

Computer Vision

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Schedule for today

- Logistics
- Resources
- What is computer vision?
- Some typical computer vision problems

Logistics

- **E-Mail:** Roland [dot] Kwitt [at] plus [dot] ac [dot] at
- **Course material:** available online at <http://rkwitt.org> (→ Teaching)

Logistics

Grading

1 final exam at the end of the course (see course website for details)

Resources

PyTorch (most recent version v1.12.1)

<https://pytorch.org/>

scikit-learn (Python)

<http://scikit-learn.org/stable/>

scikit-image (Python)

<http://scikit-image.org>

Resources

“Deep Learning”

Goodfellow, Bengio, Courville

<http://www.deeplearningbook.org/>

Please check the course website for updates on relevant research papers.

Resources

Throughout the lecture, we will primarily cover “**modern**” approaches to computer vision, using (deep) neural networks.

However, I still do want to mention a “classic” vision book which is definitely worth reading.

“Computer Vision: Algorithms and Applications”

R., Szeliski, 2010

<http://szeliski.org/Book/>

What is computer vision?



Courtesy of Szeliski



(Luiz Gomez Photos)

The **human visual system (HVS)** is remarkably good at so many tasks, e.g.,

- detecting people & object's
- perceiving translucency, shape, color (see figure on the left),
- counting people & vehicles (see middle figure)
- recognizing scenes, etc.

What is computer vision?

Remarkable fact:

A substantial fraction of the macaque's total cortical area is devoted to vision (approx. 15% according to [\[Hubel, "Eye, Brain and Vision"\]](#))

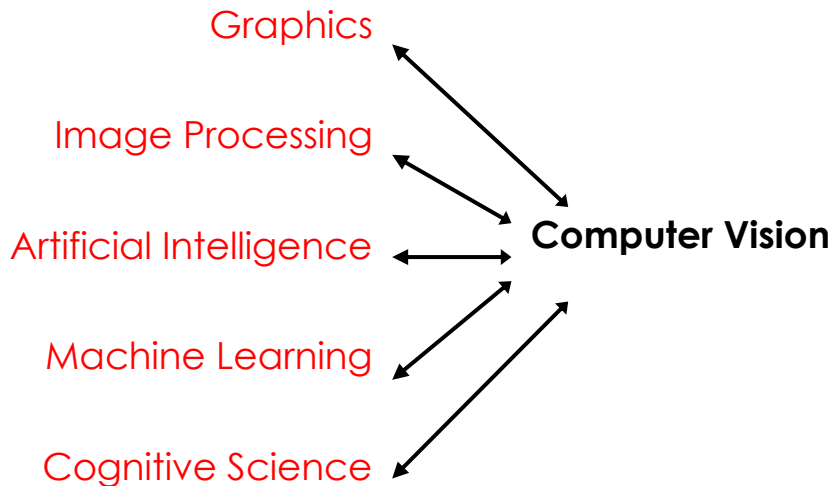
What is computer vision?

We want to build systems for **automatic understanding of images/videos**.

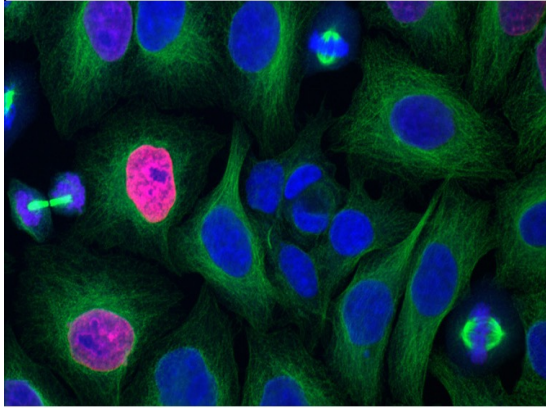
This includes, but is not limited to,

- 1) inferring properties of the 3D world (**measurement**)
- 2) enabling recognition of objects, people, scenes, etc. (**perception**)
- 3) mining, searching and interacting with visual data (**search / organization**)

What is computer vision?



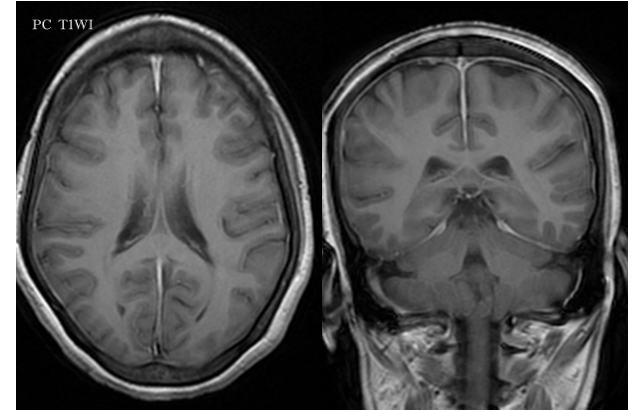
Bio-Imaging



Surveillance



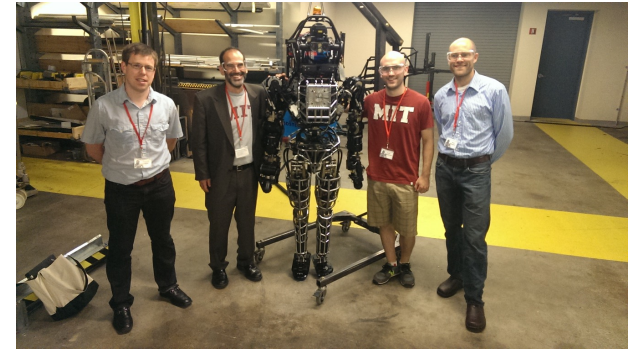
Medical Imaging



Autonomous Cars



Mapping



Robotics

Overview of the field

Conferences

Computer Vision

- Computer Vision and Pattern Recognition (CVPR)
- International Conference on Computer Vision (ICCV)
- European Conference on Computer Vision (ECCV)
- British Machine Vision Conference (BMVC)

Machine learning

- Neural Information Processing Systems (NIPS)
- International Conference on Machine Learning (ICML)
- International Conference on Learning Representations (ICLR)

Overview of the field

1.	Advanced Materials	<u>252</u>	342
2.	IEEE/CVF Conference on Computer Vision and Pattern Recognition	<u>240</u>	383
3.	Energy & Environmental Science	<u>207</u>	323
4.	ACS Nano	<u>203</u>	280
5.	Nano Letters	<u>188</u>	270
6.	Nature Materials	<u>179</u>	323
7.	Renewable and Sustainable Energy Reviews	<u>174</u>	238
8.	Neural Information Processing Systems (NIPS)	<u>169</u>	334
9.	Journal of Materials Chemistry. A	<u>163</u>	214
10.	Nature Nanotechnology	<u>160</u>	278
11.	Advanced Functional Materials	<u>154</u>	203
12.	Advanced Energy Materials	<u>152</u>	211
13.	International Conference on Learning Representations	<u>150</u>	276
14.	Nature Photonics	<u>150</u>	261
15.	ACS Applied Materials & Interfaces	<u>147</u>	188
16.	Chemistry of Materials	<u>141</u>	191
17.	Nanoscale	<u>139</u>	188
18.	European Conference on Computer Vision	<u>137</u>	263
19.	International Conference on Machine Learning (ICML)	<u>135</u>	254
20.	Journal of Cleaner Production	<u>132</u>	166

Typical vision problems

Recognition



→ “Saiga antelope”

Task: Label an image by its class membership

Typical vision problems

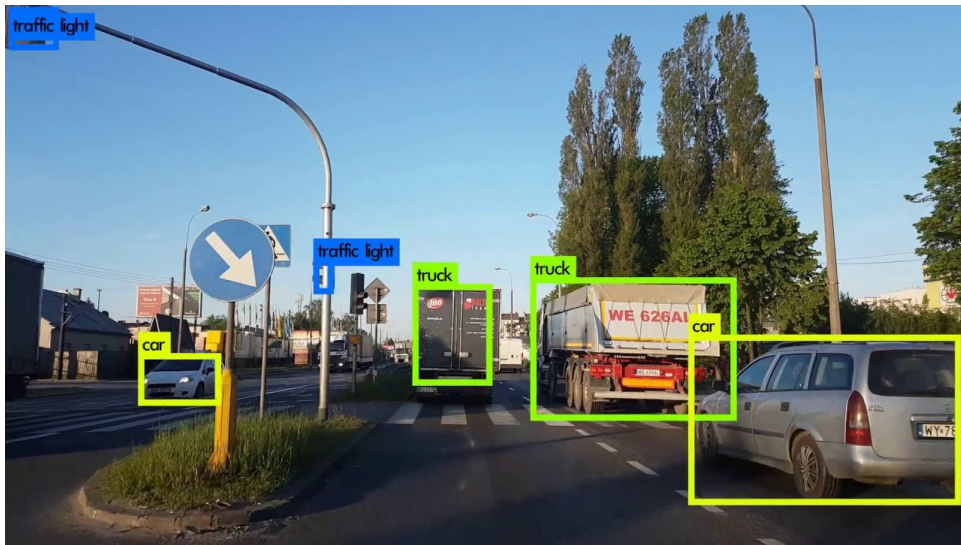
Segmentation



Task: Label each pixel of an image by its class membership.

Typical vision problems

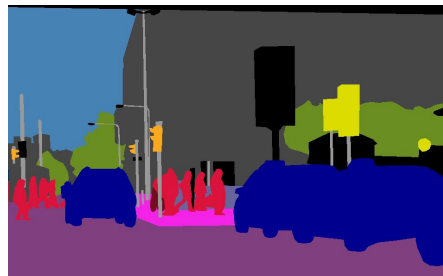
Detection



Task: Locate and label objects via, e.g., bounding boxes (i.e., coordinates)

Typical vision problems

Panoptic Segmentation



Semantic
segmentation



Instance
segmentation



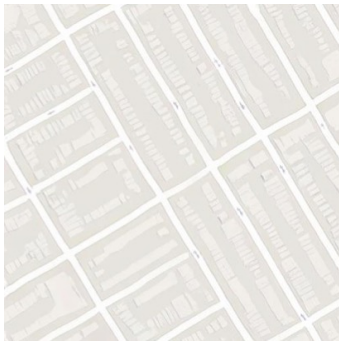
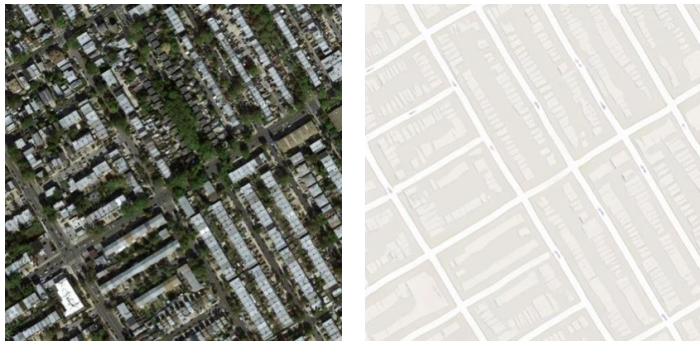
Panoptic
segmentation

Image source: Kirillov et al., "Panoptic Segmentation", In: CVPR '19

Goal: Unify semantic segmentation and instance segmentation.

Typical vision problems

Image-to-Image translation



Arial \rightarrow Map



BW \rightarrow Color

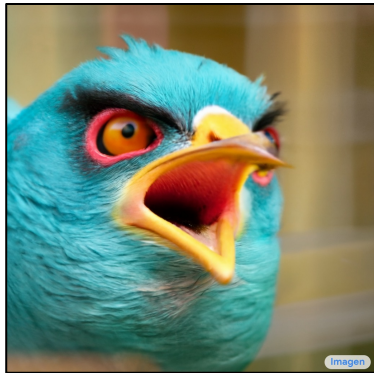


Label map \rightarrow Image



Typical vision problems

Text-to-Image Generation



Prompt: *An extremely angry bird.*



Prompt: *A photo of a Persian cat wearing sunglasses and a red shirt skateboarding on a beach.*

Some interesting resources

Browse D. H. Hubel's online book (Nobel prize winner, 1981)

<http://hubel.med.harvard.edu/book/bcontext.htm>

Read one of his and Torsten Wiesel's seminal papers, e.g.,

Receptive Fields and Functional Architecture of Monkey Striate Cortex,

D. H. Hubel and T. N. Wiesel

J. Physiol., 1968

<http://www.ncbi.nlm.nih.gov/pubmed/4966457>)