

State of the LOCOS

2 October 2025

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University
of Glasgow

School of Computing Science

locos (*noun*):
lunatics

Looking back

Theme activities in the past year

- Learning and teaching
- Research
- Projects
- Community Engagement
- Outreach

Learning and teaching

Sustainability in Our Curriculum

- Sustainability-focused aims and four ILOs in all our undergraduate programmes since AY 24/25
- Implemented across core courses
- Following a pilot (the GA programme)
- SoCS Sustainability Teaching Workshop on 4 September 2024 to support changes
- University press release and news paper articles in September 2024



Sustainability in Our Curriculum

- COMPSCI5012 (Internet Technology) has a new sustainability course aim:
 - To promote the design of accessible and sustainable web applications.
- and two revised ILOs:
 - 6. Evaluate and assess specifications and designs of web applications, including their accessibility and sustainability;
 - 7. Construct, build and deploy a web application, considering sustainable development practices.

New Course “Cloud Systems” (H/M)

- Co-proposed, co-designed, and co-delivered by Lauritz and Yehia
 - Focus on scalable and sustainable
 - cloud systems (i.e. ILOs, chapters, and assessments)
 - So far, a popular course:
 - Fully booked in AY 24/25 year (72 students)
 - More capacity this AY (currently ~105 registrations)
 - Positive feedback (from both students and the external examiner)
- Week 1: Cloud Computing Intro
Week 2: Virtual Machines
Week 3: Containers
Week 4: Cloud Infrastructure Management
Week 5: Cloud Sustainability
5.1 The Rising Footprint of Data Centers
5.2 Energy Efficiency, Energy Proportionality, and PUE
5.3 Cloud Carbon Footprint Assessment
5.4 Carbon-Aware Cloud Computing
Week 6: Cloud System
Week 7: Modern Cloud Architectures
Week 8: Flavours of Cloud
Week 9: A Wider Lens on Sustainability
9.1 Dependable Data Centres
9.2 Carbon Footprint Measurement
9.3 Measurement Granularities
9.4 Carbon Intensity
9.5 Carbon-Aware Decision Making
Week 10: Guest Lectures and Exam Prep

Research

PhD Project with Barclays: Estimating and Reducing the Carbon Emissions of Lakehouses Queries



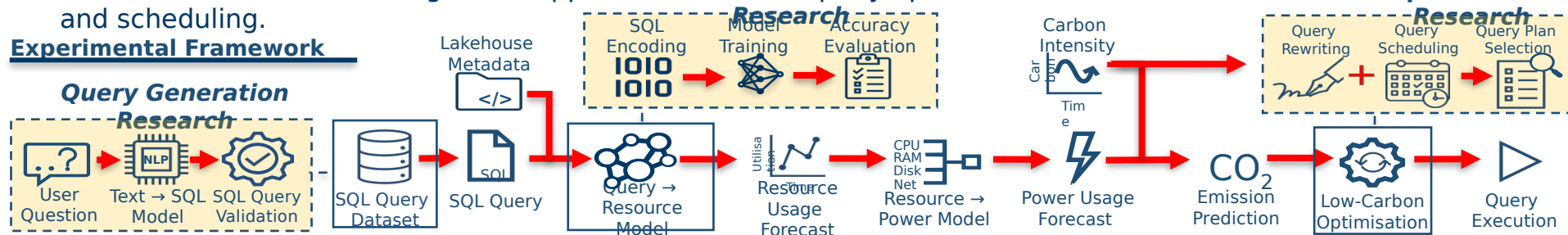
• **James Nurdin** (UofG), **Dr Lauritz Thamsen** (UofG), **Dr Richard McCreddie** (UofG), and **Dr Wei Liu** (Barclays).

Goal: To improve the sustainability of big data analytics by accurately **estimating and reducing the carbon emissions of analytical queries** executed over data lakehouses.

Research Objectives

1. **Data Availability & Quality:** Obtain diverse and realistic training queries.
2. **SQL $\rightarrow$ CO₂ Estimation:** Develop a robust method which maps SQL queries to carbon emissions via resource & power modelling and carbon intensity signals.
3. **Evolving Context:** Maintain accuracy under query workload/schema drift.
4. **Downstream Optimisation Strategies:** Use predictions as a signal for downstream resource management applications such as **Performance Prediction** and scheduling.

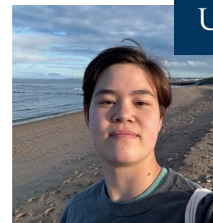
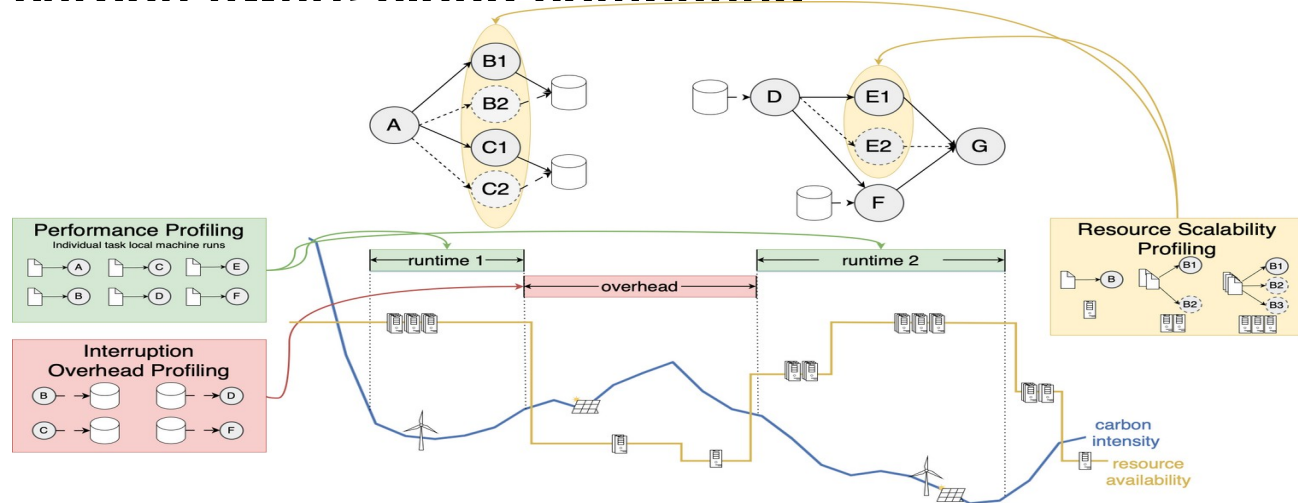
Experimental Framework



Casper: Carbon-Aware Scalable Processing in Elastic Clusters

Runtime: 2025-2027 (2.5 years)

Research area: **Performance prediction for
carbon-aware cloud computing**



Industry partners:



Website: casperproject.gitlab.io

Ichnos: Carbon Footprint Estimator for Cluster Computing Applications



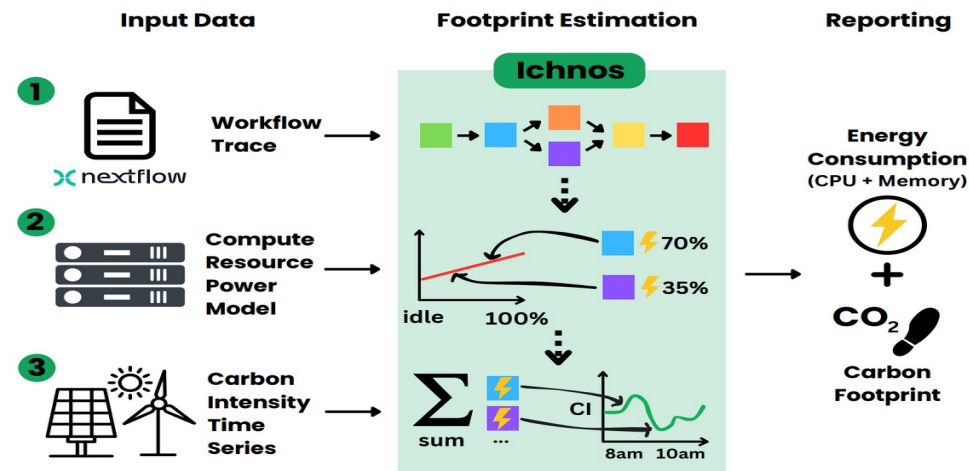
- A toolchain for estimating the footprint of distributed batch processing jobs (e.g. workflow and dataflow applications)

- First presented at LOCO24, with a focus on CPU power modelling and nf-core Nextflow workflows

- Currently expanding the work:

- Support for more systems
- Embodied carbon estimates
- Water and land use footprints

Testing across more applications and infrastructures



<https://github.com/GlasgowC3lab/ichnos>



SAPIENZA
UNIVERSITÀ DI ROMA

PhD Project with Barclays: Estimating and Reducing the Carbon Emissions of Lakehouses Queries



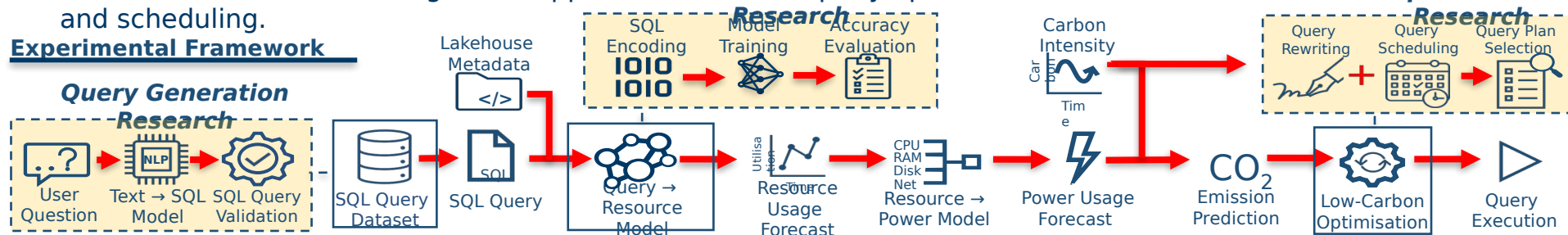
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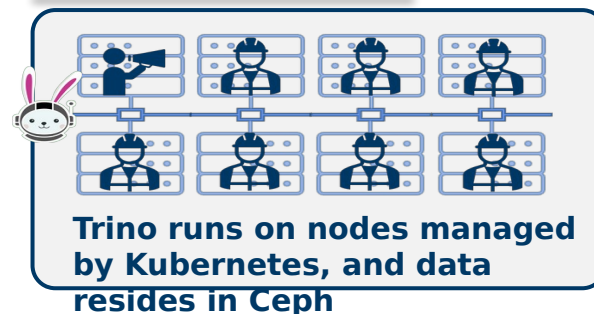
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Experimental Framework



Lakehouse Architecture



LOCOS-Related Publications 2024-25

- **Energy-Aware Workflow Execution: An Overview of Techniques for Saving Energy and Emissions in Scientific Compute Clusters.** L. Thamsen, Y. Elkhatib, P. Harvey, S. W. Nabi, J. Singer, and W. Vanderbauwhede. To appear in U. Leser, M. Hilbrich, S. R. Wilkinson, R. Ferreira da Silva (eds.), Workflow Systems for Large-Scale Scientific Data Analysis. Berlin Universities Publishing. 2025.
- **Predicting the Performance of Scientific Workflow Tasks for Cluster Resource Management: An Overview of the State of the Art.** J. Bader, K. West, S. Becker, S. Kulagina, F. Lehmann, L. Thamsen, H. Meyerhenke, and O. Kao. To appear in U. Leser, M. Hilbrich, S. R. Wilkinson, R. Ferreira da Silva (eds.), Workflow Systems for Large-Scale Scientific Data Analysis. Berlin Universities Publishing. 2025.
- **Ichnos: A Carbon Footprint Estimator for Scientific Workflows.** K. West, M. Reid, Y. Elkhatib, and L. Thamsen. 1st International Workshop on Low Carbon Computing (LOCO). LOCO/arXiv. 2025.
- **Flora: Efficient Cloud Resource Selection for Big Data Processing via Job Classification.** J. Will, L. Thamsen, J. Bader, and O. Kao. 25th IEEE International Symposium on Cluster, Cloud and Internet Computing (CCGrid). IEEE. 2025.
- **Exploring the Potential of Carbon-Aware Execution for Scientific Workflows.** K. West, F. Lehmann, V. Bountris, U. Leser, Y. Elkhatib, and L. Thamsen. 25th IEEE International Symposium on Cluster, Cloud and Internet Computing (CCGrid). IEEE. 2025.
- **Ponder: Online Prediction of Task Memory Requirements for Scientific Workflows.** F. Lehmann, J. Bader, N. De Mecquenem, X. Wang, V. Bountris, F. Friederici, U. Leser, and L. Thamsen. 20th IEEE International Conference on e-Science (e-Science). IEEE. 2024.
- **Sizey: Memory-Efficient Execution of Scientific Workflow Tasks.** J. Bader, F. Skalski, F. Lehmann, D. Scheinert, J. Will, L. Thamsen, and O. Kao. 26th IEEE International Conference on Cluster Computing (Cluster). IEEE. 2024.
- **Demeter: Resource-Efficient Distributed Stream Processing under Dynamic Loads with Multi-Configuration Optimization.** M. Geldenhuys, D. Scheinert, O. Kao, and L. Thamsen. 15th ACM/SPEC International Conference on Performance Engineering (ICPE). ACM. 2024.
- **FedZero: Leveraging Renewable Excess Energy in Federated Learning.** P. Wiesner, R. Khalili, D. Grinwald, P. Agrawal, L. Thamsen, and O. Kao. 14th ACM International Conference on Future Energy Systems (e-Energy). ACM. 2024.
- **Lotaru: Locally Predicting Workflow Task Runtimes for Resource Management on Heterogeneous Infrastructures.** J. Bader, F. Lehmann, L. Thamsen, U. Leser, and O. Kao. Future Generation Computer Systems 150. Elsevier. 2024.

LOCOS-Related Publications 2024-25

- **A Systematic Evaluation of the Potential of Carbon-Aware Execution for Scientific Workflows** [Kathleen West](#), [Youssef Moawad](#), Fabian Lehmann, Vasilis Bountris, Ulf Leser, [Yehia Elkhatib](#), [Lauritz Thamsen](#) **arXiv preprint arXiv:2508.14625 (2025)**
- **A Digital Twinning Approach to Decarbonisation: Research Challenges** Blair Archibald, [Paul Harvey](#), Michele Sevegnani **arXiv preprint arXiv:2506.23733 (2025)**
- **Modelling Scenarios for Carbon-aware Geographic Load Shifting of Compute Workloads** [Wim Vanderbauwhede](#) **arXiv preprint arXiv:2509.07043 (2025)**
- **Life cycle analysis for emissions of scientific computing centres.** Mattias Wadenstein, [Wim Vanderbauwhede](#) **Eur. Phys. J. C 85, 913 (2025).** <https://doi.org/10.1140/epjc/s10052-025-14650-8>
- **Estimating the Increase in Emissions caused by AI-augmented Search** [Wim Vanderbauwhede](#) **arXiv preprint arXiv:2407.16894 (2024)**

LOCOS PhD Projects

- **Kathleen West:** Carbon-Aware Execution of Scientific Workflows (since 2023; supervised by Lauritz and Yehia)
- **James Nurdin:** Optimising Data Services for Sustainability Using Machine Learning (since 2024; supervised by Lauritz and Richard McCreadie)
- **Max MacDonald:** Sacrifice Acceptance of Sustainable Practices Within Computing: How Serious Games Can Educate Professionals (since 2025; supervised by Matthew Barr, Lauritz, and Chris McCaig)
- **Tobey Froehlich:** Estimating the Full Impact of AI Tools for Specific Tasks (since 2025; supervised by Lauritz, Tiffany Vlaar, and Wim)
- **Shuxuan Li:** Sparsification of NNs on FPGAs (since 2024; supervised by Nikela Papadopoulou and Wim Vanderbauwhede)

Projects and proposals

EPSRC project: IDEAL

- Reducing Carbon Footprints of IoT Developments through Extension of Active Lifespans
- started April 2025, runs until end of 2027
- with Oxford (Nobuko Yoshida) and Essex (Klaus McDonald-Maier)
- Cris is the PDRA on this

Community engagement

1st International Workshop on Low Carbon Computing (LOCO 2024)

- A low-carbon, diverse, inclusive, accessible and critical event hosted in Glasgow, Scotland, UK, on 3 December 2024
- 100+ attendees (~50 in person, as many online)
 - Large and diverse PC (with 42 members)
 - Full programme and post-proceedings
 - 21 out of 41 extended abstracts accepted
 - 8 abstracts extended into full papers
 - 10 lightning talks
 - 2 keynotes (Anne Currie; Ayse Coskun)
- A sister event of the ProPL workshops
- Strong involvement of LOCOS theme members
 - Wim: General & PC chair; Lauritz: PC chair; Yehia: Local chair; Nikela and Christian: Finance;



Other Community Engagement – Lauritz



Invited talk at the 19th Symposium of the HPI Research Schools: Lauritz Thamsen – **Leveraging Low-Carbon Energy for Flexible Cloud and Edge Workloads**

- Recording: <https://www.tele-task.de/series/1508/>



Called for papers on **carbon-aware computing testbeds, metrics, and benchmarks** at our EuroSys workshop TDIS2025 (<https://tdis.gitlab.io/tdis25/>)

Other Community Engagement – Wim

- Invited talk at “Shaping the Digital Future of ErUM Research: Sustainability & Ethics” (Aug 2025): **Life cycle analysis for emissions of scientific computing centres.**
- Invited talk at “WLCG Environmental Sustainability Workshop” (Dec 2024) , Report the LOCO Int’l Workshop on Low Carbon Computing

Outreach

Frugal Computing and AI

- Talks at Datadog, Euro-CSDMS, EFSA, EIF project.
- Interview for CTXT (Spanish magazine)
- Blog posts: limited.systems

Looking forward

Scheduled LOCOS talks

- 16 Oct: Dan Macquillan (Lecturer in Critical AI, Goldsmiths College, UoLondon, author of “Resisting AI”)
- 13 Nov: Ana Valdivia (Research Lecturer in Artificial Intelligence (AI), Government, and Policy Oxford Internet Institute)
- 27 Nov: Thomas Fricke (Freelance cloud expert)
- 11 Dec: Sylvia Wenmackers (Professor in Philosophy of Science, KU Leuven)

Plans?

- Learning and teaching
- Research
- Projects
- Community Engagement
- Outreach

Thank you!