

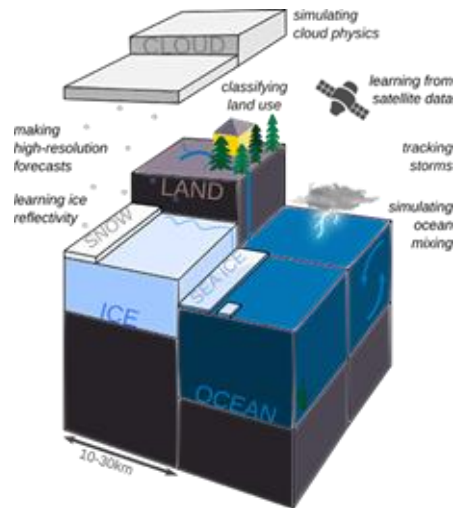
An aerial photograph of a coastline. The top half of the image shows a rugged, brownish landmass with a network of rivers and streams. The bottom half shows a vibrant turquoise sea with white waves breaking against a sandy beach. The text is overlaid on the image.

# **AI and Climate Change:** Opportunities, challenges, and dangers

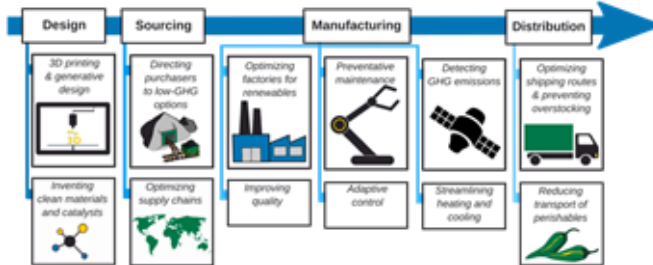
David Rolnick

McGill University / Mila

## Climate prediction



## Industry



## Transportation



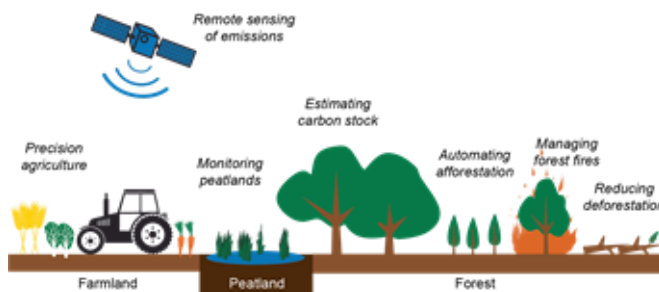
## Buildings



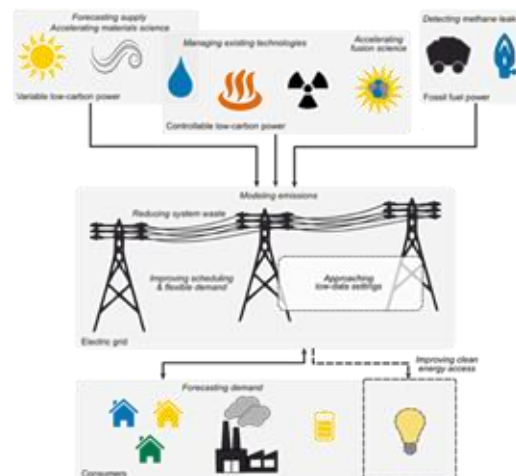
## Societal adaptation



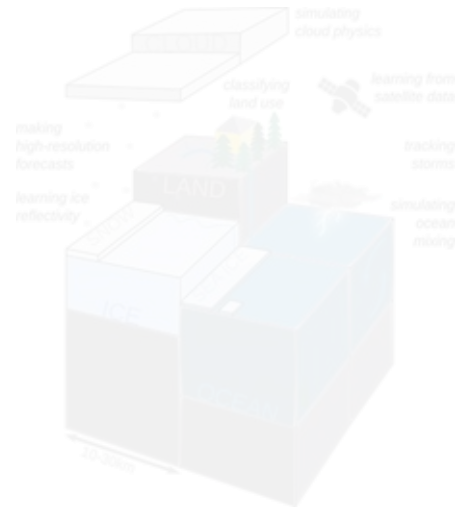
## Land use



## Electricity systems



# Climate prediction



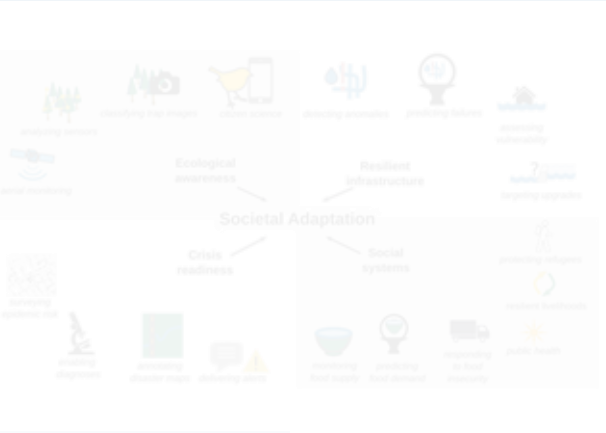
# Industry



# Transportation



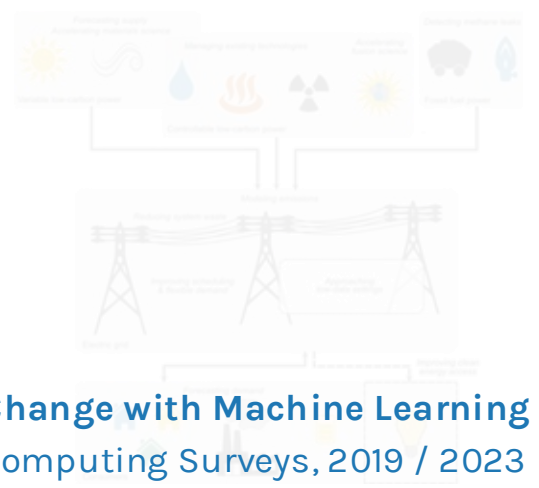
# Buildings



# Land use



# Electricity systems



# Opportunities for AI

**Tackling Climate Change with Machine Learning**  
 Climate Change AI / ACM Computing Surveys, 2019 / 2023  
[www.climatechange.ai/reports/tccml](http://www.climatechange.ai/reports/tccml)

# Opportunities for AI

- **Distilling raw data into actionable information**

Ex: remote sensing for emissions inventories, disaster response



Image source: Climate TRACE

**Tackling Climate Change with Machine Learning**  
Climate Change AI / ACM Computing Surveys, 2019 / 2023  
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Ex: HVAC systems, industrial processes

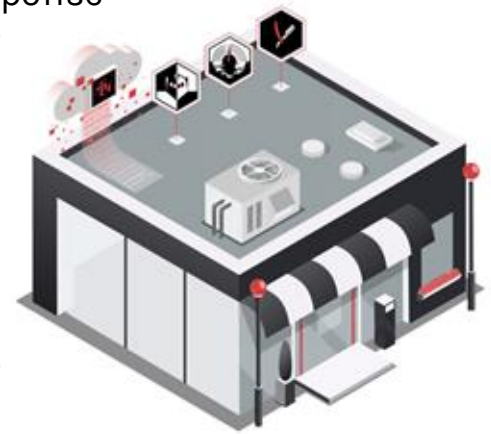


Image source: BrainBox AI

## Tackling Climate Change with Machine Learning

Climate Change AI / ACM Computing Surveys, 2019 / 2023

[www.climatechange.ai/reports/tccml](http://www.climatechange.ai/reports/tccml)

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- **Forecasting**  
Ex: nowcasting electricity supply & demand

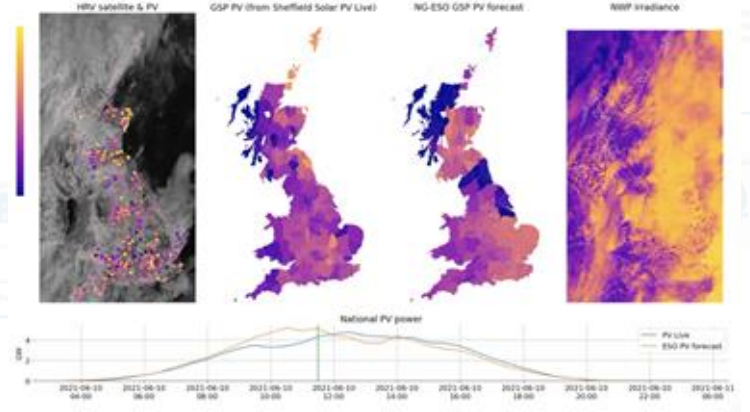


Image source: Open Climate Fix

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Ex: extreme weather emulation and downscaling

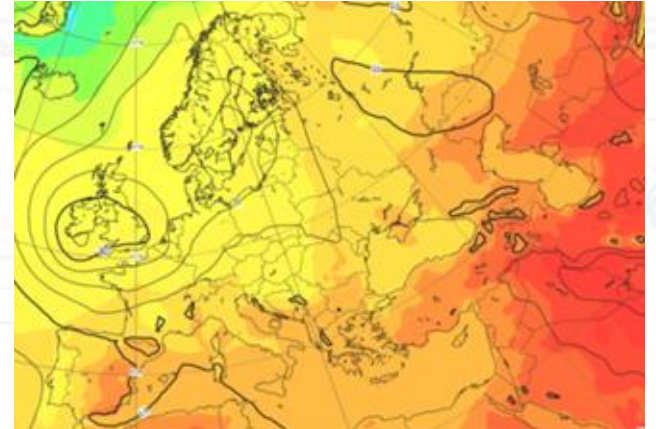


Image source: ECMWF

**Tackling Climate Change with Machine Learning**  
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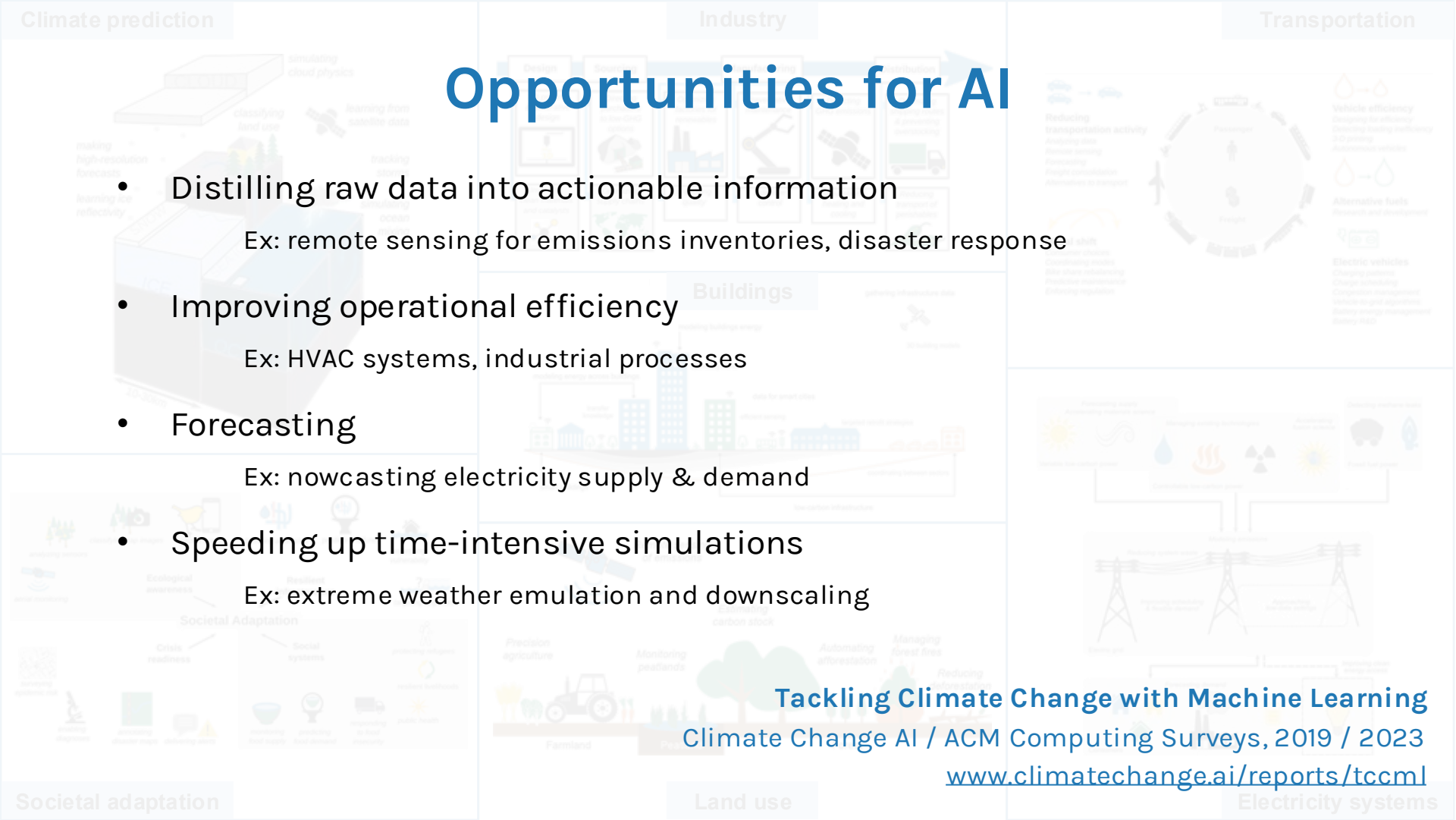
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Tackling Climate Change with Machine Learning

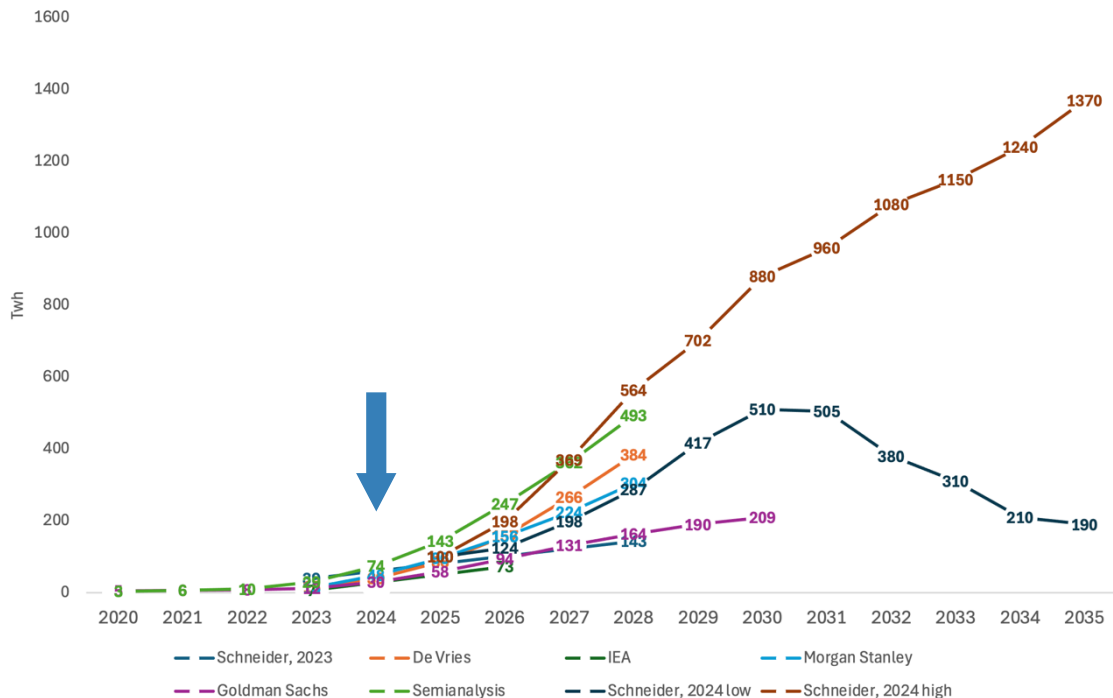
Climate Change AI / ACM Computing Surveys, 2019 / 2023

[www.climatechange.ai/reports/tccml](http://www.climatechange.ai/reports/tccml)



“AI can help solve climate change,  
but it uses a lot of energy” ?

# Estimated total energy consumption of AI



## Comparison

Total electricity in 2023:

- Global: 29,479.05 TWh
- Low-income countries: 126.35 TWh
- United States: 4,249.05 TWh

Source: Our World in Data

Adapted by Lynn Kaack from Roegen Centre for Sustainability and INFRAS with data from Schneider Electric, 2023; Schneider Electric, 2024; De Vries, 2023; IEA, 2024; Morgan Stanley, 2024; Goldman Sachs, 2024; Semianalysis, 2024

# A menagerie of AI algorithms

Gemini  
ChatGPT  
DeepSeek  
Midjourney  
...



Massive energy / consolidated infra.

Large-scale Generative AI

Top-down, problem-agnostic design

Some uses in climate-relevant areas



Remote sensing  
AI for opt. / control  
Time series analysis  
Physics-informed ML  
...

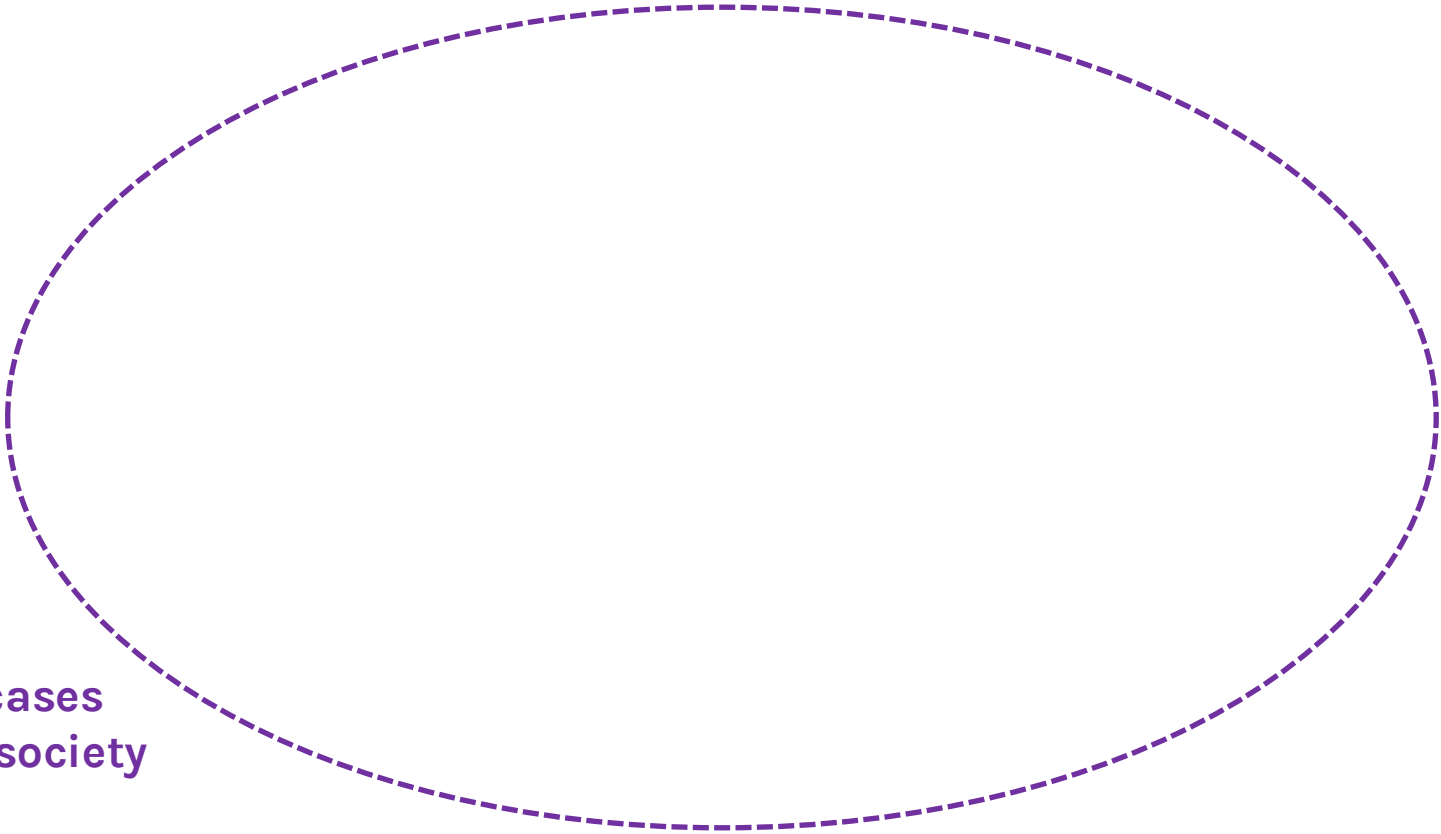
Scalable, distributed use

Classification / optimization / prediction

Collaborative, user-centered design

Widely needed / used across sectors

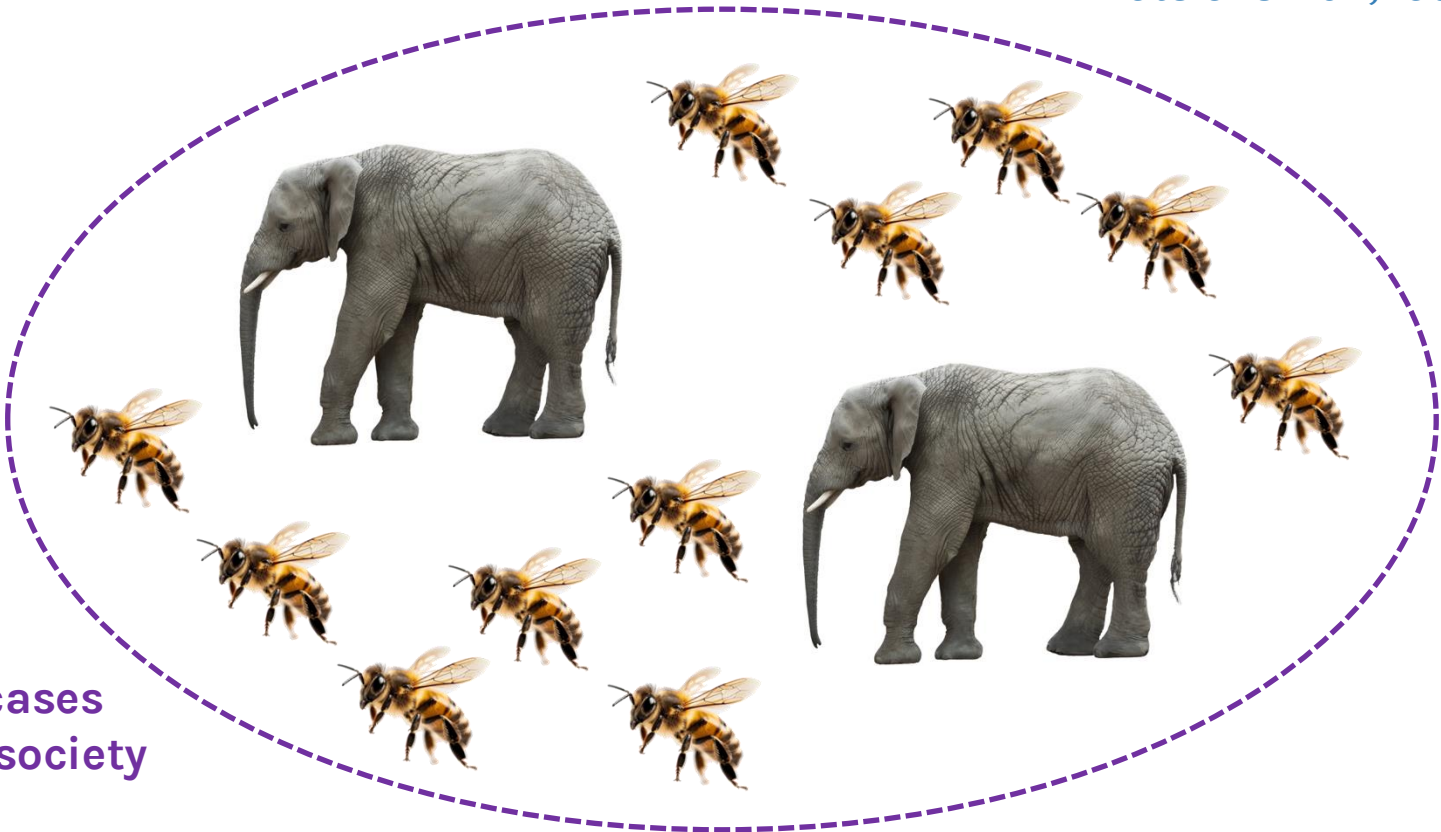
# What algorithms do we need to be effective?



AI use cases  
across society

# Right approach

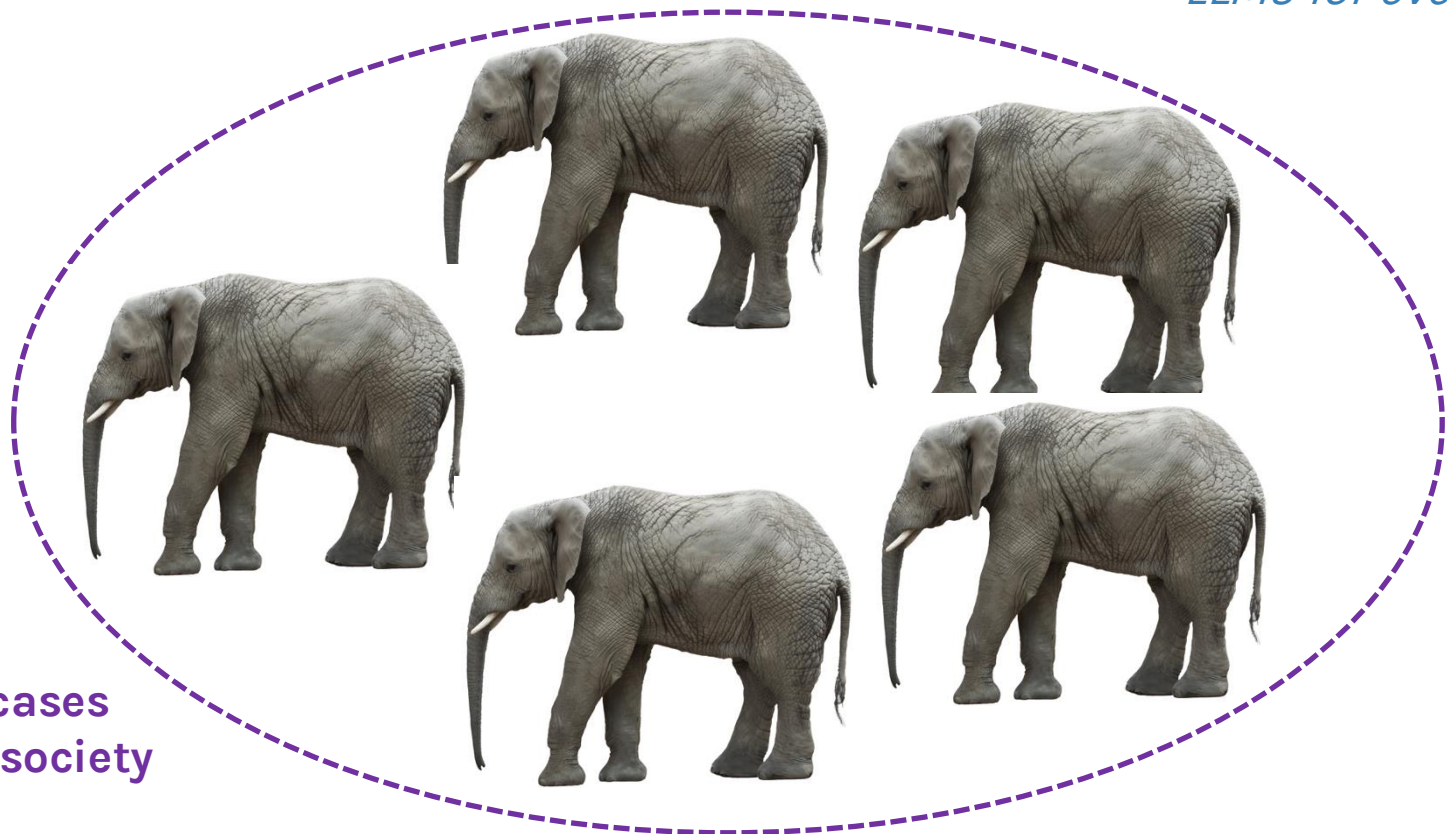
*Some big generative AI  
Lots of small, focused AI*



**AI use cases  
across society**

# Wrong approach

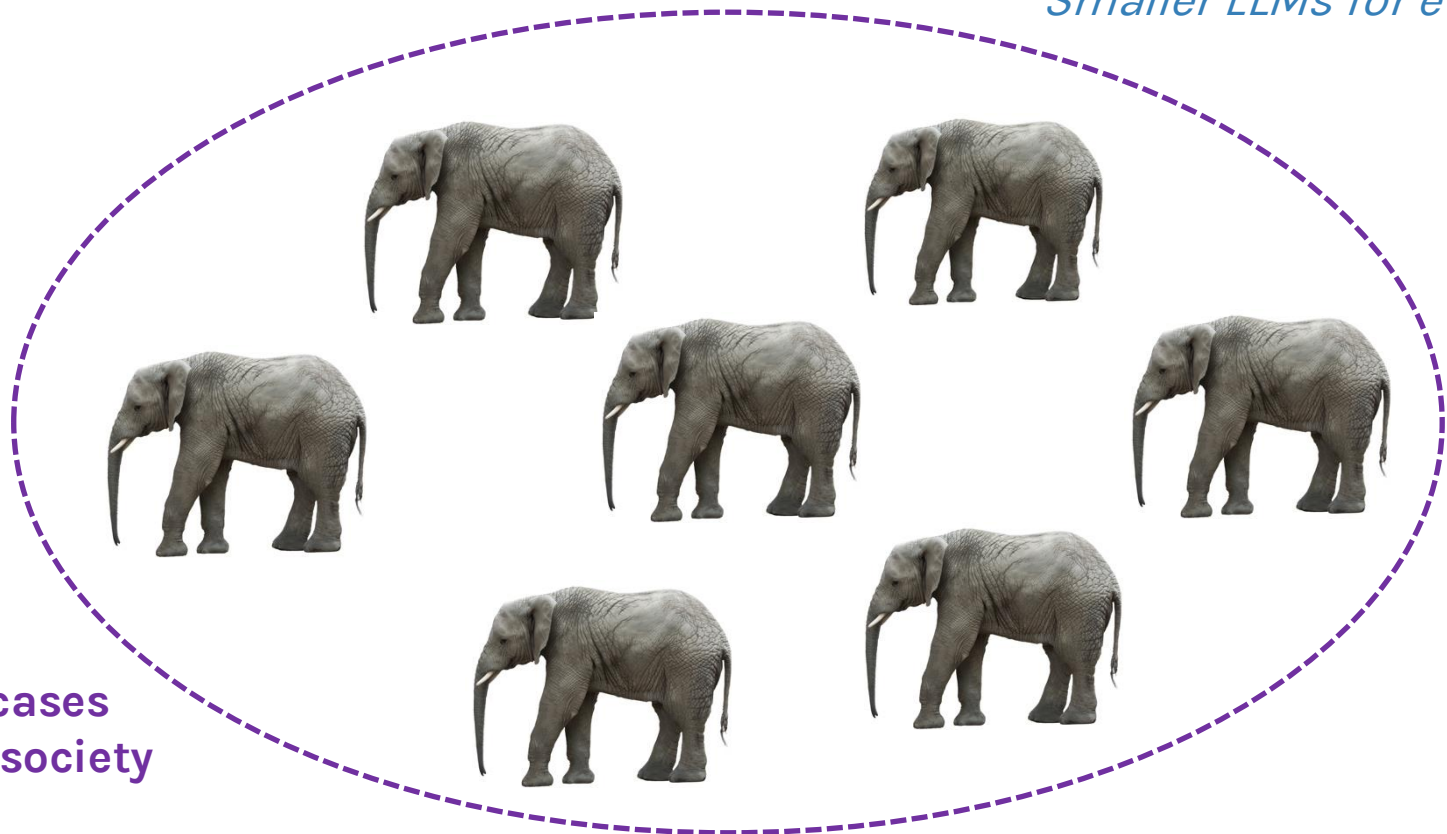
*LLMs for everything*



**AI use cases  
across society**

# Wrong approach

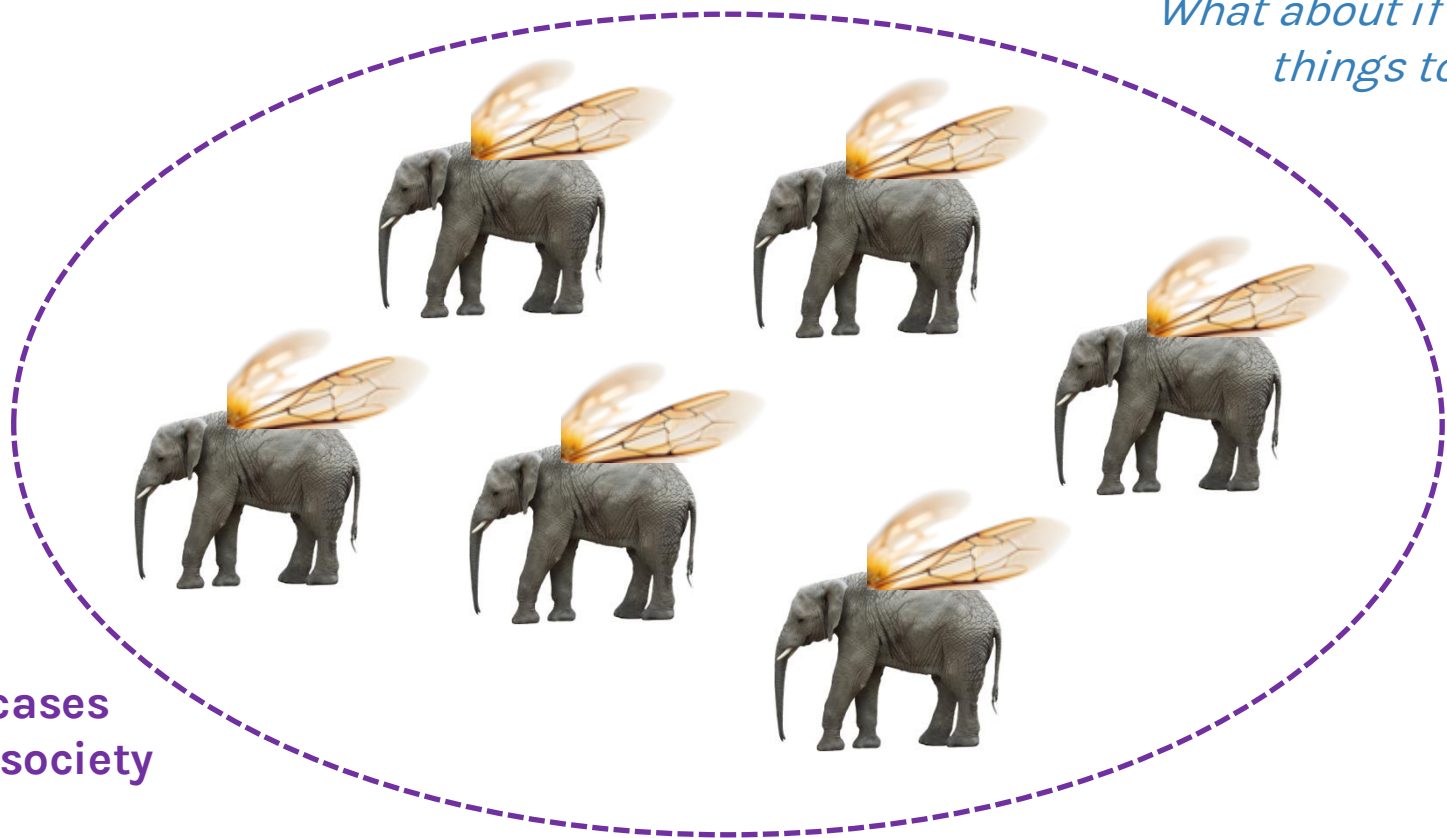
*Smaller LLMs for everything*



**AI use cases  
across society**

# Wrong approach

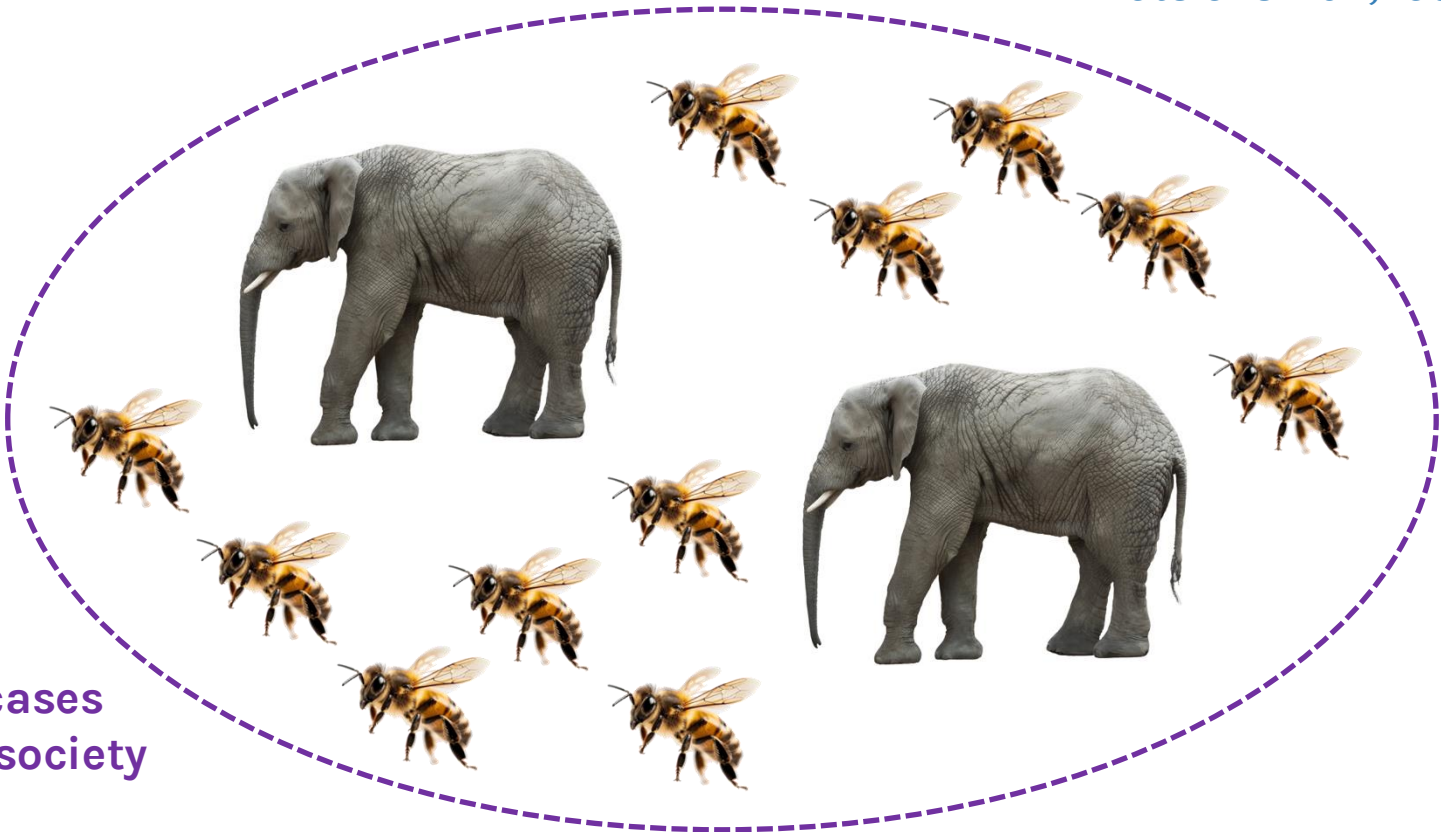
*What about if we add things to LLMs?*



**AI use cases  
across society**

# Right approach

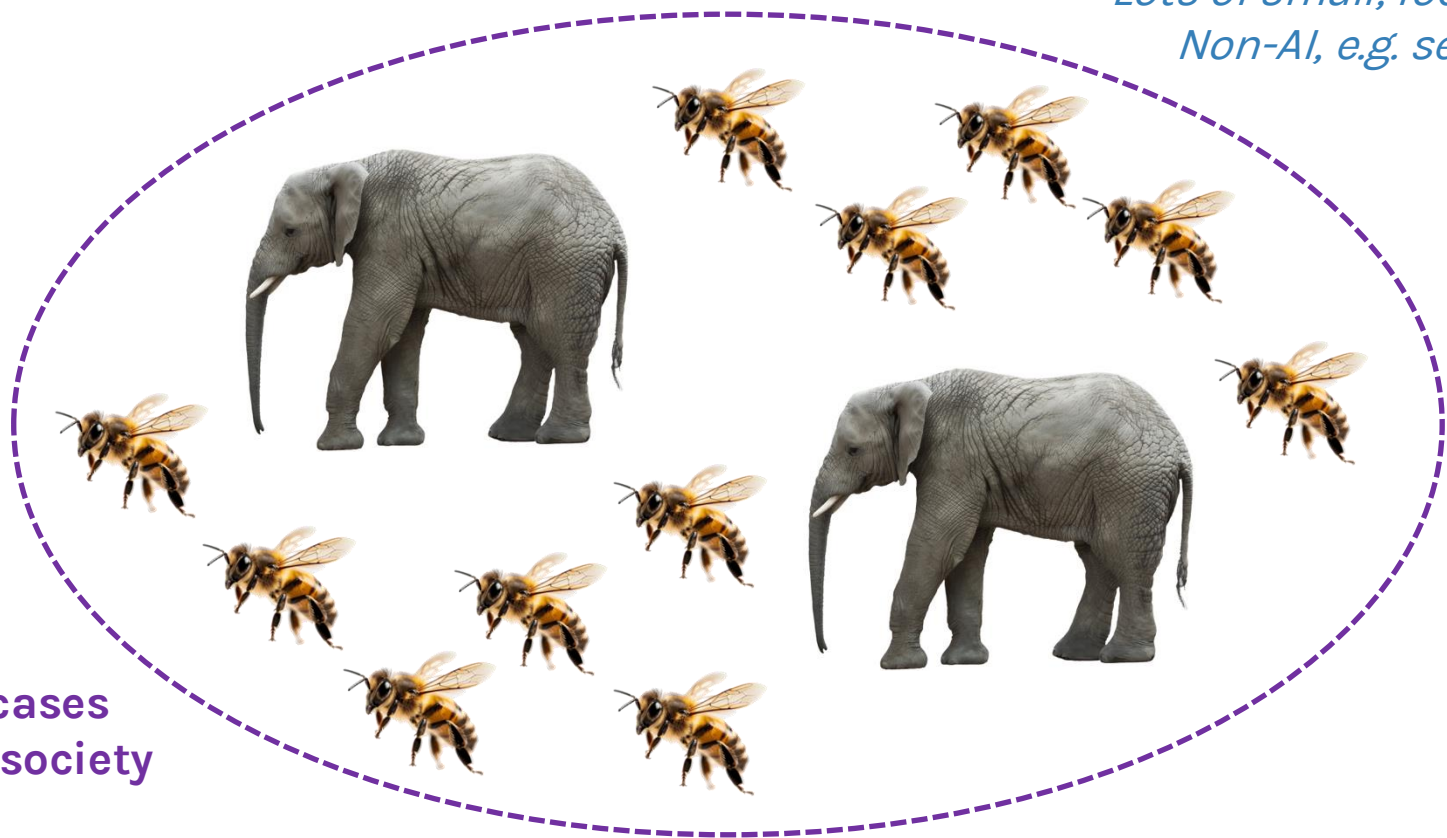
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**AI use cases  
across society**

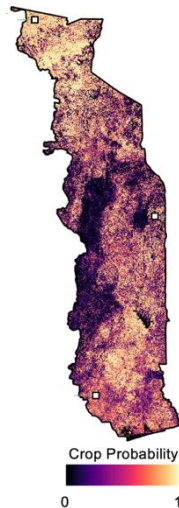
# Right approach

*Some big generative AI  
Lots of small, focused AI  
Non-AI, e.g. search/UI*



AI use cases  
across society

# Ex. 1: AI for remote sensing



**Galileo** is a self-supervised transformer designed specifically for remote sensing

In addition to higher accuracy, it also needs much less labeled data

## Approach



ChatGPT, DeepSeek, etc.



Standard vision transformers



Galileo

## # Parameters

~1,000,000,000,000

~100,000,000

~1,000,000

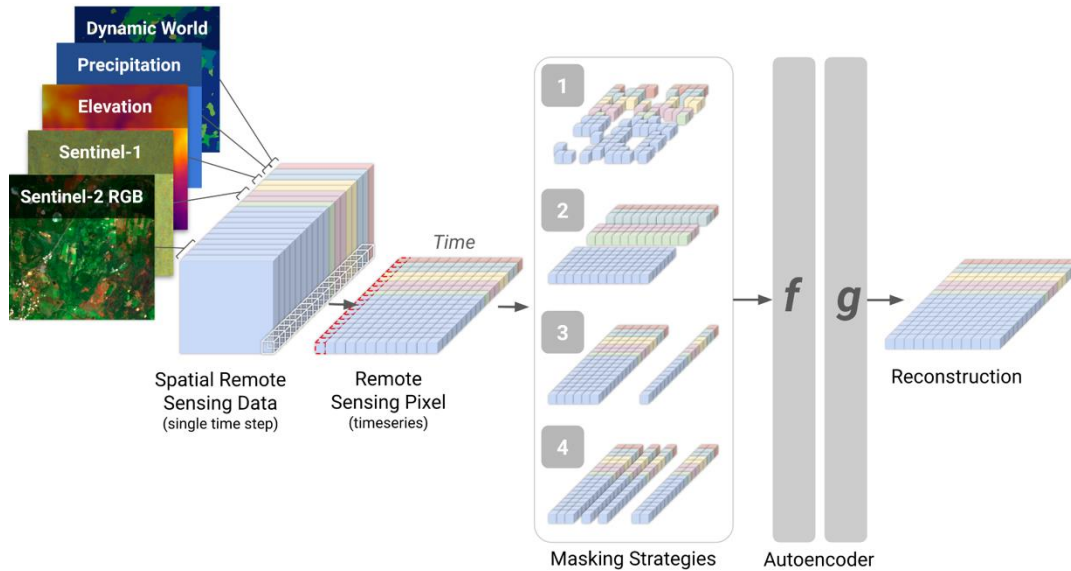
## Does it help here?

No

Somewhat

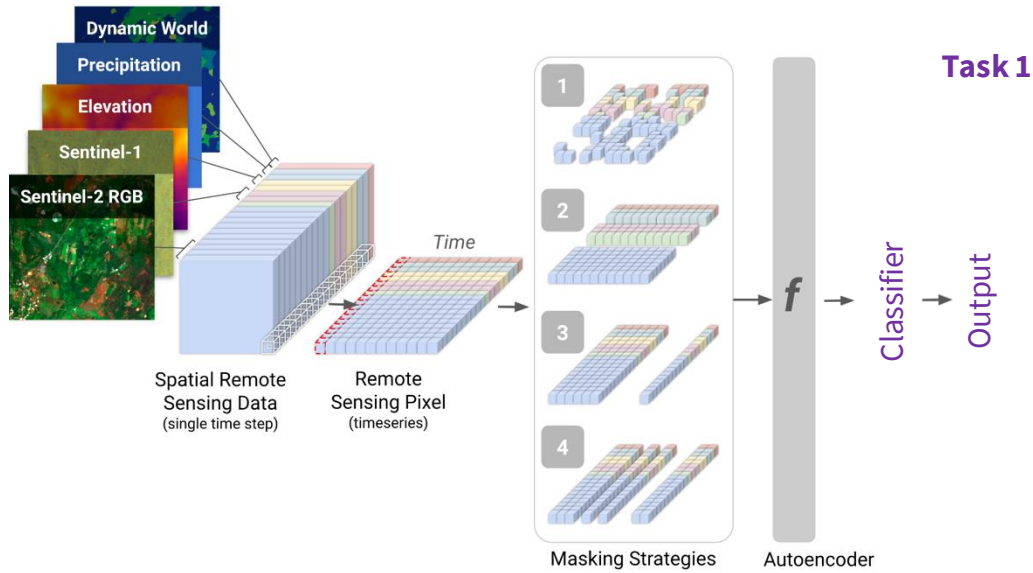
Yes

# Ex. 1: AI for remote sensing



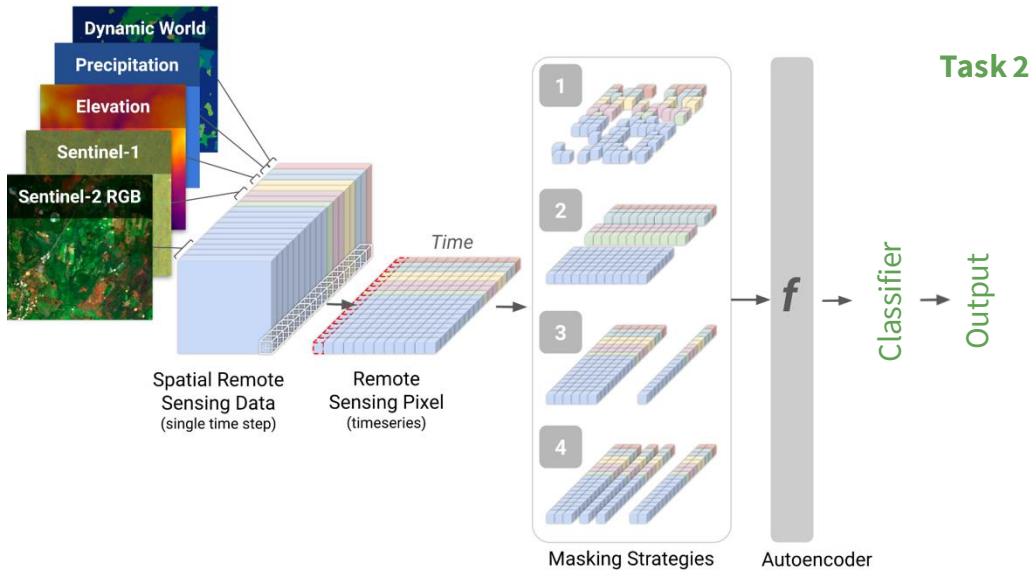
Tseng et al. "Galileo: Learning Global & Local Features of Many Remote Sensing Modalities", Int'l Conf. on Machine Learning (ICML) 2025.

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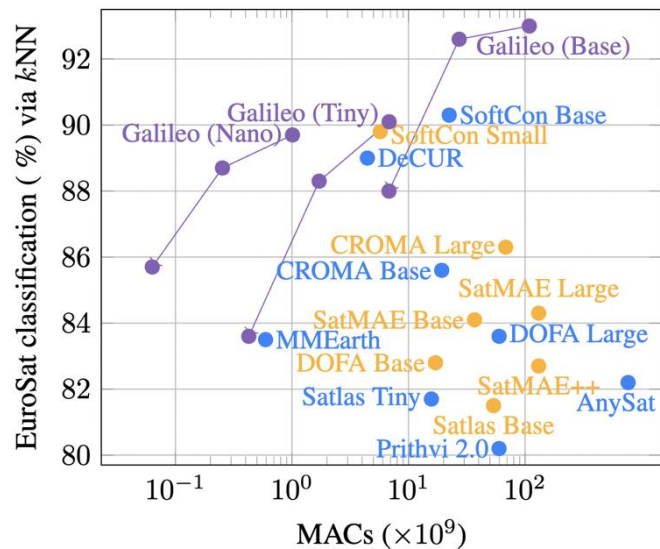
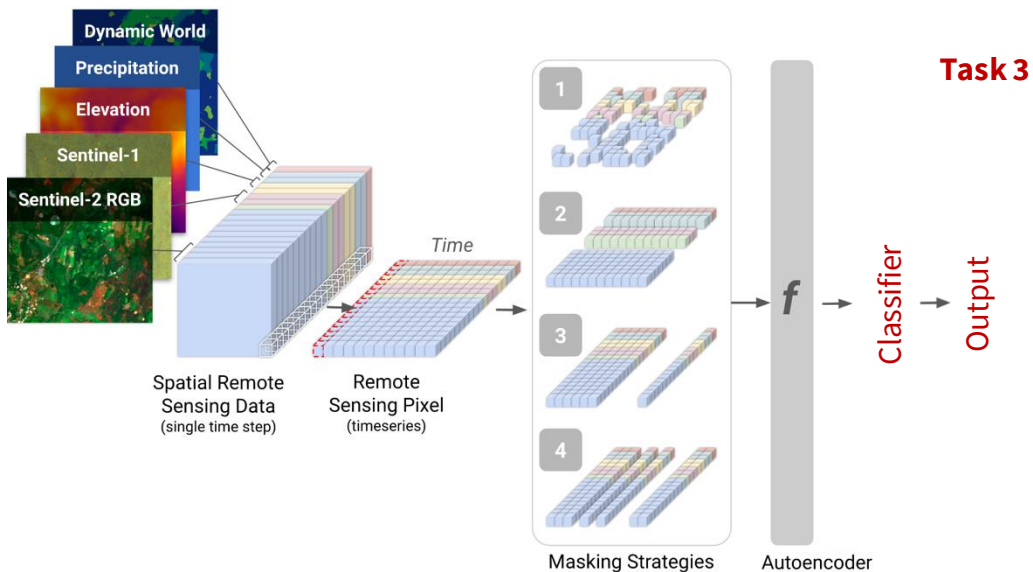
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# Ex. 1: AI for remote sensing



Tseng et al. "Galileo: Learning Global & Local Features of Many Remote Sensing Modalities", Int'l Conf. on Machine Learning (ICML) 2025.

# Frontiers for innovation

Out-of-distribution generalization

Uncertainty quantification

Model explainability

Physical constraints

Multi-modal data

Limited labels

Causality

**Impactful innovations driven by  
user needs / specific applications**

Rolnick, et al. “Application-driven innovation in machine learning”,  
Int’l Conf. on Machine Learning (ICML) 2024.

Cutting-edge AI innovation across  
“elephants” and “bees”

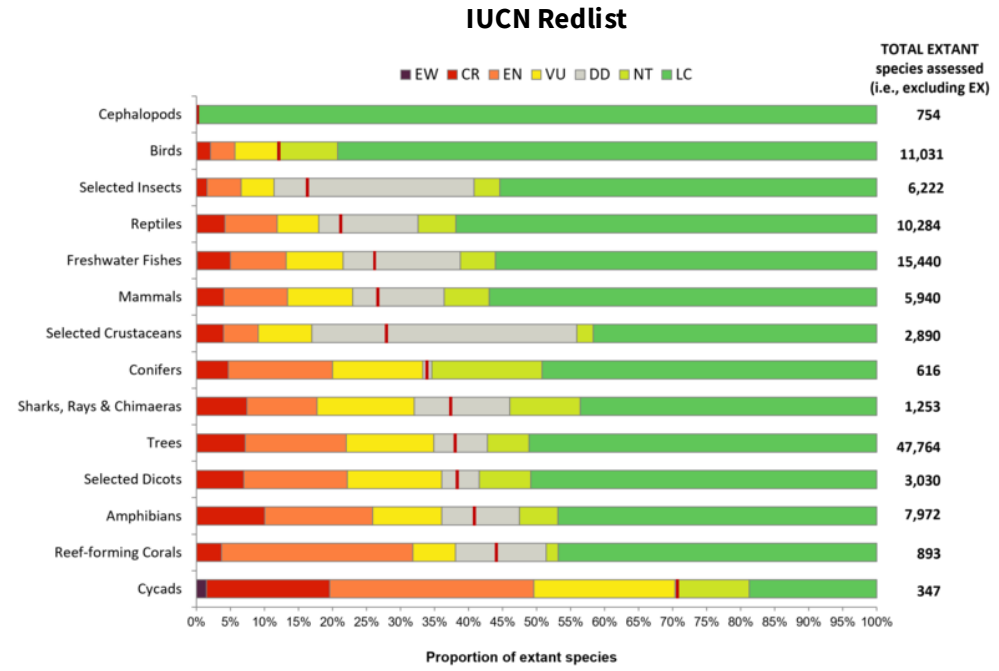
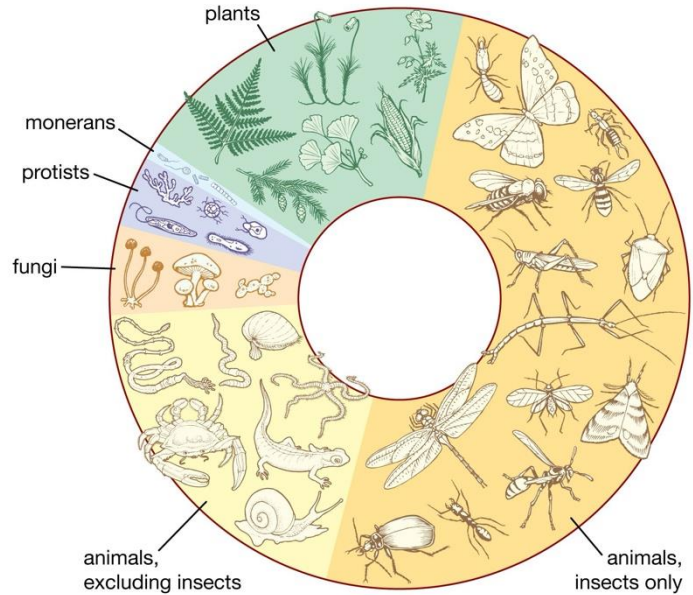


Also many uses for older methods  
(e.g. simple neural nets, random forests)



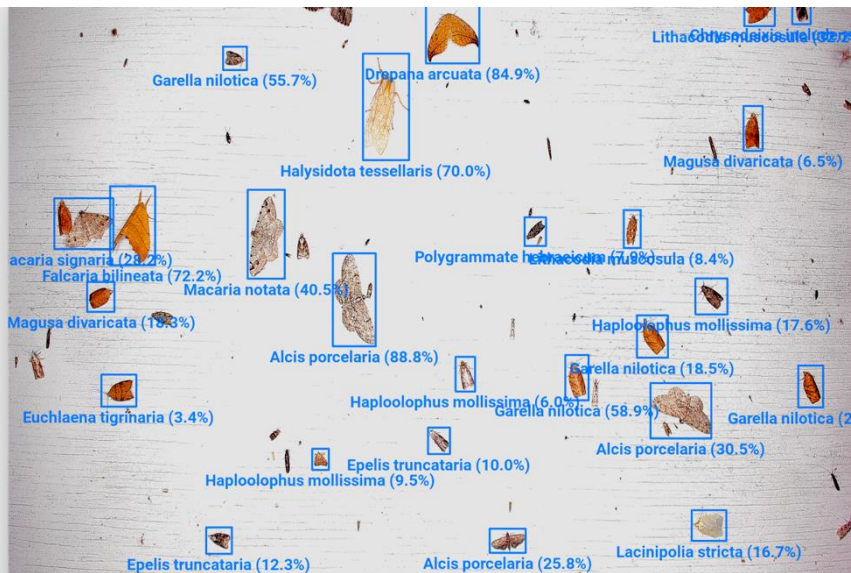
Image credit: Louisville Fossils

# Ex. 2: Gathering data on insect biodiversity



© Encyclopædia Britannica, Inc.

# Ex. 2: Gathering data on insect biodiversity



# Ex. 2: Gathering data on insect biodiversity



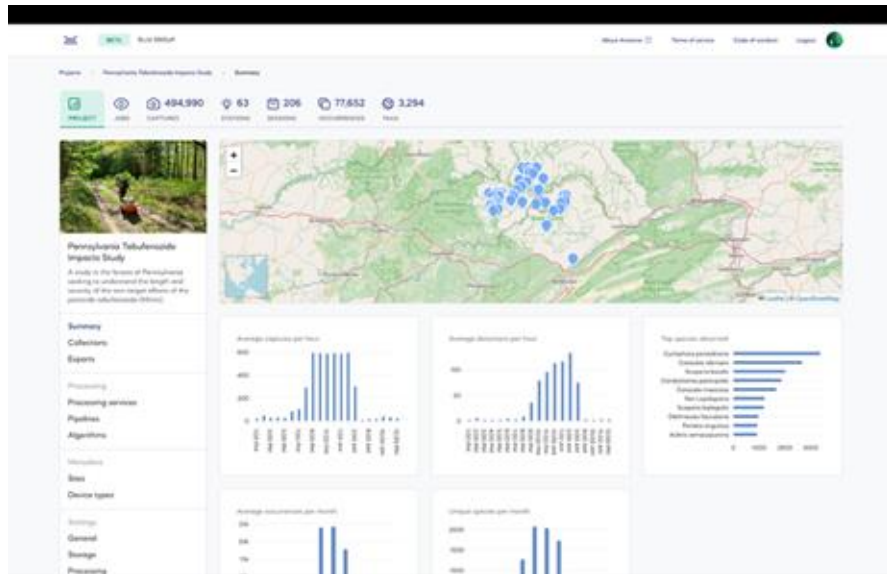
**Core algorithm:** ResNet50  
(standard AI approach)

**AI frontier:** Undescribed species!  
(open-set recognition)



Chen et al. "Open-Insect: Benchmarking Open-Set Recognition of Novel Species in Biodiversity Monitoring", Advances in Neural Information Processing Systems (NeurIPS) 2025.

# Ex. 2: Gathering data on insect biodiversity



**Core algorithm:** ResNet50  
(standard AI approach)

**AI frontier:** Undescribed species!  
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**Also essential:**  
Software and human capacity



**Antenna**

# Takeaways

1. Opportunities for AI to advance climate action across sectors
2. Need for cutting-edge AI, but mostly not large-scale GenAI
3. Impactful innovations are driven by user needs



# Climate Change AI

*Catalyzing impactful work at the intersection of climate change & ML*

## Digital resources

**Reports** with opportunities for researchers, practitioners, and policymakers

Paper Section  ML Keywords  Thematic Keywords

Electricity Systems

- + Forecasting supply and demand High Leverage
- + Improving scheduling and flexible demand

## Conferences & events

### Workshop series

- ▶ Most recently at NeurIPS 2025
- ▶ 1,000+ past papers at: [www.climatechange.ai/papers](http://www.climatechange.ai/papers)

### Summer school (materials online)



**Learn more & join in:**

[www.climatechange.ai](http://www.climatechange.ai)

[Twitter](#) [Facebook](#) [LinkedIn](#) @ClimateChangeAI

## Funding programs

**Global research funding** for impactful projects

Climate Change AI **Innovation Grants**

Announcing a **\$1.8M grants program** for projects at the intersection of AI and climate change

- Funding of up to **\$150K** for **year-long** research projects
- Supporting projects involving AI or machine learning that address problems in climate change mitigation, adaptation, or climate science

## Newsletter, blog, & community



Welcome to the Climate Change AI community!

We are excited to have you here!

This is a space to connect, share and discuss all things related to climate change & machine learning.

If this is your first time here, you might want to head over to the [intro channel](#) and introduce yourself!



Calls for Submissions



Funding



Projects & Courses



Readings



Jobs



# Questions?

