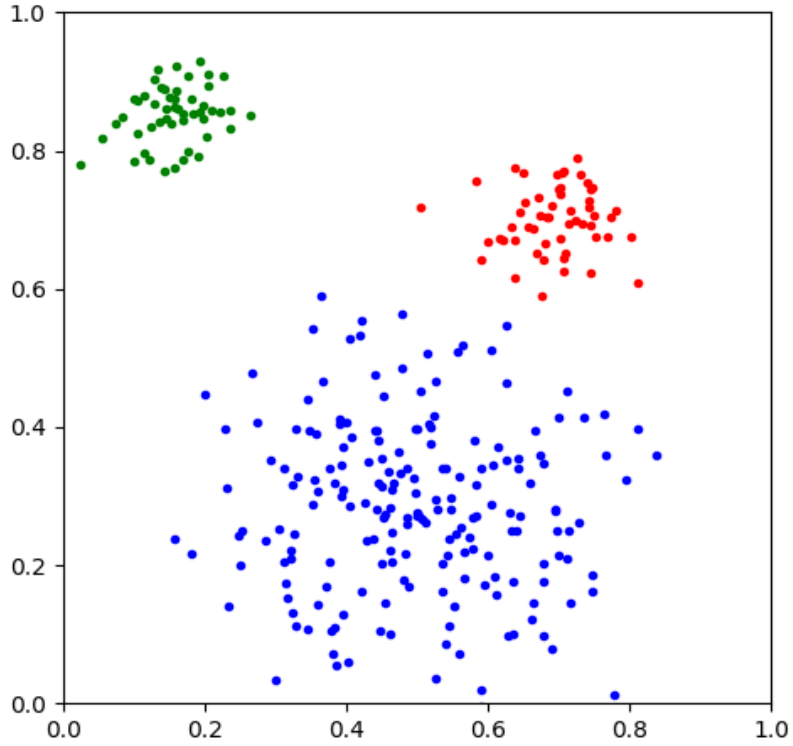

• Traditional algorithms: K-means clustering, Principle Component Analysis…

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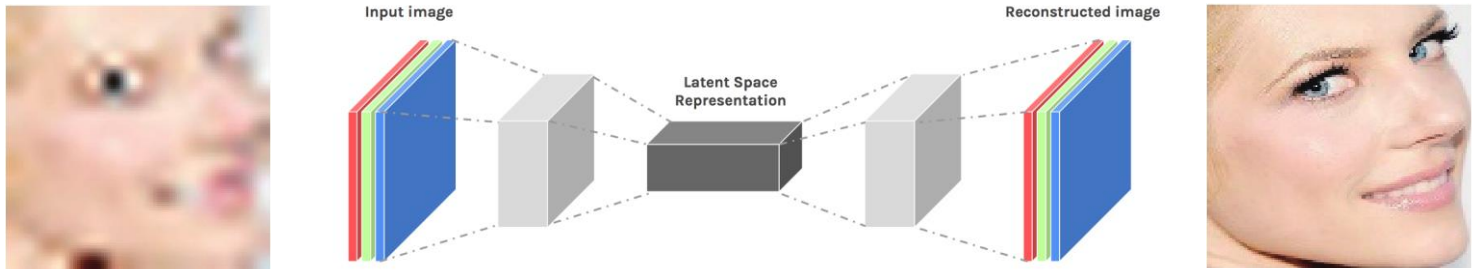

- deep learning methods: autoencoder, GAN…

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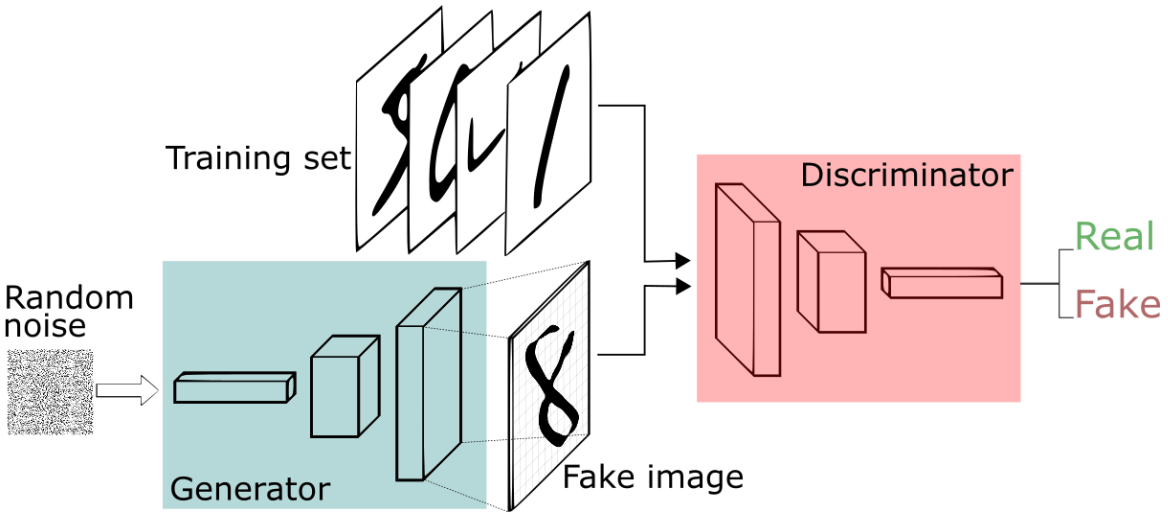

- deep learning methods: autoencoder, GAN…

**https://thispersondoesnotexist.com/*

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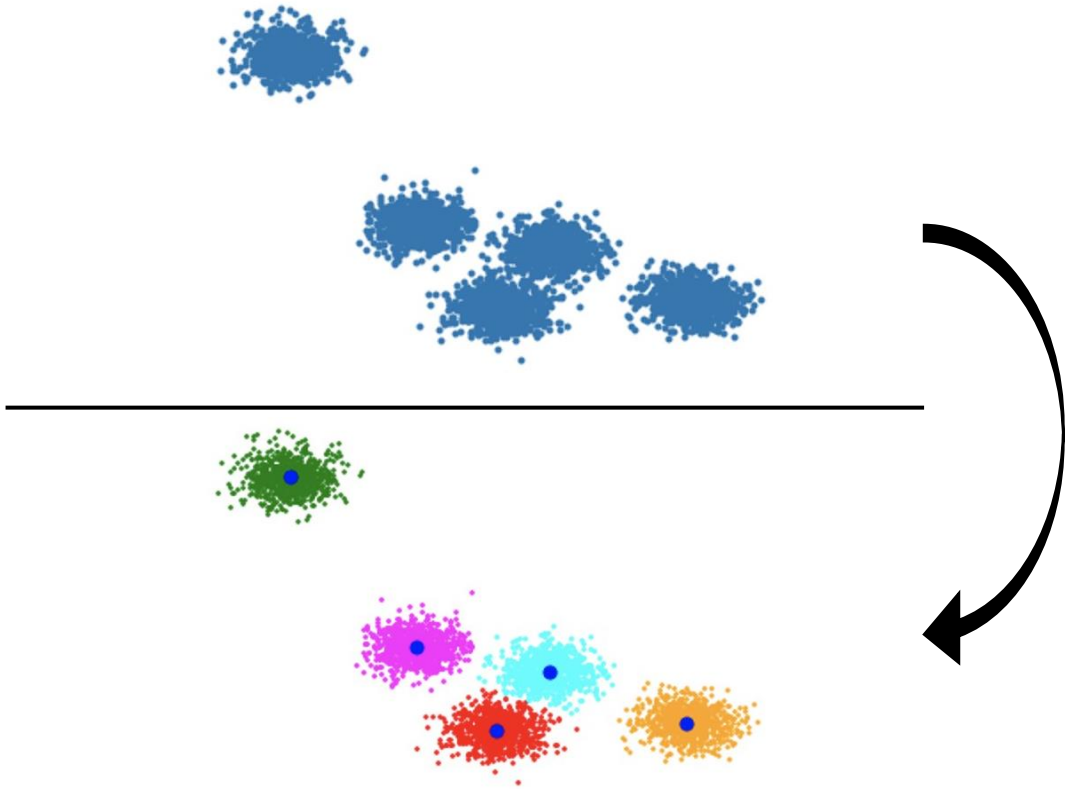

• not enough labels for training, but labelled data can be used to identify clusters

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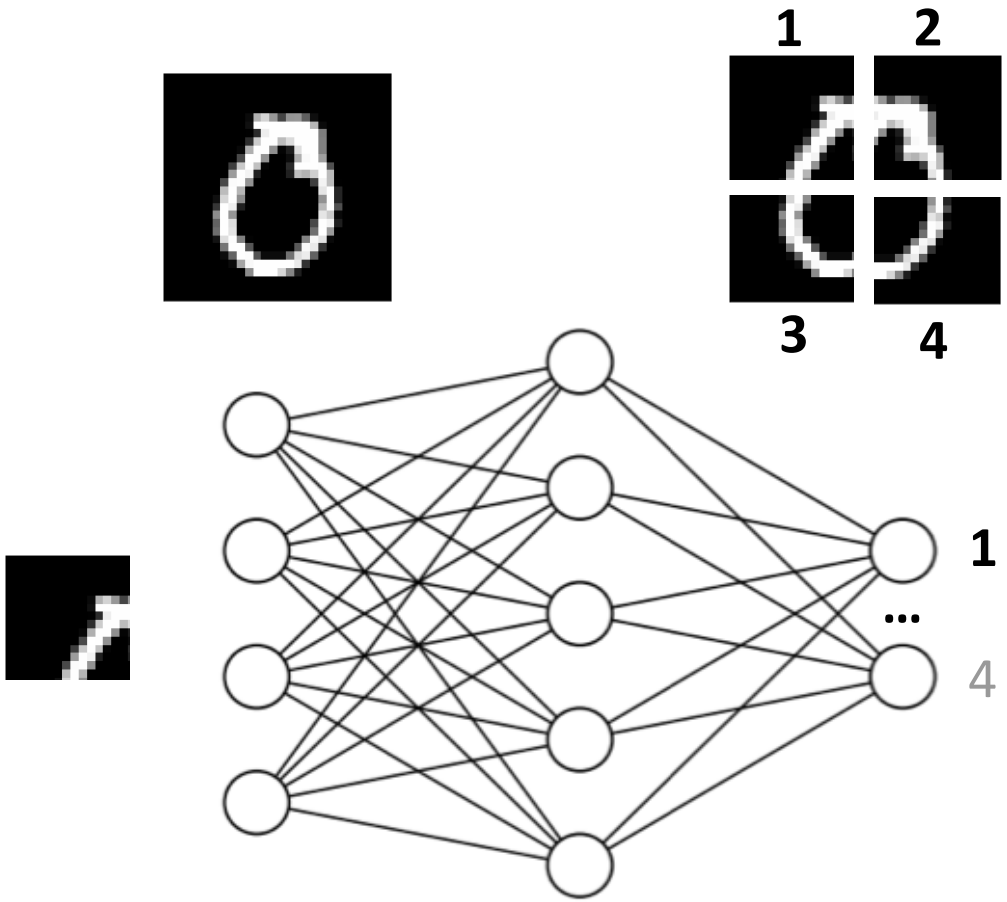
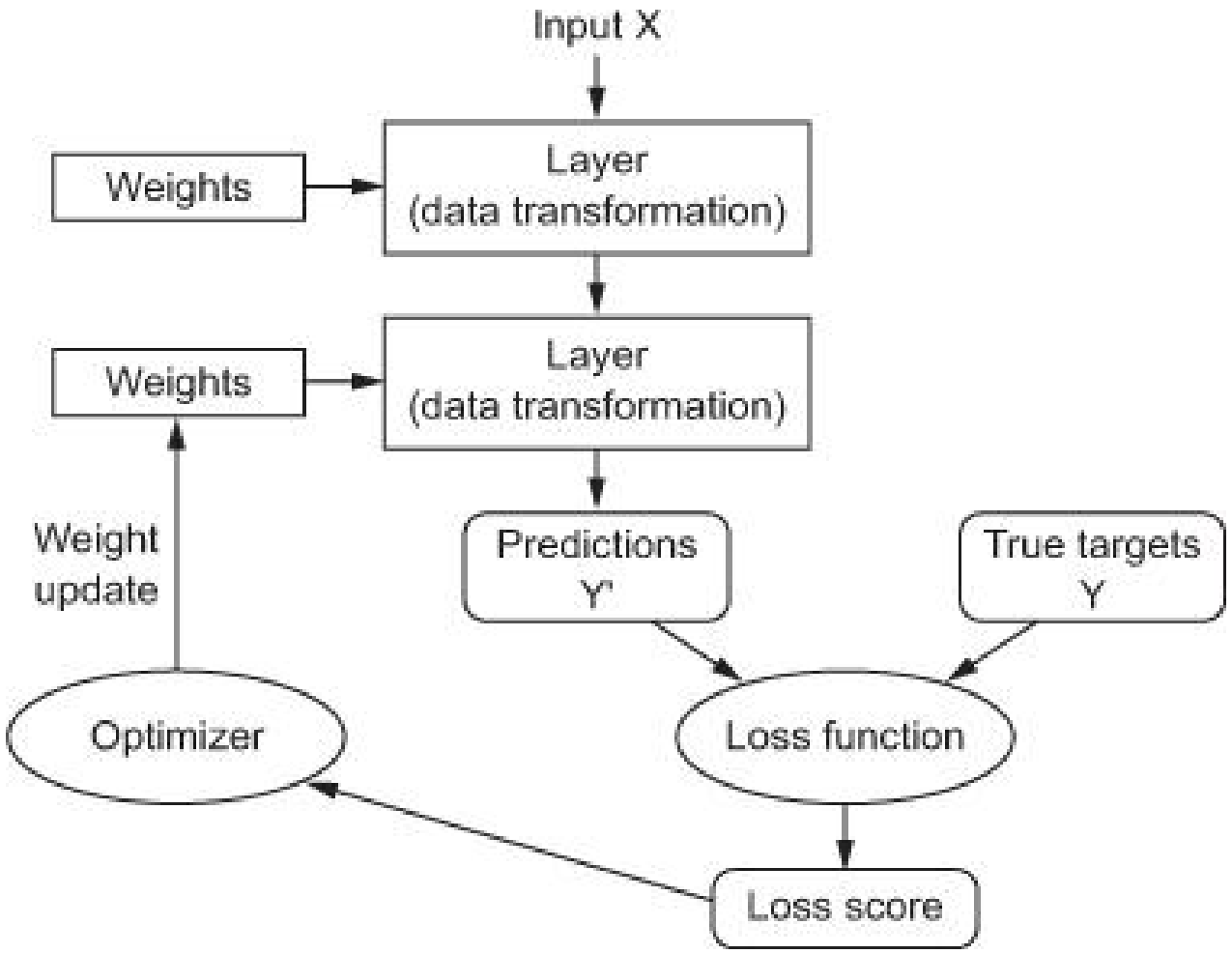


• puzzle solving

- The general deep learning concept -



- Deep learning frameworks -

- Povzetek 3. laboratorijske vaje -

- 1. naloga :

  Izločanje robov z uporabo knjižnjice PyTorch

- 2. naloga:

  Razvoj, učenje in testiranje konvolucijske nevronske mreže za razvrščanje slik

- 1. Naloga –
- Izločanje robov s knjižnjico PyTorch -

- *S konvolucijskim slojem torch.nn.Conv2d() izvedite pretvorbo barvne slike v sivinsko*

$$Y = 0.299 \cdot R + 0.587 \cdot G + 0.114 \cdot B$$

- 1. Naloga –
- Izločanje robov s knjižnjico PyTorch -

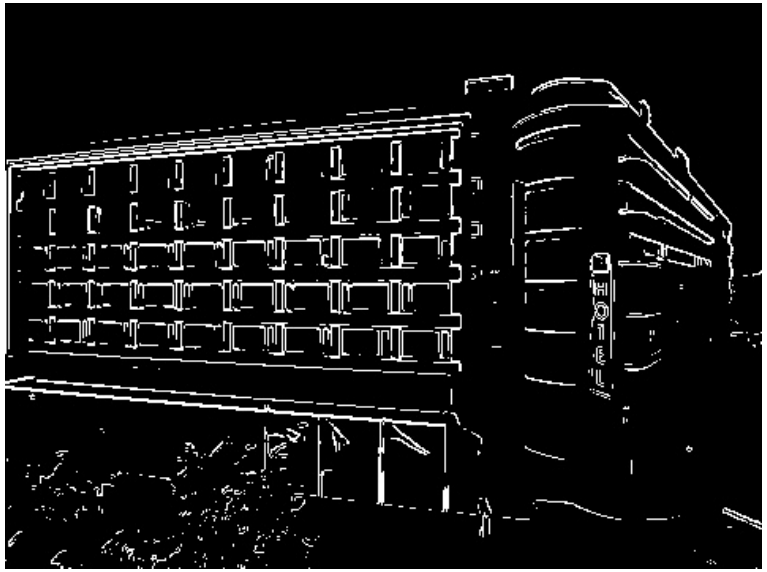
- *S filtri Sobelovega operatorja in z uporabo enega novega konvolucijskega sloja torch.nn.Conv2d() izračunajte gradiente sivinske slike*

$$S_x = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{bmatrix}, \; S_y = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix}$$

- 1. Naloga –
- Izločanje robov s knjižnjico PyTorch -

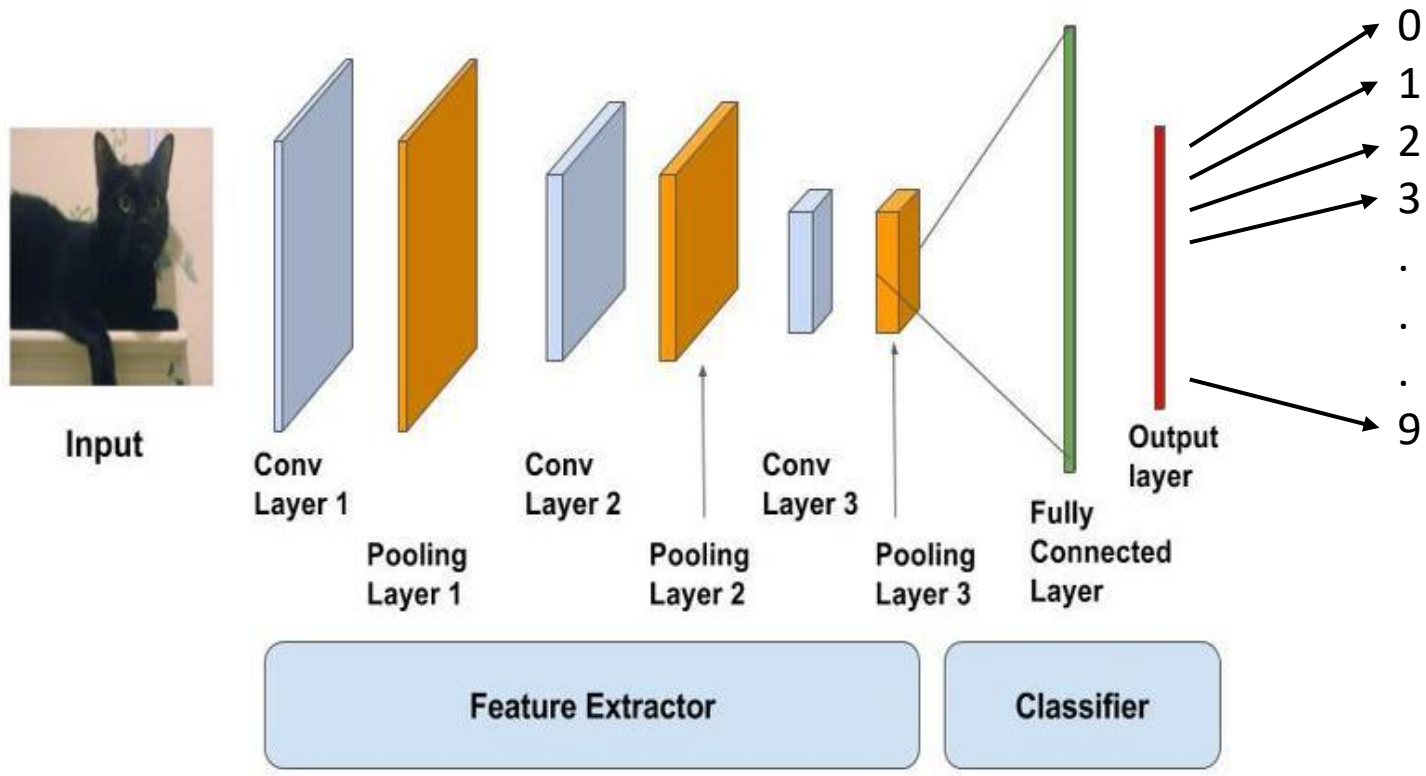
- *Sliko gradientov binarizirajte tako, da so robovi beli, okolica pa črna*

thresholding



- 2. Naloga –
- Konvolucijska mreža za razvrščanje slik -

- *Zgradili bomo konvolucijsko nevronsko mrežo, ki bo razvrščala slike različnih razredov*



- 2. Naloga –
- Podatkovne baze -

- *Baza je na voljo na laboratorijskih računalnikih v mapi **/home/uporabniško_ime/MNIST***

MNIST

- 2. Naloga -

- *Iz spletne učilnice eFE si prenesite datoteko classifier.zip*
- *V mapi classifier boste našli:*
    - *Skripto dataloader.py – na začetku naredi seznam učnih in testnih vzorcev. V tej skripti je definiran tudi način branja podatkov (beremo jih sproti) .*
    - *Skripto network.py – vsebuje definicijo arhitekture mreže. Definira tudi način posredovanja podatkov med posameznimi sloji.*
    - *Skripto train.py – Izvaja učenje in testiranje nevronske mreže*
    - *Mapo output – v tej mapi hranimo rezultate učenja modela (na primer uteži mreže)*

- 2. Naloga -

- *V skripti network.py definirajte arhitekturo konvolucijske nevronske mreže.*

RGB image 32x32x3
conv3-64/p1 conv3-64/p1
maxpool2/s2
conv3-128/p1 conv3-128/p1
maxpool2/s2
conv3-256/p1 conv3-256/p1 conv3-256/p1
maxpool2/s2
FC-512
FC-512
FC-10
softmax