curriculum vitæ of

# Katja Hauser

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## RESEARCH INTERESTS

I am interested in the application and some of the properties of neural networks. The current focus of my research are inherent structures in neural networks. Specifically, I am interested in analysing networks found by magnitude pruning as proposed in the *Lottery Ticket Hypothesis*[1] by means of *Topology*.

In the course of my university studies I have focused on *Scientific Visualization*, *Knowledge Discovery in Databases* and *Machine Learning*, specifically *Deep Learning*. I have written my master's thesis on a specific type of invertible *Normalizing Flow*: the *Invertible Neural Network*[2] (INN).

**Keywords:** Lottery Ticket Hypothesis, Deep Learning, Scientific Visualization, Knowledge Discovery in Databases

## RESEARCH

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|---|---|---|
| 05/2021 – Present | **Independent Research** (parental part-time work, 25h/week) | HEIDELBERG, GERMANY |

The goal of this line of research is to uncover and analyze inherent structures in neural networks by means of *Topology*. Of specific interest are networks obtained by magnitude pruning as proposed in the *Lottery Ticket Hypothesis*[3], as well as the development of structures during training and pruning.

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| 02/2021 – 03/2021 | **Independent Research** (parental part-time work, 16h/week) | HEIDELBERG, GERMANY |

I focused on an extensive literature review for the work on structures in Lottery Tickets described above in these two months.

## EDUCATION

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| 04/2020 – 01/2021 | **Ph.D.** in computer science (parental part-time work, 16h/week) | HEIDELBERG UNIVERSITY, GERMANY |

Preliminary thesis title: *Practical Application and Theoretical Analysis of Invertible Neural Networks*
Advisors: apl. Prof. Dr. Ullrich Köthe, Prof. Dr. Artur Andrzejak
The first goal of the thesis was to develop an INN[4]-type neural network for complex sequence data. We planned on using it for RNA base calling from nanopore data with focus on the detection of modified bases.

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| 04/2017 – 12/2019 | **M.Sc.** in Applied Computer Science (final grade 1.1) | HEIDELBERG UNIVERSITY, GERMANY |

*Exploration of INNs*
Advisors: apl. Prof. Dr. Ullrich Köthe, Prof. Dr. Artur Andrzejak
Thesis topics:

- **Mode finding in toy data**: finding high probability regions in a learned feature space as well as in a known latent space in INNs[5], creating a mapping of corresponding regions in latent and feature space.

- **High level analysis of the transport process** between feature and latent space in trained INNs (in both directions).

- **Pruning INNs**: several experiments using *layer-wise pruning* by different criteria (e.g., average magnitude of weights or a layer's contribution to the transport) and *iterative magnitude pruning* (i.e., the approach used in the *Lottery Ticket Hypothesis*).

[1] J. Frankle and M. Carbin. *The Lottery Ticket Hypothesis: Finding Sparse, Trainable Neural Networks*, In International Conference on Learning Representations, 2019.

[2] L. Ardizzone, J. Kruse, S. J. Wirkert, D. Rahner, E. W. Pellegrini, R. S. Klessen, L. Maier-Hein, C. Rother, and U. Köthe. *Analyzing Inverse Problems with Invertible Neural Networks*. In International Conference on Learning Representations, 2019.

[3] J. Frankle and M. Carbin. *The Lottery Ticket Hypothesis: Finding Sparse, Trainable Neural Networks*, In International Conference on Learning Representations, 2019.

[4] L. Ardizzone, J. Kruse, S. J. Wirkert, D. Rahner, E. W. Pellegrini, R. S. Klessen, L. Maier-Hein, C. Rother, and U. Köthe. *Analyzing Inverse Problems with Invertible Neural Networks*. In International Conference on Learning Representations, 2019.

[5] ibid.

- **Ensembles, uncertainty quantification and outlier detection**: performance of ensembles of INNs, uncertainty quantification using *Deep Ensembles*[6] and outlier detection using *WAIC*[7].

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| 10/2012 – 04/2017 | **B.Sc.** in Applied Computer Science  (final grade **1.8**)  *Latent Information Networks from German Newspaper Articles*  Advisors: Prof. Dr. Michael Gertz | HEIDELBERG UNIVERSITY, GERMANY |

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|---|---|---|
| 2012 | **Abitur**  (final grade **1.4**)  University entrance qualification | HEBEL-GYMNASIUM SCHWETZINGEN, GERMANY |

## FAMILY

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| 04/2020 – Present | **Parental part-time work** | HEIDELBERG, GERMANY |

I am the primary care giver for my daughter (\*01/2020) and currently working in part-time (04/2020 – 03/2021: 16h/week,05/2021 – present: 25h/week).

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| 12/2019 – 03/2020 | **Maternity leave**[8] | HEIDELBERG, GERMANY |

## TEACHING AND WORK EXPERIENCE

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| 04/2017 – 08/2017 | **Student Assistant** for the lecture *Betriebssysteme und Netzwerke*[9] | HEIDELBERG, GERMANY |

I graded homework and exams, planned and taught weekly tutorials for a group of about 30 students.

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| 04/2016 – 09/2016 | **Student Assistant** for the lecture *Betriebssysteme und Netzwerke* | HEIDELBERG, GERMANY |

I graded homework and exams, planned and taught weekly tutorials for a group of about 30 students.

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| 10/2015 – 03/2016 | **Student Assistant** for the lecture *Einführung in die Praktische Informatik*[10] | HEIDELBERG, GERMANY |

I graded homework and exams, planned and taught weekly tutorials for two groups of about 20 students each with a focus on C++ basics.

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| 11/2014 – 06/2015 | **Student Assistant** at the *Visualization and Numerical Geometry* group | HEIDELBERG, GERMANY |

I implemented algorithms for the efficient computation of ray-object intersections in C++.

## SKILLS

### PROGRAMMING LANGUAGES

**Python** – excellent
I wrote the practical homework for several lectures, two student projects and the main work for bachelor's and master's theses in Python.
I have programming experience, among others, with `numpy`, `scipy`, `pytorch` and `tensorflow` (Tensorflow 2), `matplotlib` and `networkx`, `pymongo` and `re`.

**C++** – working knowledge
C++ was the main focus of two courses (mandatory programming course and *Object Oriented Programming for Scientific Computing* (grade 1.0)). I used it for the practical homework in an additional lecture.
I taught basic concepts (including pointers, inheritance and templates) as tutor (10/2015 - 04/2016).
C++ was the main programming language during my work as a student assistant (11/2014 - 06/2015).

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[6]B. Lakshminarayanan, A. Pritzel, and C. Blundell. *Simple and Scalable Predictive Uncertainty Estimation using Deep Ensembles*, In Advances in Neural Information Processing Systems, 2017

[7]Following H. Choi, E. Jang, and A. A. Alemi. *WAIC, but Why? Generative Ensembles for Robust Anomaly Detection*, arXiv preprint arXiv:1810.01392, 2018., WAIC: S. Watanabe. Algebraic Geometry and Statistical Learning Theory. 2009.

[8]By German regulation 6 weeks before due-date and 8 weeks after giving birth.

[9]Operating Systems and Networks

[10]Introduction to Practical Computer Science

**R** – working knowledge

I used R for the practical homework in one lecture and as the main programming language in a student project (grade: 1.0).

**Haskell, Java, Octave** – solid understanding

I obtained a basic familiarity with these languages using them for the practical homework in one (Haskell, Java) to two (Octave) lectures each.

### Proficiency in IT Tools

**git** – excellent

I used `git` as version control system for several projects, including my bachelor's and master's theses. I have a safe handling and understanding of the basic work flow (add-commit-push), setting up repositories, branching, reverting and merging, as well as some advanced functionality (changing the commit history). I am experienced with the use of `git` in the context of group projects.

**LaTeX** – working knowledge

I compiled numerous reports and presentations, as well as my bachelor's and master's theses using LaTeX.

**command line tools** – working knowledge

I have a good familiarity with basic operations (navigation, file creation and deletion, package management, process monitoring, searching). I am comfortable with writing small scripts for automization including the use of `parallel`.

**svn** – working knowledge

I used `svn` as version control system for two projects. I have a safe handling on the basic work flow.

### Additional IT Related Skills

**Test Driven Development** – working knowledge

I have been using the principles of TDD and Clean Coding to one project with great success.

### Language Skills

**German** – native speaker
**English** – fluent (CEFR[11] C2)
**Russian** – very good command (CEFR B2)

## Experiences Abroad

08/2017 – 01/2018    **Semester abroad** at *Saint Petersburg State University*                    Saint Petersburg, Russia

Since the campus of the sciences and the campus of the humanities lie apart about 1.5hrs by public transport (one way), I did a full-time language course.

## Miscellaneous

In my spare time I like to do bouldering, standard and latin dances and occasionally sew garments for my family and myself.

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[11]Overview over the levels of language proficiency as defined in the Common European Framework of Reference (CEFR)