

# Helmholtz AI for accelerator physics

an introduction



HELMHOLTZ **AI**

Peter Steinbach  
*HZDR / Mar 9, 2021*

# What is AI?

# “Artificial Intelligence”!

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## 1956 Dartmouth Conference: The Founding Fathers of AI



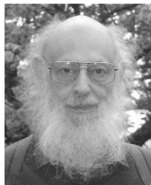
**John McCarthy**



**Marvin Minsky**



**Claude Shannon**



**Ray Solomonoff**



**Alan Newell**



**Herbert Simon**



**Arthur Samuel**



**Oliver Selfridge**



**Nathaniel Rochester**



**Trenchard More**

# Machine Learning Landscape

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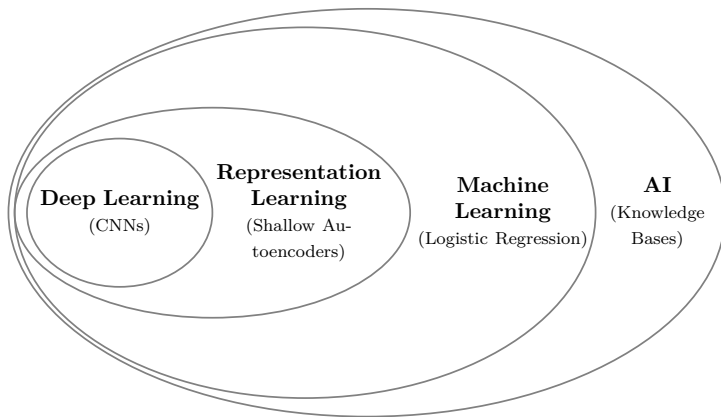
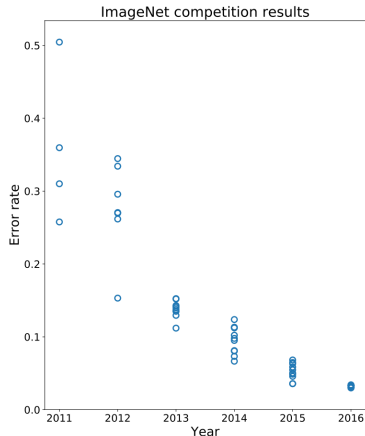


Figure: I. Goodfellow, Deep Learning, MIT Press

# Deep Learning Boom in Classification



2012, three things merged:

✓ machine learning

🗄️ (large) datasets

+ 🎮 GPUs

[en.wikipedia.org/ImageNet](https://en.wikipedia.org/ImageNet)

# Object Localisation and Segmentation



Figure: [github.com/matterport/Mask\\_RCNN](https://github.com/matterport/Mask_RCNN)

# Domain Transfer

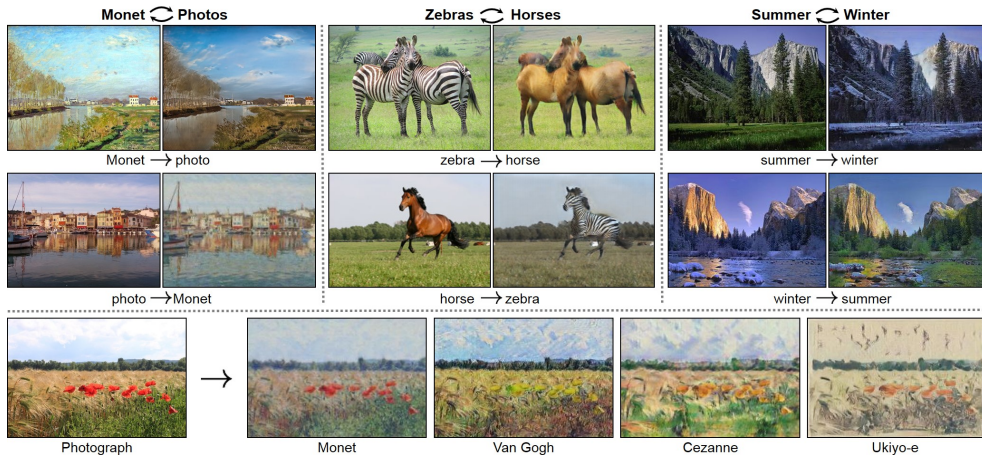


Figure: [github.com/junyanz/CycleGAN](https://github.com/junyanz/CycleGAN)

# Helmholtz AI



## What is Helmholtz AI?

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- initiative by President of the Helmholtz Association, Prof. Otmar D. Wiestler

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- central installation in Munich  
(universities and Helmholtz center)

# Our Steering Board



**FABIAN THEIS**

Scientific director  
HAICU  
Helmholtz Zentrum  
München



**FRANK JENKO**

Max Planck  
Institute for  
Plasma Physics



**GUIDO  
JÜCKELAND**

Helmholtz-Zentrum  
Dresden-  
Rossendorf



**JUDITH KATZY**

Deutsches  
Elektronen-  
Synchrotron



**ANDREAS  
KOSMIDER**

Helmholtz  
Association



**LARS MEHWALD**

Helmholtz  
Association



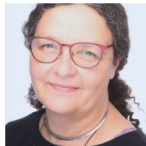
**RALF MIKUT**

Karlsruhe Institute  
of Technology



**MORRIS RIEDEL**

Forschungszentrum  
Jülich



**CORINNA  
SCHRUM**

Helmholtz-Zentrum  
Geesthacht



**OLIVER STEGLE**

German Cancer  
Research Center



**FREDERIK  
TILMANN**

German Research  
Centre for  
Geosciences



**XIAOXIANG ZHU**

German Aerospace  
Center

## Two Funding Lines

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### Helmholtz AI Projects



unsplash.com:Glenn Carstens-Peters

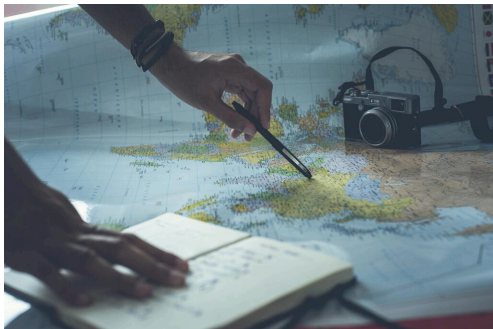
### Helmholtz AI Vouchers



unsplash.com:Dominik Scythe

# Helmholtz AI Projects

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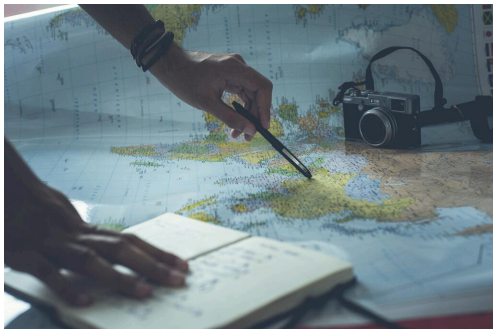


[unsplash.com:Glenn Carstens-Peters](https://unsplash.com/photos/Glenn-Carstens-Peters)

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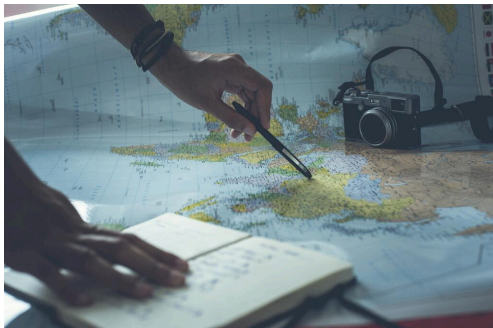
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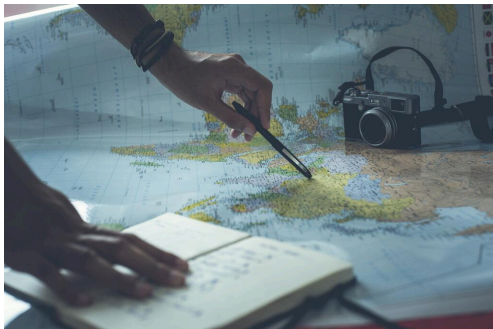


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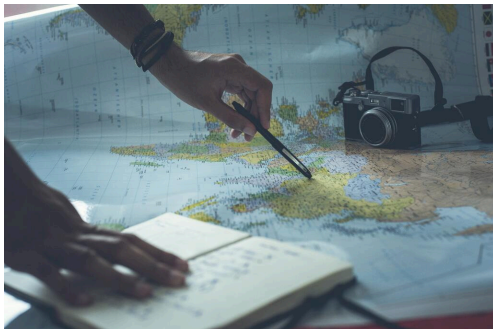


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  - 2019: 18/58 selected

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  - 2019: 18/58 selected
  - 2020: 19/62 selected

# Helmholtz AI Vouchers

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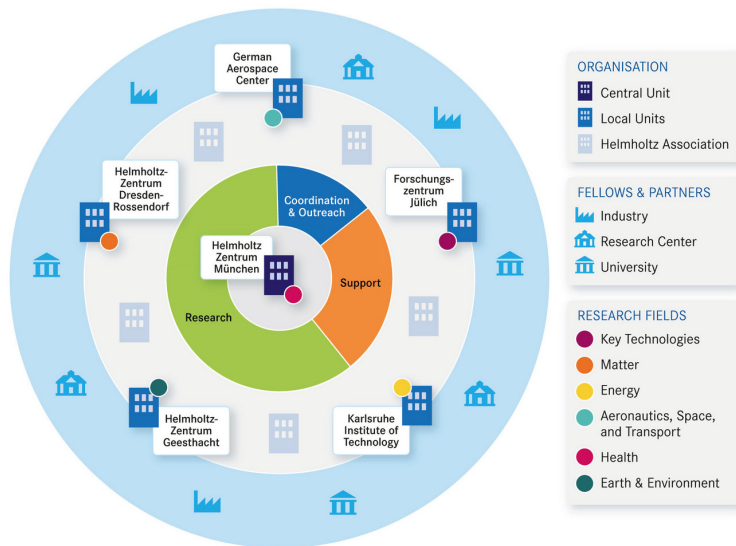
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(2 weeks to 6 months FTE)
- **free of charge for scientists**
- additional funding available  
(travel, licenses, workshop fees)
- accepting pilot vouchers:  
[consultant-helmholtz.ai@hzdr.de](mailto:consultant-helmholtz.ai@hzdr.de)

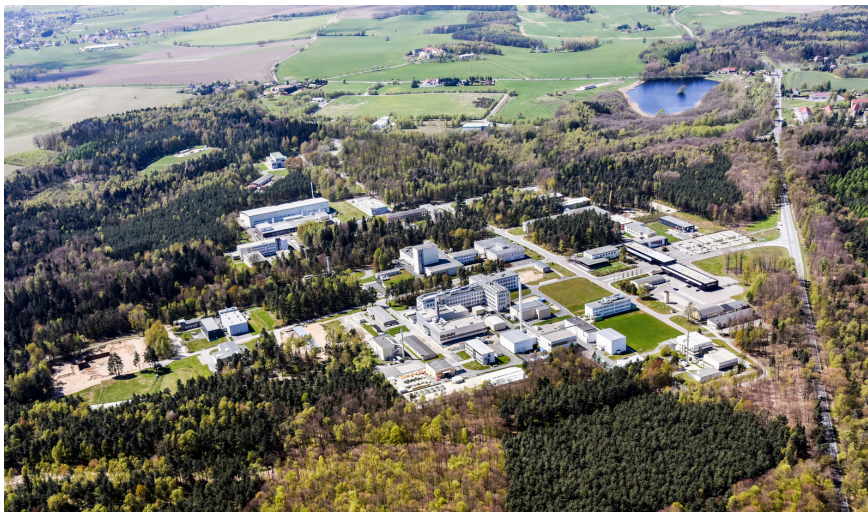
# Helmholtz AI localisation



# Helmholtz AI at Helmholtz-Zentrum Dresden-Rossendorf

# HZDR from above

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# Our Center

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Figure: HZDR/Oliver Killig

- founded January 1st, 1992
- 1200 **employees**
- **sites:** *Dresden*,  
Freiberg, Görlitz, Grenoble (France),  
Leipzig, Schenefeld near Hamburg
- operating **large-scale facilities**  
(for external and internal users from  
around the world)

# Helmholtz AI Local Unit For Matter At HZDR

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Figure: Nico Hoffmann, YIG Lead



Figure: Peter Steinbach, Consultant Lead



# Helmholtz AI Consultant Team at HZDR

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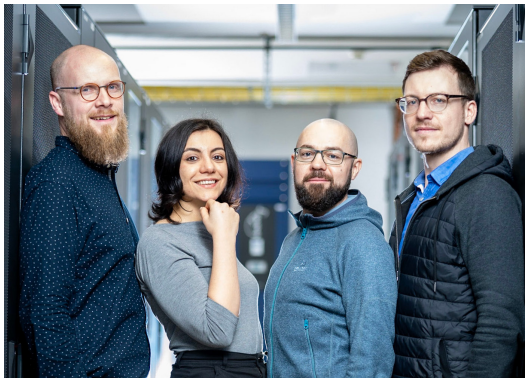
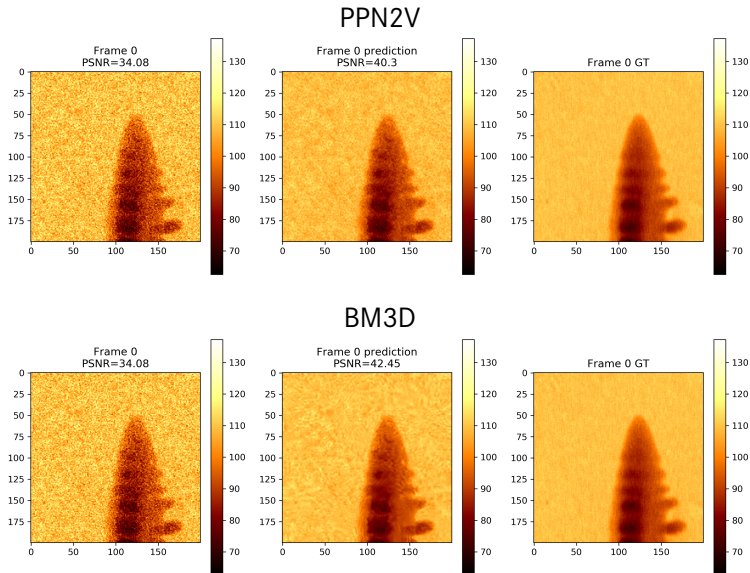


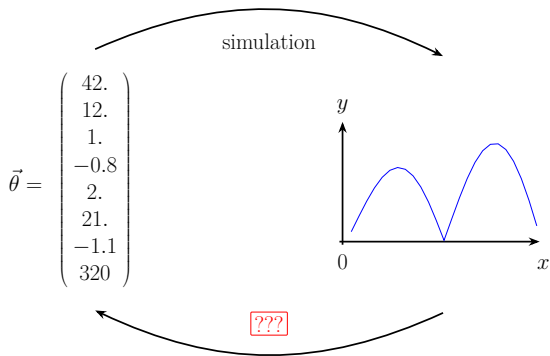
Figure: Peter Steinbach, Neda Sultova, Sebastian Starke, Helene Hoffmann, Steve Schmerler

- reproducible automated pipelines
- inverse problems
- (image) denoising
- anomaly detection
- (image) classification
- regression & pattern recognition  
(object localisation, image segmentation)

# Example Voucher: Not so Liquid Metal with HZDR



## Example Voucher: Inverting a Beamline Simulation with HZB



- application: beam profile of beamline parameters
- beam simulation of high precision available
- given experimental beam profile, what are the simulation parameters?

# Example Voucher: AI Teaching and Training with DESY HH

The screenshot shows a conference voucher interface. At the top, there is a navigation bar with icons for home, back, forward, search, calendar, and a user profile. The user profile is set to 'Public', 'Europe/Berlin', and 'P. Steinbach'. Below the navigation bar, the title '2nd Terascale School of Machine Learning' is displayed in a blue header. Underneath, the dates '1-11 March 2021' and 'Europe/Berlin timezone' are shown. A sidebar on the left contains a menu with items: Overview (selected), Timetable, Contribution List, My Conference, My Contributions, and Registration. The main content area contains a paragraph describing the school's aim and a list of topics.

2nd Terascale School of Machine Learning

1-11 March 2021  
Europe/Berlin timezone

**Overview**

- Timetable
- Contribution List
- My Conference
- My Contributions
- Registration

The school aims at PhD students and young postdocs, and offers not only a basic introduction to machine learning, but also talks from leading experts in the field on their current research projects. The list of lectures comprises:

- Introduction to Machine Learning with special focus on Deep Learning
- Latest developments and new challenges in the field.
  - Network architectures with a focus on Graph networks
  - Generative Models

- challenge: from zero to hero
- sustainable teaching using the [carpentries approach](#)
- denovo material purpose fit to audience

## Detailed Voucher: Anomaly Detection

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by Helene Hoffmann

# Summary

- Helmholtz AI is an unprecedented investment within HGF
- Helmholtz AI Projects and **Vouchers** here to support science
- Local Unit for Matter Unit at HZDR installed and operational

*Thank you for your Attention!  
Questions, Concerns, Feedback?*