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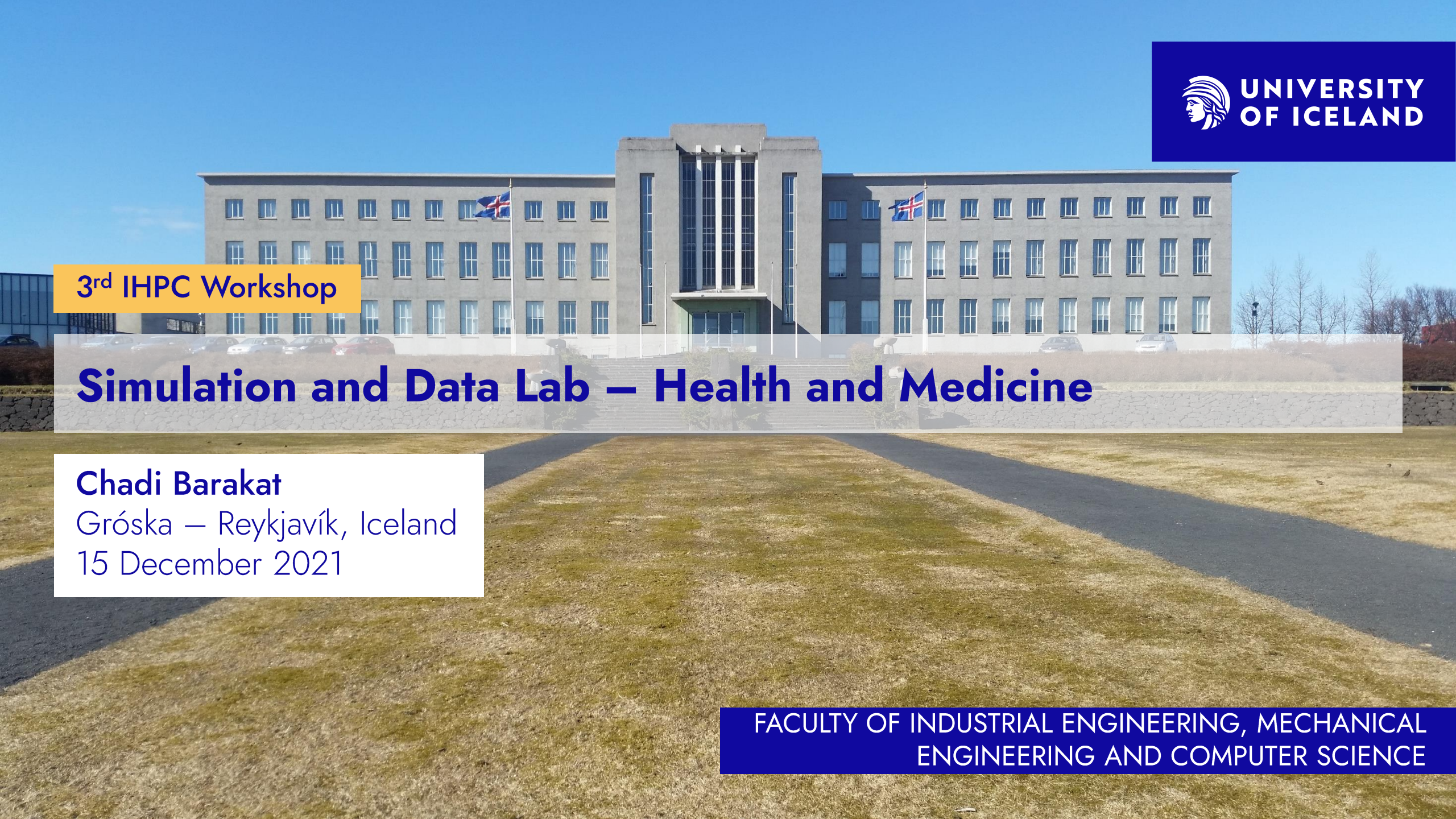

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3rd IHPC Workshop

Simulation and Data Lab – Health and Medicine

Chadi Barakat
Gróska – Reykjavík, Iceland
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FACULTY OF INDUSTRIAL ENGINEERING, MECHANICAL ENGINEERING AND COMPUTER SCIENCE

Smart Medical Information Technology for Healthcare

- The SMITH project is one of the four consortia of the German Medical Informatics Initiative (MII) [16].
- Aims to establish infrastructure for research in healthcare:
  - Define governance architecture for this infrastructure.
  - Determine paths of communication and data sharing between partner university clinics and research centres.
- Two clinical use cases:
  - HELP – Hospital-wide electronic medical record-based computerized decision support system to improve outcomes of patients with blood-stream infections.
  - ASIC – Algorithmic Surveillance of ICU Patients.

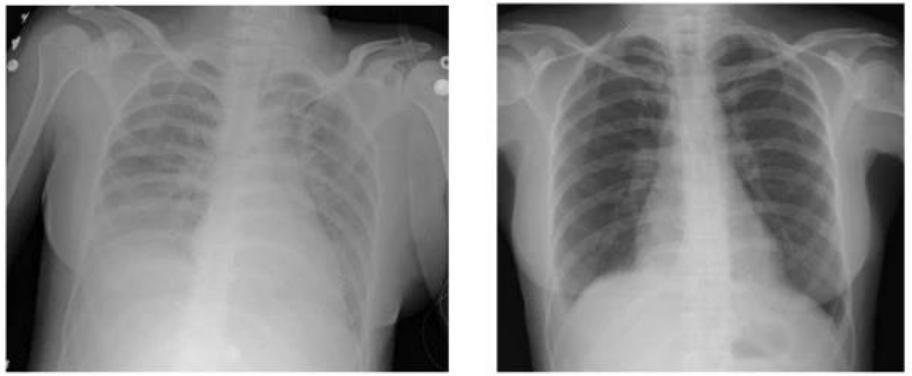
Acute Respiratory Distress Syndrome

- Acute Respiratory Distress Syndrome (ARDS) is a severe condition that affects a significant fraction of Intensive Care Unit (ICU) patients with a high mortality rate [1].
- It is characterised by bronchoalveolar injury and alveolar collapse, and is visible in chest X-rays as bilateral infiltrates in the lungs.
- Early detection is generally associated with positive outcomes [4,5].
- Diagnosis based on the “Berlin Definition” [6].

I. Direct injury
1. Aspiration.
2. Diffuse pulmonary infection (e.g., bacterial, viral, *Pneumocystis*.
3. Infection, and others).
4. Near-drowning.
5. Toxic inhalation.
6. Lung contusion.

II. Indirect Injury
1. Sepsis syndrome, with or without clinically significant hypotension, (e.g., systolic blood pressure ⩽ 90 mm Hg), with or without evidence of infection outside the lung. This syndrome can be described as having both signs of systemic inflammation (i.e., by abnormalities of body temperature, heart rate, respiratory rate, and white blood cell count) and signs of organ system dysfunction including, but not limited to, pulmonary, hepatic, renal, central nervous, and cardiovascular systems.
2. Severe nonthoracic trauma as indicated by:
   (1) Clinical description.
   (2) Scoring systems such as the Injury Severity Score (ISS) or APACHE II/III.
   (3) Treatment interventions such as the Treatment Intervention Scoring System (TISS).
3. Hypertransfusion for emergency resuscitation.
4. Cardiopulmonary bypass (rare).

ARDS Risk Factors [2]

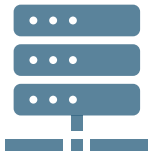


Comparison of ARDS (left) and healthy lungs (right) [3]

ARDS as a Major Use Case

- ARDS – major application field in the ASIC use case.
- Challenge 1: Disease onset, progression, diagnosis, and treatment need algorithmic support.
  - Berlin Definition aids diagnosis [6].
  - No consensus on optimal treatment strategy [1,17,18,19].
  - Wealth of clinical data, but analysis is slow.
- Challenge 2: Medical staff lack the necessary knowledge in HPC to conduct simulations.
- Opportunity: Use of ML and HPC to speed up analysis.
  - Nottingham Physiology Simulator/Warwick Physiological Model obtained through project partners [19,20].
  - HPC resources within the Jülich Supercomputing Centre.

SMITH
Smart Medical Information Technology for Healthcare



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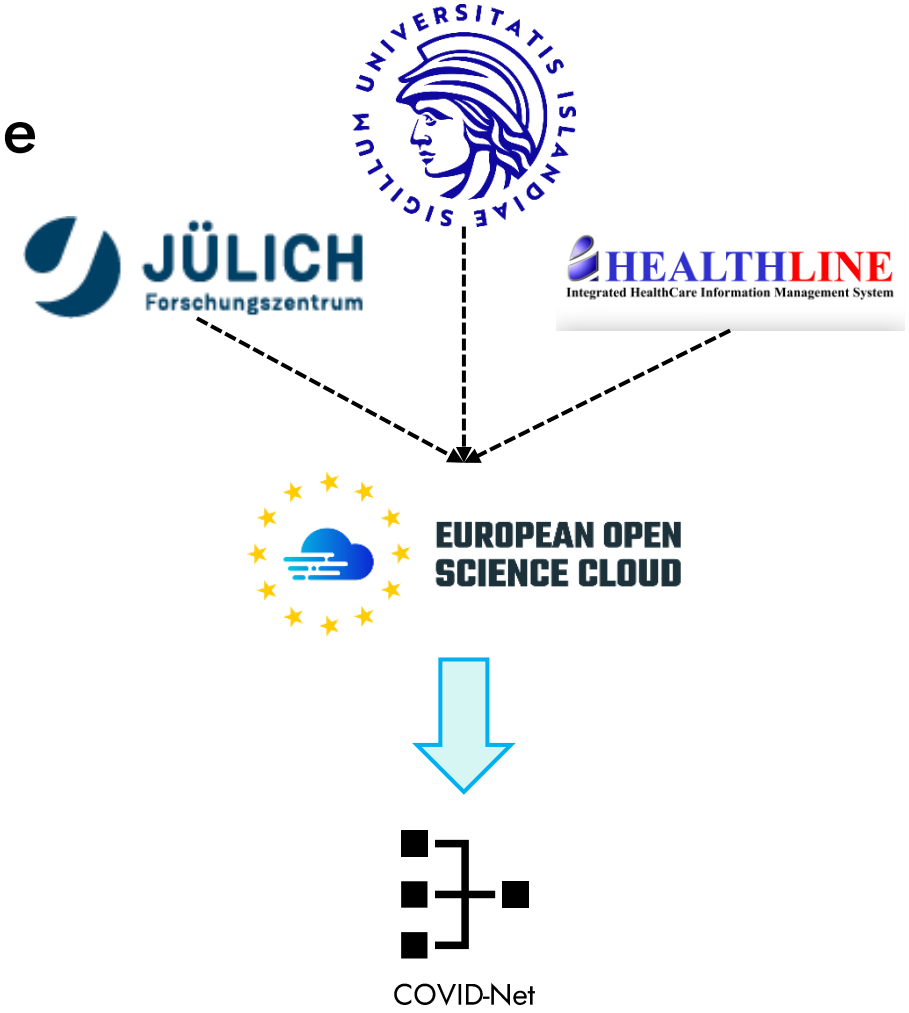
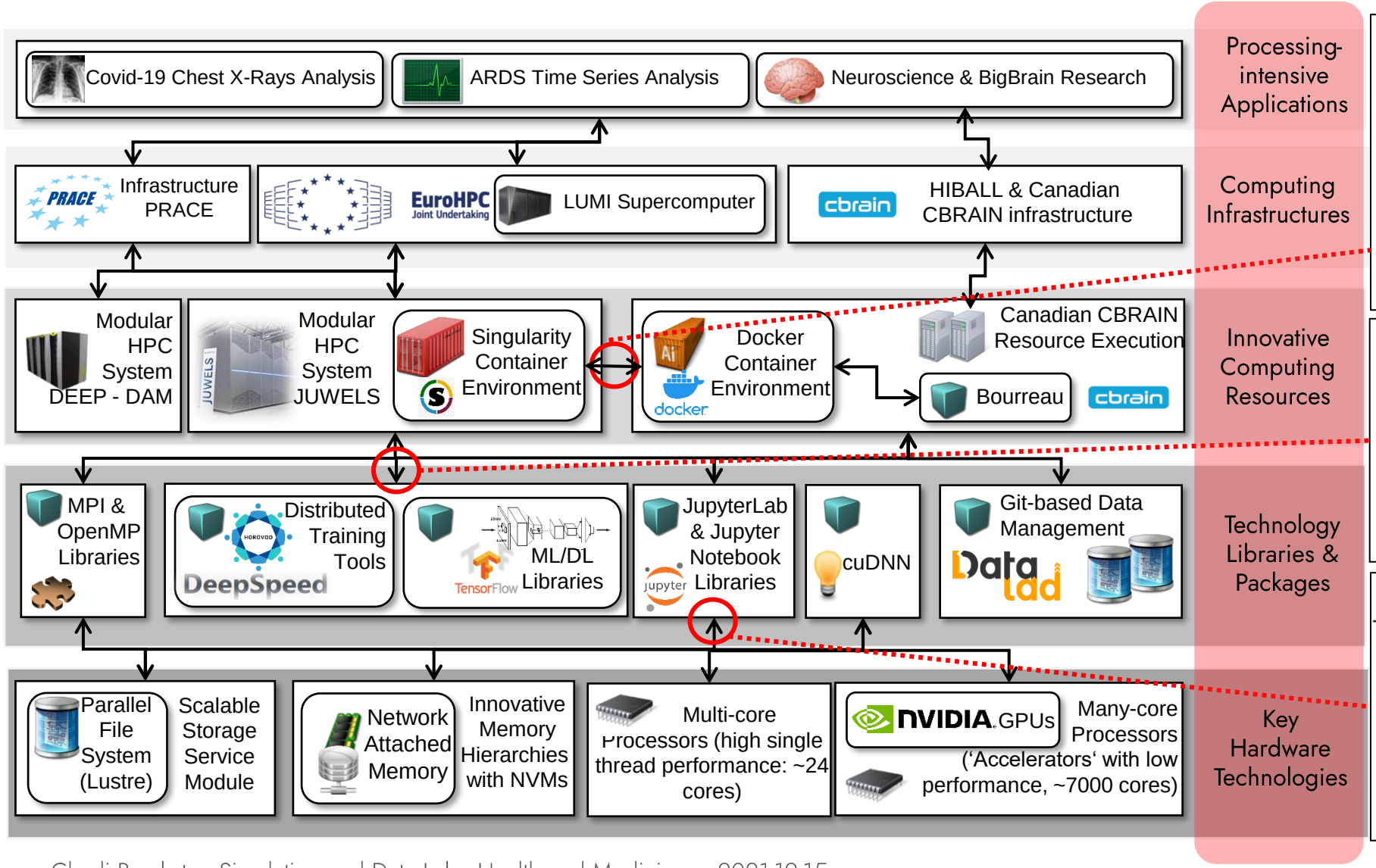
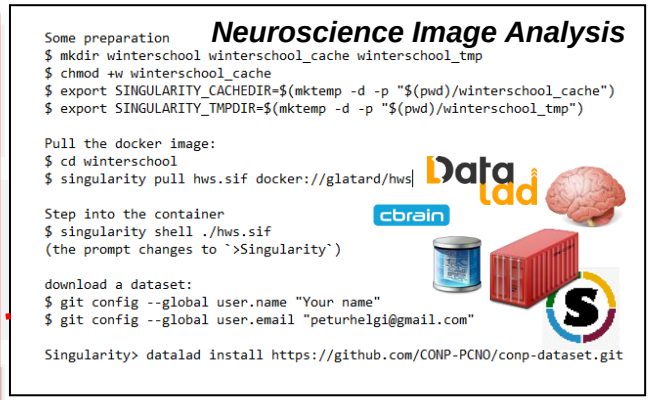
Parallel Research Opportunity

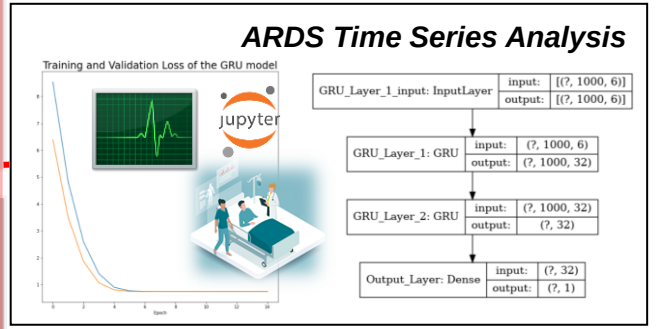
- Covid-19: wealth of data and research made available within a short time:
  - Similar application field to ARDS.
  - Joining established knowledge in the field with experience gained from working in SMITH.
- EOSC Fast-Track Grant (FZ-Jülich/HÍ/e-HealthLine).
- Co-supervising M.Sc. Thesis Gísli Ingólfsson:
  - Verifying outputs of Deep Learning model for chest X-ray classification [21].
  - Testing the model "as is" on new data.
  - Transfer Learning in real-world applications.

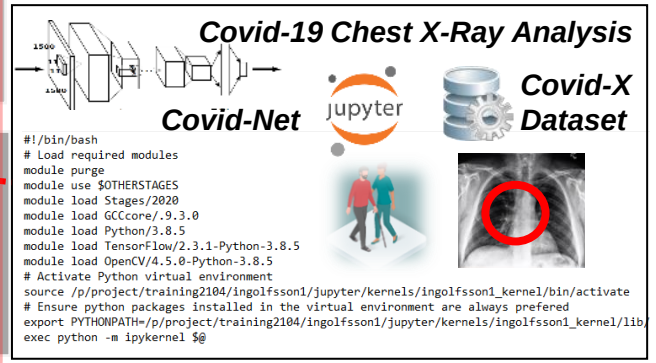


System Blueprint – ML for Healthcare









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Thank you for your attention

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