Dr. Christian Limberg Curriculum Vitae

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Summary

I am an enthusiast in applied and explainable AI, driven by a vision to find intelligent solutions for tackling today's major problems and improving company processes with the most recent technologies. During my research, I applied Machine Learning to solve complex Computer Vision and Robotics challenges.
Since my master's studies in 2013, I focused extensively on these areas, mastering numerous skills, tools, and APIs. I e.g. participated in the RoboCup@Home competition with my university team, which taught me early on that seamlessly integrating a Machine Learning model into human environments involves much more than merely deploying it on a robot. This realization guided my PhD research in collaboration with the Honda Research Institute EU, where I developed meta Machine Learning approaches for robot self-assessment in human-robot teaching scenarios to ensure reliability and effectiveness.
In my postdoctoral research at the National Institute of Informatics (NII) in Tokyo, I extended my expertise in Generative AI, specifically Transformer-based models, which are the foundation of approaches like GPT-4. I explored Generative AI for audio by training a latent 2D audio map with a Variational Autoencoder to condition a GPT-2 model for more natural audio generation. Additionally, for Vision-Language Models, I combined YOLO World for detecting people and GPT-4V for classifying their actions to create a flexible perception framework for autonomous drones. My current work on this topic involves investigating the trustworthiness of GPT-4o explanations and their impact on classification accuracy.

Work Experience

Senior Researcher 09/2022 – Present
National Institute of Informatics (NII), Tokyo, Japan
- Postdoctoral Fellow of DAAD (German Academic Exchange Service)
- Project: *Vision Architectures for Drones* (4 first-author publications)
- Investigated in-depth into single-stage Object Detection approaches, such as YOLO variants, using Python and Torch
- Introduced Explainable AI approaches for visualizing YOLO gradients, learned features and salience maps
- Investigated into LLMs/VLMs for zero-shot classification in aerial images using OpenAI API and locally deployed models
- Developed generative models in Torch and Torchvision/Torchaudio for 1. robot control using Reinforcement Learning in realistic simulation environments and 2. for conditioned audio synthesis using Transformer and intelligent user-interfaces

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Researcher 07/2019 – 06/2022
Bielefeld University, Cluster of Excellence Cognitive Interactive Technology (CITEC)
- Staff member of Research Institute for Cognition and Robotics (CoR-Lab)
- Developed models for enabling the applicability of robots in daily living environments and human-robot teaching scenarios
- Implemented service robot demos, including perception and navigation with human-in-the-loop in ROS, Python, C++

Researcher 10/2016 – 06/2019
Honda Research Institute Europe GmbH, Offenbach am Main
- PhD Project: *Competence-based human-machine interaction models for cooperative intelligence in task completion*
- Contributed to advancing the institute's mission of *Cooperative Intelligence*
- Published Python libraries for human-aware active and incremental Machine Learning using Tensorflow, Keras and Torch
- Developed an intelligent robot user interface with JavaScript web frontend and backend in Python, Flask and PostgreSQL

Intern 07/2015 – 01/2016
CLAAS KGaA mbH, Gütersloh
- Project: *Electronic Environment Recognition with Combine Harvesters*
- Master Thesis: *Vision-based anomaly detection in grain fields*
- Developed image segmentation and single-class classification approaches for anomaly detection using Matlab
- Acquired training data within harvesting field tests

Freelancer in software development (part time) 03/2015 – 10/2019
Bielefeld/Offenbach am Main
- Developed management tools for mid-size companies

Positions as teaching assistant (part time) 10/2012 – 08/2021
Bielefeld University
- 07/2017–07/2021: Lecture on *Vision in Human and Machine*
- 10/2013–04/2015: Lecture on *Digital Communication and Internet Services*
- 04/2013–07/2013: Lecture on *Operating Systems*
- 10/2012–02/2013: Lecture on *Computer Architecture*

Education

PhD 10/2016 – 12/2021
Bielefeld University, Cluster of Excellence Cognitive Interactive Technology (CITEC)
In cooperation with Honda Research Institute Europe GmbH, Offenbach am Main
- Dissertation Title: *Competence Modeling for Human-Robot Cooperation*
- Defense: Bielefeld University, 12/2021 with grade *Magna cum Laude*
- Regularly presented research findings at prestigious international conferences (8 first-author publications)

M.Sc. in *Intelligent Systems*, Grade: 1.4 (1.0-6.0, 1.0 is best) 10/2013 – 02/2016
Bielefeld University
- Focus: Robotics, Computer Vision and Machine Learning
- Thesis: *Development of an Image Processing System for Camera-Based Grain Field Classification Using Machine Learning*
- Master Project: Implementation of an cooperative ball-maze application with NAO robot, where NAO is visually perceiving the game state and acts according multiple strategies (implemented in Python and OpenCV, evaluated within a user study)
- Developed person detection, identity and emotion recognition in Java and C++ with integration into ROS ecosystem
- Participated in RoboCup@Home German Open 2015 and Worldcup 2015 in Hefei, China, achieving third place in both. Responsible for person localization and feature estimation (e.g., age, sex, posture), as well as an elderly care robot challenge

B.Sc. in *Cognitive Informatics*, Grade: 1.9 (1.0-6.0, 1.0 is best) 10/2010 – 10/2013
Bielefeld University
- Thesis: *Development of a Rapid-Prototyping Software for Constructing Environments in Virtual Reality*

Abitur (German High School Diploma) 08/2007 – 06/2010
Hermann-Vöchting-Gymnasium, Blomberg

Skills

Core Competencies:
- Python: advanced programming and debugging and most common packages
- Data Science libraries: NumPy/SciPy, Pandas, Matplotlib, OpenCV
- Machine Learning frameworks: Torch, SkLearn, TensorFlow, Keras, HuggingFace
- Linux: Administration and development

Other Skills:
- Programming Languages: C/C++, Matlab, Java
- Web-Based languages: HTML, CSS, JavaScript, PHP, SQL, Flask, React
- Robot Operating System (ROS), Azure
- Project Management Tools: GIT, SVN, Redmine, Slack, Docker, Jenkins, GitLab
- Other Tools: LaTeX, MS-Office, Blender, GIMP, Inkscape, OpenSCAD

Lanuage Skills:
- German: Native language
- English: Business fluent
- Japanese: Basic knowledge
- French: Basic knowledge

Interests

Professional Interests:

- Machine Learning
- Robotics
- Large/Vision Language Models
- Computer Vision

Personal Interests:

- Guitar
- Electronics
- Hiking
- 3D Printing

Academic Service

- Topic Coordinator of *Frontiers in Robotics and AI* research topic
  "Computer Vision Mechanisms for Resource-Constrained Robotics Applications"
- Session Chair of *VISAPP 2023* session on *Assistive Computer Vision*
- Session Chair of *VISAPP 2023* session on *Deep Learning for Visual Understanding*
- Programme Committee member of *ICRA2022* workshop on *Behaviour Priors in Reinforcement Learning for Robotics*
- Programme Committee member of *ICANN2020*
- Programme Committee member of *ICANN2019*

Selected Publications

Limberg, C., Goncalves, A., Rigault, B., & Prendinger, H. (2024). Leveraging yolo-world and gpt-4v lmms for zero-shot person detection and action recognition in drone imagery. *ICRA 2024 First Workshop on Vision-Language Models for Navigation and Manipulation*.

Limberg, C., & Zhang, Z. (2024). Mapping the audio landscape for innovative music sample generation. *ACM International Conference on Multimedia Retrieval*.

Limberg, C., Harter, A., Melnik, A., Ritter, H., & Prendinger, H. (2024). Deep detection dreams: Enhancing visualization tools for single stage object detectors. *Springer Communications in Computer and Information Science*.

Limberg, C., Melnik, A., Ritter, H., & Prendinger, H. (2023). Yolo: You only look 10647 times. *Proceedings of the 18th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications*.

Limberg, C. (2022). *Competence Modeling for Human-Robot Cooperation* [Doctoral dissertation]. Universität Bielefeld. https://doi.org/10.4119/unibi/2962486

Limberg, C., Wersing, H., & Ritter, H. (2020a). Accuracy estimation for an incrementally learning cooperative inventory assistant robot. *International Conference on Neural Information Processing (ICONIP)*.

Limberg, C., Göpfert, J., Wersing, H., & Ritter, H. (2020). Prototype-based online learning on homogeneously labeled streaming data. *International Conference on Artificial Neural Networks (ICANN)*.

Limberg, C., Wersing, H., & Ritter, H. (2020b). Beyond cross-validation - accuracy estimation for incremental and active learning models. *Machine Learning and Knowledge Extraction (MAKE)*, *2*(3), 327–346. https://doi.org/10.3390/make2030018

Limberg, C., Krieger, K., Wersing, H., & Ritter, H. (2019). Active learning for image recognition using a visualization-based user interface. *International Conference on Artificial Neural Networks (ICANN)*, 495–506.

Limberg, C., Wersing, H., & Ritter, H. (2018a). Improving active learning by avoiding ambiguous samples. *International Conference on Artificial Neural Networks (ICANN)*.

Limberg, C., Wersing, H., & Ritter, H. (2018b). Efficient accuracy estimation for instance-based incremental active learning. *European Symposium on Artificial Neural Networks (ESANN)*, 171–176.