

Welcome to
Advanced Topics in Machine Learning (02901):
Self-Supervised (Representation) Learning
Ph.D. Summer School
21st of August – 25th of August 2023

We thank our sponsors:

**DTU Compute PhD School,
Danish Pioneer Centre for AI**

Some months ago at UCL



Mirco Musolesi @mircomusolesi · 24m

This afternoon's departmental talk at @UCL @uclcs appears to be quite popular (Sam Altman from @OpenAI is the speaker).



Mirco Musolesi @mircomusolesi · 14m

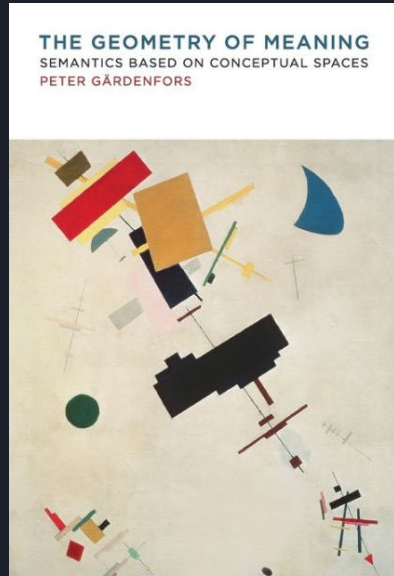
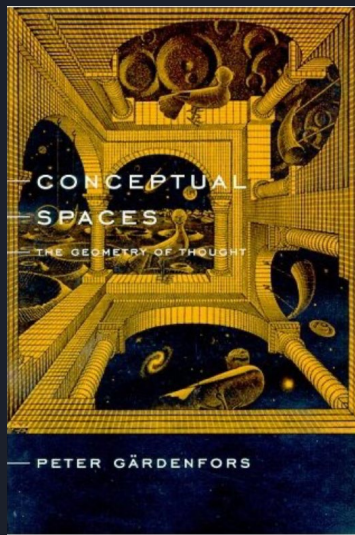
And we also got some anti-AGI protesters outside the lecture hall. We can manage that, we are disruptive since 1826 after all.



<https://twitter.com/mircomusolesi/status/1661374229193916418>

Alignment of human and AI concepts?

Are machines using the same logic?

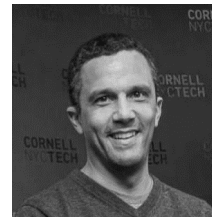
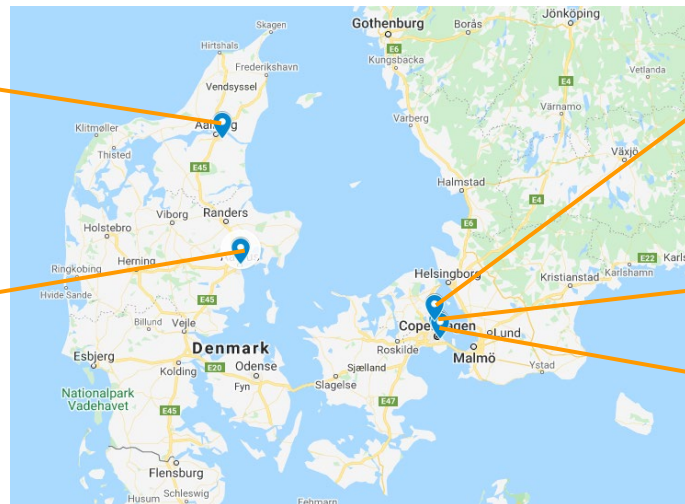
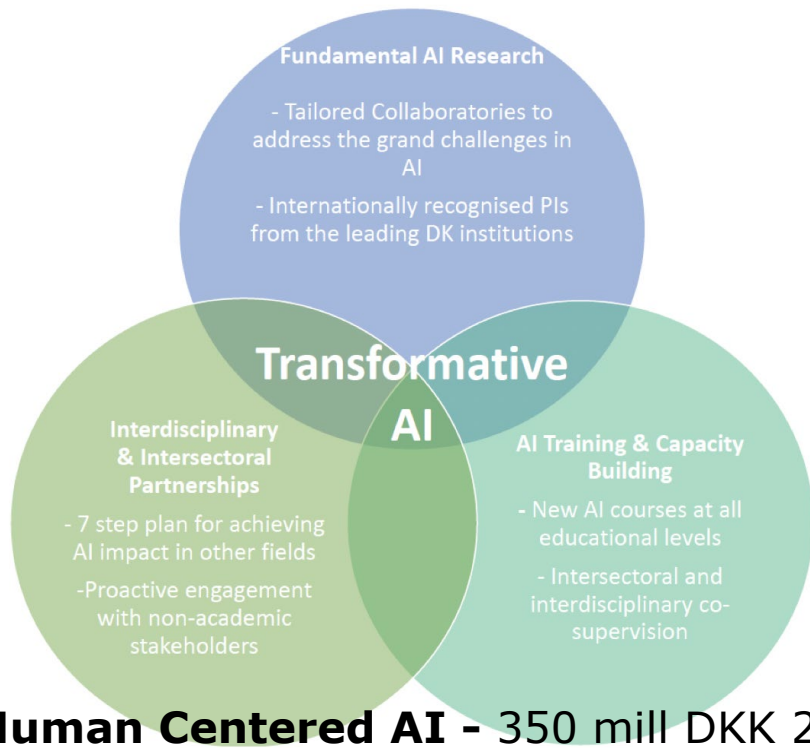


Gärdenfors, P., 2004. *Conceptual spaces: The geometry of thought*. MIT press.

Gärdenfors, P., 2014. *The geometry of meaning: Semantics based on conceptual spaces*. MIT press.



PIONEER CENTRE FOR ARTIFICIAL INTELLIGENCE



Serge Belongie

Human Centered AI - 350 mill DKK 2021-2034

UFM, Grundforskningsfonden, VILLUM, NNF, Carlsberg, Lundbeck

Danish Data Science Academy

The Challenge

- A **strong, visible, collaborative research environment is needed** to educate, attract, and retain the next generation of data scientists

The opportunity

- Create a collaborative community that **unites universities with the private and public sectors**
- Support education of the **next generation** of data scientists

The Solution

The Danish Data Science Academy is a self-governing national network that

- Awards **PhD and postdoc fellowships** in open competition
- Supports and develops **training and education initiatives**
- Stimulates **networking, community-building and collaboration** between academic research groups, hospitals, companies, and public institutions

The details

- Budget: 184.3 million DKK (ca. 25 Million EUR)
- Duration: 2021-2026
- Funders: Novo Nordisk Foundation (152 MDKK) & VILLUM Foundation (32 MDKK)
- Governance: Universities, industry and public sector

novo nordisk **fonden**

WIDE SUPPORT TO CATALYZE AND UNITE DANISH DATA SCIENCE

by Hanne Kokkegørd, March 14, 2022



The Danish Data Science Academy is ready for take-off with help from 57 people representing the diversity of the data science community.

Sofie Castella

Annual meeting D3A Feb 1-2, 2024

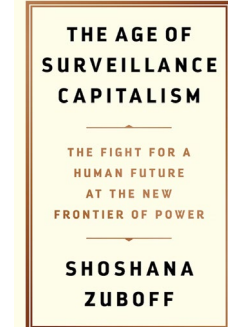
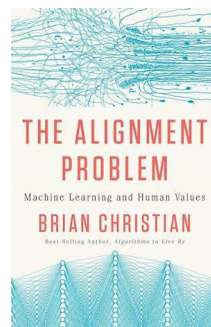
Alignment - Human Centered AI

AI as human augmentation

Human centered AI is a tool, not a new species

Value alignment

How can we assure that AI systems amplify humans for the good of humanity



Machine learning - representational alignment

We need to understand how AI systems “see” the world

Can AI solutions learn to communicate in a language we understand?

Alignment is necessary for communication

Sucholutsky and Griffiths’
“Chemist and Alchemist”

As a motivating example, imagine a meeting between a 16th century alchemist and a 21st century chemist. They live in the same physical world and are intimately familiar with the materials that comprise it, but they would have significant difficulty expressing their values and generalizing the results of an experiment they observe together. The alchemist would likely learn poorly from examples of a reaction demonstrated by the chemist, not having the right inductive biases for the way the world actually works. The alchemist and the chemist lack representational alignment – they represent the world in fundamentally different ways – and this impedes generalization and learning.

Course Programme



Monday: Location: Building 303A auditorium 49

[Lars Kai Hansen](#), *Introduction/SSL cookbook*

[Kristoffer Wickstrøm](#), UiT The Arctic University of Norway, *XAI for understanding of SSL representations*

Exercise: *XAI*

Tuesday: Location: Building 324 room 040

[Alessio Ansuini](#) & [Alberto Cazzaniga](#), AREA Science Park, Italy, *SSL Representations & Intrinsic dimension*

Exercise: *Intrinsic dimension*

Wednesday: Location: Building 324 room 040

[Emanuele Rodolà](#), Sapienza University of Rome, Italy, *Introduction to relative representations*

Exercise: *Relative representations*

Summer School Dinner at 6 PM **(If you are unable to attend the dinner or have dietary requests not yet informed to us, please write to annri@dtu.dk ASAP)**

Thursday: Location: Building 324 room 040

[Anna Rogers](#), ITU, Denmark, *SSL and NLP*

Exercise: *NLP*

[Sadaf Farkhani](#), DRCMR / DTU Compute, *Vision Transformer in Healthcare: Harnessing the Power and Unraveling the Trade-offs*

Friday: Location: Building 324 room 04

Work on student presentations or report

Student presentations, wrap-up & goodbye

Course material will be available on DTU Learn: <https://learn.inside.dtu.dk/> **(select the 02901 course)**

Course details

- The course gives 2.5 ECTS
- The course is passed by handing in a small presentation/report using one (or more) of the topics covered in the course preferably applied to your own research domain.

Two options for passing the course:

Option 1: Give a short 10-15 minute presentation during Friday afternoon.

You need to prepare for this presentation during the week as well as Friday morning.

Slides of your presentations to be uploaded on DTU inside

(<https://learn.inside.dtu.dk/> go to "assignment" and hand-in under the assignment "Project").

(We can maximally accommodate this for 12 students, if more are interested we will have a draw ☺)

Option 2: Hand-in a short 3-page report no later than Sunday 17th of September.

Report to be uploaded on DTU inside (<https://learn.inside.dtu.dk/> go to "assignment" and hand-in under the assignment "Project")

Structure of Presentation/Report

- **Introduction**

This should include a description of the course method(s) the presentation/report covers from the course.

- **Methods/Theory**

Provide an overview/brief review of the relevant theory.

- **Results**

Preferably you should apply the method(s) to your own domain, but you can also apply the method(s) to other data, simulated data, or problem domain.

- **Discussion**

A discussion of your findings.

Course diploma will be send to you upon passing the course

What is this about?

A Cookbook of Self-Supervised Learning

Randall Balestriero*, Mark Ibrahim*, Vlad Sobal*, Ari Morcos*, Shashank Shekhar*, Tom Goldstein†, Florian Bordes*‡, Adrien Bardes*, Gregoire Mialon*, Yuandong Tian*, Avi Schwarzschild†, Andrew Gordon Wilson**, Jonas Geiping†, Quentin Garrido*§, Pierre Fernandez**, Amir Bar*, Hamed Pirsiavash†, Yann LeCun* and Micah Goldblum**

*Meta AI, FAIR

**New York University

†University of Maryland

+University of California, Davis

‡Universite de Montreal, Mila

§Univ Gustave Eiffel, CNRS, LIGM

*Univ. Rennes, Inria, CNRS, IRISA

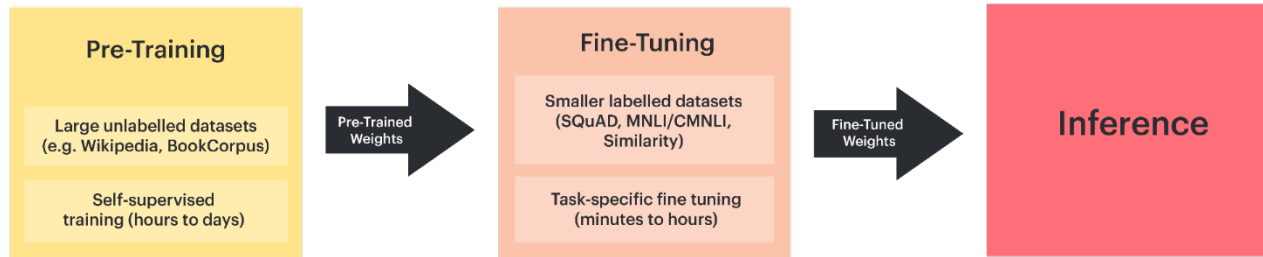
*italic*Equal contributions, randomized ordering

Challenge:

Abundant unlabeled data, limited labeled data

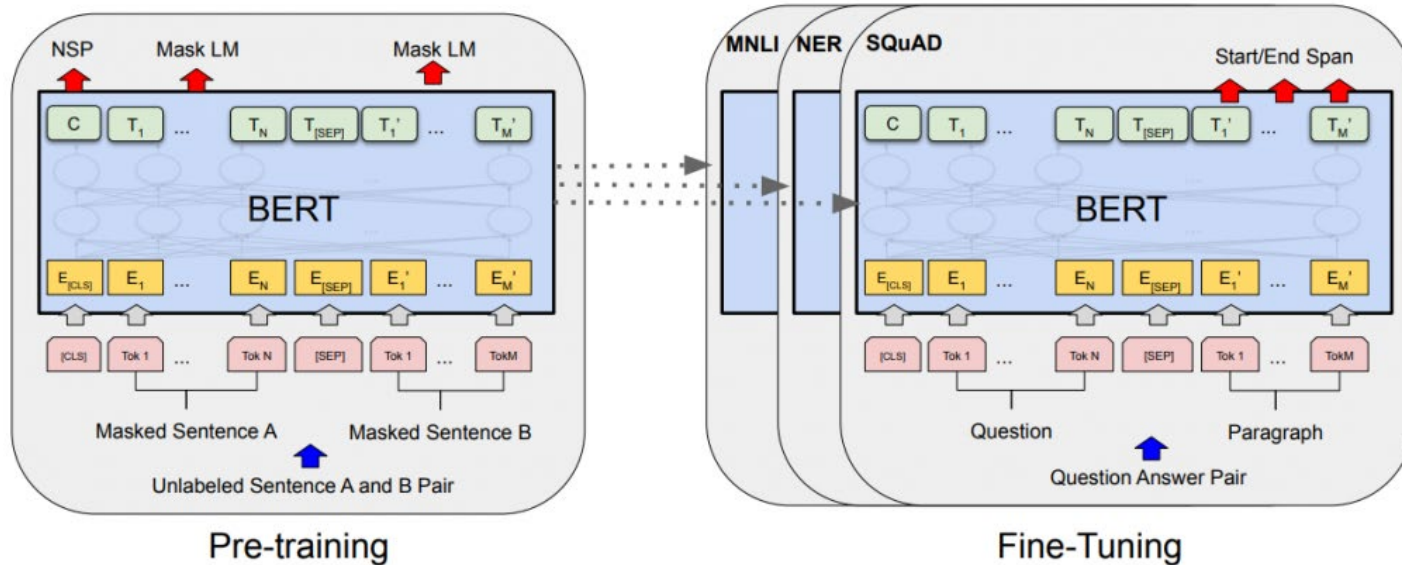
Solution:

Self-supervised learning



<https://docs.graphcore.ai/projects/bert-training/en/latest/bert.html>

Example – text representation



<https://www.linkedin.com/pulse/bert-pre-training-deep-bidirectional-transformers-hitesh-jhamtani>

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What's still missing?

Analysis, theory when, why?

Understanding representations

Wickstrøm: Relax

Ansuini & Cazzaniga:

Intrinsic dimension

Universality?

Rodola: Relative representations

Representations at work

Rogers: NLP

Farkhani: Health