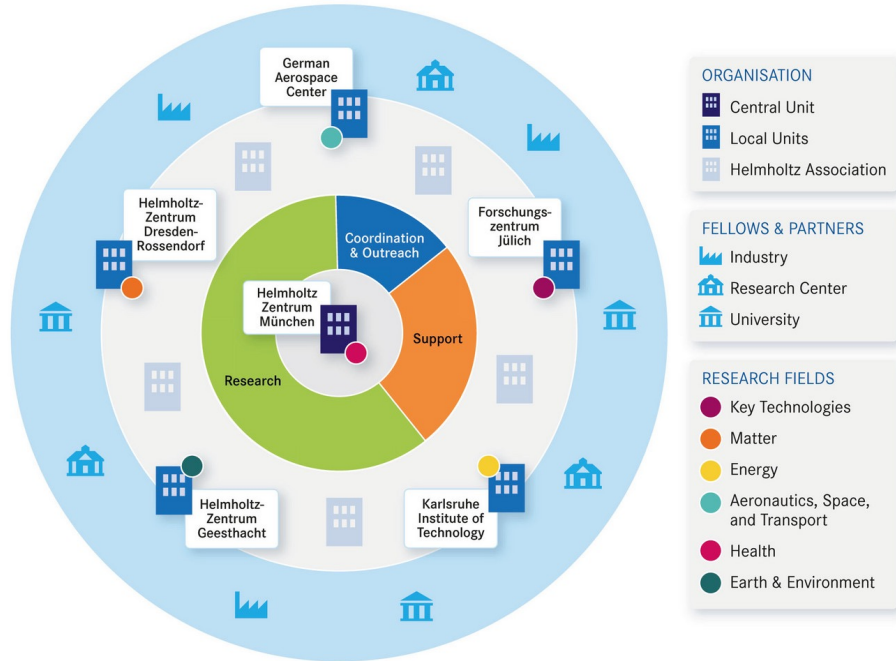


# From small data to high-performance computing: Highlights from the AI consultant team in Jülich

Stefan Kesselheim, Roshni Kamath, Alexandre Strube, Mehdi Cherti, Jan Ebert, Alina  
Bazarova, Sabrina Narimene Benassou

# Helmholtz AI

## Hub and Spokes



- Six Centers, six research fields
- Central Unit HGMU München
- Each Center:
  - AI Consultants team
  - Young Investigator's group
- **Yearly project call**
- **Goals**
  - Foster the usage of AI methods in all research fields
  - Democratize access by lowering entrance barriers
  - Stimulate creation of a dense network

# Helmholtz Data Challenges Initiative

## From Jülich Challenges to Helmholtz Challenges

- Idea: Provide Helmholtz' own data challenges platform
- Challenge formulation following FAIR+ principles
- Submission evaluation according to scientific standards
- Platform for hackathons, conferences, ...
- Raise visibility of scientific questions & datasets

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### Helmholtz Data Challenges

Helmholtz Challenges is a platform for scientific data challenges. We host data challenges on the edge of scientific discovery promoting unique scientific data and according research problems. We target Machine Learning researchers, image and data analysts, looking for a new playing field and new and interesting data to work on.

[Host Challenge](#) [Participate](#)  
How to host a challenge? How to participate in a challenge?

### Popular Challenges

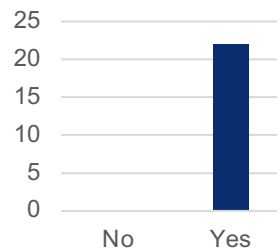


# H<sup>3</sup>: Helmholtz Herbst Hackathon

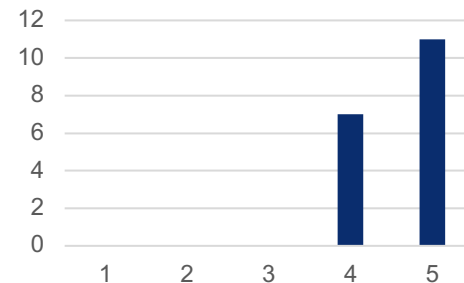
## Four days of hacking in Gummersbach (Sep 2021)

- 45 PhD students from HIDA schools
- Six Challenges, provided by **Jülich Challenges**
- Two keynotes, two poster sessions
- Compute provided by HAICORE (+ intro course)
- And finally real people!

Recommendation for young researchers?



Hackathon program





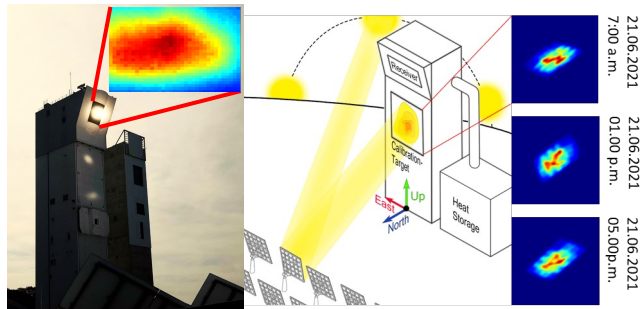
# Differentiable Rendering @DLR Solarturm Jülich

## Voucher Project



Thousands of *heliostats* reflect sunlight to the solar tower.

Imperfections of the surface create non-ideal flux distributions.



Jan Ebert



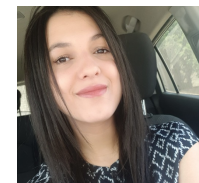
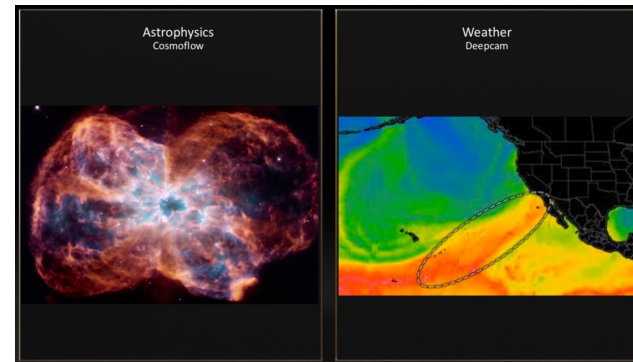
We reconstruct the heliostat surface from **single images** and predict intensity profiles for unseen sun positions.



# MLPerf Training HPC

## Highly Parallel Training of Neural Networks

- Active contributions to the MLCommons working group
- Training on up to 3072 GPUs on JUWELS Booster
- Based on containerized solution from NVIDIA
- IO Optimization (HDF5)
- Hacking around PyTorch problems for 2048+ GPUs



1.0-1110	HelmholtzAI	horeka_gpu_n512_pytorch1.10	Intel Xeon Platinum 8368	256	NVIDIA A100-PCIE-40GB	512	PyTorch 1.10		4.36
1.0-1111	HelmholtzAI	juwelsbooster_gpu_n1024_mxnet1.9	AMD EPYC 7402	512	NVIDIA A100-SXM4-40GB	1024	MXNet 1.9	16.73	
1.0-1112	HelmholtzAI	juwelsbooster_gpu_n1024_pytorch1.10	AMD EPYC 7402	512	NVIDIA A100-SXM4-40GB	1024	PyTorch 1.10		2.73
1.0-1113	HelmholtzAI	juwelsbooster_gpu_n2048_pytorch1.10	AMD EPYC 7402	1024	NVIDIA A100-SXM4-40GB	2048	PyTorch 1.10		2.56

# Large Language Model

## Interesting behaviour + a lot to find out

### (a) Few-shot

Q: Roger has 5 tennis balls. He buys 2 more cans of tennis balls. Each can has 3 tennis balls. How many tennis balls does he have now?

A: The answer is 11.

Q: A juggler can juggle 16 balls. Half of the balls are golf balls, and half of the golf balls are blue. How many blue golf balls are there?

A:

(Output) The answer is 8. ✗

### (c) Zero-shot

Q: A juggler can juggle 16 balls. Half of the balls are golf balls, and half of the golf balls are blue. How many blue golf balls are there?

A: The answer (arabic numerals) is

(Output) 8 ✗

### (b) Few-shot-CoT

Q: Roger has 5 tennis balls. He buys 2 more cans of tennis balls. Each can has 3 tennis balls. How many tennis balls does he have now?

A: Roger started with 5 balls. 2 cans of 3 tennis balls each is 6 tennis balls.  $5 + 6 = 11$ . The answer is 11.

Q: A juggler can juggle 16 balls. Half of the balls are golf balls, and half of the golf balls are blue. How many blue golf balls are there?

A:

(Output) The juggler can juggle 16 balls. Half of the balls are golf balls. So there are  $16 / 2 = 8$  golf balls. Half of the golf balls are blue. So there are  $8 / 2 = 4$  blue golf balls. The answer is 4. ✓

### (d) Zero-shot-CoT (Ours)

Q: A juggler can juggle 16 balls. Half of the balls are golf balls, and half of the golf balls are blue. How many blue golf balls are there?

A: **Let's think step by step.**

(Output) There are 16 balls in total. Half of the balls are golf balls. That means that there are 8 golf balls. Half of the golf balls are blue. That means that there are 4 blue golf balls. ✓

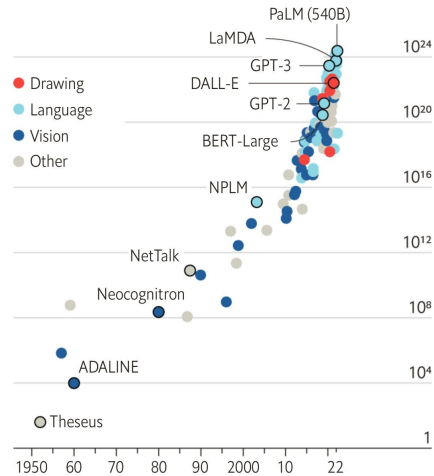
# Large Language Models

## The power of scale

AT&T Wi-Fi 21:07 62%  
< Weekly AA

### The blessings of scale

AI training runs, estimated computing resources used  
Floating-point operations, selected systems, by type, log scale



Sources: "Compute trends across three eras of machine learning", by J. Sevilla et al, arXiv, 2022; Our World in Data

Training compute (FLOPs) of milestone Machine Learning systems over time

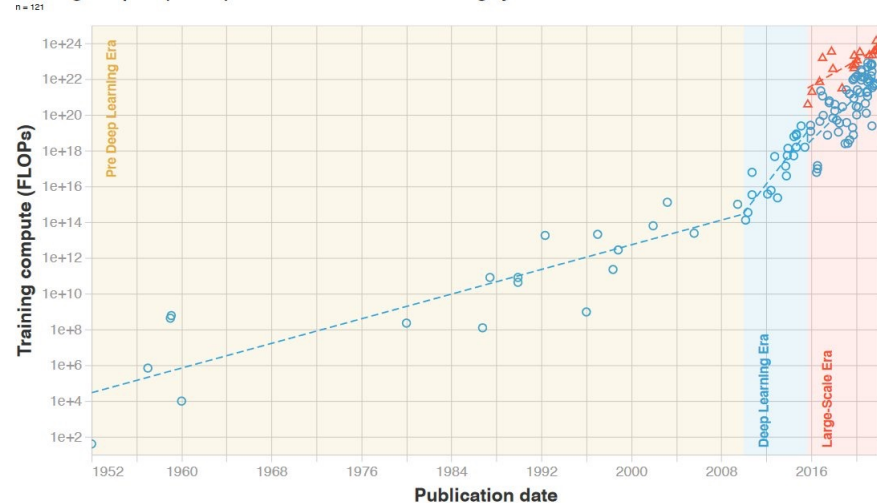


Figure 1: Trends in  $n = 121$  milestone ML models between 1952 and 2022. We distinguish three eras. Notice the change of slope circa 2010, matching the advent of Deep Learning; and the emergence of a new large-scale trend in late 2015.



# OpenGPT-X consortium

Developing a Gaia-X node for large AI language models and innovative language application services

## OpenGPT-X Goals

- › Create and make available large scale language models
- › Focus on German/European languages
- › Provide a scenario for vertical integration with use cases
  - TopExpert: Usage in insurance sector
  - WDR: Usage for digital assistants for program



# Helmholtz AI Consulting @JSC

## Acknowledgements – the team

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Alina Bazarova



Sabrina Narimene  
Benassou



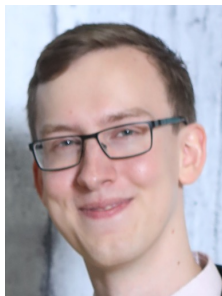
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Aamod Kulkarni