

AI for climate adaptation and mitigation

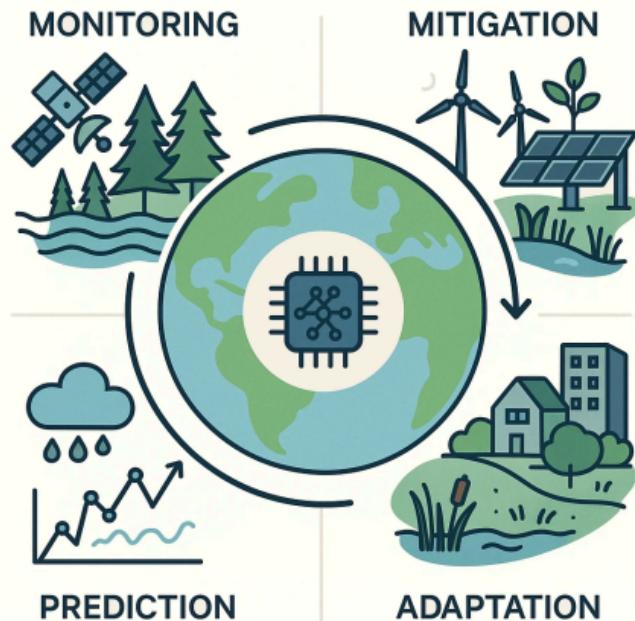
AI for environmental data, Uppsala University

Olof Mogren, RISE Research Institutes of Sweden

Climate change

A multifaceted challenge benefiting from AI at every level

- Monitoring
 - remote sensing, sensor networks, bioacoustics
- Mitigation
 - Emission reduction and carbon sequestration
- Adaptation
 - Resilience planning
- Prediction
 - Weather systems and extreme events



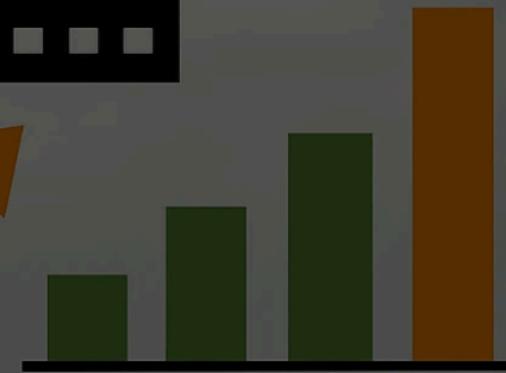
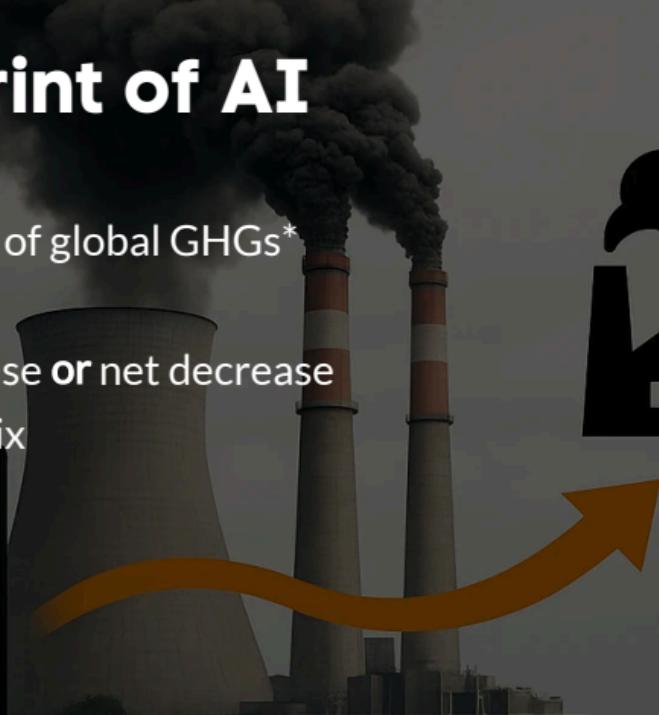
Both mitigation & adaptation necessary

- We are heading for 2°C
- Mitigation is essential to slow warming and reduce long-term risks
- Adaptation is unavoidable, impacts are already here and will intensify
- Neither is sufficient alone



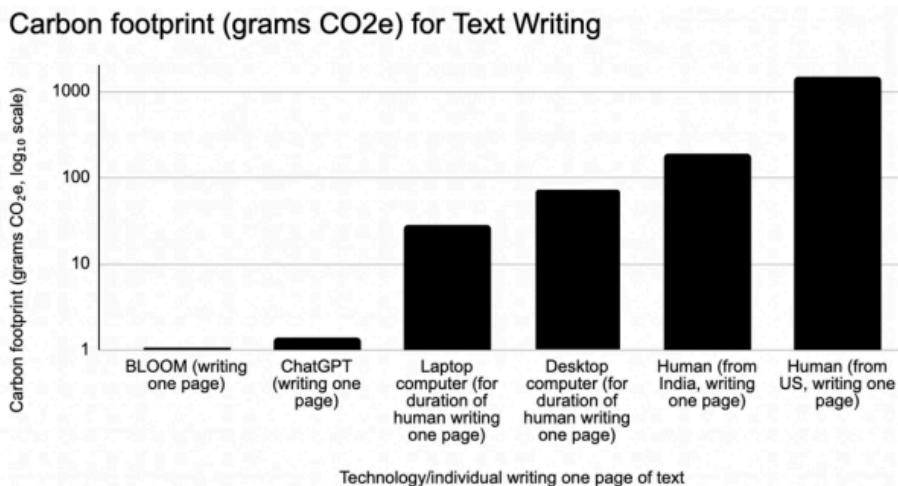
Climate footprint of AI

- Less than **one** percent of global GHGs*
- Likely increasing
- May lead to net increase **or** net decrease
- Depends on energy mix



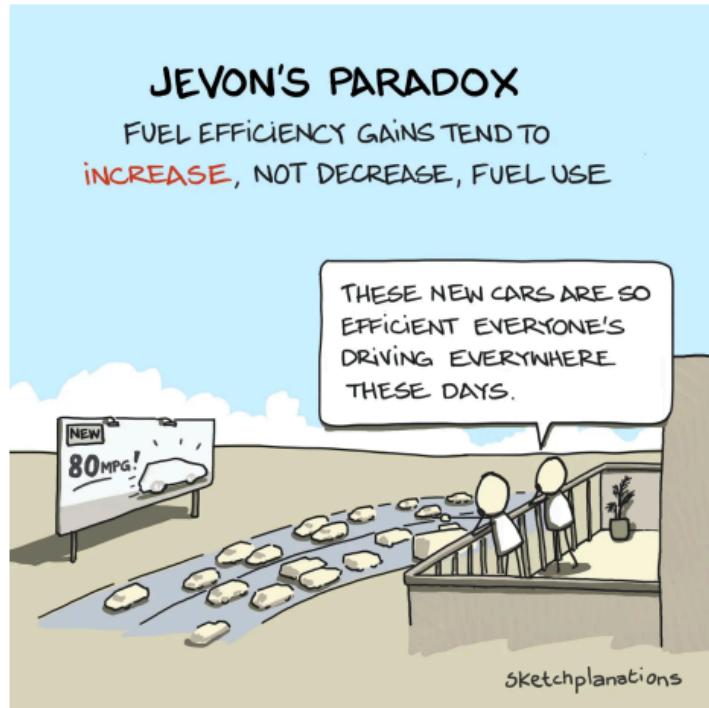
Footprint

- Generating a page of text with AI emits less than human writing (Tomlinson, et al, 2024)
- One prompt to Chat GPT -> approximately two to five grams of CO₂ equivalents



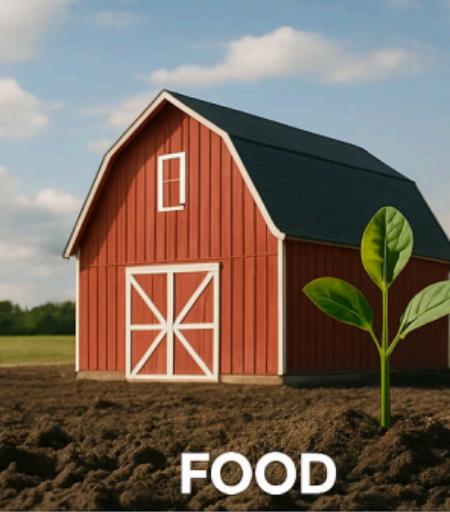
Indirect environmental effects of AI

- AI can make us more efficient
- Fast-fashion is already a burden to the environment
- Jevon's paradox/rebound effects

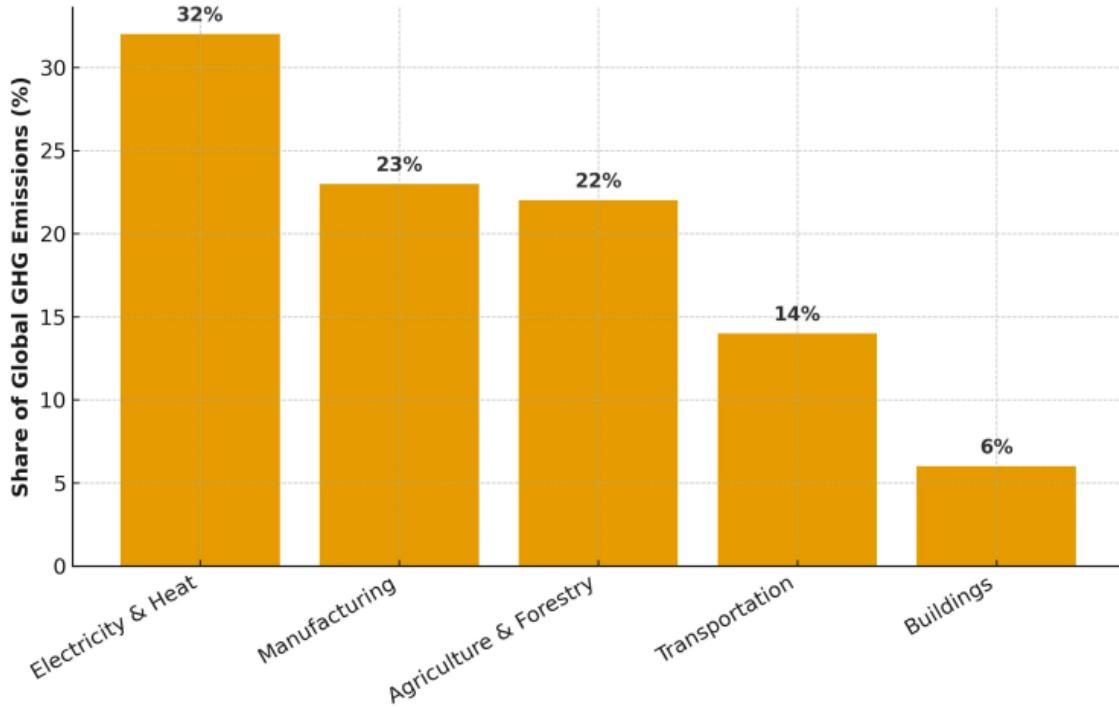


The potential of AI

- Incremental gains
 - Enhancing solar energy output
 - Improving building efficiency
- Transformational gains
 - Discovering new clean energy sources, materials, etc.



GHG emissions by sector



The energy sector



The energy sector

- Energy production = ~32% of global GHG emissions
- Fossil fuels (coal, oil, gas) dominate electricity and heat globally



AI for the energy sector

- Grid integration of renewables
 - Reduce wasted solar/wind power
- Demand & supply forecasting
 - Reduce overproduction
- Dynamic load balancing
 - Reduce transmission loss
- Energy efficiency across sectors



INPUT

| | Data | |
|-------------|-------|-------|
| Weather | 33 | 350 |
| Date/Time | 14.45 | 10,25 |
| Load | 21.25 | 1,08 |
| Temperature | 81.0 | 1,120 |
| Humidity | 8,56 | 1,510 |
| Price | 3.15 | 2,36 |
| Price | 1,99 | 8,80 |



PAST DATA

| Date | Sin | Un |
|-------------|-------|--------|
| Load | 17.64 | 10,955 |
| Temperature | 76.90 | 2,915 |
| Humidity | 5,694 | 2,936 |
| Price | 1,99 | 4,396 |



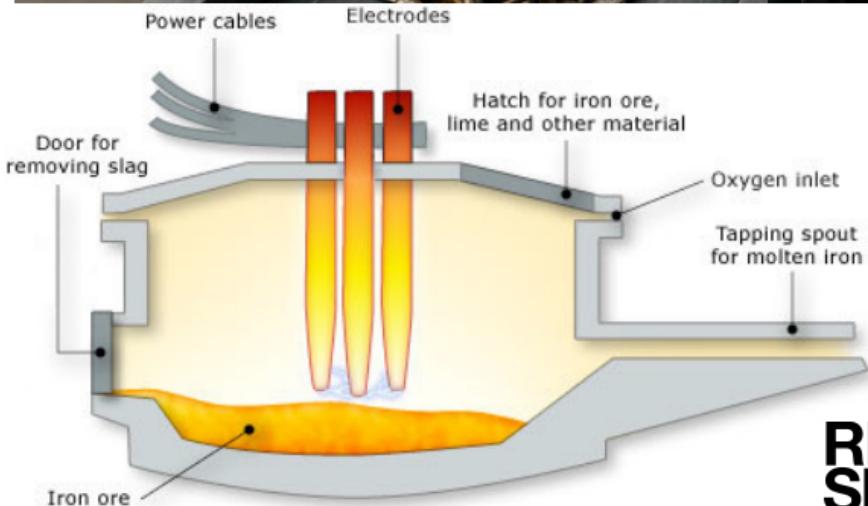
Manufacturing

- ~23% of global GHG emissions
- Largest sources:
 - Steel, cement, chemicals
- Challenges:
 - High-temperature industrial heat
 - Chemical process emissions (e.g. cement calcination)



AI for steel production

- Optimizing steel Electric Arc Furnaces (EAF) with scrap variability
- Reducing overuse of costly additives in steel



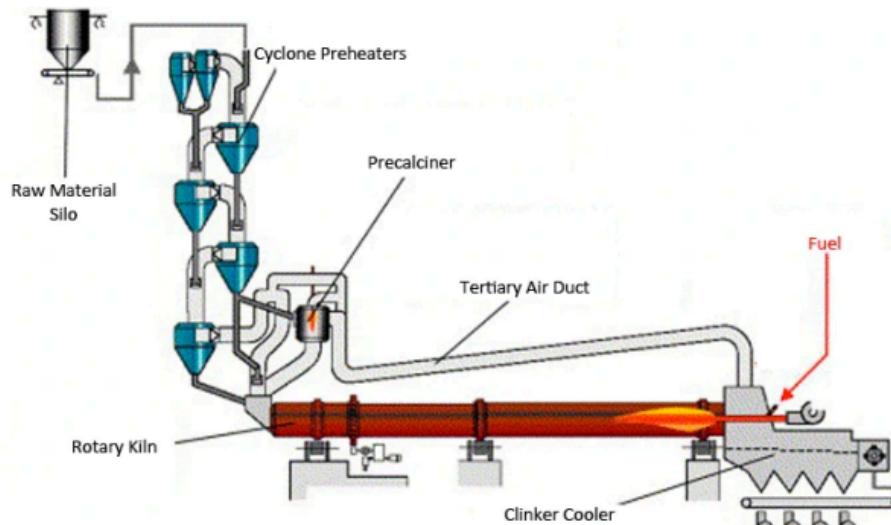
Cement: 8% of global GHG emissions



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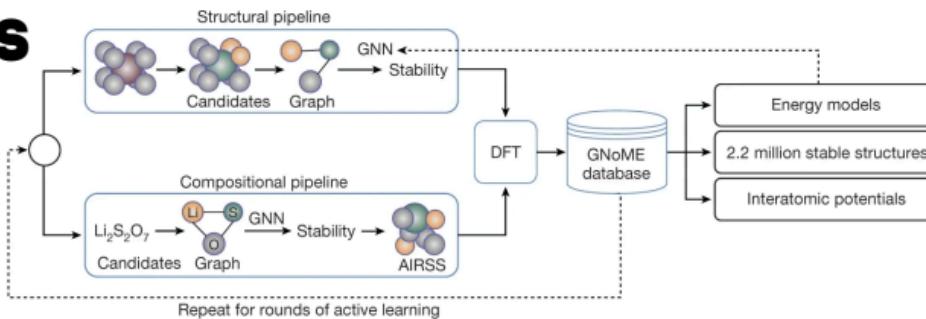
AI optimizing cement production

- Lessen demand of petroleum coke
- Optimize air temperature for the clinker kiln
- Less fuel is needed

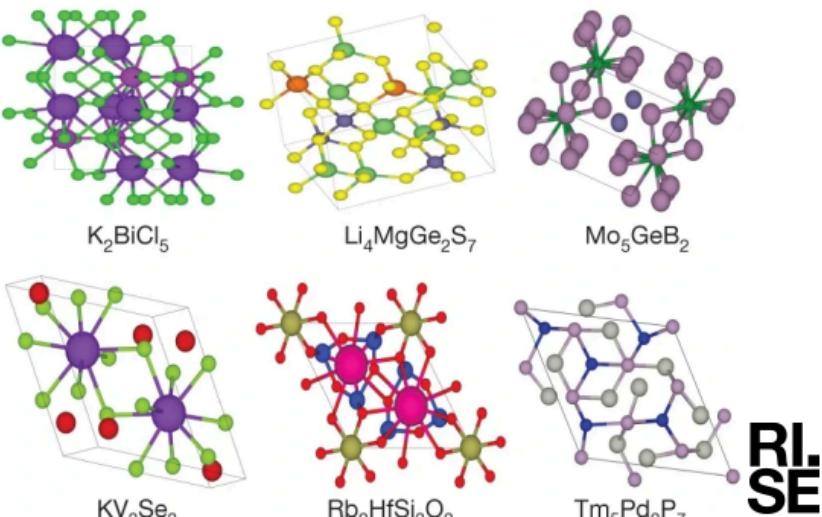


Source: Modified from Giannopoulos et al., 2006

Graph neural networks for materials discovery



- Stable inorganic materials
- Batteries, superconductors, and electronics
- Active learning
- Graph neural networks



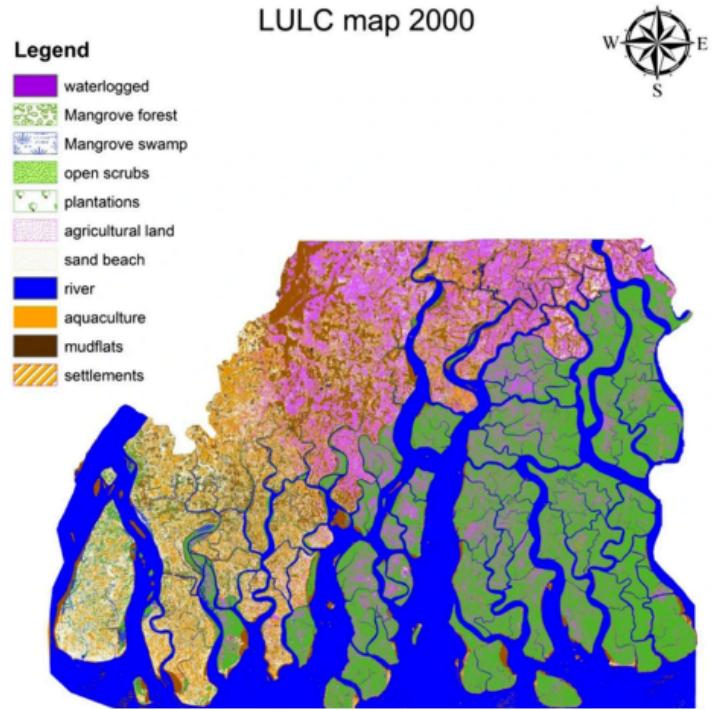
Agriculture, forestry, land use (AFOLU)

- ~22% of global GHG emissions
- Main drivers:
 - Deforestation
 - Methane from livestock
 - Fertilizer use (N_2O)

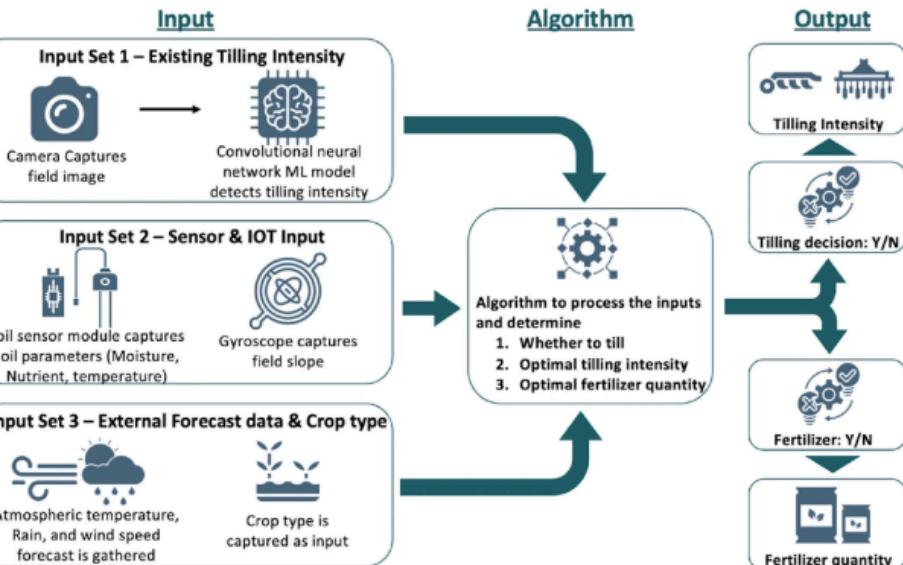


AI for agriculture and forestry

- Monitoring land use change (remote sensing)
- Optimizing fertilizer use
- Improving livestock management
- Forest management & carbon accounting

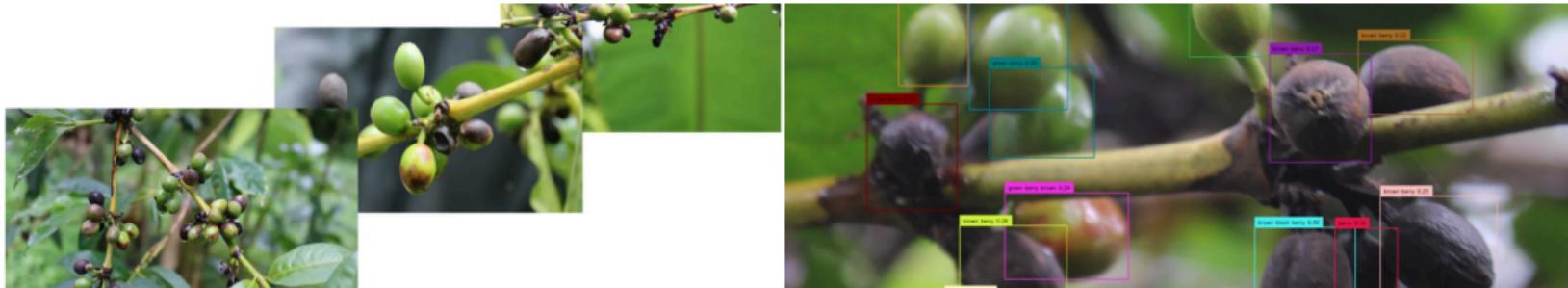


Optimizing fertilizer use



- Suggesting N,P,K dosage, tillage, timing
- Based on environmental variables

AI for climate-smart agriculture



- Precision irrigation and yield prediction
- Pest/disease detection under climate stress
- Example: ML-based decision support for smallholder farmers

Transportation

- ~14% of global GHG emissions
- Fossil based fuels





AI for transportation

- Route optimization and EV charging
- Reducing congestion and fuel use
- ML in logistics and shipping
- Smart infrastructure and modal shift

Buildings



- ~8% direct emissions
- ~25% including electricity/remote heat

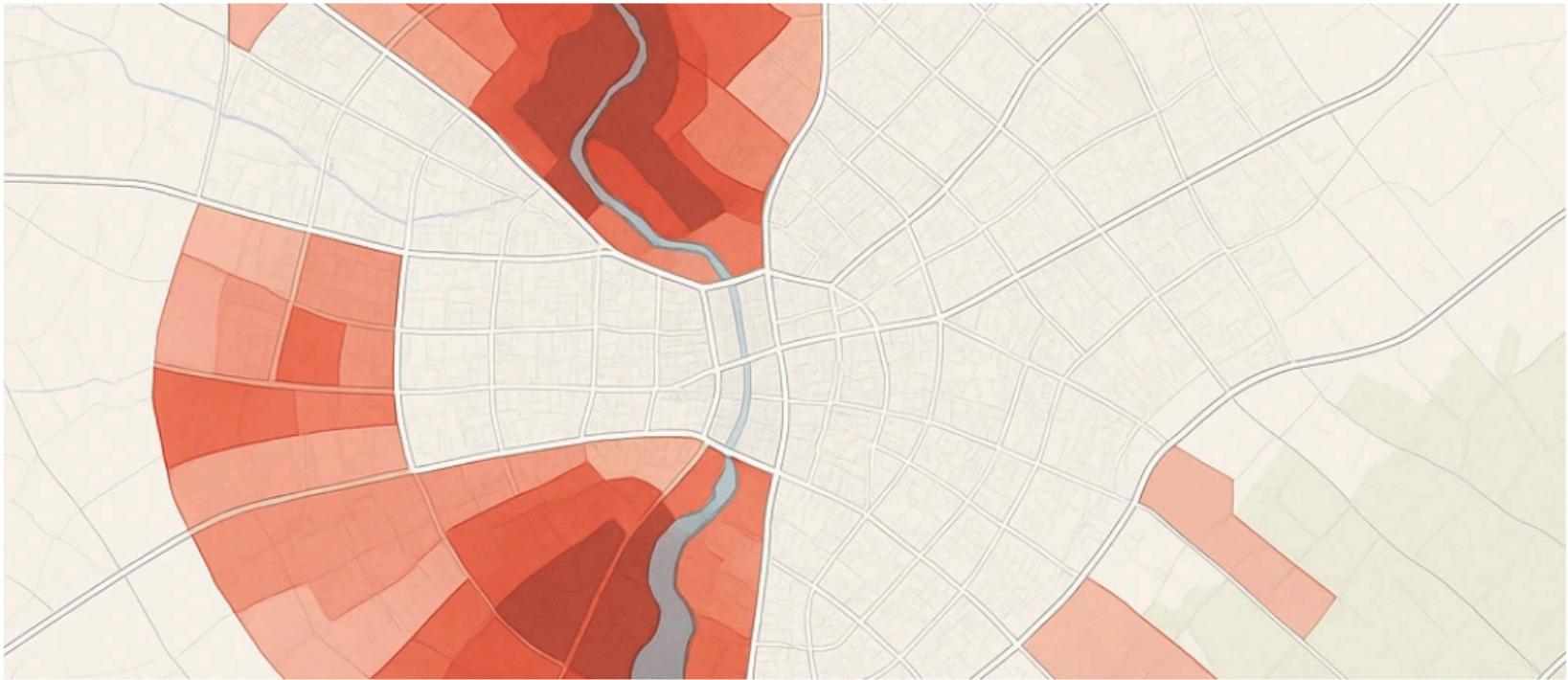
AI for building optimization

- Design and materials
 - Passive designs
 - Heating/cooling load modeling
 - Sustainable or recycled materials
- Construction and demolition
 - Reduce material waste
 - Optimize low-tech cooling/heating
- Operations
 - Smart grid coordination



Climate adaptation

Urban flood risk forecasting



Constructions



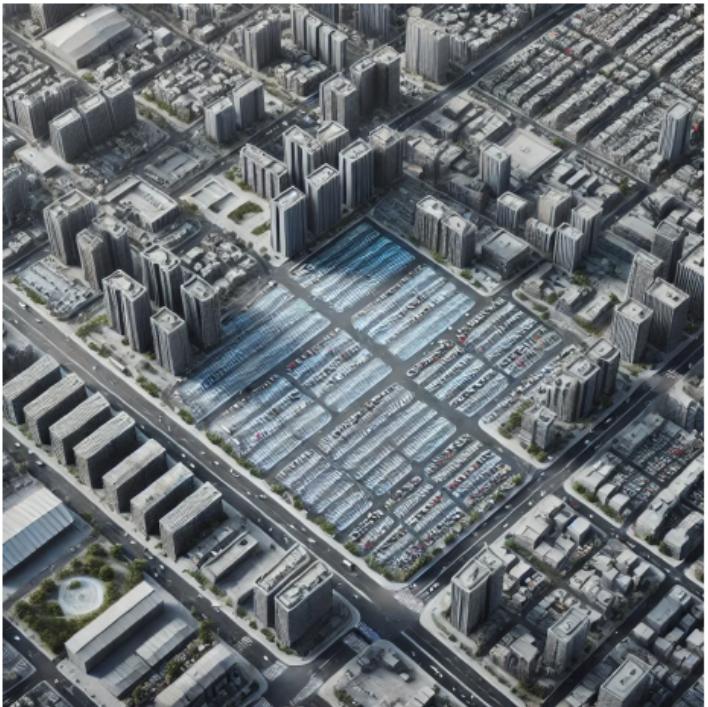
Planning urban green areas

- Optimize conversion of grey areas to green areas
 - 3-30-300
 - Climate resilience and biodiversity
 - Cost efficiency
- Satellite data, ML, GIS
- Cooling, biodiversity, public health, and carbon benefits
- RISE, SLU, Malmö Stad, Uppsala Municipality

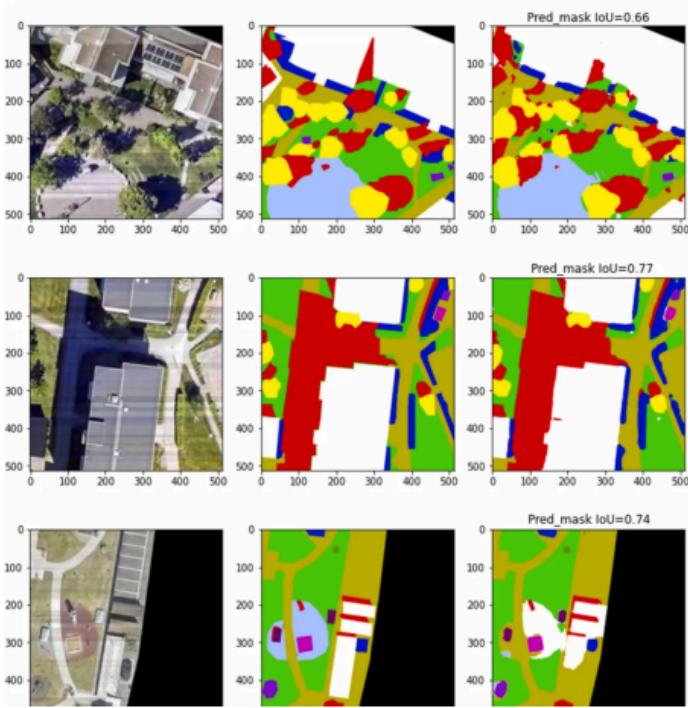


Detecting potential areas for green transformation

- Identify grey spaces
- Identify areas where green transformation
 - is the most useful
 - is possible



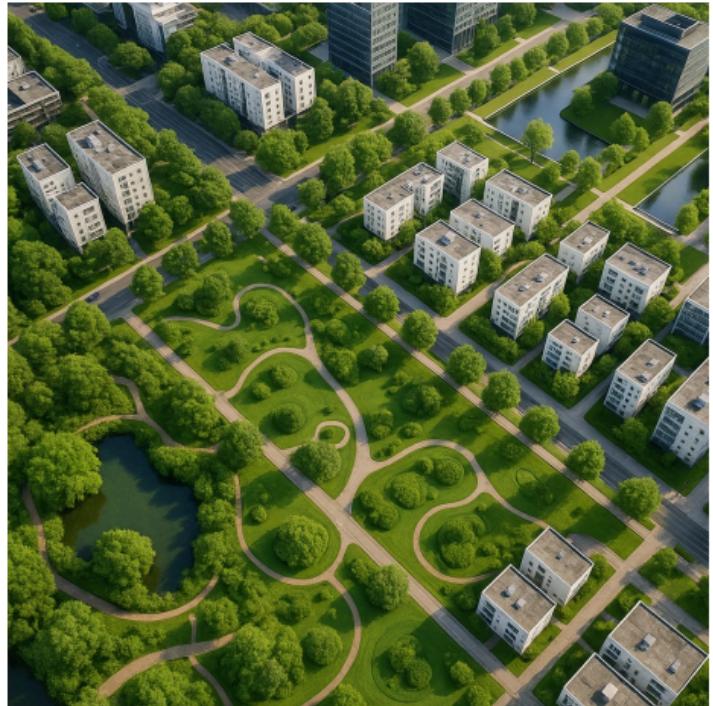
AI for urban green infrastructure

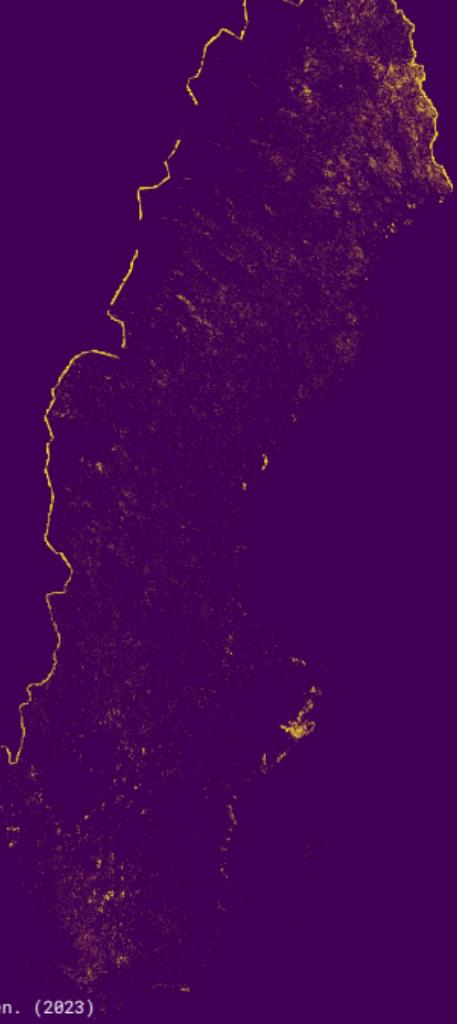


- Quantifying urban green infrastructure in Örebro (left)
- Algorithmic green infrastructure

Algorithmic green infrastructure

- Using remote sensing, geospatial data, environmental data
- Scenario planning
- Provide urban planners with AI-optimised layouts that balance multiple objectives (cooling, water, biodiversity, equity).





Earth observation for wetland estimation

- Generated map, crucial for
 - Wetland restoration
 - Biodiversity
 - Climate adaptation



Decision Support for urban planning, emission estimation
Optimization of nature restoration, production, energy grid, transport system

High tech for low tech

- Wetland restoration
- Mangrove and coastal ecosystem protection
- Urban green infrastructure
- Agroforestry
- Restoring river floodplains
- Rewilding



Common challenges

- Data availability and bias (e.g. Global North vs Global South)
- Energy use of AI systems themselves
- Interpretability, trust, and ethics in deployment
- Improved efficiency may increase demand
- AI is not a silver bullet
 - Could divert attention from simpler solutions



Workshops



Slack workspace

Start collaborations

Share

- Positions
- Calls
- Papers



Climate AI Nordics
climateainordics.com

176 Nordic members

Dissemination

Website, newsletter, social media

The screenshot shows the Climate AI Nordics website. At the top right, there is a navigation bar with links: Climate AI Nordics, News, People, Events, Join, Follow, Partners, and About. Below the navigation, there is a section titled "Climate AI Nordics Newsletter, June 2025". It features a circular profile picture of the Earth with green continents and blue oceans. To the right of the image, there is a grid of 12 small portrait photos of people. Below the grid, there is a link to "Welcome to the Climate AI Nordics Newsletter June 2025". At the bottom of the newsletter section, there is a paragraph of text: "Since our launch in October 2024, the Climate AI Nordics network has grown to include 171 members across the Nordic region, along with 52 international affiliates who contribute to our shared interests. The network brings together researchers and practitioners working at the interface of artificial intelligence and climate challenges, including mitigation, adaptation, and monitoring."



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Klimatkollen





Climate Change AI



AfriClimate AI

Schedule

Today:

- 10: Introduction to AI and Machine Learning
 - Olof Mogren
- 11: Introduction and Brief History of Natural Language Processing (NLP)
 - Murathan Kurfali
- 13: AI for Climate Adaptation and Mitigation
 - Olof Mogren
- 14: Exercises

Tomorrow:

- 10: AI for Environmental Monitoring
 - Olof Mogren
- 11: AI for Prediction and Earth System Modelling
 - Olof Mogren
- 13: Using NLP and Large Language Models: General Concepts and Climate Applications
 - Murathan Kurfali
- 14: Exercises

