An Overview of the European HPC Strategy and Highlights from the Icelandic HPC Communities

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Summer school on "High Performance and Disruptive Computing in Remote Sensing",
29 May - 1 June, 2023, Reykjavik, Iceland
Talk: May 29, 2023
• The Icelandic National Competence Center (NCC) for HPC and AI
• Access to HPC Infrastructure: Iceland and EuroHPC JU
• Icelandic HPC activities: workshops and training
• International Partnerships and Collaborations
• Some applications from Simulation and Data Labs:
  • HPC/AI for remote sensing
  • HPC/AI for NLP
• Selected References
• Acknowledgments
EU National Competence Centers (NCC's)

Single point of contact at national level for technology transfer in High Performance Computing (HPC), High Performance Data Analysis (HPDA), and Artificial Intelligence (AI).

To assist and provide service to the national needs of SMEs, industry, academia, and public administration (EuroCC,EuroCC2).

NCC Iceland lead by
Prof. Dr. – Ing. Morris Riedel, University of Iceland

https://www.eurocc-access.eu/
Icelandic National Competence Center

- Established 12 Simulation & Data Labs
  - different areas of science & engineering
  - with industry use cases & participation
  - EU collaborations (JSC, BSC, ...)
  - support industries, government bodies

- Promote competencies:
  - HPC
  - AI
  - Digital transformation through EDIH-IS

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Access to High-Performance Computing (HPC)

✓ Different HPC Systems available with CPUs & GPUs
✓ Complementary Data Infrastructure available
HPC Beginner/Moderate Users: ELJA & DEEP Systems

• ELJA System in Iceland
  • Small Size HPC System
  • Deployed at University of Iceland (UTS)

• DEEP System in Germany
  • Moderate Size HPC System
  • Deployed at the Juelich Supercomputing Centre (JSC)
  • Access through close cooperation between Germany and Iceland

Access to HPC systems DEEP & ELJA is free of charge for academic & government users, including storage of datasets in the realm of MBs & GBs

Access to HPC systems DEEP & ELJA is free of charge for industrial / SME users for prototyping, research & development before business licensing

Users requiring significantly more storage in the realm of TBs & PBs can be negotiated also free of charge for a specific period during HPC system runs

A sustainable long-term data storage & sharing infrastructure for Iceland is in development by the EDIH-IS & NCC HPC/AI & will be available 2024 (expected)
HPC Expert Users: JUELICH & EuroHPC JU Systems

• JUELICH Systems in Germany
  • Large HPC Systems
  • JUWELS → https://www.fz-juelich.de/en/ias/jsc/systems/supercomputers/juwels
  • JURECA → https://www.fz-juelich.de/en/ias/jsc/systems/supercomputers/jureca

• LUMI System in Finland
  • Iceland’s System Share → https://lumi-supercomputer.eu/

• EuroHPC Systems in Europe
  • Apply jointly via EuroHPC JU Calls – Open for academics, government & industry/SME
    • https://eurohpc-ju.europa.eu/participate/access-our-supercomputers_en

- Access to HPC systems JUWELS, JURECA & LUMI is **free of charge** for academic & government users, including storage of datasets in the realm of MBs & GBs
- Access to HPC systems JUWELS, JURECA & LUMI is **free of charge** for industrial / SME users for prototyping, research & development before a business license
- Users requiring significantly more storage in the realm of TBs & PBs can be negotiated also free of charge for a specific period during HPC system runs
- A sustainable long-term data storage & sharing infrastructure for Iceland is in development by the EDIH-IS & NCC HPC/AI & will be available 2024 (expected)
bi-monthly IHPC Community Workshops with public participation and is open to everyone interested.

Funded by the EuroCC project

Latest: 10th Icelandic HPC Community Workshop (2023-04-26)

Training material from Prof Dr - Ing Morris Riedel
YouTube channel: @profdr-ingmorrisriedel5563
Collaboration Highlights

- **NCC DE** (‘big brother to learn from’)
  - Juelich Supercomputing Centre (JSC) with joint Simulation & Data Labs Members
- **CASTIEL Quantum Computing WG**
  - NCC DE, NCC IT, NCC DK, NCC IE, NCC NL
  - Mentoring Path – First Workshop & Report
- **Centre of Excellence RAISE** for HPC/AI
- **Mentoring Path** – First Workshop & Report
- **Joint Workshops** (e.g., Prague 11/2022)
  - NCC CY, NCC CZ, NCC DE, NCC LV & SMEs
- **EDIH-IS of Iceland** (‘on-boarding HPC/AI’)
  - Joining forces to work with SMEs on EU level
  - Working with Audna Tech Transfer Office
Why using High-Performance Computing (HPC)?

✓ Benefit #1: Faster Training of AI Models → Speed-up!
✓ Benefit #2: Train Better AI Models → Higher Accuracy!
Needs of using Artificial Intelligence (AI) with HPC

• Goal Faster AI Model Training using HPC
  • Challenge: Complexity in AI stacks on HPC
  • CoE RAISE offers a Unique AI Framework

• Simulation & Data Labs use AI
  • Accoustic & Tactile Engineering (SME Treble)
  • Natural Language Processing (SME Mideind)
  • Computational Fluid Dynamics (SME Icewind)
The challenge of finding the right versions of modules that work together (ca. 2-3 days/month)

• Solution: Use LAMEC – API of the UAIF framework of CoE RAISE

• Simplify HPC access using AI libraries with the LAMEC – API

• LAMEC = Load AI Modules, Environments, & Containers

• Support of many HPC systems in Europe already
Benefit #1: Faster Training of AI Models – Examples

Figure 1. Multinode, time per epoch, multispectral model.
Benefit #2: Train Better AI Models – Examples

- **Mean validation loss decreased by ~44% giving a significant performance improvement**

- Better AI models with higher accuracy or lower error rates through hyperparameter optimization
“AI at Scale Applications” Example Large Language Models

- Large Language Model & OpenAI / GPT-4
- Example: SME Mideind ehf
- Natural Language Processing (NLP) SME & NCC Iceland Simulation & Data Lab NLP
- Develop ‘google translate’ that works
- Submitted joint EU proposal using AI on HPC
- CoE RAISE Unique AI Framework (UAIF)
- Selected Building Blocks used for AI on HPC
• Simulation & Data Lab Natural Language Processing (NLP) activities
• Addressing societal challenge: Preserving ‘small country’ languages
Quantum Simulation and Data Science Lab

Exploiting cutting-edge technologies to advance materials modelling and simulations.
Selected References

[1] EuroCC NCC Iceland IHPC Community, Online: https://ihpc.is/community/

[2] CoE RAISE YouTube Channel for joint Trainings, Online: https://www.youtube.com/@coeraise6339


[8] YouTube Channel with publicly accessible training material on HPC/Cloud Courses, Online: https://www.youtube.com/channel/UCWG5VKHmL4NZgFFk0HTANKt
Revolutionising recycling with AI

The challenge

Recycling waste is one of the easiest ways to reduce the use of limited resources and curb climate change, but often the materials that end up on the conveyors of the materials recovery facilities (MRFs) are not what recyclers want and many contaminants such as containers soiled with food waste have to be removed by hand. It’s estimated that the world generates three billion tonnes of domestic waste each year, but less than 10 per cent of it is recycled.

The solution

Danu Robotics, an Edinburgh-based start-up specialising in AI solutions that protect the environment, has come up with a solution based on machine learning software that can visually identify recyclable and non-recyclable material and remove any items that should not be there.

Before deploying the robot picking hardware, the company had to build up a waste image database to help the system identify contaminants. Now that the initial system training is complete, Danu Robotics is working on the software which will direct the robotic sorting system to remove contaminants from a moving conveyor belt as efficiently and effectively as possible. For this part of the programme, the company called in EPCC for support. EPCC initially worked with DanuRobotics to outline the system’s architecture and this led to further work to train the AI part of the system to identify recyclable and contaminant items. EPCC’s Cirrus supercomputer was employed to help process the data and train the software.

Impact of this EuroCC project

In mid 2022 the project began two months of lab tests to integrate the software with the robotic hardware, and then a three-month trial of the prototype system at Glasgow City Council’s recycling centre. Several large European recycling companies are interested in the company’s product.

The system is designed to be sustainable, flexible, affordable, scalable and future proof, and the technology can help recycling companies recoup their investment within two years, and double their profit within three or four years’ time.

https://www.eurocc-access.eu/
This project has received funding from the European High-Performance Computing Joint Undertaking (JU) under grant agreement No 101101903. The JU receives support from the Digital Europe Programme and Germany, Bulgaria, Austria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Italy, Lithuania, Latvia, Poland, Portugal, Romania, Slovenia, Spain, Sweden, France, Netherlands, Belgium, Luxembourg, Slovakia, Norway, Türkiye, Republic of North Macedonia, Iceland, Montenegro, Serbia.
Why using High-Performance Computing (HPC)?

✓ Benefit #1: Faster Training of AI Models → Speed-up!
Status of the NCC Iceland
Prof. Dr. – Ing. Morris Riedel, The University of Iceland

- Interactions with Industry work well
  - Example: SME Mideind ehf
  - Natural Language Processing (NLP) SME & NCC Iceland Simulation & Data Lab NLP
  - Develop ‘google translate’ that works
  - Joining forces in EU Horizon & DEP proposals

Mideind develops Natural Language Processing and Artificial Intelligence applications for the Icelandic language (mideind.is)

12 employees, based in Reykjavik, Iceland
Applications include spelling and grammar correction, a voice assistant, machine translation, question answering, summarization, chatbots & more

We have received great support from Forschungszentrum Jülich and the University of Iceland regarding access to GPU clusters for training and fine-tuning of large language models.

We are looking to contribute to European projects to support smaller languages in NLP and AI

* Many thanks to Prof. Dr. – Ing. Morris Riedel & his NCC team.
Activities of the Simulation & Data Lab Natural Language Processing (NLP)

Addressing societal challenge: Preserving ‘small country’ languages

SME Mideind ehf & OpenAI / GPT - 4

SME Mideind CEO
Vilhjálmur Porsteinsson

OpenAI Representatives

Lilja Alfreðsdóttir,
Minister of Culture & Business Affairs
CoE RAISE & Unique AI Framework

- Activities of the Simulation & Data Lab Remote Sensing & CFD
- Addressing technical challenge: Solving complexity of AI/HPC software tools
Icelandic High-Performance Computing (IHPC) Activities

- IHPC Community Workshop [bi-monthly]
- Activities are increasing in academia and industry that also includes related areas such as Artificial Intelligence (AI), Machine Learning (ML), Data Analytics, and Data Sciences.
- 10 workshops since August 2021
- Center for remote sensing
  - Gabriele, Gro Birkefeldt Moller Pedersen, Rocco,
- CFD
  - A
- Cybersecurity
Icelandic HPC Activities & Long-Term Collaboration Partners

Icelandic National Infrastructure for HPC
- HPC hardware funds by RANNIS; now via roadmap IReiP
- Proposals yearly required to obtain funds still
- Joint proposal from IHPC community

EuroHPC EuroCC National Competence Center for HPC & AI
- EU Project (09/2019-08/2021), 2 years
- Building Simulation and Data Labs (SDLs) of the IHPC Community of Users
- Supports industry engagement in HPC

IHPC Community of Users
- Organized around RANNIS proposals
- ~53 scientific experts & research group
- UoLceland/UoReykjavik, Iceland Geo Survey
- ISOR, Met Office & industry: Matis, etc.

EuroHPC LUMI Supercomputer in Finland
- Supercomputer funded by Finland, Belgium, Czech Republic, Denmark, Estonia, Iceland, Norway, Poland, Sweden, Switzerland
- Co-Funds by EC and Iceland participation funds from: UoLceland, UoReykjavik, and Hannes Jonsson & Egil Skulason

Teaching & Education in HPC & AI
- University of Reykjavik
- University of Iceland
- Arctic Webinar Series (with US partners)
- Digital/Horizon Europe MSc in HPC

International Cooperations
- Tactical: 4 Joint PhDs with Juelich Supercomputing Centre in Germany (#1 HPC System in Europe)
- Tactical: EC Projects like DEEP-EST, EOSC-Nordic, RAISE Center of Excellence (CoE)
- Strategic: Plans of building an Icelandic National Lab with international cooperation together with industry
Why Iceland?

- Clean and data
Main achievements of NCC Iceland
Prof. Dr. – Ing. Morris Riedel, University of Iceland

• Recognized by ministries, SME & Industry
• Established 12 Simulation & Data Labs in key areas of science & engineering
  • With industry use cases & participation
• Identified HPC/AI activities in Iceland
• Promoted six unique competencies

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**Competence category** | Level of HPC readiness of users
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Awareness creation |  
Expert technical capability | Digitally ready | HPC ready | HPC users | HPC champions
Services and products |  
Professional & project consultancy |  
Technological assessment and HPC |  
Monitoring the EU HPC ecosystem |  

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Current Status of the NCC – KPIs
Prof. Dr. – Ing. Morris Riedel, The University of Iceland

The IHPC workshop series of NCC Iceland was key to success in many of the KPI activities

[7] EuroCC NCC Iceland Icelandic HPC (IHPC) Community Workshop Events

[8] YouTube Channel with HPC & Cloud Computing Courses

Training: Publicly Accessible Lectures

Mural Bayoun • 3 weeks ago
Great course thanks a lot, hope to see more contents related to HPC

Orbitfighter • 3 weeks ago
I would like to thank you to make your lectures on yt, appreciate it Prof.

Vincent Hus • 1 month ago
Thanks a lot for sharing this course! This really helps the world 😊

Matt Kaffar • 7 months ago • 9 subscribers
Thank you very much for posting these lectures, professor! They are helping with my Ph.D. research.

Khadija Eltaghit • 5 months ago
Nice lecture, thank you Professor.

Tom • 1 month ago • 38 subscribers
Beautiful

Antonis Polychron • 1 month ago • 13 subscribers
Super interesting curriculum. Thanks prof.
Current Status of the NCC
Prof. Dr. – Ing. Morris Riedel, The University of Iceland

- Increased number of HPC/AI users
  - Enabled national/EU access to HPC
- Interactions with Industry work well
  - Example: SME Mideind ehf
- Natural Language Processing (NLP) SME & NCC Iceland Simulation & Data Lab NLP
  - Develop ‘google translate’ that works
  - Joining forces in EU Horizon & DEP proposals
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