Prof. Dr. – Ing. Morris Riedel

Working with Cutting-Edge Technologies

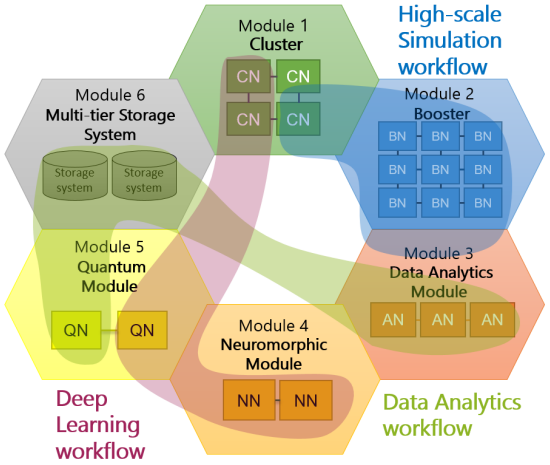
Master Topics Seminar

University of Iceland

2021-05-28

Online

International Collaboration Partner: Juelich Supercomputing Centre



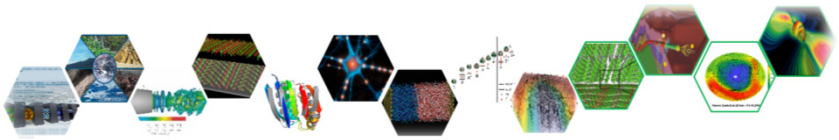
DEEP Series of Projects Web Page

Simulation and Data Laboratories
SDL Biology
SDL Plasma Physics
SDL Molecular Systems
SDL Climate Science
SDL Fluid & Solid Engineering
SDL Quantum Materials
SDL Terrestrial Systems
SDL Numerical Quantum Field Theory
SL Neuroscience
SDL Astrophysics

JSC Simlabs

Potentially first Exascale system in Europe

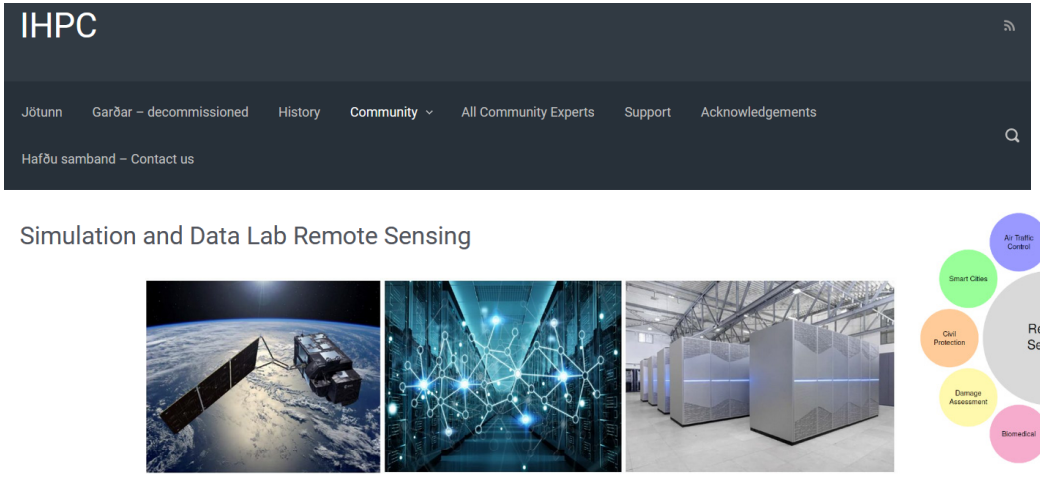
Application Co-Design

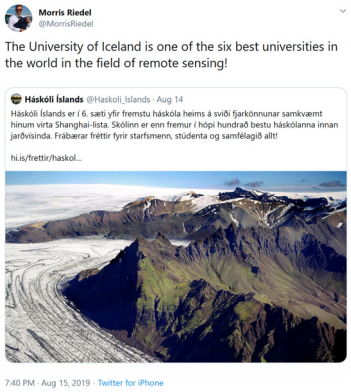


YouTube, 'flexible and energy-efficient supercomputer: JUWELS is faster than 300 000 modern PCs


Preserving our Environment

Icelandic HPC Community – Simulation & Data Lab Remote Sensing





General information

The Simulation and Data Lab Remote Sensing (SimDataLab RS) leads to increase the visibility on interdisciplinary research between remote sensing and advanced computing technologies and parallel programming. This includes high-performance and distributed computing, quantum computing and specialized hardware computing. The SimDataLab RS is based at the University of Iceland and works together with the High-performance and Disruptive Computing in Remote Sensing (HDCRS) working group of the Geoscience and Remote Sensing Society (GRSS). Together with HDCRS, the SimDataLab RS disseminates information and knowledge through educational events, special sessions and tutorials at conferences and publication activities.

Members

Prof. Dr. – Ing. Morris Riedel

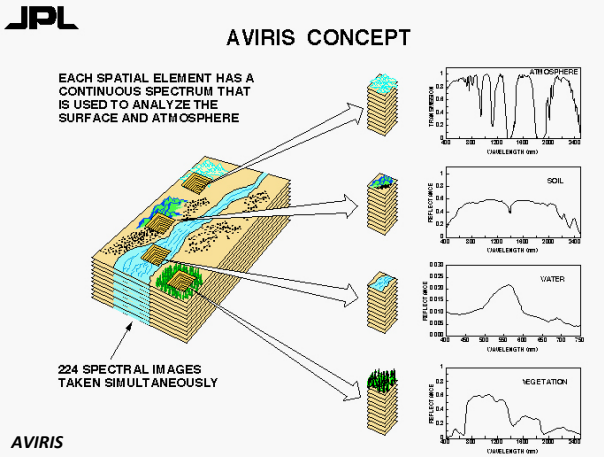
Dr. -Ing. Gabriele Cavallaro

Ing. Rocco Sedona

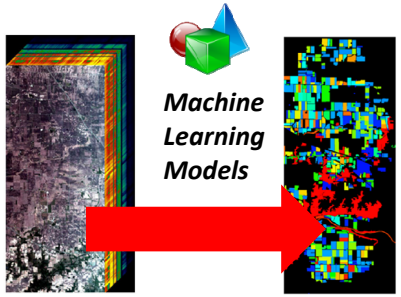
Surbhi Sharma

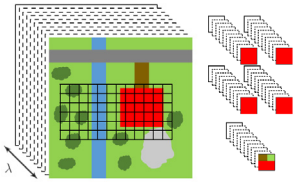
Ernir Erlingsson

IHPC SimDataLab Remote Sensing Web Page



Example: Land cover classification

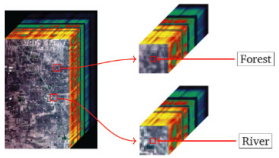




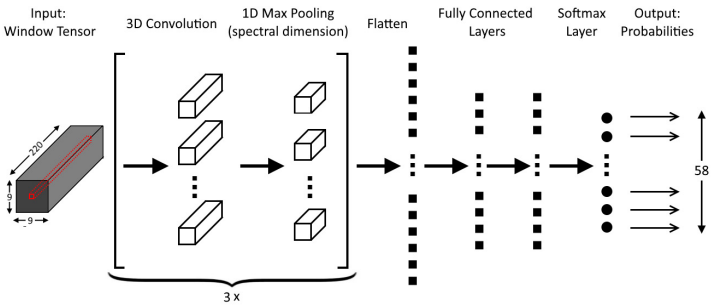
Challenges: mixed pixels & unbalanced land cover classes

Master Topic: Deep Learning Architectures for Remote Sensing Applications

- Convolutional Neural Networks (CNNs)
  - Used with hyperspectral remote sensing data
  - Rare labeled/annotated data in science (e.g. 36,000 vs. 14,197,122 images ImageNet)
  - Scene vs. pixel-wise classification challenges
- Combining Machine Learning Models
  - Using CNNs basic principle
  - Apply SVMs in different layers of CNN

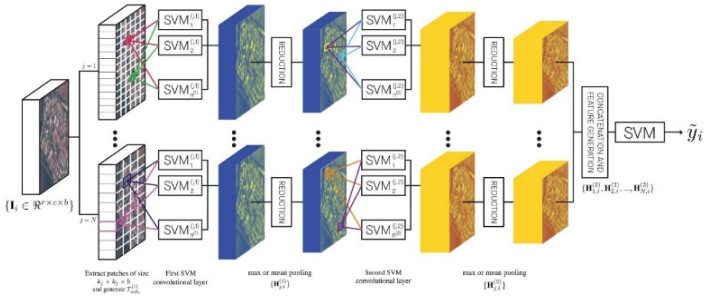


research challenges:
rare groundtruth and surrounding labels bias in training, but key challenge remain: hyper-parameter tuning



J. Lange, G. Cavallaro, M. Riedel et al., IGARSS Conference, 2018

Feature	Representation / Value
Conv. Layer Filters	48, 32, 32
Conv. Layer Filter size	$(3,3,5)$, $(3,3,5)$, $(3,3,5)$
Dense Layer Neurons	128, 128
Optimizer	SGD
Loss Function	mean squared error
Activation Functions	ReLU
Training Epochs	600
Batch Size	50
Learning Rate	1
Learning Rate Decay	5×10^{-6}



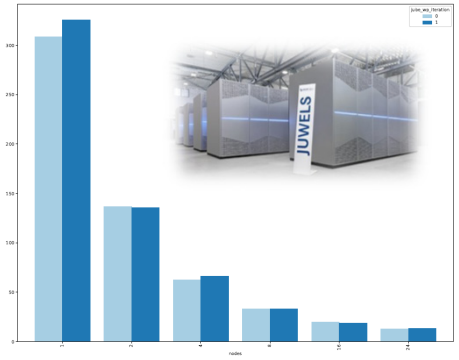
G. Cavallaro, M. Riedel et al., IGARSS 2019

Dr. – Ing. Gabriele Cavallaro (2016)
PhD Student Graduate, University of Iceland
IHPC Simulation and Data Lab
Remote Sensing

Master Topic: Analyse Distributed Training of Deep Learning Networks

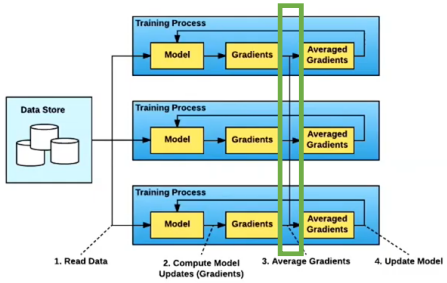
- RESNET-50 Architecture: Case for interconnecting GPUs
  - RESNET-50 is a known neural network architecture that has established a strong baseline in terms of accuracy
  - Computational complexity of training the RESNET-50 architecture relies in the fact that is has ~ 25.6 millions of trainable parameters
  - RESNET-50 still represents a good trade-off between accuracy, depth and number of parameters
  - Distributed training challenges (i.e. large batch size)

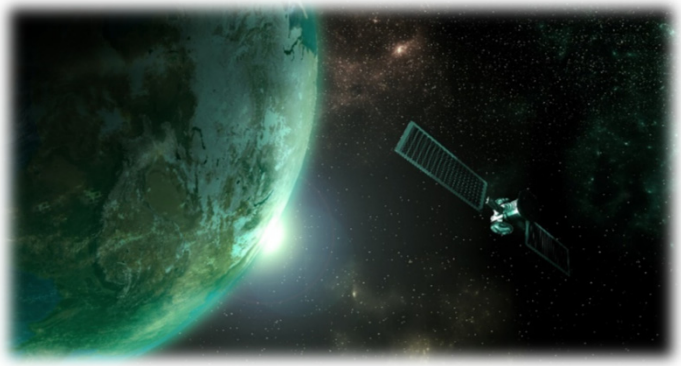
Partition of the JUWELS system has 56 compute nodes, each with 4 NVIDIA V100 GPUs (equipped with 16 GB of memory)



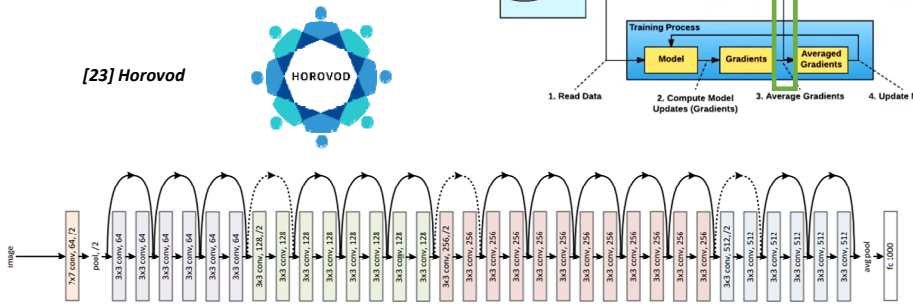
24 nodes x 4 GPUs = 96 GPUs

Horovod distributed training via MPI_Allreduce()





[23] Horovod



R. Sedona, G. Cavallaro, M. Riedel, J.A. Benediktsson et al.: Remote Sensing Big Data Classification with High Performance Distributed Deep Learning, Journal of Remote Sensing, Multidisciplinary Digital Publishing Institute (MDPI), Special Issue on Analysis of Big Data in Remote Sensing, 2019

Rocco Sedona
PhD Student, University of Iceland
IHPC Simulation and Data Lab
Remote Sensing


Improving our Healthcare

Icelandic HPC Community – Simulation & Data Lab Health & Medicine

IHPC

Jötunn | Garðar – decommissioned | History | Community | All Community Experts | Support | Acknowledgements

Hafðu samband – Contact us

Simulation and Data Lab Health and Medicine



General information

The Simulation and Data Lab Health and Medicine (SimDataLab HM) aims to shed light on novel data analysis approaches in the medical field with extra focus on the application of High Performance Computing (HPC) architectures in the processing of patient medical data, as well as diagnosis and treatment assistance. The SimDataLab HM works in cooperation with the Juelich Supercomputing Centre (JSC) of Forschungszentrum Juelich (FZJ) – Juelich, Germany as part of the SMITH consortium's Algorithmic Surveillance of ICU Patients (ASIC) use case.

Prof. Dr. – Ing. Morris Riedel

Chadi Barakat

Gísli Ingolfsson (MSc student)

IHPC SimDataLab Health & Medicine Web Page

UKH Universitätsklinikum Halle (Saale)

Universitätsmedizin Essen

Universitätsmedizin Rostock

UNIKLINIK RWTH AACHEN

UKE HAMBURG

UKD Universitätsklinikum Düsseldorf

ukb universitäts klinikumbonn

Universitätsklinikum Leipzig

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

SMITH Smart Medical nformation Technology for Healthcare

SMITH Project Web Page

JOURNAL OF MEDICAL INTERNET RESEARCH — Maassen et al

Original Paper

Future Medical Artificial Intelligence Application Requirements and Expectations of Physicians in German University Hospitals: Web-Based Survey

Oliver Maassen[1,2], MSc; Sebastian Fritsch[1,2,3], MD; Julia Palm[2,4], MSc; Saskia Deffge[1,2], MSc; Julian Kunze[1,2], MD; Gernot Marx[1,2], MD, Prof Dr, FRCA; Morris Riedel[2,3,5], Prof Dr; Andreas Schuppert[2,6], Prof Dr; Johannes Bickenbach[1,2], MD, Prof Dr

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[3]Jülich Supercomputing Centre, Forschungszentrum Jülich, Jülich, Germany
[4]Institute of Medical Statistics, Computer and Data Sciences, Jena University Hospital, Jena, Germany
[5]School of Natural Sciences and Engineering, University of Iceland, Reykjavik, Iceland
[6]Institute for Computational Biomedicine II, University Hospital RWTH Aachen, Aachen, Germany

O.Maassen 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

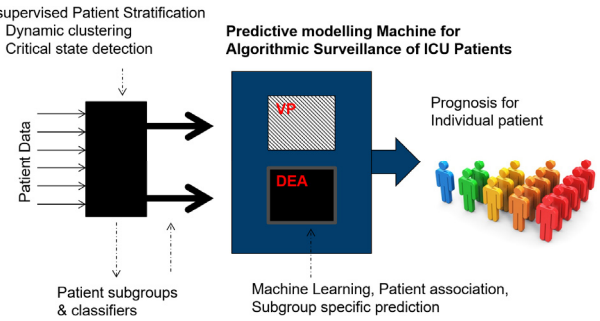
relatively low HPC & AI usage still, strict regulations for AI

data silos: no data sharing, GDPR & reiterating clinical studies

Master Topic: Deep Learning Architectures for Health Applications

- Acure Respiratory Distress Syndrome (ARDS)
  - Rare condition that affects ICU patients with high mortality rate
  - Develop algorithms that can efficiently & accurately diagnose the onset of ARDS, and provide suggestions for treatment
  - Use of recurrent neural networks for time series analysis

Approaches require massive computational resources



Research challenges:
Combining mechanistic modeling (Nottingham simulator) with machine learning models

- Covid-19 X-Ray analysis
  - Use Transfer Learning techniques
  - Cooperate with Healthcare Industry

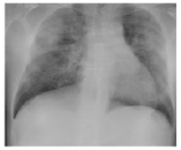
Gísli Ingolfsson (MSc student)

Research challenges:
Fine-tuning of Covid-Net on COVIDx dataset using ResNet-152x4 and pre-trained on ImageNet-1k

	Precision	Recall	F1-score
COVID-19	0.88	0.84	0.86
Normal	0.96	0.92	0.94
Pneumonia	0.87	0.93	0.90

	Healthy	Pneumonia	Covid-19
# of Images	8.066	5.538	358

Healthy Patient



Covid-19 Patient

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 Strube[1], Roshni Kamath[1], Martin G. Schultz[1], Morris Riedel[1,2], Thomas Lippert[1]

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[2] School of Engineering and Natural Sciences, University of Iceland, Reykjavik, Iceland
[3] University of Duisburg-Essen, Germany

S. Kesselheimet al., 'JUWELS Booster - A Supercomputer for Large-Scale AI Research', Submitted, ICS 2021

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Health & Medicine

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, to appear

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