

I am a PhD student in computer vision who is passionate about theory and practice. I have five years of computer vision experience in industry, and in my PhD, I am applying computer vision techniques to digital pathology to improve the quality of cancer prognoses based on medical images. My research interests include weakly supervised learning, self-supervised learning, and vision-language models. I am always excited to work on new problems, not only by developing new deep learning models, but also seeing that they are deployed efficiently and have a real-world impact.

## Education

- since Aug 2021 **Doctor of Philosophy (PhD), Computer Science**, *University of St Andrews*, Scotland.  
My PhD is under the supervision of Dr Ognjen Arandjelović and lies at the intersection of deep learning and computer vision for computational pathology, funded by the NHS.
- Sep 2017 – Jun 2021 **Master in Science (MSci), Computer Science**, *University of St Andrews*, Scotland.  
(2<sup>nd</sup> year direct entry) First-Class Honours, GPA: 95%  
Master's thesis: "Determining chess game state from an image" (grade: 20.0/20).  
Honours level courses include machine learning, AI principles & practice, language & computation, data-intensive systems, information visualisation, concurrency & multi-core architectures, constraint programming, software architecture, software engineering, complexity, OS, databases, data encoding, component technology, logic, software verification, compiler design & implementation.
- 2005 – 2017 **International Baccalaureate and Abitur**, *Dresden International School*, Germany.  
IB Diploma: 40 points, German Abitur: 1.3  
Valedictorian. Higher level subjects: maths, physics, computer science.

## Experience

- since Nov 2024 **Researcher**, *Else Kröner Fresenius Center for Digital Health (EKFZ)*, Dresden, Germany  
I am a Postdoc at Kather Lab at EKFZ for Digital Health, working on LLMs in medicine and deep learning for digital pathology.
- Jul-Oct 2024 **Research Intern**, *Google*, London, UK  
Conducted comprehensive evaluation of FitBit's activity recognition model, focusing on performance across diverse activity classes and demographic groups. Identified and quantified key failure modes, performed an in-depth analysis of root causes, and communicated actionable recommendations for model improvement to cross-functional teams.
- Jul-Sep 2023 **Research Intern**, *Else Kröner Fresenius Center for Digital Health (EKFZ)*, Dresden, Germany  
During an internship at Prof Jakob Kather's Clinical AI research group at EKFZ for Digital Health (part of Dresden University of Technology), I developed a novel multi-zoom deep learning model for whole slide image classification, performed an extensive benchmarking study of self-supervised feature extractors for histopathology, and participated in various other projects including a study assessing the use of LLMs in oncology. Papers are currently in preparation.
- Jan-Mar 2023 **PhD Placement**, *Lay Summaries Ltd*, Glasgow, Scotland  
Developed a NLP pipeline for automating the generation of lay summaries of EU clinical trials in a part-time PhD placement funded by The Data Lab.
- May 2018 – May 2022 **Working Student – Computer Vision**, *Robotron Datenbank-Software*, Dresden, Germany  
Gained practical experience in deep learning and software engineering by developing deep learning models and deploying them to production in the Realtime Computer Vision (RCV) department.
  - Designed and implemented containerised infrastructure for automatically training, evaluating, and deploying TensorFlow and PyTorch models for industrial use cases.
  - Selected and trained deep learning models for various industrial use cases, including a system for a car manufacturer that reduced the error rate of detecting faulty parts by 90%.
- Jun-Aug 2019 **Software Engineering Intern**, *J.P. Morgan*, Glasgow, Scotland  
Developed a data visualisation and reporting dashboard for an automated testing framework using Python, React, TypeScript, and SQL that gave the team new insights. Gained hands-on experience with Scrum, working in a team, and prioritising requirements from different stakeholders.

## Skills

- Programming Python, C/C++, Java, SQL, JavaScript, TypeScript, Haskell, C#,  $\LaTeX$
- Technologies PyTorch, Triton, TensorFlow, Keras, JAX, Docker, Dask, Apache Spark, Postgres, React

## Prizes and awards

- 2020 Adobe Prize (£750) for the highest GPA in Senior Honours Computer Science  
2018 – 2021 4x Dean's List Award of Academic Excellence at the University of St Andrews  
2017 Valedictorian at Dresden International School; subject awards for maths and computer science  
2010 – 2017 12x High Honour Roll (GPA over 6.0 of 7) at Dresden International School

## Publications

### Under review

- 2024 T. Lenz, P. Neidlinger, M. Ligerio, **G. Wölflein**, M. van Treeck, and J. N. Kather, *Unsupervised foundation model-agnostic slide-level representation learning*, under review, Nov. 2024. ([link](#))
- M. Ligerio, T. Lenz, **G. Wölflein**, O. S. M. El Nahhas, D. Truhn, and J. N. Kather, *Abnormality-driven representation learning for radiology imaging*, under review, Nov. 2024. ([link](#))
- D. Ferber, L. Hilgers, I. C. Wiest, M.-E. Leßmann, J. Clusmann, P. Neidlinger, J. Zhu, **G. Wölflein**, J. Lammert, M. Tschochohei, H. Böhme, D. Jäger, M. Aldea, D. Truhn, C. Höper, and J. N. Kather, *End-to-end clinical trial matching with large language models*, under review, Jul. 2024. ([link](#))
- G. Wölflein**, D. Ferber, A. R. Meneghetti, O. S. M. El Nahhas, D. Truhn, Z. I. Carrero, D. J. Harrison, O. Arandjelović, and J. N. Kather, *Benchmarking pathology feature extractors for whole slide image classification*, under review, Jun. 2024. ([link](#))
- D. Ferber, O. S. M. El Nahhas, **G. Wölflein**, I. C. Wiest, J. Clusmann, M.-E. Leßman, S. Foersch, J. Lammert, M. Tschochohei, D. Jäger, M. Salto-Tellez, N. Schultz, D. Truhn, and J. N. Kather, *Autonomous artificial intelligence agents for clinical decision making in oncology*, under review, Apr. 2024. ([link](#))
- 2023 **G. Wölflein**, L. C. Magister, P. Liò, D. J. Harrison, and O. Arandjelović, *Deep multiple instance learning with distance-aware self-attention*, under review, May 2023. ([link](#))

### Conference papers

- 2024 O. S. M. El Nahhas, **G. Wölflein**, M. Ligerio, T. Lenz, M. van Treeck, F. Khader, D. Truhn, and J. N. Kather, "Joint multi-task learning improves weakly-supervised biomarker prediction in computational pathology," in *International Conference on Medical Image Computing and Computer-Assisted Intervention (MICCAI)*, Springer Nature Switzerland, Oct. 2024, pp. 254–262. ([link](#))
- G. Wölflein**, D. Ferber, A. R. Meneghetti, O. S. M. El Nahhas, D. Truhn, Z. I. Carrero, D. J. Harrison, O. Arandjelović, and J. N. Kather, "A good feature extractor is all you need for weakly supervised pathology slide classification," in *European Conference on Computer Vision (ECCV)*, BiImage Computing Workshop (oral), Springer, Sep. 2024. ([link](#))
- 2023 **G. Wölflein**, I. H. Um, D. J. Harrison, and O. Arandjelović, "HoechstGAN: Virtual lymphocyte staining using generative adversarial networks," in *Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision (WACV)*, Jan. 2023, pp. 4997–5007. ([link](#))

### Journal articles

- 2024 D. Ferber, **G. Wölflein**, I. C. Wiest, M. Ligerio, S. Sainath, N. G. Laleh, O. S. M. El Nahhas, G. Müller-Franzes, D. Jäger, D. Truhn, and J. N. Kather, "In-context learning enables multimodal large language models to classify cancer pathology images," *Nature Communications*, vol. 15, no. 1, p. 10 104, Nov. 2024. ([link](#))

\*equal contribution

O. S. M. El Nahhas, M. van Treeck, **G. Wölflein**, M. Unger, M. Ligerio, T. Lenz, S. J. Wagner, K. J. Hewitt, F. Khader, S. Foersch, D. Truhn, and J. N. Kather, "From whole-slide image to biomarker prediction: End-to-end weakly supervised deep learning in computational pathology," *Nature Protocols*, Sep. 2024. ([link](#))

D. Ferber, I. C. Wiest, **G. Wölflein**, M. P. Ebert, G. Beutel, J.-N. Eckardt, D. Truhn, C. Springfield, D. Jäger, and J. N. Kather, "GPT-4 for information retrieval and comparison of medical oncology guidelines," *NEJM AI*, vol. 1, no. 6, Alcs2300235, May 2024. ([link](#))

2023 **G. Wölflein\***, I. H. Um\*, D. J. Harrison, and O. Arandjelović, "Whole-slide images and patches of clear cell renal cell carcinoma tissue sections counterstained with Hoechst 33342, CD3, and CD8 using multiple immunofluorescence," *Data*, vol. 8, no. 2, Feb. 2023. ([link](#))

2022 R. De Filippis\*, **G. Wölflein\***, I. H. Um, P. D. Caie, S. Warren, A. White, E. Suen, E. To, O. Arandjelović, and D. J. Harrison, "Use of high-plex data reveals novel insights into the tumour microenvironment of clear cell renal cell carcinoma," *Cancers*, vol. 14, no. 21, Nov. 2022. ([link](#))

2021 **G. Wölflein** and O. Arandjelović, "Determining chess game state from an image," *Journal of Imaging*, vol. 7, no. 6, Jun. 2021. ([link](#))

### Abstracts

2023 D. Alouges, **G. Wölflein**, I. H. Um, D. Harrison, O. Arandjelović, C. Battail, and S. Gazut, *Performance comparison between federated and centralized learning with a deep learning model on Hoechst stained images*, ISMB/ECCB Abstracts, Jul. 2023. ([link](#))

### Datasets

2022 **G. Wölflein**, I. H. Um, D. J. Harrison, and O. Arandjelović, *Whole slide images and patches of clear cell renal cell carcinoma counterstained with multiple immunofluorescence for Hoechst, CD3, and CD8*, BioImage Archive, Dec. 2022. ([link](#))

2021 **G. Wölflein** and O. Arandjelović, *Dataset of rendered chess game state images*, Open Science Foundation, May 2021. ([link](#))

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## Invited talks

Feb 2024 **Tissue Image Analytics (TIA) Centre, University of Warwick**

A good feature extractor is all you need for weakly supervised learning in histopathology ([link](#))

Apr 2022 **KATY EU Project**

High-plex data reveal novel insights into the tumour microenvironment of clear cell renal cell carcinoma (with Raffaele De Filippis)

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## Selected projects and coursework

2021 **Determining chess game state from an image**, *master's thesis*, grade: 20.0/20



For my master's thesis, I developed a system for identifying the chess position from a photo of a chess game using deep learning and traditional computer vision techniques, achieving a 23× reduction in error rate compared to the previous state of the art. It also includes a one-shot transfer learning approach to adapt to an unseen chess set based on just two images. This project received 90+ stars on GitHub.

2020 **Recap: configuration management for reproducible research**, *Python package*



Research should be reproducible. Especially in deep learning, it is important to keep track of hyperparameters and configurations used in experiments. I had to write similar configuration management code in several projects, so I created a Python package and published it on PyPI.

2020 **Freeing neural training through surfing**, *SH project*, grade: 19.0/20



For my undergraduate thesis, I investigated the local minimum problem in neural networks and developed a novel technique for training neural networks. Through this project, I developed independent research skills whilst learning a lot about the internals of neural networks. The report is available [here](#).

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## Courses and training

Dec 2023 Focus on Peer Review, *Nature Masterclasses*.

- Mar 2023 Clinicum Digitale, *Dresden University of Technology*: attended a two-week interdisciplinary spring school on medicine and technology.
- Jun 2020 Deep Learning Specialisation, *Coursera*.
- May 2020 PyTorch for Deep Learning and Computer Vision, *Udemy*.
- Sep 2019 Mathematics for Machine Learning Specialisation, *Coursera*.
- Sep 2019 TensorFlow 2.0: A Complete Guide on the Brand New TensorFlow, *Udemy*.
- 2013 – 2014 C/C++ Course, *Volkshochschule Dresden (Community College Dresden)*.

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## Service

- 2024 Reviewer for *ECCV BIC*
- 2023 Reviewer for *CVPR* and *npj Precision Oncology*

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## Volunteering

- 2021 – 2022 **Developmental squad representative**, *University of St Andrews Volleyball Club*  
I was elected to represent the recreational volleyball team within the committee and club decision-making process. This role helped me improve communication and organisational skills.
- 2018 – 2020 **Secretary**, *University of St Andrews Muscle and Athletics Sports Society (MASS)*  
As secretary of MASS, I was in charge of coordinating meetings, writing minutes, and taking care of administrative tasks. This position has helped me develop teamwork and organisational skills.
- 2010 – 2017 **Volunteer firefighter**, *Freiwillige Feuerwehr Possendorf*  
I am passionate about giving back to the community. Since age eleven, I was a youth fire fighter in my local fire department. In 2015, I completed the training qualification to become a member of the adult fire department, and participated in active service until I moved to Scotland in September 2017.

In my free time, I enjoy playing chess, volleyball, lifting weights, and improvising on the piano.