
Cognitive Computer Vision Introduction

SS 2018

Prof. Dr. Simone Frintrop

Cognitive Vision Group, Department of Informatics
University of Hamburg, Germany

Who are we?

Lecturer



Prof. Dr. **Simone Frintrop**

frintrop@informatik.uni-hamburg.de

Room R105

Exercises:



Dr. Mikko Lauri

lauri@informatik.uni-hamburg.de

Room R104

Group: **Computer Vision:**

<https://www.inf.uni-hamburg.de/en/inst/ab/cv.html>

Just drop by if you have questions

Questionnaire

- At end of lecture...

Organization

- Lecture: Tuesdays 12:15 - 13:45 (in room G021/022)
- Exercises/Seminar: 14:15– 15:45 (either in computer rooms D118/119, or in lecture room G021/022)
- Exercises/Seminar:
 - first few weeks: practical exercises
 - After that: seminar part

Organization

- Exercise:
 - In Python, with Tensorflow + OpenCV
 - Implementing your own saliency system
 - Competition: Which saliency system is best?
 - **Deadline for submitting saliency system results: June, 12th**

- Seminar: one recent research paper per person, presented during a **poster session at end of semester: July 10th**
 - First draft of poster ready (student peer-review): June, 26th
 - Prepare a spotlight (teaser talk of 2 min, max 4 slides)
 - Present poster during poster session



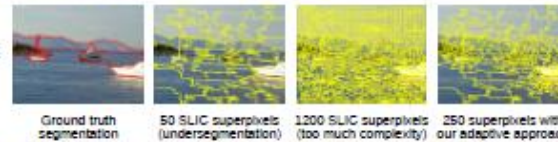
Edge Adaptive Seeding for Superpixel Segmentation

Christian Wilms and Simone Frintrop

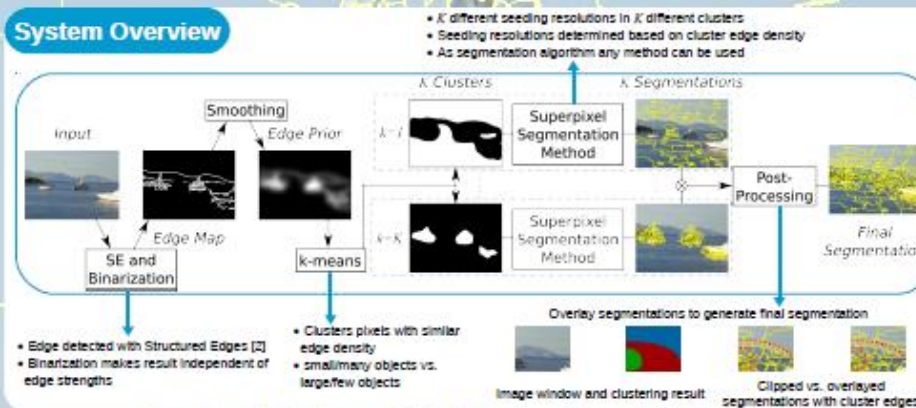
{wilms,frintrop}@informatik.uni-hamburg.de

Motivation

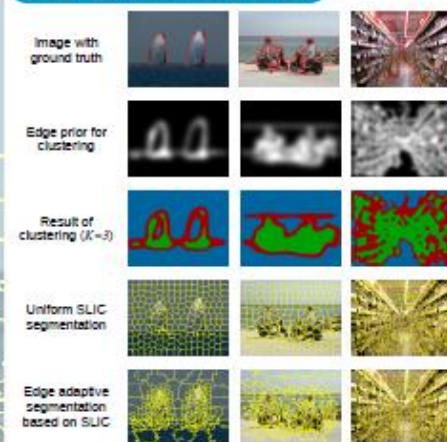
- Superpixels are used to reduce complexity of an image
- However, image content has very different scales
- Thus, one superpixel resolution is not suitable (undersegmentation vs. more complexity)
- Our solution: adapt the seeding of superpixels segmentations based on edge density



System Overview

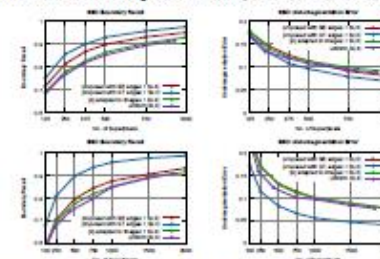


Results (for more results scan the QR code)



Evaluation based on [3]

- Five datasets used: BSD, SBD, NYUV2, SUNRGBD, Fashionista
- Comparison to [4] and uniform seeding
- Methods chosen for segmentation: SLIC, SEEDS and SMURFS



Paper + Code



References

- [1] Arbelaez, P., Maire, P., Sivic, B., Lischke, A., Hol, P., Szeliski, R.: SLIC superpixels computed by state-of-the-art superpixel methods. *IEEE Trans. Pattern Anal.*, 2014 (2014)
- [2] Wilms, C., Frintrop, S.: Fast edge detection using structured forests. *IEEE Trans. Pattern Anal.*, 2014 (2014)
- [3] Wilms, C., Frintrop, S., Lischke, A.: Superpixels: An evaluation of the state-of-the-art. *CVPR* (2017), in press
- [4] Chen, D., Li, Y., Zhang, D., Frintrop, S.: Iterative guided adaptive seeding for superpixel segmentation. *in: ICCV* (2017)

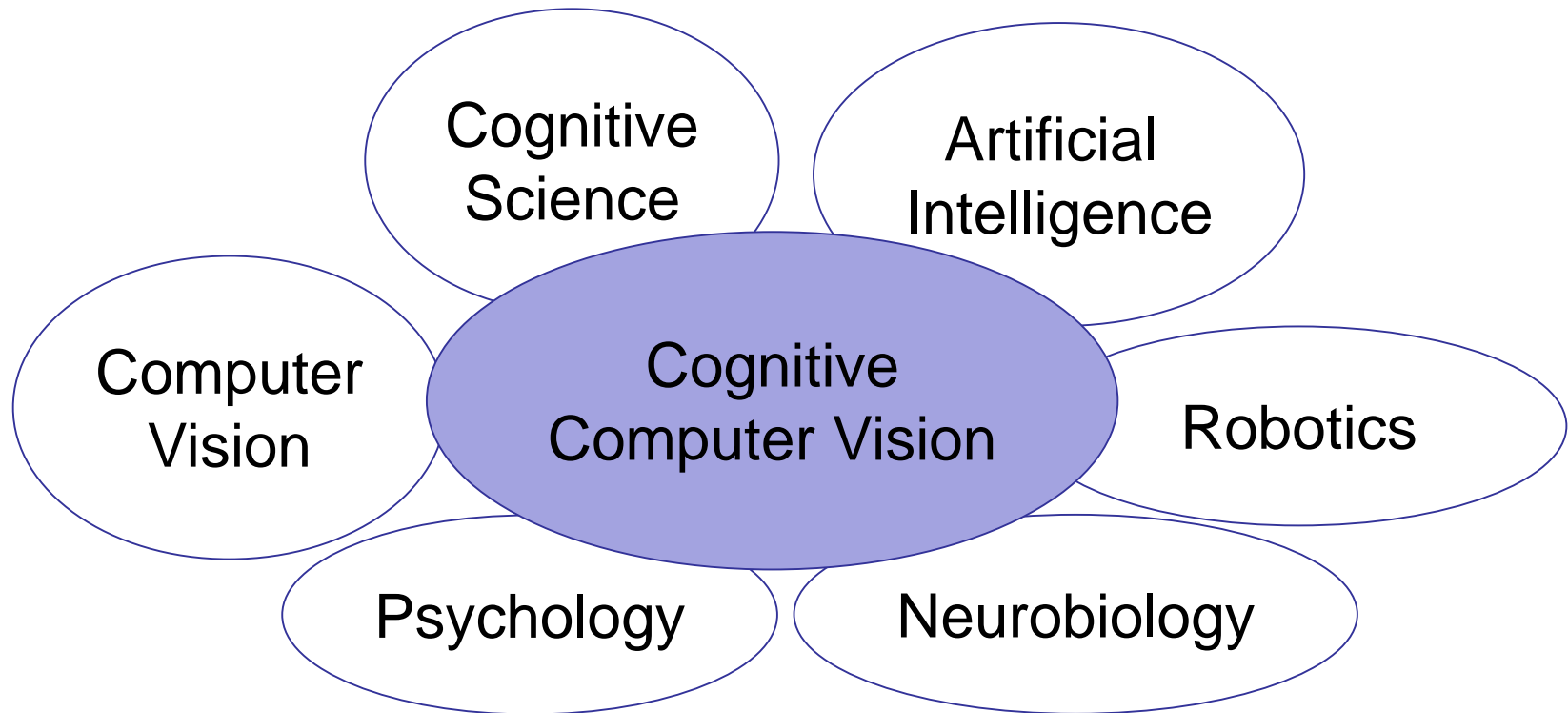
Exam

- Exam: oral exam (dates: to be announced)
1st exam: probably first week after lecture period
- To complete the module, you should:
 - Regularly attend (lecture +) exercises, get a running saliency system
 - Seminar: present a poster
- If you don't, you can take the exam, but you will have to complete the requirements in the next semester to complete the module

Stine and Moodle

- We will use Stine and Moodle
- Stine only for grades, times, rooms
- Moodle: platform to collaborate online
- For emails, sharing material, discussion
- How to access Moodle: will be announced on Stine
- You will find the slides on Moodle: before the lecture a draft, after the lecture the final version. So make sure to update your slides later!

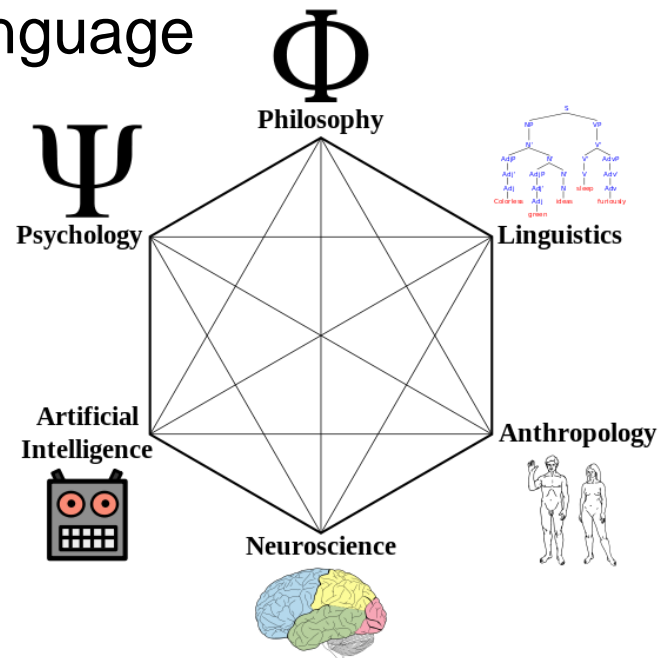
What is Cognitive Computer Vision?



What is Cognition?

Cognition is a group of **mental processes** that includes

- attention,
- memory,
- producing and understanding language
- learning,
- reasoning,
- problem solving, and
- decision making.



[Wikipedia: Cognition]

What is Cognitive Vision?

Cognitive Vision contains the **visual** aspects of cognition:

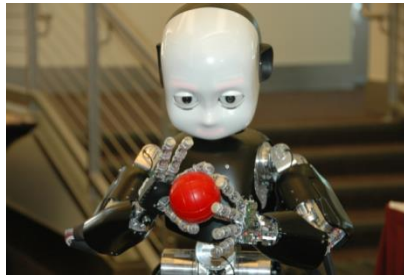
- object detection & recognition,
- visual attention,
- visual search,
- scene recognition and categorization,
- visual memory,
- visual learning

What are Cognitive Systems?

- **Cognitive Systems** are computer systems with cognitive abilities, e.g. perception, attention, anticipation, planning, complex motor coordination, reasoning about other agents
- Cognitive Systems are often robots, but can be also wearable cameras such Google Glass or other systems
- Cognitive Computer Vision is often used for the perceptual modules of cognitive systems



Google Glass



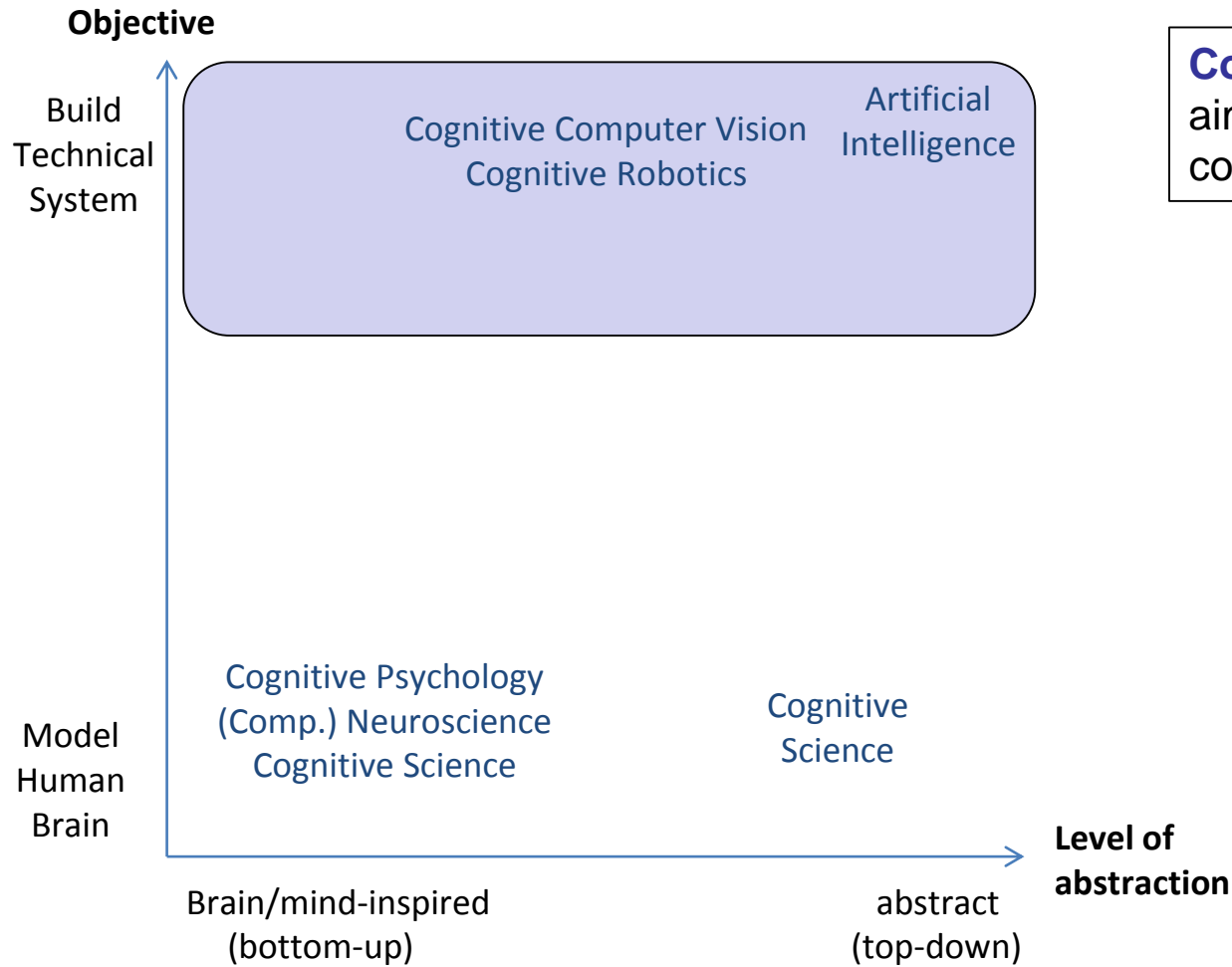
iCub



Rhino

Cognitive Systems Space

Why?

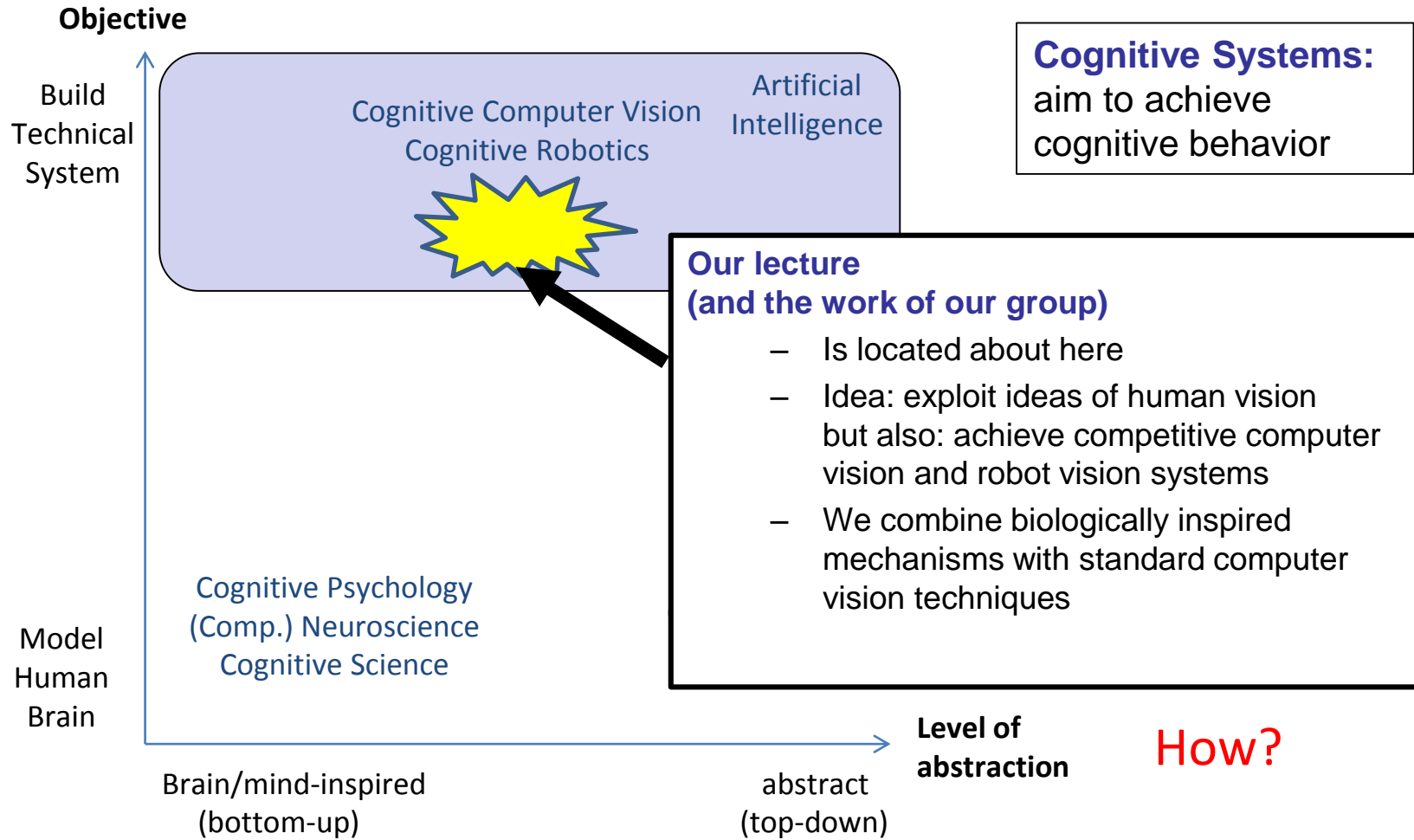


Cognitive Systems:
aim to achieve
cognitive behavior

How?

Cognitive Systems Space

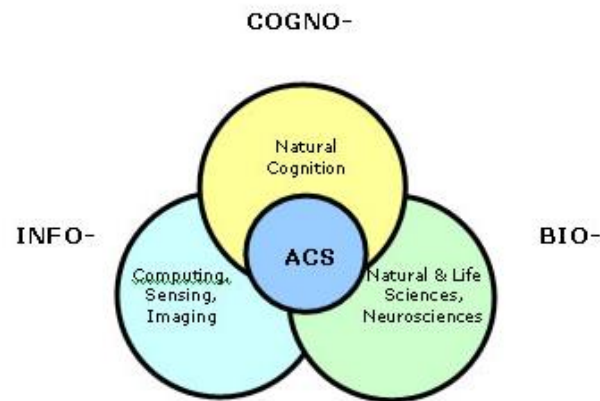
Why?



Cognitive Systems in the EU

- Since 2001: Cognitive Systems intensely funded by the EC
 - More than 100 projects on Cognitive Systems funded, e.g.: CogX, COSY, MACS, CogVis, NEUROBOTICS, Paco-Plus, POP, ...
- "Robots need to be more **robust, context-aware and easy-to-use**.
Endowing them with advanced **learning, cognitive and reasoning capabilities** will help them adapt to changing situations, and to carry out tasks intelligently with people"

[Challenge 2: Cognitive Systems, Interaction, Robotics]



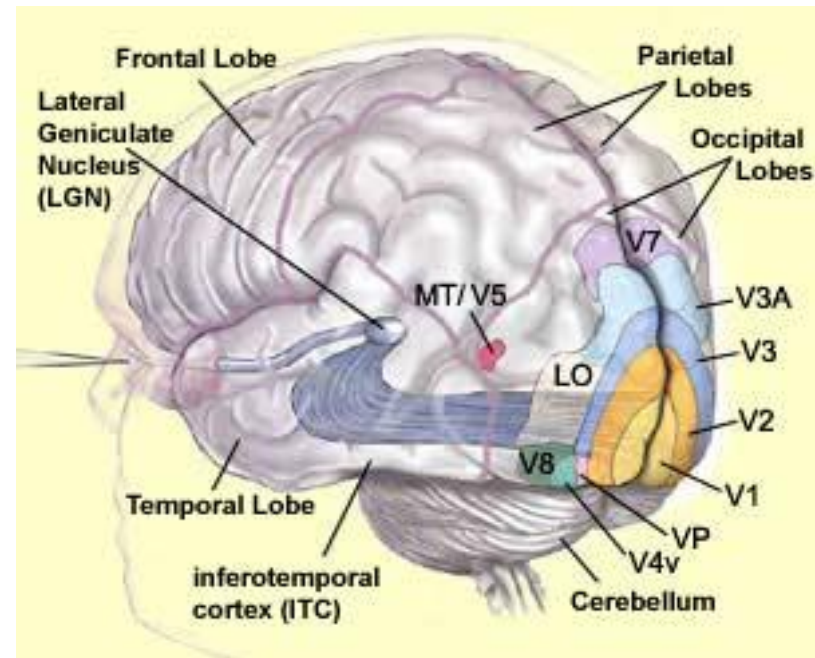
http://cordis.europa.eu/fp7/ict/cognition/home_en.html

Overview Lecture

- Introduction: What is Cognitive Computer Vision? (today)
- The Human Visual System
- Receptive Fields and Digital Filters
- More on Convolutional Neural Networks
- Visual Attention and Saliency
- Visual Search for Objects
- Active Camera Control/Sensor Management
- Semantic Segmentation
- Object Discovery/Object Proposal Detection

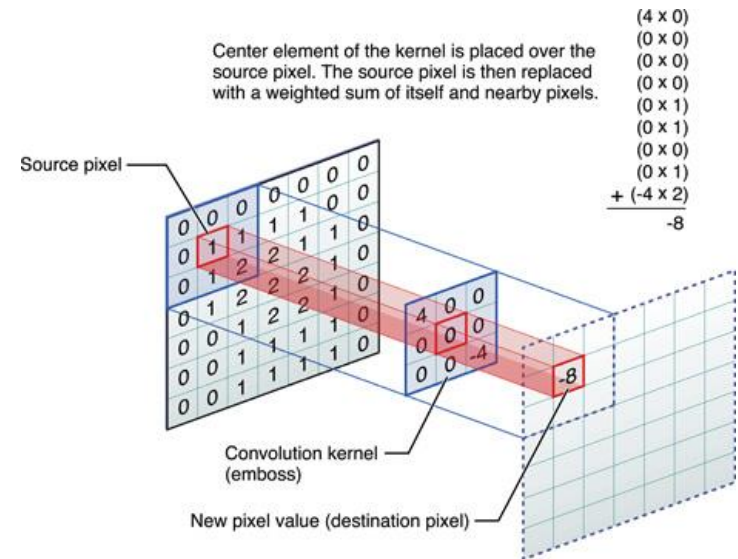
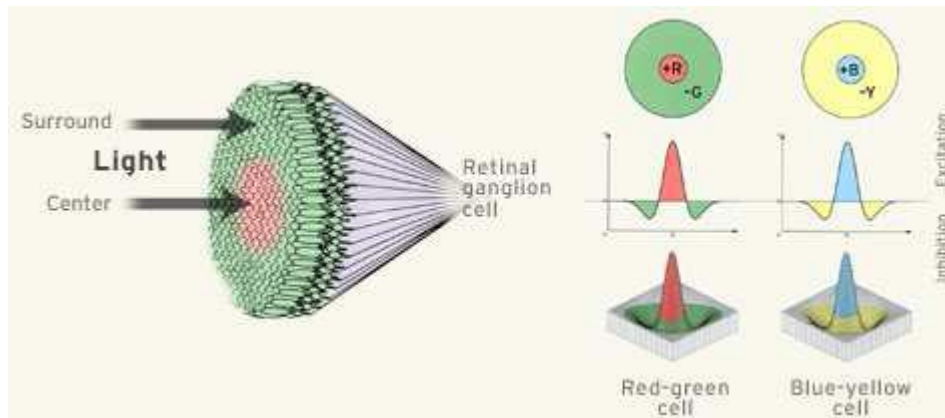
Overview Lecture

- Introduction: What is Cognitive Computer Vision? (today)
- **The Human Visual System**



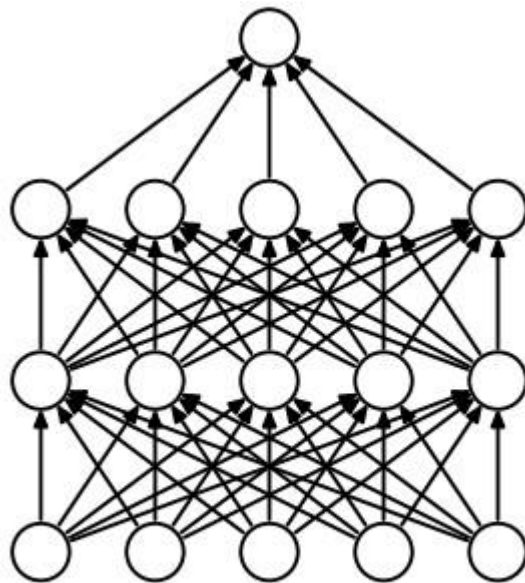
Overview Lecture

- Introduction: What is Cognitive Computer Vision? (today)
- The Human Visual System
- **Receptive Fields and Digital Filters**

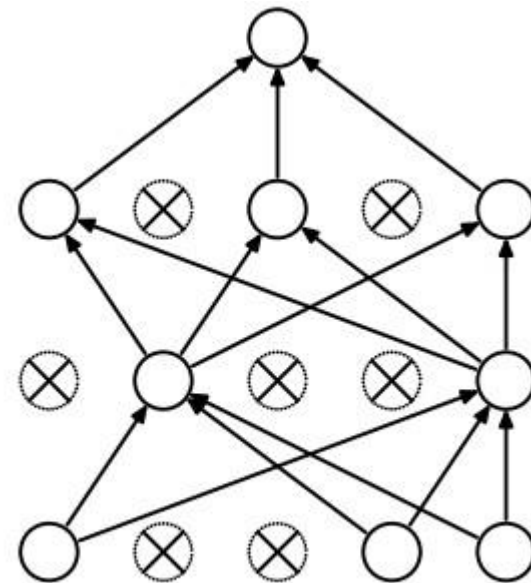


Overview Lecture

- Introduction: What is Cognitive Computer Vision? (today)
- The Human Visual System
- Receptive Fields and Digital Filters
- **More on Convolutional Neural Networks**



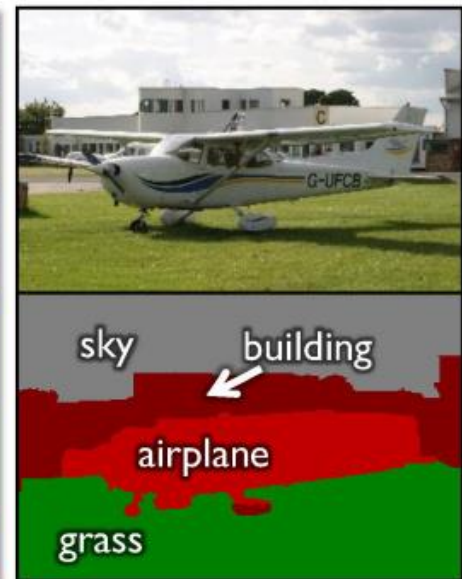
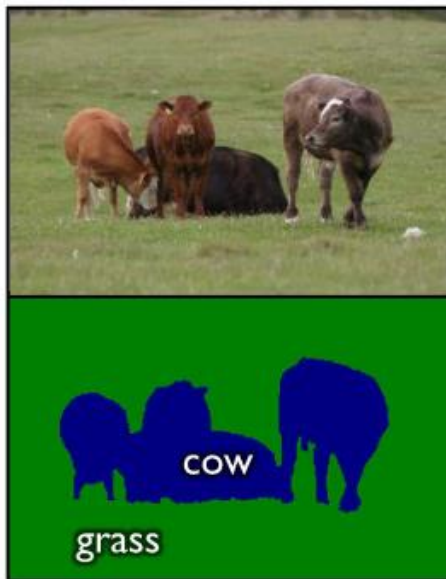
(a) Standard Neural Net



(b) After applying dropout.

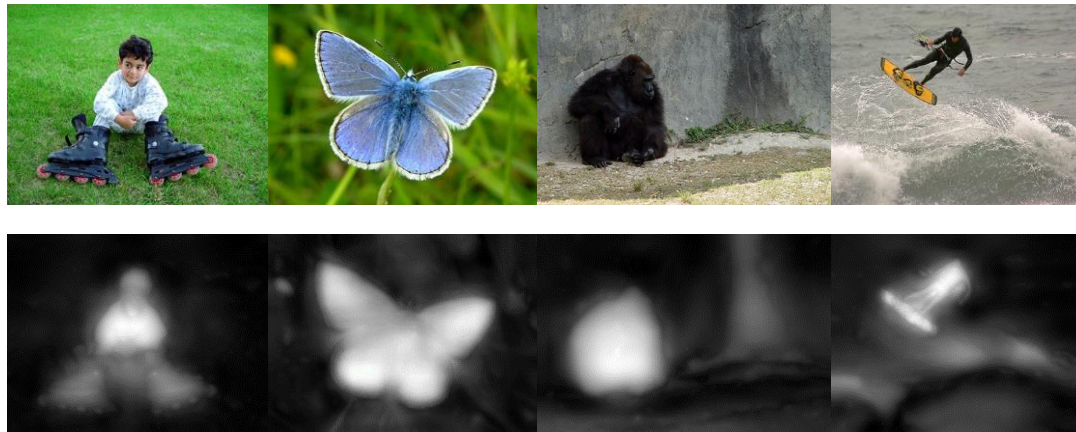
Overview Lecture

- Introduction: What is Cognitive Computer Vision? (today)
- The Human Visual System
- Receptive Fields and Digital Filters
- More on Convolutional Neural Networks
- **Semantic Segmentation**



Overview Lecture

- Introduction: What is Cognitive Computer Vision? (today)
- The Human Visual System
- Receptive Fields and Digital Filters
- More on Convolutional Neural Networks
- Semantic Segmentation
- **Visual Attention and Saliency**

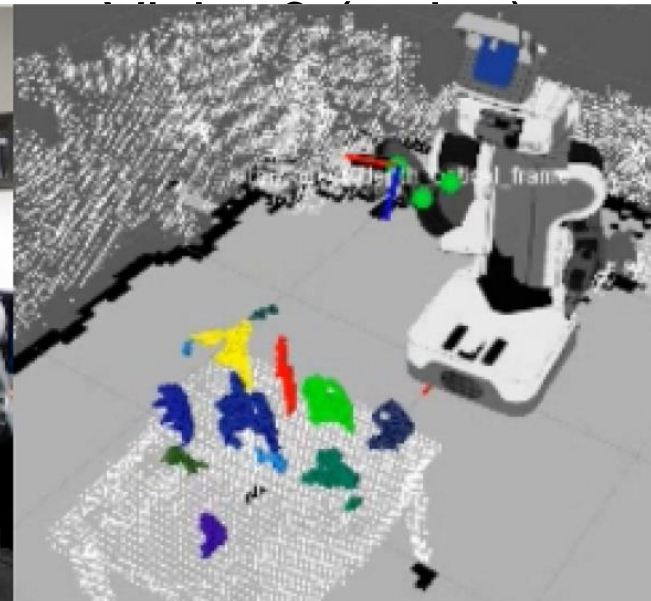


Overview Lecture

- Introduction: What is Cognitive Computer Vision? (today)
- The Human Visual System
- Receptive Fields and Digital Filters
- More on Convolutional Neural Networks
- Semantic Segmentation
- Visual Attention and Saliency
- **Visual Search for Objects**



Overview Lecture



- **Active Camera Control/Sensor Management**

Overview Lecture

-
-
-
-
-
-
-
-



on? (today)



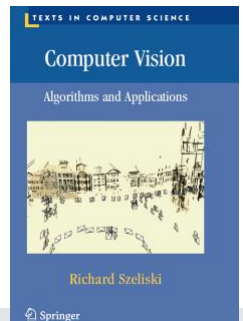
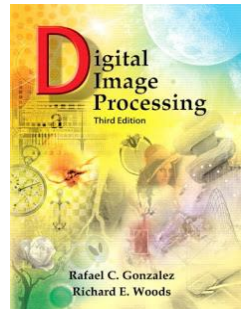
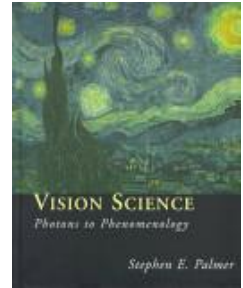
- **Object Discovery/Object Proposal Detection**

Overview Lecture

- Introduction: What is Cognitive Computer Vision? (today)
- The Human Visual System
- Receptive Fields and Digital Filters
- More on Convolutional Neural Networks
- Semantic Segmentation
- Visual Attention and Saliency
- Visual Search for Objects
- Active Camera Control/Sensor Management
- Object Discovery/Object Proposal Detection

Literature

- There is no single textbook, we base mainly on papers
- Reasonable is one book on human vision, e.g.:
 - Human Vision: Stephen E. Palmer:
Vision Science: Photons to Phenomenology, MIT Press 1999
 - Or online: The brain from top to bottom – An interactive website about the human brain and behaviour: <http://thebrain.mcgill.ca>
- And one book on Computer Vision, e.g.:
 - Rafael C. Gonzalez and Richard E. Woods: Digital Image Processing, Addison-Wesley Publishing Company, 1992, 3rd edition: 2007. or:
 - Computer Vision: Algorithms and Applications, Richard Szeliski, Microsoft Research, 2010 (also online: szeliski.org/Book)
- Literature is mentioned at the end of each slide set:
 - **Primary literature:** directly related. Read to prepare for exam.
 - **Secondary literature:** references and additional reading



Research oriented course

- The course is strongly research oriented
- Topics are close to research in „computer vision“ group
- Enables best preparation for master project, independent study, master thesis, etc.

Who are you?

Questionnaire