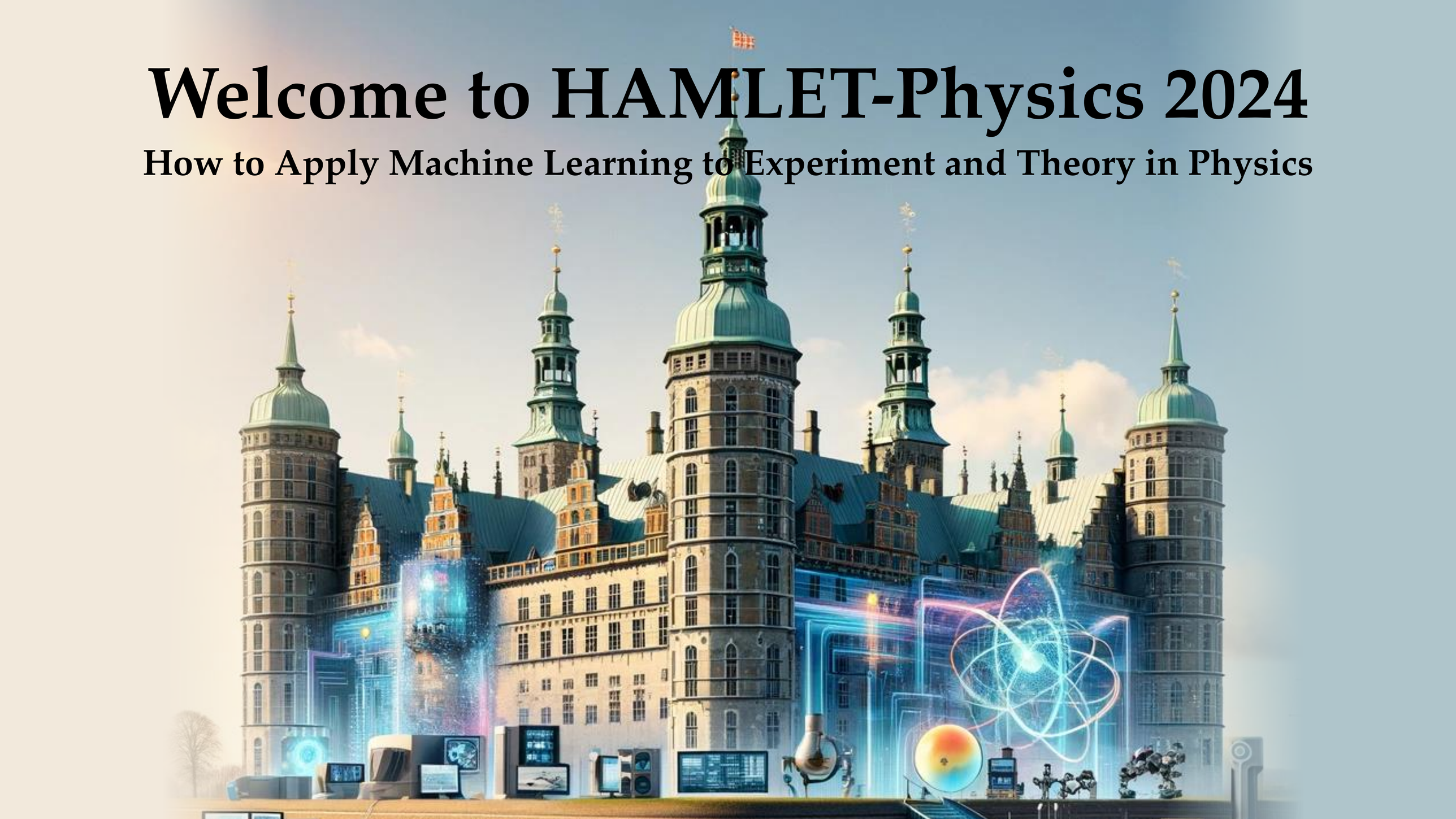
Welcome to HAMLET-Physics 2024

How to Apply Machine Learning to Experiment and Theory in Physics



What is HAMLET-Physics?

HAMLET-Physics is conference/workshop on using Machine Learning in physics research.

<u>The conference/workshop has three main goals:</u>

1. To bring together Danish and international physicists using ML to meet, share ideas, and build community across location and physics specialty.

2. To bring domain scientists into close contact with ML experts, to build community across the theory → application bridge

3. To provide a friendly environment for researchers to share best practices, for students to interact with experts, and for other sciences and industry to understand the state of ML in physics.

Who Are We?

Daniel Murnane (NBI)
93 83 89 58

Troels Petersen (NBI)
26 28 37 39

Stefan Pollok (DTU)
91 37 00 65

Malene Vinding (NBI)
29 36 99 69

Troels Haugbølle (NBI)
29 38 25 88

Inar Timiryasov (NBI)
50 26 90 72

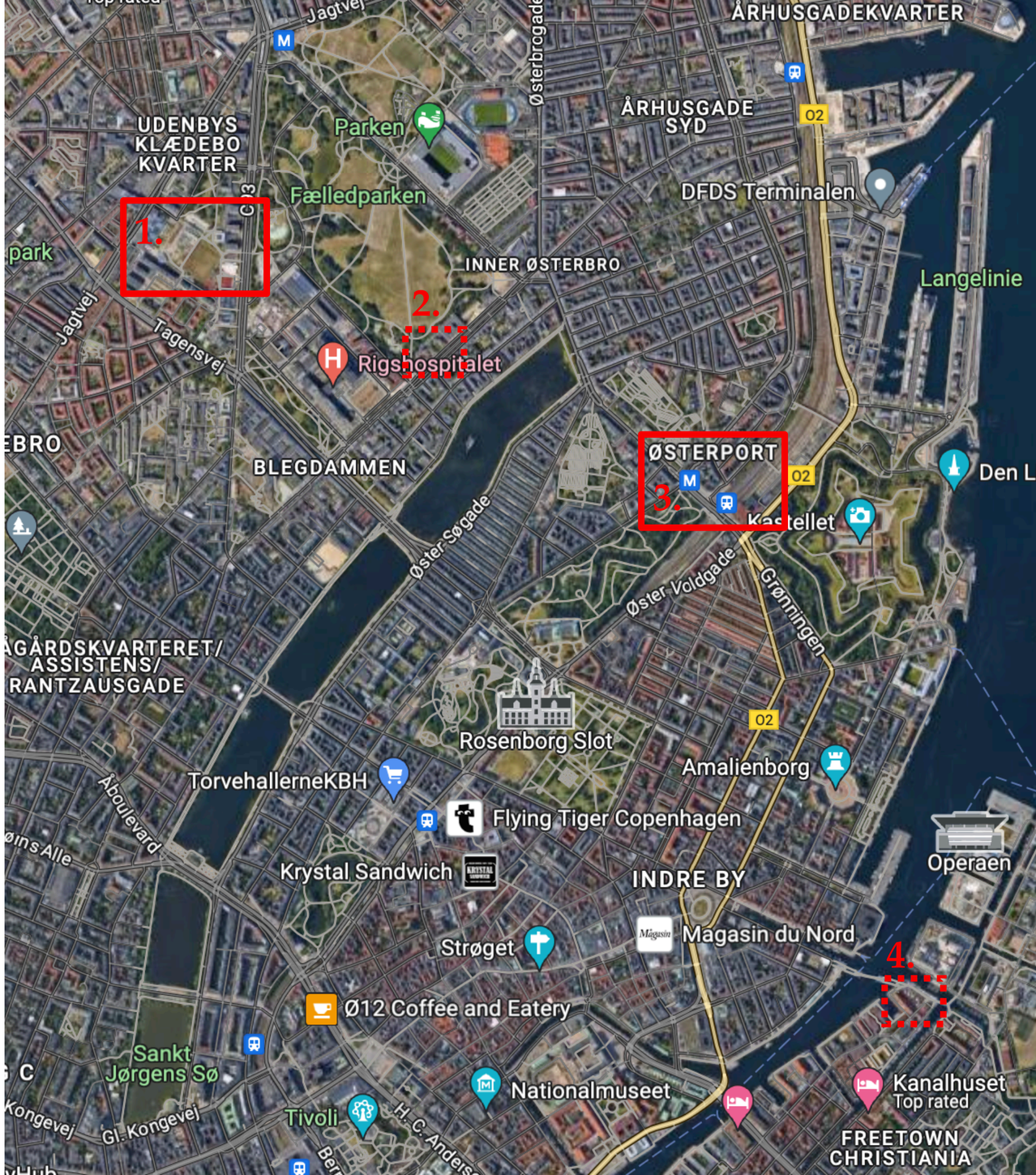
Oswin Krause (DIKU)
52 74 18 92

Asbjørn Preuss (NBI)
50 44 36 96

Overview

This is Copenhagen with the (potentially) useful places to know for this conference:

1. **Conference Venue**.
   Lundbeck Auditorium and H. C. Ørsted Inst.
2. **Niels Bohr Institute.**
   For those who wants to visit Bohr's old lairs.
3. **Østerport Station.**
   From where we depart Tuesday at 15:55!
4. **Broens Gadekøkken (street food by Nyhavn).**
   Which could be a place to go for dinner Monday.



Local area

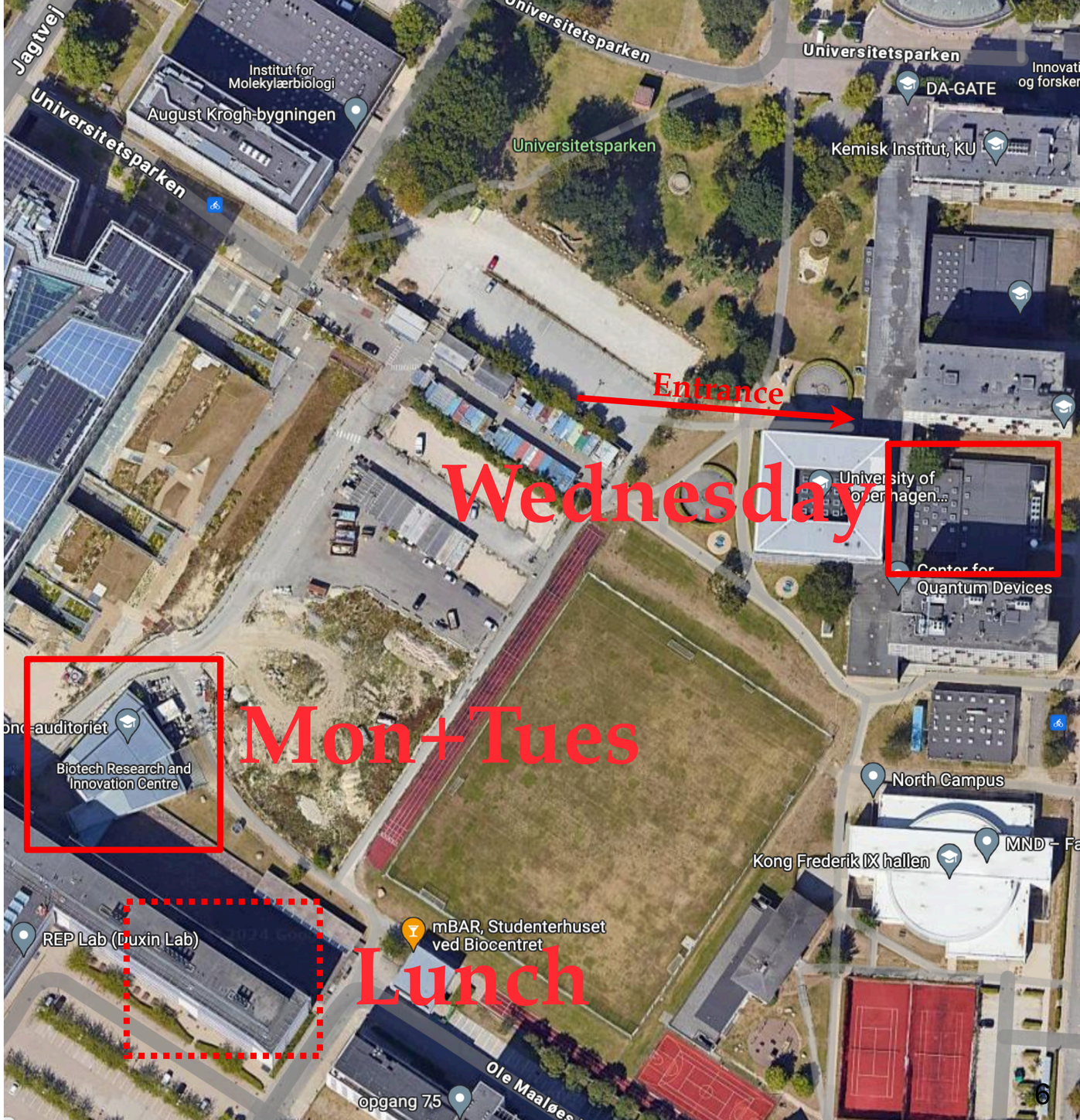
This is where the conference takes place:

1. **Venue (Mon. + Tues.)**.
   Lundbeck Auditorium.
2. **Venue (Wednesday).**
   H. C. Ørsted institute Auditorium 4.
3. **Vibenhus Metro Station.**
   From where we depart Tuesday at < 15:30!

Very locally

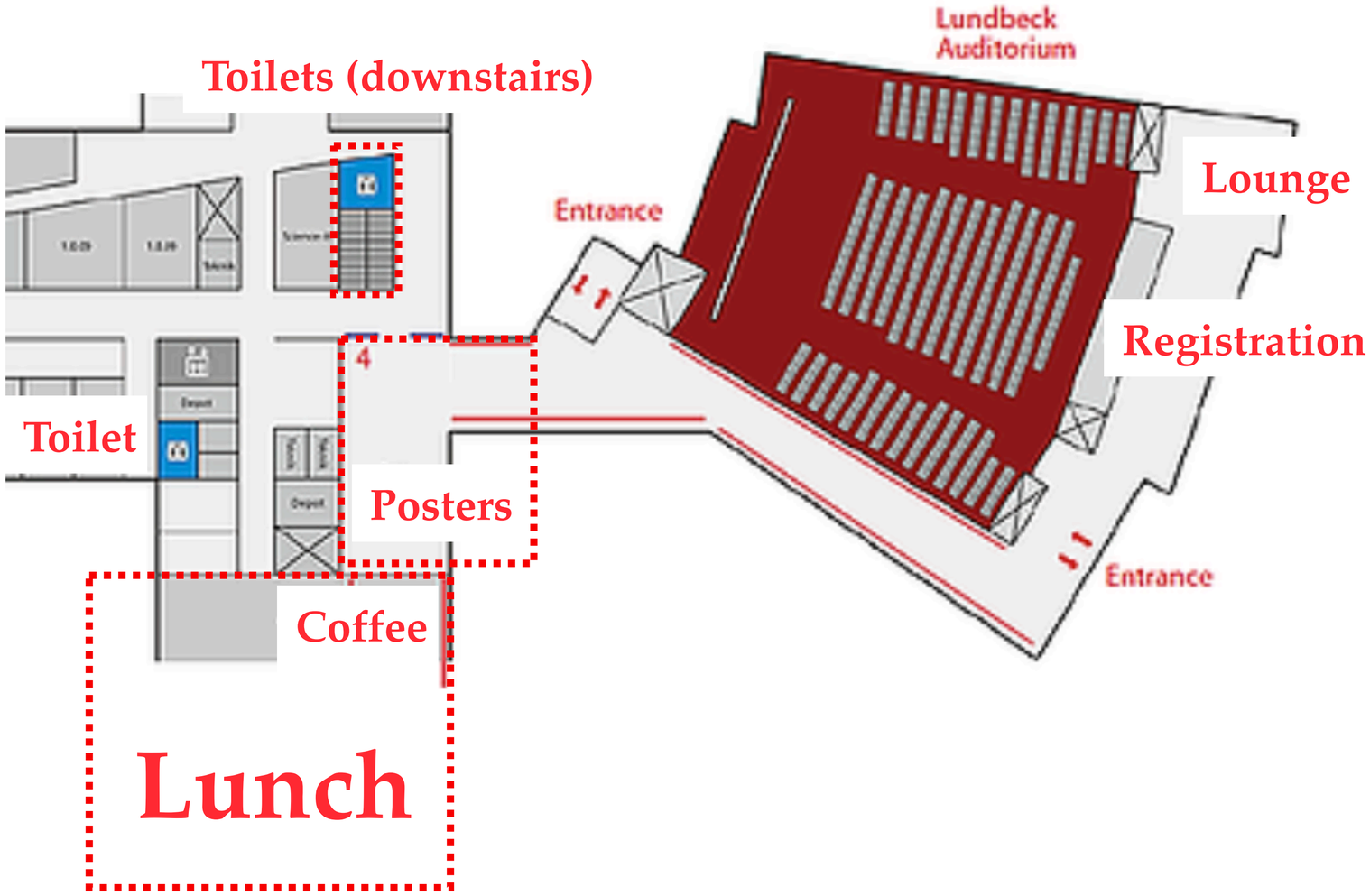
This is our very local area:

1. **Venue (Mon+Tues).**
   Lundbeck Auditorium.
2. **Venue (Wednesday).**
   H. C. Ørsted Institute Aud. 4.
3. **Daily Lunch.**
   From 12-13 (vegetarian options).



The Lundbeck Auditorium

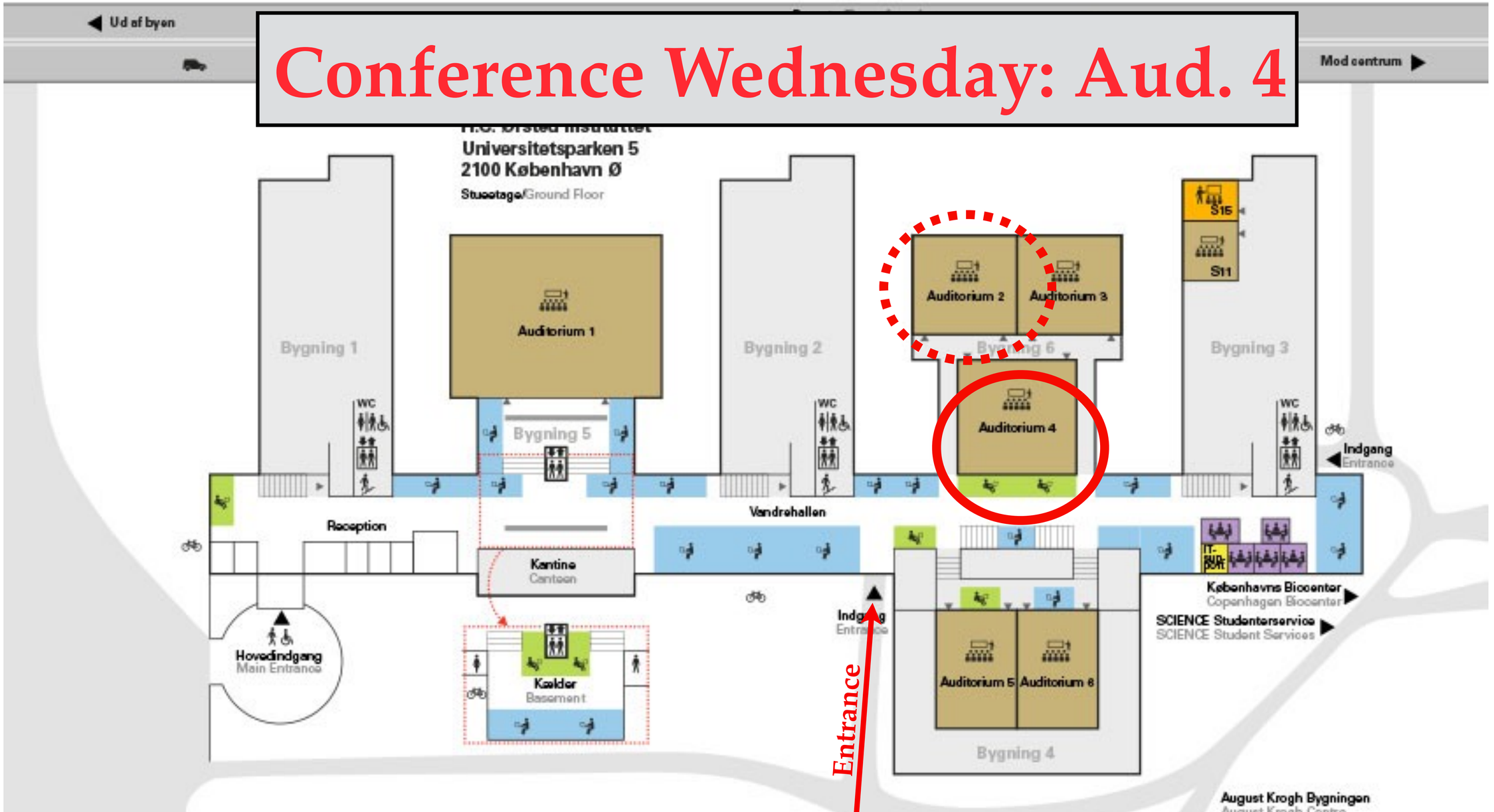
Monday and Tuesday, we will mainly be in and around the Lundbeck Auditorium (see below).
Wednesday, we will be at HCØ (but still have lunch as before).



Daily Lunch 12:00-13:00 (better start early!)

The (vegetarian) lunch is served in the canteen around the corner. You take a plate and **the food you want**, and then put it on **one of the weights**. We will take care of payment (Malene and Asbjørn will help).
Water can be gotten right after the two freestanding weights (dashed red box).

H. C. Ørsted Auditorium



Conference Wednesday: Aud. 4

The Program

Monday

Intro
Lundbeck Auditorium 09:30 - 09:50

10:00

Keynote: Search for New Physics with Machine Learning: concepts, applications and recent progress
Prof. Roman Pasechnik
Lundbeck Auditorium 09:50 - 10:45

Coffee
Lundbeck Auditorium 10:45 - 11:10

11:00

GraphNeT 2.0 *Rasmus Ørsøe*
Lundbeck Auditorium 11:10 - 11:35

Transforming the Bootstrap: Using Transformers to Compute Scattering Amplitude *Dr Matthias Wilhelm*
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12:00

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Keynote - Savannah Thais (Columbia): Trustworthy and Robust AI for Science and Society
Lundbeck Auditorium 13:00 - 13:55

14:00

Advancing Ultra-High Energy Neutrino Astronomy through Deep Learning and Differential Programming *Christian Glaser*
Lundbeck Auditorium 13:55 - 14:20

Coffee
Lundbeck Auditorium 14:20 - 14:45

15:00

cp3-bench: A tool for benchmarking symbolic regression algorithms tested with cosmology *Mattias Ermakov Thing*
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Data challenges for black-hole image reconstruction and feature identification *Raúl Carballo-Rubio*
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Decoding the Early Universe: Machine Learning Applications in CMB Analysis *Leonora Kardum*
Lundbeck Auditorium 15:35 - 16:00

16:00

Poster Lightning Talks
Lundbeck Auditorium 16:00 - 16:30

Joint …	ML in	Geo… Forec… with Neural Netw…	Explo	Data-driven mode… for limited area forec…	Predi Glacier Thick… A Mach… Learn… Appr…	Metal…	Inves noise patter… in the JWST… detec… with ML techn…	Data-…	Simul…	Mode Indep… Fits of Gravi… Wave Signals	Machi…
Y…	*R…*	*Ali A… et al.*	*A…*	*Leif D…*	*Ms J… K…*	*M…*	*P… A…*	*Ji…*	*M…*	*E… H…*	*Bj…*
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17:00

18:00

Social Session: OPTIONAL: Dinner

Tuesday

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Exploring Bottomonium Behaviour at Finite Temperatures: Machine Learning and Lattice QCD *Benjamin Jaeger*
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Development of a Neural-Network-Based Event Reconstru…
Luise Meyer-Hetling

Tutorials & Demos
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15:00

From Lundback Aud to Østerport Station (Self transport)
Lundbeck Auditorium 15:00 - 15:35

16:00

Social Session: Heritage Train Ride from Østerport to Helsingør Station
Lundbeck Auditorium 15:50 - 17:00

17:00

Social Session: Visit Kronborg

Wednesday

09:00

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Auditorium 4, HC Ørsted Building 09:00 - 09:05

An overview of the Gefion Supercomputer *Morten Bache*
Auditorium 4, HC Ørsted Building 09:05 - 09:30

Symbolic regression for Science: challenges and opportunities. *Alessandro Lucantonio*
Auditorium 4, HC Ørsted Building 09:30 - 09:55

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Discovering interpretable physical models using Symbolic Regression and Discrete Exterior Calculus *Simone Manti*
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RECLAIM-DAQ: A framework for Reclaiming the DAQ for …
Carlos Abellan Beteta

Exploring the Impact of Pseudospectra on the Stability of…
SEBASTIAN Basterrech

Deep Learning-Based Data Processing in Large-Sized Tel…
Iaroslava Bezshyiko

ADVANCING NON-LINEAR SPACE CHARGE SIMULATIONS
Isabella Vojskovic

GNN Classification of Muon- and Electron Neutrino Event…
Kaare Endrup Iversen

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Uncertainty estimation in magnetic field inference *Stefan Pollok*
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Nothing organised!

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Everything organised!

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The Program

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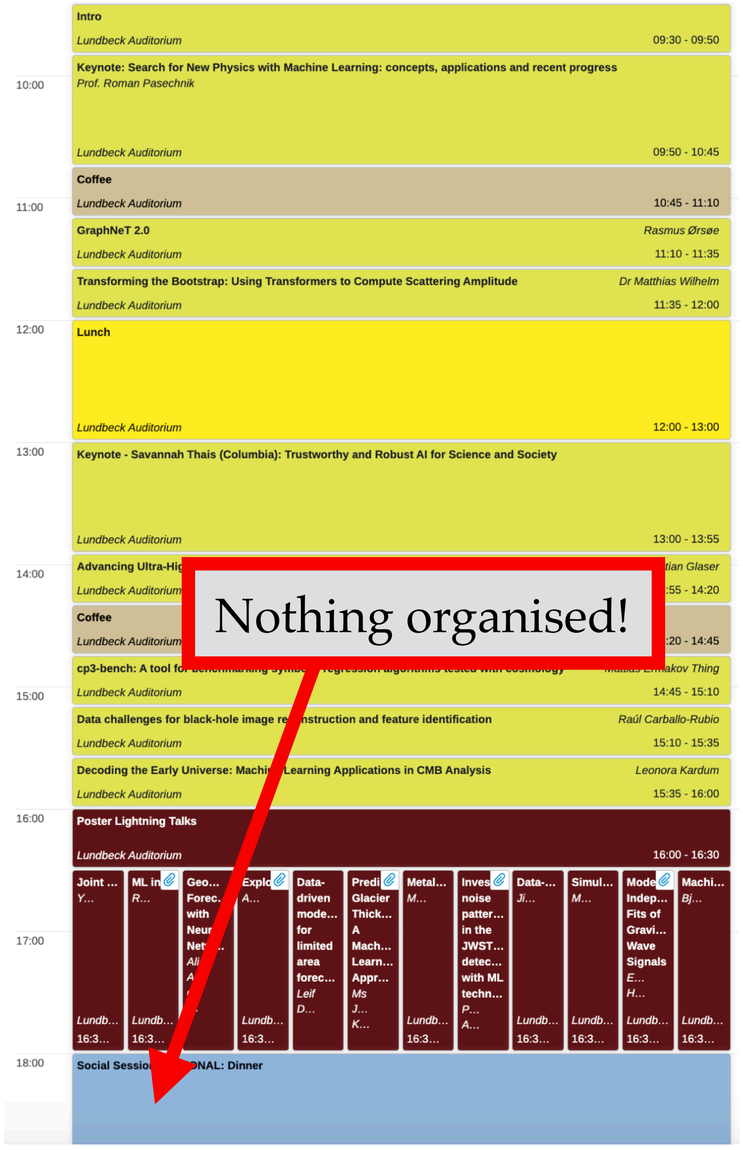

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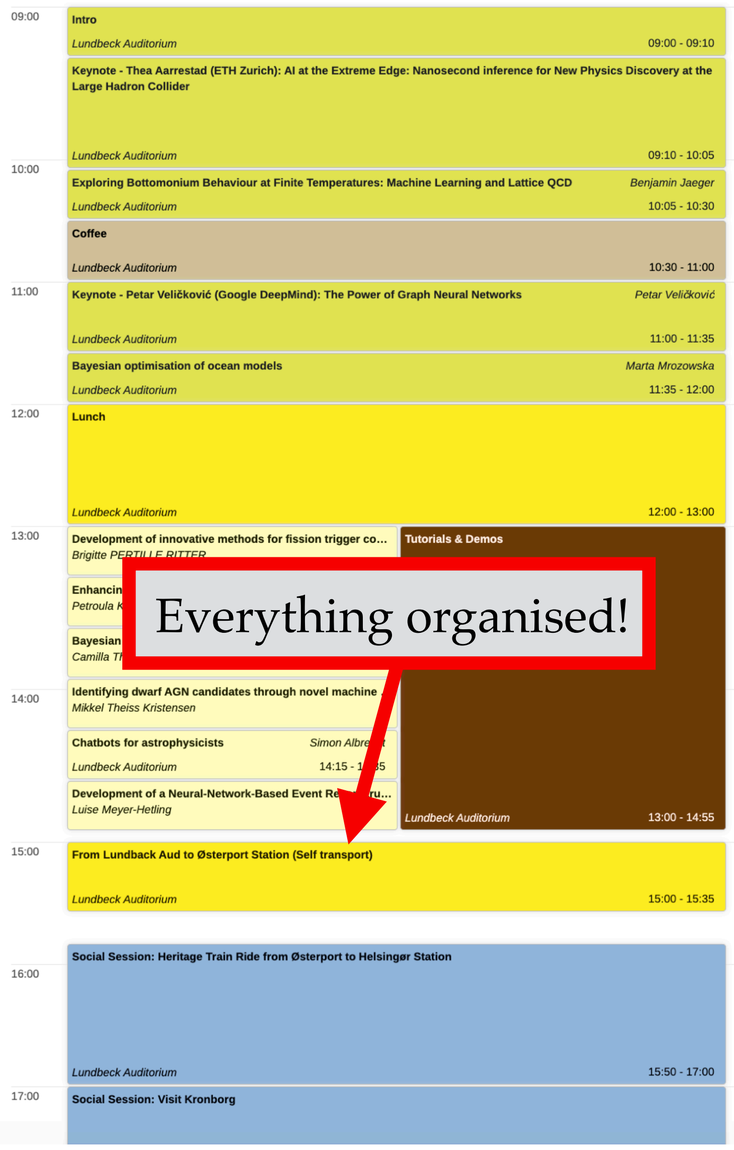


Wednesday

Slides, Computers and Zoom

For the sake of everyone (those on Zoom, the near sighted, the organisers, etc.), we request that you kindly **submit your slides in PDF format at least 4 hours before the start of your session**, either by:

- Uploading them on Indico yourself.
- Sending them by (a link on) Email: inar.timiryasov@nbi.ku.dk

The speakers are welcome to present on their own laptops (except the poster lightning talks, Monday). We have a central laptop, which is connected to Zoom permanently, and which displays the screen in the room.

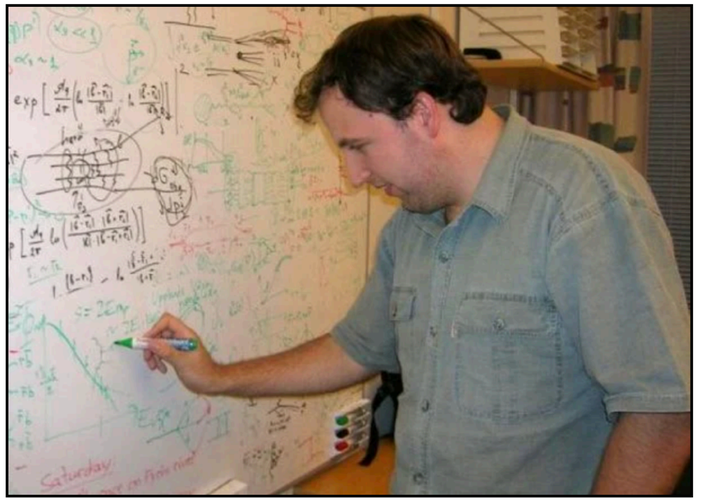
Plenary Sessions: https://ucph-ku.zoom.us/j/63460201538?pwd=YYibNORPmFCfAjjiBnmVOZxa05cyir.1
Meeting ID: 634 6020 1538, Passcode: 808014
Parallel Session 1: https://ucph-ku.zoom.us/j/64544000502?pwd=3x0PljwWlOQb8gpzjsY2XEhvKIgvAb.1
Meeting ID: 645 4400 0502, Passcode: 626075
Parallel Session 2: https://ucph-ku.zoom.us/j/64429958243?pwd=GZ0keAFotMpHQTzWivFLbM08b5aTQw.1
Meeting ID: 644 2995 8243, Passcode: 105183

Important Notes:
- The event will be shared as a webinar format. Questions will be addressed after each talk.
- If you have questions for the speakers, please use the Q&A feature in Zoom.

Monday

The Monday Keynotes

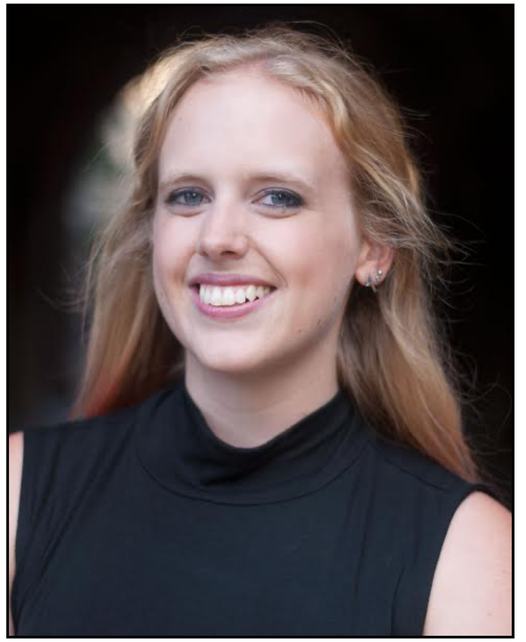
The two keynotes Monday are:



Roman Pasechnik (Lund University):

Search for New Physics with Machine Learning: Concepts, applications and recent progress

Think: Overview & Methods



Savannah Thais (Columbia University):

Trustworthy and Robust AI for Science and Society

Think: Robustness & Ethics

The Poster session

The poster session start Monday afternoon 16:00 with introductory lightning talks (2 minutes!) in the Auditorium, following by seeing the posters, discussing them, voting on them, having a drink, and mingling (right) around the corner, when you exit the auditorium.

Those with posters should hang these on the designated walls ahead of time, and prepare a "one slide, two minutes" lightning talk to introduce the poster subject.

Everyone can vote for the best posters (please do so). The four best will be transferred to the postal carriage on the train and celebrated on the trip to Kronborg Castle.

We will serve drinks for the Poster session. Please mingle (see how in a few slides!)

After the poster session we suggest (but do not organise, and weather permitting) that people take the metro to Kgs. Nytorv, walk down Nyhavn, cross the bridge to "Broens Gadekøkken", where there is a great outdoors food market.

Take away message: Monday night you are on your own (nothing official planned)!

Tuesday

The Tuesday Keynote

The keynote Tuesday is:

Thea Aarrestad (ETH Zurich):

AI at the Extreme Edge:

Nanosecond inference for New Physics Discovery at the Large Hadron Collider

Think: Speed & AI in Hardware

Petar Veličković (Google DeepMind):

The Power of Graph Neural Networks.

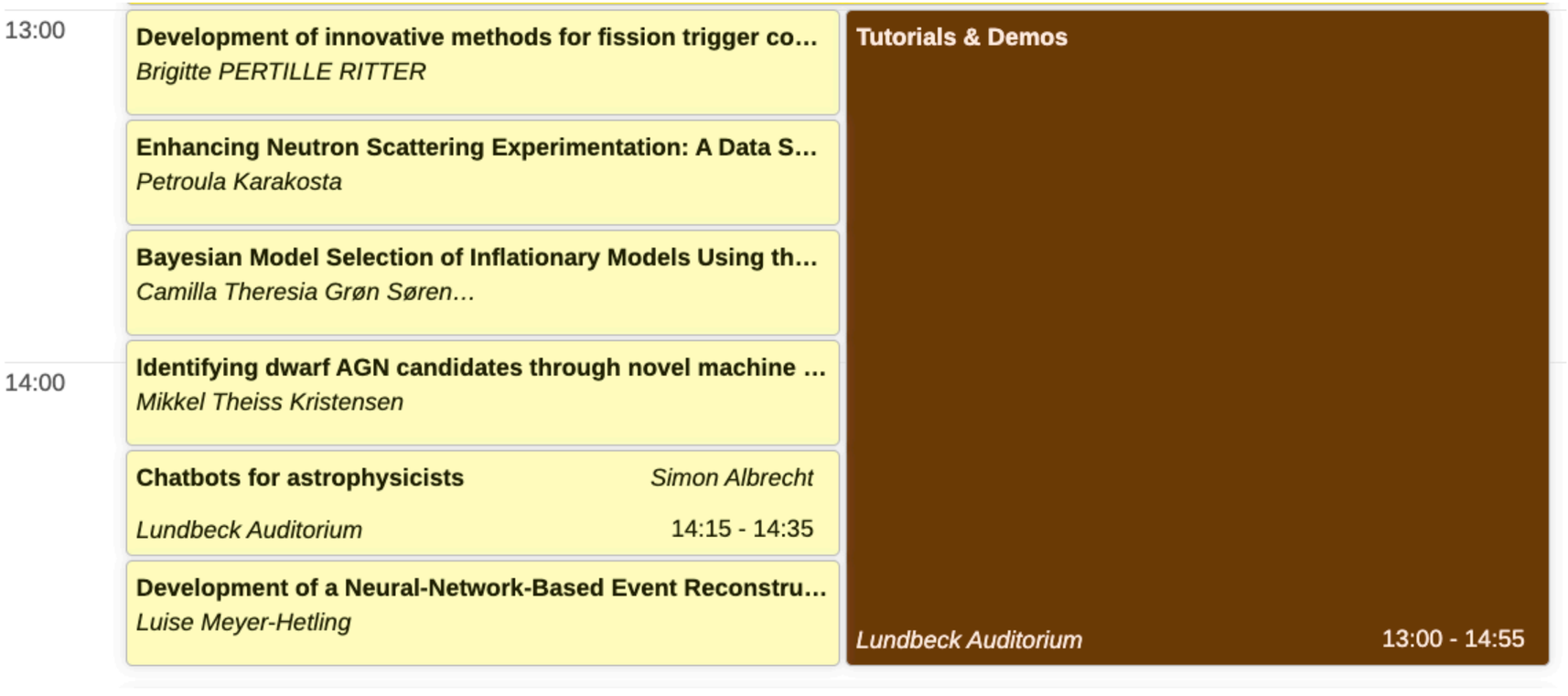
Think: Geometric Deep Learning & Graphs

Parallel Vs. Tutorial

The afternoon session (13:00 - 14:50) has two tracks:

- Talks in a parallel session
- Tutorials & demos

The tutorials & demos are a brief introduction to applying ML to physics problems, followed by a few examples (with code!), starting from Boosted Decision Trees and to Graph Neural Networks.



Getting on our train to Helsingør

Copenhagen part:

15:10: We depart from Lundbeck Auditorium (at the latest!).

The metro is 1.0 km away, which is a 14 minute walk.

15:30: We take the metro line 3 three stops to Østerport metro.

This takes 1-3 minutes of waiting and 7 minutes of driving.

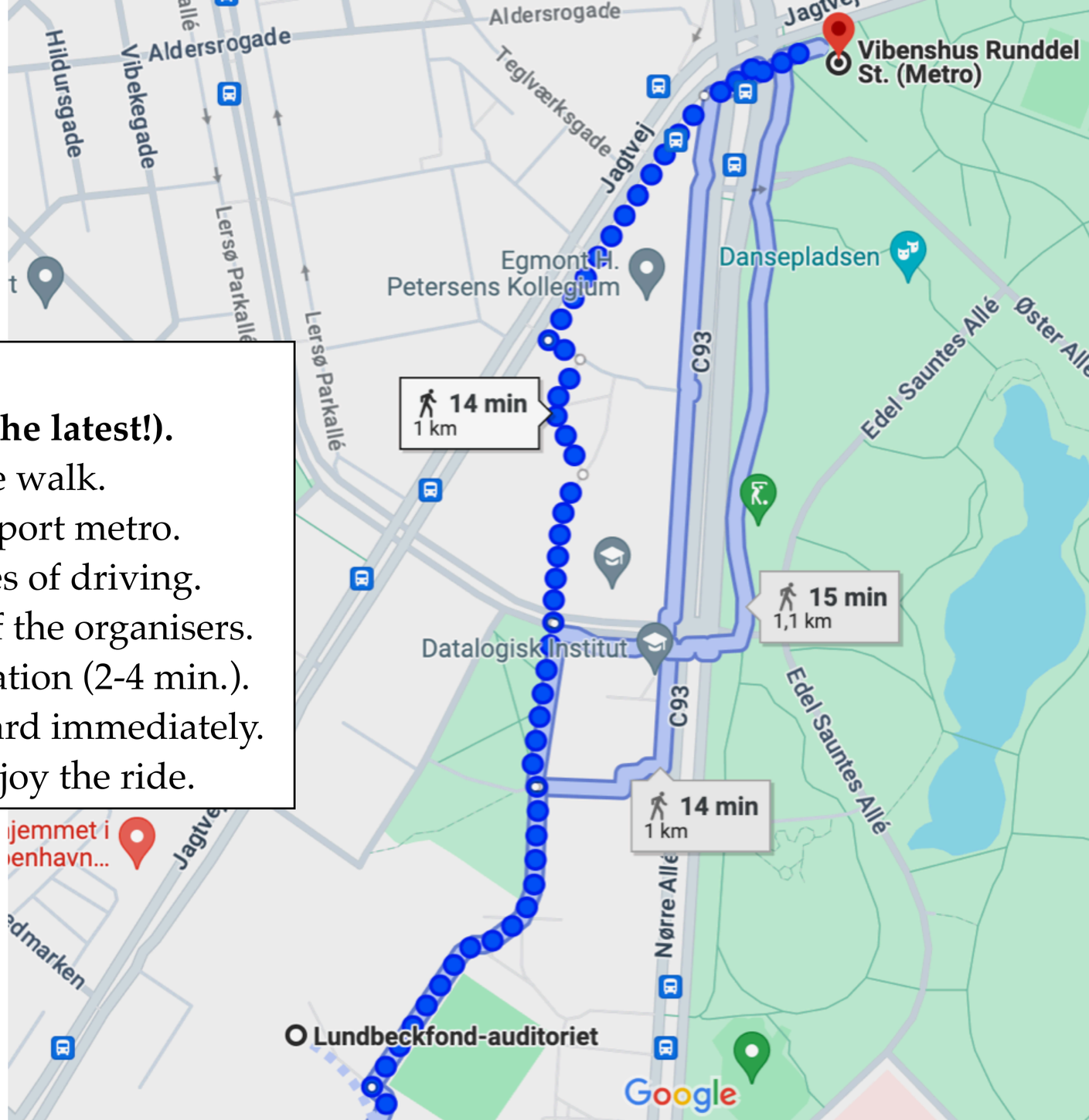
We will check you in, so please report to one of the organisers.

15:40: We transfer from metro to Østerport train station (2-4 min.).

15:47: Train arrives at track 1/2, and we all go aboard immediately.

15:55: Train departs. We all mingle, discuss, and enjoy the ride.

The “locals” can of course take their bike and use their own “Rejsekort”. Please help non-locals to find the way.




Hopefully a ride like this!
Train departs from Østerport 15:55!!!

Plan for Helsingør

<u>Helsingør part:</u>

16:54: Planned arrival at Helsingør, where we leave the train.
Walk towards Kronborg (1.4km, 19 minutes).
Kronborg closes at 18:00, and we have paid your tickets.

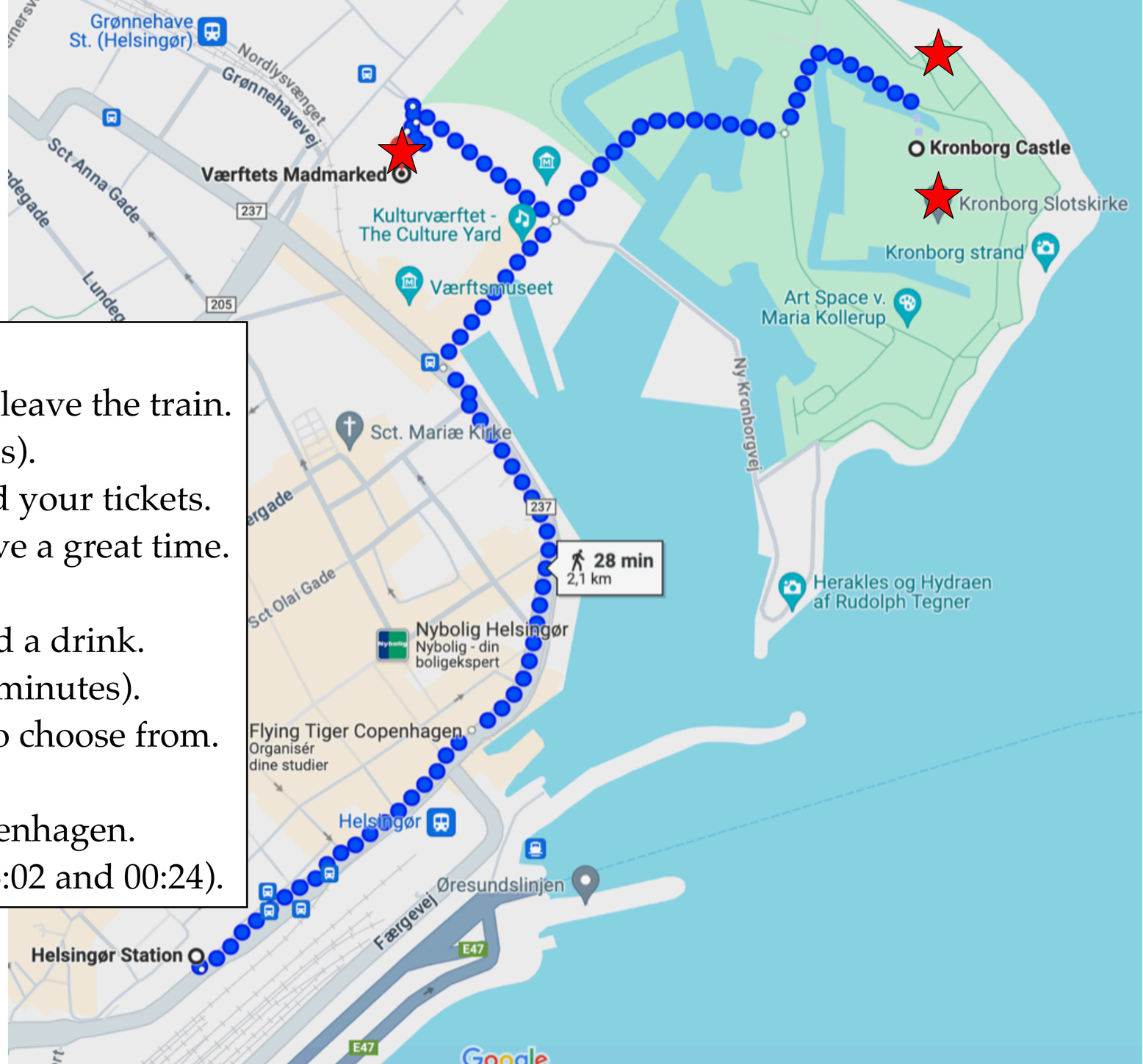
17:14: Enter Kronborg, enjoy the place and have a great time.

18:10: We assemble on the northern ramparts.
Purpose: Great view, conference photo, and a drink.

18:30: Walk to Værftets Madmarket (0.7km, 9 minutes).
Here you will find 15+ different kitchens to choose from.
We will hand out tickets to buy the food.

22:20 and 22:50: Last direct trains back to Copenhagen.
Later, a replacement bus and then train (23:02 and 00:24).

Sorry… no fancy train home!



Værftets Madmarked (dinner!)

We will provide 200 Kr. “cards” at the entrance for buying food and drinks. After that, you are on your own!
Note: In order to eat together, we will try to assemble in the room next to where the food is bought.

Wednesday

New venue & Physics+ML discussions

Wednesday will be held at a new (but very close) venue: H. C. Ørsted Institute (HCØ), Auditorium 4
For the parallel session, we will also be using Auditorium 2 (just across).

The day (and conference) will end with two sessions in smaller groups (held in HCØ rooms on 1st floor):

- First, we divide according to **field of physics**.
- Next, we divide according to **ML methodologies used**.

After these two 20 minutes discussion sessions, we will reconvene to conclude for a potential…

Short White paper

- The current status of ML usage in physics: The Physics Fields and the ML Methods
- The education & infrastructure status and needs
- The future directions

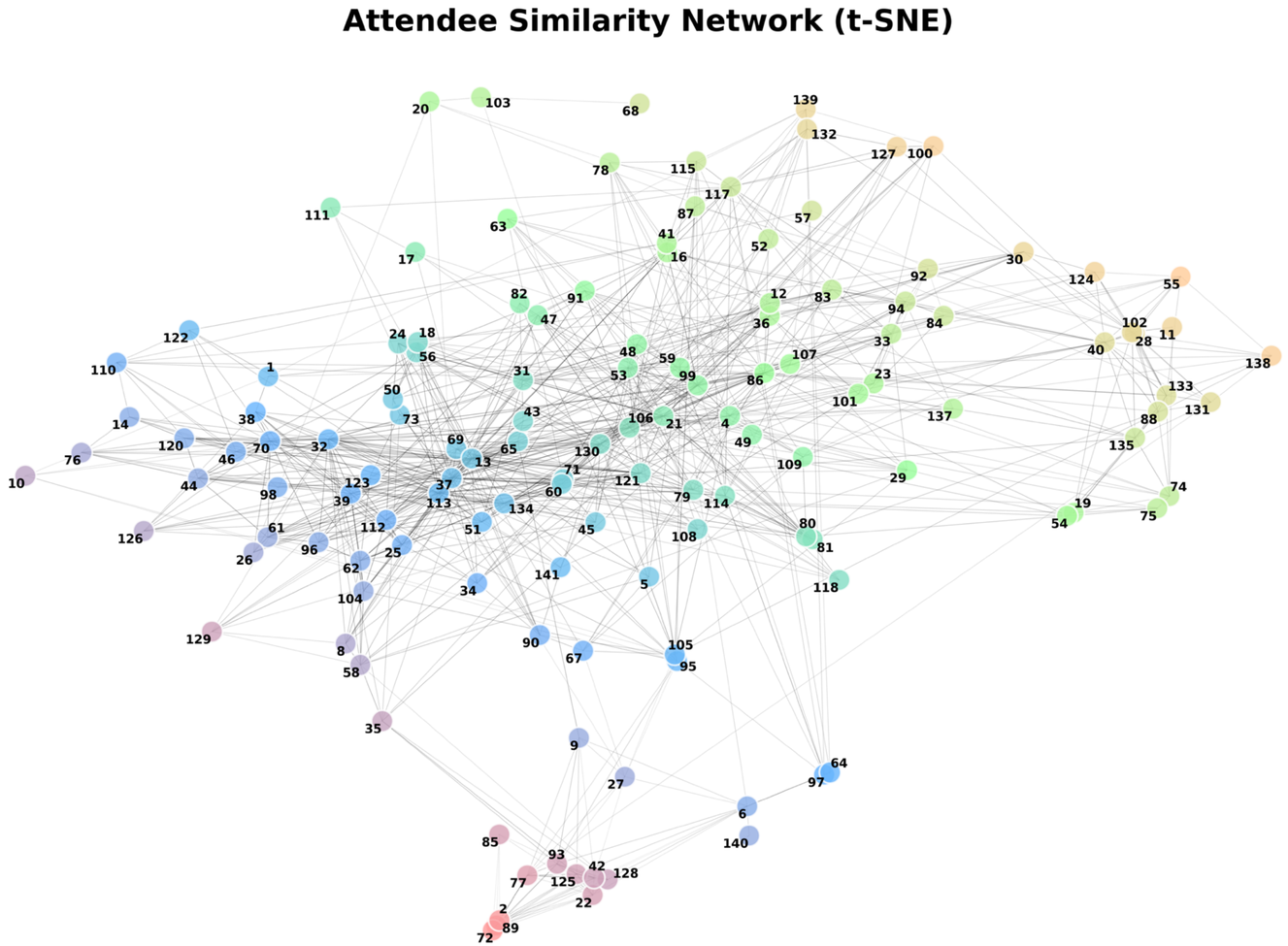
If we have a yearly HAMLET - Physics conference, then this series of white papers will be very useful for other fields to follow in our footsteps (for good and for bad).

The conference will conclude with us serving the remaining drinks (if any is left)!

“Participant Proximity” & HAMLET Meet App

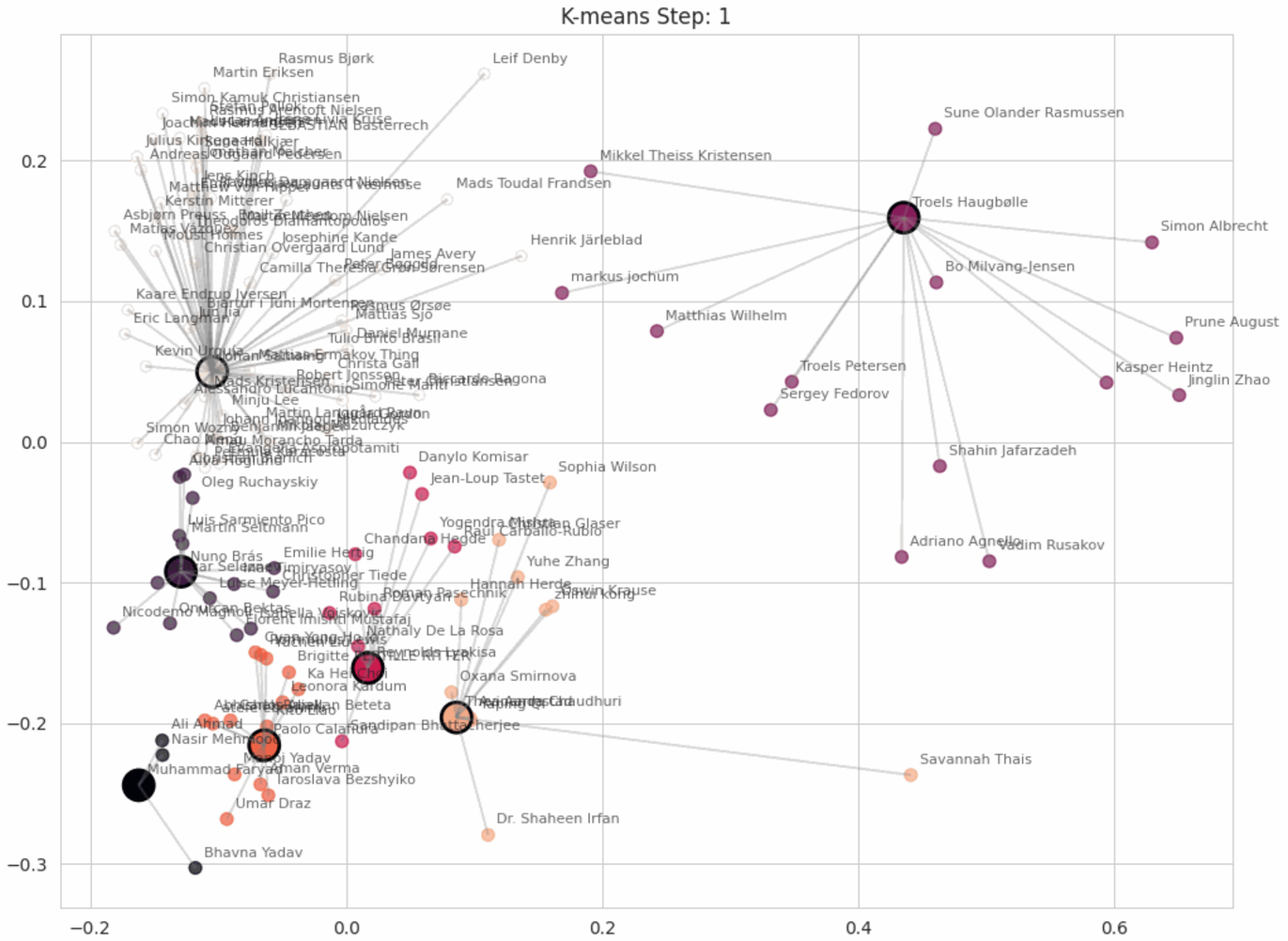
Who are you alike? Dislike?

In order to let everyone get an idea of who is who at the HAMLET-Physics conference, we wanted to try to find out, who were alike/dislike. Using your registration information, the following pattern came out:



Who are you alike? Dislike?

But that of course does not tell you, who you are really alike. Nor did it involve any ML… so… Using similar information, we used t-SNE to map us all into a 2D space, which we then applied clustering to:



The HAMLET MeetUp App

Using ChatGPT, Daniel put together a short Physics-ML Bio of everyone, which can be found using the conference numbers here: https://hamlet-conf.github.io/hamlet-meet/

Try to look up yourself…

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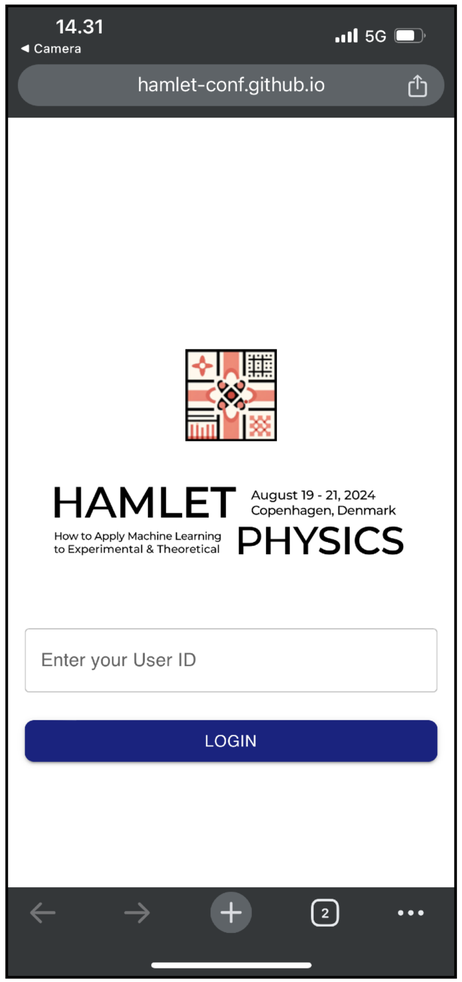

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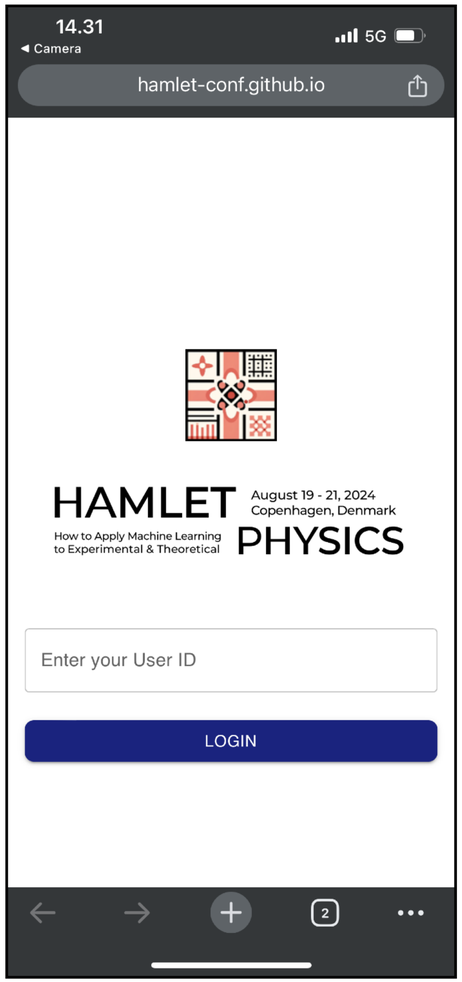

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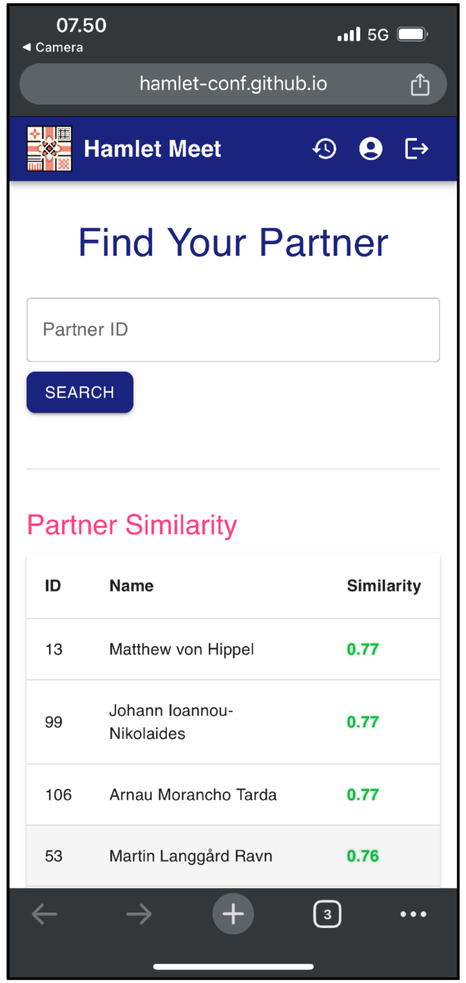

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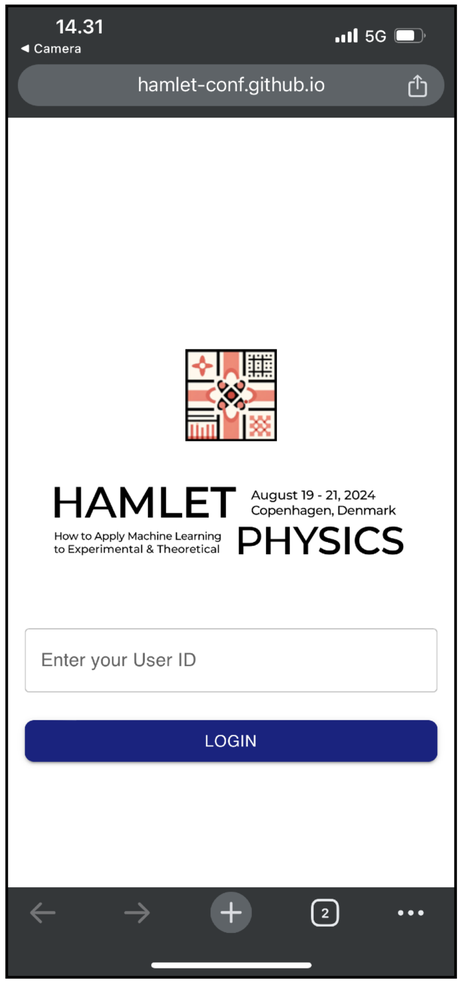

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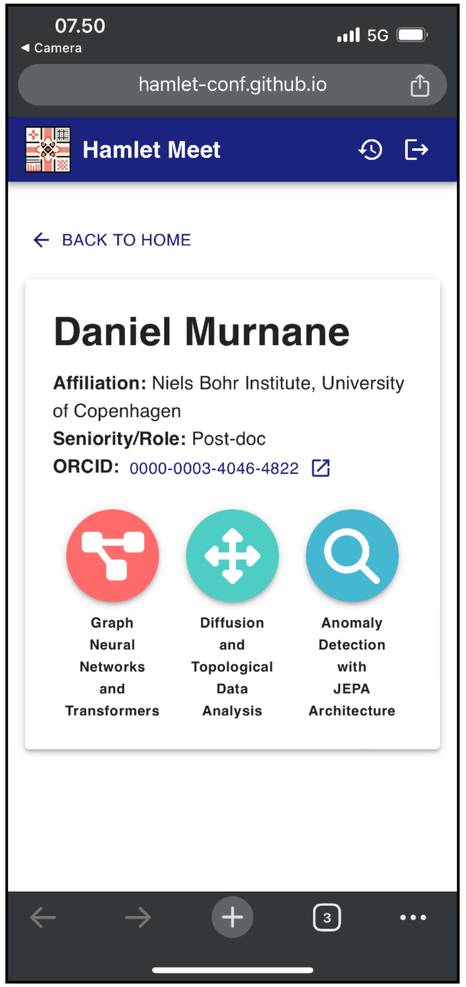

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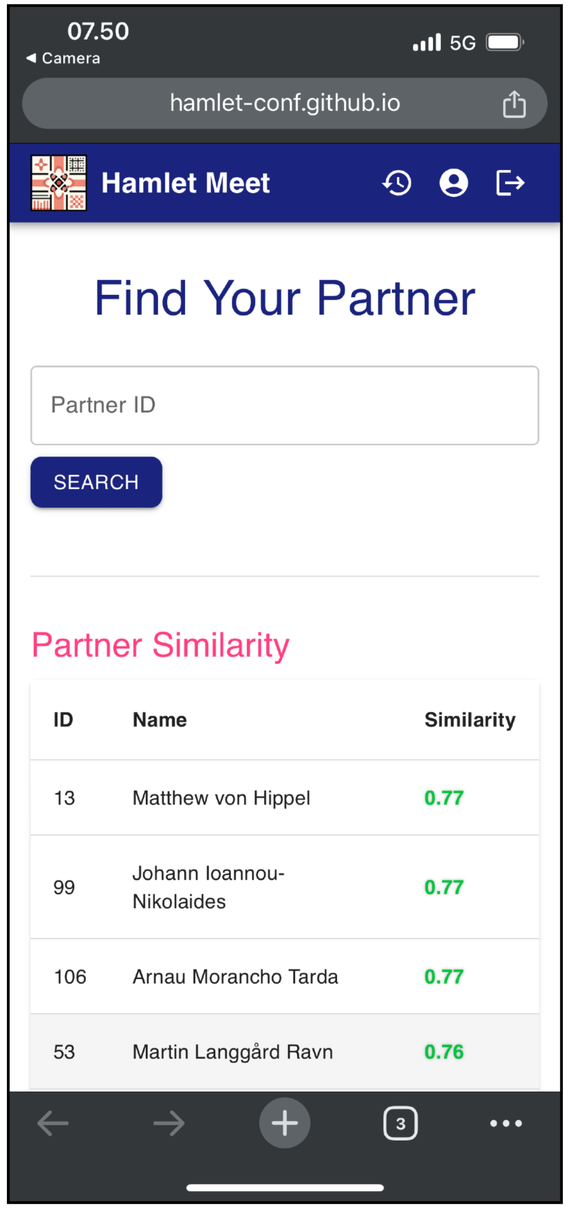
Try to look up yourself…

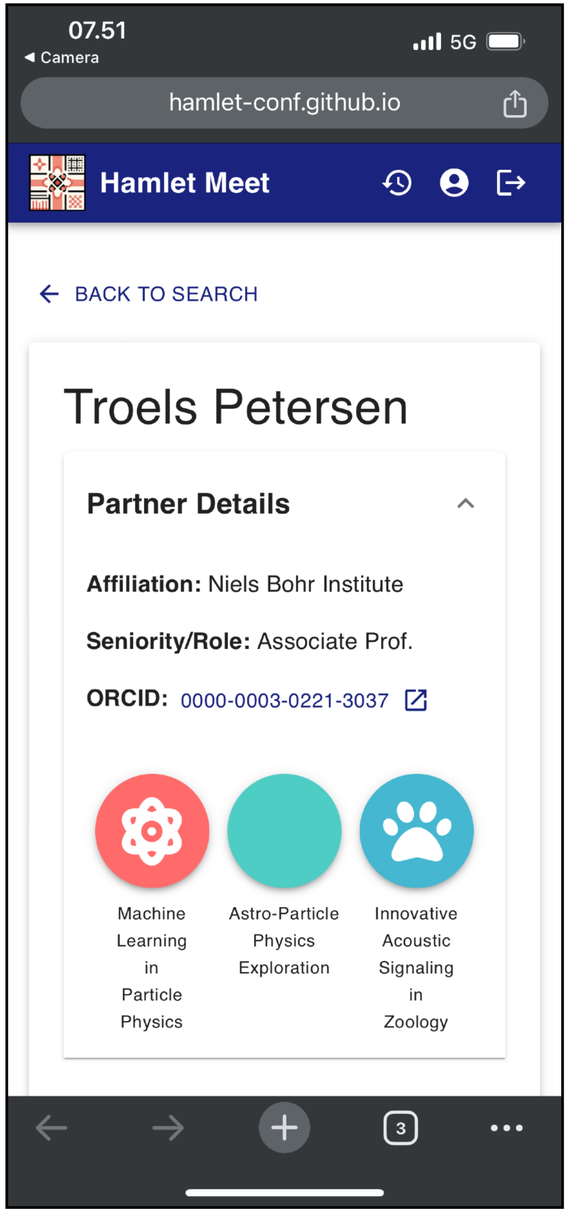
Pushing this idea, Daniel (in collaboration with ChatGPT) also worked out, how we all pair-wise scientific connection/overlap (or lack of).

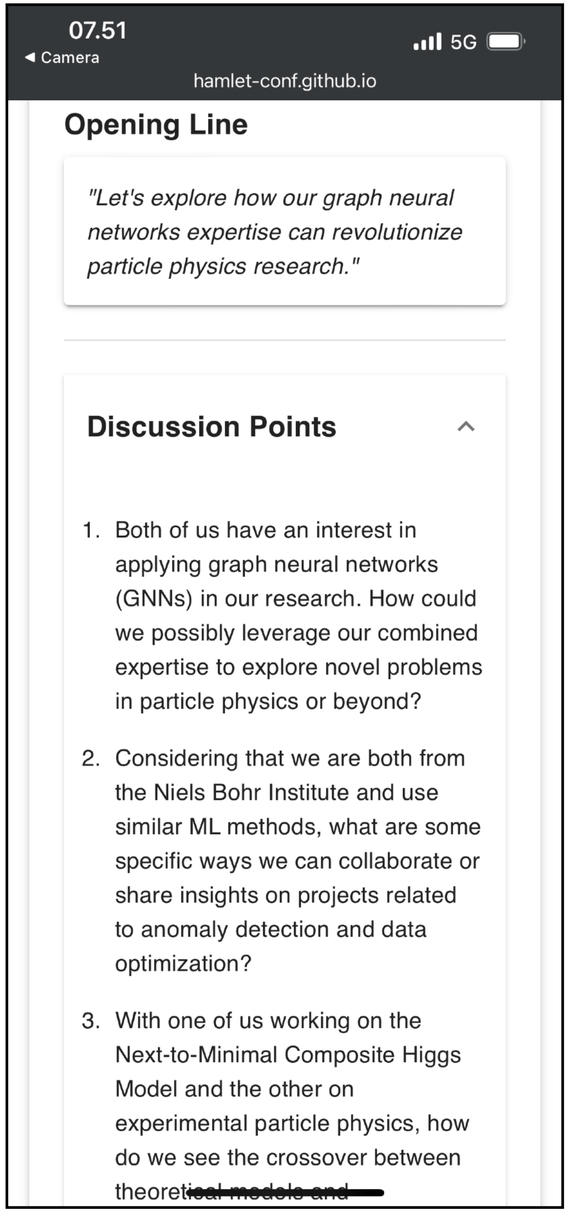
Using the conference number of others, you can in the app find your connection to others at the conference. We list the 5 closest (and 3 furthest) co-HAMLETs, and save your history, so that you can continue possible collaborations after the conference.

Try to look up the connection you have with someone near you…

The HAMLET MeetUp App







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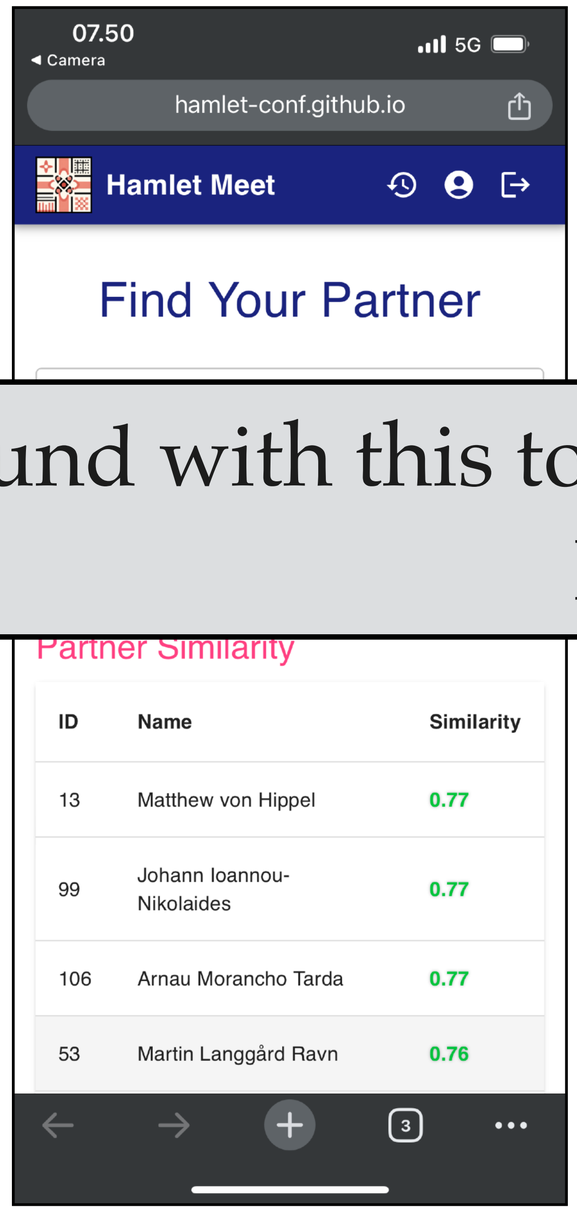

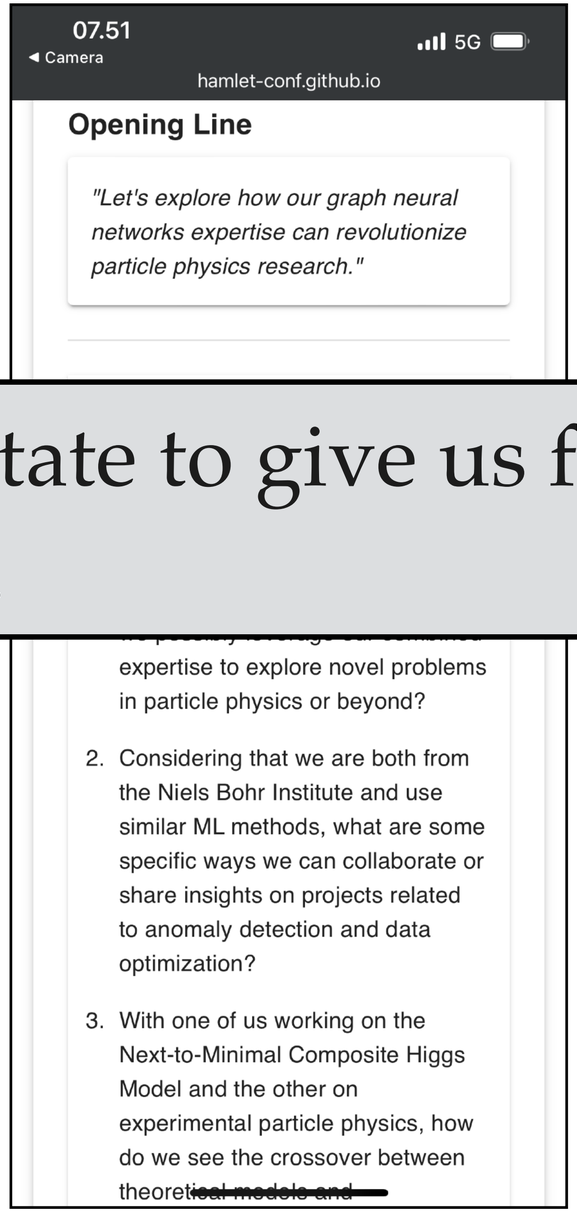

Play around with this tool, and don't hesitate to give us feedback.
Happy App'ing…

Code of Conduct

HAMLET-Physics is a community event intended for presentations, networking and collaboration. We value a civil and respectful environment which encourages the free expression and exchange of scientific ideas.

All attendees are expected to adhere to the CERN Code of Conduct.

Should a lapse of professional decorum occur (such as discrimination or harassment), attendees are encouraged to bring issues, in a confidential setting, to the advisors appointed by the conference organizers. The advisors will suggest ways of redressing the matter and counsel the parties involved. The conference organisers may, after due consideration, take action as they deem appropriate, including, in severe cases, expulsion from the conference.

If you believe someone is violating the code of conduct, we ask that you report it by emailing Daniel Murnane (daniel.murnane@nbi.ku.dk) and/or Troels C. Petersen (petersen@nbi.dk).

The “old” Niels Bohr Institute

And on that happy note… Welcome!