Computer vision and image processing introduction

Ronan Sicre
Credits to Yannis Avrithis https://sif-dlv.github.io/
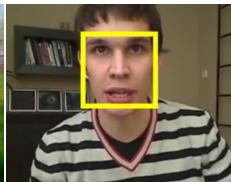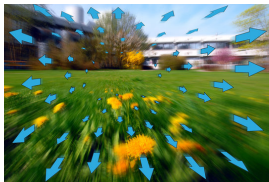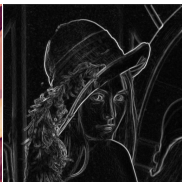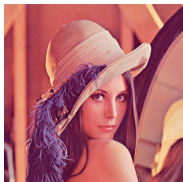
computer vision in images
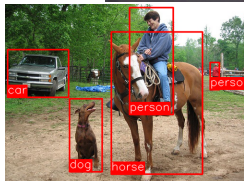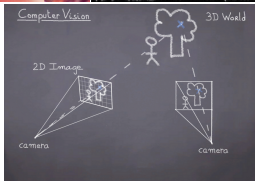
computer vision in images
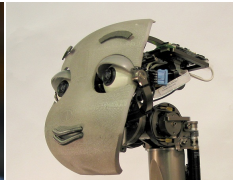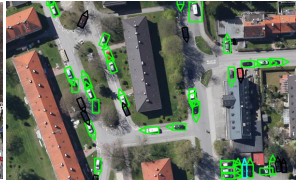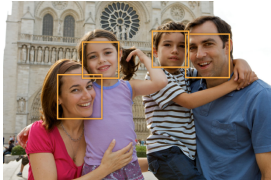
computer vision—related fields
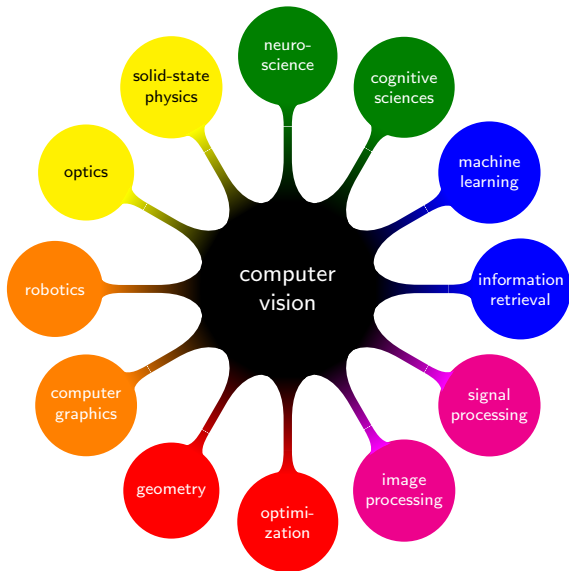
machine learning—related fields
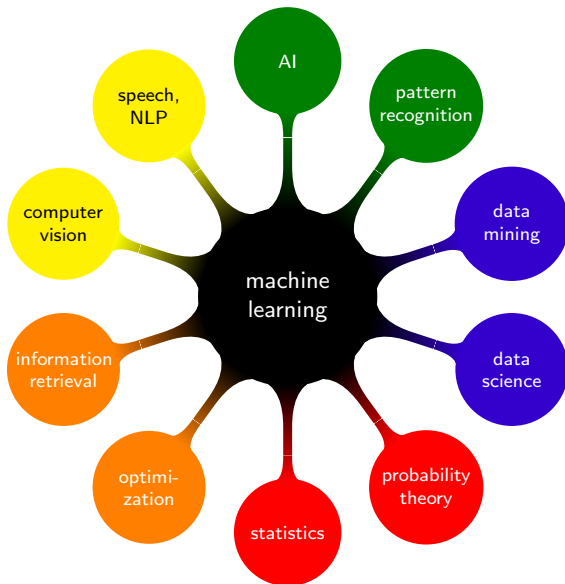
modern deep learning

ImageNet

[Russakovsky et al. 2014]
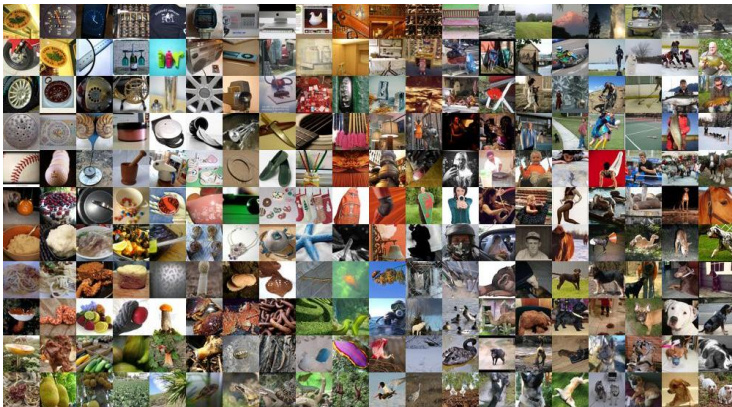
- 22k classes, 15M samples
- ImageNet Large-Scale Visual Recognition Challenge (ILSVRC): 1000 classes, 1.2M training images, 50k validation images, 150k test images

Russakovsky, Deng, Su, Krause, *et al.* 2014. Imagenet Large Scale Visual Recognition Challenge.

AlexNet

[Krizhevsky et al. 2012]
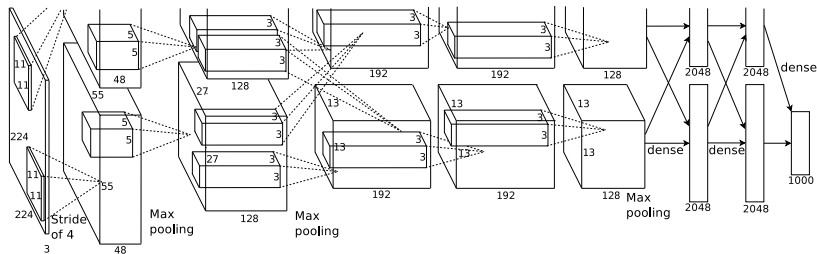
- implementation on two GPUs; connectivity between the two subnetworks is limited
- ReLU, data augmentation, local response normalization, dropout
- outperformed all previous models on ILSVRC by 10%

Krizhevsky, Sutskever, Hinton. NIPS 2012. Imagenet Classification with Deep Convolutional Neural Networks.

learned layer 1 kernels
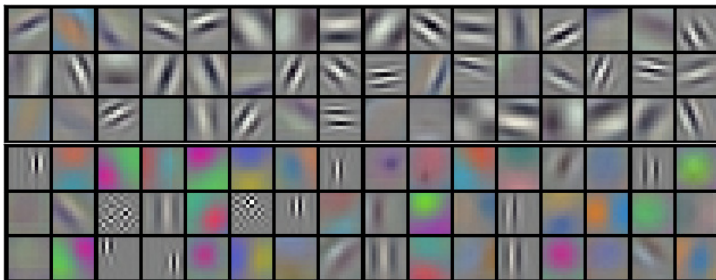
- 96 kernels of size $11 \times 11 \times 3$
- top: 48 GPU 1 kernels; bottom: 48 GPU 2 kernels

Krizhevsky, Sutskever, Hinton. NIPS 2012. Imagenet Classification with Deep Convolutional Neural Networks.

ImageNet classification performance

Russakovsky, Deng, Su, Krause, *et al.* 2014. Imagenet Large Scale Visual Recognition Challenge.

object detection

1. Resize image.
2. Run convolutional network.
3. Threshold detections.
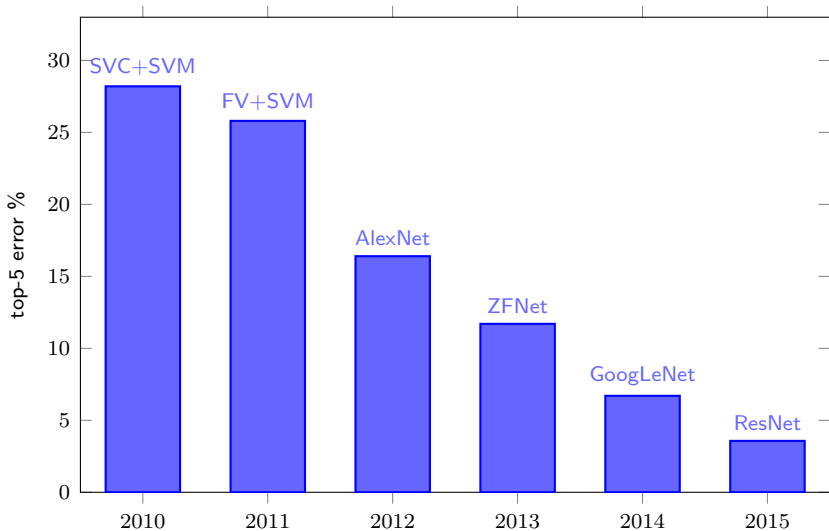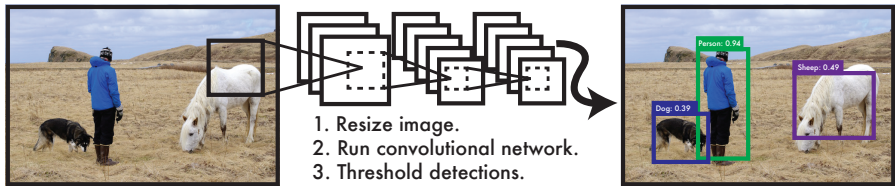
- learn to detect objects as a single classification and regression task, without scanning the image or detecting candidate regions
- first object detector to operate at 45fps

Redmon, Divvala, Girshick, Farhadi. CVPR 2016. You Only Look Once: Unified, Real-Time Object Detection.

semantic segmentation

[Long et al. 2015]

| FCN-8s | SDS [15] | Ground Truth | Image |
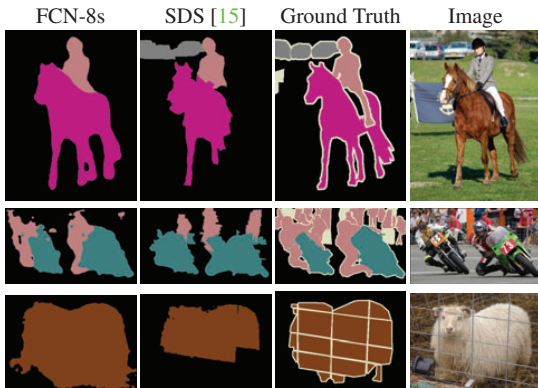
- learn to upsample
- apply to pixel-dense prediction tasks

Long, Shelhamer, Darrell. CVPR 2015. Fully Convolutional Networks for Semantic Segmentation.

instance segmentation and pose estimation

[He et al. 2017]

- semantic segmentation per detected region
- pose estimation as regression

He, Gkioxari, Dollar, Girshick. ICCV 2017. Mask R-CNN.
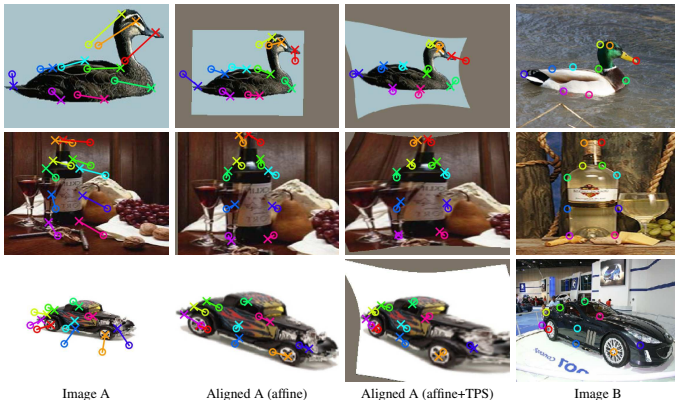
multi-task learning

[Kokkinos 2017]

Input	Boundaries	Saliency	Normals

Detection	Semantic Boundaries & Segmentation	Human Parts
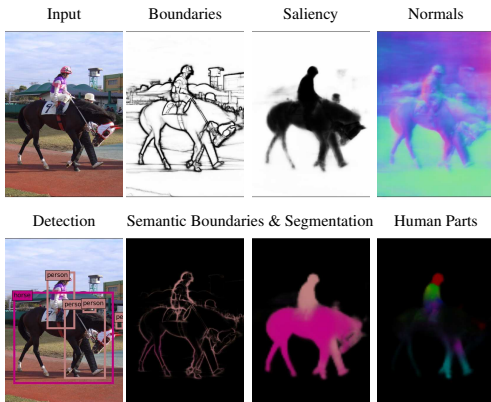
- learn several vision tasks with a joint network architecture including task-specific skip layers

Kokkinos. CVPR 2017. Ubernet: Training a Universal Convolutional Neural Network for Low-, Mid-, and High-Level Vision Using Diverse Datasets and Limited Memory.

geometric matching

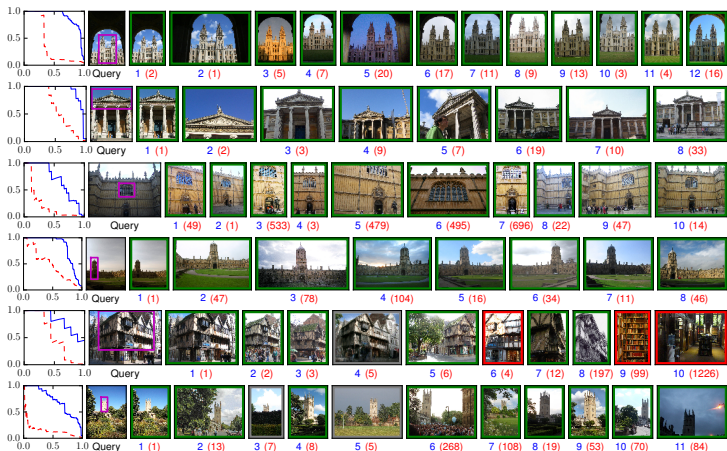| Image A | Aligned A (affine) | Aligned A (affine+TPS) | Image B |

- mimic the standard steps of feature extraction, matching and simultaneous inlier detection and model parameter estimation
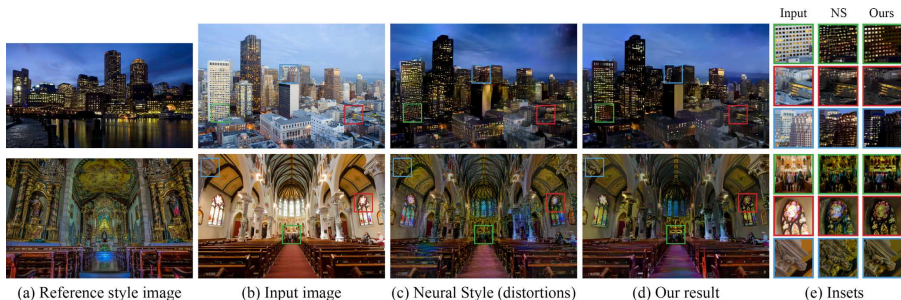- still trainable end-to-end

Rocco, Arandjelovic, Sivic. CVPR 2017. Convolutional Neural Network Architecture for Geometric Matching.

image retrieval

[Gordo et al. 2016]

- learn to match
- apply as generic feature extractor

Gordo, Almazan, Revaud, Larlus. ECCV 2016. Deep Image Retrieval: Learning Global Representations for Image Search.

photorealistic style transfer

[Luan et al. 2017]

| (a) Reference style image | (b) Input image | (c) Neural Style (distortions) | (d) Our result | (e) Insets |

- generate same scene as input image
- transfer style from reference image
- photorealism regularization

image captioning

[Vinyals et al. 2017]

- image description by deep CNN
- language generation by RNN

Vinyals, Toshev, Bengio and Erhan. PAMI 2017. Show and Tell: Lessons Learned From the 2015 MSCOCO Image Captioning Challenge.