



Learning from Images

Introduction

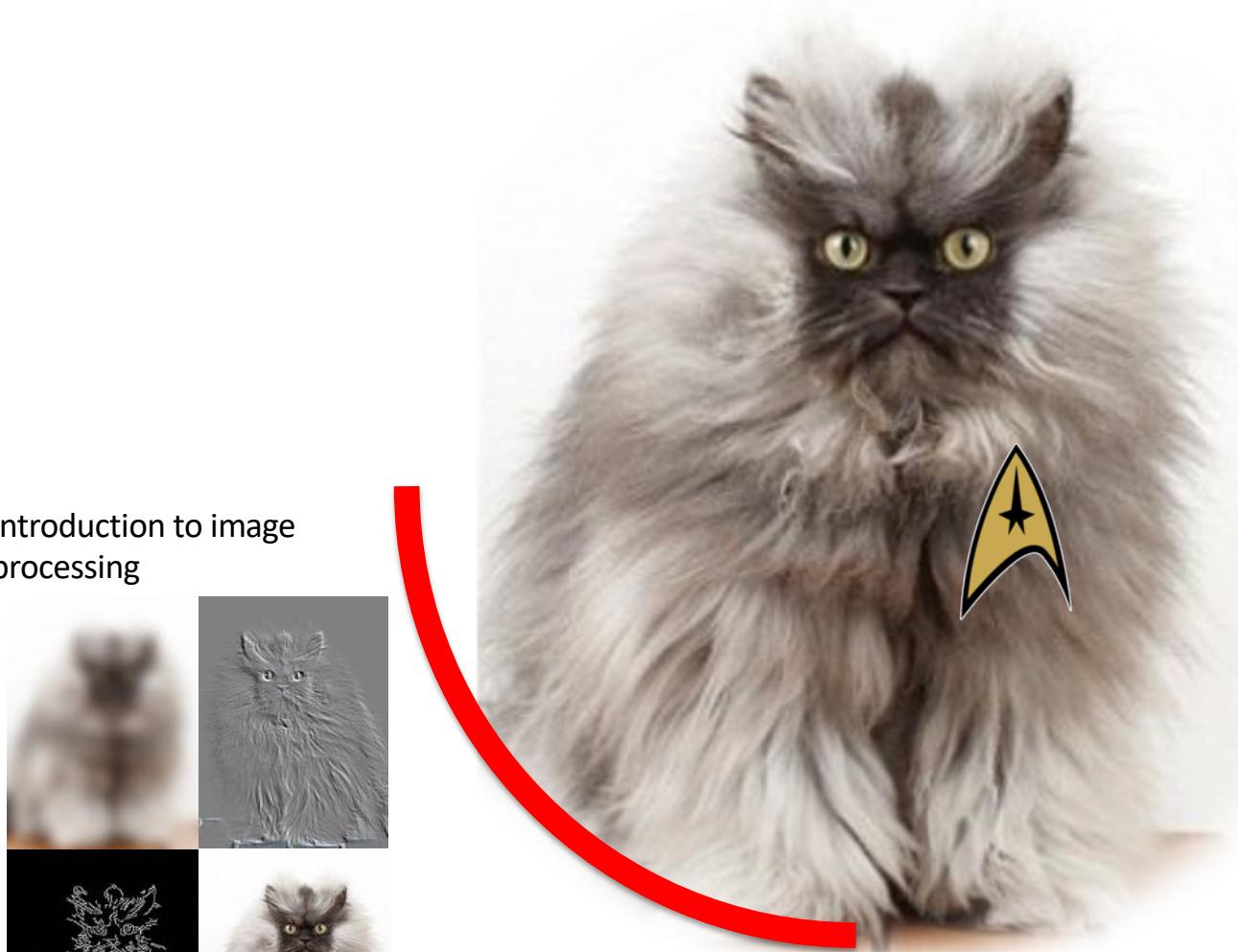
Master DataScience
Winter term 2019/20

Prof. Dr. Kristian Hildebrand
khildebrand@beuth-hochschule.de



https://en.wikipedia.org/wiki/Colonel_Meow

Introduction to image processing



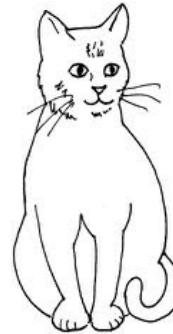


Image features and
Image retrieval

Introduction to image
processing

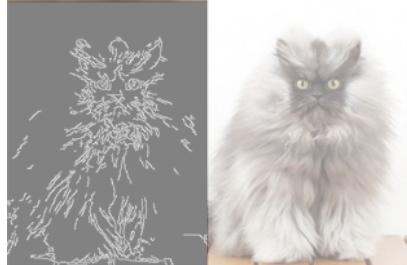




Image retrieval

Introduction to image processing

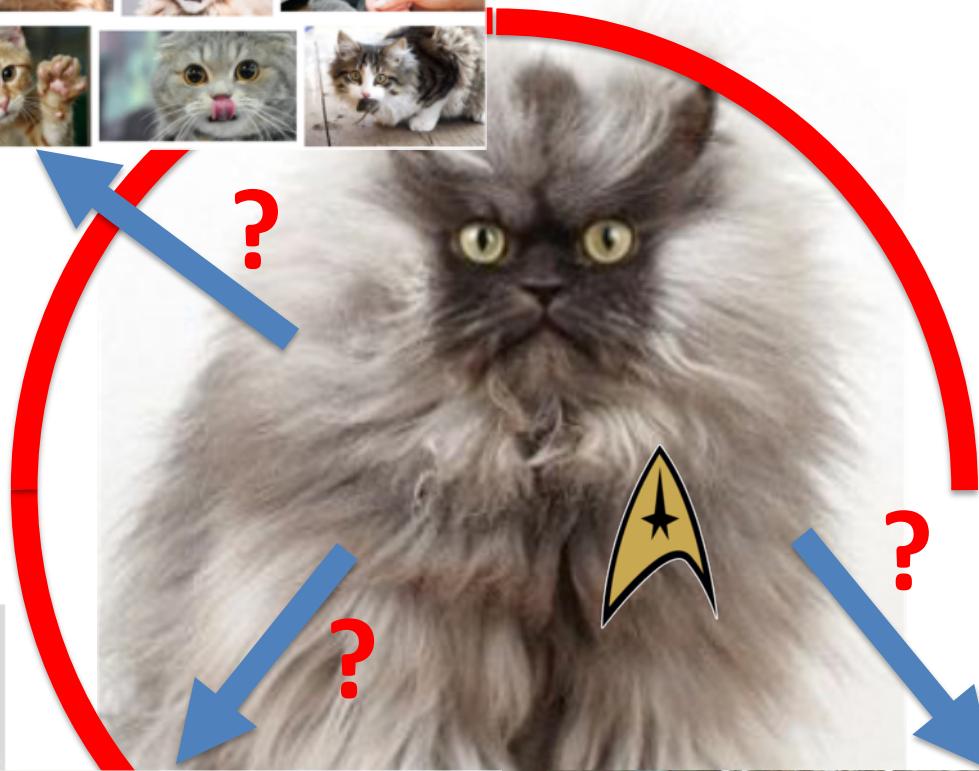


Image classification and
object detection
(SVM, CNN, YOLO)



Image features and
Image retrieval



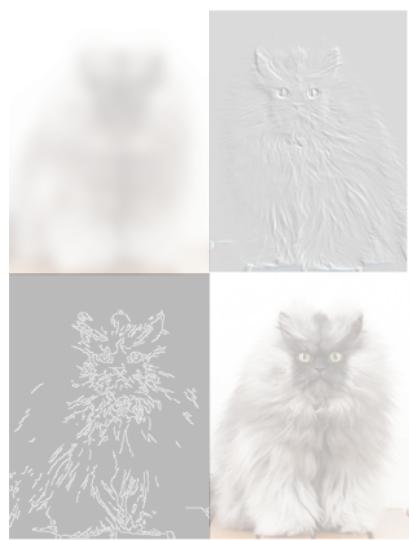
Image classification and
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(SVM, CNN, YOLO)

Introduction to image
processing





Image features and
Image retrieval



Introduction to image
processing

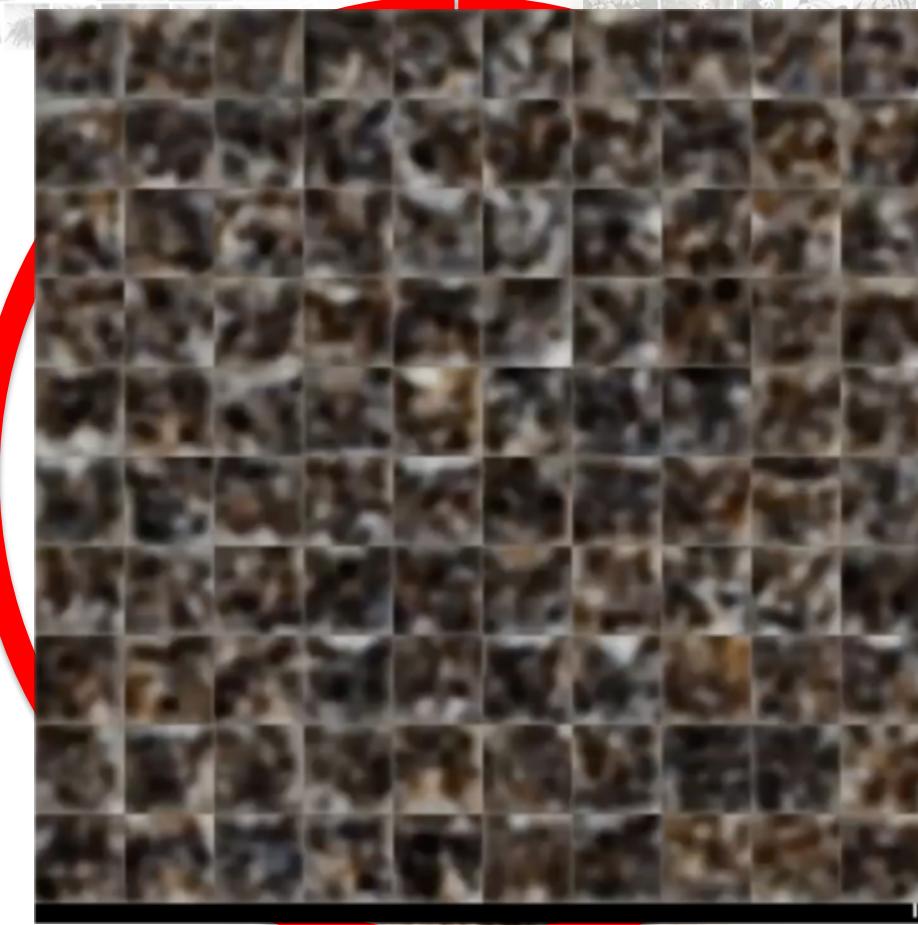


Image classification and
object detection
(SVM, CNN, YOLO)

Generative Adversarial
Networks

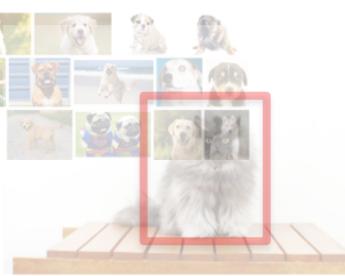


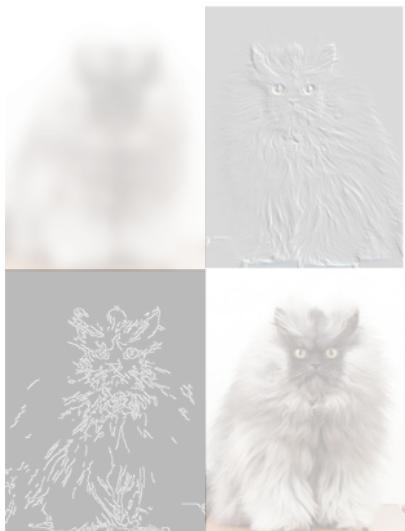


Image features and
Image retrieval

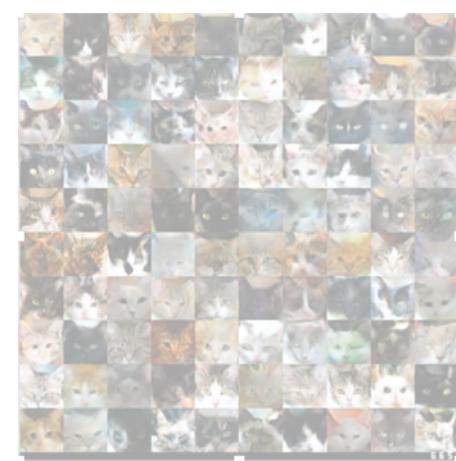


Image classification and
object detection
(SVM, CNN, YOLO)

Introduction to image
processing



Deep Reinforcement Learning



Generative Adversarial
Networks



Image features and
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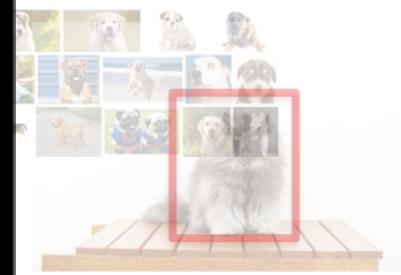
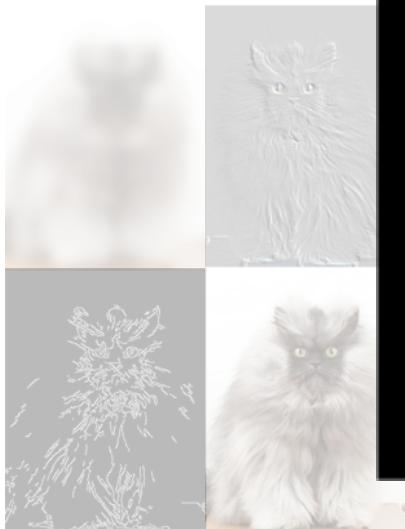


Image classification and
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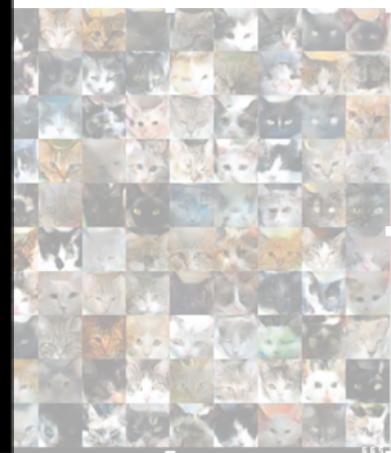
After 120 minutes of training

It plays like an expert!

Introduction to image
processing



Generative Adversarial
networks



Deep Reinforcement Learning

It's not data science



Image features and
Image retrieval

Introduction to image
processing



Deep Reinforcement Learning



?

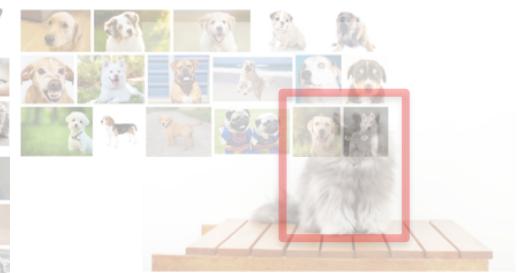


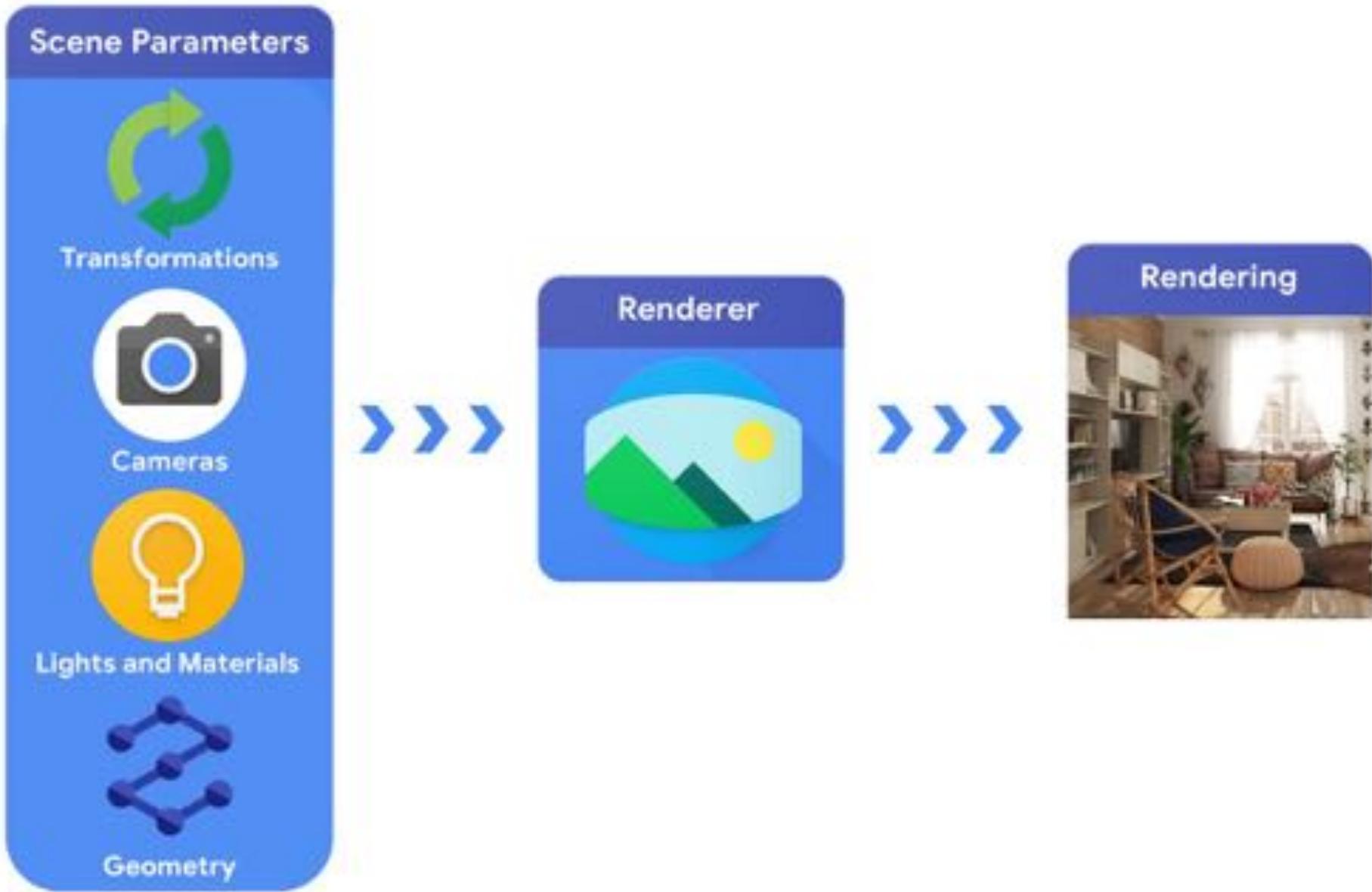
Image classification and
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(SVM, CNN, YOLO)

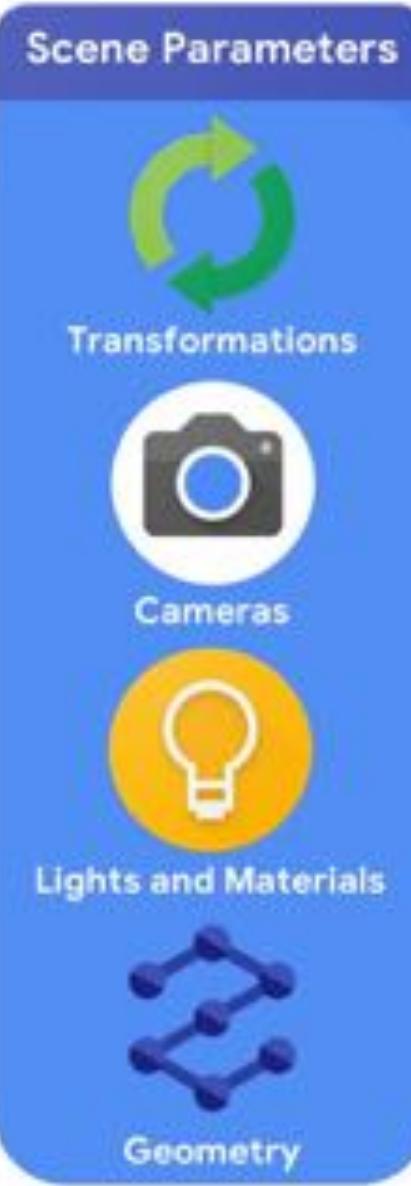
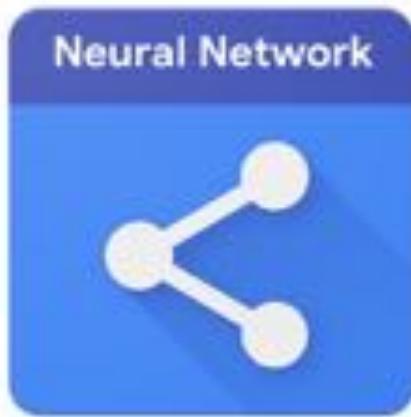
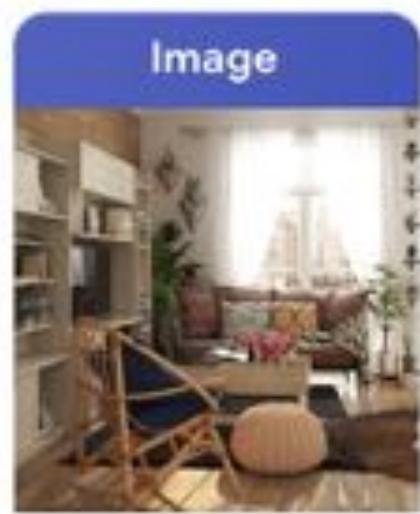
Generative Adversarial
Networks



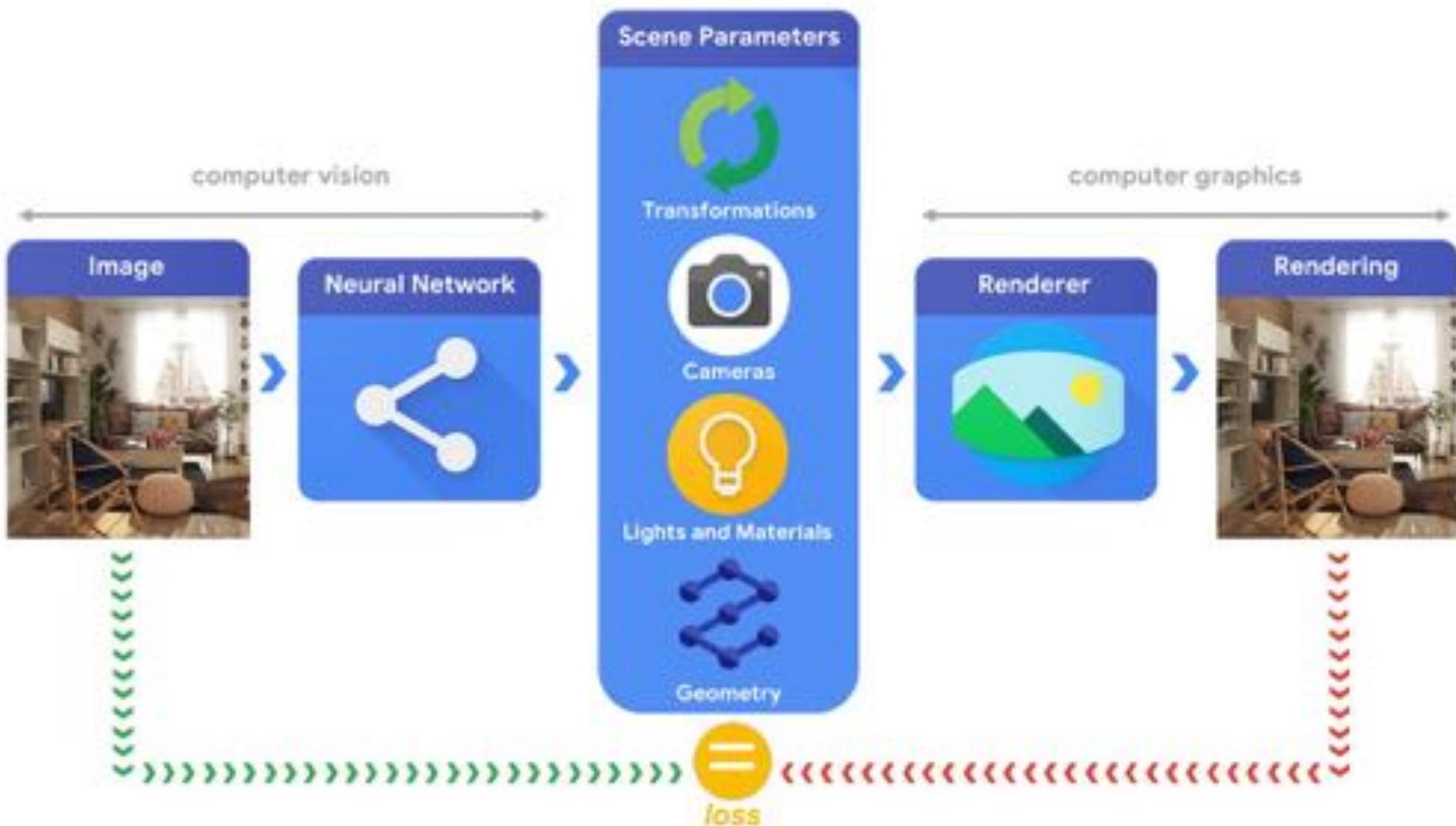
It's ~~cat~~ science

Why Computer Vision topics in
Data Science curriculum?

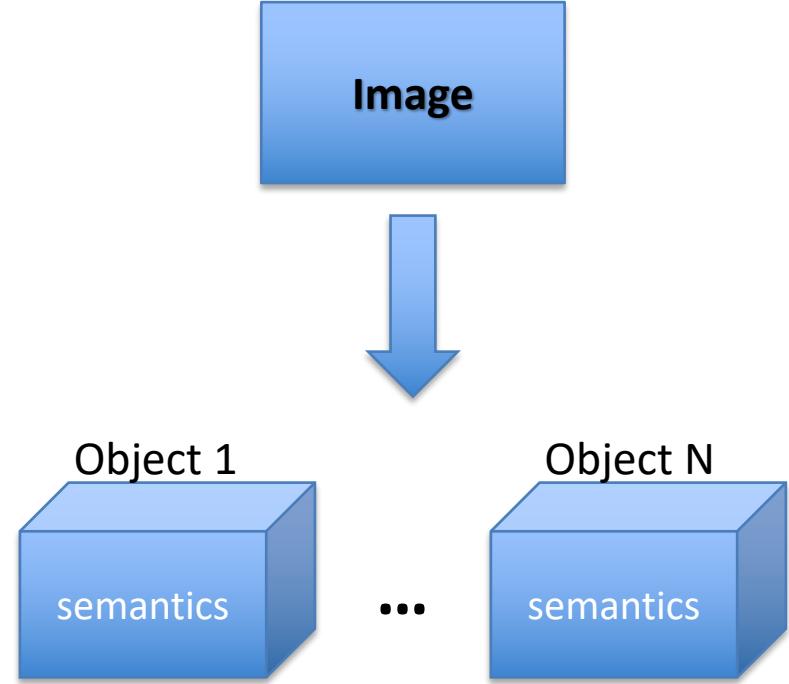
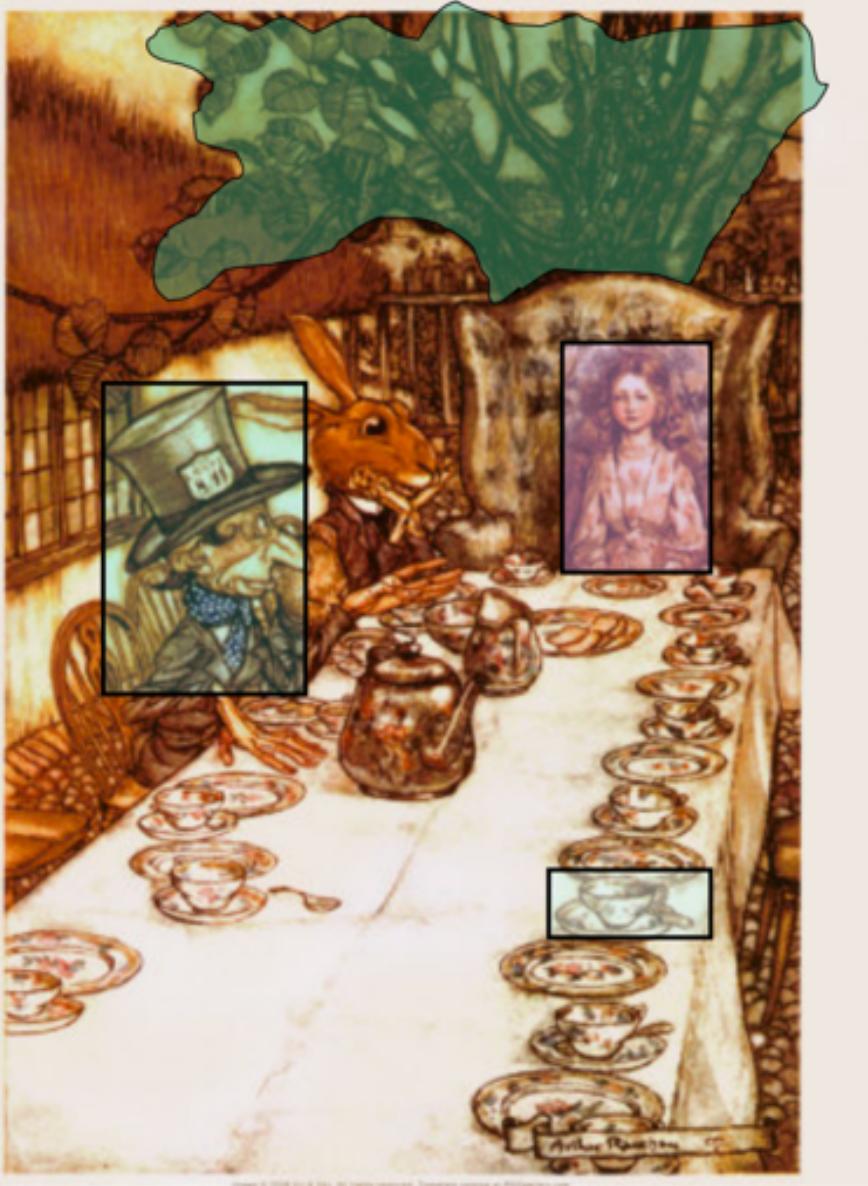




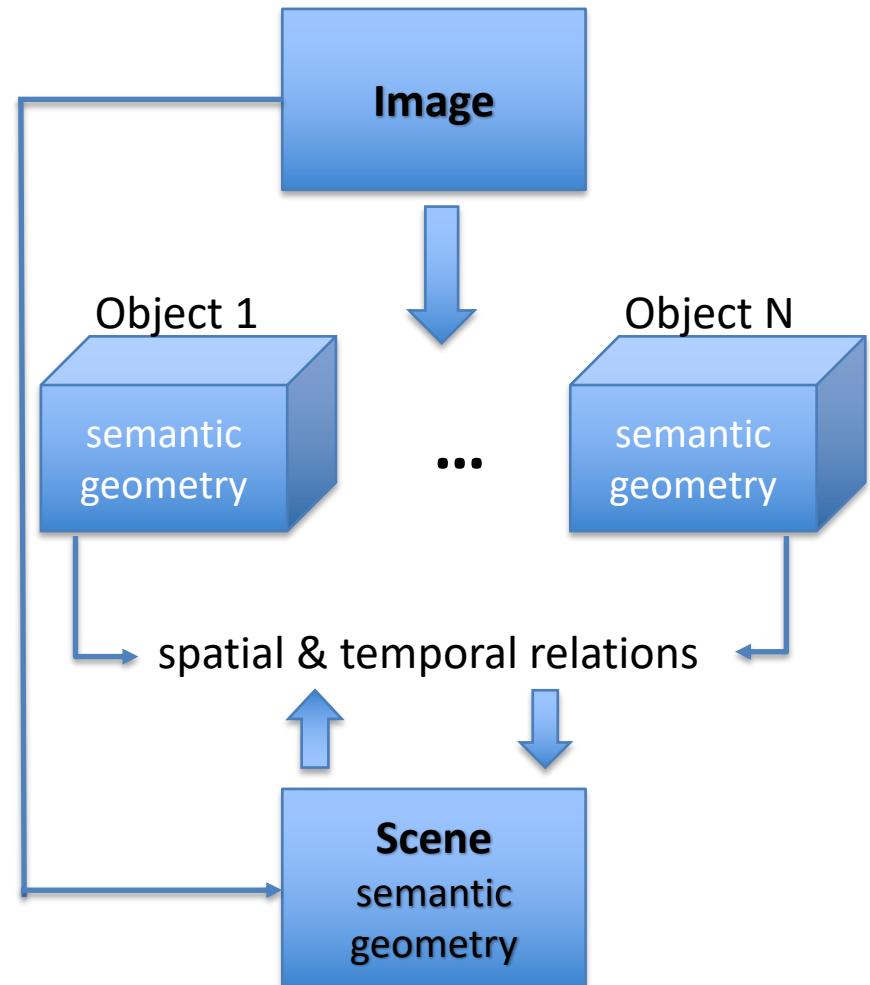
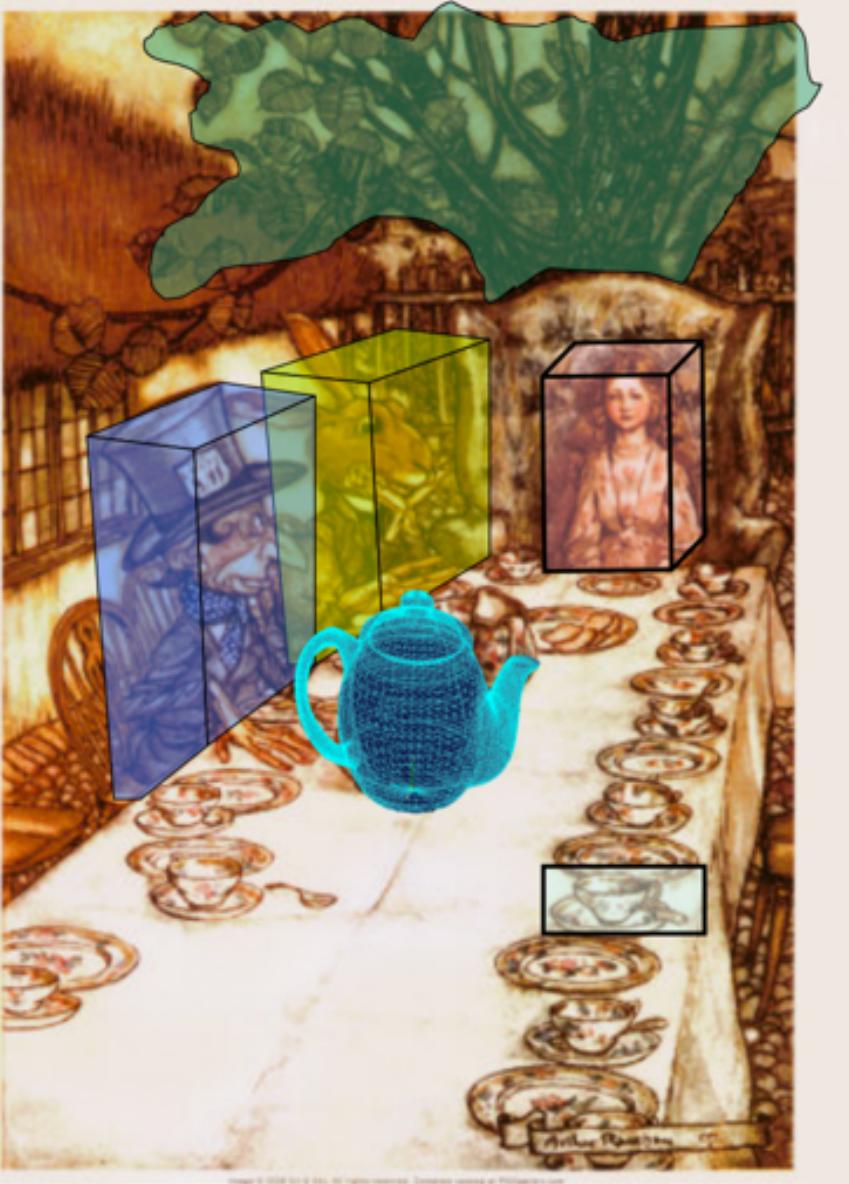
Goal of Computer Vision



Goal of Computer Vision



Goal of Computer Vision



Computer Vision Pipeline



- Information extraction:
 - features, 3D structure, motion flows etc.
- Interpretation:
 - recognize objects, scenes, events etc.

Computer Vision and Applications



<http://web.stanford.edu/class/cs231a>

Computer Vision and Applications

- Fingerprint Biometrics



- Augmentation with 3D Graphics



2d3
sensing

- 3D Object prototyping

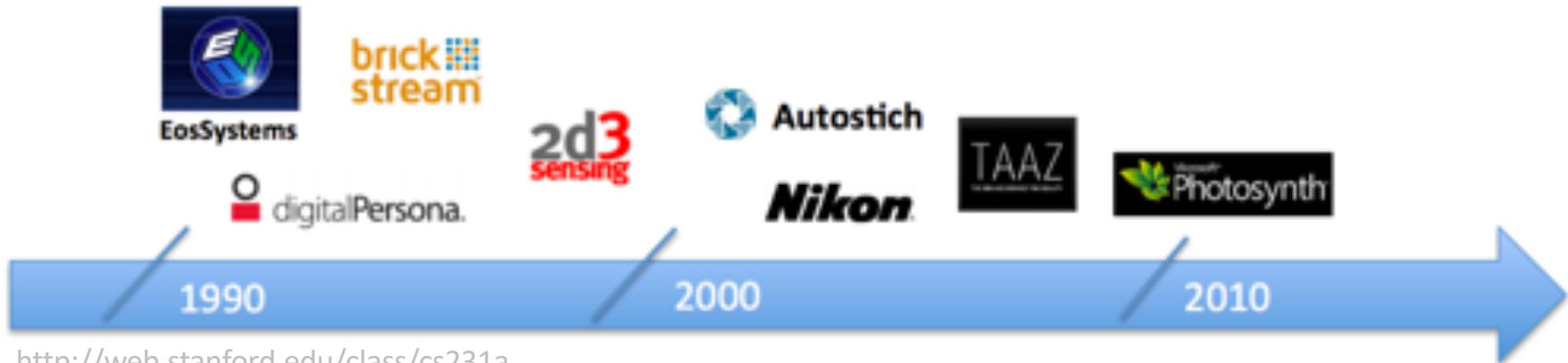



EosSystems

Photomodeler

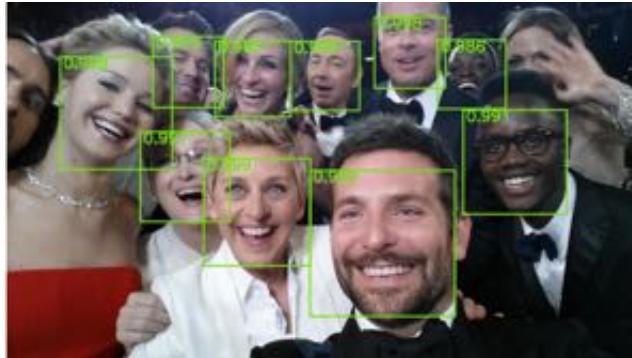
Computer Vision and Applications

- New features detector/descriptors
- CV leverages machine learning



Computer Vision and Applications

- Face detection

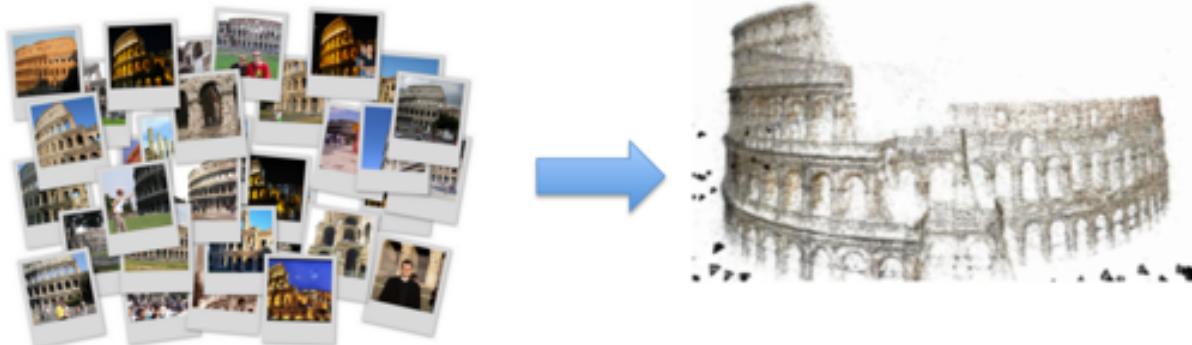


© <http://www.ukprogressive.co.uk/>

- Panoramic Photography



- 3D modeling of landmarks



Computer Vision and Applications

- Efficient SLAM/SFM
- Large scale image repositories
- Deep learning
- Better clouds
- More bandwidth
- Increase computational power

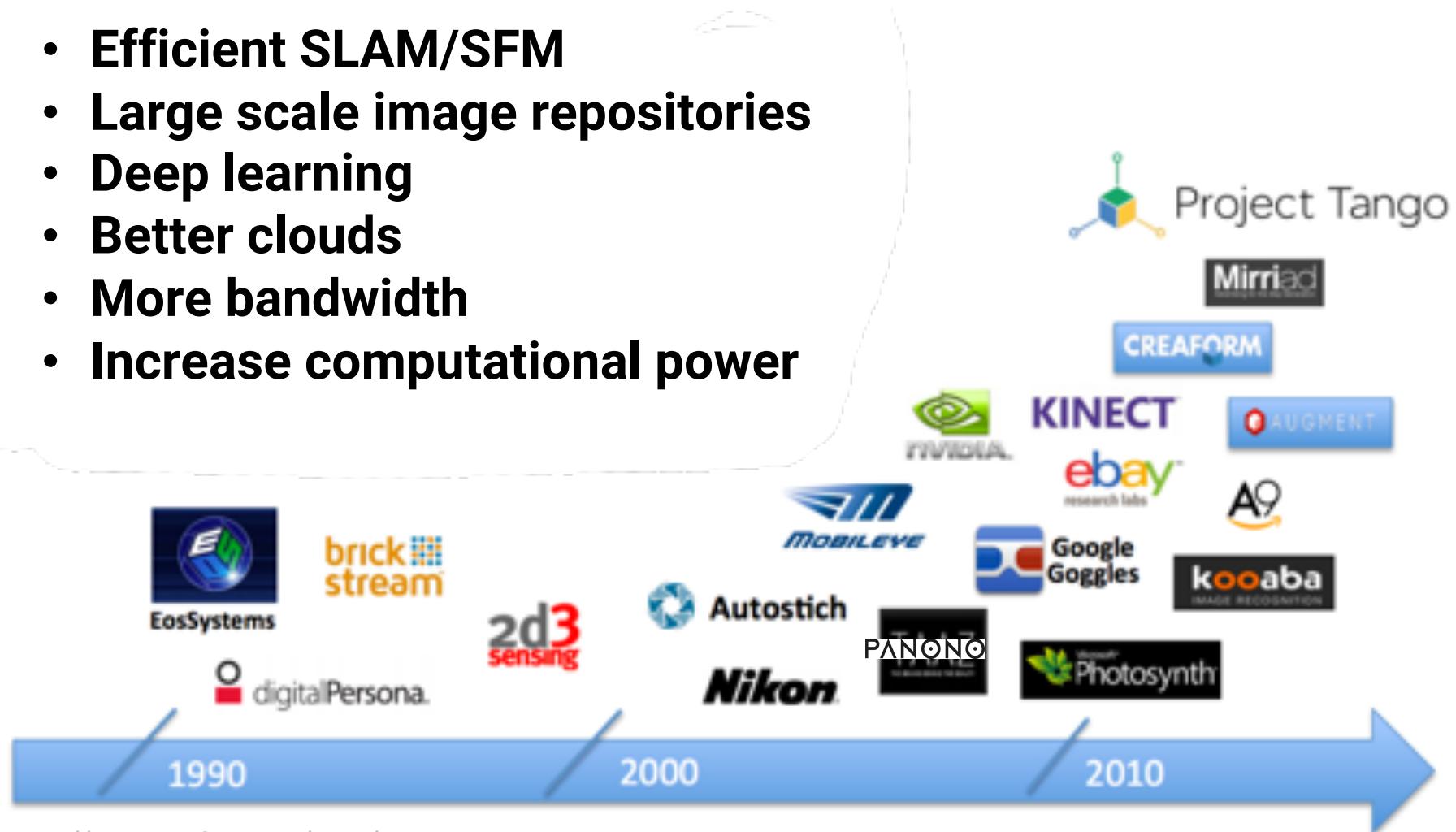


Image search engines

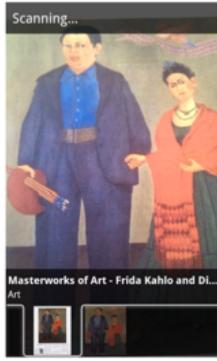


Computer Vision and Applications

- Visual search and landmarks recognition



Google Goggles



kooaba
IMAGE RECOGNITION



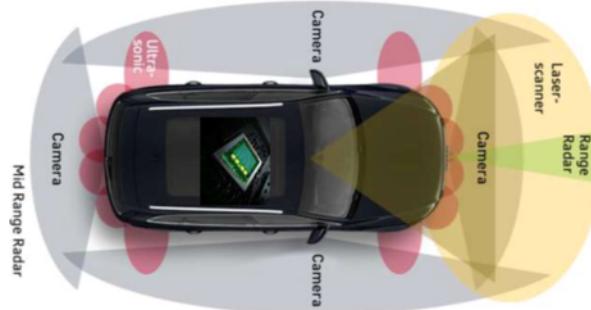
A9

- Augmented reality



Computer Vision and Applications

- Motion sensing and gesture recognition

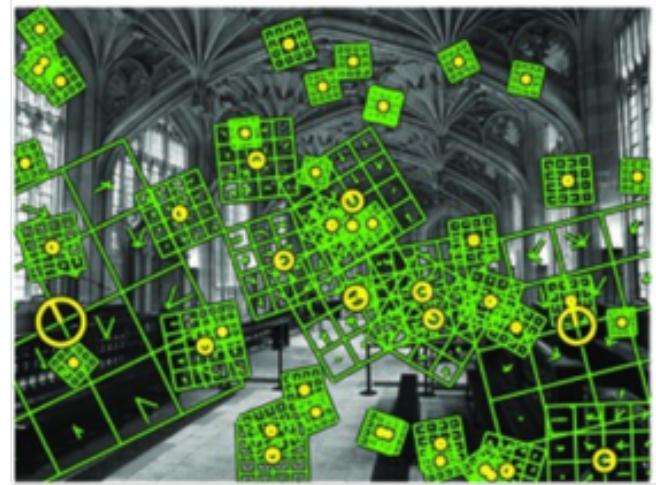
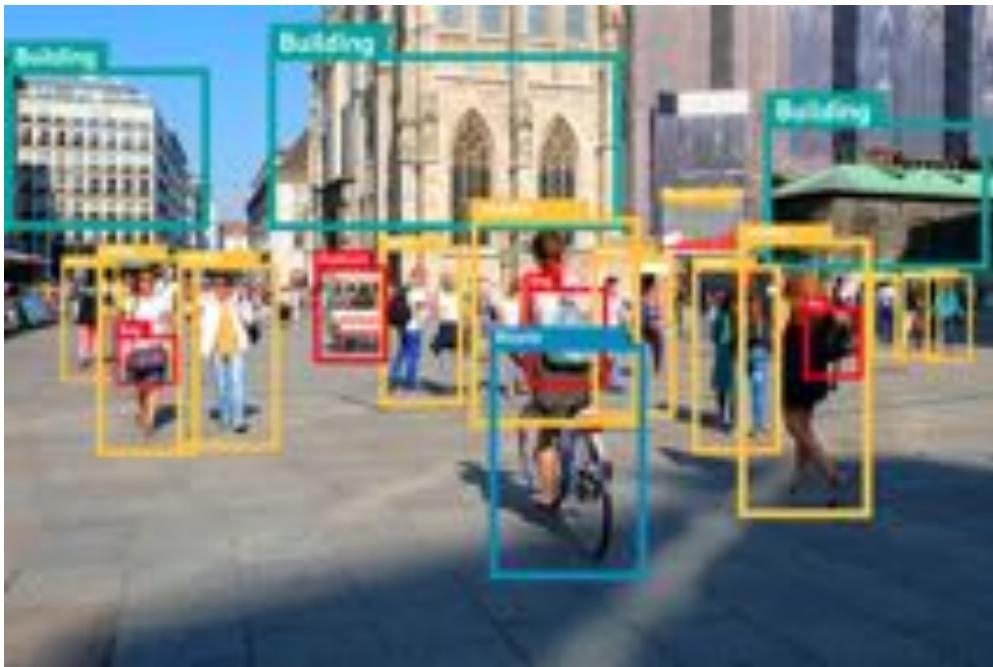
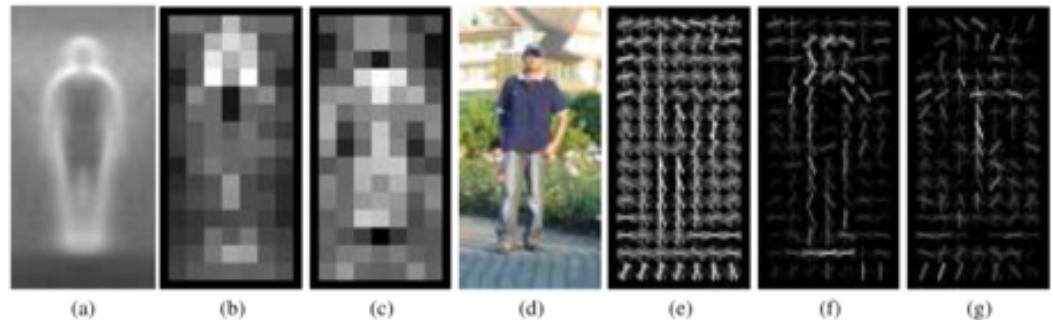
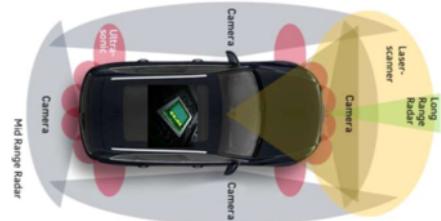


- Autonomous Driving



- Personal robotics

What I'd like you to learn here?



Computer Vision topics

Have fun coding a cool project demo!

Optional: Reading scientific papers (parallel to the lecture material)

“You can’t teach people everything they
need to know...

The best you can do is to position them
where they can find what they need to
know when they need to know it.”

Seymour Papert, MIT, Lego Mindstorms Erfinder

Syllabus

Date	Lecture topic	Assignment due date
10.10.19	Introduction / Quiz	
17.10.19	A shortcut through image processing	
24.10.19	Features and Feature Matching	
31.10.19	Image retrieval	Assignment 1
07.11.19	Image classification Features + SVM	
14.11.19	Neural Network Recap	Assignment 2
21.11.19	ConvNets, ConvNet Architectures	
28.11.19	Object recognition (YOLO, MobileNet)	
05.12.19	Auto-encoder and embeddings	Assignment 3
12.12.19	Generative Adversarial Networks	
20.12.19	Project idea presentation	
09.01.20	Generative Model Architectures	Assignment 4
16.01.20	Reinforcement learning on Images	
23.01.20	Recent research development in CV	
31.01.20	Project presentation	
12.02.20	Documentation due	

About me

Contact and Information

- Kristian Hildebrand
 - Computer Graphics and Interactive Systems
- Email
 - khildebrand@beuth-hochschule.de
- Website
 - <http://hildebrand.beuth-hochschule.de>
 - Course material + news via **Moodle**
- Room
 - B332
- Office
 - Haus Gauß, Room B218
 - Consultation hours as needed
 - Available on DSM-Students Slack-Workspace

Kristian Hildebrand

- Since 10/2015 Professor Graphics and Interactive Systems
 Beuth University for Applied Science
- 2014 – 2015 Principal Research Engineer, DISDAR GmbH, Berlin
- 2008 – 2013 Research Assistant, TU Berlin
- 2012 Disney Research, Visiting Researcher, Zürich
- 2006 – 2008 Software developer, art+com AG, Berlin
- 1999 – 2005 Diploma, Max-Planck-Institut Informatik,
 Saarbrücken
 Computer Science, UBC, Vancouver
 Mediensystems, Bauhaus University Weimar

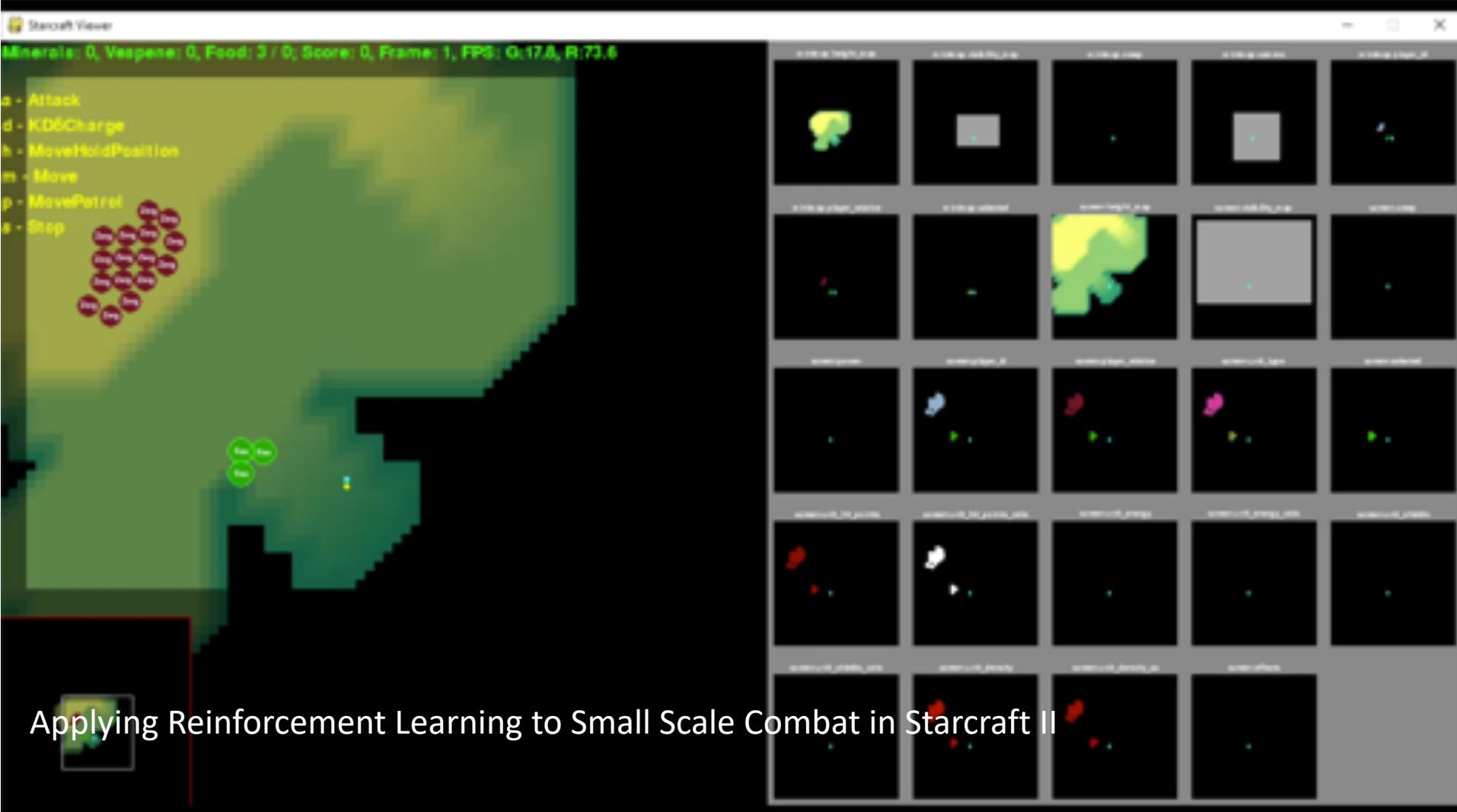


Draw me Something

and I'll tell you, what i think it is!

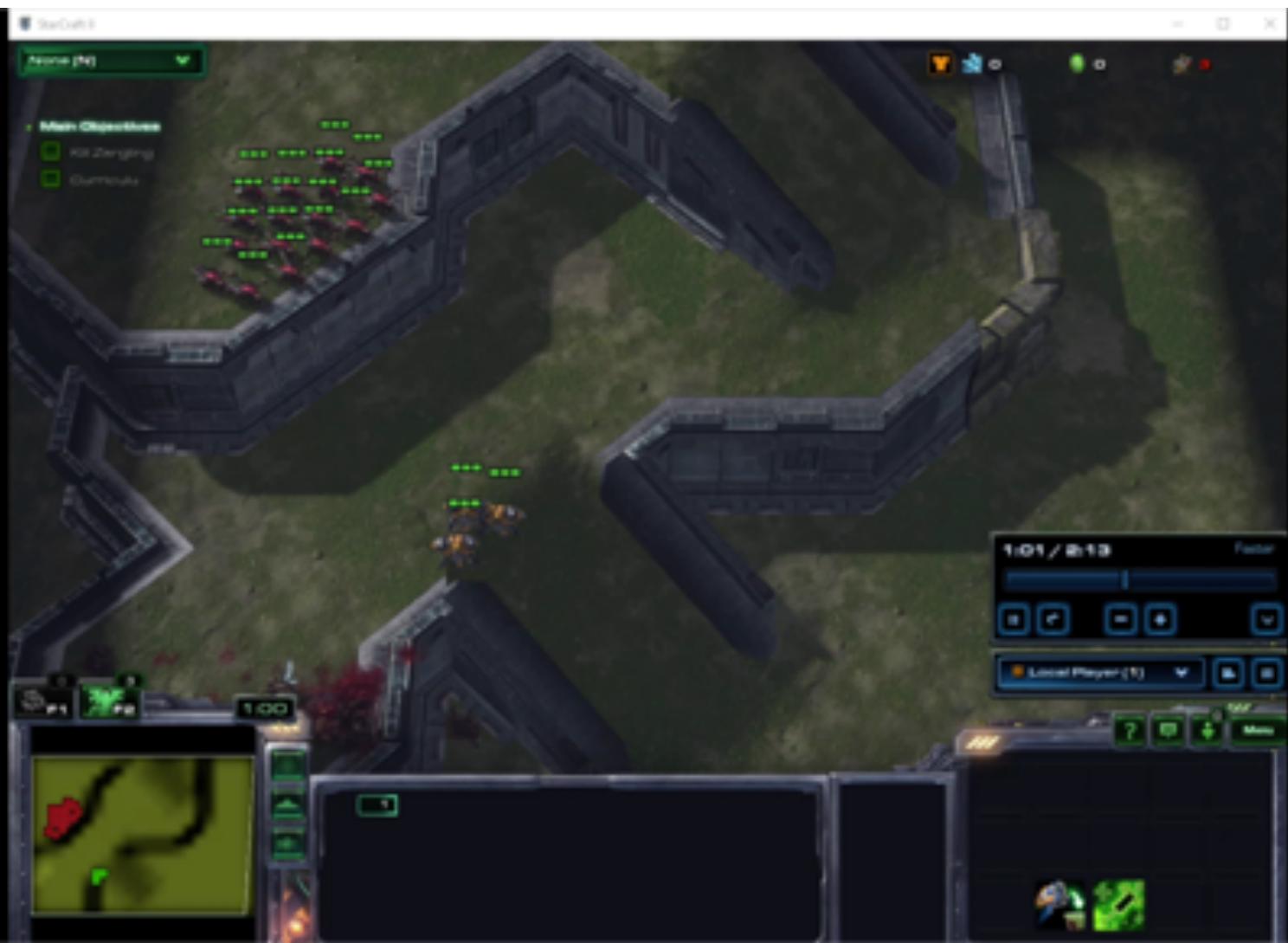


[Start again!](#)

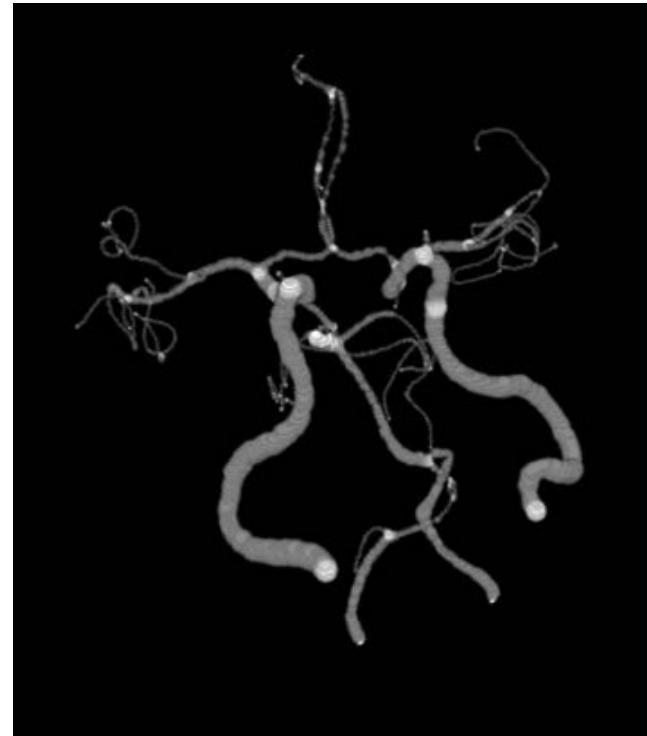
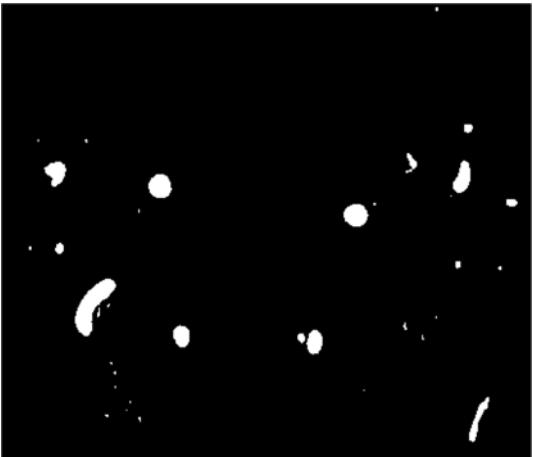
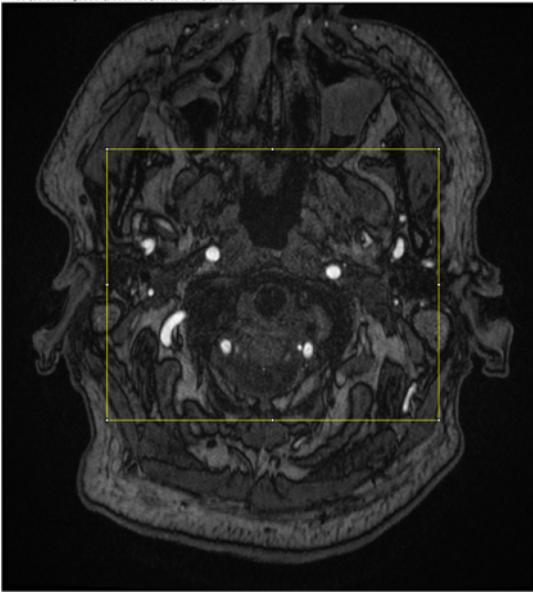


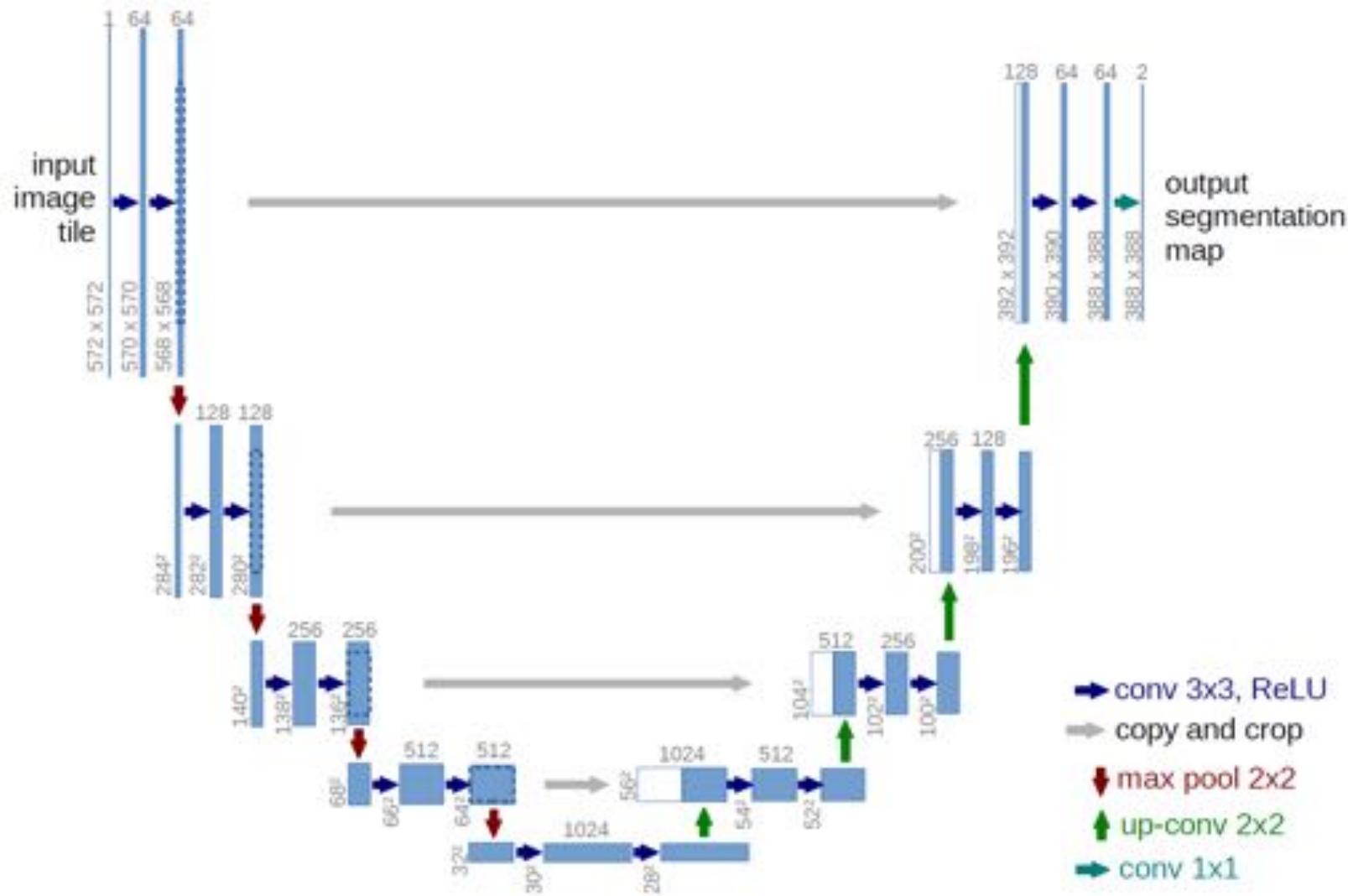
Applying Reinforcement Learning to Small Scale Combat in Starcraft II





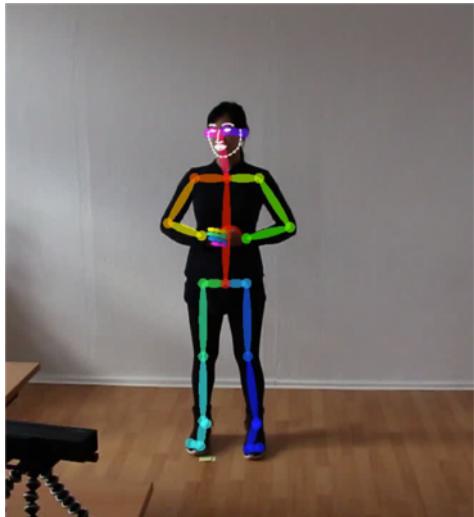
1/166 (ser005mg0001), 696x768 pixels; 16-bit, 169MB





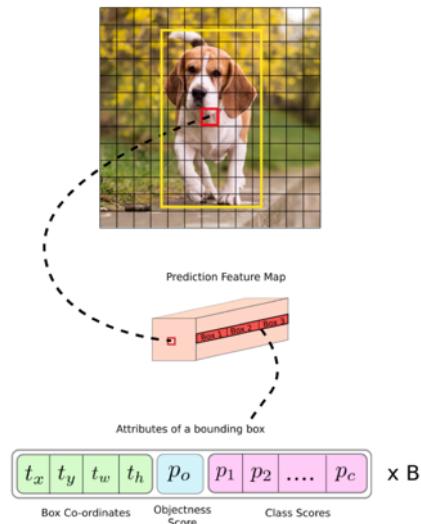
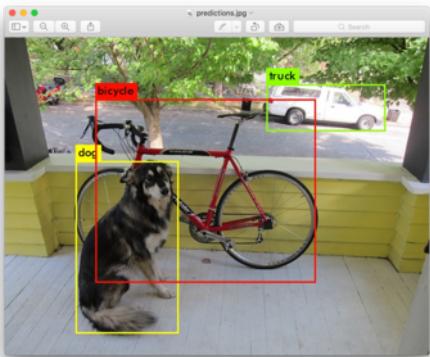
VITALAB

MOBILE



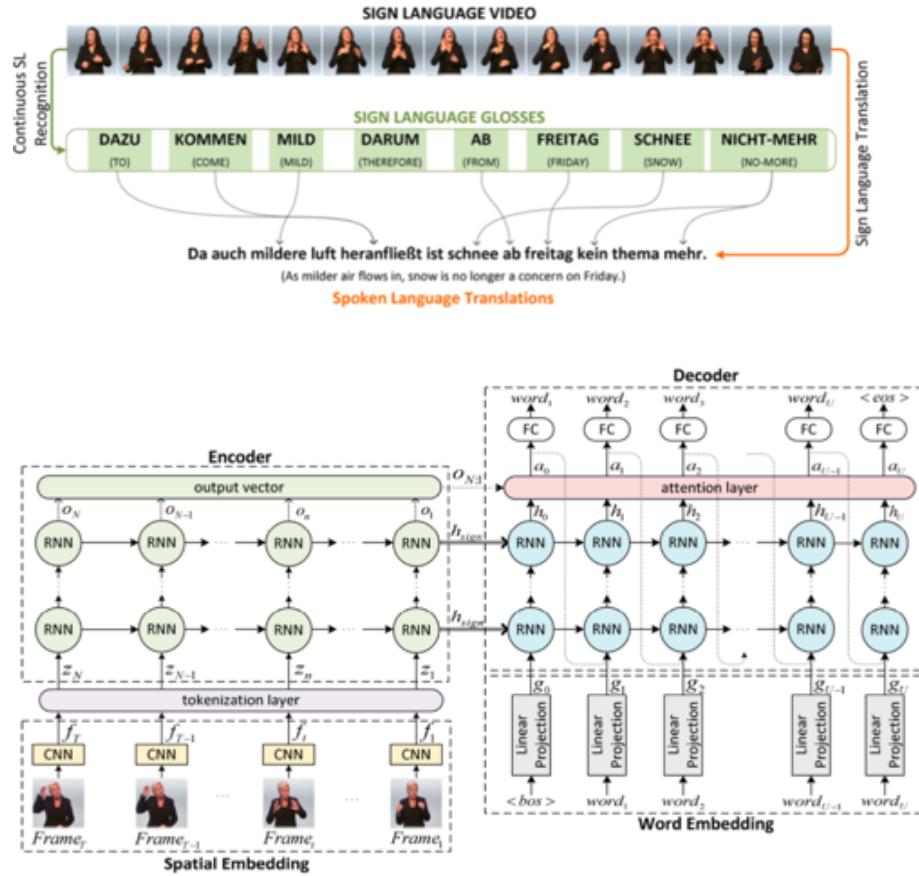
Navigation for visually impaired based on object recognition and actuators

- Real-time object detection
 - Using CNNs
- Vibrotactile Feedback
- Runs on mobile devices



Sign Language Translation

- Translation from video to text
 - Frame-by-frame camera input
 - Sentence as output
- Encoder-decoder architecture with attention
 - CNNs & spatial embeddings as input for encoder
 - Word embeddings as input for decoder



About you

Organization Facts

Facts

- 4 Assignments: **done alone**
- Course Project: done in groups (2-4 people)
- Frameworks: Python + Numpy, scikit-learn, opencv, pytorch
- GPU resources will be needed
 - Who has, who needs?
- **Please bring your laptop**

Rules I

- **There are no stupid questions! Ask – It is not always a receiver problem!** ☺
 - **Attendance mandatory for Part 1** , I'll keep a list
 - **Grading**
 - Exercises: 60%
 - Project (implementation): 40% ← **Why?**
 - Project Presentation / Evaluation / Documentation (pdf) (33% of project grade)
- ← **Why?**
Get familiar with evaluating your work!

Rules II

- Reuse existing resources, but
 - **Must give references**
 - Example: you may use illustrations in your talk taken from other slides, but add a note such as [image: taken from Alexa et al.]
 - For the assignments and your projects rather complete implementations are available on the web – **use them for inspiration, do not copy!**
 - **If in doubt, ask me**
- **Two days before presentation – send me your slides!**

Important information

- Assignments due in time
- Assignments need to run out of the box
 - Don't copy paste code (communicate but implement alone)
- Advice for data path

```
Assignments/
├── lfi-01/
│   ├── your_code.py
│   └── your_code2.py
├── lfi-02/
│   └── your_code.py
├── lfi-03/
│   └── your_code.py
└── lfi-04/
    ├── your_code.py
    └── your_code2.py
Data/
# please refer to your data dir in a relative path
.../..../Data/lfi-01/...
```

Possible to use colab

QUIZ

- Who had image processing in bachelor program?
- What is an image?
- Pixel? Voxel?
- Feature / SIFT / Corner detectors?
- Convolution

QUIZ

- Linear algebra
 - Transformation
 - PCA / SVD?
- Machine Learning
 - SVM?
 - K-means? Kd-Tree
 - Implemented your own basic neural network from scratch?
 - ConvNet / Auto-Encoder / GAN?

Questions?