

# Dr. Sebastian Lapuschkin *(né Bach)*, December 16, 1986

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## Summary

Sebastian received the Dr. rer. nat. (PhD) degree with distinction (“summa cum laude”) from the Berlin Institute of Technology in 2018. From 2007 to 2013 he studied computer science (B. Sc. and M. Sc.) at the Berlin Institute of Technology, with a focus on software engineering and machine learning. Currently, he is a tenured researcher at the machine learning

group at Fraunhofer Heinrich Hertz Institute (HHI) in Berlin. His research interests include computer vision, (efficient) machine learning and data analysis, data and algorithm visualization, and the interpretation, (meta-)analysis and rectification of machine learning system behavior. Sebastian loves automation and woodland hiking (not simultaneously).

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## Professional Experience

### Fraunhofer Heinrich Hertz Institute/HHI

BERLIN, GERMANY

#### Tenured Researcher

Jan '19 – present

Occupation of a PostDoc position at Fraunhofer HHI.

*Current research focus:* Development of (meta-)analysis methods of machine learning behaviour. Improving machine learning predictors and data sources using interpretability feedback. Supervision of PhD students and student assistants.

#### Research Associate

Oct '14 – Dec '18

Affiliation to the newly founded machine learning group at Fraunhofer HHI with simultaneous continuation of PhD studies at TU Berlin.

*Research focus:* Applications and refinement of the “Layer-wise Relevance Propagation” (LRP) method, resulting in several highly cited publications and multiple open source software tools and repositories.

*Other work:* Extensions of the h.265 (HEVC) video codec towards the upcoming h.266 standard.

Conceptualization and setup of a HPC cluster with modern GPU hardware.

Implementation of multiple live demos hands-on showcasing the groups’ research nation-wide and internationally.

Additional supervision by Dr. Wojciech Samek.

### Berlin Institute of Technology/TU Berlin

BERLIN, GERMANY

#### Research Associate

Sep '13 – Sep '14

*Research focus:* Formalization of the “Layer-wise Relevance Propagation” (LRP) concept for explaining individual and nonlinear decisions of machine learning methods, including Neural Networks and kernelized predictors.

Extension of LRP to one class learning and anomaly detection tasks.

Supervision by Prof. Dr. Klaus-Robert Müller and Prof. Dr. Alexander Binder.

#### Research/Teaching Assistant

Oct '11 – Aug '13

Research assistant to Prof. Dr. Alexander Binder at the department for machine learning at TU Berlin.

*Tasks:* Structure and cell type detection in large histopathology images using Bag of Words image processing pipelines and SVM classifiers.

Teaching assistant to Prof. Dr. Klaus-Robert Müller and Prof. Dr. Franz Király.

*Tasks:* Preparation and lecturing of exercise sessions complementing the lectures “Machine Learning 1” and “Machine Learning 2 – Theory and Application”.

Visualization and animation of data and learning algorithms discussed in the lecture.

#### Teaching Assistant

Oct '09 – Sep '11

Teaching assistant to Prof. Dr. Marc Alexa, Prof. Dr. Odej Kao and Prof. Dr. Oliver Brock.

*Tasks:* Course instruction for algorithmic and practical foundations of computer science (B.Sc.).

*Curriculum:* Basic and advanced Java development, software engineering and OOP concepts, algorithms on image and graph data, among others.

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## Education

Berlin Institute of Technology/TU Berlin

BERLIN, GERMANY

**PhD in Machine Learning** (with distinction / “summa cum laude”)

2013 – 2018

*Research focus* on methods and applications of *explainable AI (XAI)*:

Layer-wise Relevance Propagation, Deep Taylor Decomposition, Spectral Relevance Analysis, et cetera.

20 published and peer-reviewed research papers with over 2000 citations according to Google Scholar.

*Thesis*: “Opening the machine learning black box with Layer-wise Relevance Propagation”

Supervision headed by Prof. Dr. Klaus-Robert Müller.

**Master of Science degree in Computer Science**

2010 – 2013

Heavy focus on machine learning, computer vision and large scale data processing. Development dominantly using C++, C#, Java, Matlab and python.

My thesis introduces a precursor concept to “Layer-wise Relevance Propagation” for interpreting predictions of Bag of Words image processing pipelines with-multiple-kernel SVMs.

*Thesis*: “On Pixel-wise Predictions from Image-wise Bag of Words Classification” (Grade: 1.0 / A)

Supervision headed by Prof. Dr. Alexander Binder.

**Bachelor of Science degree in Computer Science**

2007 – 2010

Focus on algorithms, software development and data analysis using imperative (Java, C, C++) and functional (OPAL) programming languages.

*Thesis*: “Keyword-Based Image Browsing of Large Image Databases” (Grade: 1.0 / A)

Supervision headed by Prof. Dr. Kristian Hildebrand.

Deutschhaus-Gymnasium/DHG

WÜRZBURG, GERMANY

**Abitur** (pre-university secondary education)

1998 – 2007

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## Skills

**Technical specialties:** Extensive experience in software development using various languages, tools and environments: (e.g. python, Linux, bash, git, subversion, Slurm, Sun Grid Engine, Matlab, HTML, C#, C++, C, Java, lua, SQL, ...)

Proficiency in scientific working and writing (e.g. L<sup>A</sup>T<sub>E</sub>X, Inkscape, ...),

the development and application of machine learning methods

(e.g. SVMs, DNNs, preprocessing pipelines, embeddings, clustering, ...),

in various application domains

(text, audio, video, images, time series and biomechanical data, ...).

**Natural languages:** German (*mother tongue*), English (*full professional proficiency*).

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## Awards

**Hugo-Geiger-Prize (2019, 1st place)** Förderpreis für herausragende Promotionsleistungen

**Freunde des HHI (2019)** Förderpreis für exzellente wissenschaftliche Arbeiten am HHI

**ERCIM (2019, finalist)** Cor Baayen Young Researcher Award

**Best Paper Prize (2016)** ICML'16 Workshop on Visualization for Deep Learning

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## Patents

**Relevance Score Assignment for Artificial Neural Networks** (submitted 2015)

granted: RU 2703343, CA 2979579

pending: EP 3271863A1, JP 2018513507A, US 15710455

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## Publications

Journal Articles

Hägele M, Seegerer P, **Lapuschkin S**, Bockmayr M, Samek W, Klauschen F, Müller K-R and Binder A (2020).

“Resolving Challenges in Deep Learning-based Analyses of Histopathological Images using Explanation Methods”.

In: *Scientific Reports* 10:6423

Alber M, **Lapuschkin S**, Seegerer P, Hägele M, Schütt K T, Montavon G, Samek W, Müller K-R, Dähne S and Kindermans P-J (2019).  
 “iNNvestigate Neural Networks!”.  
 In: *Journal of Machine Learning Research* 20(93):1-8

**Lapuschkin S**, Wäldchen S, Binder A, Montavon G, Samek W and Müller K-R (2019).  
 “Unmasking Clever Hans Predictors and Assessing what Machines Really Learn”.  
 In: *Nature Communications* 10:1069

Horst F, **Lapuschkin S**, Samek W, Müller K-R and Schöllhorn W I (2019).  
 “Explaining the Unique Nature of Individual Gait Patterns with Deep Learning”.  
 In: *Scientific Reports* 9:2391

Montavon G, **Lapuschkin S**, Binder A, Samek W and Müller K-R (2017).  
 “Explaining NonLinear Classification Decisions with Deep Taylor Decomposition”.  
 In: *Pattern Recognition* 65:211-222

Samek W, Binder A, Montavon G, **Lapuschkin S**, and Müller K-R (2017).  
 “Evaluating the Visualization of what a Deep Neural Network has Learned”.  
 In: *IEEE Transactions of Neural Networks and Learning Systems*

Sturm I, **Lapuschkin S**, Samek W and Müller K-R (2016).  
 “Interpretable Deep Neural Networks for Single-Trial EEG Classification”.  
 In: *Journal of Neuroscience Methods* 274:141-145

**Lapuschkin S**, Binder A, Montavon G, Müller K-R and Samek W (2016).  
 “The Layer-wise Relevance Propagation Toolbox for Artificial Neural Networks”.  
 In: *Journal of Machine Learning Research* 17(114):1-5

**Bach S**, Binder A, Montavon G, Klauschen F, Müller K-R and Samek W (2015).  
 “On Pixel-wise Explanations for Non-Linear Classifier Decisions by Layer-wise Relevance Propagation”.  
 In: *PLoS ONE* 10(7):e0130140

#### Contributions to Conference Proceedings and Workshops

Kohlbrenner M, Bauer A, Nakajima S, Binder A, Samek W and **Lapuschkin S** (2020).  
 “Towards Best Practice in Explaining Neural Network Decisions with LRP”.  
 In: *Proceedings of the IEEE International Joint Conference on Neural Networks*

Sun J, **Lapuschkin S**, Samek W and Binder A (2020).  
 “Understanding Image Captioning Models beyond Visualizing Attention”.  
 In: *XXAI: Extending Explainable AI Beyond Deep Models and Classifiers. ICML Workshop*

Anders C J, Neumann D, Marinč T, Samek W, Müller K-R and **Lapuschkin S** (2020).  
 “XAI for Analyzing and Unlearning Spurious Correlations in ImageNet”.  
 In: *XXAI: Extending Explainable AI Beyond Deep Models and Classifiers. ICML Workshop*

Sun J, **Lapuschkin S**, Samek W, Zhao Y, Cheung N-M and Binder A (2020).  
 “Explain and Improve: Cross-Domain-Few-Shot-Learning Using Explanations”.  
 In: *XXAI: Extending Explainable AI Beyond Deep Models and Classifiers. ICML Workshop*

Alber M, **Lapuschkin S**, Seegerer P, Hägele M, Schütt K T, Montavon G, Samek W, Müller K-R, Dähne S and Kindermans P-J (2018).  
 “How to iNNvestigate Neural Networks’ Predictors!”.  
 In: *Machine Learning Open Source Software: Sustainable Communities. NIPS Workshop*

**Lapuschkin S**, Binder A, Müller K-R and Samek W (2017).  
 “Understanding and Comparing Deep Neural Networks for Age and Gender Classification”.  
 In: *Proceedings of the ICCV’17 Workshop on Analysis and Modeling of Faces and Gestures (AMFG)* 2017:1629-1638

Srinivasan V, **Lapuschkin S**, Hellge C, Müller K-R and Samek W (2017).  
 “Interpretable Action Recognition in Compressed Domain”.  
 In: *Proceedings of the IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)* 2017:1692-1696

**Bach S**, Binder A, Müller K-R and Samek W (2016).  
 “Controlling Explanatory Heatmap Resolution and Semantics via Decomposition Depth”.  
 In: *Proceedings of the IEEE International Conference of Image Processing (ICIP)* 2016:2271-2275

Binder A, Samek W, Montavon G, **Bach S**, and Müller K-R (2016).  
 “Analyzing and Validating Neural Network Predictions”.  
 In: *Proceedings of the ICML’16 Workshop on Visualization for Deep Learning . Best paper award winner*

**Lapuschkin S**, Binder A, Montavon G, Müller K-R and Samek W (2016).  
 “Analyzing Classifiers: Fisher Vectors and Deep Neural Networks”.  
 In: *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)* 2016:2912-2920

Montavon G, **Bach S**, Binder A, Samek W and Müller K-R (2016).  
 “Deep Taylor Decomposition of Neural Networks”.  
 In: *Proceedings of the ICML’16 Workshop on Visualization for Deep Learning* 2016:1-3

Samek W, Montavon G, Binder A, **Lapuschkin S** and Müller K-R (2016).  
 “Interpreting the Predictions of Complex ML Models by Layer-wise Relevance Propagation”.  
 In: *Proceedings of the Interpretable ML for Complex Systems NIPS’16 Workshop*

## Book Chapters

Montavon G, Binder A, **Lapuschkin S**, Samek W and Müller K-R (2019).  
 “Layer-wise relevance propagation: An Overview”.  
 In: *Explainable AI: Interpreting, Explaining and Visualizing Deep Learning* 193-209. Springer, Cham

Binder A, **Bach S**, Montavon G, Müller K-R and Samek W (2016).  
 “Layer-wise Relevance Propagation for Deep Neural Network Architectures”.  
 In: *Information Science and Applications (ICISA) 2016. Lecture Notes in Electrical Engineering* 276:913-922. Springer, Singapore

Binder A, Montavon G, **Lapuschkin S**, Müller K-R and Samek W (2016).  
 “Layer-wise Relevance Propagation for Neural Networks with Local Renormalization Layers”.  
 In: *Lecture Notes in Computer Science* 9887:63-71. Springer, Berlin/Heidelberg

## Preprints

Aeles J, Horst F, **Lapuschkin S**, Lacourpaille L, and Hug F (2020).  
 “Revealing the unique features of each individual’s muscle activation signatures”.  
 In: *bioRxiv* 2020.07.23.217034

Sun J, **Lapuschkin S**, Samek W and Binder A (2020).  
 “Explanation-Guided Training for Cross-Domain Few-Shot Classification”.  
 In: *CoRR abs/2007.08790*

Goh G S W, **Lapuschkin S**, Weber L, Samek W and Binder A (2020).  
 “Understanding Integrated Gradients with SmoothTaylor for Deep Neural Network Attribution”.  
 In: *CoRR abs/2004.10484*

Samek W, Montavon G, **Lapuschkin S**, Anders C J, and Müller K-R (2020).  
 “Toward Interpretable Machine Learning: Transparent Deep Neural Networks and Beyond”.  
 In: *CoRR abs/2003.07631*

Sun J, **Lapuschkin S**, Samek W and Binder A (2020).  
 “Understanding Image Captioning Models beyond Visualizing Attention”.  
 In: *CoRR abs/2001.01037*

Anders C J, Marinč T, Neumann D, Samek W, Müller K-R and **Lapuschkin S** (2019).  
 “Analyzing ImageNet with Spectral Relevance Analysis: Towards ImageNet un-Hans’ed”.  
 In: *CoRR abs/1912.11425*

Yeom S-K, Seegerer P, **Lapuschkin S**, Wiedemann S, Müller K-R and Samek W (2019).  
 “Pruning by Explaining: A Novel Criterion for Deep Neural Network Pruning”.  
 In: *CoRR abs/1912.08881*

Horst F, Slijepcevic D, **Lapuschkin S**, Raberger A-M, Zeppelzauer M, Samek W, Breiteneder C, Schöllhorn W I and Horsak B (2019).  
 “On the Understanding and Interpretation of Machine Learning Predictions in Clinical Gait Analysis Using Explainable Artificial Intelligence”.  
 In: *CoRR abs/1912.07737*

Becker S, Ackermann M, **Lapuschkin S**, Müller K-R and Samek W (2018).  
 “Interpreting and Explaining Deep Neural Networks for Classification of Audio Signals”.  
 In: *CoRR abs/1807.03418*

Schwenk G and **Bach S** (2014).  
 “Detecting Behavioural and Structural Anomalies in Media-Cloud Applications”.  
 In: *CoRR abs/1409.8035*