BIG DATA INSIGHTS FROM FEDERATED DATA SYSTEMS

SELECTED SOLUTIONS FOR PARAMETER SEARCH PROBLEMS IN ARTIFICIAL INTELLIGENCE

PROF. DR. – ING. MORRIS RIEDEL, JUELICH SUPERCOMPUTING CENTRE (JSC) / UNIVERSITY OF ICELAND

HEAD OF HIGH PRODUCTIVITY DATA PROCESSING & CROSS-SECTIONAL TEAM DEEP LEARNING

20ND NOV., MEDICA HEALTH IT FORUM, NEXT STEPS FOR ARTIFICIAL INTELLIGENCE IN CLINICAL PRACTICE

SMITH Smart Medical Information Technology for Healthcare

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

HAICU HELMHOLTZ ARTIFICIAL INTELLIGENCE COOPERATION UNIT

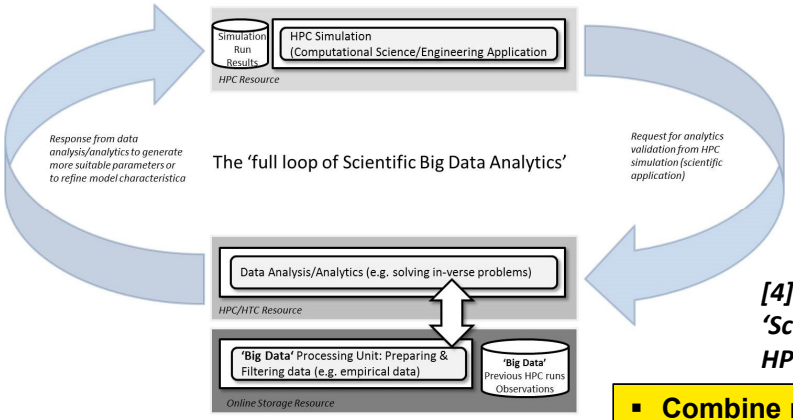
DEEP Projects

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

JÜLICH Forschungszentrum
JÜLICH SUPERCOMPUTING CENTRE

INTERTWINED HPC SIMULATIONS & MACHINE LEARNING

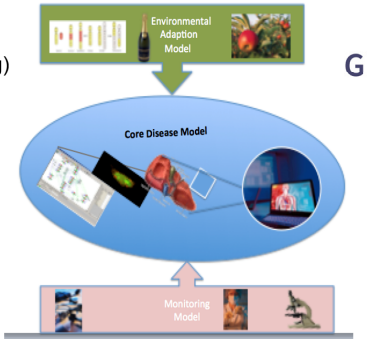
‘full loop‘ in research – forward patient simulations – backwards machine learning learns from ‘big data‘



[4] Th. Lippert & M. Riedel et al., ‘Scientific Big Data Analytics by HPC’, NIC Series 48, 2016

- **Combine mechanistic/numeric modeling with machine learning modeling in one ‘full loop‘ (~ ‘hybrid modeling‘)**
- **Hardest challenge remains for clinical practice: parameter setups for AI models to be used for daily patients care**

Patient + state paramters: individualisation (Machine Learning)



generic model (mechanistic)

adaption of generic model to available data (Machine Learning)

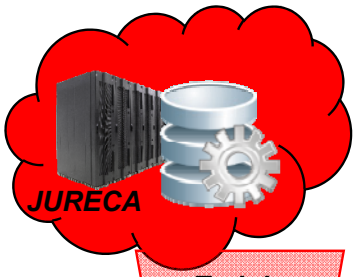
[5] Alfred Winter, G. Marx, A. Schuppert, M. Riedel et al., Journal of Methods of Information in Medicine, 2018

ARTIFICIAL INTELLIGENCE – COMPLEX RELATIONSHIPS

Big Data & Machine/Deep Learning & Modular Supercomputing

[1] Neural Network 3D Simulation

#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



High Performance Computing & Cloud Computing

Training Time

Model Performance / Accuracy

Large Deep Learning Networks

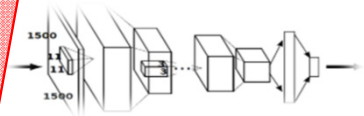
Medium Deep Learning Networks

Small Neural Networks

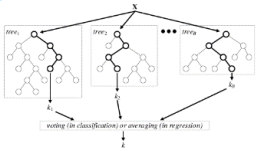
Traditional Learning Models

'small datasets'

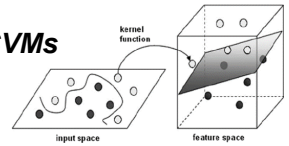
manual feature engineering' changes the ordering



Random Forests



SVMs



Statistical Computing with R

MatLab

scikit-learn ***Weka*** ***Octave***

Dataset Volume

→ 'Big Data'

[2] www.big-data.tips

NEXT STEPS FOR AI IN CLINICAL PRACTICE: DO IT!

Different Factors that all Combined Provide new Chances for Clinical Practice via Federated Data Systems

1952 Stochastic Gradient Descent
- Solving optimization problems

1958 Perceptron Learning Model
- Learning weights

⋮

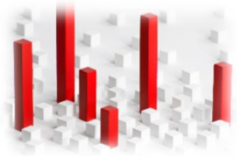
1985 'Backpropagation of Error' approch in learning
- Artificial Neural Networks

1995 Deep Convolutional Neural Networks
- Significant improvements in image analysis

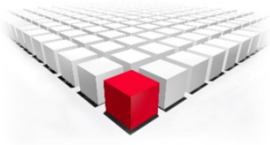
⋮

Impact in AI & HPC in industry & science

Big Data
- Large datasets
- Easy access
- More storage for less cost



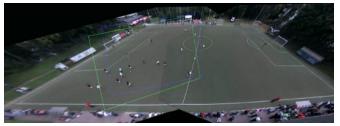
Hardware
- More memory
- Graphical Processing Units (GPUs)
- HPC & parallel systems



Software
- Scalable data science tools
- New learning models
- Open Source & free software packages

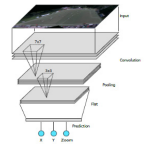
K Keras

TensorFlow



UNIVERSITÄT DUISBURG ESSEN

eXIST Existenzgründungen aus der Wissenschaft



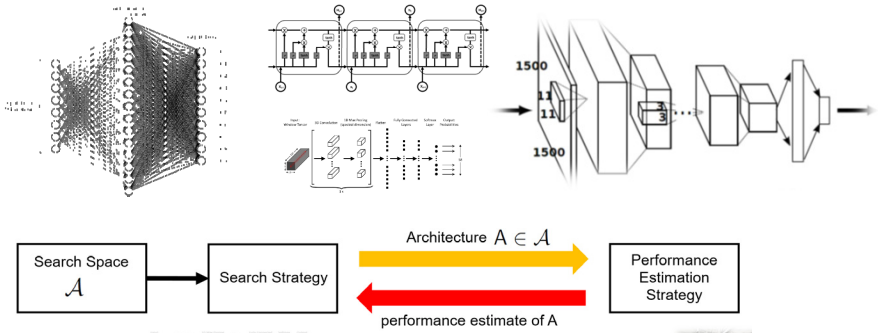
[6] soccerwatch.tv

Combination: Start-up Example of my research group

[3] C. Bodenstein & M. Riedel et al., Automated Soccer Scence Tracking using Deep Neural Networks

DIFFERENT STRATEGIES FOR AI IN CLINICAL PRACTICE

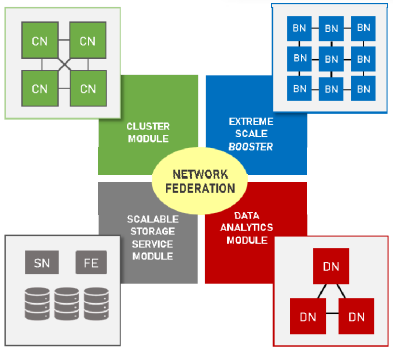
Finding Parameters Setups for AI Models in a Systematic Fashion & Model Reduction

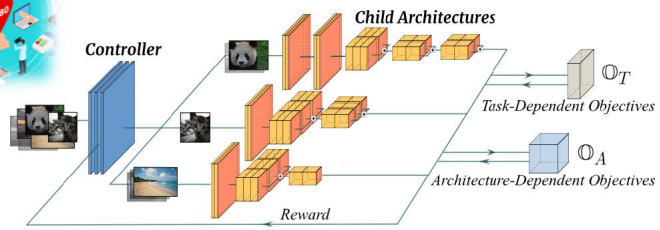


- **Markov Chains Monte Carlo (MCMC) with Virtual Patient (VP) models**
- **In clinical practise not feasible with today's computer technology => model reduction is necessary**
- **Virtual Patient (VP) model mapped into a deep learning network**
- **DL-network is hard to train (HPC), but fast to simulate and providing inference**

GDPR

[7] M. Riedel, 'NAS with Reinforcement Learning'





[8] A.C. Cheng et al., 'InstaNAS: Instance-aware Neural Architecture Search', 2018

UKH Universitätsklinikum Halle (Saale)

UKD Universitätsklinikum Düsseldorf

Universitätsmedizin Rostock

ukb universitäts klinikum bonn

Universitätsmedizin Essen

UK HAMBURG

UNIKLINIK RWTH AACHEN

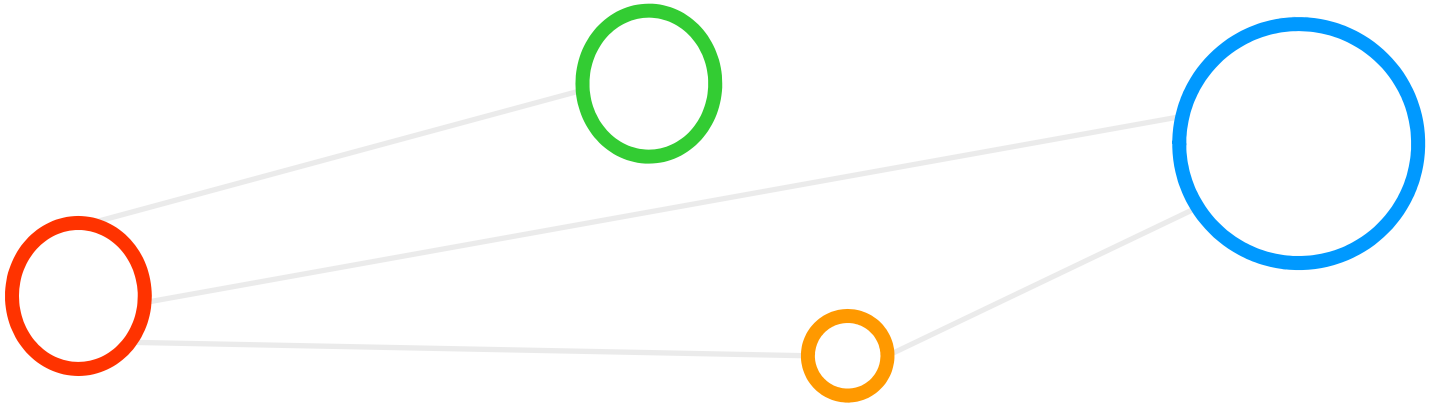
Universitätsklinikum Leipzig
Medizin ist unsere Berufung.

DEEP Projects

NAM

GCE

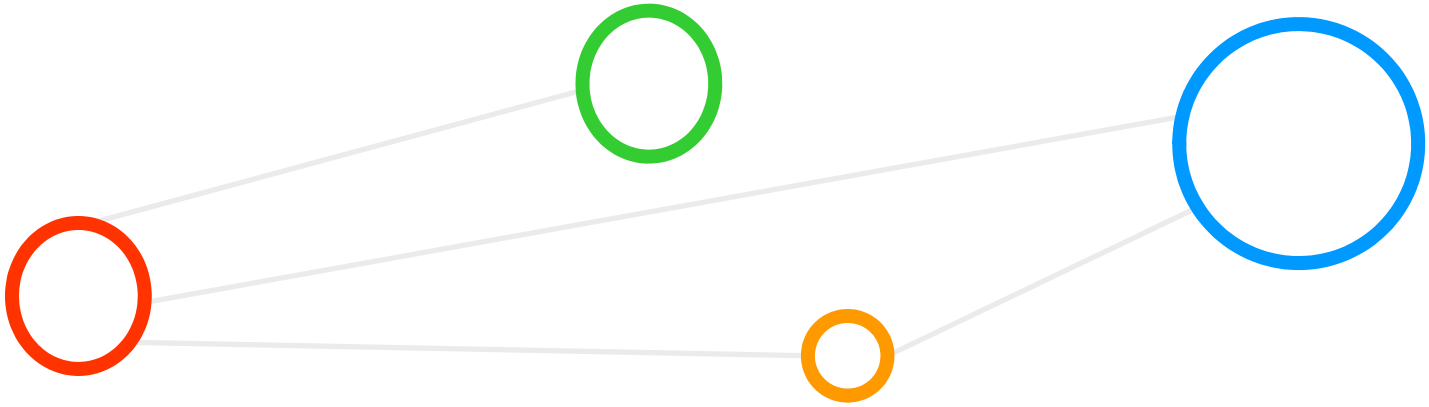
REFERENCES



REFERENCES

- [1] YouTube Video, 'Neural Network 3D Simulation', Online: https://www.youtube.com/watch?v=3JQ3hYko51Y
- [2] Big Data Tips – Big Data Mining & Machine Learning, Online: http://www.big-data.tips/
- [3] C. Bodenstein, M. Goetz, M. Riedel, 'Automated Soccer Scene Tracking using Deep Neural Networks', Poster NIC Symposium, 2016, Online: https://www.researchgate.net/publication/328997974_Automated_Soccer_Scene_Tracking_Using_Deep_Neural_Networks
- [4] Th. Lippert, D. Mallmann, M. Riedel, 'Scientific Big Data Analytics by HPC', Publication Series of the John von Neumann Institute for Computing (NIC) NIC Series 48, 417, ISBN 978-3-95806-109-5, pp. 1 - 10, 2016
- [5] Alfred Winter, A. Schuppert, M. Riedel et al., 'Smart Medical Information Technology for Healthcare (SMITH) – Data Integration based on Interoperability Standards', Journal of Methods of Information in Medicine, 57 (S 01), e92-e105, 2018, Online: https://www.researchgate.net/publication/326465733_Smart_Medical_Information_Technology_for_Healthcare_SMITH
- [6] Deep Learning Start-Up Beispiel Deutschland, Online: https://soccerwatch.tv/
- [7] M. Riedel, 'Neural Architecture Search with Reinforcement Learning', Online: http://www.morrisriedel.de/neural-architecture-search-with-reinforcement-learning
- [8] Cheng, A.C, Lin, C.H., Juan, D.C., InstaNAS: Instance-aware Neural Architecture Search, Online: https://arxiv.org/abs/1811.10201

ACKNOWLEDGEMENTS

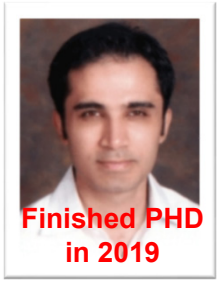


ACKNOWLEDGEMENTS

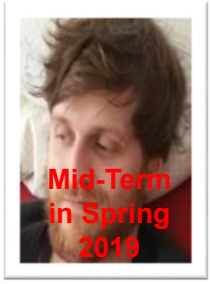
Previous & current members of the High Productivity Data Processing Research Group

PD Dr.
G. Cavallaro

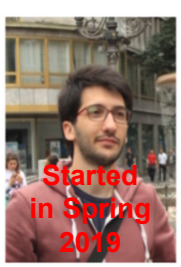
Senior PhD
Student A.S. Memon



Dr.
M.S. Memon



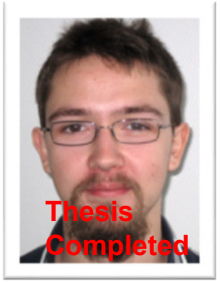
PhD Student
E. Erlingsson



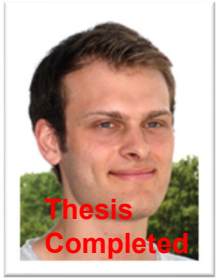
PhD Student
S. Bakarat

PhD Student
R. Sedona

Dr. M. Goetz
(now KIT)



MSc M.
Richerzhagen
(now other division)



MSc
P. Glock
(now INM-1)

MSc
C. Bodenstein
(now
Soccerwatch.tv)

MSc Student
G.S. Guðmundsson
(Landsverkjun)

This research group has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 763558 (DEEP-EST EU Project)

THANKS

Talk shortly available under www.morrisriedel.de