UNIVERSITÄT BONN

Welcome to the Machine Learning for Principal Investigators Course

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High-Performance Computing and Analytics Lab, Universität Bonn

Overview

Organization

Machine Learning Applications

Course Contents

Organization

Who are we?

Instructors

- Elena Trunz, Postdoc with the Visual Computing Group
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- Lokesh Veeramacheneni, PhD student with the HPCA Lab
  - lokiv@uni-bonn.de
- Moritz Wolter, Postdoc with the HPCA Lab
  - moritz.wolter@uni-bonn.de

Teaching Assistants:

- Niklas Kerkfeld, Master student Computer Science
- Zahra Ganji, Master student Computer Science

Course Material

- We will upload GitHub-Classroom links, Lecture recordings and slides onto Ecampus.
  - `https://ecampus.uni-bonn.de/`
  - To access eCampus, you need a UniID $\rightarrow$ helpdesk HRZ.
- You can opt out of GitHub use. We provide zip files via Ecampus.
- We envision a hands-on course experience.
- You should be able to gain an intuition for modern machine learning algorithms and possible applications.
- Many exercises come with unit tests, which allow you to check your work.

Github Classroom

- We will archive the GitHub Classroom in approximately one year.
- After the course, download the material or create a fork in your account for long-term access.
- Your repositories will appear at `https://github.com/Machine-Learning-for-PIs`.
- You can opt out of GitHub use. We also provide zip files via Ecampus.

Course Philosophy

- Understand key methods
- and use these.
- Understand resource needs.
- Learn how to supervise with software engineering and best practices in mind.

Machine Learning Applications

Machine learning is everywhere

- Image processing
- Protein structure prediction
- Language processing
- Virtual personal assistants
- Fraud detection
- Autonomous robots
- Recommendation systems
- Photo editing
- ...

Example: Medical image processing [Wol+24]

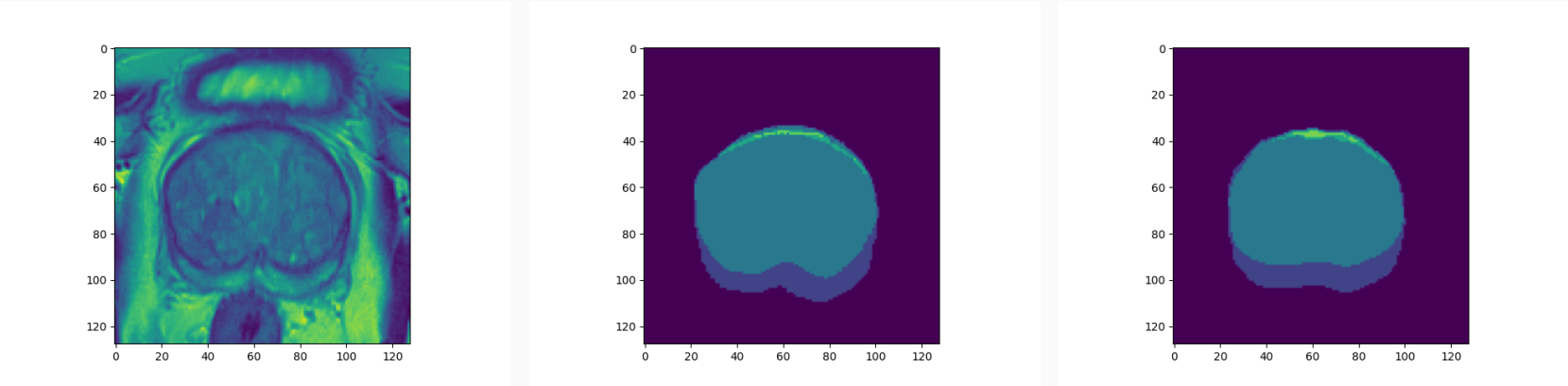


Figure: A prostate (left) with expert (center) and network (right) annotation.

We thank Barbara Wichtmann for bringing this problem to our attention.

Example: Processing of historical newspapers [Sch+24]

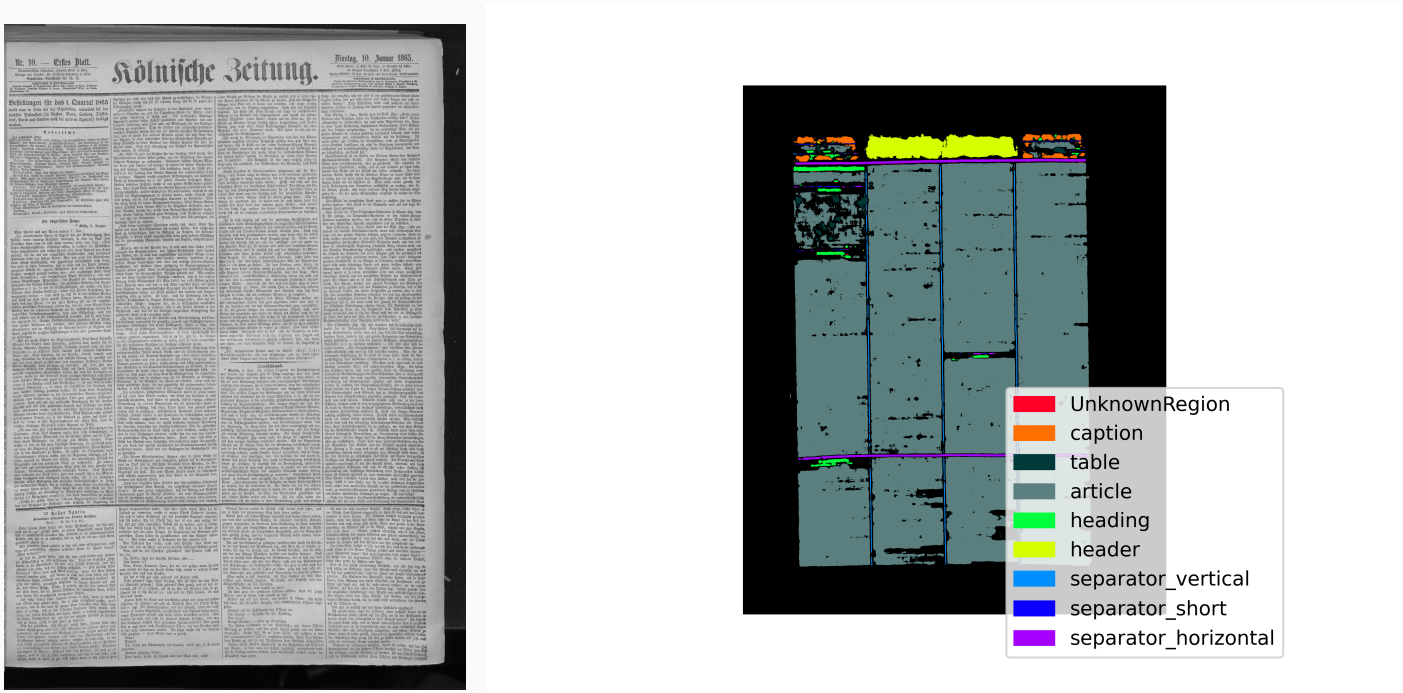


Figure: An old newspaper page and its network segmentation.

We thank Felix Selgert for bringing this problem to our attention.

Stilization [GEB16]

Image Classification [KSH12]

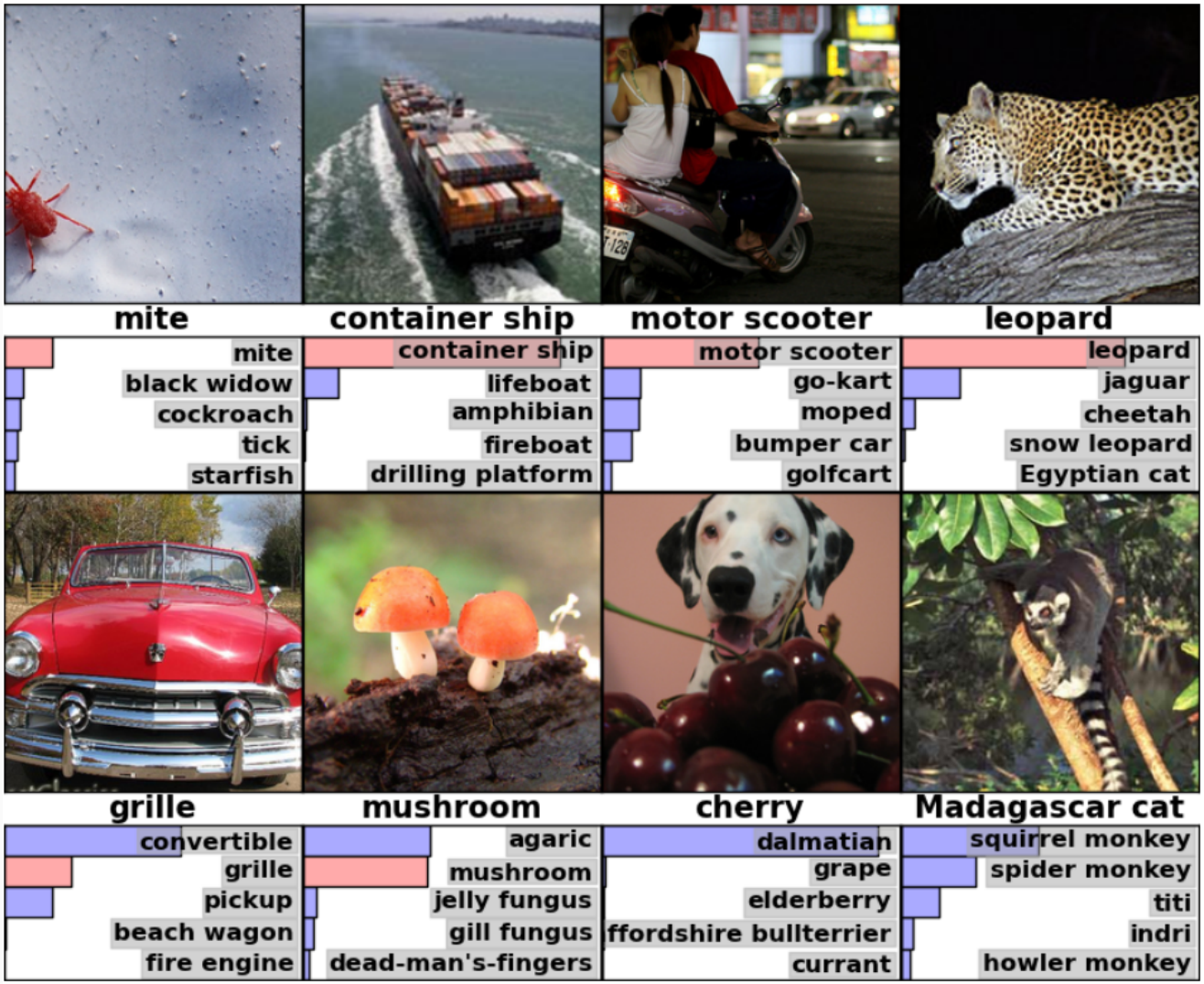
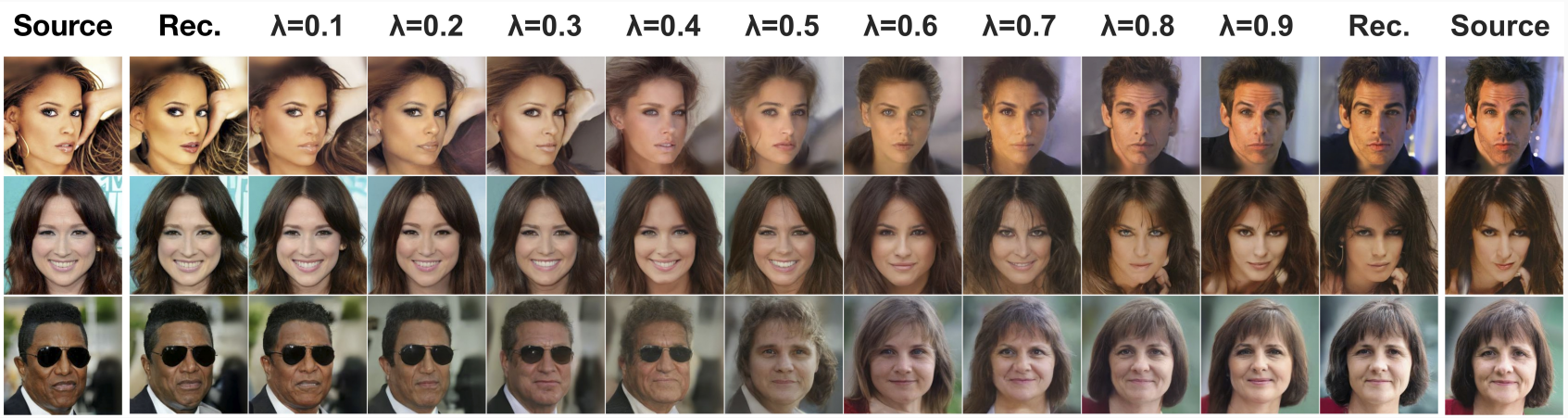


Image Captioning [Liu+23]

Visual input example, Constrained JSON Output:	
	
User	Please read the text in this image and return the information in the following JSON format (note xxx is placeholder, if the information is not available in the image, put "N/A" instead). {"class": xxx, "DLN": xxx, "DOB": xxx, "Name": xxx, "Address": xxx, "EXP": xxx, "ISS": xxx, "SEX": xxx, "HGT": xxx, "WGT": xxx, "EYES": xxx, "HAIR": xxx, "DONOR": xxx}
GPT-4V	{"class": "C", "DLN": "1234568", "DOB": "08/31/1977", "Name": "Ima Cardholder", "Address": "2570 24th Street, Anytown, CA 95818", "EXP": "08/31/2014", "ISS": "08/31/2011", "SEX": "F", "HGT": "5-05", "WGT": "125 lbs", "EYES": "BRN", "HAIR": "BRN", "DONOR": "VETERAN"}
LLaVA	{"class": "Driver License", "DLN": "CA123 456 789", "DOB": "01/01/1990", "Name": "Amy", "Address": "Anytown, CA", "EXP": "08/31/2023", "ISS": "Veteran", "SEX": "F", "HGT": "5'5", "WGT": "130", "EYES": "Brown", "HAIR": "Brown", "DONOR": "Unknown"}
LLaVA-1.5	{"class": "C", "DLN": "1132456789", "DOB": "08/23/1971", "Name": "Ima Cardholder", "Address": "Anytown, State, Zip", "EXP": "08/23/2014", "ISS": "California", "SEX": "F", "HGT": "5'5", "WGT": "123", "EYES": "Brown", "HAIR": "Brown", "DONOR": "N/A"}

Media Synthesis [HJA20]



Course Contents

Course Outline

- Day 1: Mathematical and software engineering foundations, based on [DFO20]
  - Software engineering for supervisors
  - Introduction, Optimization
  - Linear Algebra, Statistics
- Foundations of machine learning, based on [DFO20]
  - Classic Methods
  - Support Vector Machines and Principal Component Analysis
- Deep learning, based on [GBC16]
  - Convolutional neural networks (CNN) for image classification
  - CNN for image segmentation

BNTrainee

Bonn transdisziplinäre Ausbildung in künstlicher Intelligenz
Bonn transdisciplinary training in artificial intelligence

- We offer interdisciplinary machine learning projects.
- With CS-department: project groups/ labs, Bachelor or Master Thesis projects.

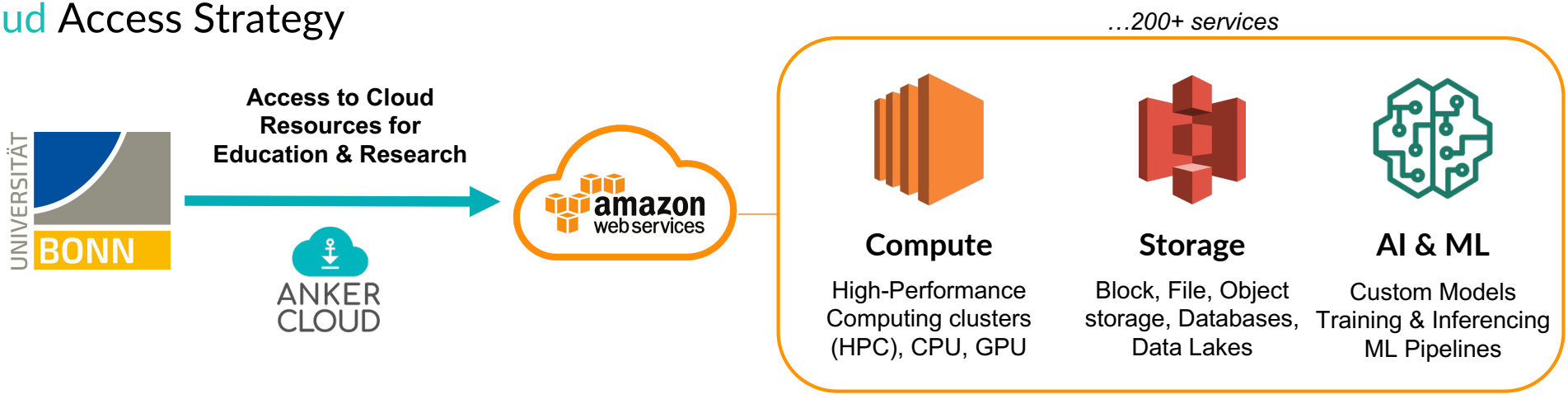
Website: https://trainee.informatik.uni-bonn.de/

Contact:

- Elena Trunz: trunz@cs.uni-bonn.de
- Moritz Wolter: moritz.wolter@uni-bonn.de

We offer new projects at the start of each semester.

Cloud Access Strategy



Advantages of Cloud

- ✓ Dedicated resources
- ✓ Optimized workloads
- ✓ 24/7 availability
- ✓ Worldwide coverage

Challenges in Public Sector

- ✗ Time bandwidth
- ✗ Approach and best practices
- ✗ Security & Compliance
- ✗ Pricing model

Approach with Ankercloud

- ➢ Custom setup and dedicated team
- ➢ Security posture definition
- ➢ Budget allocation strategy
- ➢ Dedicated AWS funding

About Ankercloud

www.ankercloud.com

info@ankercloud.com

150+	5	20+	200+	150+
People	Offices	Countries	Projects	Customers

Past Projects

ecap Erlangen Centre for Astroparticle Physics

University of Bremen

References

[DFO20] Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong. ***Mathematics for Machine Learning***. https://mml-book.com. Cambridge University Press, 2020. DOI: 10.1017/9781108679930.

[GEB16] Leon A Gatys, Alexander S Ecker, and Matthias Bethge. **"Image style transfer using convolutional neural networks."** In: *Proceedings of the IEEE conference on computer vision and pattern recognition*. 2016, pp. 2414–2423.

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[GBC16] Ian Goodfellow, Yoshua Bengio, and Aaron Courville. ***Deep Learning***. http://www.deeplearningbook.org. MIT Press, 2016.

[HJA20] Jonathan Ho, Ajay Jain, and Pieter Abbeel. **"Denoising Diffusion Probabilistic Models."** In: *arXiv preprint arxiv:2006.11239* (2020).

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[KSH12] Alex Krizhevsky, Ilya Sutskever, and Geoffrey E. Hinton. **"ImageNet Classification with Deep Convolutional Neural Networks."** In: *Advances in Neural Information Processing Systems 25: 26th Annual Conference on Neural Information Processing Systems 2012. Proceedings of a meeting held December 3-6, 2012, Lake Tahoe, Nevada, United States*. Ed. by Peter L. Bartlett, Fernando C. N. Pereira, Christopher J. C. Burges, Léon Bottou, and Kilian Q. Weinberger. 2012, pp. 1106–1114. URL: https://proceedings.neurips.cc/paper/2012/hash/c399862d3b9d6b76c8436e924a68c45b-Abstract.html.

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[Liu+23] Haotian Liu, Chunyuan Li, Qingyang Wu, and Yong Jae Lee. **"Visual instruction tuning."** In: *arXiv preprint arXiv:2304.08485* (2023).

[Sch+24] Christian Schultze, Niklas Kerkfeld, Kara Kuebart, Princilia Weber, Moritz Wolter, and Felix Selgert. ***Chronicling Germany: An Annotated Historical Newspaper Dataset.*** 2024. arXiv: 2401.16845 [cs.DL]. URL: https://arxiv.org/abs/2401.16845.

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