

# **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 v1.9)

<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

We will mostly be talking about “**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"] )

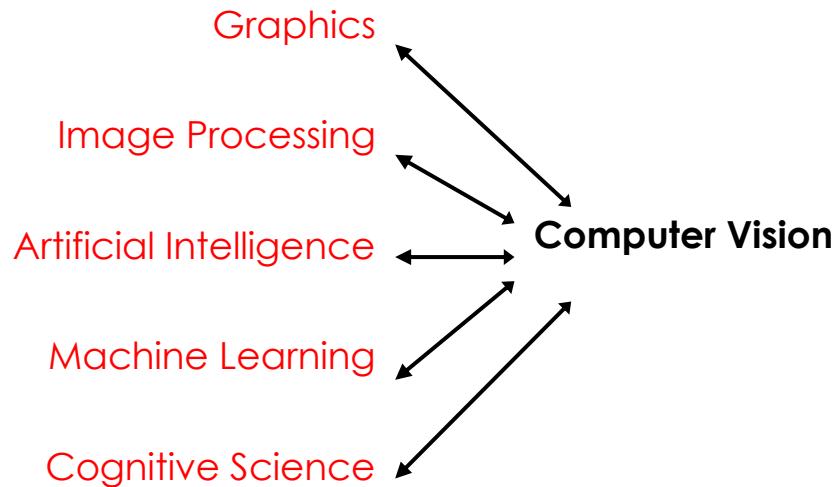
# What is computer vision?

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

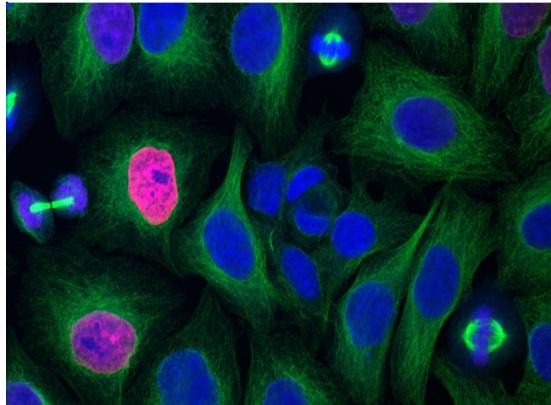
This includes, but is not limited to,

- 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?



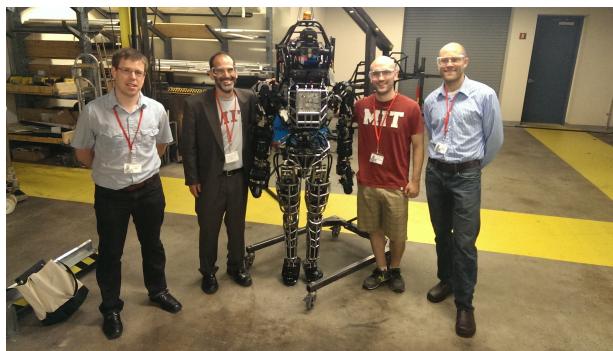
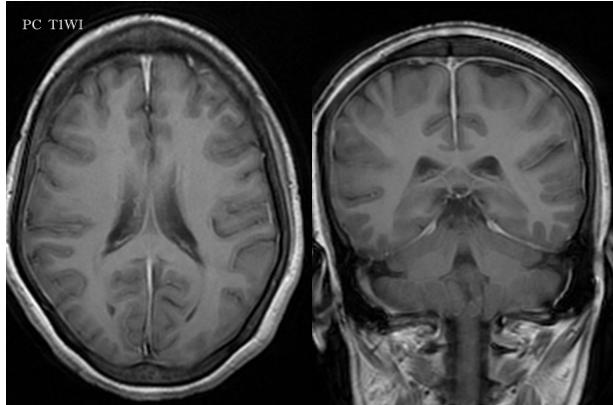
## Bio-Imaging



## 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.	<b>IEEE/CVF Conference on Computer Vision and Pattern Recognition</b>	<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.	<b>Neural Information Processing Systems (NIPS)</b>	<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.	<b>International Conference on Learning Representations</b>	<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.	<b>European Conference on Computer Vision</b>	<u>137</u>	263
19.	<b>International Conference on Machine Learning (ICML)</b>	<u>135</u>	254
20.	Journal of Cleaner Production	<u>132</u>	166

# Typical vision problems

## Recognition

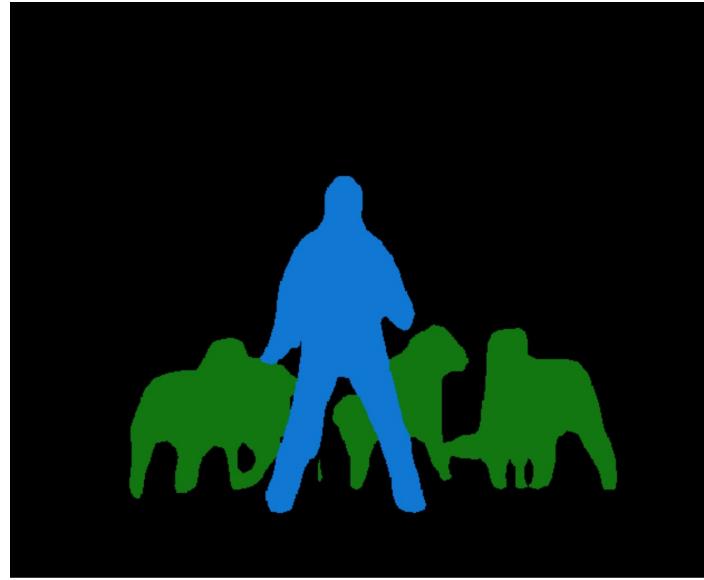


→ “Saiga antilope”

**Task:** Label an image by its class membership

# Typical vision problems

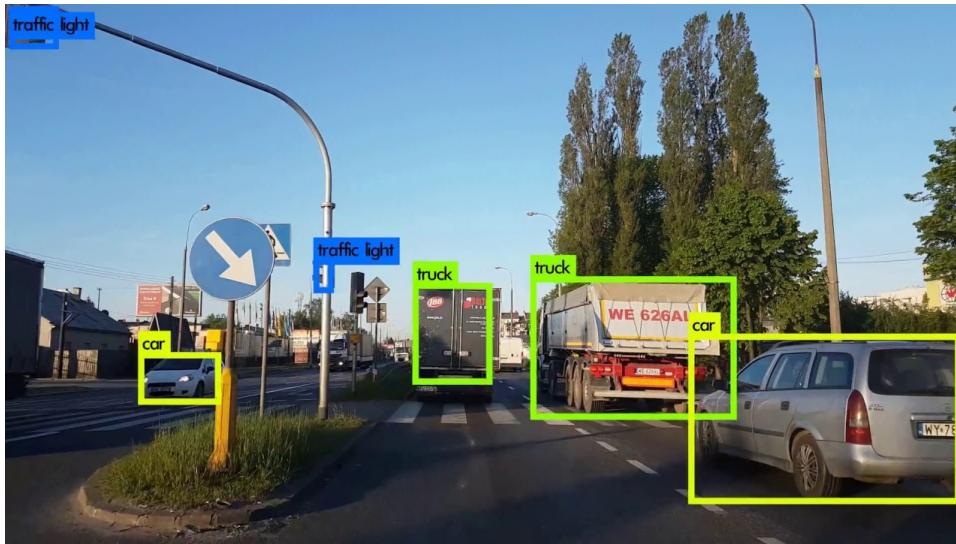
## Segmentation



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

# Typical vision problems

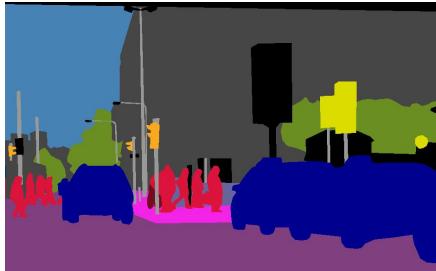
## Detection



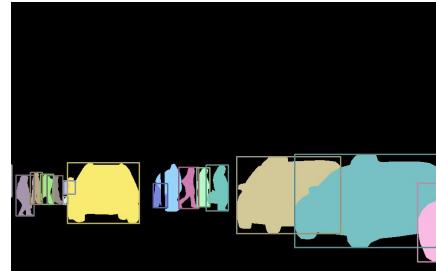
**Task:** Locate and label objects via, e.g., bounding boxes (i.e., coordinates)

# Typical vision problems

## Panoptic Segmentation



**Semantic**  
segmentation



**Instance**  
segmentation



**Panoptic**  
segmentation

**Goal:** Unify semantic segmentation and instance segmentation.

# Typical vision problems

Image-to-Image translation



Arial → Map



BW → Color



Label map → Image



# 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>)