Machine learning in climate projects

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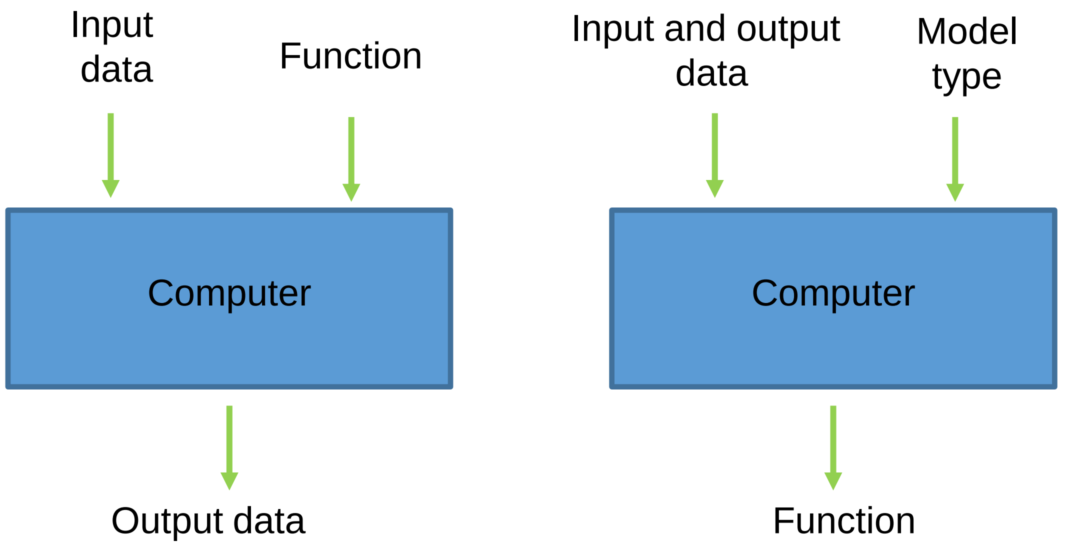
Machine learning

Group of techniques that automatically extract patterns from (large amounts of) data



Simulation algorithm **ML algorithm**

Computer vision with machine learning

Input:

Input:

Label: `Cat`

Label: `Dog`

What can I do with machine learning?

Gather new information at scale from pictures, texts, etc. (Crop health, GHG emissions)

Create better forecasts (renewable energy, transportation demand)

Improve the efficiency of operations (heating and cooling, food waste)

Make maintenance cheaper and more effective (natural gas leaks, resilient infrastructure)

Accelerate scientific experimentation (batteries, clean energy materials)

Speed up time-intensive simulations (climate science, city planning)

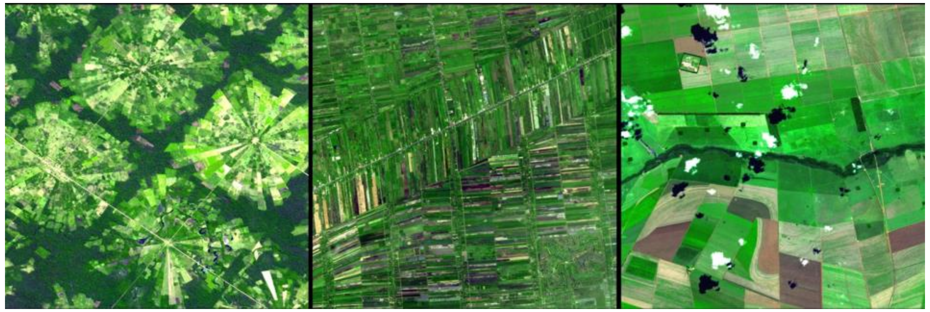
Rolnick, D., Donti, P.L., Kaack, L.H., Kochanski, K., Lacoste, A., Sankaran, K., Ross, A.S., Milojevic-Dupont, N., Jaques, N., Waldman-Brown, A. Luccioni, A., et al., 2019. Tackling Climate Change with Machine Learning. *arXiv preprint arXiv:1906.05433*.

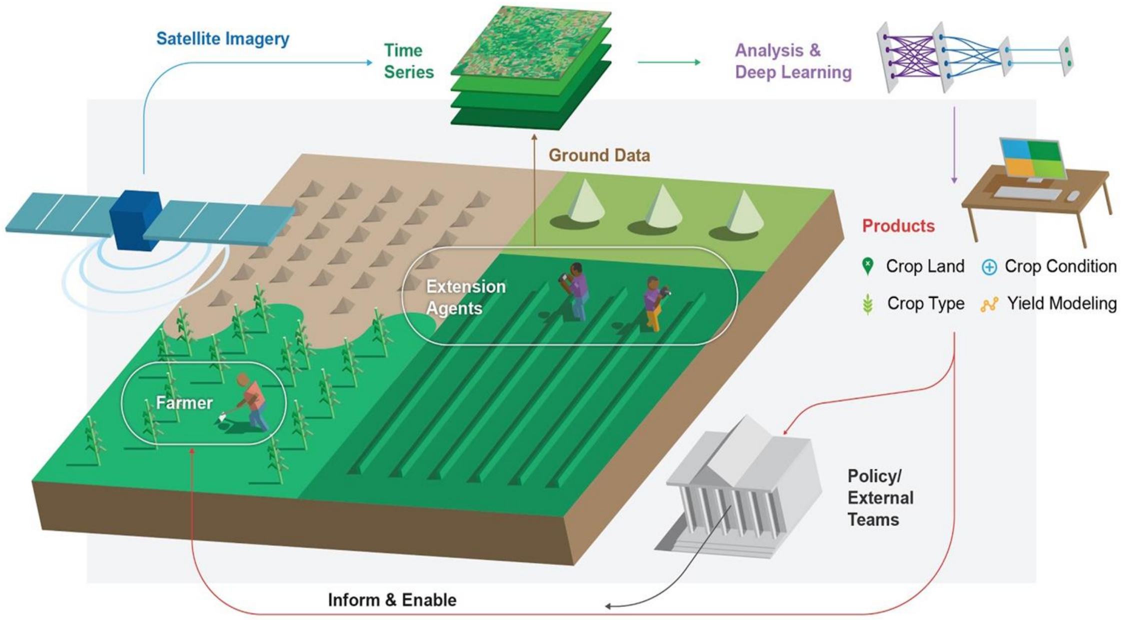
Computer vision for improving food security

Motivation: Agriculture is very sensitive to extreme weather events aggravated by climate change

Application: Monitoring yield at scale via satellite and aerial imagery by assessing crop distribution and crop health to inform early warning and emergency response

ML: Computer vision, e.g., to automatically label crops over a wide area





Images: C. Nakalembe (GEOGLAM and NASA Harvest)

District energy

Motivation: District heating systems for use of waste heat

Application: Forecasting heat demand for better scheduling of efficient production units

ML: Sequence prediction based on heat generation and metering and environmental data

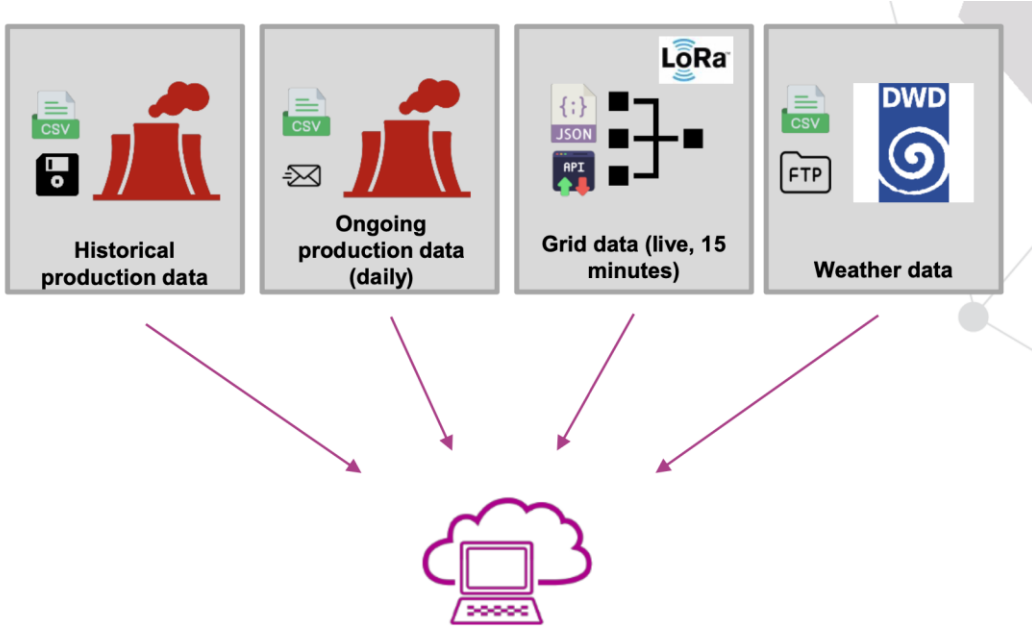


Image: dena

Corporate climate risk disclosure

Motivation: Financial implications of physical and transition risks and opportunities

Application: Analyzing climate risk disclosure in annual reports by companies

ML: Natural language processing, e.g. to automatically analyze text

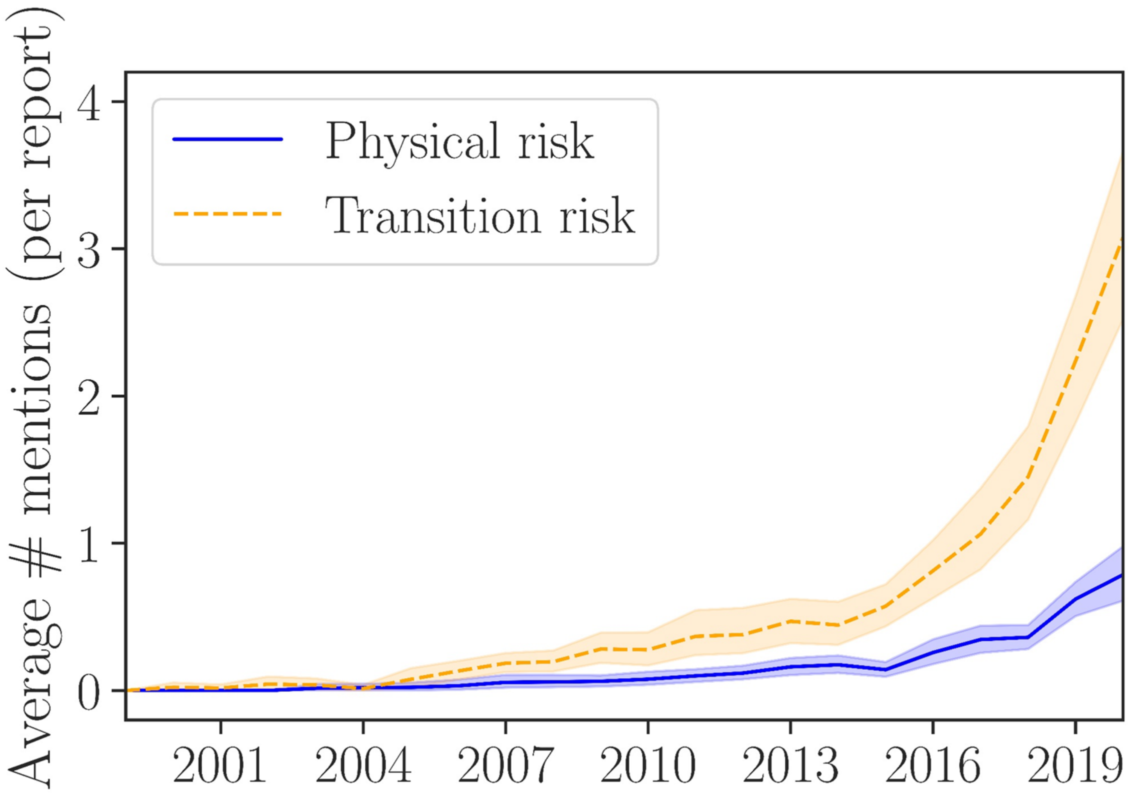


Image: Friedrich et al., 2021

Urban planning

Motivation: Designing new walkable and energy-efficient districts

Application: Pedestrian-level wind simulation during design stage

ML: Modeling the urban microclimate in seconds, rather than hours, by approximating time-intensive simulations

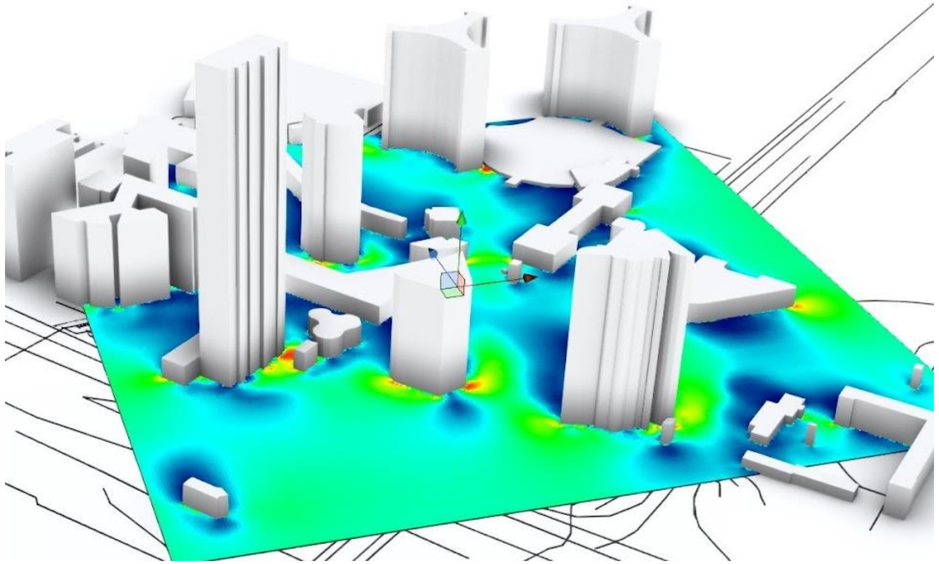
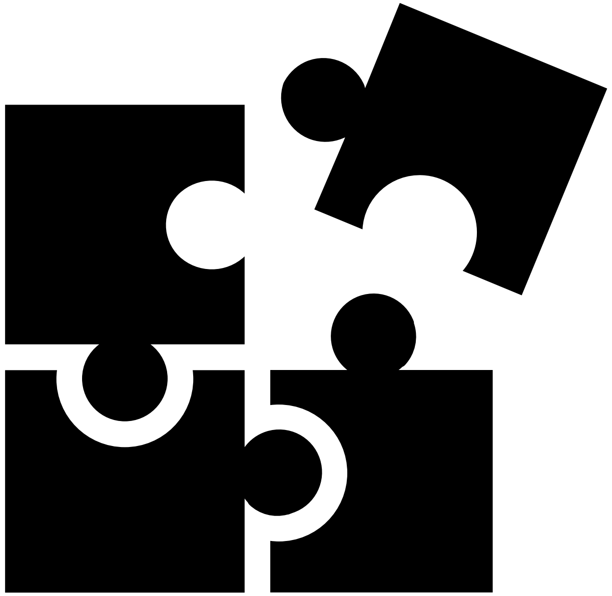


Image: InFraReD by AIT

Where ML is applicable, it is only one piece of the puzzle!



Limitations of ML

- ML models must be customized and mostly trained specifically for the task
- ML models are based on huge amounts of data and compute
- “Garbage in, garbage out”
  - Important for data to represent what you need
  - Important for data to be “clean”
- Inherits biases in data/design/use - not “objective”
- Assumes patterns are persistent
  - Difficulty with e.g. long-term forecasts
- Finds correlation, not causation

Benefits and costs of ML

- Benefits from enabling new or improved way of working
- Generating insights where human expertise does not exist or is hard to make explicit
- Performing tasks in a way that's cheaper or more scalable than what humans can do
- Benefits from operational efficiency

- Costs for data and IT infrastructure
- Costs for highly skilled personnel
- Risk that ML solution does not outperform simpler approaches
- Not a one-off: Costs for updates and maintenance
- Costs from institutional or process changes

Governance of ML for urban climate change mitigation

ML for municipal governments:

- Motivations for and barriers to deployment
- (Perceived) benefits and risks

Systematic map (in review):

- Rapidly evolving research area
- Largely impactful areas according to the IPCC
- Most studies on Eastern Asia, Europe and North America

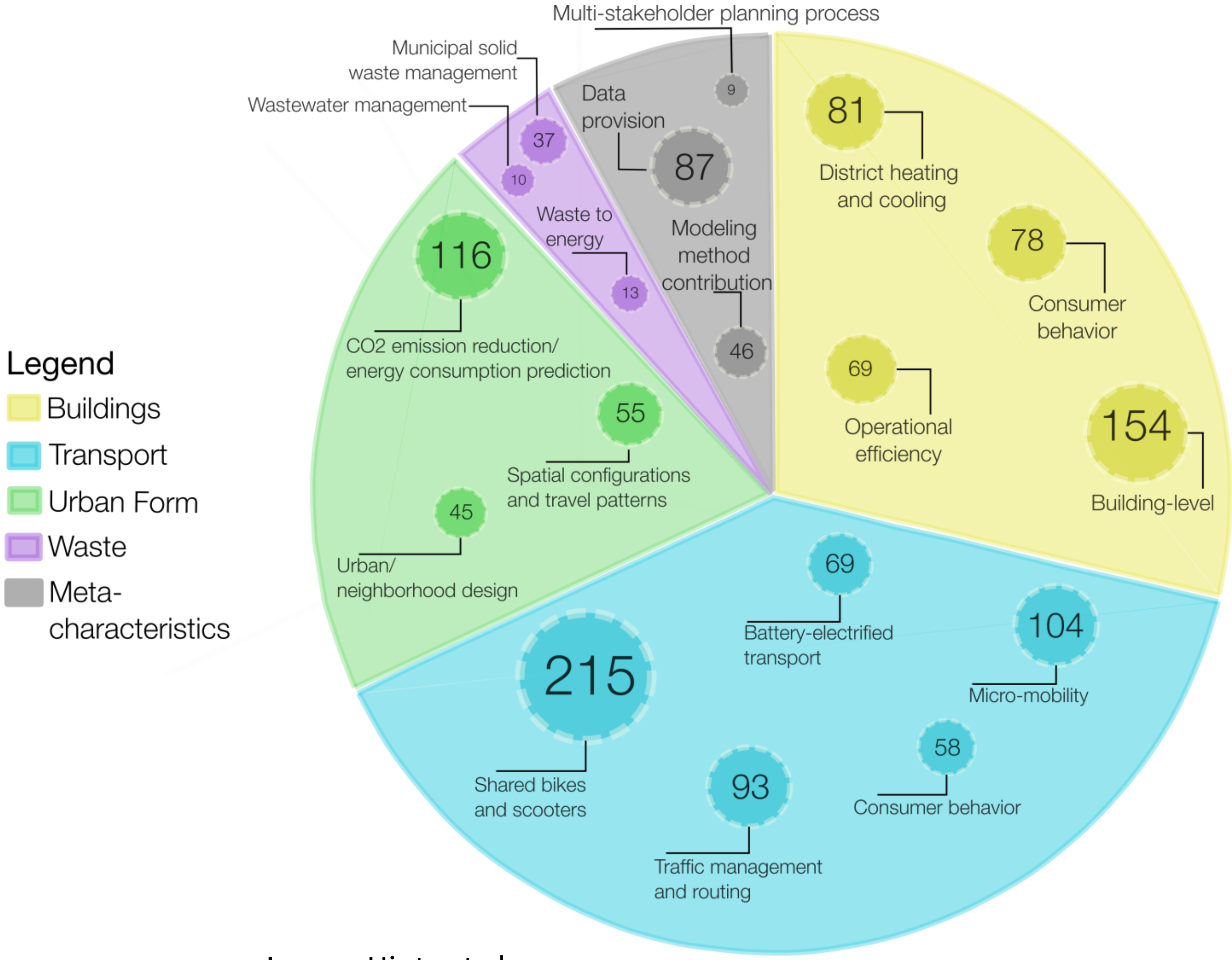


Image: Hintz et al.

Thank you!

Contact

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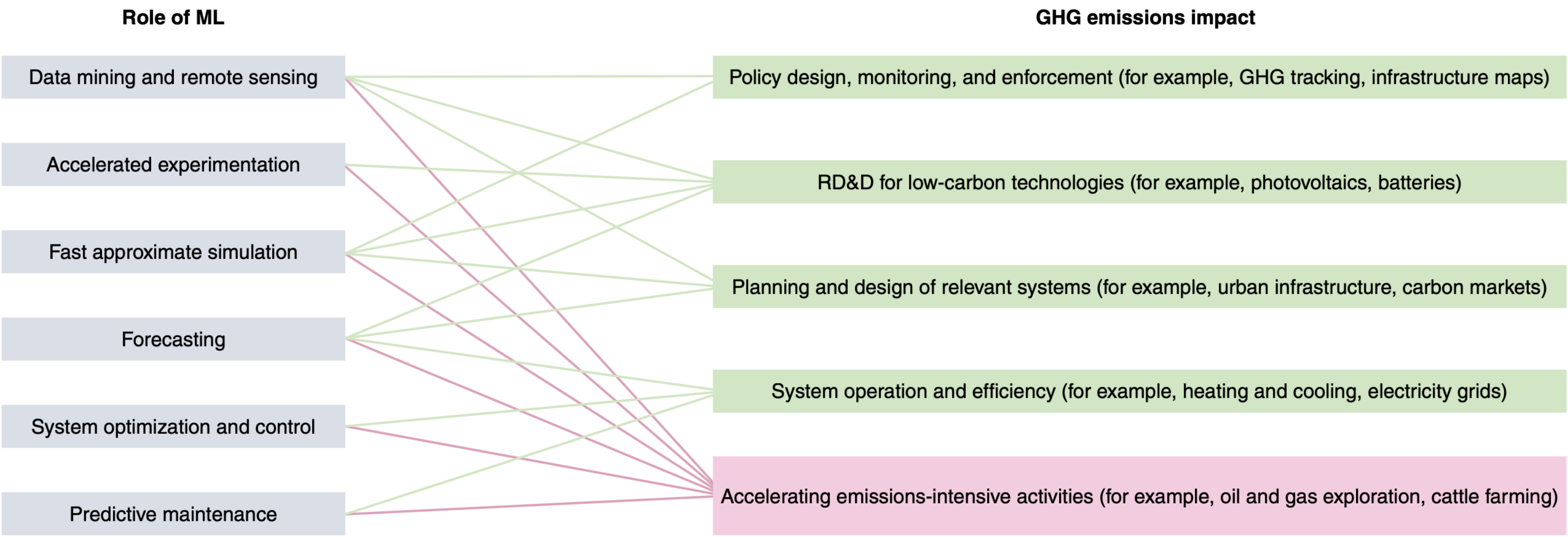
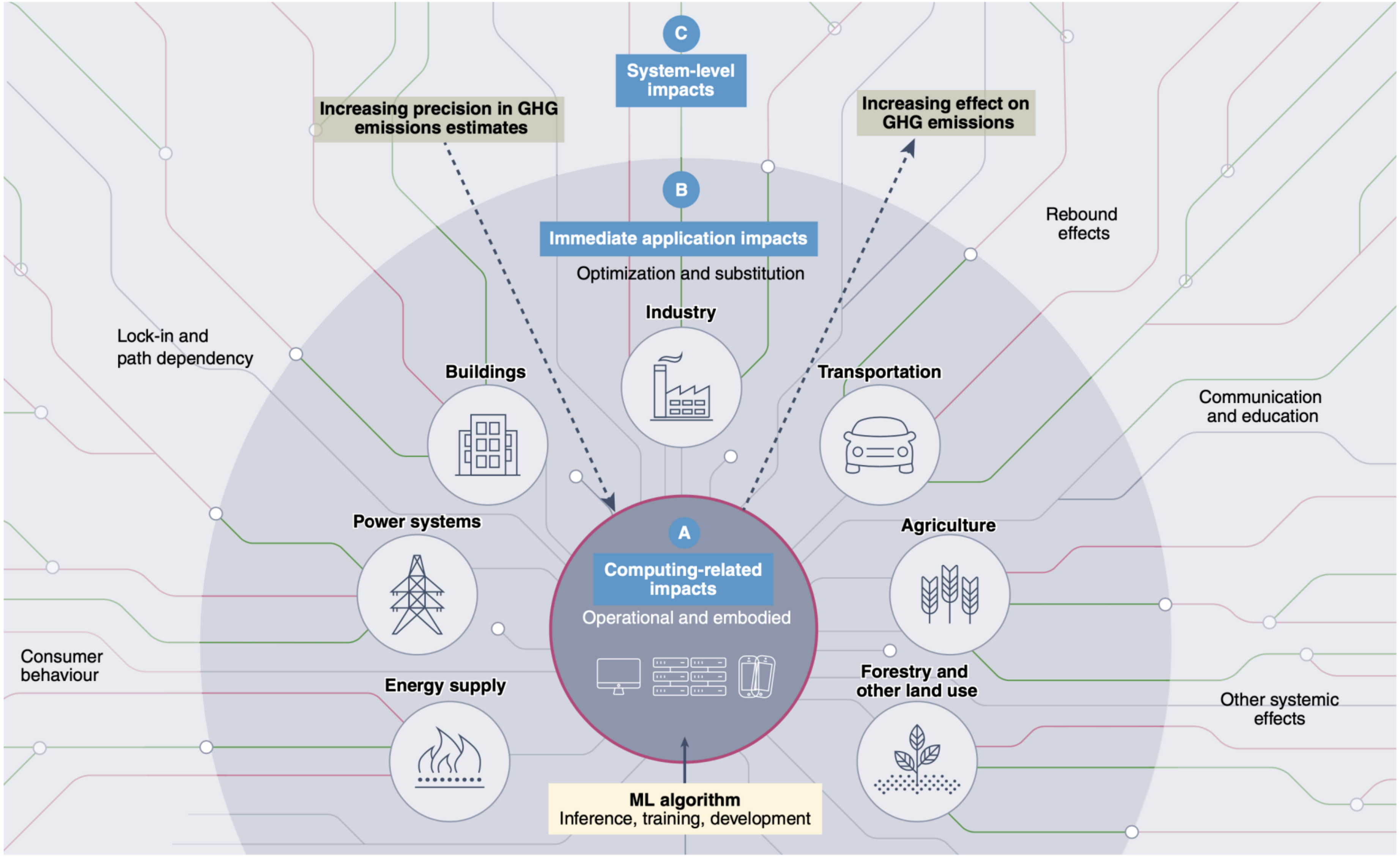
Applications and impacts



Kaack, L. H., Donti, P. L., Strubell, E., Kamiya, G., Creutzig, F., & Rolnick, D. (2022). Aligning artificial intelligence with climate change mitigation. *Nature Climate Change*, 1-10.

Carbon footprint of machine learning



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