Computer Vision
(VO, 911.908, Winter term 22/23)

Roland Kwitt

Department of Artificial Intelligence and Human Interfaces (AIHI)

University of Salzburg, Austria

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"])
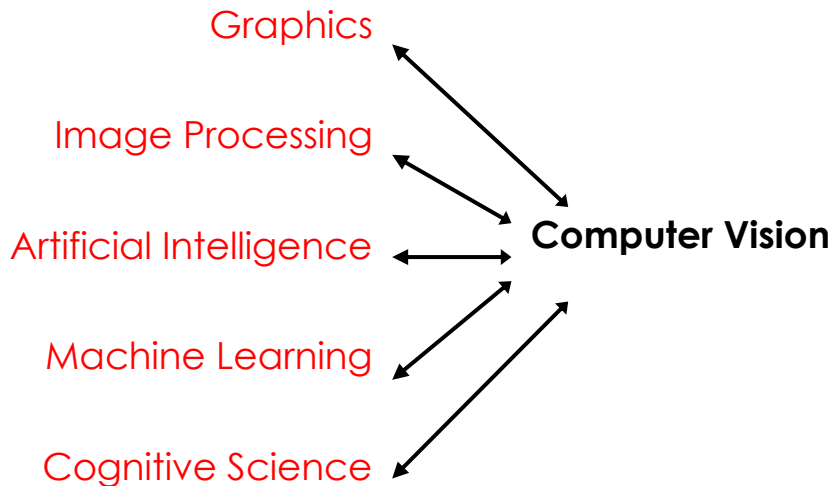
What is computer vision?

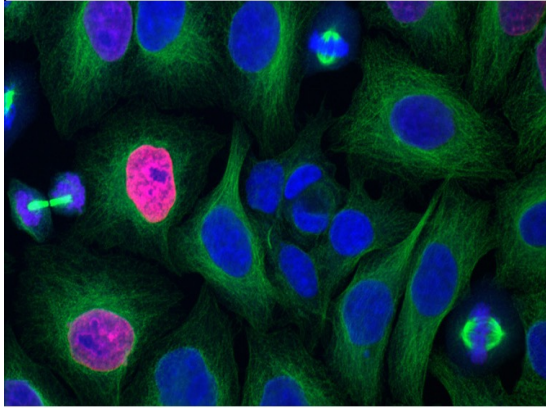We want to build systems for **automatic understanding of images/videos**.

This includes, <u>but is not limited to</u>,

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)**
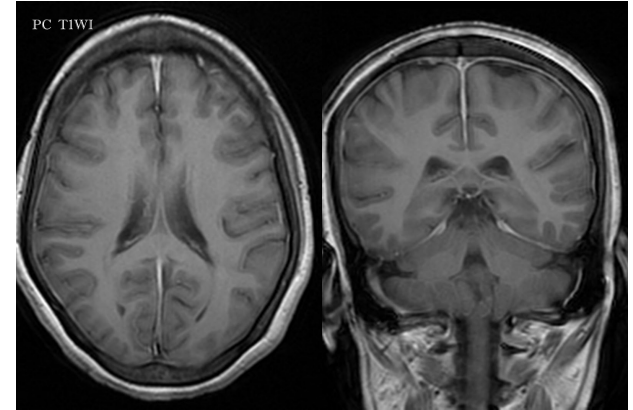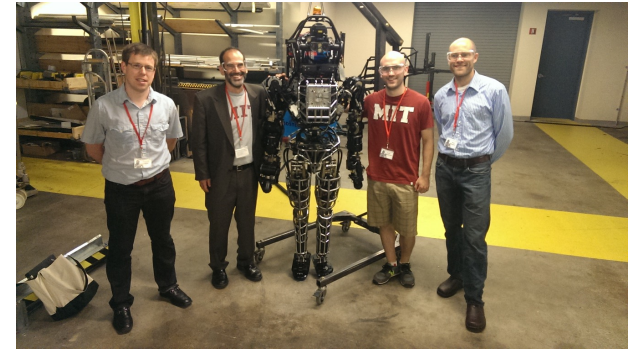
What is computer vision?

Graphics

Image Processing

Artificial Intelligence ⟷ **Computer Vision**

Machine Learning

Cognitive Science

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

Some metrics: checkout Google scholar on that, here!

Typical vision problems

Recognition

 ⟶ "Saiga antilope"

Task: Label an image by its class membership

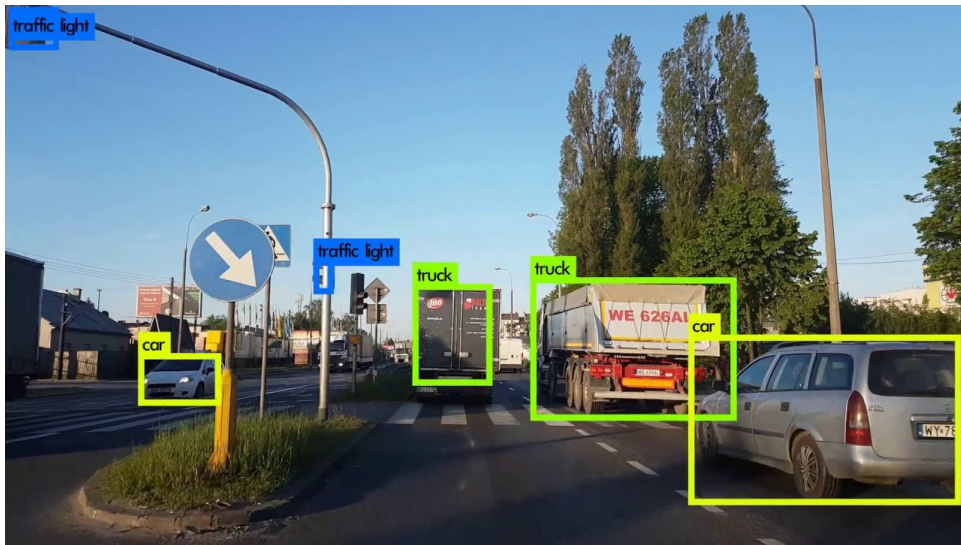# Typical vision problems

Segmentation

Task: Label <u>each pixel</u> of an image by its class membership.
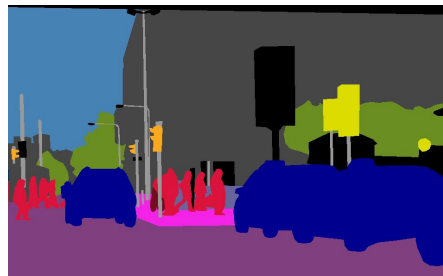
Typical vision problems

Detection

Task: <u>Locate and label</u> objects via, e.g., bounding boxes (i.e., coordinates)
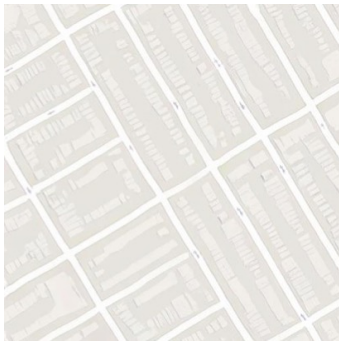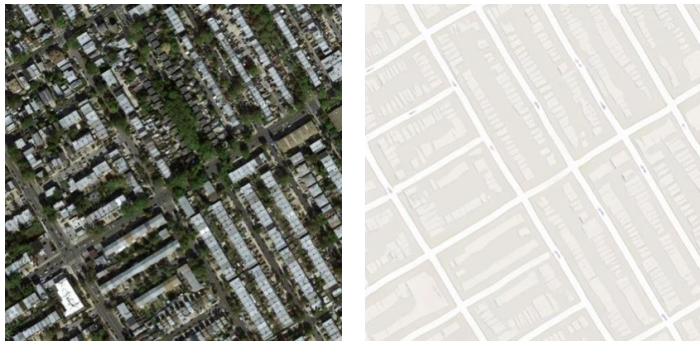
Typical

Panoptic Segmentation

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

Semantic segmentation

Instance segmentation

Panoptic segmentation

instance segmentation.

Typical vision problems

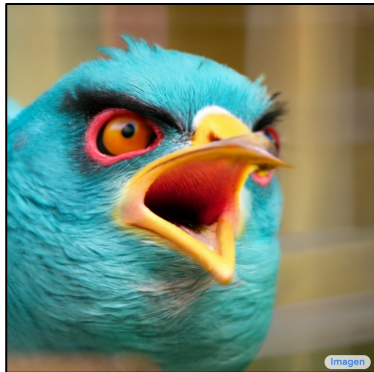## Image-to-Image translation

Arial → Map

BW → Color

Label map → 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.

Image source: imagen.research.google

Typical vision problems

Synthesizing novel views

Typical vision problems

[Dalle-2 Demo](#) (not publicly available, you need to sign up and get approved).

Some interesting resources

Browse D. H. Hubel's online book (Nobel prize winner, 1981)
http://hubel.med.harvard.edu/book/bcontex.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)