

Practice & Experience of using AI for Healthcare in Covid – 19 & ARDS Applications

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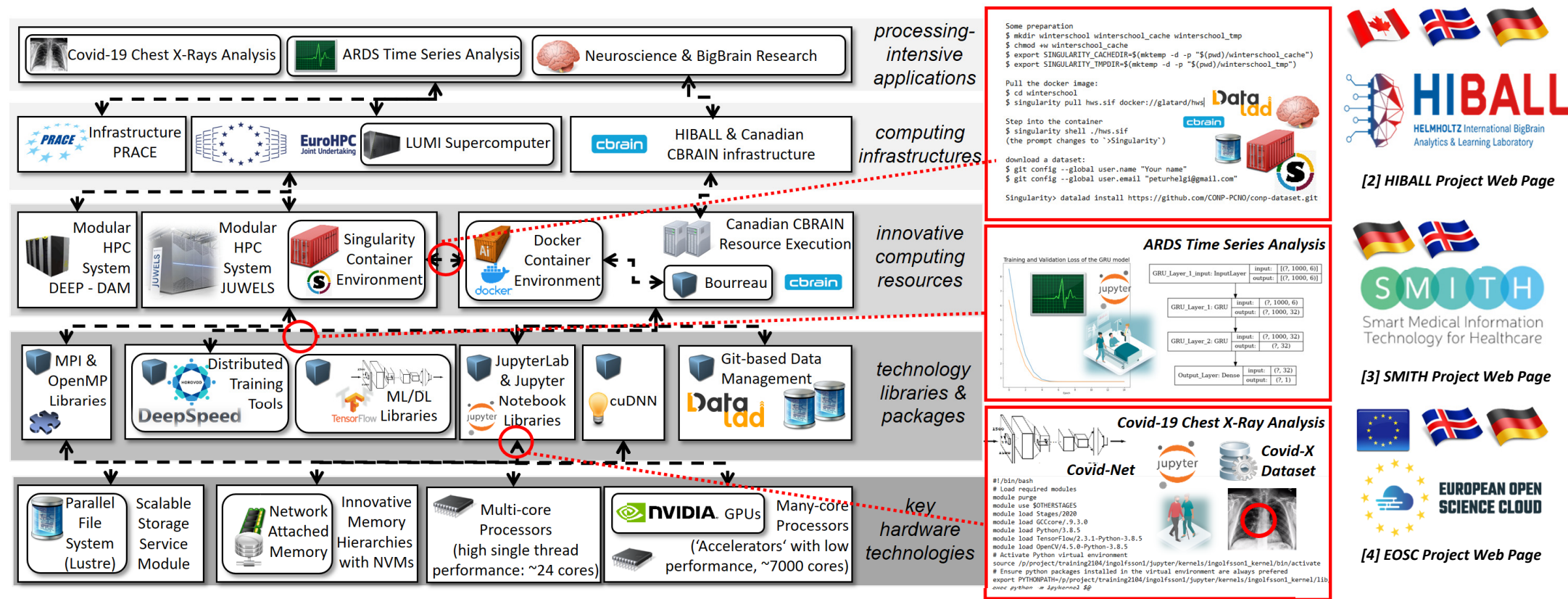


EUROPEAN OPEN
SCIENCE CLOUD



SELECTED RESEARCH ACTIVITIES & GRANTS AT A GLANCE

Research Focus at the Interaction of Healthcare & Disruptive Computing Approaches (HPC, Clouds, Quantum, Graphs)



[1] M. Riedel et al., 'Practice & Experience in using Parallel & Scalable Machine Learning with Heterogenous Modular Supercomputing Architectures', in proceedings of IEEE IPDPS, 2021

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12. January 2022

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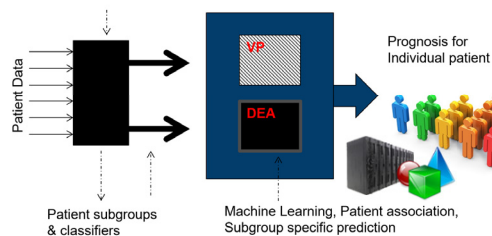
ACUTE RESPIRATORY DISTRESS SYNDROME (ARDS)

Selected Activities of the Smart Medical Information Technology for Healthcare (SMITH) Project

- ARDS Medical Application of using advanced HPC technologies → SMITH Use Case Application
 - Affects ~10% Intensive Care Units (ICU) patients with high mortality rate
 - Develop algorithms that can efficiently & accurately diagnose the onset of ARDS → treatment ideas
 - Use of recurrent neural networks for time series analysis data is very computational intensive
 - Porting of mechanistic modelling (i.e., 'Warwick' model) to HPC & intertwined machine learning models

Unsupervised Patient Stratification

- Dynamic clustering
- Critical state detection



practice & experience:
data sharing challenges &
medical experts far away
from using machine learning &
HPC in daily medical practice;
HPC enables major speed-ups



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[5] Alfred Winter, M. Riedel et al., 'Smart Medical Information Technology for Healthcare (SMITH): Data Integration based on Interoperability Standards', *Journal of Methods of Information in Medicine*, 2018

[6] C. Barakat, S. Fritsch, M. Riedel, S. Brynjólfsson, 'A HPC-driven data science platform to speed-up time series data analysis of patients with the Acute Respiratory Distress Syndrome', *IEEE MIPRO 2021*

[7] O. Maassen, S. Fritsch, M. Riedel et al., *Future Medical Artificial Intelligence Application Requirements and Expectations of Physicians in German University Hospitals: Web-based Survey*, *Journal of Medical Internet Research*, 2021



COVID – 19 CHEST X – RAY ANALYSIS

Selected Activities of the European Open Science Cloud (EOSC) Covid-19 ‘Fast Track’ Grant



[4] EOSC Project Web Page

- Selected Practice & Experience working with open-source CovidX data & Covid-Net
 - Check of neural network architectures with a real healthcare provider (e*HealthLine) & new data
 - Significant work required (data cleaning, check for duplicates of open data, versioning of AI tools) generalizing to unseen data
 - Speed-up of HPC infrastructures enormously compared to ‘MatLab’-driven medical hospital infrastructures
 - Cooperation with Helmholtz AI for better models



[9] E*HealthLine Web Page

[6] C. Barakat, S. Fritsch, M. Riedel, S. Brynjólfsson, ‘A HPC-driven data science platform to speed-up time series data analysis of patients with the Acute Respiratory Distress Syndrome’, IEEE MIPRO 2021

	Healthy	Pneumonia	Covid-19
# of Images	8.066	5.538	358



JUWELS Booster – A Supercomputer for Large-Scale AI Research

Stefan Kesselheim^{1*}, Andreas Herten^{1*}, Kai Krajsek^{1*}, Jan Ebert^{1*},
Jenia Jitsev^{1*}, Mehdi Cherti^{1*}, Michael Langguth^{1*}, Bing Gong^{1*},
Scarlet Stadtler^{1*}, Amirpasha Mozaffari^{1*}, Gabriele Cavallaro^{1*},
Rocco Sedona^{1,2*}, Alexander Schug^{1,3*}, Alexandre Strube¹, Roshni Kamath¹,
Martin G. Schultz¹, Morris Riedel^{1,2}, Thomas Lippert¹

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³ University of Duisburg-Essen, Germany



Healthy Patient



Covid-19 Patient

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[8] S. Kesselheim et al., ‘JUWELS Booster - A Supercomputer or Large-Scale AI Research’, ICS 2021



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Chadi Barakat
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Supercomputing Centre &
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HPC Simulation and Data Lab
Health & Medicine



PROMISING RESEARCH DIRECTIONS

New PhD Students & Started Healthcare & Medicine Projects exploiting HPC technologies



[2] HIBALL Project Web Page

- HIBALL

- Use of advanced technology to connect JSC modular supercomputing to CBRAIN infrastructure in Canada
- Joint research on Cerebelum research (INM-1 & McGill)



Pétur Helgi Einarsson
PhD Student, University of
Iceland
Icelandic HPC Simulation and




- Genomics

- Addressing HPC & AI limits of 'RossetaFold'



[12] Cavallaro, G., Willsch, D., Willsch, M., Michielsen, K., Riedel, M.: APPROACHING REMOTE SENSING IMAGE CLASSIFICATION WITH ENSEMBLES OF SUPPORT VECTOR MACHINES ON THE D-WAVE QUANTUM ANNEALER, in conference proceedings of the IEEE IGARSS 2020

- Transfer of Knowledge from Remote Sensing Applications to Covid-19

- Hyperspectral image datasets via HPC & AI → Covid-19 Chest X-Rays
- Quantum Computing (i.e., D-Wave Quantum Annealer & JUNIQ)
- GraphCore with Intelligence Processing Units (IPUs) 



[11] *Graphcore Web Page*



RAISE
Center of Excellence

[10] RAISE COE Project Web Page

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PhD Student @Jülich
Supercomputing Centre &
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Icelandic HPC Simulation and Data
Lab

Rocco Sedona
PhD Student @ Jülich
Supercomputing Centre & University
of Iceland
Icelandic HPC Simulation and Data
Lab
Remote Sensing



- Virtual Acoustics

- Aimed towards visual impaired patients

Eric Michael Sumner
PhD Student, University of Iceland
Icelandic HPC Simulation and Data
Lab
Acoustic & Tactile Engineering



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PROMISING RESEARCH COLLABORATIONS

Towards a closer collaboration with UniKlinik RWTH Aachen – Maybe JARA-MED?

JARA Jülich Aachen
Research
Alliance

MED?
NEW

- Application of AI methods on clinical data
 - Risk stratification for COVID-19 patients using AI methods [13]
 - Algorithmic detection and distinction of Acute respiratory distress syndrome (ARDS) [14,15]
- Medical advice on the use of clinical data for HPC-AI models [6,16]
- Evaluation of human factors using AI in medicine [7,17]
- Knowledge transfer & support of understanding for AI within the medical community [18,19]



ASIC
Algorithmic Surveillance



Gernot Marx, MD, FRCA, full Professor of Anesthesiology & Critical Care Medicine
Chair at the University RWTH Aachen; Head of the Department of Intensive Care Medicine & Intermediate Care at the University Hospital RWTH Aachen



[13] Sharafutdinov, K., Fritsch, S.J., Marx, G. et al. Biometric covariates & outcome in COVID-19 patients: are we looking close enough? *BMC Infect Dis* 21, 1136 (2021).

[14] Fonck, S., Fritsch, S., Kowalewski, S., Hensen, R., & Stollenwerk, A. (2021). Algorithmic distinction of ARDS & Heart Failure in ICU data from medical embedded systems by using a computer model. *IFAC-PapersOnLine*, 54(4), 135-140.

[15] Fonck, S., Fritsch, S., Janssen, A., Bickenbach, J., Stollenwerk, A. Bayesian Network for the Identification of Patients with ARDS in secondary intensive care data sources, submitted

[16] Fritsch SJ, Sharafutdinov K, Einollahzadeh Samadi M, Marx G, Schuppert A, Bickenbach J. The Influence of Inhomogeneous Input Data from Different Waves on Predictive Model Development for COVID-19 ICU Patients *JMIR Preprints*.

[17] Maassen O, Fritsch S, Gantner J, Deffge S, Kunze J, Marx G, Bickenbach J. Future Mobile Device Usage, Requirements, and Expectations of Physicians in German University Hospitals: Web-Based Survey; *J Med Internet Res* 2020;22(12):e23955

[18] Fritsch, S., Sharafutdinov, K., Schuppert, A., Bickenbach, J. (2022), Nutzung von KI zur Bekämpfung der COVID-Pandemie, *AINS* (accepted)

[19] Fritsch, S., Maaßen, O., Riedel, M. (2022), Artificial Intelligence: Infrastructures and Preconditions from a European Perspective, *AINS* (accepted)

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UNIKLINIK
RWTHAACHEN

JÜLICH
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SELECTED REFERENCES (1)



- [1] M. Riedel *et al.*, "Practice and Experience in using Parallel and Scalable Machine Learning with Heterogenous Modular Supercomputing Architectures," *2021 IEEE International Parallel and Distributed Processing Symposium Workshops (IPDPSW)*, 2021, pp. 76-85, doi: 10.1109/IPDPSW52791.2021.00019, Online: <https://ieeexplore.ieee.org/document/9460702>
- [2] Helmholtz International BigBrain Analytics & Learning Laboratory (HIBALL) Web Page, Online: <https://bigbrainproject.org/hiball.html>
- [3] Smart Medical Information Technology for Healthcare (SMITH) Project Web Page, Online: <https://www.smith.care/home-2/>
- [4] European Open Science Cloud (EOSC) Web Page, Online: <https://eosc.eu/>
- [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] C. Barakat, S. Fritsch, M. Riedel and S. Brynjólfsson, 'An HPC-Driven Data Science Platform to Speed-up Time Series Data Analysis of Patients with the Acute Respiratory Distress Syndrome,' *2021 44th MIPRO 2021*, pp. 311-316, doi: 10.23919/MIPRO52101.2021.9596840, Online: <https://ieeexplore.ieee.org/document/9596840>
- [7] O. Maassen, S. Fritsch, M. Riedel *et al.*, Future Medical Artificial Intelligence Application Requirements and Expectations of Physicians in German University Hostpitals: Web-based Survey, *Journal of Medical Internet Research*, 2021, Online: https://www.researchgate.net/publication/349343535_Future_Medical_Artificial_Intelligence_Application_Requirements_and_Expectations_of_Physicians_in_German_University_Hospitals_Web-Based_Survey
- [8] S. Kesselheim, A. Herten, K. Krajsek, J. Ebert, J. Jitsev, M. Cherti, M. Langguth, B. Gong, S. Stadtler, A. Mozaari, G. Cavallaro, R. Sedona, A. Schug, A. Strube, R. Kamath, M.G. Schultz, M. Riedel, Th. Lippert, 'JUWELS Booster - A Supercomputer for Large-Scale AI Research', *ICS 2021*, Online: <https://arxiv.org/abs/2108.11976>
- [9] E*HealthLine Web Page, Online: <http://ehealthline.com/>
- [10] European Center of Excellence Research On AI – and Simulation-Based Engineering at Exascale (COE RAISE), Online: <https://www.coe-raise.eu/>
- [11] GraphCore – Accelerating Machine Learning, Online: <https://www.graphcore.ai/>
- [12] Cavallaro, G., Willsch, D., Willsch, M., Michielsen, K., Riedel, M.: APPROACHING REMOTE SENSING IMAGE CLASSIFICATION WITH ENSEMBLES OF SUPPORT VECTOR MACHINES ON THE D-WAVE QUANTUM ANNEALER, in conference proceedings of the IEEE International Geoscience and Remote Sensing Symposium (IGARSS 2020), September 26 – October 2nd, 2020, Virtual Conference, Hawaii, USA, to appear, Online: <https://igarss2020.org/Papers/ViewPapers.asp?PaperNum=1416>

SELECTED REFERENCES (2)



- [13] Sharafutdinov, K., Fritsch, S.J., Marx, G. et al. Biometric covariates and outcome in COVID-19 patients: are we looking close enough?. BMC Infect Dis 21, 1136 (2021).
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ACKNOWLEDGEMENTS – JSC & UNIVERSITY OF ICELAND



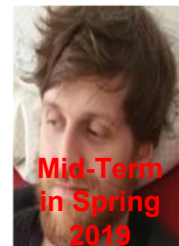
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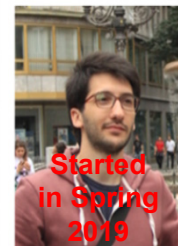
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A.S. Memon



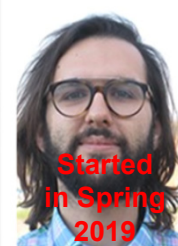
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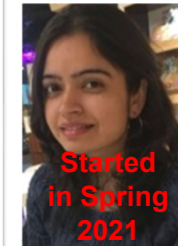
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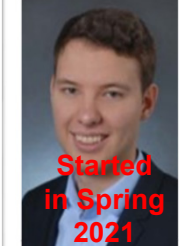
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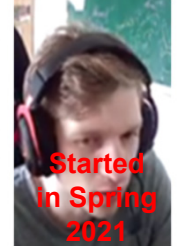
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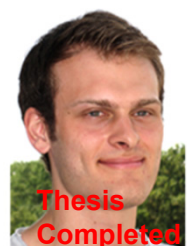
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D. Helmrich



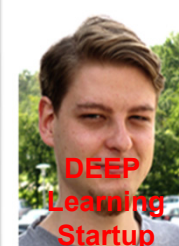
Dr. M. Goetz
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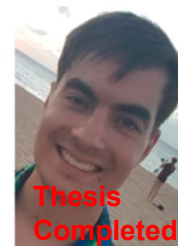
MSc M.
Richerzhagen
(now other division)



MSc
P. Glock
(now INM-1)



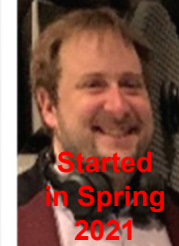
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This research group has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 763558 (DEEP-EST EU Project) and grant agreement No 951740 (EuroCC EU Project) & 951733 (RAISE EU Project)



