HELMHOLTZ AI | ARTIFICIAL INTELLIGENCE COOPERATION UNIT

Introduction of Helmholtz AI young investigator groups (YIGs)

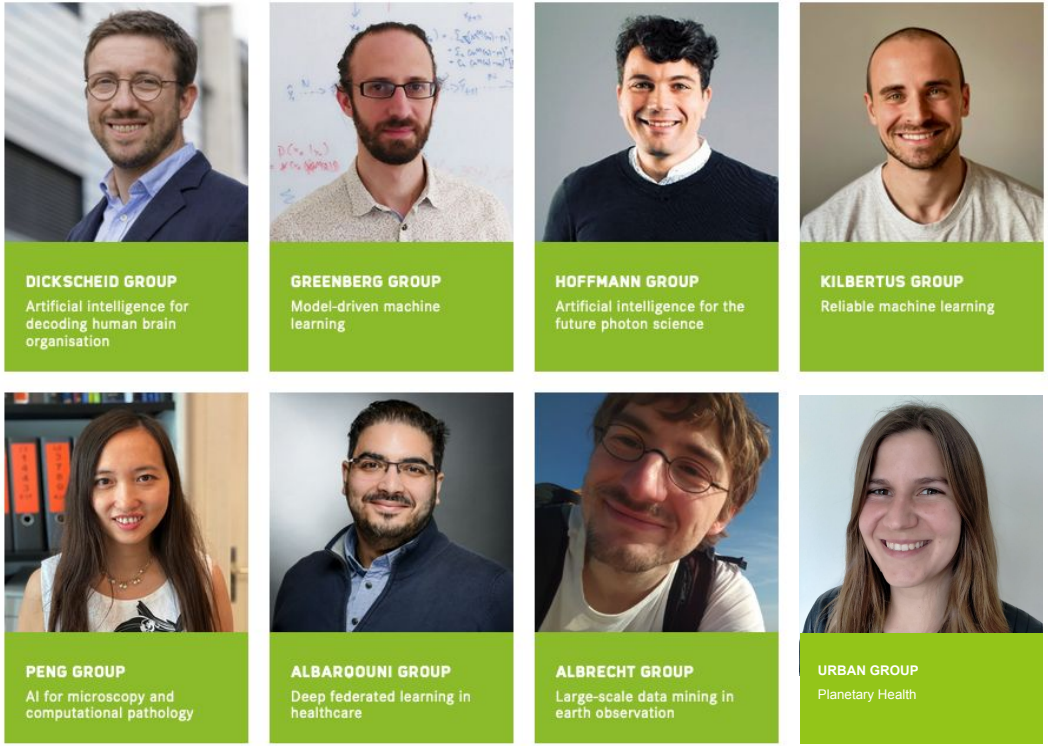
Tingying Peng
Helmholtz AI central unit
Helmholtz Munich

Helmholtz AI

Young investigator groups

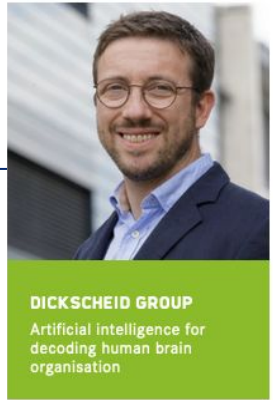
8 young investigator groups (YIGs)

- They provide new scientific topics and strategies, and
- promote young talents.



Dickscheid Group @ FZJ

Artificial intelligence for decoding human brain organisation



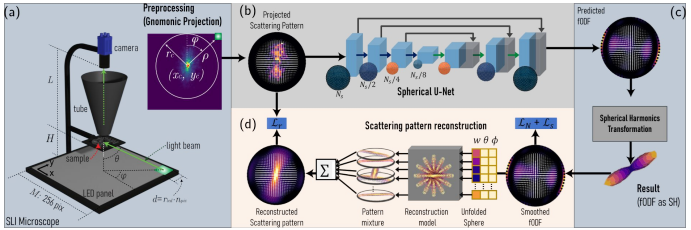
Research lines:

- Machine Learning and Computer Vision for biomedical image analysis
- High throughput imaging and HPC environments for microscopy
- Neuroinformatics

Main projects:

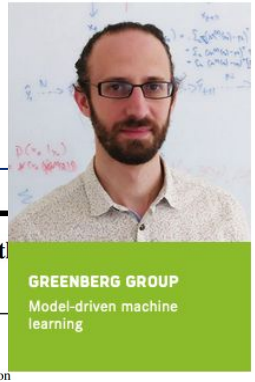
- Development of an online accessible multimodal human brain atlas with cellular resolution
- AI-driven image registration for micrometer resolution biomedical images
- Deep Learning methods for brain mapping and instance segmentation of microstructural objects

Vaca et al. (2021)
GORDA: Graph-based ORientation Distribution Analysis of SLI scatterometry Patterns of Nerve Fibres, ISBI 2022
Best Paper Award finalist



Greenberg Group @ Hereon

Model-driven machine learning



Physical models

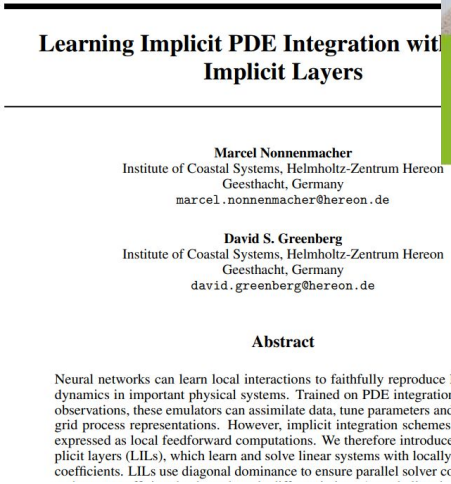
Numerical simulations based on known physics simulators handle complex systems well, but struggle with data assimilation, parameter tuning and uncertainty quantification.

Machine Learning

Conversely, machine learning techniques can absorb and process large datasets, but typically ignore physics and generalize poorly to new scenarios.

Model-driven Machine Learning

We develop hybrid methods that combine the advantages of deep learning and physical modeling in a Bayesian framework.



Learning Implicit PDE Integration wit
Implicit Layers

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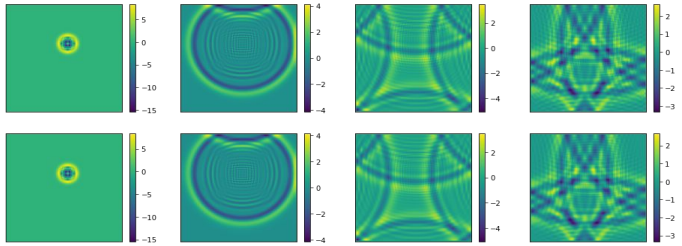
Abstract

Neural networks can learn local interactions to faithfully reproduce large-scale dynamics in important physical systems. Trained on PDE integrations or noisy observations, these emulators can assimilate data, tune parameters and learn sub-grid process representations. However, implicit integration schemes cannot be expressed as local feedforward computations. We therefore introduce linear implicit layers (LILs), which learn and solve linear systems with locally computed coefficients. LILs use diagonal dominance to ensure parallel solver convergence

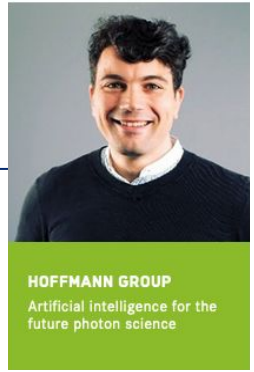
Shallow water equations

CNN with implicit linear layers



Hoffmann Group @ HZDR

Artificial intelligence for future photon science

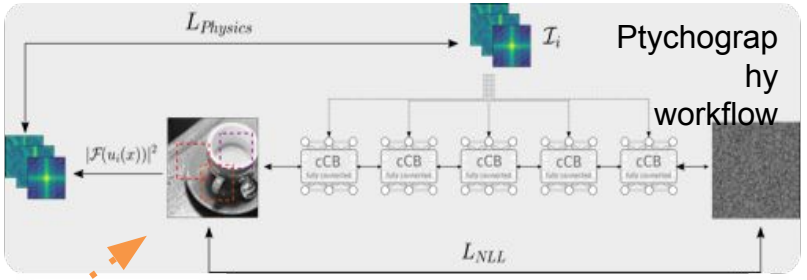


Goals:

- to loop between theory and experiment
- research data-driven digital twinning techniques
- stimulate theoretical comprehension and experimental validation of very complex dynamics involved in laser-particle acceleration

(deep) physics prior for unsupervised reconstruction

our (fancy) imaging data at DESY, XFEL, …



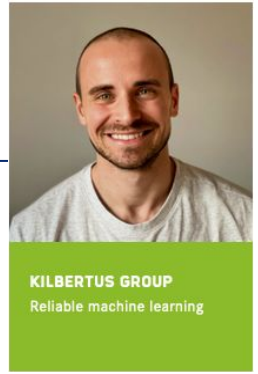
Ptychography workflow

solution of inverse imaging problem

supervised training of memory

Kilbertus Group @ Helmholtz Munich

Reliable machine learning



Niki Kilbertus named **Assistant Professor** at TUM Informatics for *Ethics in Systems Design and Machine Learning!*

Goal:

- Investigate machine learning systems that interact with humans, e.g. by making consequential decisions, affecting our behaviour, or challenging our privacy

Focus:

- Reliable,
- Fair, and
- Privacy preserving algorithms

Multi-disciplinary fairness considerations in machine learning for clinical trials

Isabel Chien, Nina Deliu, Richard Turner, Adrian Weller, Sofia Villar, **Niki Kilbertus**

To appear at FAccT 2022

Peng Group @ Helmholtz Munich

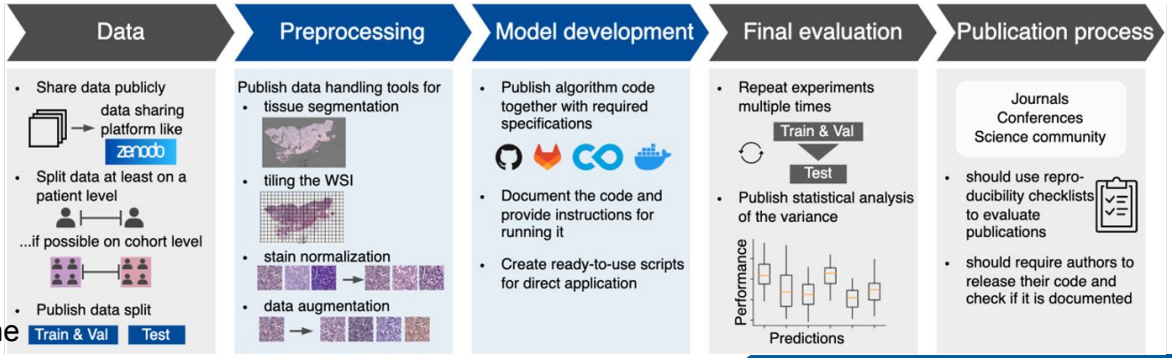
AI for microscopy and computational pathology

Goal:

- create new AI methods to analyse microscopic images quantitatively and efficiently,
- to help life scientists and pathologists to extract more knowledge

Main projects:

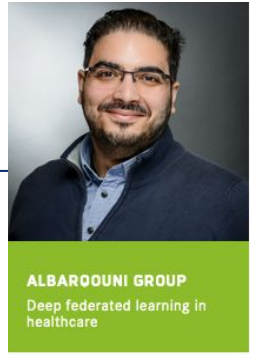
- large diversity of different microscopy modalities, such as Cryo-electron tomography (Cryo-ET),
- extended depth-of-field (EDOF) microscope with “Electrically Tunable Lenses” (ETL),
- 3D light-sheet microscopy, and
- lens-free microscopy.



Wagner et al. (2022) Accepted by Nature Medicine

Albarqouni Group @ Helmholtz Munich

Deep federated learning in healthcare



- **Medical Imaging with Deep Learning:** We will continue our research directions to develop fully-automated, high accurate solutions that save export labor and efforts, and mitigate the challenges in medical imaging.

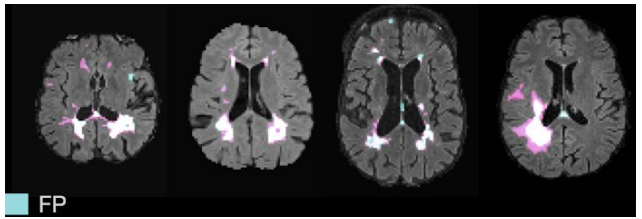
- **Federated Learning in Healthcare:** We will focus our research on developing innovative deep Federated Learning algorithms that can distill and share the knowledge among AI agents in a robust and privacy-preserved fashion.

- **Affordable AI and Healthcare:** In addition, we are interested in developing affordable AI solutions suitable for poor-quality data generated by low infrastructure and point-of-care diagnosis.

FedDis: Disentangled Federated Learning for Unsupervised Brain Pathology Segmentation

CI Bercea, B Wiestler, D Rueckert, **S Albarqouni**

Preprint on arXiv (https://arxiv.org/abs/2103.03705)
Presented at MICCAI'21 -DCL Workshop.
Extended and almost Accepted in Nature Machine Intelligence 2022



Urban Group @ Helmholtz Munich

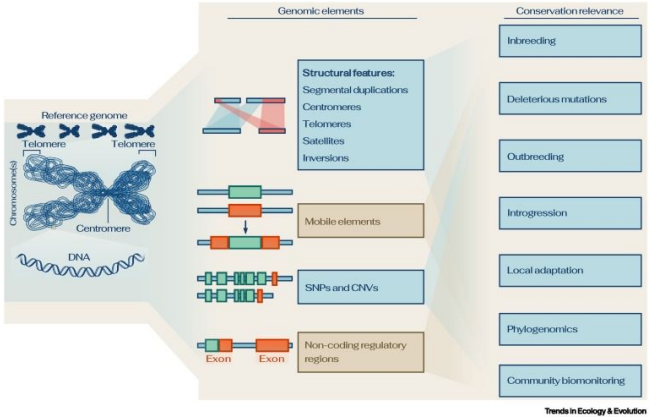
Planetary Health

NEW: group started on 01 June 2022

Research topics:

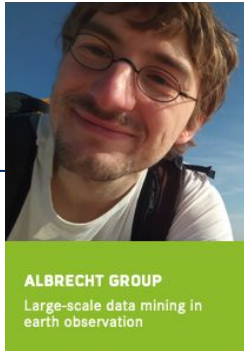
- leveraging genomics and AI to study the diversity and distribution of bioaerosols and their impact on human health, also in the context of climate change;
- pioneering portable genomic and data analysis approaches for in situ real-time detection and classification of pathogens;
- monitoring the spread of zoonotic diseases in the context of animal health/biodiversity conservation and global health.

The era of reference genomes in conservation genomics.
G Formenti, (...), **L Urban**, (...)., M Bálint (2022)
Trends in Ecology & Evolution 37, 3: 197-202.



Albrecht Group @ DLR

Large-scale data mining in Earth observation



Goal:

- apply and advance state-of-the-art methodologies in semi-supervised machine learning for large-scale spatio-temporal Earth observation data

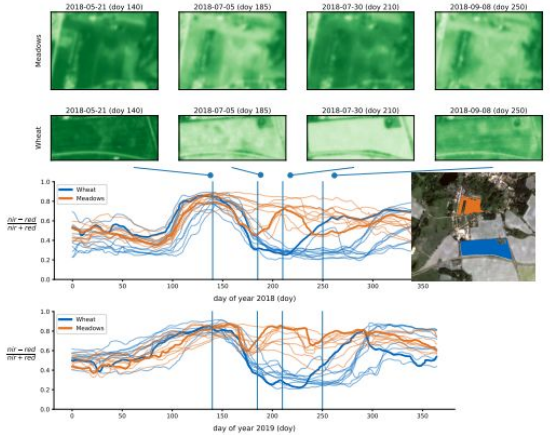
Research interests:

- machine learning and numerical optimization to advance AI for spatio-temporal data
- development of scalable algorithms and compute pipelines for scientific big data analytics
- remote sensing archeology and contribution to open source software

DENETHOR: The DynamicEarthNET dataset for Harmonized, inter-Operable, analysis-Ready, daily crop monitoring from space

L Kondmann, A Toker, M Rußwurm, A Camero, D Peressuti, G Milcinski, P Mathieu, N Longépé, T Davis, G Marchisio, L Leal-Taixé and X Zhu

NeurIPS 2021 Datasets and Benchmarks



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