Learning from Image

Master DataScience

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BHT
Berliner Hochschule für Technik

Studiere Zukunft

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

Introduction to image processing

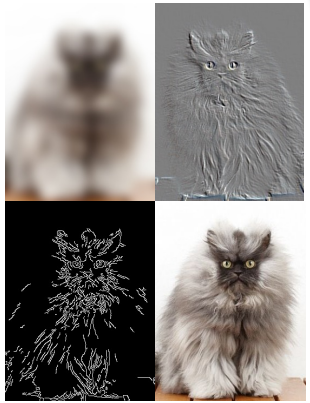

Image features and
Image retrieval

Introduction to image processing

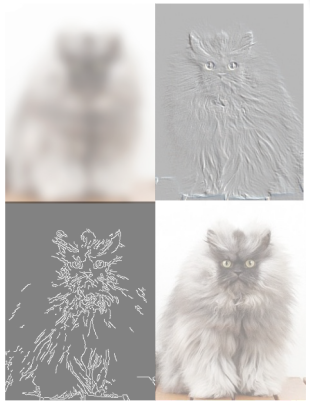

Image retrival

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

?

?

?

Introduction to image processing

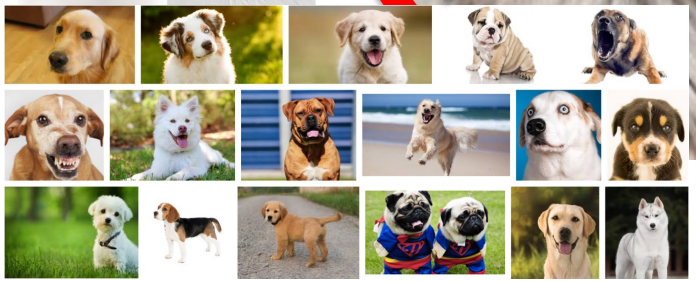

Image features and
Image retrival

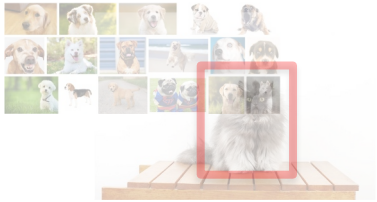

Image classification and
object detection
(SVM, CNN, YOLO)

Introduction to image
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Image features and
Image retrival

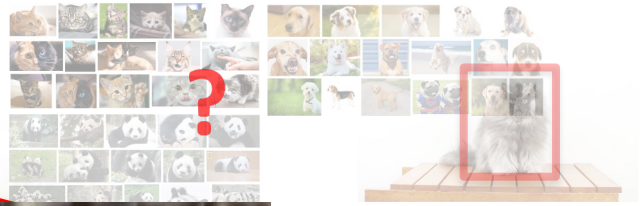

Image classification and
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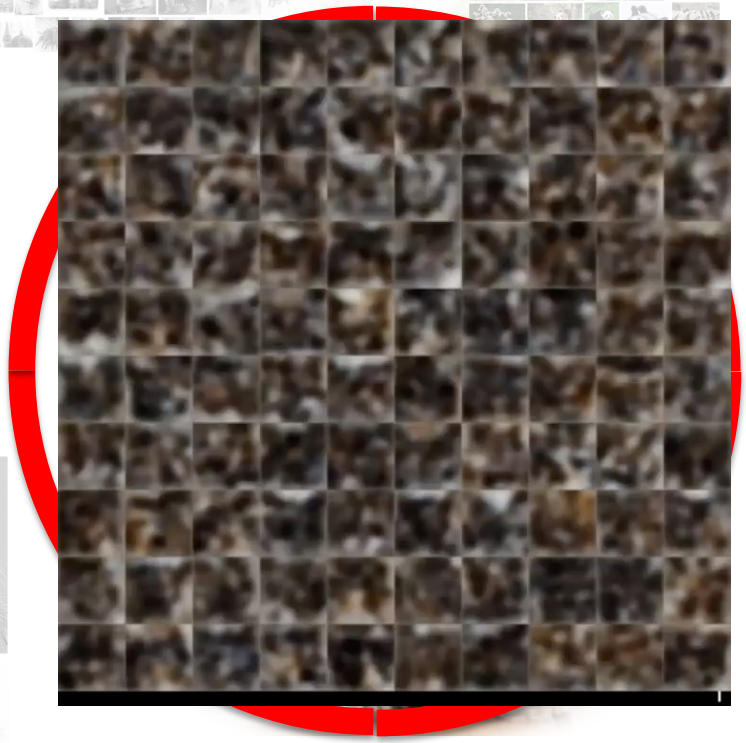


Introduction to image
processing

Generative Adversarial
Networks

Image features and
Image retrival

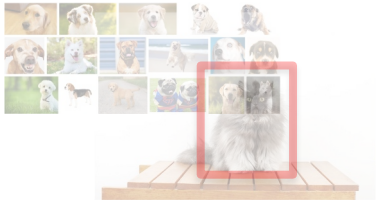


Image classification and
object detection
(SVM, CNN, YOLO)

Introduction to image
processing

Generative Adversarial
Networks

Deep Reinforcement Learning

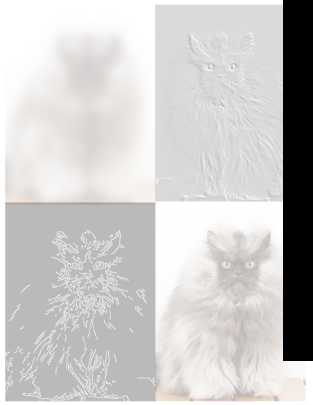
Image features and
Image retrival

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

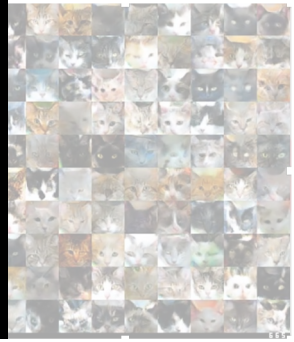
After 120 minutes of training

It plays like an expert!

Introduction to image
processing



Generative Adversarial
Networks



Deep Reinforcement Learning

It’s not data science

Image features and
Image retrival

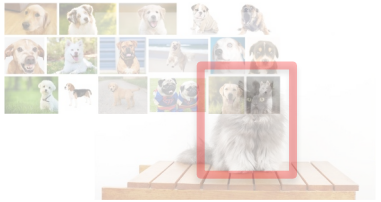


Image classification and
object detection
(SVM, CNN, YOLO)

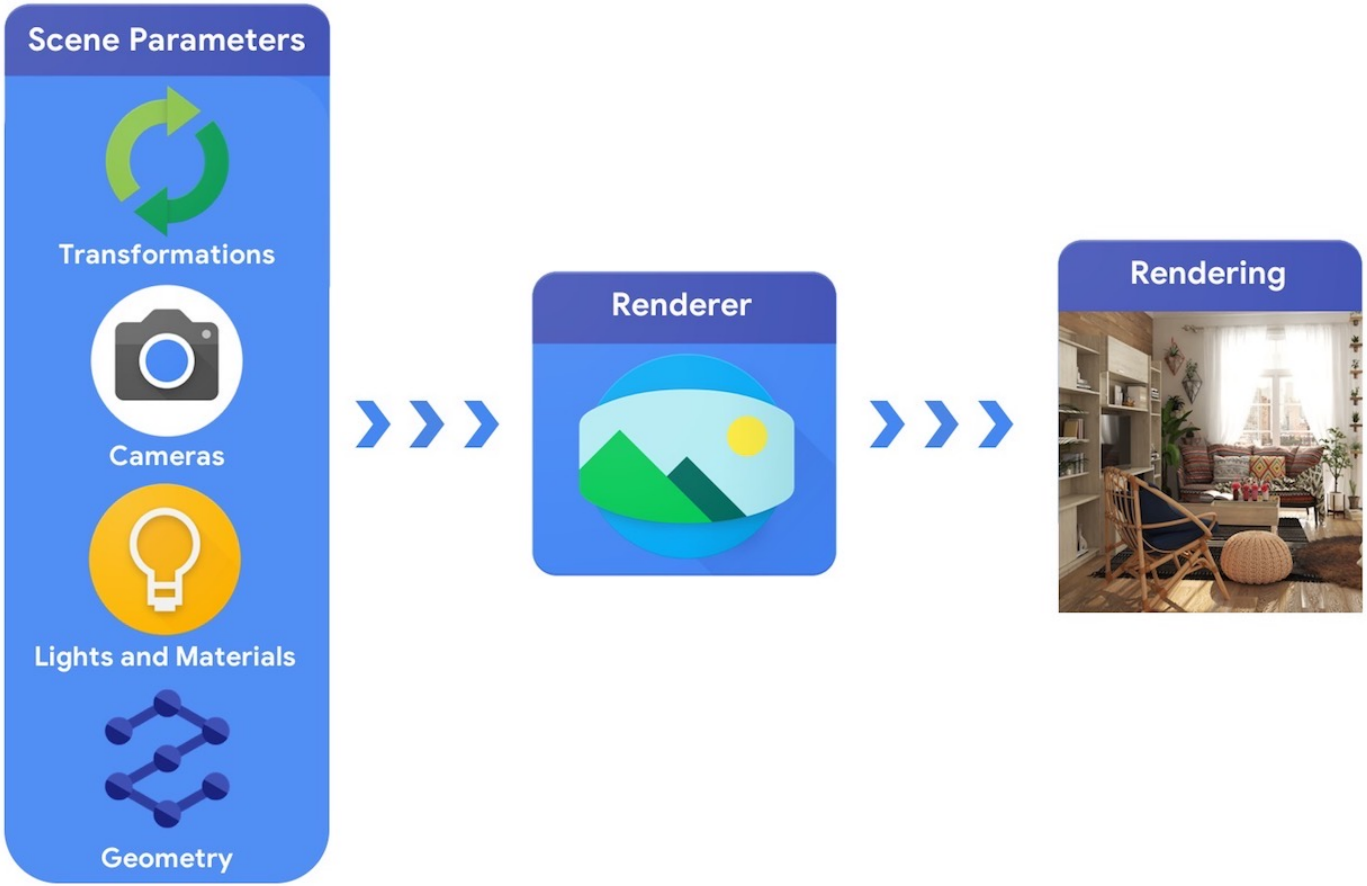
Introduction to image
processing

Generative Adversarial
Networks

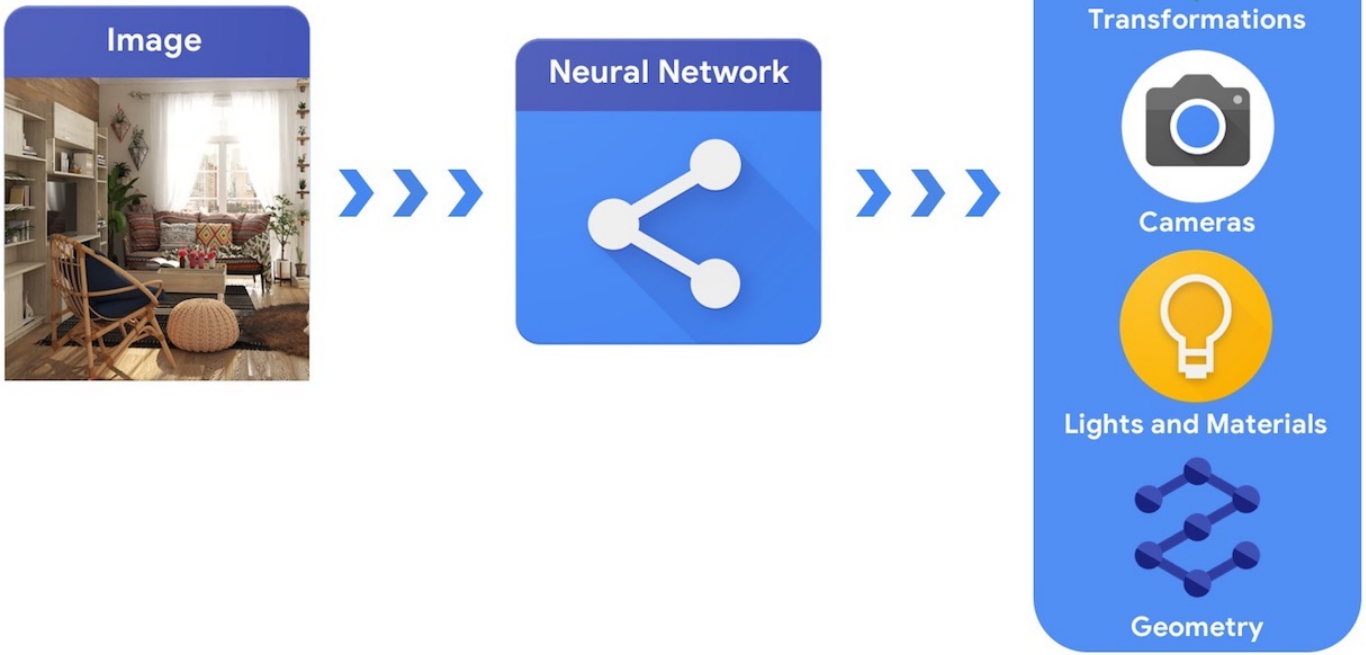
Deep Reinforcement Learning

image
It’s ~~cat~~ science

Why Computer Vision topics in Data Science curriculum?

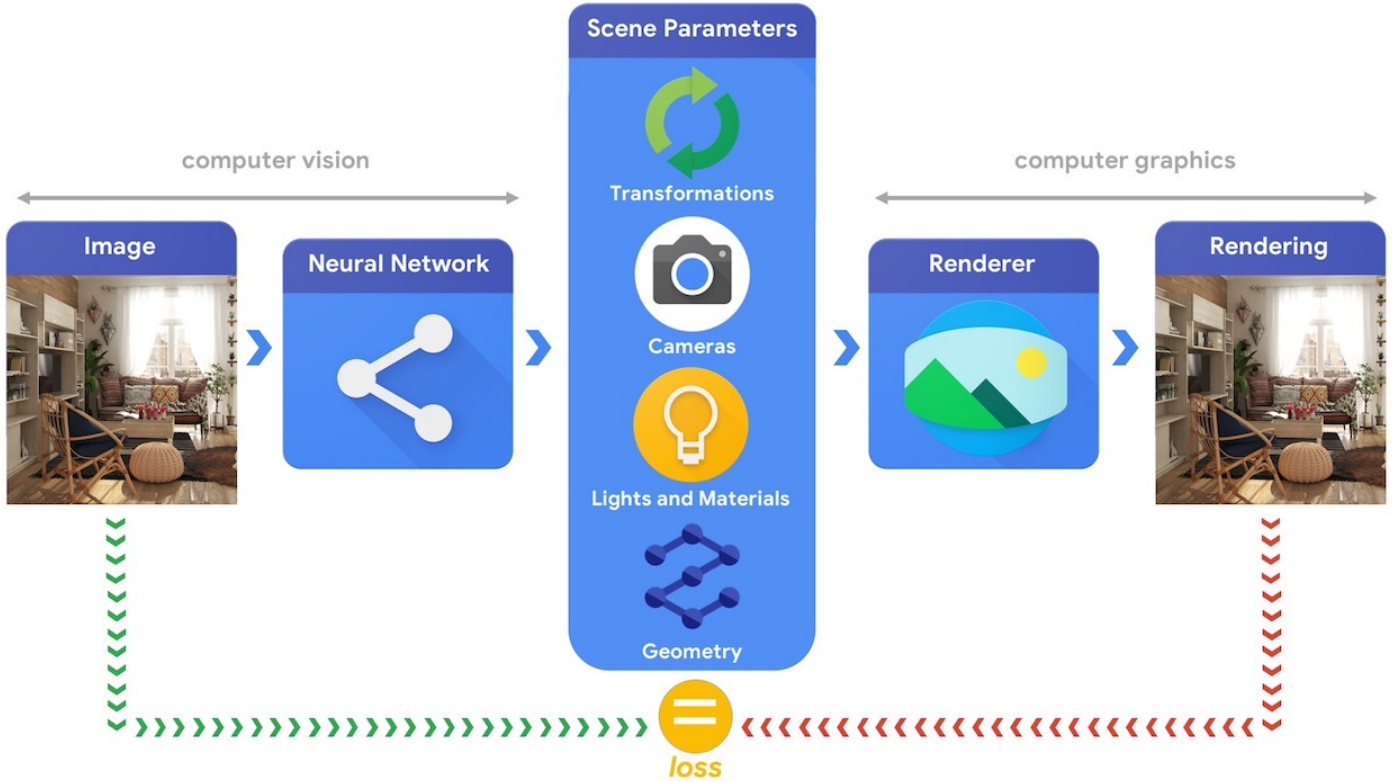


https://github.com/tensorflow/graphics



https://github.com/tensorflow/graphics

Goal of Computer Vision



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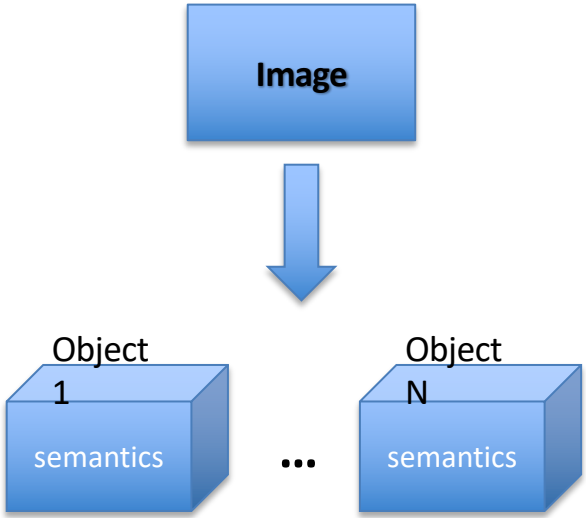
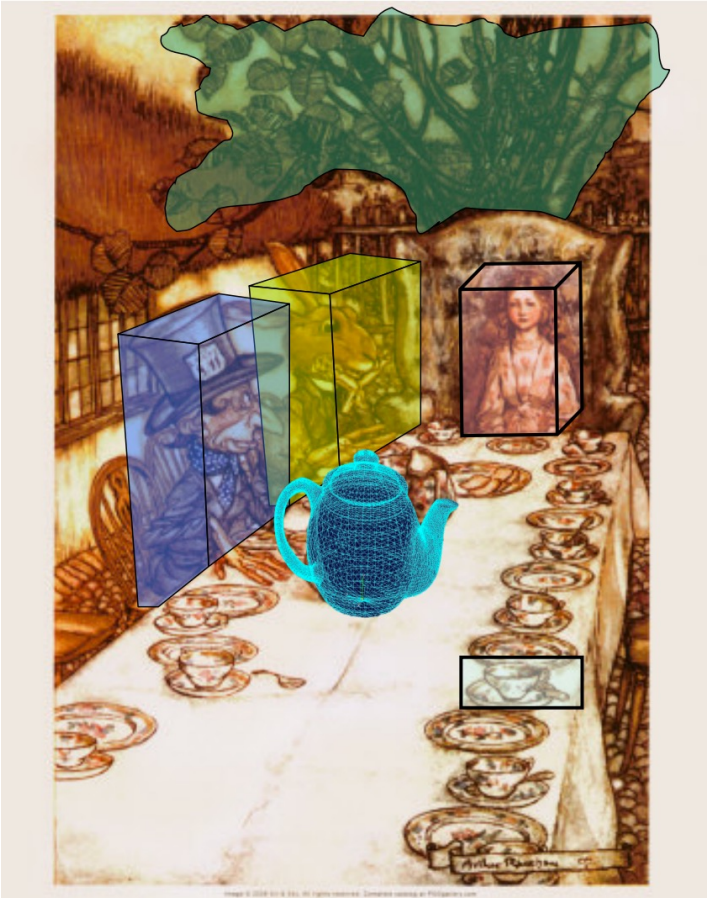
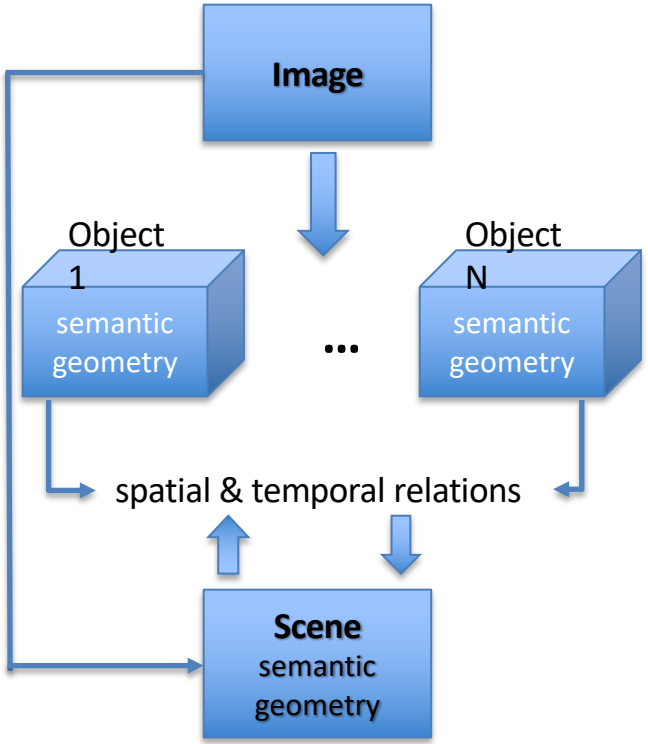
Goal of Computer Vision



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

Goal of Computer Vision



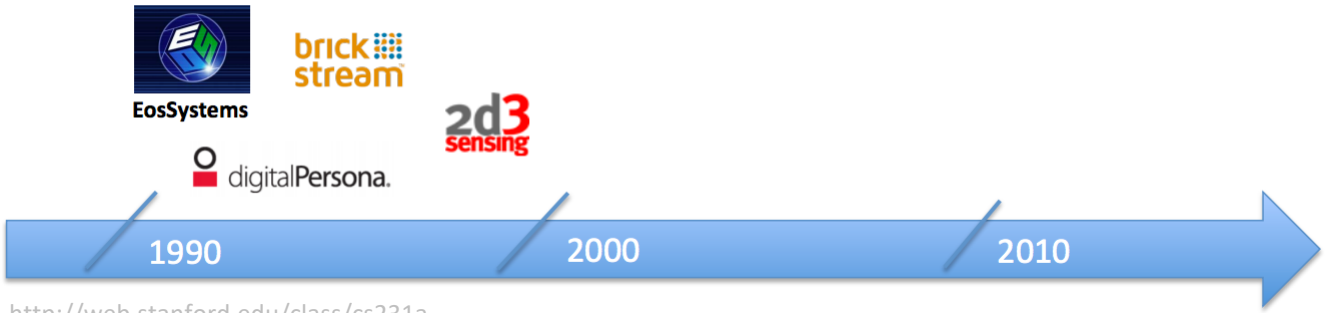


Computer Vision Pipeline

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

- Informationextraction:
  - 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

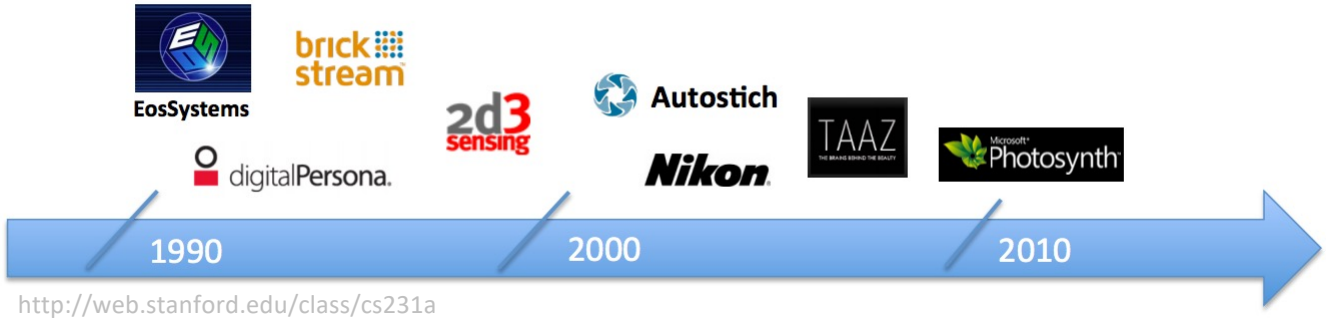
EosSystems

Photomodeler

- 3D Object prototyping

Computer Vision and Applications

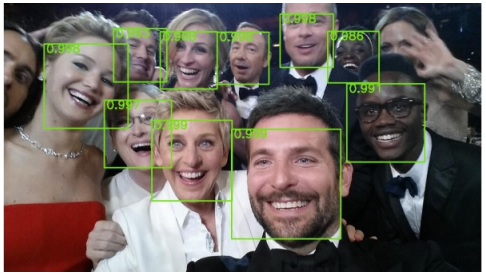
- New features detector/descriptors
- CV leverages machine learning



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

Computer Vision and Applications

- Face detection

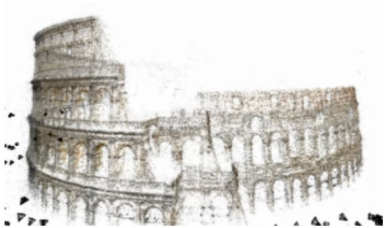


© http://www.ukprogressive.co.uk/

- Panoramic Photography

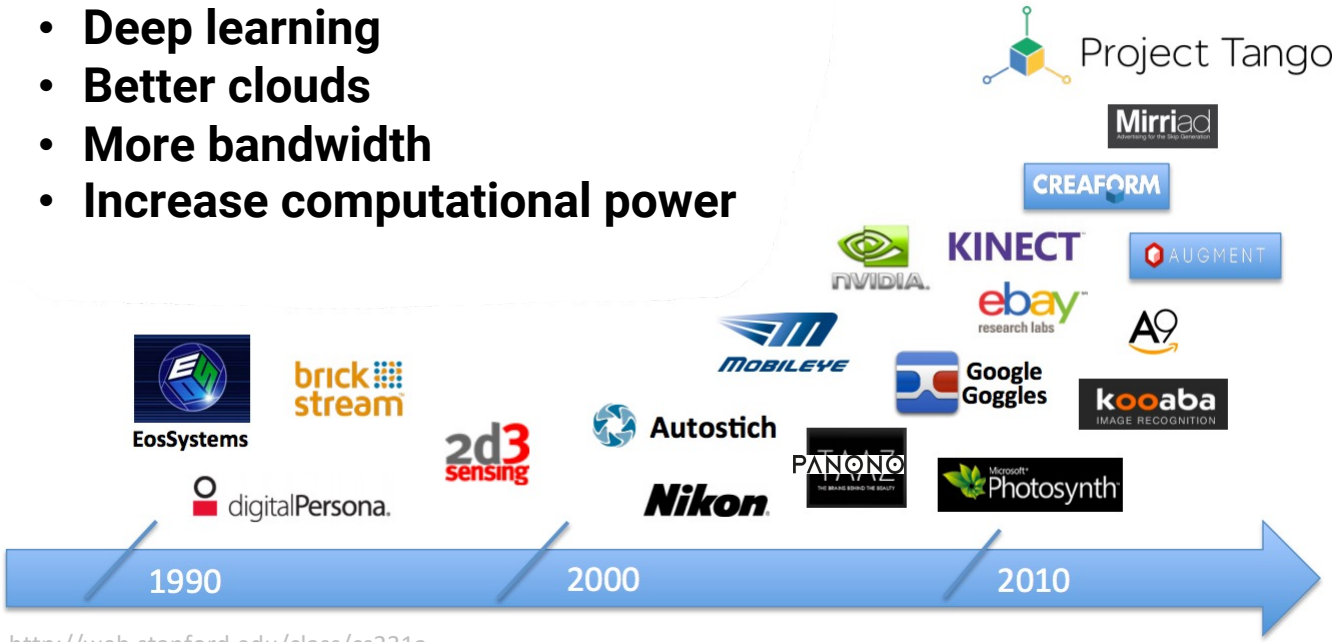
- 3D modeling of landmarks

Microsoft Photosynth



Computer Vision and Applications

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



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

Image search engines

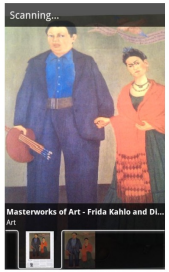
Google Image Search
Picasa
flickr
webshots
bing
YouTube Broadcast Yourself
Incogna
LTU technologies
picsearch
YAHOO!

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

Computer Vision and Applications

- Visual search and landmarks recognition

Google Goggles



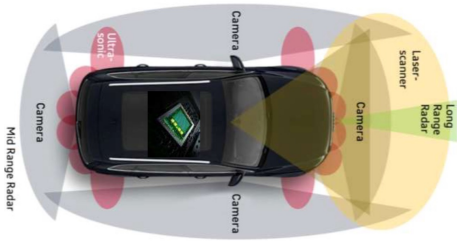
kooaba
IMAGE RECOGNITION

- Augmented reality

Computer Vision and Applications

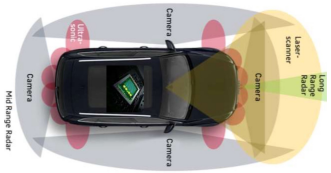
- Motion sensing and gesture recognition

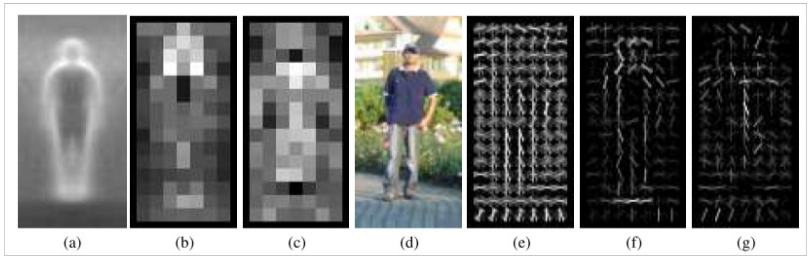
- Autonomous Driving

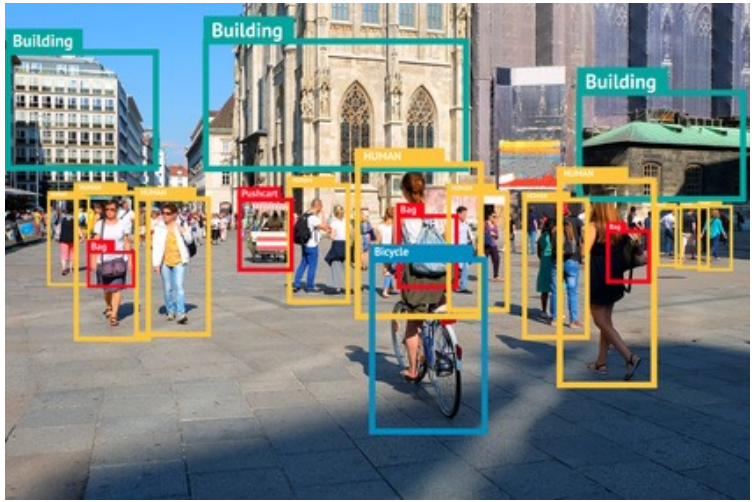


- Personal robotics

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
09.10.23	Introduction	Assignment 0
16.10.23	Image Processing (Filter, Transforms)	
23.10.23	Image Features	Assignment 1
30.11.23	Feature Matching	
06.11.23	Image Retrieval	
13.11.23	Neural Networks recap	Assignment 2
20.11.23	ConvNets, ConvNet Architectures	
27.11.23	Object Detection (YOLO, MobileNet)	
04.12.23	Fine Tuning and Domain Adaptation	Assignment 3
11.12.23	Autoencoder and Embeddings	
18.12.23	Transformers	
08.01.24	Transformers and Images	
15.01.24	GANs and Diffusion Models I	Assignment 4
22.01.24	GANs and Diffusion Models II	
29.01.24	State of the Art / Recent Developments	
12.02.24	Projektpräsentation / Dokumentation	

Image Basics / Image features

Machine Learning, Supervised Image Classification

Unsupervised, Generative Methods

About me

Contact and Information

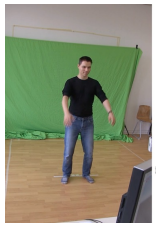
- Kristian Hildebrand
  - Computer Graphics and Interactive Systems
- Email
  - khildebrand@beuth-hochschule.de
- Website
  - http://hildebrand.beuth-hochschule.de
  - Course material + news via **Moodle**
- Room
  - B332
- Office
  - Haus Gauß, Room B218
  - Consultation hours as needed
  - Available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

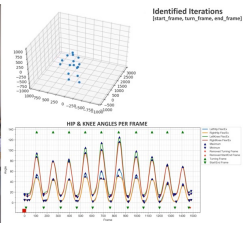
Kristian Hildebrand

Since 10/2015	Professor Graphics and Interactive Systems Beuth University for Applied Science
2014 – 2015	Principal Research Engineer, DISDAR GmbH, Berlin
2008 – 2013	Research Assistent, 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

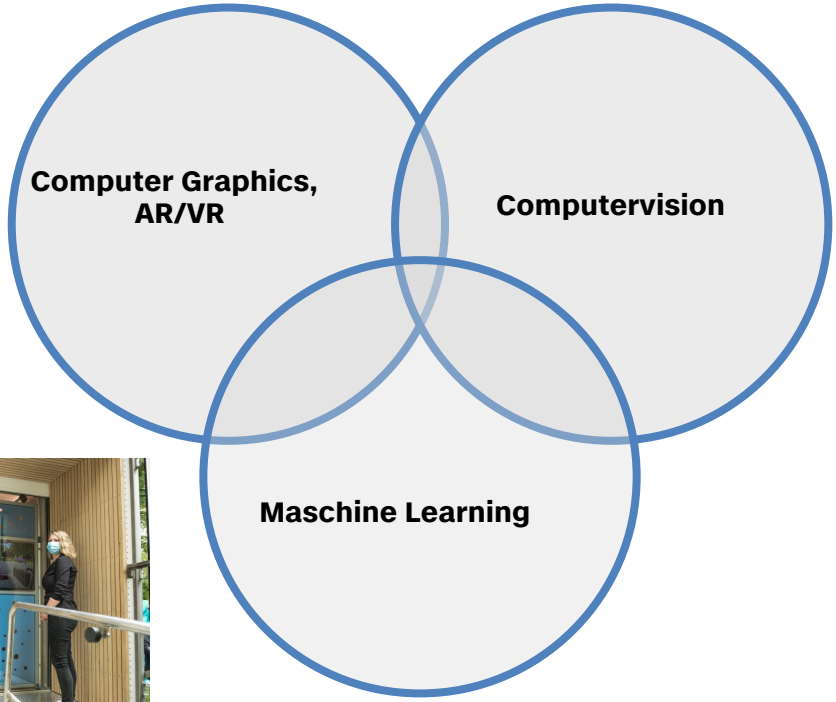
Intelligent Interactive Systems

BewARe





VITALAB MOBILE

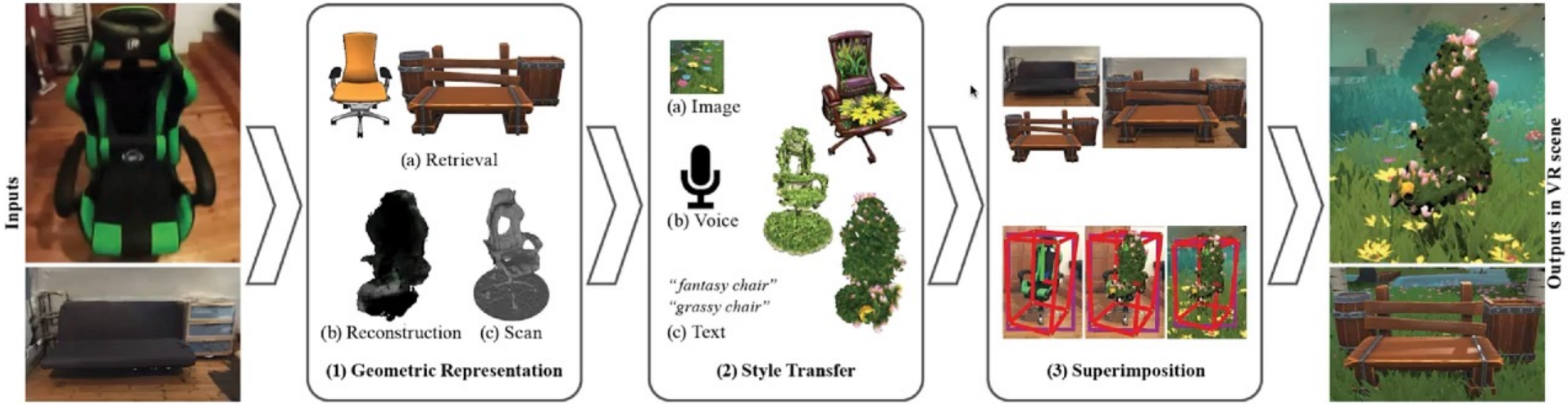


Interaction-Based Redirected Walking

VR Evaluation Toolkit

Style-aware Augmented Virtuality Embeddings (SAVE)

Online Submission ID: 1157



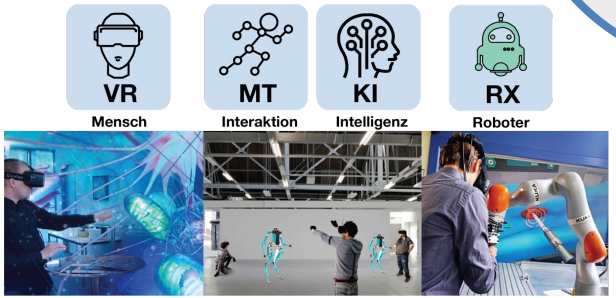
Style-aware Augmented Virtuality Embeddings (SAVE).
Johannes Hoster, Dennis Ritter, Kristian Hildebrand. IEEE Conference on Virtual Reality and 3D User Interfaces. 2023.

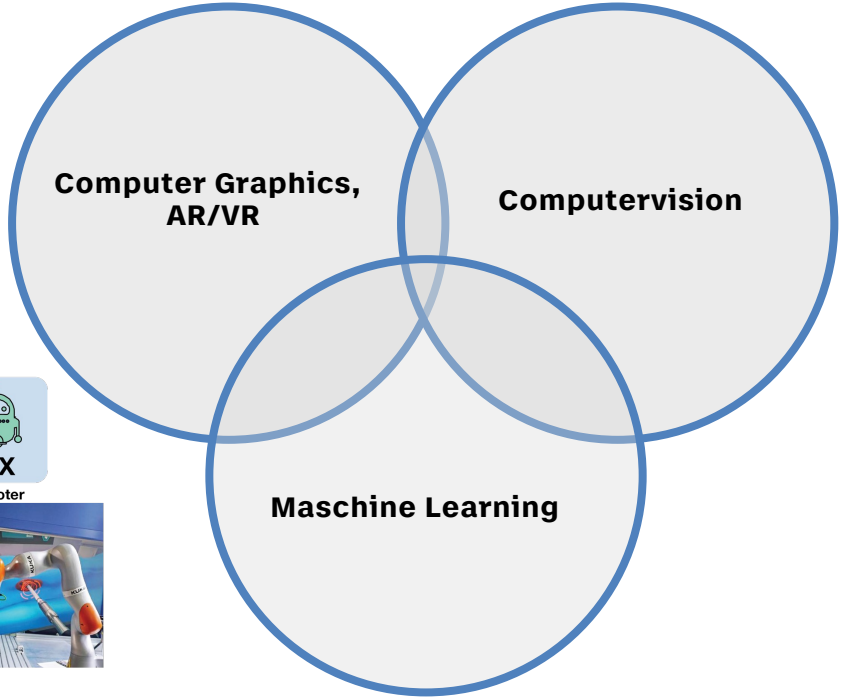

VITALAB
MOBILE
B WD 6936

Intelligent Interactive Systems

HUMAN.VR.LAB

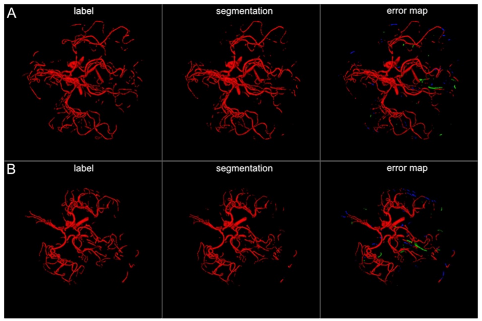
Human-Robot Interaction Virtual Reality Laboratory





SynthNet

MedicalImaging



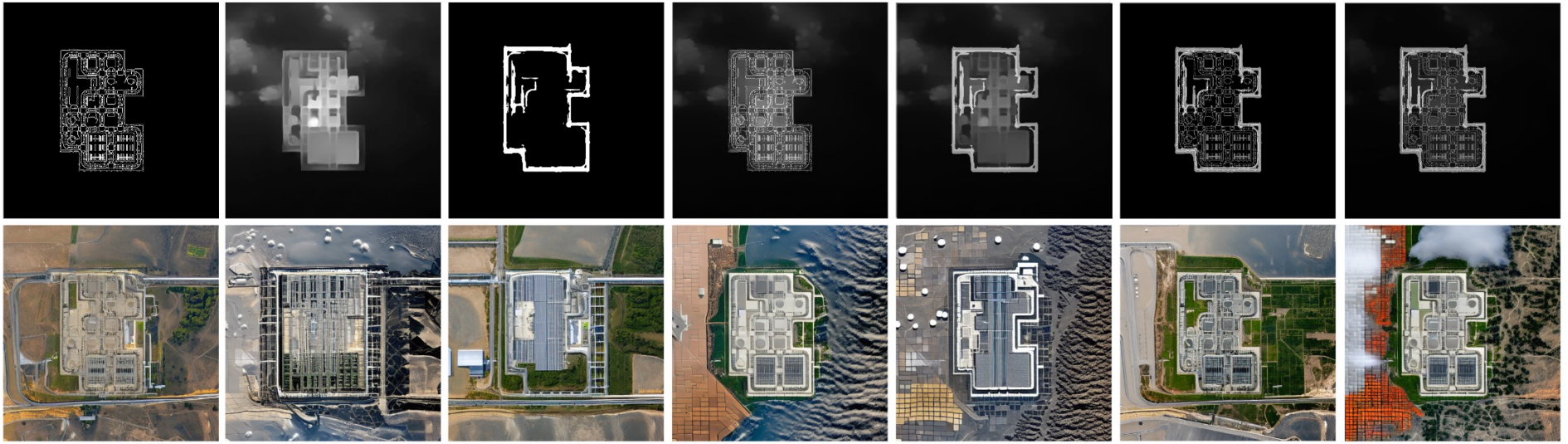

DeLonghi
NESPRESSO

Draw me something

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

Start again!

Multimodally-guided Satellite Imagery Synthesis



Canny | Depth | Sketch | Canny + Depth | Depth + Sketch | Canny + Sketch | All three content guiding modalities

Using Game Engines and Machine Learning to Create Synthetic Satellite Imagery for Tabletop Verification Excercise.
Johannes Hoster, Sara Al-Sayed, Felix Biessmann, Alexander Glaser, Kristian Hildebrand, and Vy Nguyen. INMM & ESARDA Joint Annual Meeting, Vienna, May 2023

CAD Models to Real-World Images: A Practical Approach to Unsupervised Domain Adaptation in Industrial Object Classification

Source Domain
Synthetic 3D-object renders

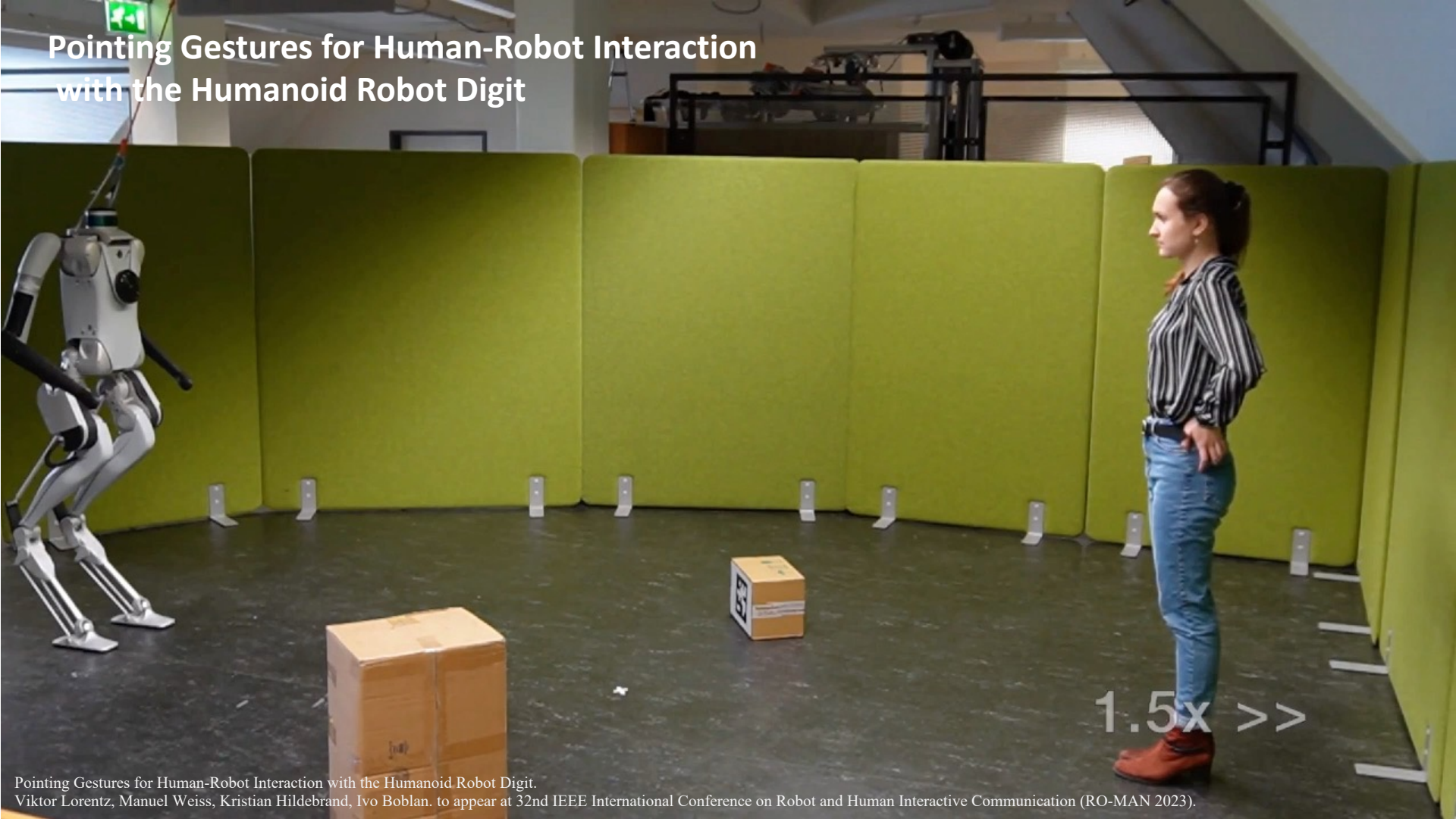
Target Domain
Real photos

CAD Models to Real-World Images: A Practical Approach to Unsupervised Domain Adaptation in Industrial Object Classification.
Dennis Ritter, Mike Hemberger, Marc Hönig, Volker Stopp, Eric Rodner, Kristian Hildebrand. Adapting to Change: Reliable Learning Across Domains - ECML-PKDD 2023 International Workshop

https://github.com/dritter-bht/synthnet-transfer-learning

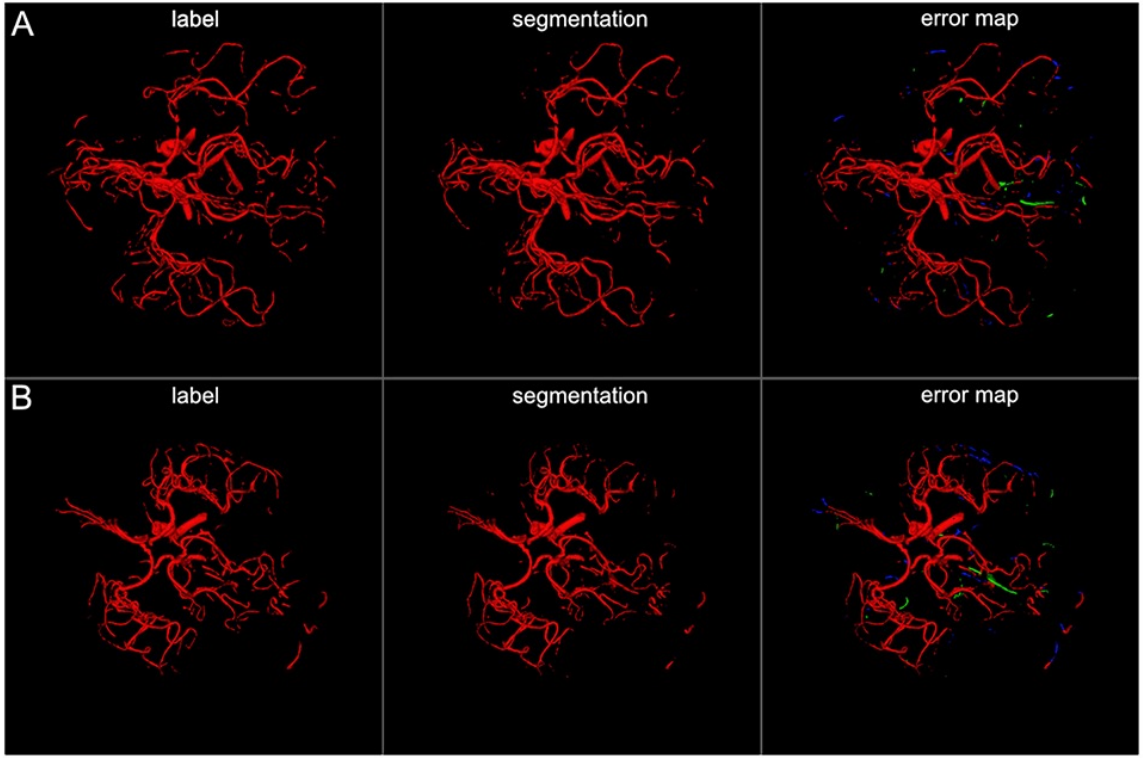

Stabilized human pose estimation
by temporal guidance
TIMELINE
Mo Di Mi Do Fr

Pointing Gestures for Human-Robot Interaction with the Humanoid Robot Digit



Pointing Gestures for Human-Robot Interaction with the Humanoid Robot Digit.
Viktor Lorentz, Manuel Weiss, Kristian Hildebrand, Ivo Boblan. to appear at 32nd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN 2023).

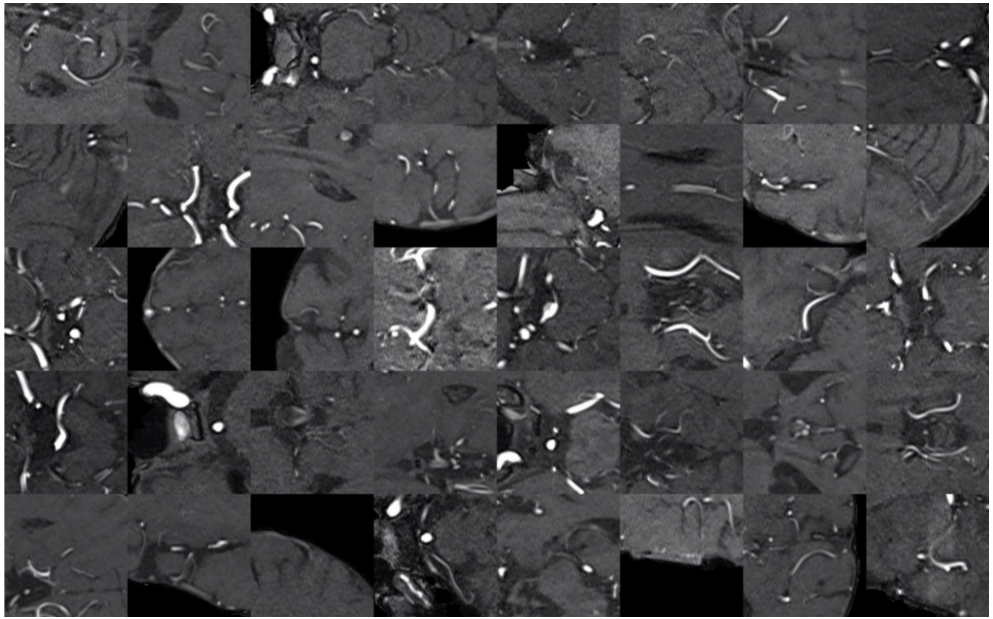
U-net Deep Learning Framework - Results

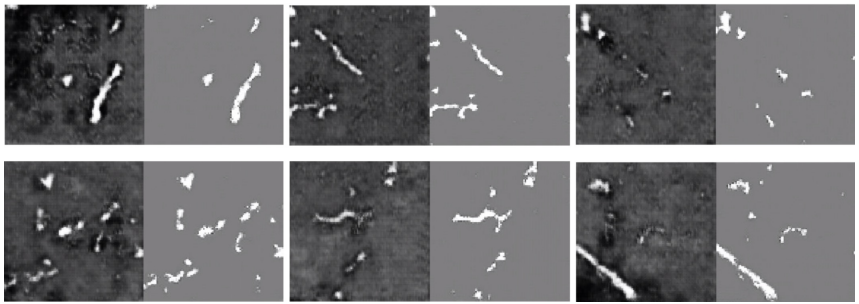


Model architecture/Performance measure	U-net
Dice coefficient	0.891
95% Hausdorff distance (voxels)	47.277
Averaged Hausdorff distance (voxels)	0.342

U-net Deep Learning Framework for High Performance Vessel Segmentation in Patients with Cerebrovascular Disease Frontiers in Neuroscience. 2019. Livne, Michelle and Rieger, Jana and Aydin, Orhun and Taha, Abdel and Akay, Ela and Kossen, Tabea and Sobesky, Jan and Kelleher, John and Hildebrand, Kristian and Frey, Dietmar and Madai, Vince

Generating MRI using Generative Adversarial Networks





Tabea Kossen

real data

synthetic data

Organization Facts

Facts

- 4 Assignments: **done alone**
- **Questionaires – easy weekly questions to recap**
- 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**
- **Grading**
  - Exercises + Questions: 50%
  - Project (implementation): 50%
    - Project Presentation / Evaluation / Documentation (pdf) (33% of project grade)

Why?

Why?
Get familiar with evaluating your work!

Rules II

- **Questions**
  - Every Week there is a set of three questions about the previous content (max(sum(0.5 points, week), 10))
    - 13 weeks, only 10 count

Rules III

- 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?