Diving into SustAInability

Date : 26th August 2023 | Speaker : Ayon Roy

Event : AI Catalyst Party by MLSA MIET | Venue : Microsoft Gurgaon, India

Visit - https://ayon-roy.netlify.app

Hello **World!**

I am **Ayon Roy**

Executive Data Scientist @ NielsenIQ

Z by HP Global Data Science Ambassador

Mentored/Judged **100+** Hackathons

Delivered **70+** Technical Talks

Brought **Kaggle Days Meetup** Community in India for the 1st time

If you haven't heard about me yet, you might have been living under the rocks. Wake up !!

Agenda

- Evolution of AI & its approaches
- The necessity for doing AI sustainably
- Brief about United Nations SDGs [Sustainable Development Goals]
- Exploring ways to use AI for achieving SDGs
- How can you approach **SustAInability**

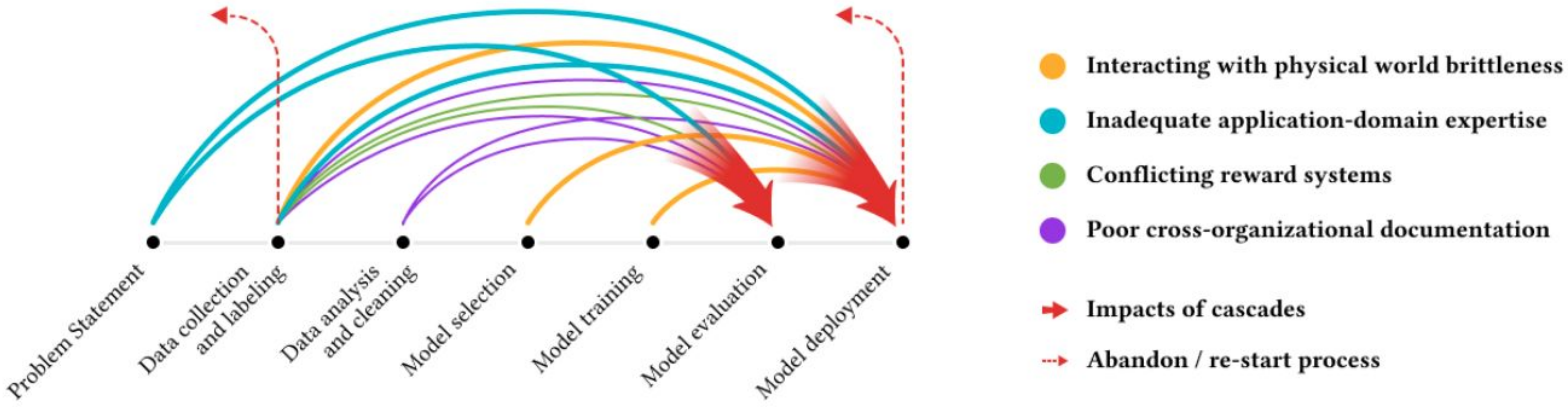
AI Systems

Artificial Intelligence Systems are projects which are undertaken with the long-term goal of simulating the human brain in real time, complete with artificial consciousness and artificial general intelligence.

How do we simulate the human brain in real time & bring artificial consciousness ?

Data + Model (Algorithms) + Compute

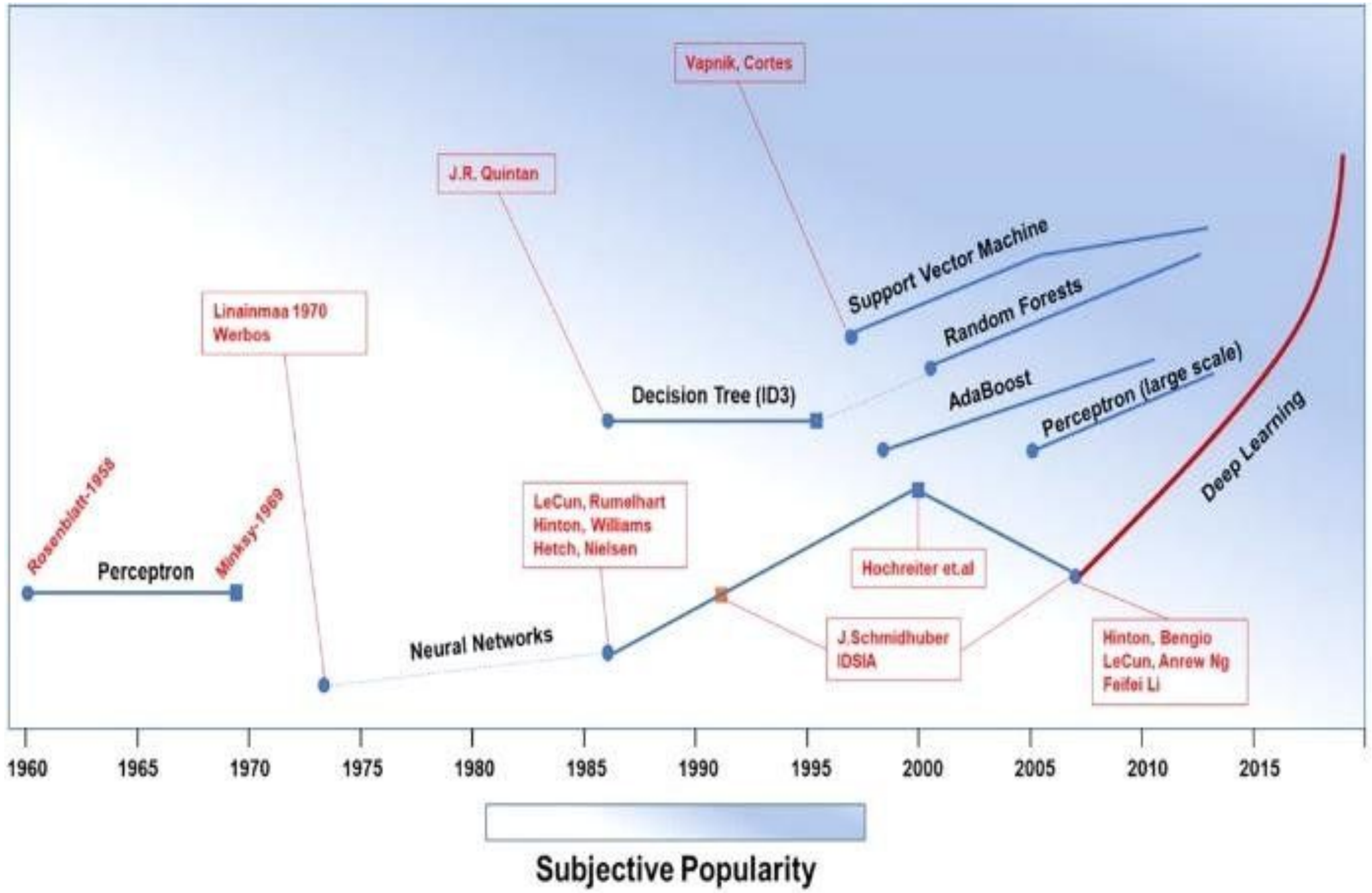
Stages to build AI Systems



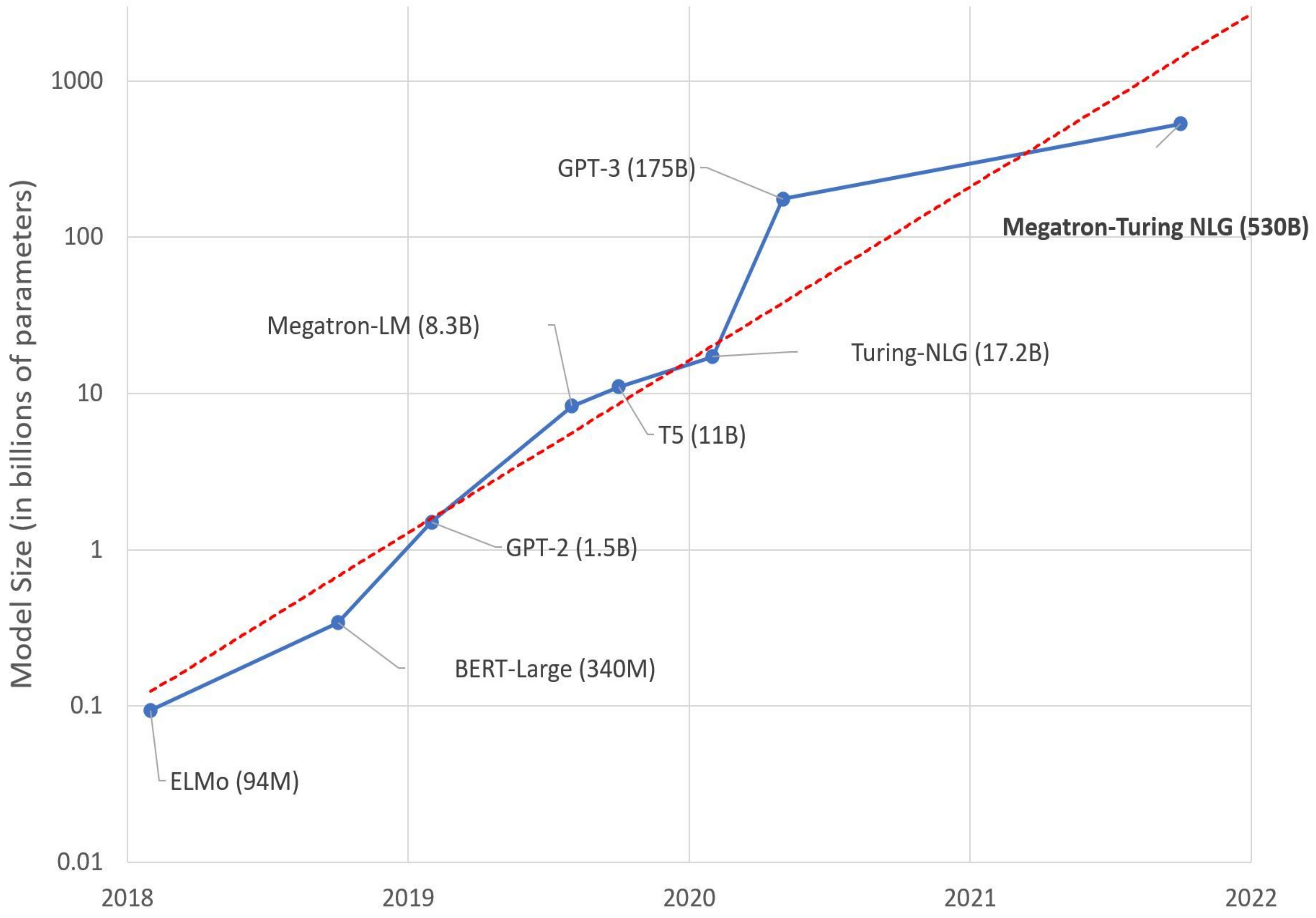
“Everyone wants to do the model work, not the data work” : Data Cascades in High-Stakes AI

https://storage.googleapis.com/pub-tools-public-publication-data/pdf/0d556e45afc54afeb2eb6b51a9bc1827b9961ff4.pdf

Evolution of AI



https://www.researchgate.net/publication/349864030_Review_of_machine_learning_and_deep_learning_application_in_mine_microseismic_event_classification



https://huggingface.co/blog/large-language-models

Visit - https://ayon-roy.netlify.app

Understanding growth in AI’s support system

AI is driven by 3 primary factors - Data, Model (Algorithms) & Compute

While model development have taken the spotlight for a few years now & have transformed the way AI advancements are happening with significant improvements in efficiency.

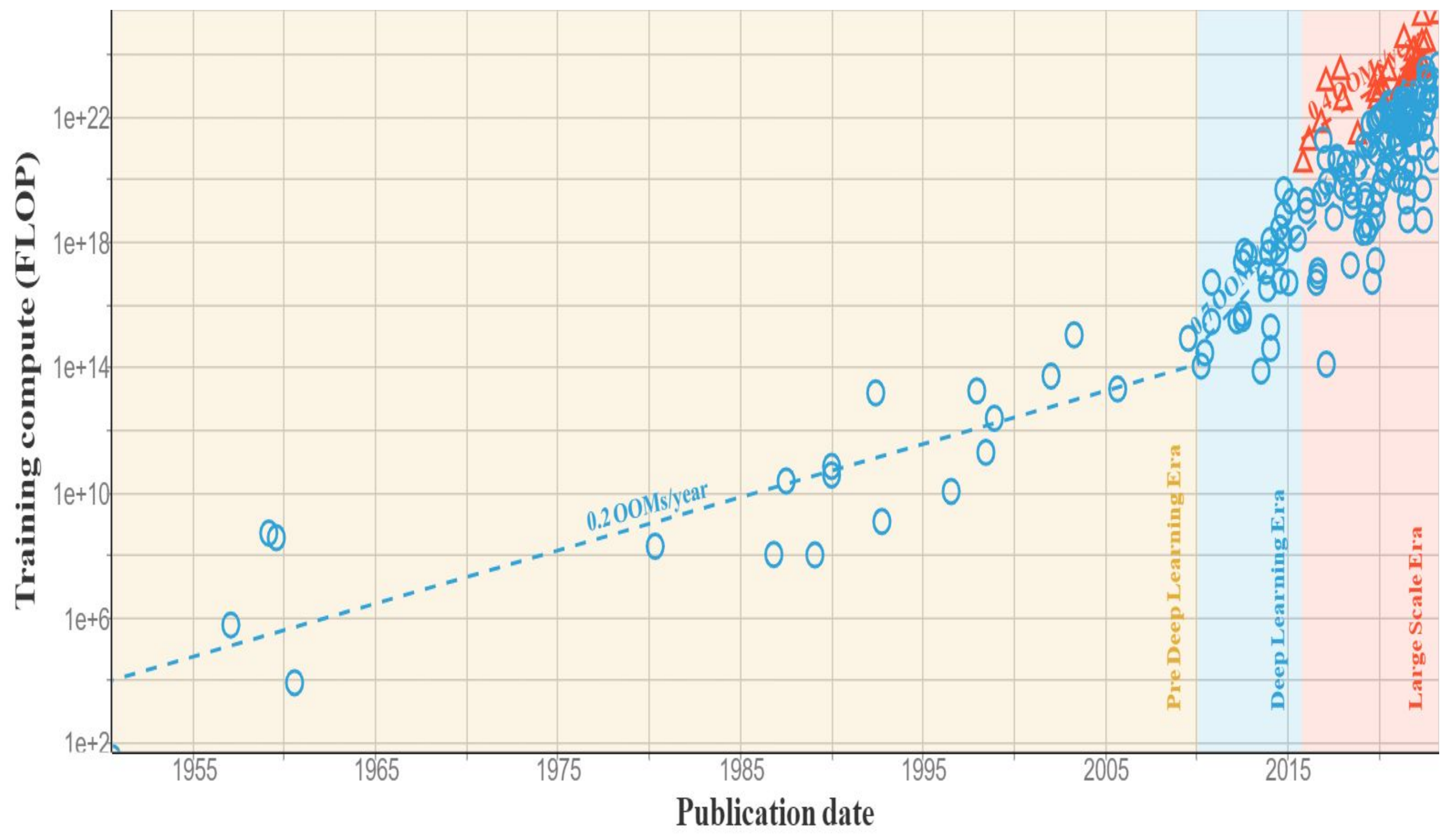
Data has been becoming increasingly available, particularly with the advent of **“big data”** in recent years.

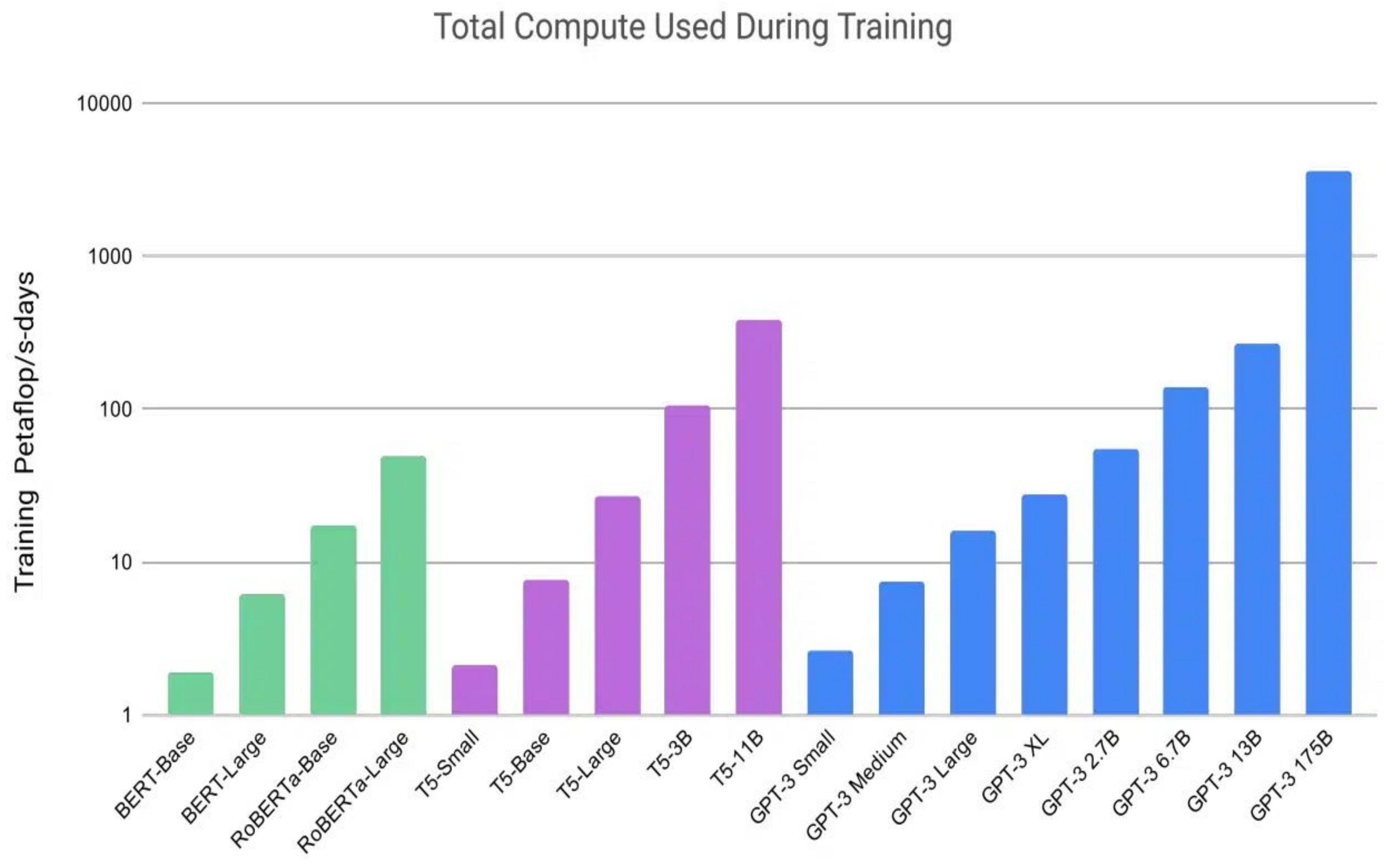
At the same time, progress in computing hardware has been rapid, with increasingly powerful and specialised AI hardware.

What is less obvious is the *relative* importance of these factors, and what this implies for the future of AI. A paper on “Scaling Laws for Neural Language Models” Kaplan *et al.* (2020) studied these developments through the lens of **scaling laws**, identifying three key variables:

- Number of parameters of a machine learning model
- Training dataset size
- Compute required for the final training run of a machine learning model (henceforth referred to as **training compute**)

Growth in Computing power requirement





https://epochai.org/blog/compute-trends

https://blogs.nvidia.com/blog/2022/10/10/llms-ai-horizon/

Visit - https://ayon-roy.netlify.app

Growth in Data usage

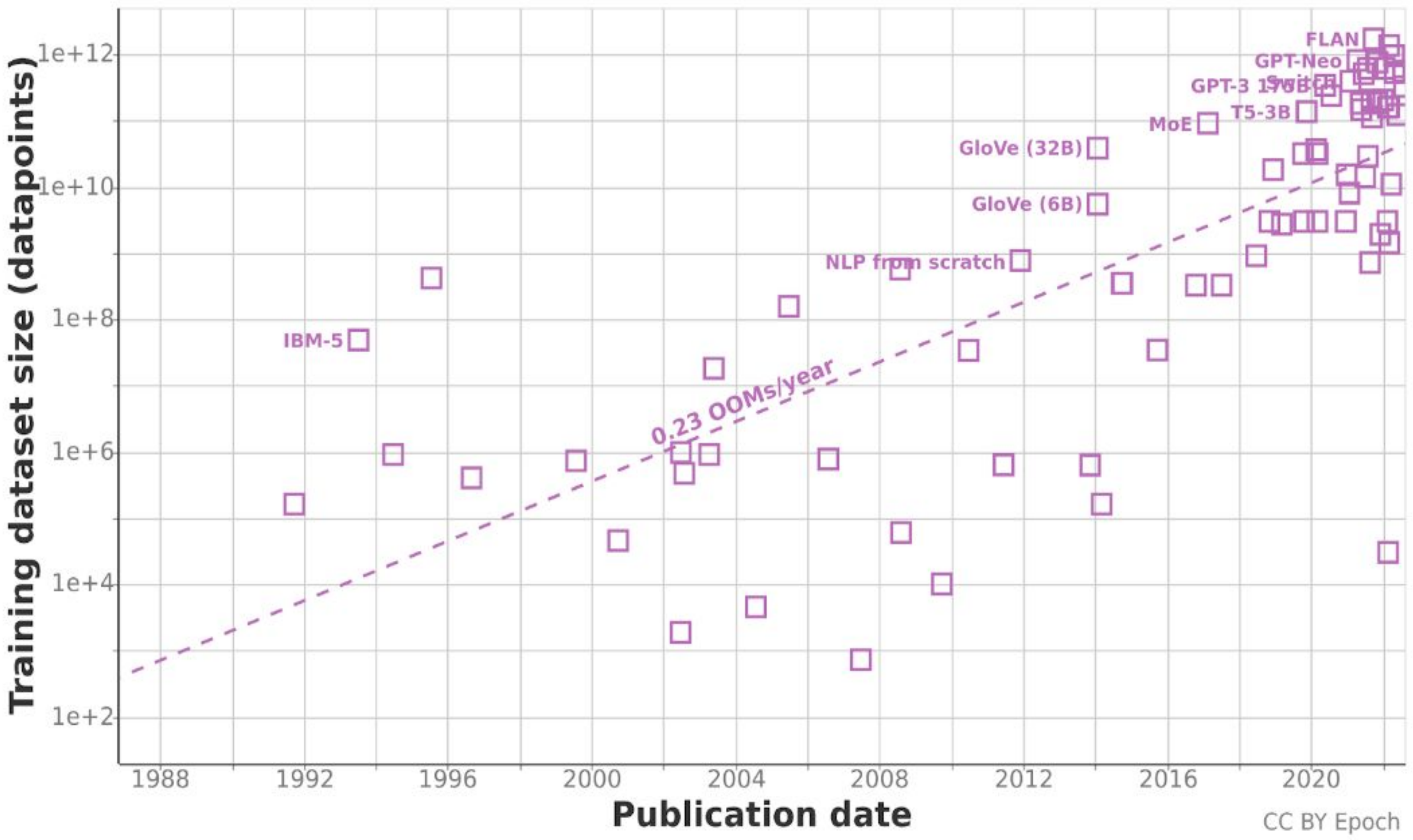


Figure 3: Evolution of language datasets

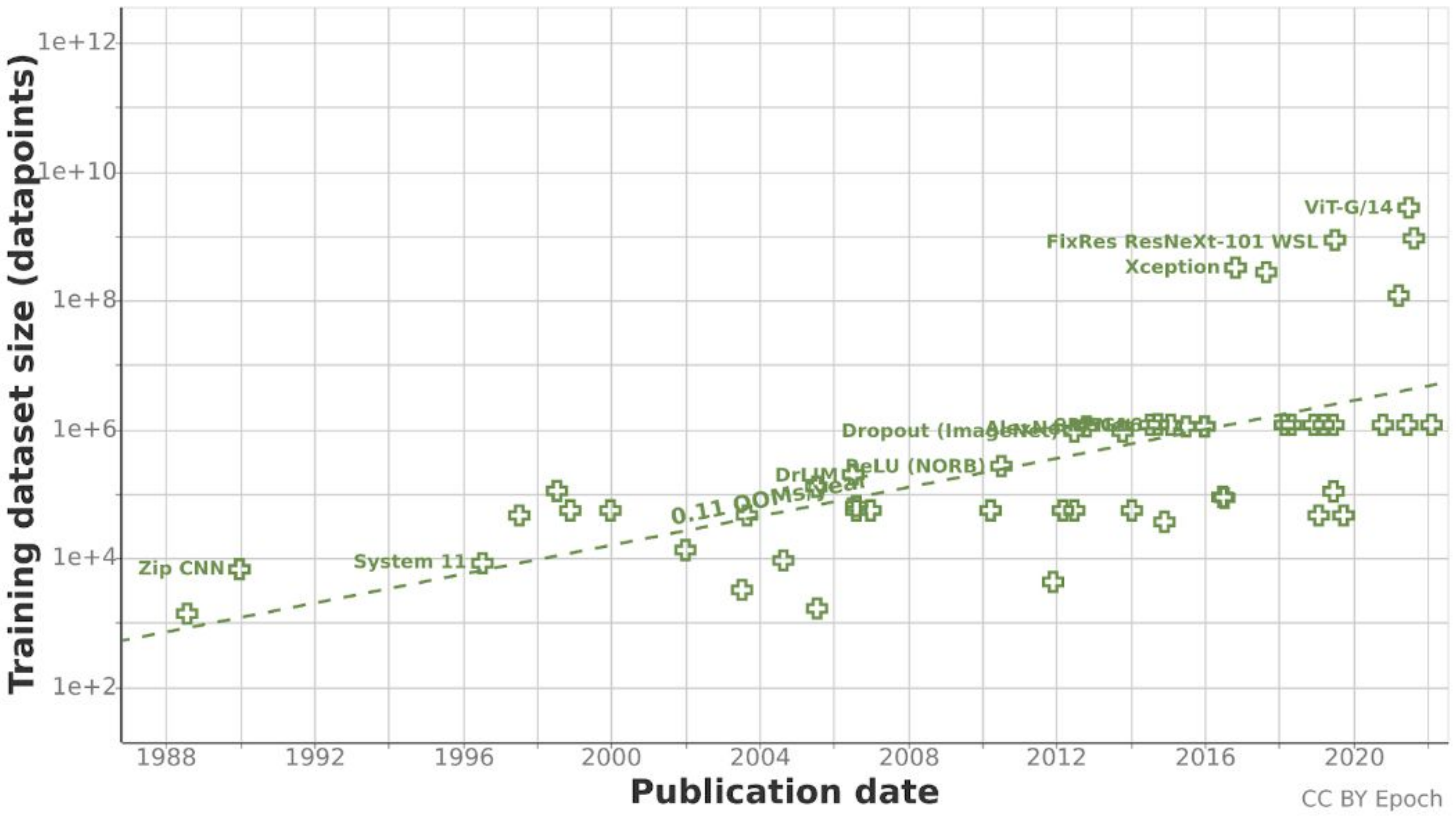
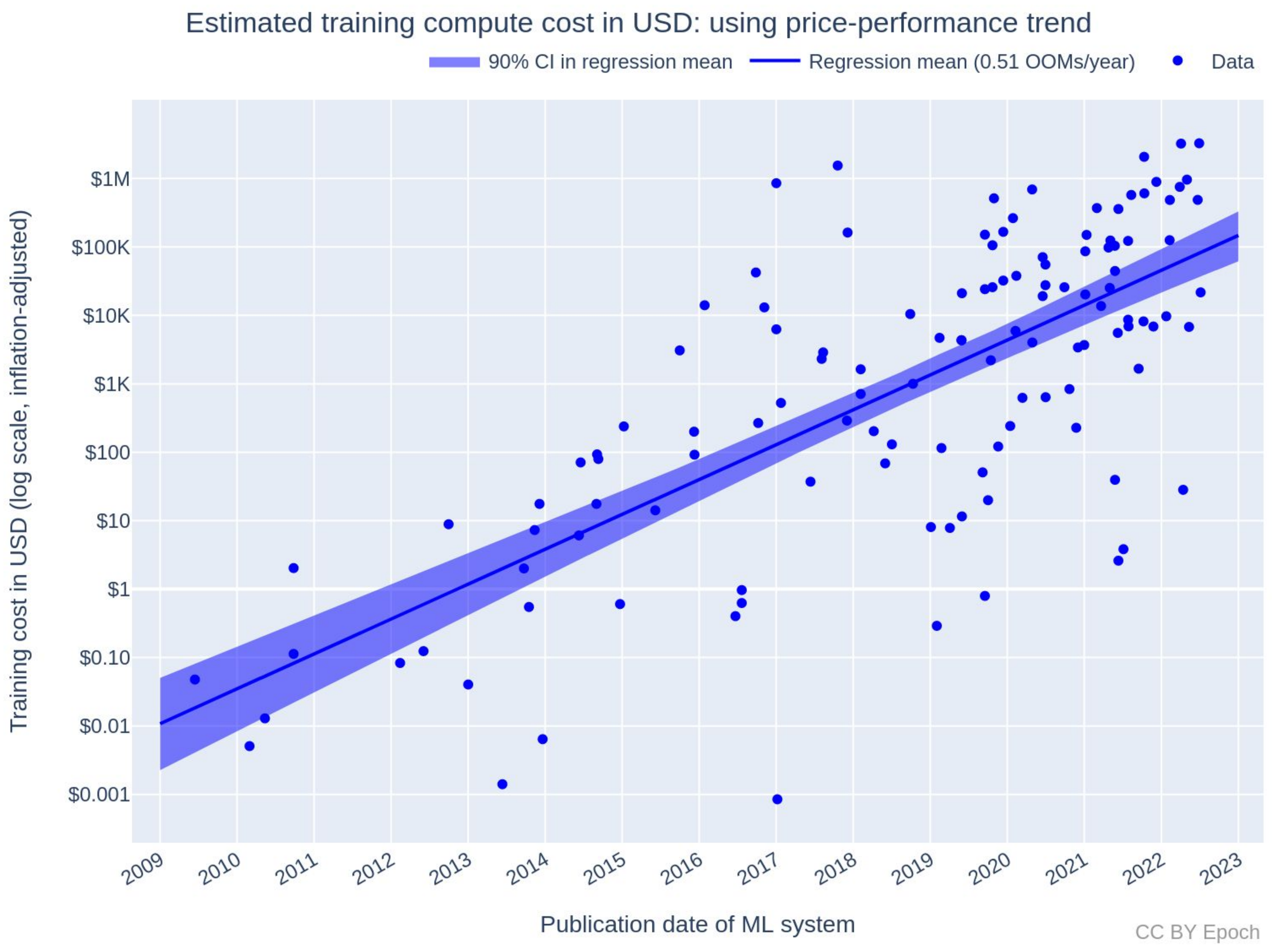


Figure 2: Evolution of vision datasets. A significant number of models is concentrated near 6e4 and 1e6, which are the sizes of MNIST and ImageNet, respectively.

https://epochai.org/blog/trends-in-training-dataset-sizes

Growth in Compute cost ($)



https://epochai.org/blog/trends-in-the-dollar-training-cost-of-machine-learning-systems

Visit - https://ayon-roy.netlify.app

Major approaches used while doing AI

Model Centric & Data Centric Approach

Model-Centric Approach

This involves designing empirical tests around the model to improve the performance. This consists of finding the right model architecture and training procedure among a huge space of possibilities.

Data-centric approach

This consists of systematically changing/enhancing the datasets to improve the accuracy of your AI system. This is usually overlooked and data collection is treated as a one off task.

https://towardsdatascience.com/from-model-centric-to-data-centric-artificial-intelligence-77e423f3f593#:~:text=Data%2Dcentric%20approach,as%20a%20one%20off%20task

Community's Bias towards Model Centric Approach

The steel sheets defect detection was one of the examples brought during the session — assuming a series of images from steel sheets we want to develop the best model to detect these defects that can happen during the process of steel sheets manufacturing. There are 39 different defects that we want to be able to identify. By developing a computer vision model with well-tuned hyperparameters, it was able to reach a **76.2% accuracy baseline system**, but the goal is to achieve **90% accuracy**. *How can this be done*?

Steel Sheets Detection Challenge

https://www.youtube.com/watch?v=06-AZXmwHjo&t=148s

Difference in Results

Knowing that the baseline model was already good, the task to have it improved to achieve 90% accuracy sound almost impossible — for the model-centric, the improvements based on Network Architecture search and using the state-of-the-art architectures, whereas, for the data-driven, the approach taken was to identify inconsistencies and clean noisy labels. The results were mind-blowing:

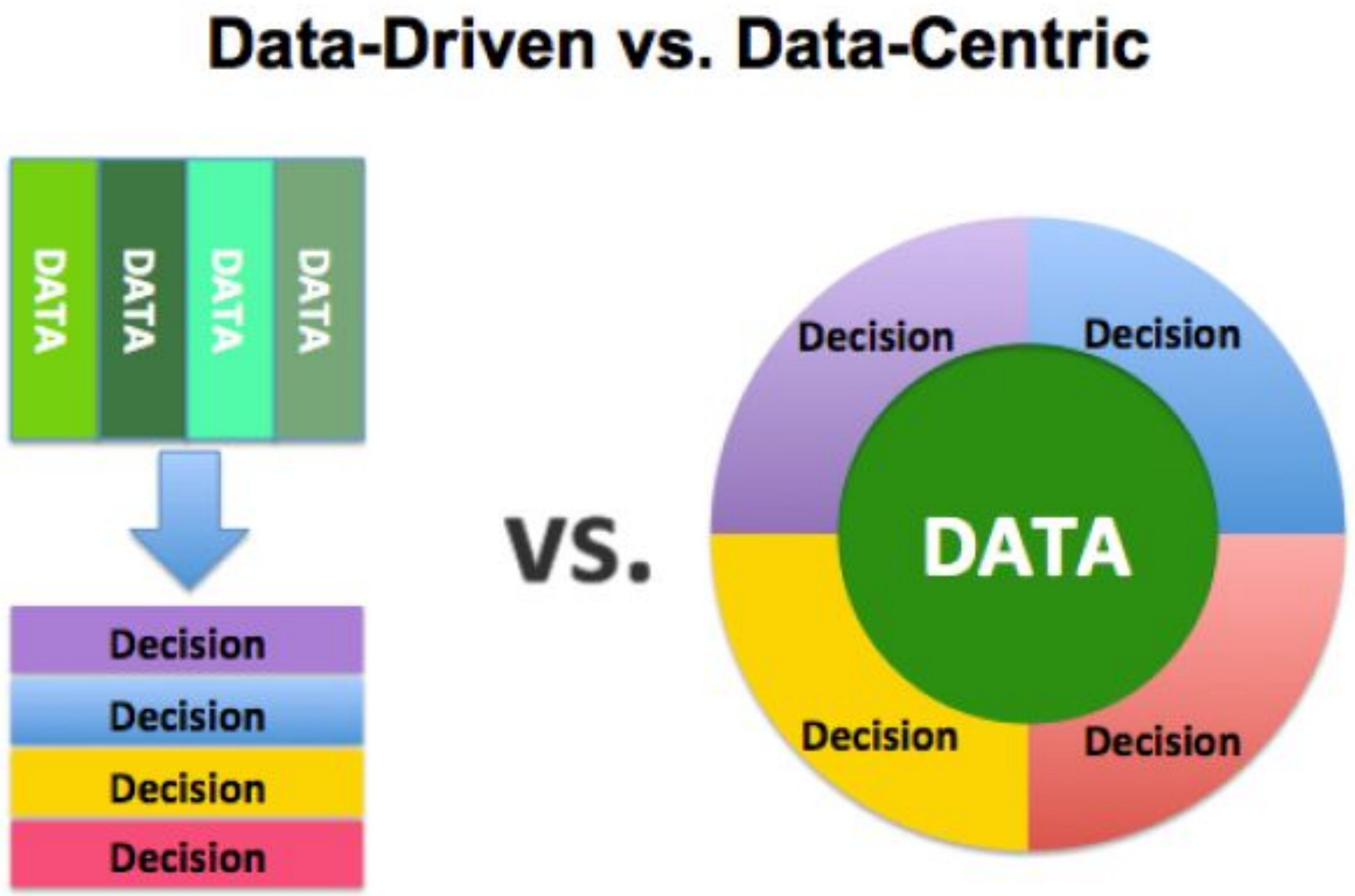
Steel sheets defects detection	**Baseline**	**Model-centric**	**Data-centric**
Accuracy	76.2%	+0% (76.2%)	+16.9% (93.1%)

Importance of Data Centric Approaches

	Steel defect detection	Solar panel	Surface inspection
Baseline	76.2%	75.68%	85.05%
Model-centric	+0% (76.2%)	+0.04% (75.72%)	+0.00% (85.05%)
Data-centric	+16.9% (93.1%)	+3.06% (78.74%)	+0.4% (85.45%)

https://www.youtube.com/watch?v=06-AZXmwHjo&t=324s

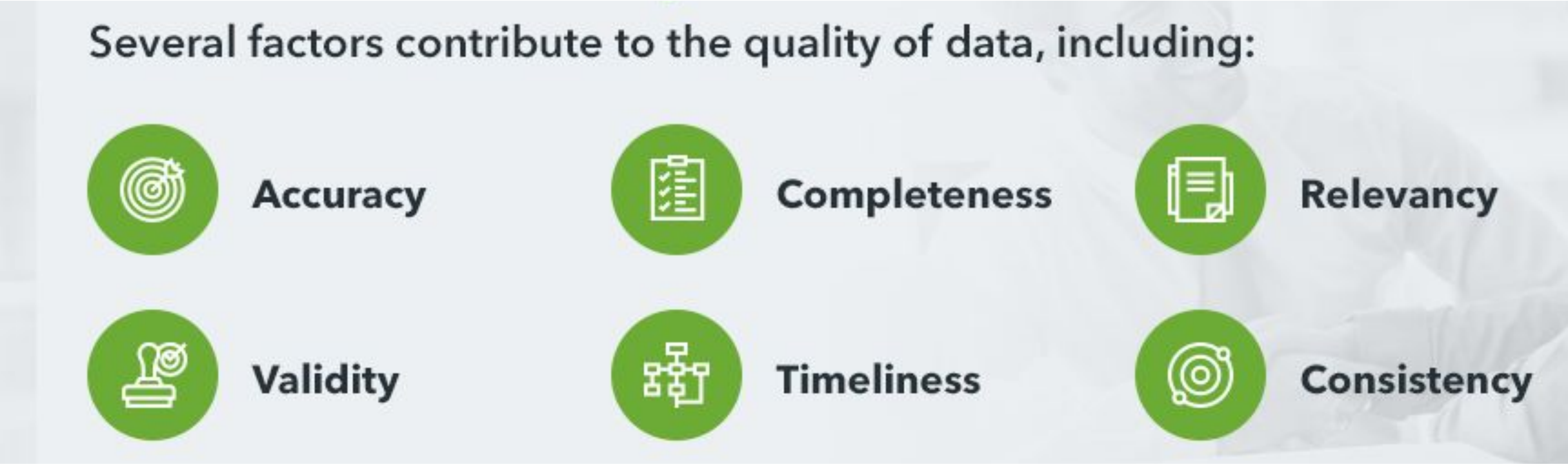
Beware of the Trade Off



https://neptune.ai/blog/data-centric-vs-model-centric-machine-learning

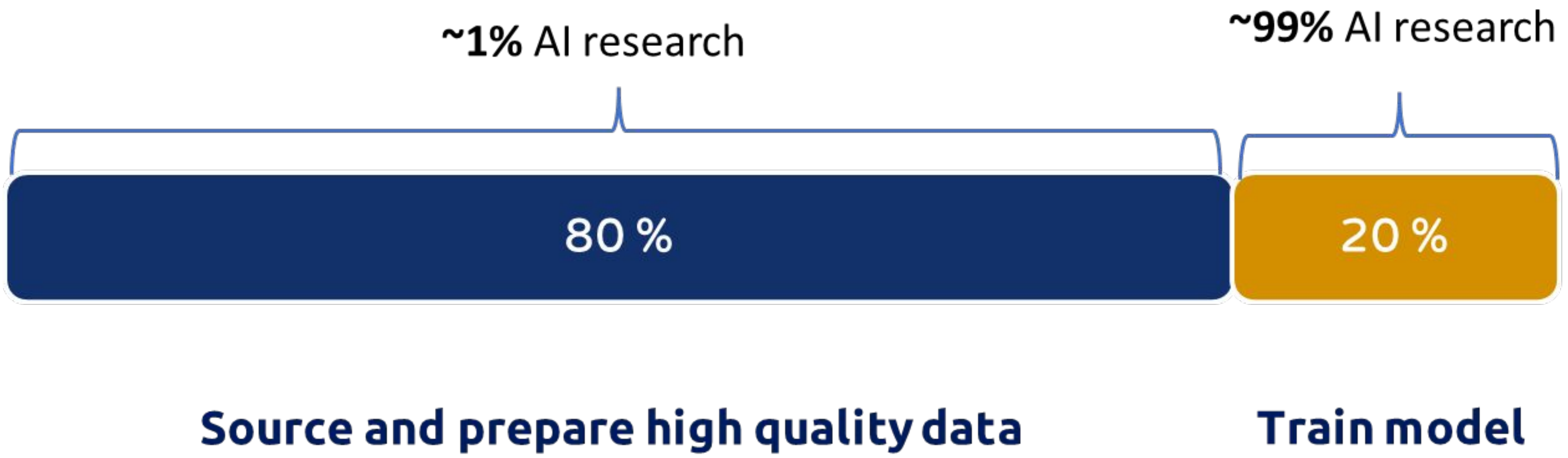
But..

Check for Data Quality



https://www.lotame.com/why-is-data-quality-important/

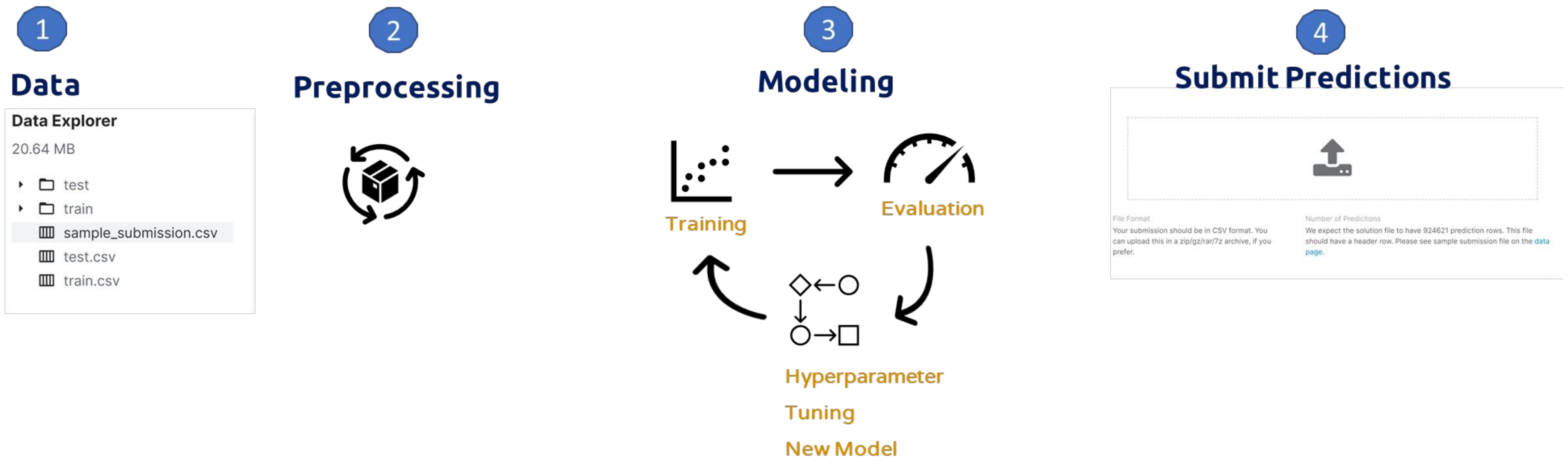
Need for Data Centric Approaches



https://www.youtube.com/watch?v=06-AZXmwHjo&t=1835s

Model Centric AI Approaches in Kaggle Competitions

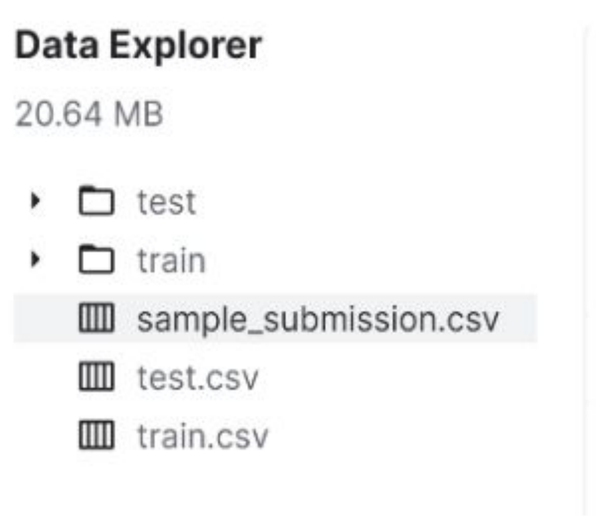
Model Centric AI



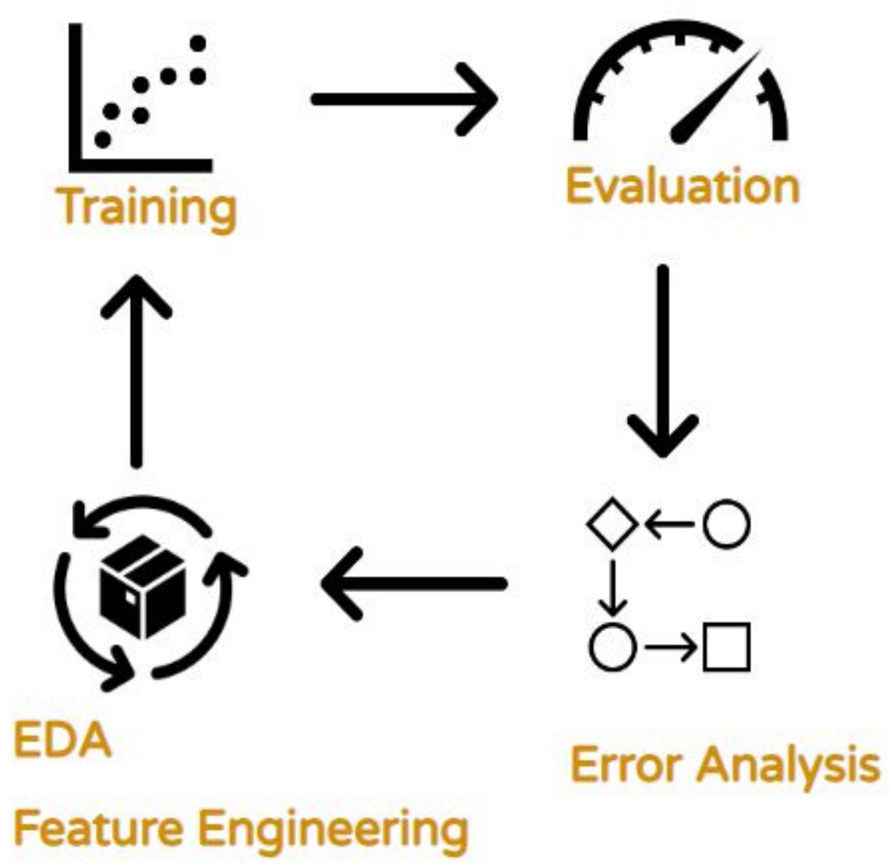
Data Centric AI Approaches in Kaggle Competitions

Data Centric AI

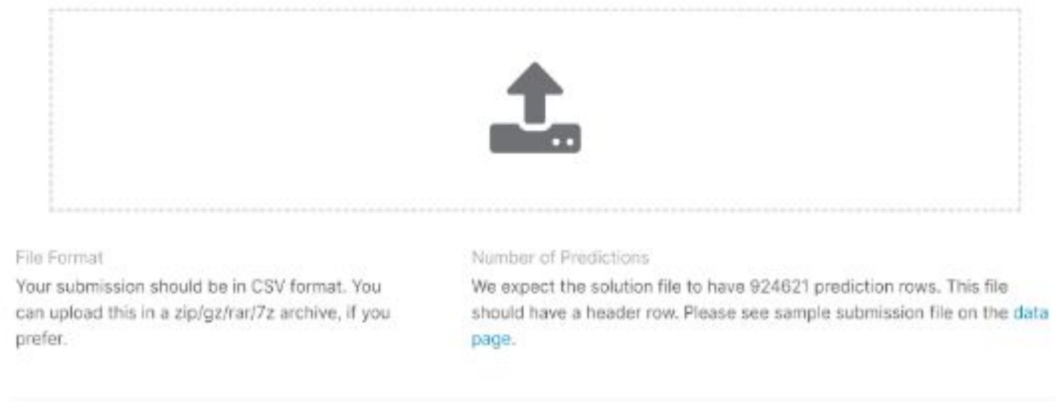
Data



Modeling

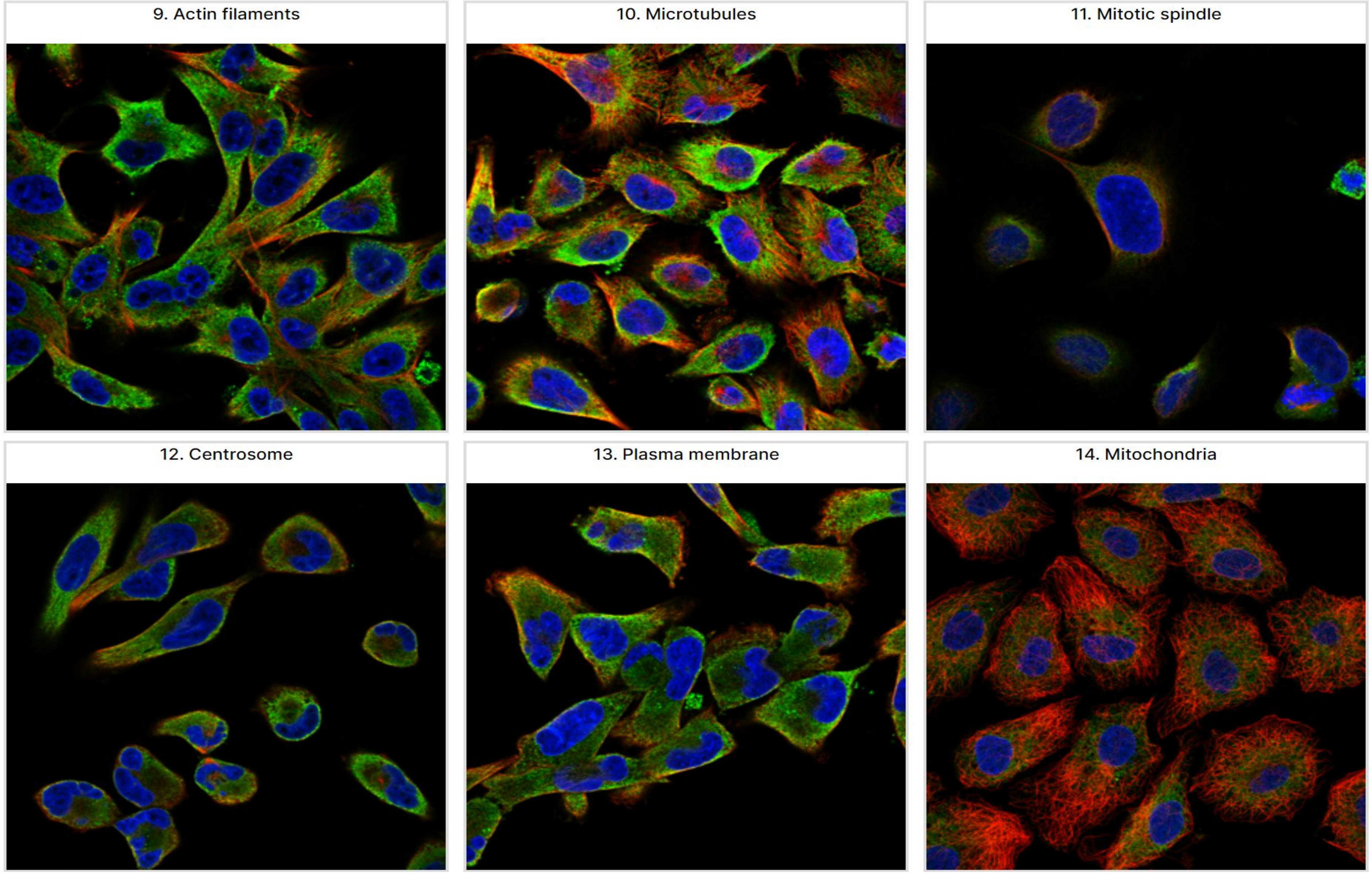


Submit Predictions



Human Protein Atlas – Single Cell Classification
[Kaggle Competition]

Data



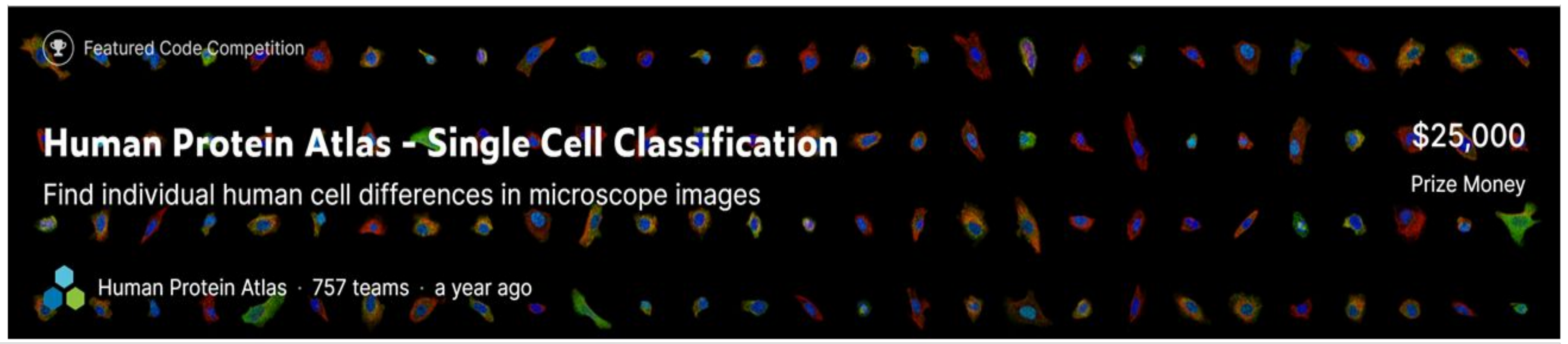
Task

Segment the cells in the images
and predict the labels of those segmented cells

Challenge

The labels you will get for training are *Image* level
labels while the task is to predict *cell* level labels

Kaggle Competition Solution Approach



#	△	Team	Members	Score	Entries	Last	Code
1	▲ 4	bestfitting		0.56670	480	1y	
2	—	[red.ai]		0.55328	459	1y	<>
3	—	MPWARE & ZFTurbo & Dieter		0.54995	500	1y	<>
4	▲ 2	MILIMED		0.54389	258	1y	

CroDoc
Topic Author
4th place

4th Place Solution: MILIMED

Posted in hpa-single-cell-image-classification a year ago

15

We are a very diverse team of computer scientists and medical doctor/students. It was our great pleasure to participate in this demanding challenge. Hope some of you find this solution useful and/or interesting.

Solution overview

1. Segmentation → HPA-Cell-Segmentation
2. Dataset → 512×512 cell images (20% removed)
3. Parallelization → speed-up → 3h left for inference
4. Manual Labeling → smaller classes & validation (soft labels)
5. Pseudo-Labeling → negative labeling (& positive for mitotic spindle)
6. EfficientNetB0 Ensemble + semi-balanced data sampling
7. Fine-tuning → on manually labeled & non-labeled validation data
8. Cell/Image Weighting → final confidence = 0.7 * cell_confidence + 0.3 * image_confidence

Use of Data effectively for AI, ML

Our projections predict that we will have exhausted the stock of low-quality language data by 2030 to 2050, high-quality language data before 2026, and vision data by 2030 to 2060. This might slow down ML progress.

All of our conclusions rely on the unrealistic assumptions that current trends in ML data usage and production will continue and that there will be no major innovations in data efficiency. Relaxing these and other assumptions would be promising future work.

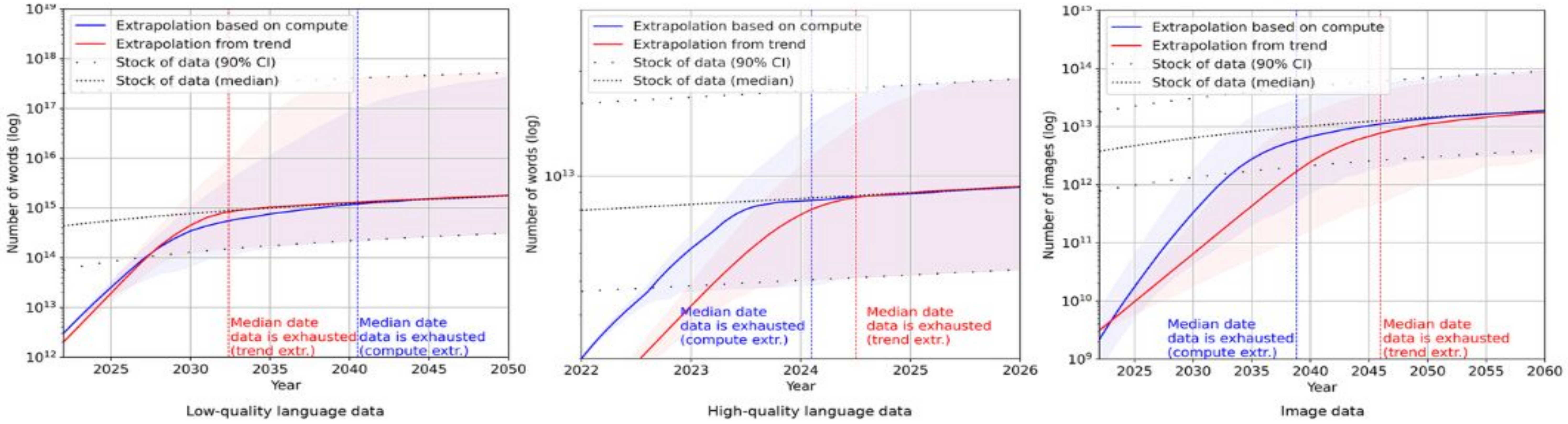
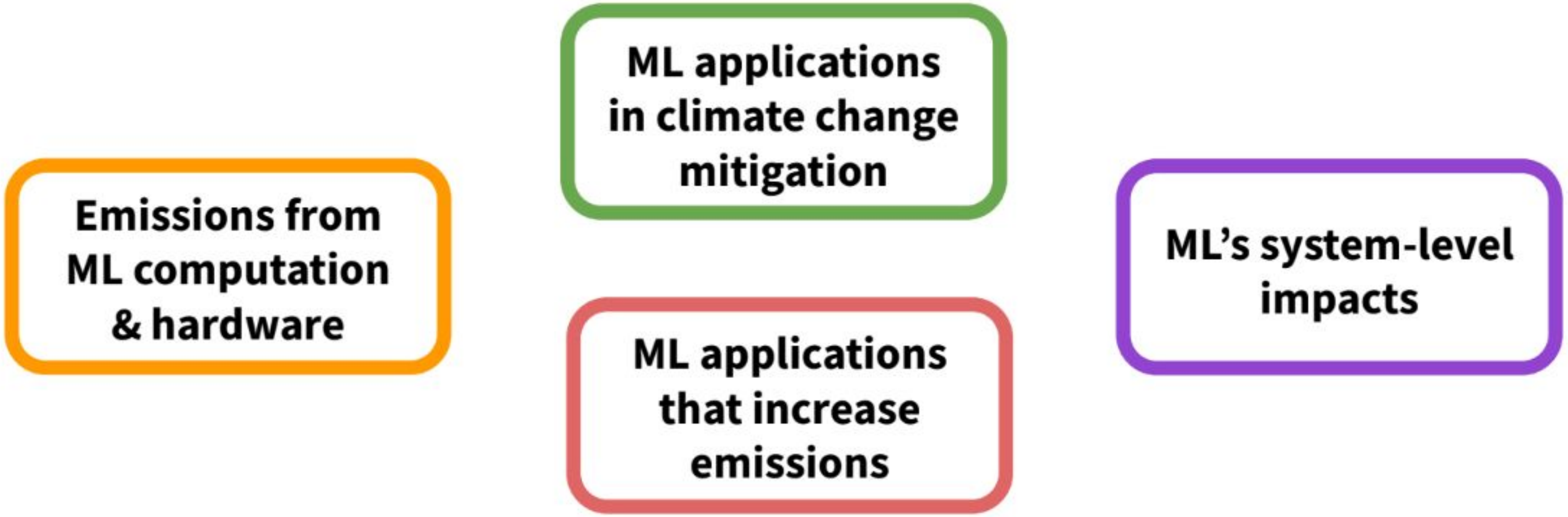


Figure 1: ML data consumption and data production trends for low quality text, high quality text and images.

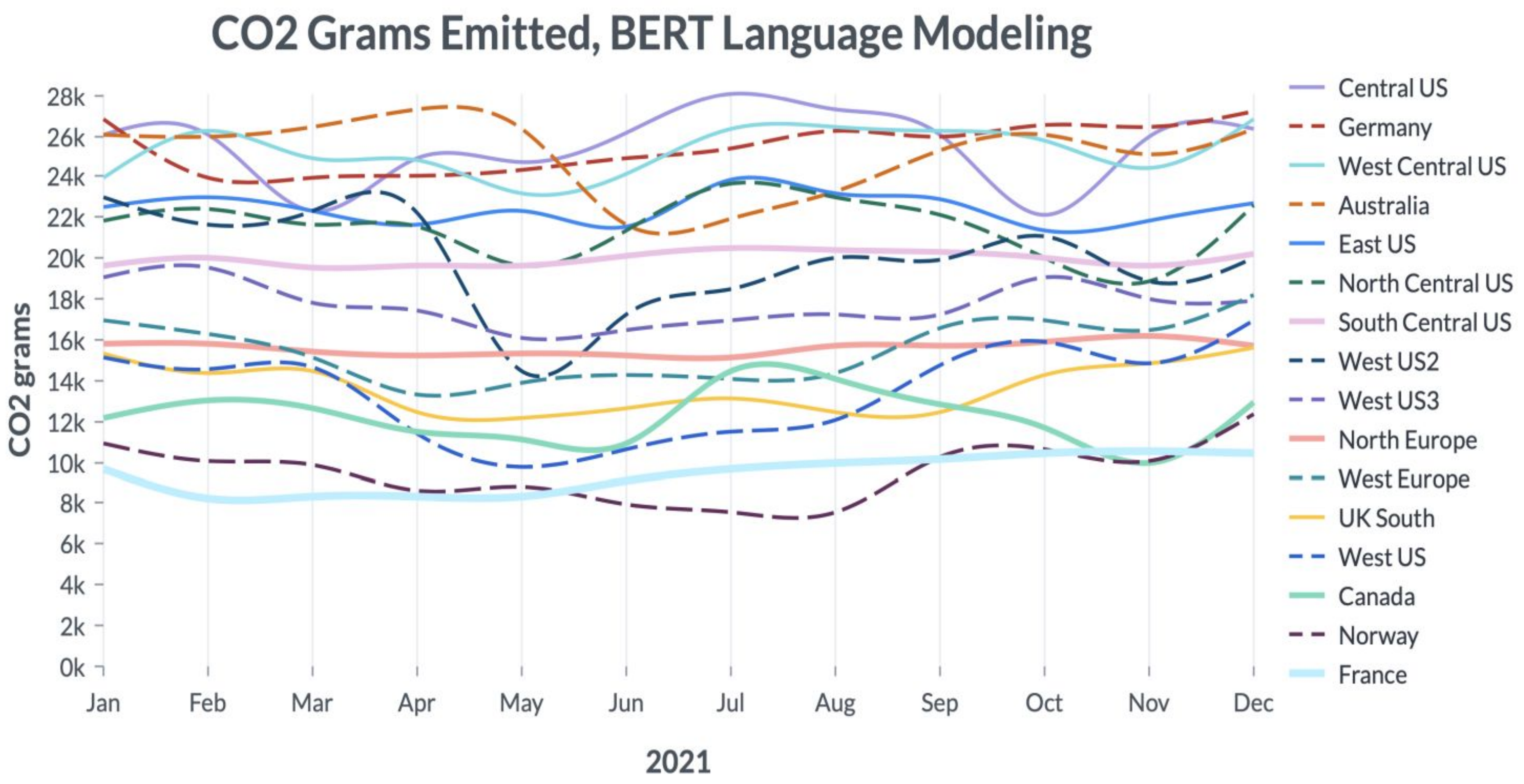
https://epochai.org/blog/will-we-run-out-of-ml-data-evidence-from-projecting-dataset

Visit - https://ayon-roy.netlify.app

AI-ML Carbon Footprint

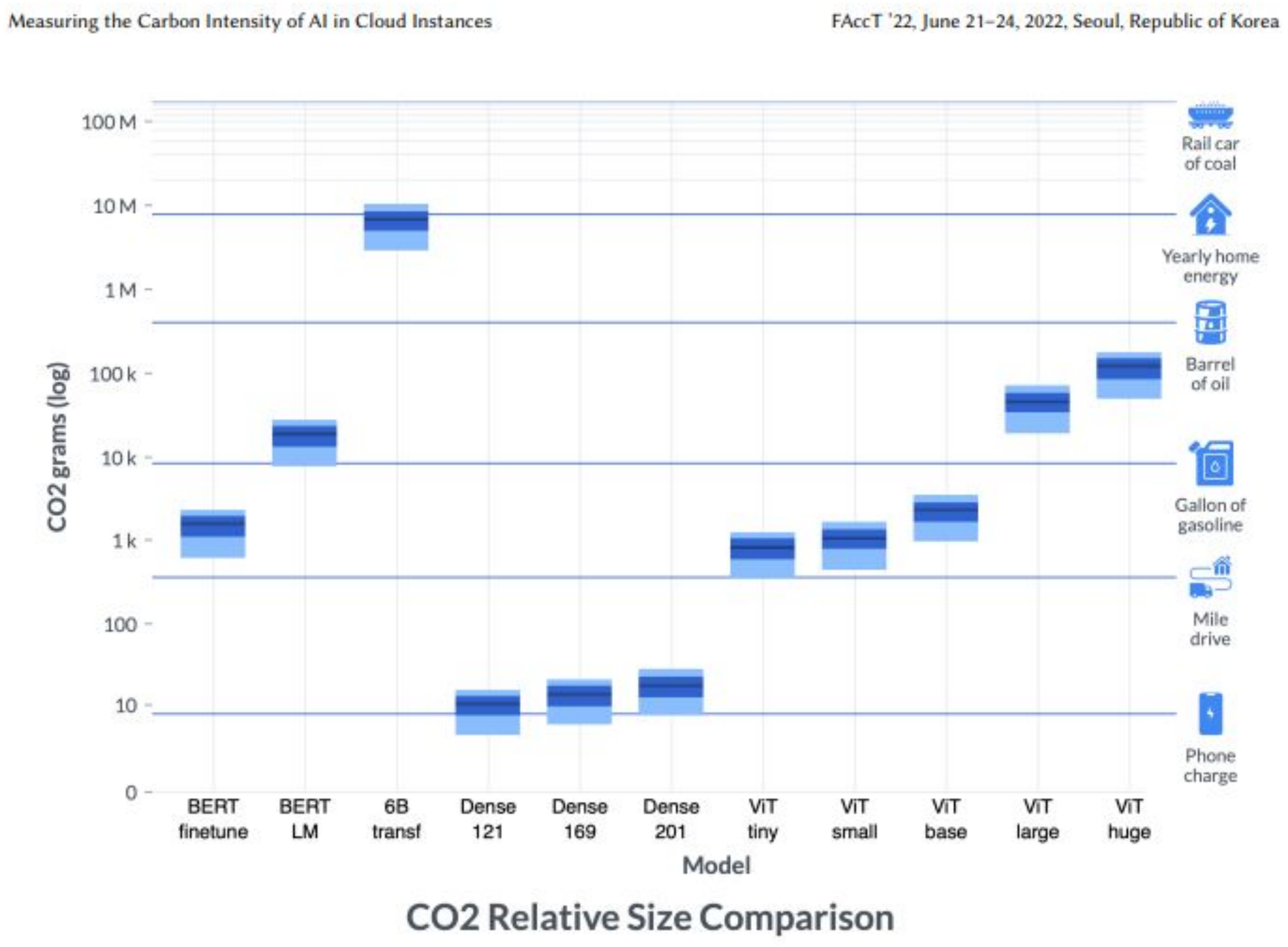


Emissions from AI Cloud Instances



Measuring the Carbon Intensity of AI in Cloud Instances : https://arxiv.org/pdf/2206.05229.pdf

Emissions from AI Cloud Instances



Measuring the Carbon Intensity of AI in Cloud Instances : https://arxiv.org/pdf/2206.05229.pdf

Emissions for the research paper's 11 experiments. For each model they show a vertical blue bar, where the top of the bar is the max, the bottom is the min, and the black line represents the average emissions (across regions and time of year).

First and fourth quartiles are represented by the light blue at the top and bottom of each vertical blue bar. The largest training runs (e.g., 6 billion parameter LM) releases a significant amount of emissions, no matter the region (and recall the 6 billion parameter LM is only trained for 13% of a full run, so a full run would emit about an order of magnitude more emissions than reported here).

The smallest experiments emit very little. Presented on a log scale, with references on the right indicating equivalent sources of emissions per the United States Environmental Protection Agency.

Necessity for exploring SustAInability

Approaching SustAInability as you build AI Systems

One consequence of this increase in computing is the heavy environmental impact of training machine learning models. A recent research paper — Energy and Policy Considerations for Deep Learning in NLP — notes that an inefficiently trained NLP model using Neural Architecture Search can emit **more than 626,000 pounds of CO_2.** That's about **five times the lifetime emissions of an average American car!**

https://wandb.ai/amanarora/codecarbon/reports/Tracking-CO2-Emissions-of-Your-Deep-Learning-Models-with-CodeCarbon-and-Weights-Biases--VmlldzoxMzM1NDg3

Comparison of Certain NLP Models

Model	Hardware	Power (W)	Hours	kWh·PUE	CO_2e	Cloud compute cost
$\text{Transformer}_{base}$	P100x8	1415.78	12	27	26	$41–$140
Transformer_{big}	P100x8	1515.43	84	201	192	$289–$981
ELMo	P100x3	517.66	336	275	262	$433–$1472
BERT_{base}	V100x64	12,041.51	79	1507	1438	$3751–$12,571
BERT_{base}	TPUv2x16	—	96	—	—	$2074–$6912
NAS	P100x8	1515.43	274,120	656,347	626,155	$942,973–$3,201,722
NAS	TPUv2x1	—	32,623	—	—	$44,055–$146,848
GPT-2	TPUv3x32	—	168	—	—	$12,902–$43,008

Table 3: Estimated cost of training a model in terms of CO_2 emissions (lbs) and cloud compute cost (USD).[7] Power and carbon footprint are omitted for TPUs due to lack of public information on power draw for this hardware.

Relevant Research Paper : https://arxiv.org/pdf/1906.02243.pdf

SustAInable Development

UN Brundtland Commission in its report "Our Common Future", published in 1987 defines sustainable development as "**development that meets the needs of the present without compromising the ability of future generations to meet their own needs**.

It contains within it two key concepts:

- the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given;
- the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

In order to achieve this **sustainable development**, objectives are necessary. This is why the United Nations General Assembly defined in 2015 the 17 Sustainable Development Goals (SDGs), adopted by all member countries, to be achieved by 2030.

https://www.un.org/sustainabledevelopment/blog/2015/12/sustainable-development-goals-kick-off-with-start-of-new-year/

SustAInable Future , is it ?

AI has the potential to assist in the achievement of each of the SDGs. This is illustrated by a study by the McKinsey Global Institute, which by November 2018 had identified as many as 135 cases of AI use worldwide that support the SDGs. [Whether concrete, partial or simply potential, these cases demonstrate real opportunities for AI applications]

The proposed hypothesis is that

> By becoming aware of the potential precariousness of the resources, room for maneuver and other properties intrinsic to the nature of the actor, the business and industry sector, nongovernmental organizations, the scientific and technological community, and local authorities, i.e. the State, are the actors best placed not only to impact generally on the progress towards the SDGs, but also to be the channels through which AI can most ideally, until then, impact beneficially on Sustainable Development and reach the SDGs.

- **In your own words, what solution did you actually build with ERP Air Force?**

"A full multi-sensor IoT monitoring ecosystem boosted by AI for reserve protection and anti-poaching measures."

- **Where and how was Artificial Intelligence involved, in more details?**

"The pieces where we've got AI involved are in the analytics of our camera-traps' photos, and in our license plates recognition, also leveraging OCR (Optical Character Recognition). And then, the biggest use of AI is in our photographs' stalls analytics [...] to look for humans."
We use a combination of OpenCV and Darknet YOLO."

- **How do you think your solution has a social impact and helps within our societies' Sustainable Development (Goals)?**

Goal 1 (No poverty); Goal 4 (Quality education); Goal 5 (Gender equality); Goal 8 (Decent work and economic growth); Goal 10 (Reduced inequalities); Goal 11 (Sustainable cities and communities); Goal 15 (Life on land); Goal 17 (Partnerships for the goals)

Economic participation opportunity: *"If we don't do something with ERP Air Force now, to conserve elephants and rhinos, there won't be economic participation opportunities for these communities in ten years' time. Nobody will want to go on safari if there's no animals. Bottom line. People go on safari, they believe in ecotourism, to see wonderful trees and forests and animals. We're certainly protecting the integrity of these opportunities for the next wave of people in probably ten years' time."*

Quality education: *"We kicked off a lot of programs, with especially schoolkids, on the back of the big ERP Air Force story. Science, technology, engineering, and math are a real problem here in terms of education in Africa. We invite students to see what we do, we show them how we fly the drones and we do demonstrations at high schools. And we've actually started sponsoring through one of our other ERP initiatives, "We Code" challenge, where there are smaller drones and we teach kids how to do basic coding and fly these drones. "*

Cultural heritage conservation: *"Those animals (elephants) have very significant religious value to different cultures in Africa. They have cultural value, they are part of people's folklore, they are part of people's learning, their songs, their dances. So if those elephants are gone, that is a huge part of Africa that's missing. "*

Use Case

A use case for SustAInable future

What do farmers want to know?

★ When to plant?
★ Crop performance
★ Potential threats to production (e.g. climate change)
★ Actual threats to production (e.g.,nearby pest/disease outbreak or weather forecasts)
★ Soil moisture, rainfall, temperature, etc.
★ Productivity potential (yield gap)
★ Suitability of crops (would a different crop or variety grow better?)

What do policymakers want to know?

★ Crop performance
★ Potential threats to production
★ Actual threats to production
★ When to intervene
★ How to intervene
★ Productivity potential
★ Suitability of crops
★ How suitability will change
★ Measure impacts of policies

2nd use case for SustAInable future

Satellite-Enabled Food Security Dashboard

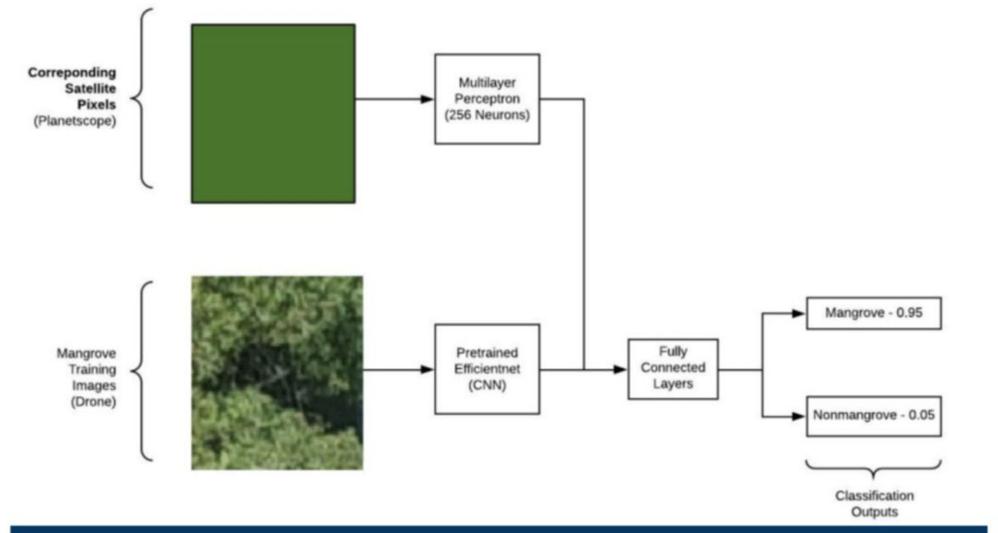
Goal : Create baseline geospatial datasets for measuring and monitoring agricultural production to support policy & efforts to improve food security

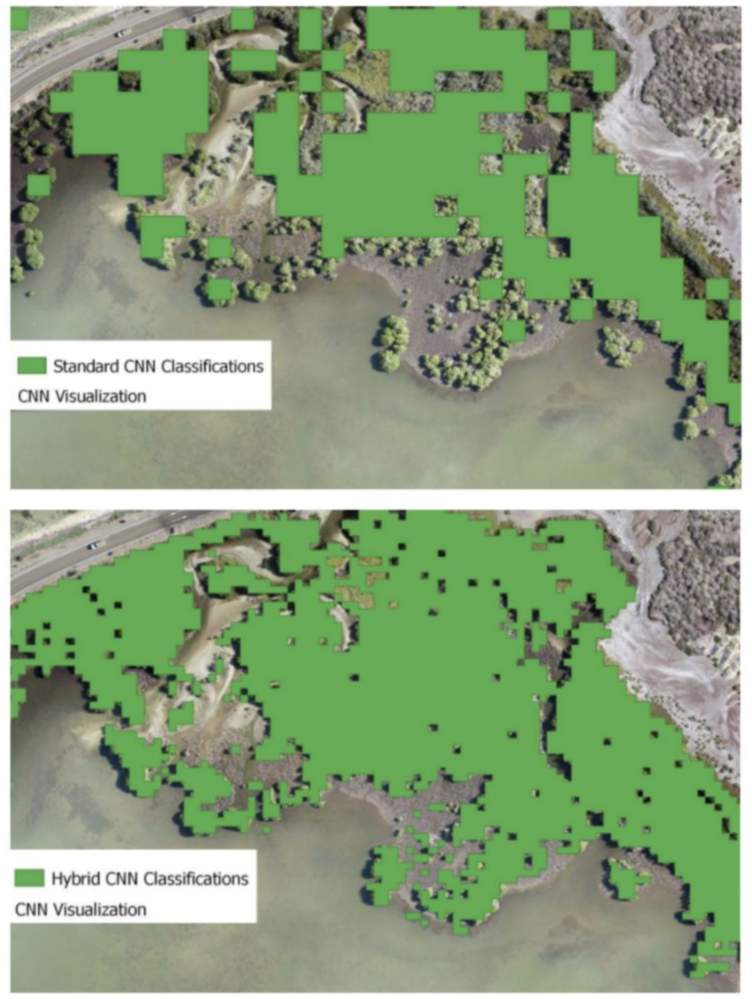
How?

- Train machine learning models to predict where crops growing based on Earth observation/satellite data
- Integrate crop maps with other relevant datasets (e.g., socioeconomic and price data)
- Make data available in a public Food Security Dashboard
- Collaborate with stakeholders to ensure products & Dashboard serve community decisions and actions
    - End users: Farmers, Dept of Ag, county council, community organizations, etc.
    - Develop of policies and practices that result in more equitable access to food for the residents
    - Boost agricultural production for food crops, including native crops

A few other use-cases

Mangrove classification

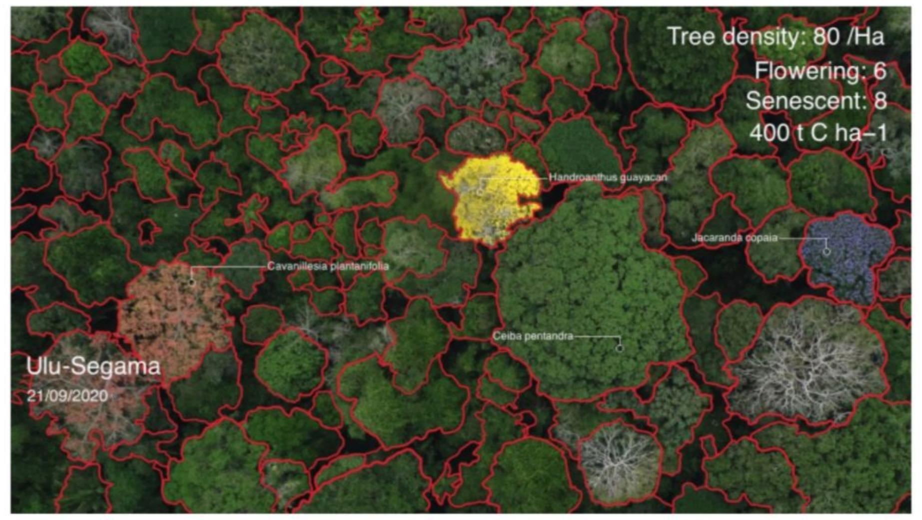


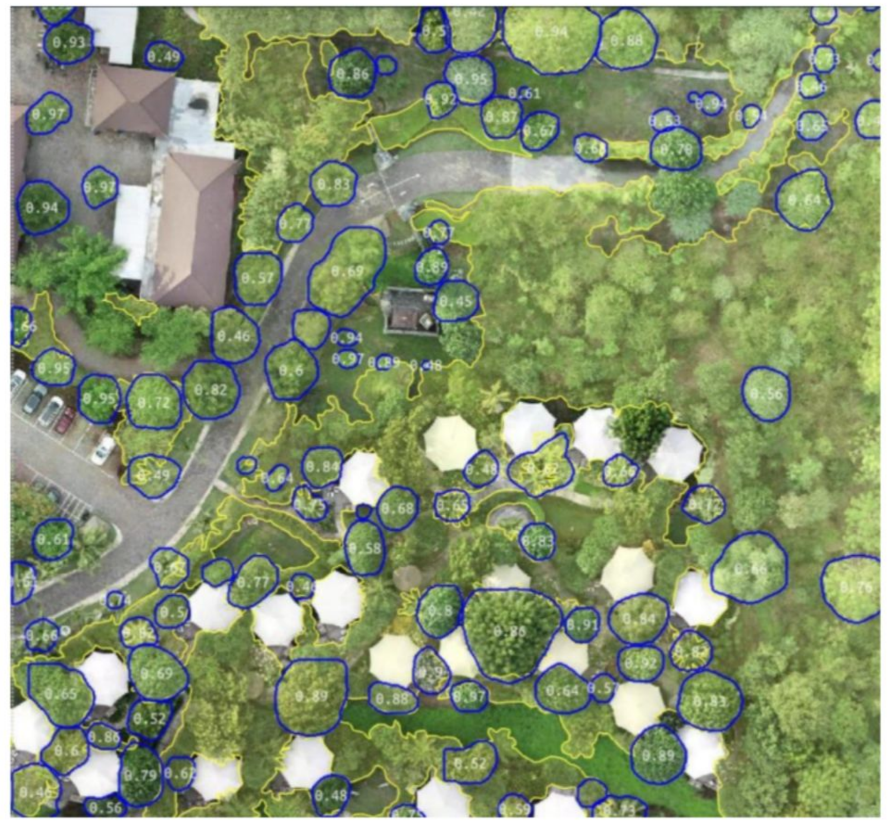


Fusing different data resolutions improves classification accuracy
Challenges: Labeled Data

Mangrove Ecosystem Detection using Mixed-Resolution Imagery with a Hybrid-Convolutional Neural Network
Hicks *et al.*, CCAI ICML20

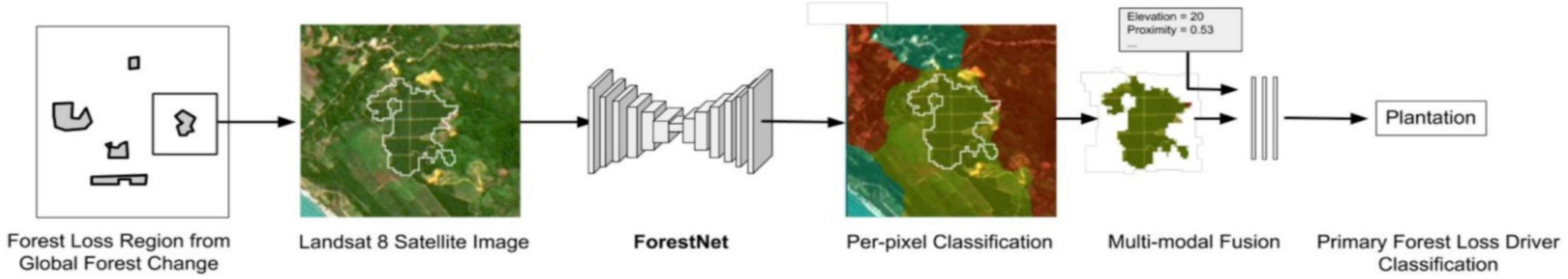
Drone-Based Biomass Estimation





Challenges:
Limited labeled data for model training

Deforestation driver classification



Model	Predictors	Val		Test	
		Acc	F1	Acc	F1
RF	Visible	0.56	0.49	0.49	0.44
RF	Visible + Aux	0.72	0.67	0.67	0.62
CNN	Visible	0.80	0.75	0.78	0.70
CNN + SDA	Visible	0.82	0.79	0.78	0.73
CNN + SDA + PT	Visible	0.83	0.80	0.80	0.74
CNN + SDA + PT	Visible + Aux	0.84	0.81	0.80	0.75

Fusing multi-modal data sources improve classification accuracy
Challenges: Labeled Data

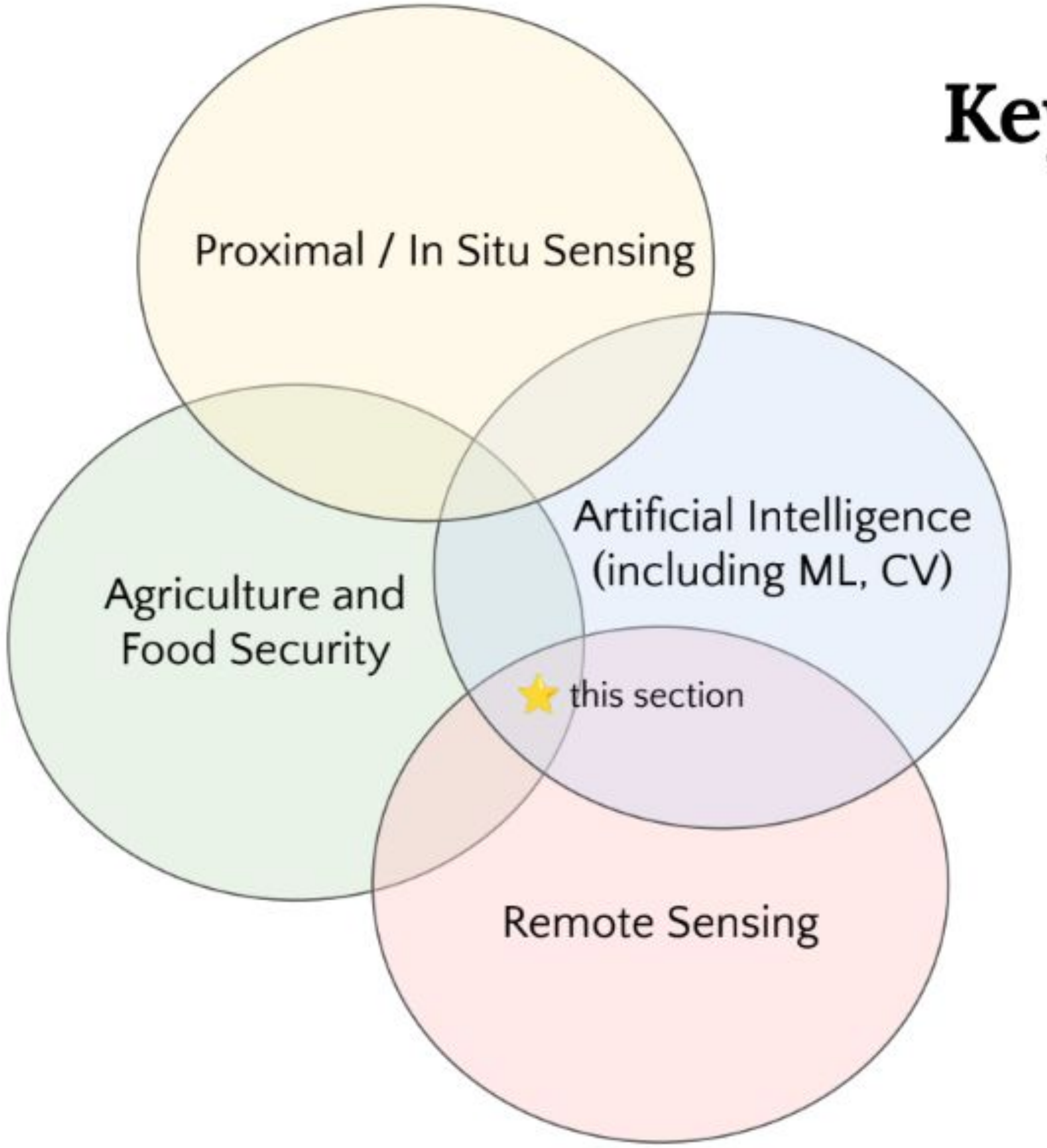
ForestNet: Classifying Drivers of Deforestation in Indonesia using Deep Learning on Satellite Imagery
Irvin *, Sheng * *et al.* CCAI NeurIPS20

AI for Mangrove Blue Carbon in Vietnam (AIMVIE)

https://aimvie.org/

Visit - https://ayon-roy.netlify.app

How AI concepts can help ?



Key topics

- Crop mapping → Binary classification
- Crop type mapping → Multi-class classification
- Field boundary delineation → Segmentation
- Yield estimation → Regression
- Pest and disease detection → OOD detection

Domain adaptation, distribution shift, multi-fidelity data fusion, learning from limited labeled data, etc.

https://drive.google.com/file/d/1gXfIrzwdZ4r1MCmdK2RPtxPp9xkl0F8F/view : Detailed PPT on how AI can be used for Agriculture

Microsoft's Open Source efforts for SustAInability

Demo

https://replicate.com/bencevans/megadetector

Important Links

https://github.com/microsoft/CameraTraps/blob/main/megadetector.md

https://agentmorris.github.io/camera-trap-ml-survey/

Colab Notebook
https://colab.research.google.com/github/microsoft/CameraTraps/blob/main/detection/megadetector_colab.ipynb

How can AI help ?

- ➢ Distilling raw data into actionable information
- ➢ Optimizing complex systems
- ➢ Improving predictions
- ➢ Accelerating scientific discovery
- ➢ Approximating time-intensive simulations

How AI can help ?

1. Distilling raw data

Role: Distilling raw data into actionable information
Some relevant ML areas: Computer vision, natural language processing for

- Gathering data on building footprints/heights [M]
- Evaluating coastal flood risk [A]
- Parsing corporate disclosures for climate-relevant info [A]

Examples
- Mapping deforestation and carbon stock [M]

2. Optimizing complex systems

Role: Improving efficient operation of complex, automated systems

Some relevant ML areas: Optimization, control, reinforcement learning

- Optimizing rail and multimodal transport [M]
- Demand response in electrical grids [M]
- Controlling heating/cooling systems efficiently [M]

3. Improving predictions

Role: Forecasts and time series predictions

Some relevant ML areas: Time series analysis, computer vision, Bayesian methods

- Forecasting electricity demand [M]
- Predicting crop yield from remote sensing data [A]
- “Nowcasting” for solar/wind power [M]

4. Accelerating scientific discovery

Role: Suggesting experiments in order to speed up the design process
Some relevant ML areas: Generative models,
active learning, reinforcement learning,
graph neural networks

- Algorithms for controlling fusion reactors [M]
- Identifying candidate materials for batteries, photovoltaics, and energy-related catalysts [M]

5. Approximating simulations

Role: Accelerating time-intensive, often physics-based, simulations

Some relevant ML areas: Physics-informed ML, computer vision, interpretable ML, causal ML

- Simulating portions of car aerodynamics [M]
- Speeding up planning models for electrical grids [M]
- Superresolution of predictions from climate models [A]

Underwater Data Centers for SustAInable Computing

Microsoft finds underwater datacenters are reliable, practical and use energy sustainably

Written by
John Roach

Published
September 14, 2020

Earlier this summer, marine specialists reeled up a shipping-container-size datacenter coated in algae, barnacles and sea anemones from the seafloor off Scotland's Orkney Islands.

The retrieval launched the final phase of a years-long effort that proved the concept of underwater datacenters is feasible, as well as logistically, environmentally and economically practical.

https://news.microsoft.com/source/features/sustainability/project-natick-underwater-datacenter/

https://www.youtube.com/watch?v=lBeepqQBpvU

AI used for Energy Saving

DeepMind's AI cuts energy costs for cooling buildings

Research firm DeepMind has built an AI to optimise cooling systems in buildings. In tests, it reduced energy usage by around 10 per cent

TECHNOLOGY 20 December 2022

By **Jeremy Hsu**

https://www.newscientist.com/article/2352075-deepminds-ai-cuts-energy-costs-for-cooling-buildings/

How can you approach SustAInability?

Focus on your day to day activities

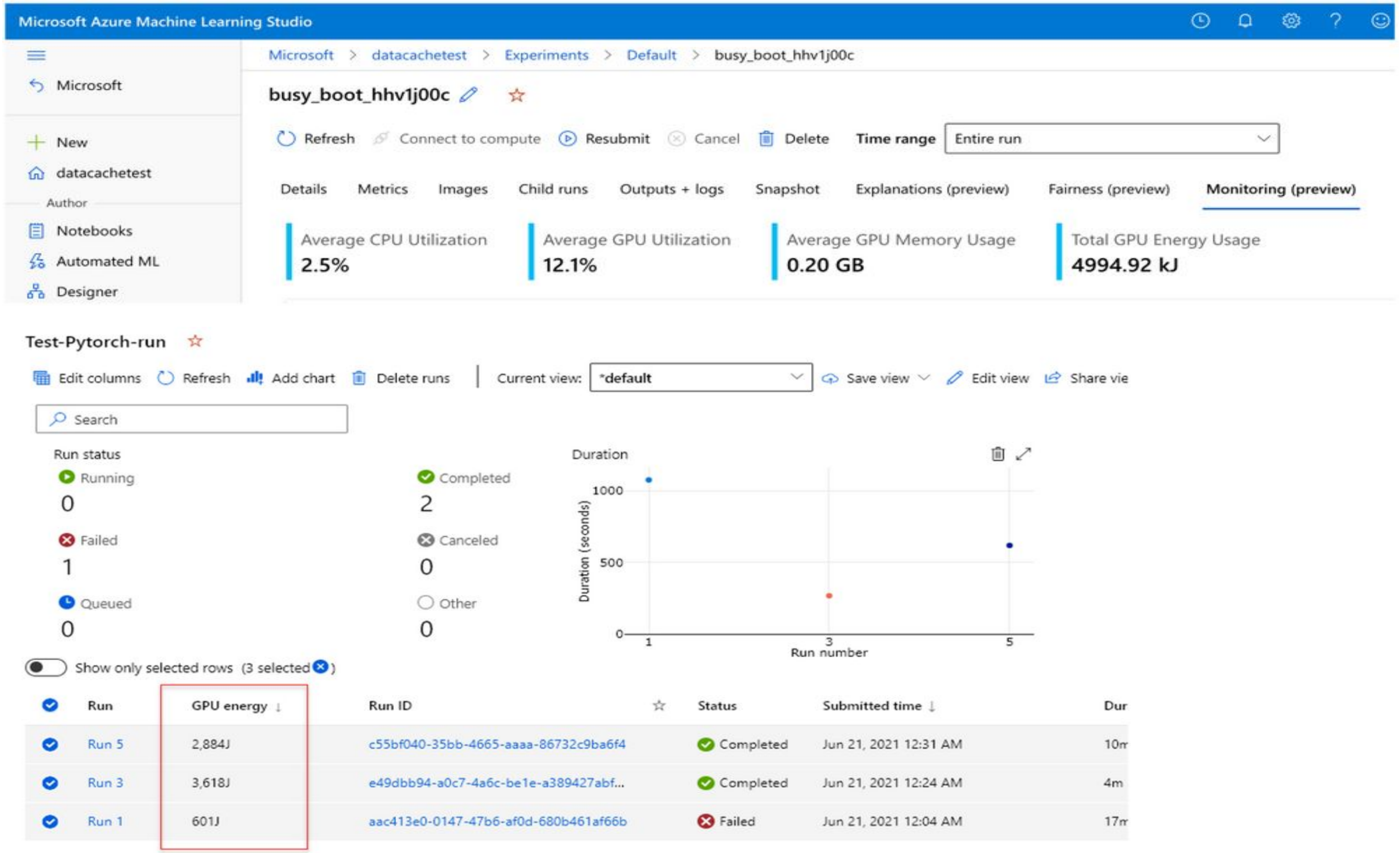
Computing-related

- Measure your footprint with tools such as ML CO2 Impact, CodeCarbon, Carbontracker, or tools specifically for Azure or Hugging Face
- Reduce your impacts by choosing more efficient models, and reducing wasteful model retraining & execution

Application-related

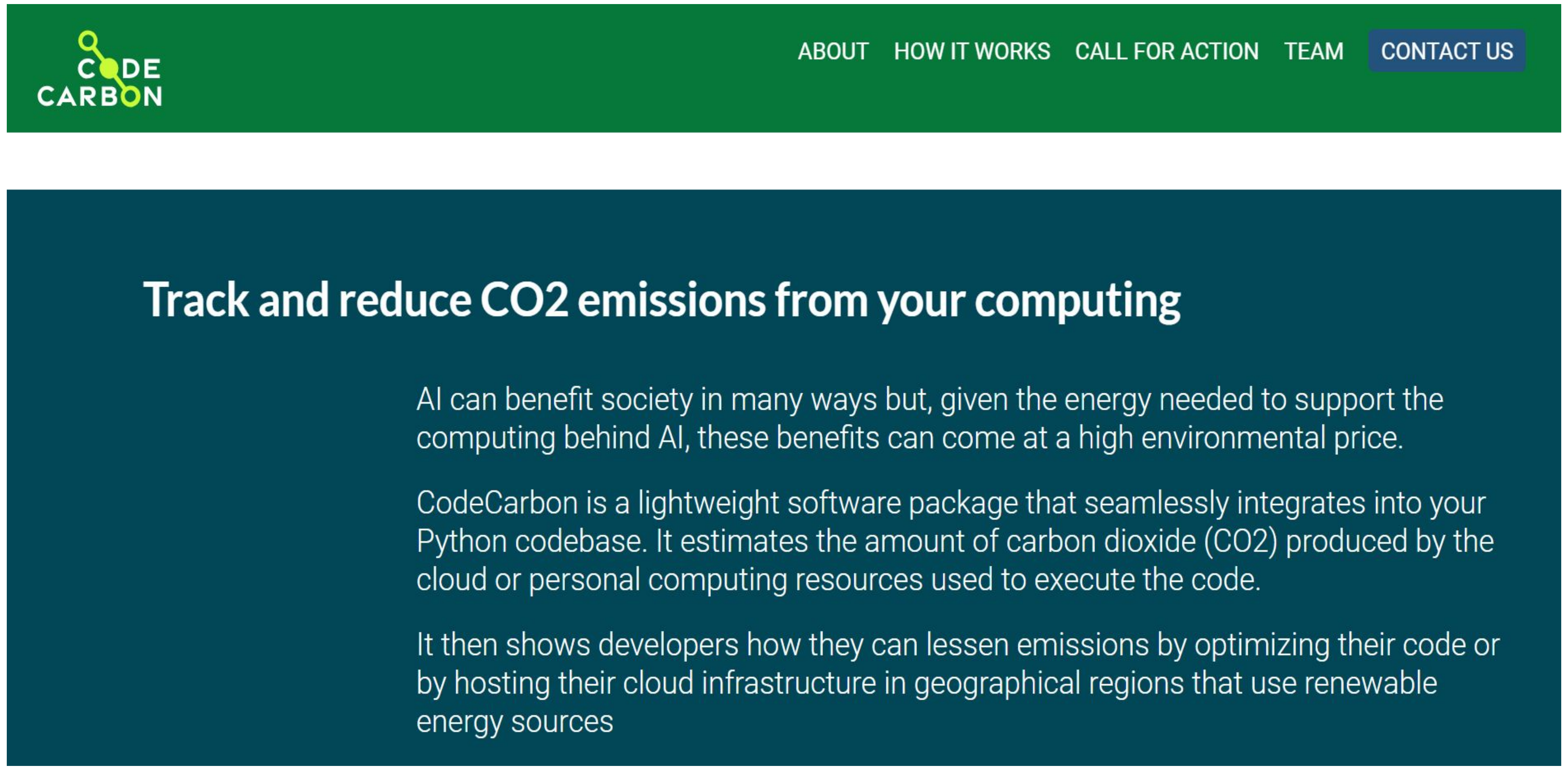
- Quantify and evaluate the application impacts where possible
- Be transparent about impacts in publications and with stakeholders (quantitatively and qualitatively)
- Choose what you (or the ML community) works on

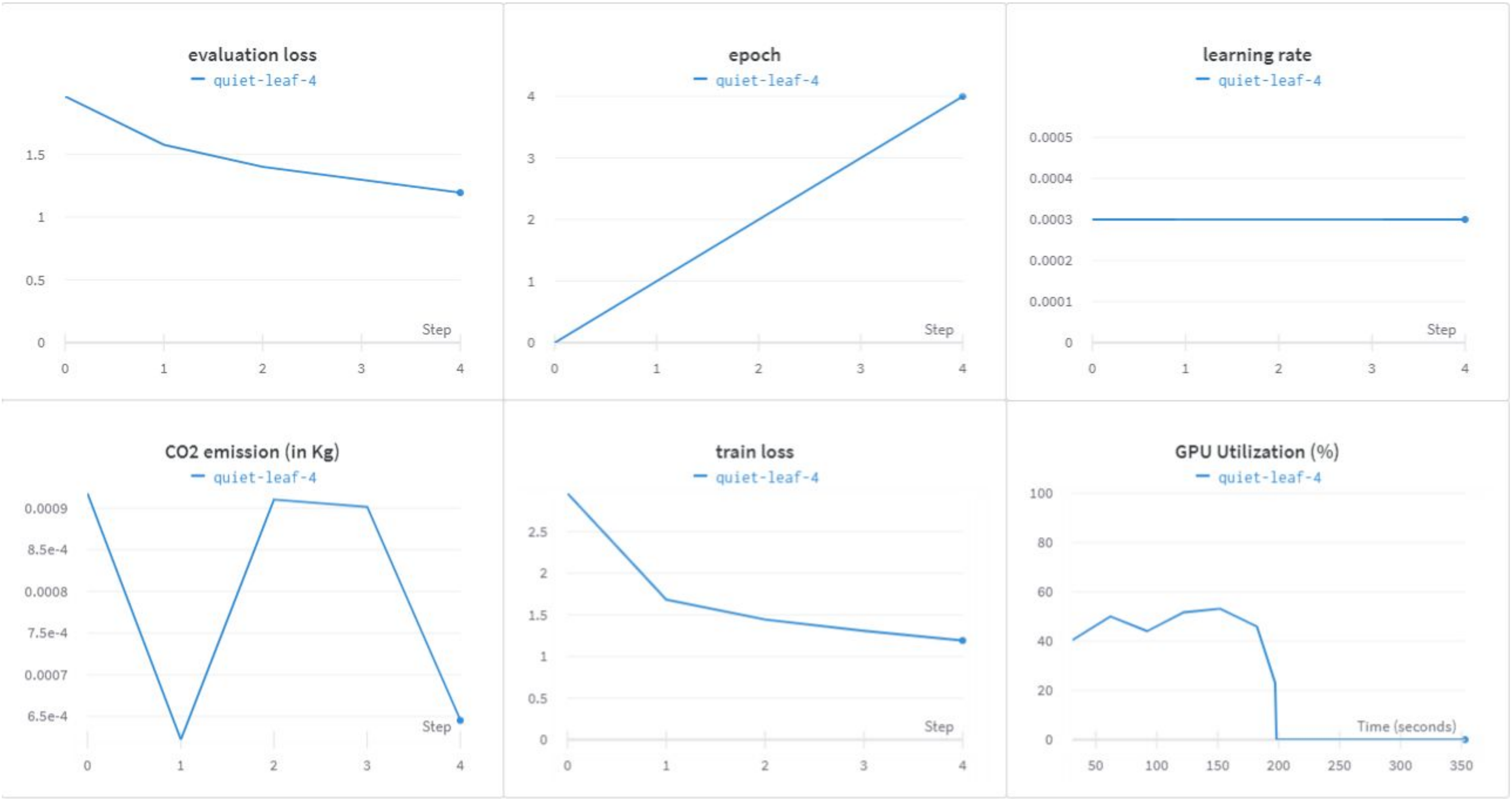
SustAInability with Azure Machine Learning resource metrics



https://techcommunity.microsoft.com/t5/green-tech-blog/charting-the-path-towards-sustainable-ai-with-azure-machine/ba-p/2866923

Tracking CO2 Emissions of Your Deep Learning Models with CodeCarbon + Weights & Biases



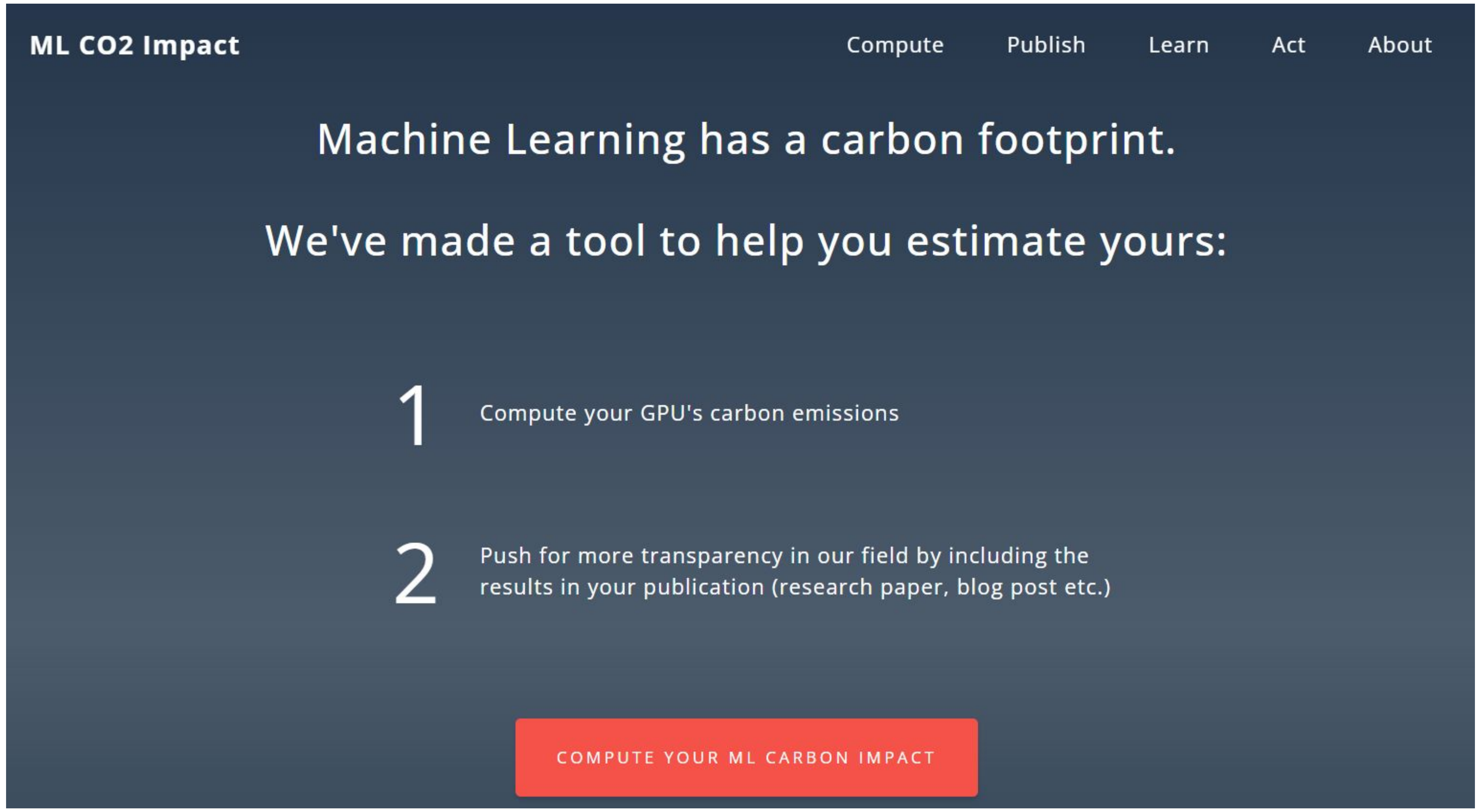


https://codecarbon.io/

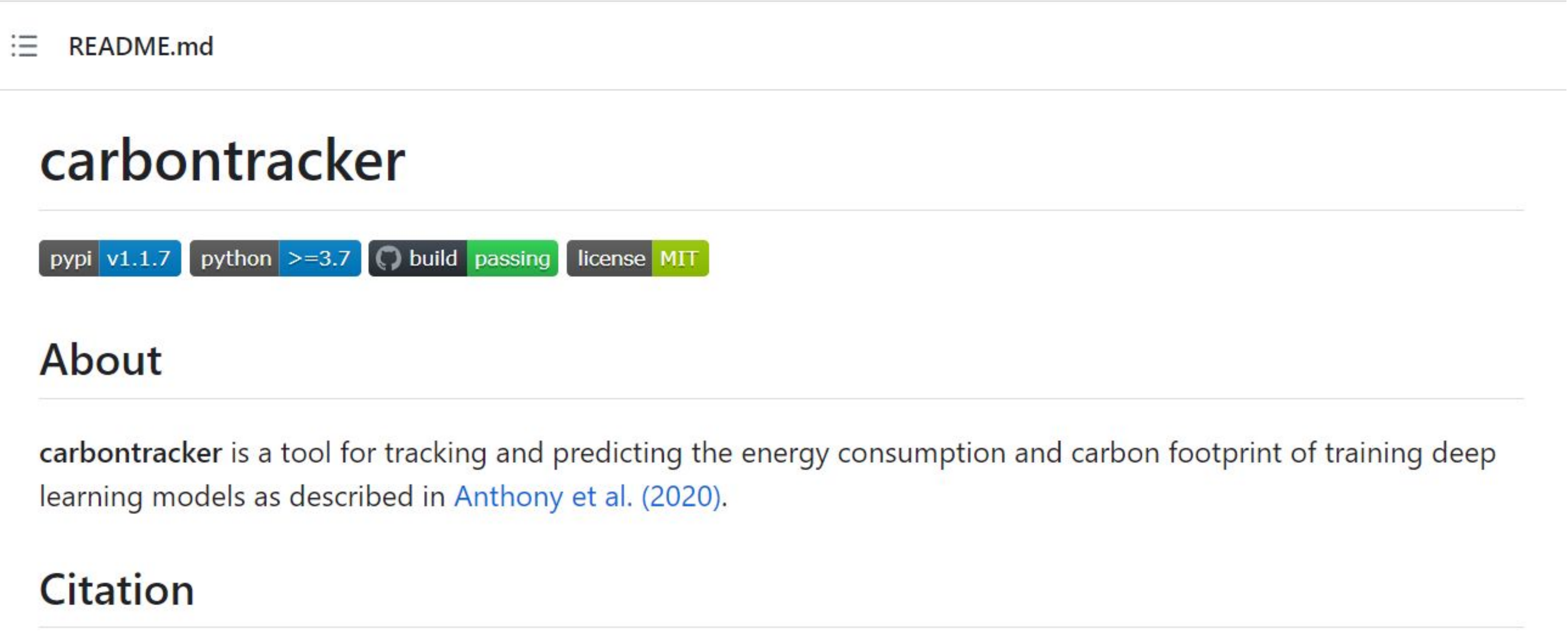
https://wandb.ai/amanarora/codecarbon/reports/Tracking-CO2-Emissions-of-Your-Deep-Learning-Models-with-CodeCarbon-and-Weights-Biases--VmlldzoxMzM1NDg3

Visit - https://ayon-roy.netlify.app

A few other interesting ideas to explore



https://mlco2.github.io/impact/



https://github.com/lfwa/carbontracker

https://huggingface.co/blog/carbon-emissions-on-the-hub

Visit - https://ayon-roy.netlify.app

Datasets to start your journey towards SustAInability

- **Energy**: CityLearn, OPFLearn, ARPA-E GO, PowerGridworld, L2RPN, BeoBench, Building Data Genome, bbd.labworks.org, COBS, BOPTEST/ACTB, Open Catalyst

- **Land use**: TorchGeo, blutjens/awesome-forests, CropHarvest, Radiant ML Hub, LandCoverNet, Agriculture-Vision, chrieke/awesome-satellite-imagery-datasets

- **Climate & Earth science**: mldata.pangeo.io, ClimateBench, ClimART

➔ ESGF; Pangeo, Large Ensemble Simulations (look for CMIP5 and CMIP6 data)
➔ ECMWF data (for historical data and near-term predictions)
➔ CORDEX (for downscaled climate models)
➔ Remote sensing data (e.g., ESA-phi lab)
➔ NASA climate datasets
➔ NCAR Climate Data Guide
➔ ClimateBench (for training ML models)

- **Adaptation**: wandb/droughtwatch, Global Flood Database, FloodNet, ITU GEOAI

- **Biodiversity**: iNat dataset, LifeCLEF, FGVC, iWildCam, Movebank

Additional resources

- Carbon Brief - how do climate models work:
https://www.carbonbrief.org/qa-how-do-climate-models-work/

- Applied Machine Learning Tutorial for Earth Scientists
https://github.com/eabarnes1010/ml_tutorial_csu

- Analyse CMIP6 data from the cloud servers
https://cmip6moap.github.io/resources/loading-data-xarray/

But...

- Is AI needed to address the problem?
- What is the scope & time horizon of the impact?
- What is the likelihood that a solution can be found?
- Can a solution feasibly be deployed?
- What are the potential side effects of deploying the candidate solution?
- Who are the relevant stakeholders who are involved in or affected by the application?

Key considerations

- AI is not a silver bullet and is only relevant sometimes
- High-impact applications are not always flashy

- Interdisciplinary collaboration
  - Scoping the right problems
  - Incorporating relevant domain information
  - Shaping pathways to impact

- Equity considerations
  - Empowering diverse stakeholders
  - Selecting and prioritizing problems
  - Ensuring data is representative

Responsible SustAInability

Mitigating biases in data and models

- E.g., Buildings data: Housing discrimination, geographic disparities in availability
- E.g., Weather models: Calibration may be optimized for particular regions

Improving trustworthiness and accountability

- Safety and robustness: Critical in, e.g., power systems and industrial operations
- Interpretability and auditability: Critical in, e.g., policymaking contexts centering equity and climate justice
- Centering diverse stakeholders: E.g., industrial ag vs. smallholder farmers
- Avoiding centralization: Democratized capacity and compute, digital divide
- Avoiding digital colonialism: E.g., smart meters, analysis of remote sensing data

Let us come together & do our bit

Bloomberg Asia Edition

● Live Now Markets Economics Industries Tech AI Politics Wealth Pursuits Opinion Businessweek Equality **Green**

Green
New Energy

Artificial Intelligence Is Booming—So Is Its Carbon Footprint

Greater transparency on emissions could also bring more scrutiny

OCTOBER 24, 2022

AXA Future Risks Report 2022

Climate change has become the number one concern around the world

IN THE NEWS | 1 MINUTE

- Climate change is the number one risk in all geographic areas
- Geopolitical risks rank second, overtaking cyber and pandemic
- Sense of vulnerability to certain risks is increasing and the level of trust is deteriorating

Over the last year, economic and geopolitical challenges have added a new layer of uncertainty to the disruptions caused by the Covid pandemic and the climate crisis.

https://www.axa.com/en/news/2022-future-risks-report

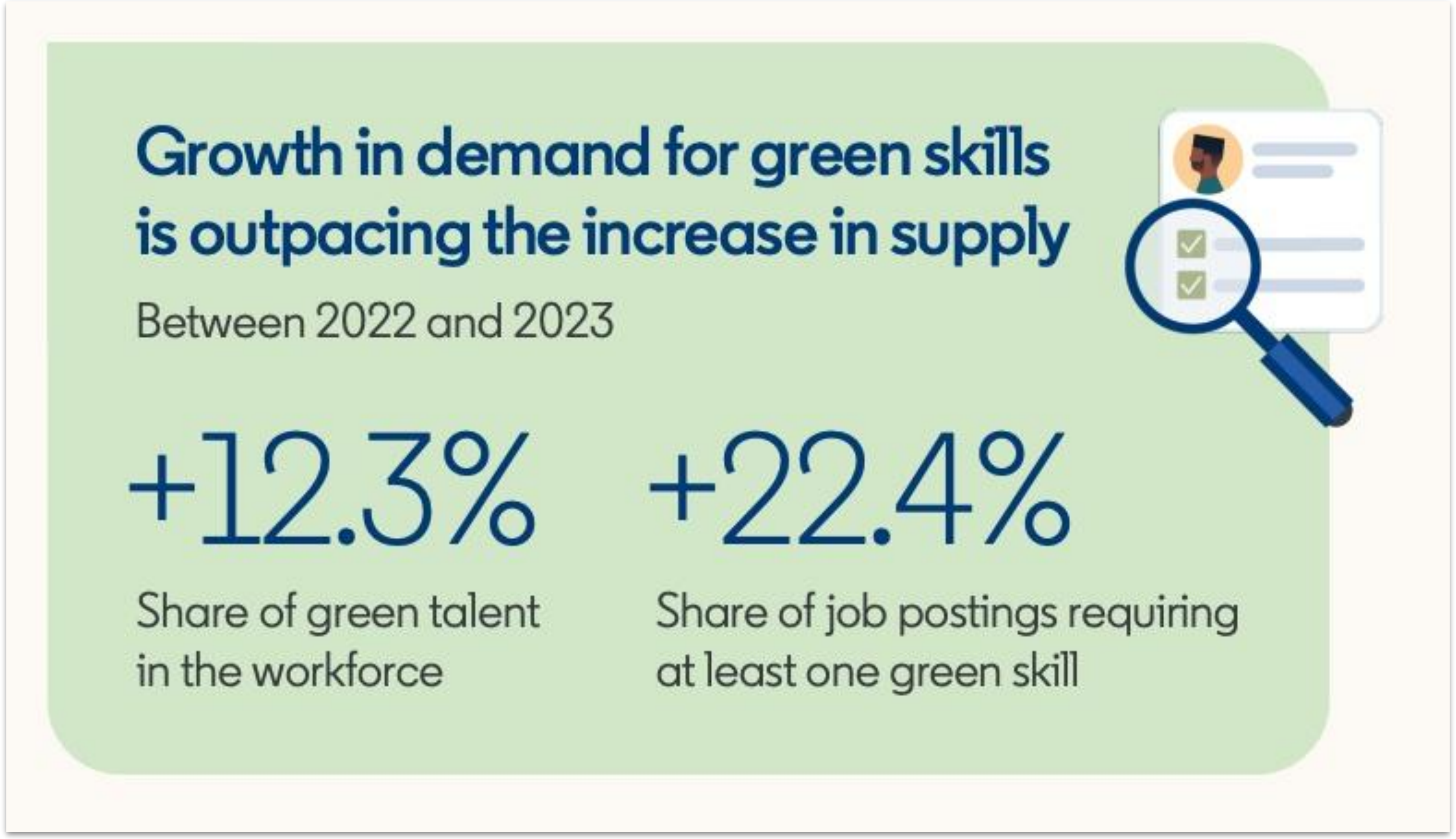
https://www.climatechange.ai/papers : Great place to look for papers on Climate Change related topics

https://www.bloomberg.com/news/articles/2023-03-09/how-much-energy-do-ai-and-chatgpt-use-no-one-knows-for-sure#xj4y7vzkg

https://www.dkn-future-earth.org/activities/working_groups/107334/index.php.en : Research group work on Sustainable ML

Why skill yourselves SustAInably ?

The green economy faces large talent bottlenecks



Source. LinkedIn Global Green Skills Report 2023

Let me answer your Questions now

Finally, it’s your time to speak!

Danke Schoen

Questions ? Any Feedbacks ? Did you like the talk?
Tell me about it.

If you think I can help you,
connect with me via

Email : ayon-roy@outlook.com

LinkedIn : https://www.linkedin.com/in/ayon-roy

Website : https://AYONROY.ML/

Download the slides