Introduction of Helmholtz AI consultant teams

Tobias Weigel Helmholtz Al local unit German Climate Computing Center (DKRZ)

Consulting

Flexible, dynamic and transparent setting up of (free!) collaborations with the Helmholtz Al consultant teams



COLLABORATION

EXPLORATION -- up to 2 weeks REALISATION -- up to 6 months

REVIEW

Formal criteria (Science management) Scientific criteria (Al consultants)

SUBMISSION

Through official online form at submission website

IDEA

Selecting, testing and implementing ML methods, knowledge transfer and networking, training and workshops, benchmark datasets...

voucher-system.helmholtz.ai

More info: bit.ly/HelmholtzAlvoucher



AI consultant teams

6 AI consultant teams

- One consultant team per Helmholtz AI local unit.
- They ensure translation of expertise into the immediate research domain of their respective units.



HELMHOLTZ AI

Helmholtz AI consultants @ DKRZ

Earth & Environment-focused AI consultant team

Example: Cyclone monitoring with scattered GPS

- Predict wind speed from 2D scatter map
- Process up to 10⁹ samples/year (4.8 TB)
- Outperforms classical algorithm by 27%

Dense Laver

MaxPool Layer

Dropout

Helmholtz AI project at GFZ / DLR

2x filter

Ancillary

narameter





Helmholtz Al

 10^{4}

10

10

25

in bin

eader @ DKR7



Helmholtz Al consultant team consultant @ DKRZ

Helmholtz Al consultant @ DKRZ









DANU CAUS Helmholtz Al consultant @ DKR7

HARSH GROVER Helmholtz Al consultant @ DKRZ

Andrey Vlasenko Helmholtz Al Consultant @ DKRZ





HELMHOLTZ

Asgarimehr, Arnold, Weigel, Ruf, Wickert, Remote Sensing of Environment (2022) doi:10.1016/j.rse.2021.112801

Helmholtz Al consultants @ KIT

Energy-focused AI consultant team

- Detection of thermal bridges in rooftop insulation on infrared recording of overhead aerial drone videos
 - Outperforms manual state-of-the-art
 - Learns expensive 3D modelling in-the-loop
- Joint publication and open-source software package
- Showcased on ZDF at Volle Kanne





Mayer, Z., Kahn, J., Hou, Y. and Volk, R., 2021, June. Al-based thermal bridge detection of building rooftops on district scale using aerial images. In *Proceedings of the EG-ICE 2021 Workshop on Intelligent Computing in Engineering proceedings, Berlin, Germany* (Vol. 30).



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Helmholtz AI consultants @ HMGU

Health-focused AI consultant team

Realisation voucher by Dr Pavlo Lutsik (DKFZ):

Systematic evaluation of cell-type deconvolution pipelines on whole-genome bisulfite sequencing data

Approach:





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Helmholtz Al consultants @ HZDR

Matter-focused AI consultant team

Consultants success story

 Title: <u>Machine Learning State-of-the-Art with Uncertainties</u> (accepted ICLR'22 workshop paper)

Challenge:

Observation in Vouchers: many published model architectures don't at all or work much worse on real data than on benchmark datasets in publications

Results:

- include uncertainties (confidence intervals) in publication plots (support authors and reviewers to consolidate paper findings)
- use approximations (where appropriate) for confidence intervals to avoid expensive training under cross-validation
- applied approximations to ICLR'22 spotlight paper <u>"How do Vision Transformers work?"</u> (see figures);



Repro of Fig. 12







SEBASTIAN STARKE Helmholtz Al consultant @ HZDR

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Helmholtz Al consultants @ DLR

Aeronautics, Space & Transport-focused AI consultant team

Collaboration with the Institute of Space Propulsion

- Title: Application of CNNs for Segmentation of Infrared Images
- Challenge: Detect anomalies in the combustion process of hybrid rockets
- Proposed solution/approach: Use local outlier factor to detect anomalous artifacts and phenomena
- Results: Multiple spurious behaviors are detected. The results were published *Rüttgers, A. and Petrarolo, A.,* 2021. Local anomaly detection in hybrid rocket combustion tests. Experiments in Fluids, 62(7), pp.1-16





Helmholtz Al consultants @ FZJ

Information-focused AI consultant team

Consultants success story - Differentiable Rendering for the DLR Soar Tower

- Idea and Concept:
 - Thousands of *heliostats* reflect the sun light to the DLR Solar Tower
 - Imperfections of the surface create non-ideal flux distributions
 - FZJ AI consultant team supports with techniques from the realm of AI to model the real flux distributions
- Goals + Solution:
 - We use differentiable rendering to simulate the reflection process in PyTorch
 - We reconstruct the heliostat surface from single images and predict intensity profiles for unseen sun positions



The DLR Solar tower





Non-ideal flux distribution







JAN EBERT Helmholtz Al consultant @ JSC

HELMHOLTZ AI

Imperfect heliostat surface

Computing resources (HAICORE)

HAICORE | HELMHOLTZ AI COMPUTING RESOURCES

The "Helmholtz AI computing resources" (HAICORE, €2.5m) provide easy, free and **low-barrier GPU access** to the entire AI community within the Helmholtz Association.

- Ad-hoc usage for initial testing with data and/or AI methods at Karlsruhe Institute of Technology (KIT; HoreKa)
- Lightweight projects of up to 5,000 GPU hours per half year at Forschungszentrum Jülich (FZJ; Juwels Booster)







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https://helmholtzaicommunity.slack.com/join/signup#/domain-signup

