PARALLEL & SCALABLE MACHINE & DEEP LEARNING @ JSC

PROF. DR. – ING. MORRIS RIEDEL, UNIVERSITY OF ICELAND / JUELICH SUPERCOMPUTING CENTRE
HEAD OF CROSS-SECTIONAL TEAM DEEP LEARNING & RDA CO-CHAIR INTEREST GROUP BIG DATA

NCSA AFFILIATES MEETING @ INTERNATIONAL SUPERCOMPUTING CONFERENCE, DALLAS, TEXAS

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

DEEP Projects

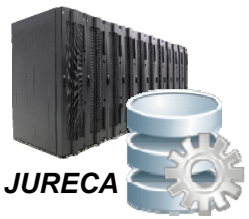
RDA
RESEARCH DATA ALLIANCE

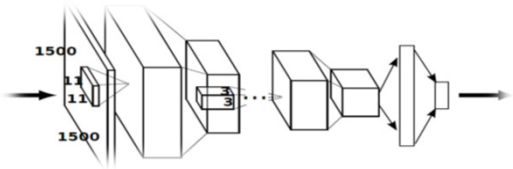
UNIVERSITY OF ICELAND
SCHOOL OF ENGINEERING AND NATURAL SCIENCES
FACULTY OF INDUSTRIAL ENGINEERING, MECHANICAL ENGINEERING AND COMPUTER SCIENCE

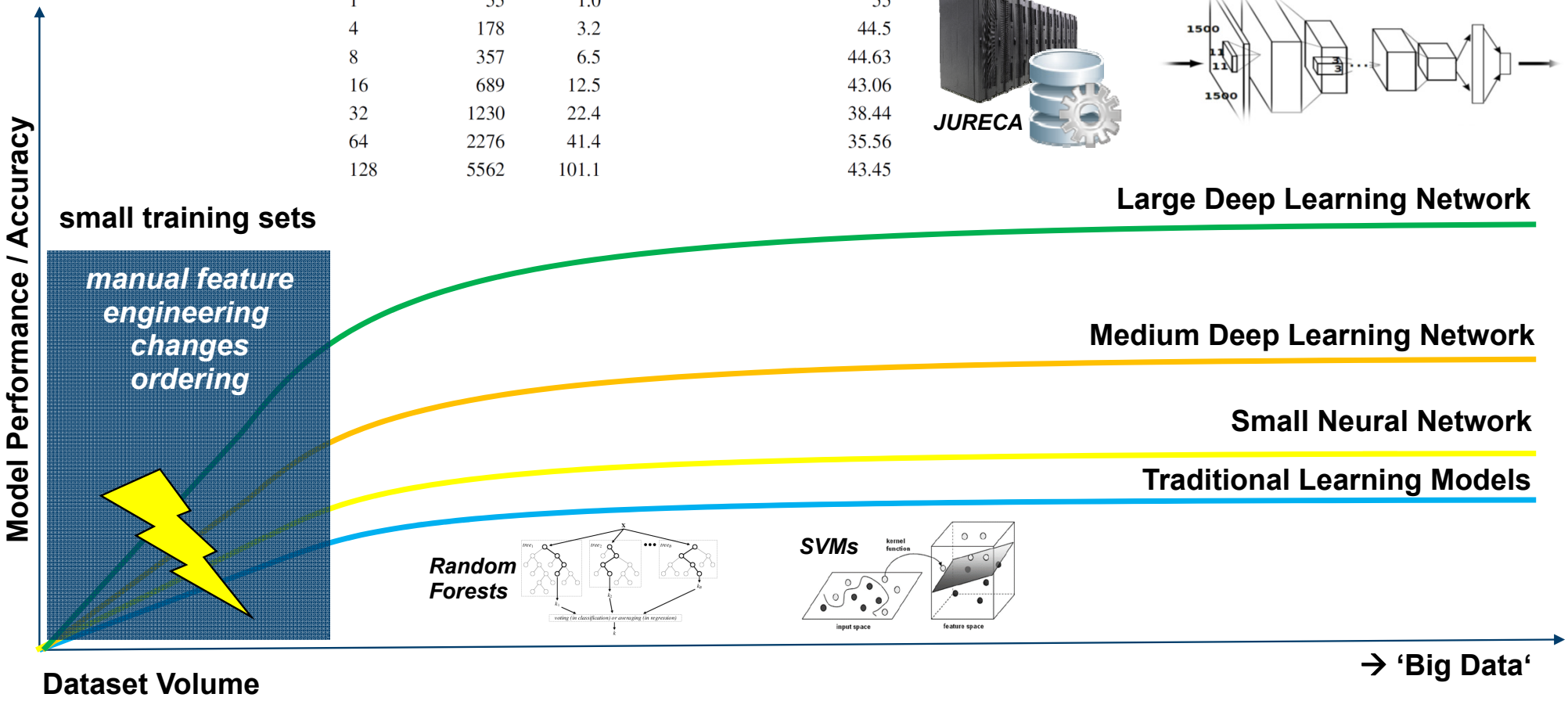
JÜLICH Forschungszentrum
JÜLICH SUPERCOMPUTING CENTRE

PARALLEL & SCALABLE MACHINE & DEEP LEARNING

#GPUs	images/s	speedup	Performance per GPU [images/s]
1	55	1.0	55
4	178	3.2	44.5
8	357	6.5	44.63
16	689	12.5	43.06
32	1230	22.4	38.44
64	2276	41.4	35.56
128	5562	101.1	43.45

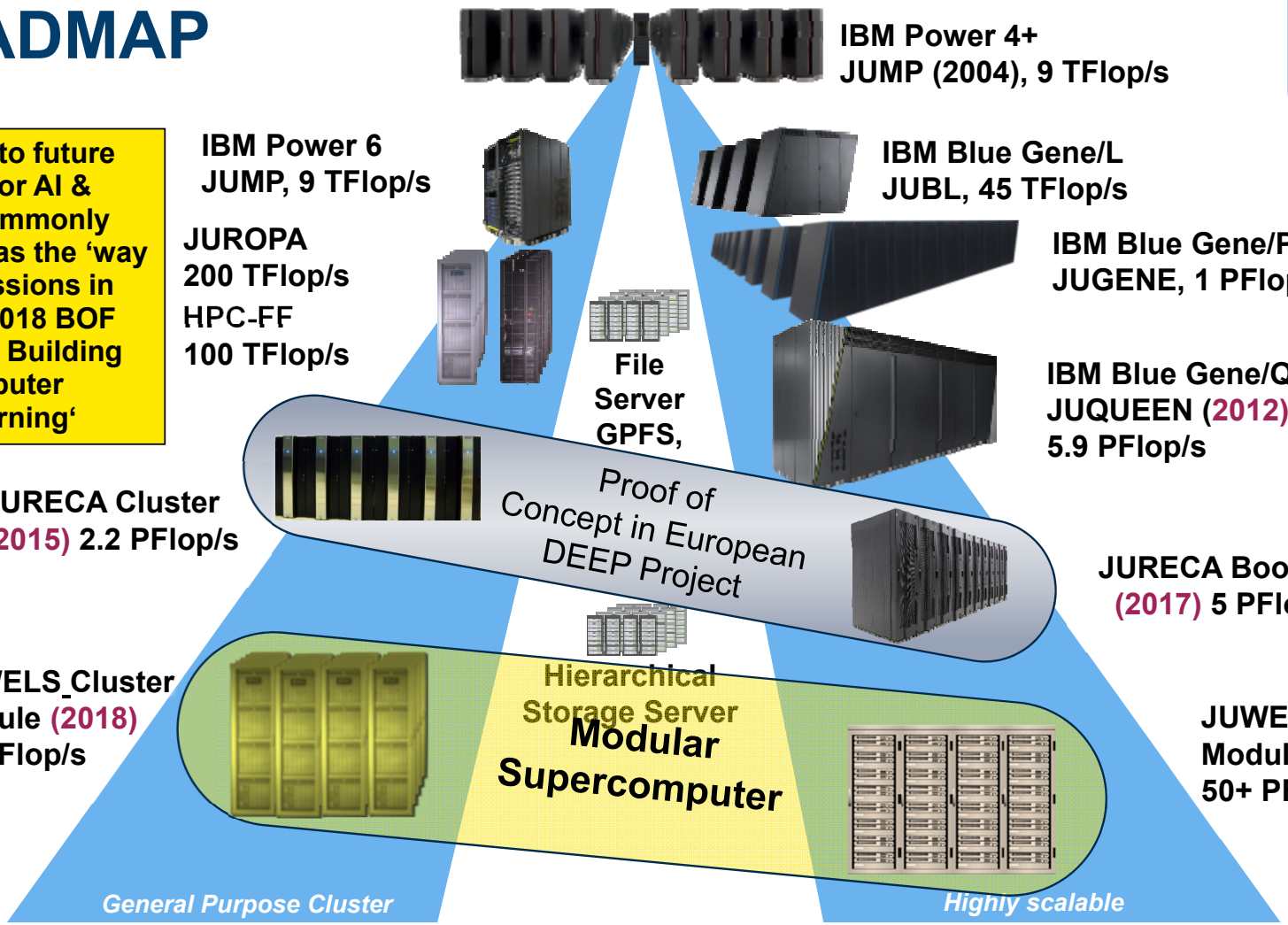






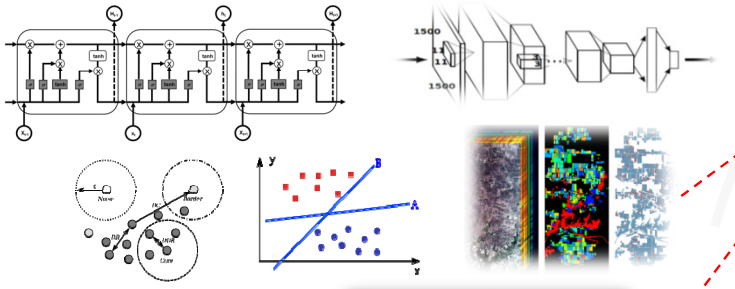
JSC ROADMAP

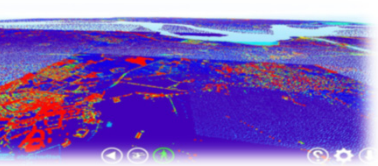
A ‘modular approach‘ to future HPC system designs for AI & Deep Learning was commonly seen by the speakers as the ‘way forward‘ during discussions in the Supercomputing 2018 BOF Session: ‘Designing & Building Next-Generation Computer Systems for Deep Learning‘

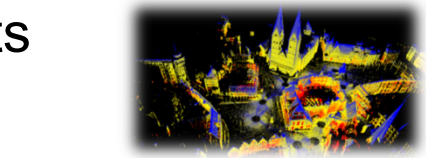


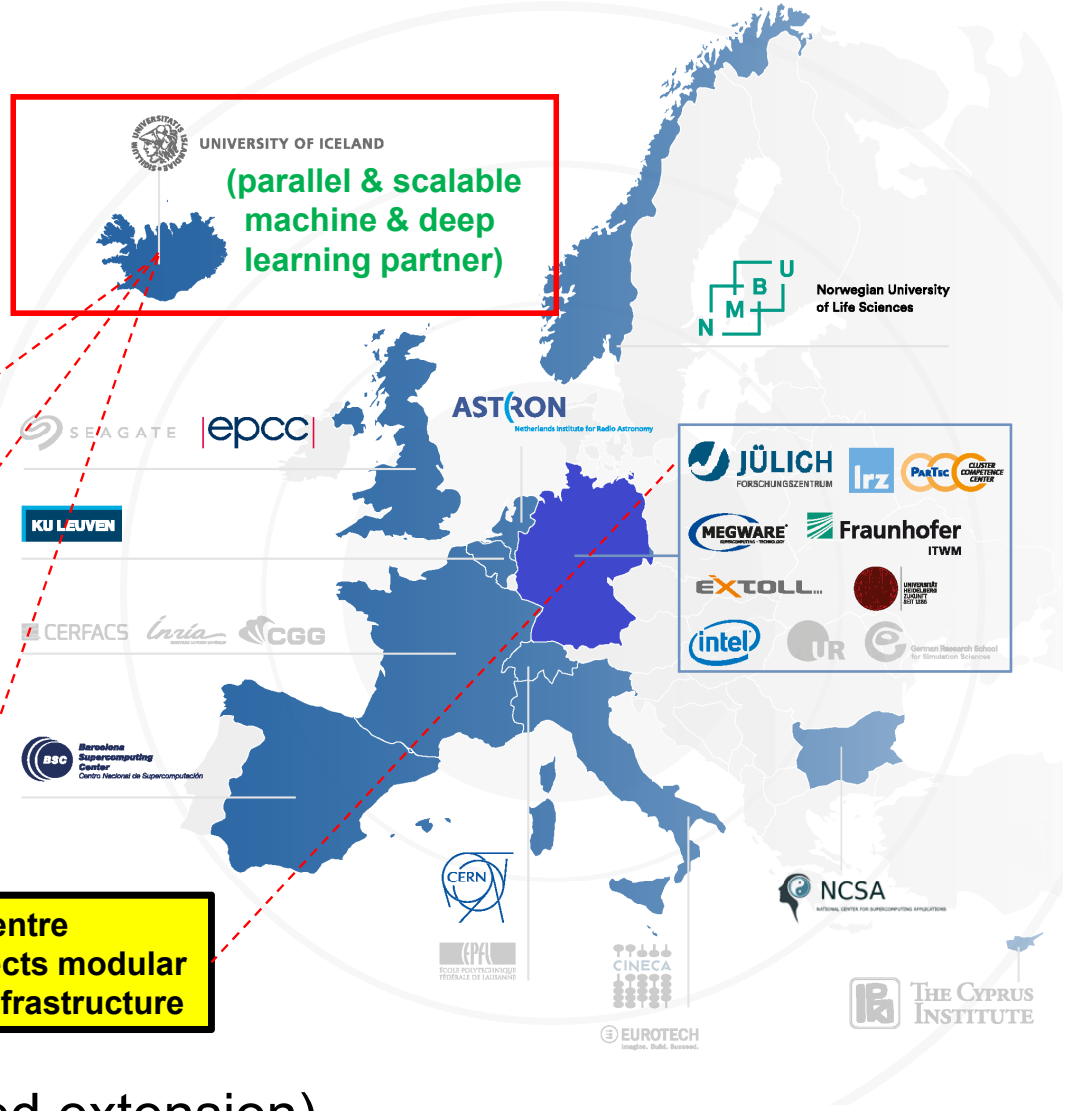
DEEP SERIES OF PROJECTS

EU Projects Driven by Co-Design of HPC Applications







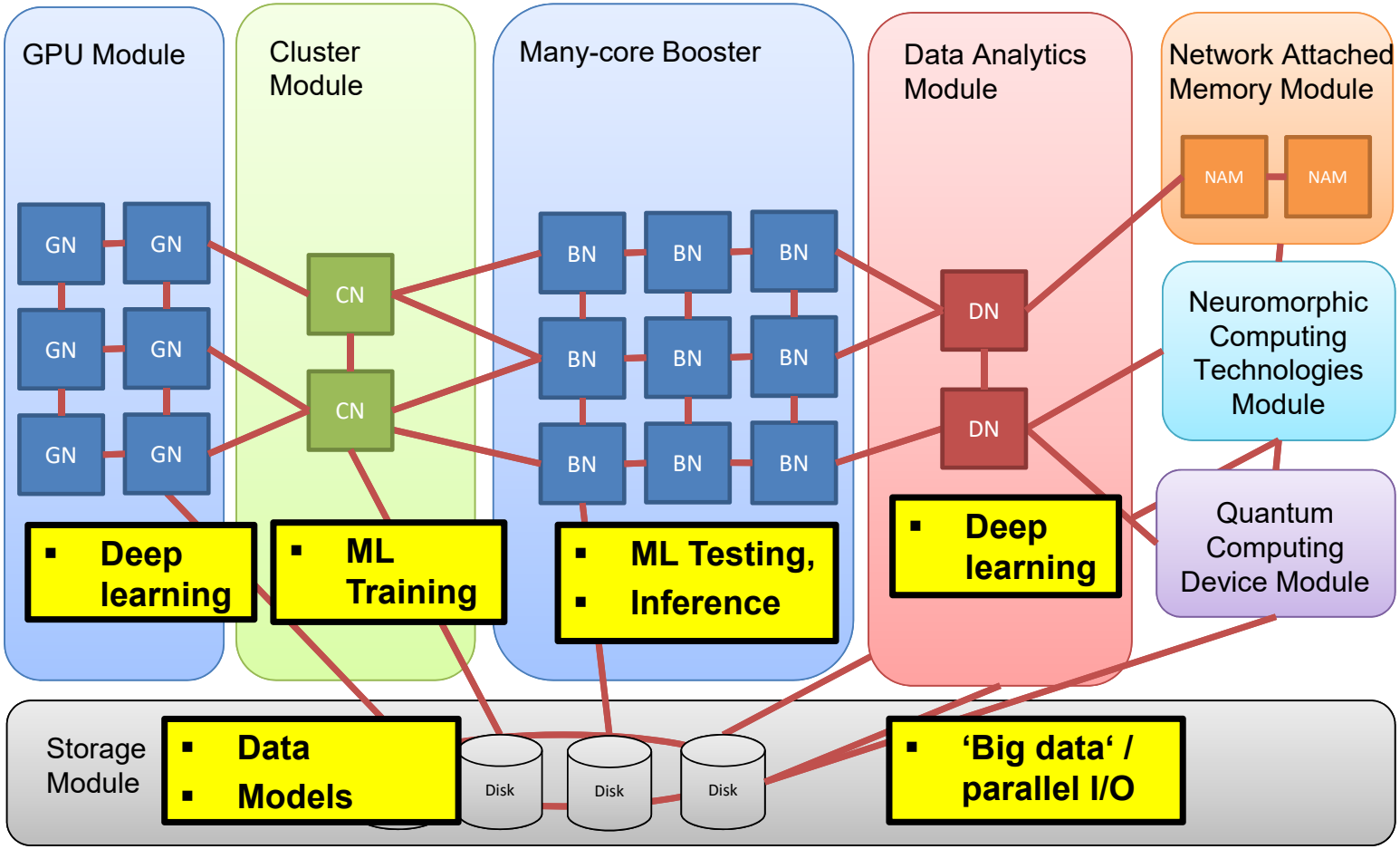


- 3 EU Exascale projects
  - DEEP
  - DEEP-ER
  - DEEP-EST
- 27 partners
  - Coordinated by JSC
- EU-funding: 30 M€
  - JSC-part > 5,3 M€
- Nov 2011 – Dec 2020 (incl. 6 month planned extension)

- **Juelich Supercomputing Centre implements the DEEP projects modular designs in its production infrastructure**

JSC – MODULAR SUPERCOMPUTING ARCHITECTURE

Modules



- **Innovative Ideas, e.g. trained models in memory**
- **Different ways for 'learning from data'**
- **Innovative Ideas, e.g. use quantum devices for certain optimization tasks**

MACHINE & DEEP LEARNING PROJECT EXAMPLE

smith
Smart Medical Information Technology for Healthcare

SPONSORED BY THE
Federal Ministry of Education and Research

MEDIZIN INFORMATIK INITIATIVE

UNIKLINIK RWTH AACHEN

ukb universitäts klinikum bonn

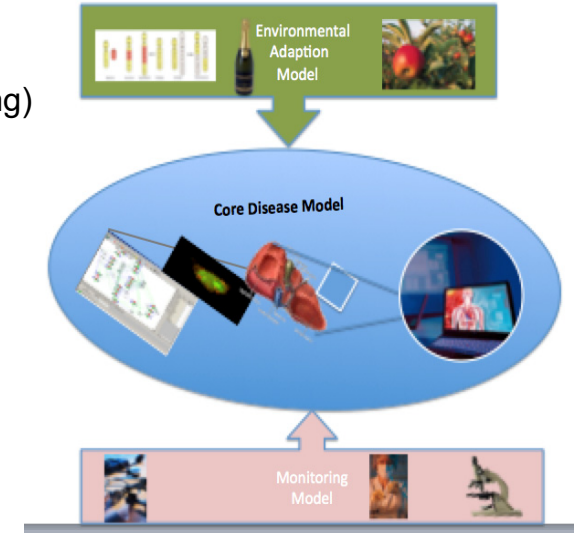
UKD Universitätsklinikum Düsseldorf

Universitätsklinikum Essen

BAYER

Patient + state paramters:
individualisation
(Machine Learning)

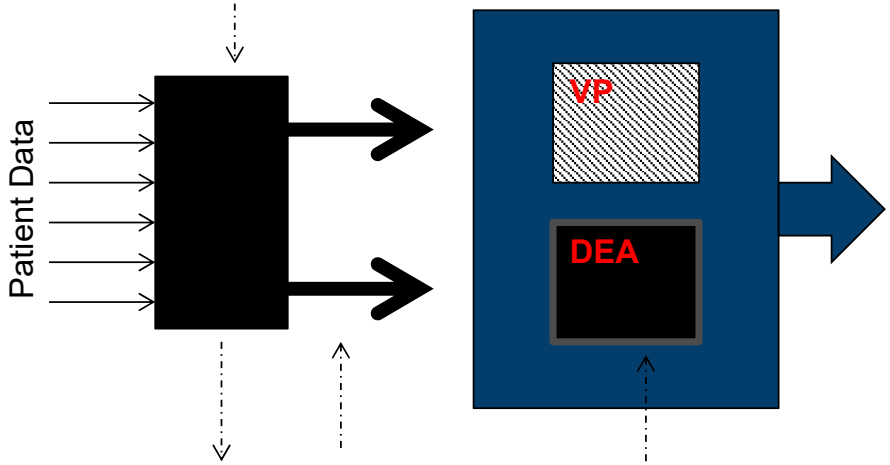
generic model
(mechanistic)



adaption of generic model
to available data (Machine Learning)

Unsupervised Patient Stratification
- Dynamic clustering
- Critical state detection

Predictive modelling Machine for Algorithmic Surveillance of ICU Patients



Prognosis for
Individual patient

Patient subgroups
& classifiers

Machine Learning, Patient association,
Subgroup specific prediction

MACHINE & DEEP LEARNING PROJECT EXAMPLE

ON4OFF

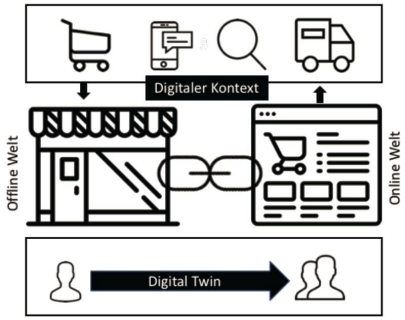
UNIVERSITÄT DUISBURG ESSEN

IN-telegence

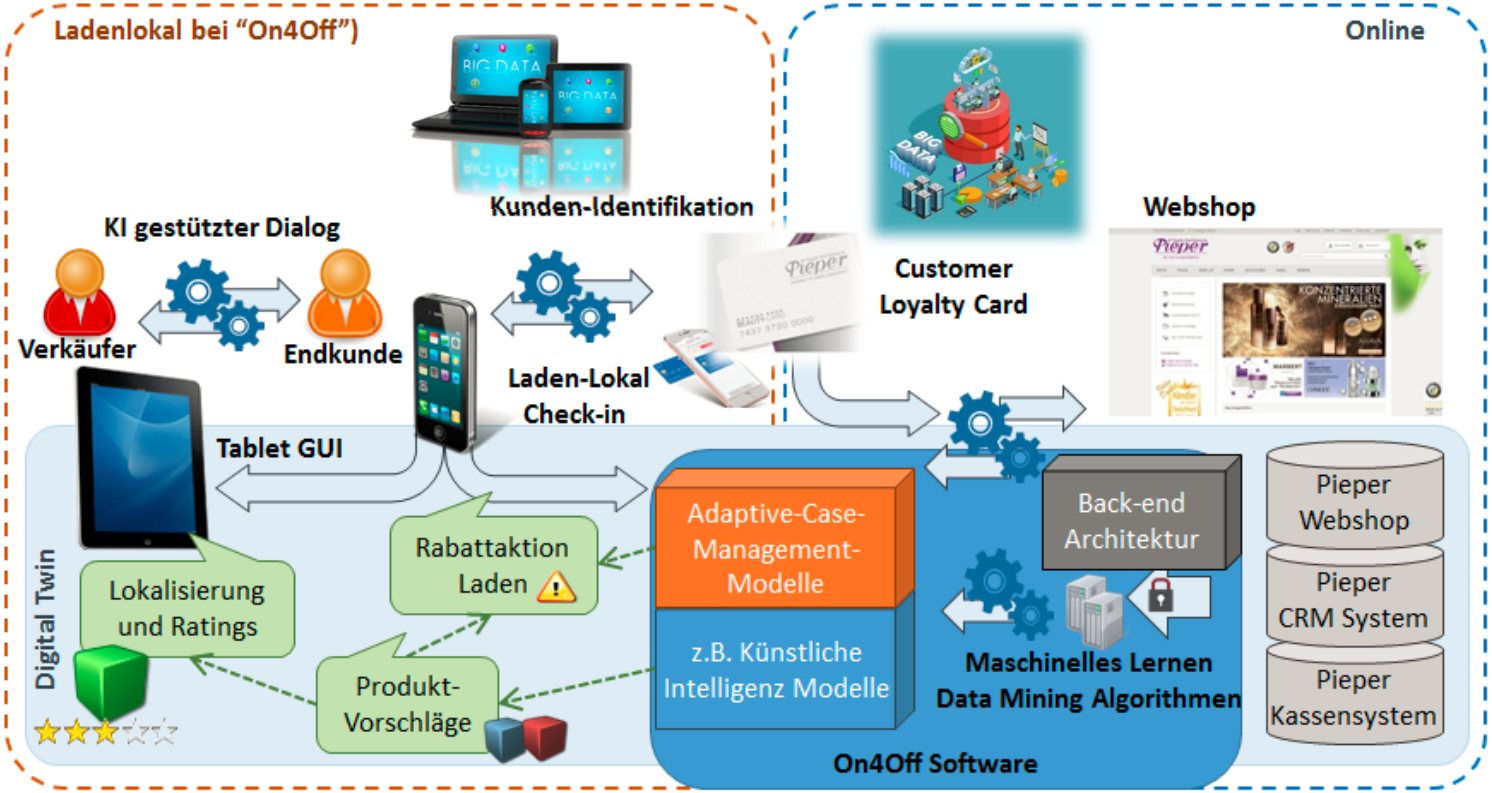
adesso

Stadt-Parfümerie Pieper SEIT 1931 IN FAMILIENBESITZ

Hochschule Niederrhein University of Applied Sciences



Leitmarkt Agentur.NRW



EUROPÄISCHE UNION
Investition in unsere Zukunft
Europäischer Fonds für regionale Entwicklung

EFRE.NRW
Investitionen in Wachstum und Beschäftigung

INTERNATIONAL PARALLEL & SCALABLE ML/DL LAB IDEA

NCSA

Prof. V. Kindratenko (machine learning)
Others?

iForge HPC System &
NCSA Infrastructure

Top 3 Lab Goals & Activities

Agile network with already funded PHDs focussing on real use cases & results

Paper studies on ML/DL applications & technologies & share scripts & notebooks

Explore innovative ML/DL computing: e.g. modular, neuromorphic, quantum, etc.

DRAFT IDEA
FOR DISCUSSIONS

Potential Steering Group:
J. Roloff?
N. Attig?
S. Gardarsson?

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Prof. H. Neukirchen (ML & Distributed Computing)
Prof. T. Runarsson (Reinforcement Learning)
Prof. S. Gudmundsson (Machine Learning)
Prof. M. Book (ML/HPC & SW Engineering)
Prof. E. Hvannberg (Cloud Computing)
Prof. K. Jonasson (Optimization)
Prof. G. Stefansson (Statistics)
others

GARPUR HPC System (+ upgrade GPUs) & teaching material & infrastructure

JÜLICH Forschungszentrum | JÜLICH SUPERCOMPUTING CENTRE

Dr. M. Schultz (Machine Learning in Earth Sciences)
Prof. K. Michelsen (Quantum Computing)
Dr. A. Strube (Machine Learning Tools)
Dr. J. Jitsev (Reinforcement Learning)

DEEP-EST Data Analytics Module (DAM) Prototype & JSC Infrastructure (12 Tesla V100)

maybe ~1-2 groups starting Q4 2019

haicu — Helmholtz Artificial Intelligence Cooperation Unit

High Productivity Data Processing Research Group (Prof. M. Riedel & Dr. G. Cavallaro)

1 PHD DEEP-EST
1 PHD SMITH
2 PHDs ON4OFF

Competence in methods & tools

Sustained Funding until end 2020

true value

THANKS

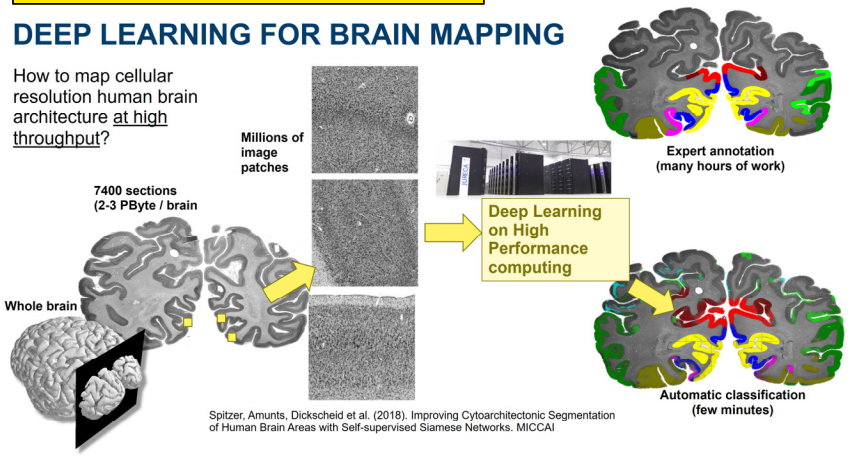
Talk shortly available under www.morrisriedel.de

OTHER BIG DATA PROJECTS & APPLICATIONS

Prof. Katrin Amunts – INM-1

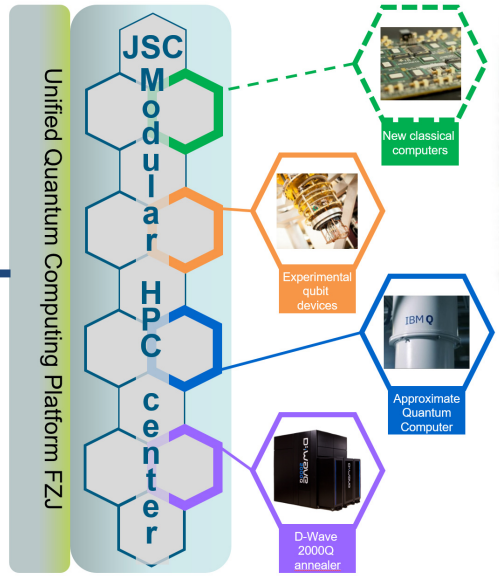
DEEP LEARNING FOR BRAIN MAPPING

How to map cellular resolution human brain architecture at high throughput?



Spitzer, Amunts, Dickscheid et al. (2018). Improving Cytoarchitectonic Segmentation of Human Brain Areas with Self-supervised Siamese Networks. MICCAI

Prof. Kristel Michielsen – JSC



Dr. Martin Schultz – JSC

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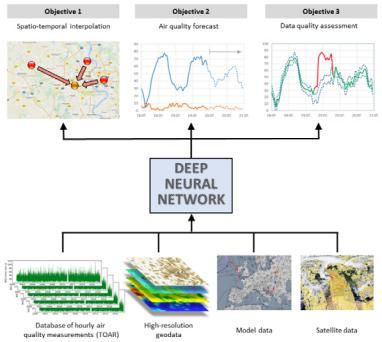
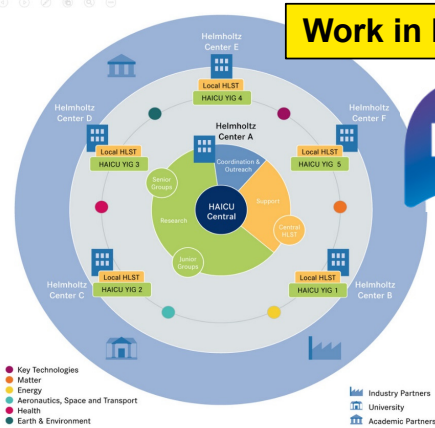
IntelliAQ: Anwendung von Deep Learning zur Interpolation, Vorhersage und Qualitätskontrolle von Daten zur Luftqualität



erc European Research Council
ERC-2017-ADG #787576

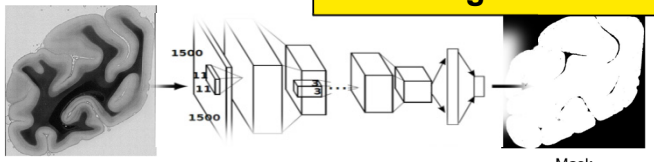
Work in Progress @ Helmholtz



haicu

Helmholtz Artificial Intelligence Cooperation Unit

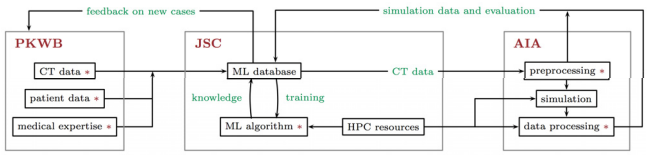
Prof. Abigail Morrison – JSC



RHINO DIAGNOST

JARA|HPC

Dr. Andreas Lintermann – JSC/RWTH



BIG DATA STORAGE INFRASTRUCTURE @ JSC

- JUST Storage Cluster
  - IBM Spectrum Scale file system (GPFS)
  - 75 PB gross capacity
  - 5th generation
  - Parallel access
- Tape Libraries
  - Automated cartridge systems
  - 300 PB
  - 3 libraries (in 2 buildings)
  - 60 tape drives
  - 35,000 tapes