IBM Sustainability

AI, GenAI and Watsonx in Sustainability Software

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IBM

Agenda

- How Foundation Models Work
- GenAI in Sustainability Software (Maximo)
- AI in Sustainability Software

Sustainability is a BIG problem

50B

$148B

75%

$68T

Sustainability Goals are best accomplished when they are in sync with key Business Imperatives

My personal question …

How can I,
How can we,
working for, in, with companies implement sustainability in action?

Where is the opportunity in sustainable operations?

Companies with a network of Physical Assets

- Reduce emissions
- Energy efficient facilities and assets
- Longer asset life
- Climate risk mitigation
- Regulatory compliance

20%–30%

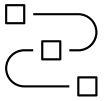
Increased productivity

Companies with a large IT Infrastructure

- Reduce emissions
- Lower cost of IT
- Improved power utilization
- Regulatory compliance

30% in 6mo.

Reduced cloud and data center consumption



Companies with complex Supply Chains

- Enable track and trace
- Lower product carbon footprints
- Reduce fuel consumption
- Deliver sustainable sourcing
- Scope 3 emissions
- Regulatory compliance

52%

Reduction in expedited freight costs

Agenda

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- AI in Sustainability Software


How do
foundation
models
work?

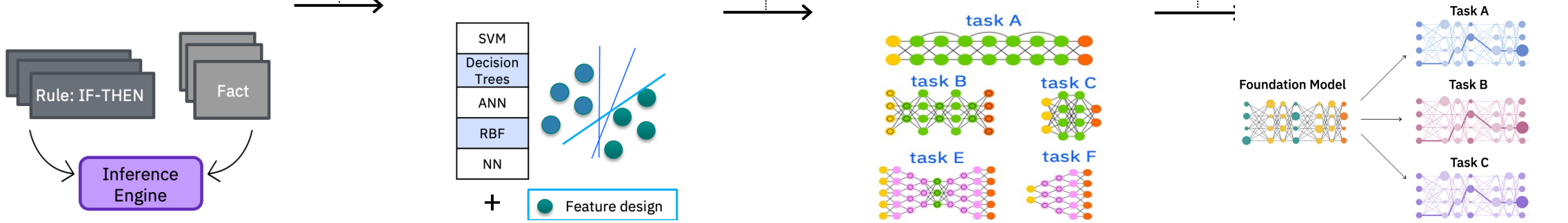
Generative AI and foundation models

The story of AI is a story of data representations

1980s Big data

1980s to ~2010 Massive labeled data + Compute

2017+ Massive unlabeled data + **Self-supervision at scale** + Compute



Expert systems

Hand-crafted symbolic representations

Machine learning

Task-specific hand-crafted feature representations

Deep learning

Task-specific learnt feature representations

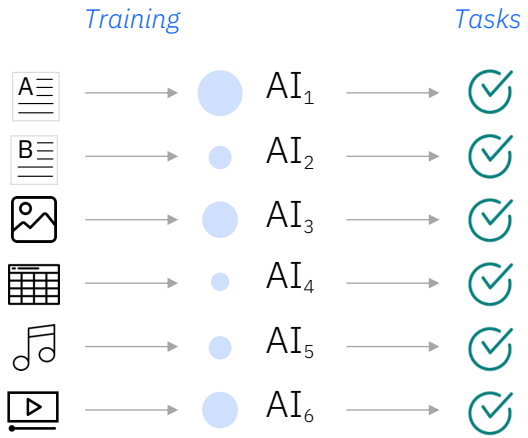
Foundation models

Generalizable & adaptable learnt representations

Foundation models establish a new paradigm for AI capabilities

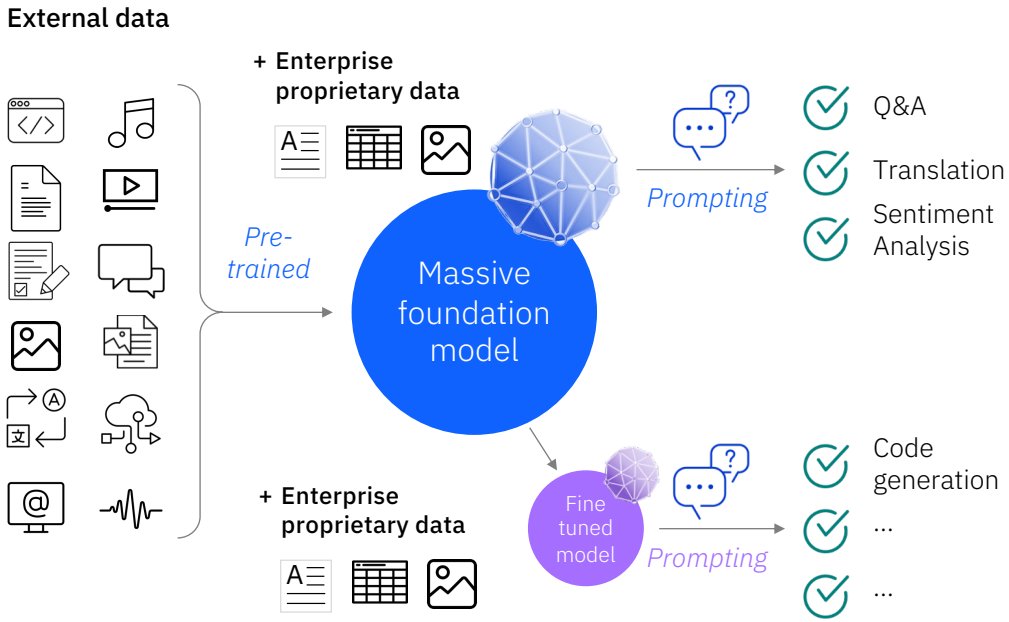
The impact of generative AI

Traditional AI models



- Individual siloed models
- Require task specific training
- Lots of human supervised training

Foundation models



- Massive multi-tasking model
- Adaptable with minimized training
- Pre-trained unsupervised learning

Enhanced capabilities

- Summarization
- Conversational Knowledge
- Content Creation
- Code Co-Creation

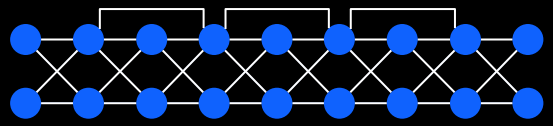
Key advantages

- Lower upfront costs through less labeling
- Faster deployment through fine tuning and inferencing
- Equal or better accuracy for multiple use cases
- Incremental revenue. through better performance

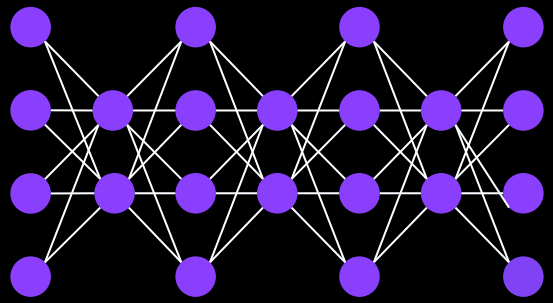
up to **70% reduction** in certain NLP tasks

Classical AI models: purpose-built and siloed

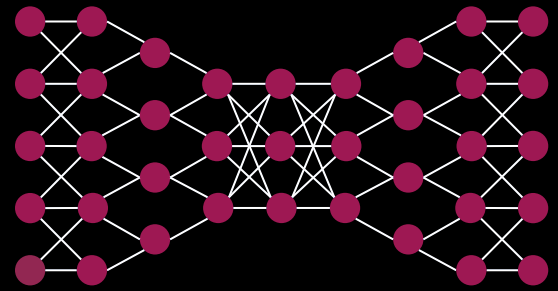
Translation



Summarization

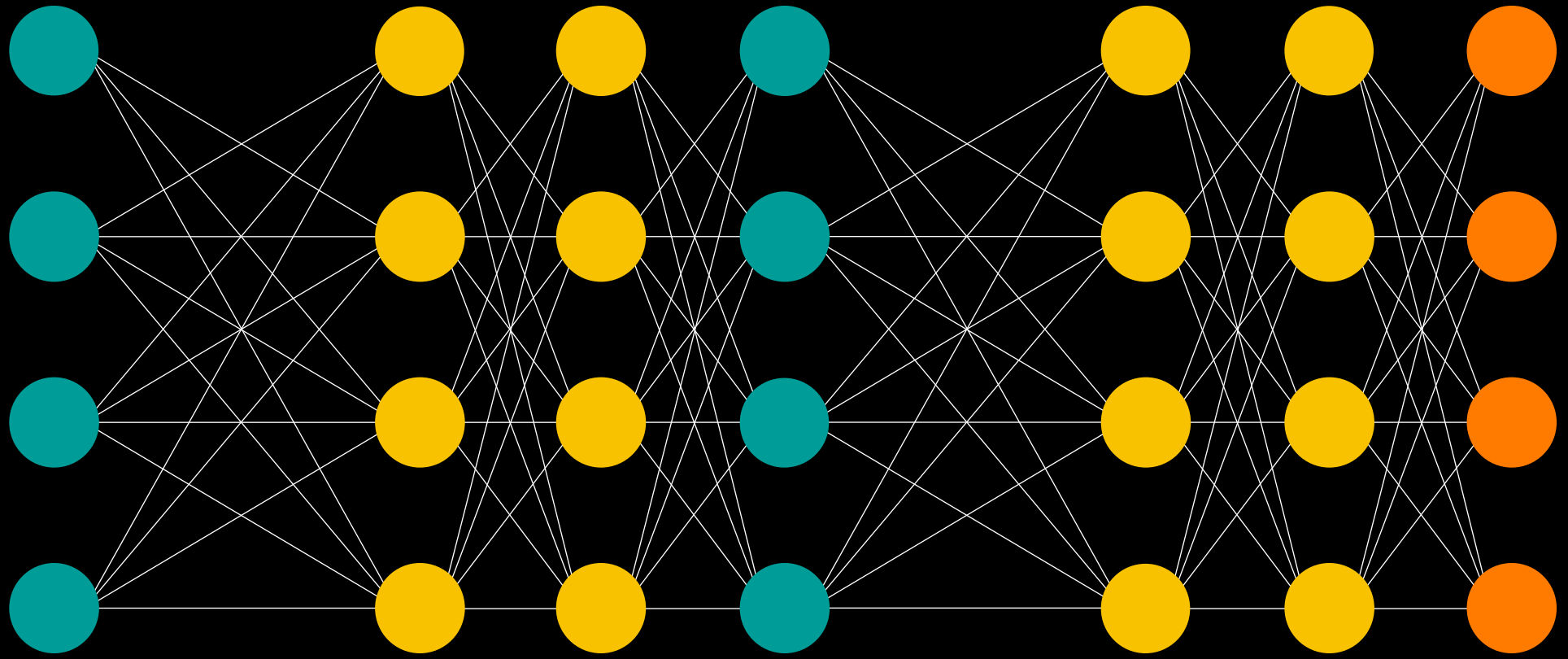


Question Answering



Each model performs a discrete task

Foundation models



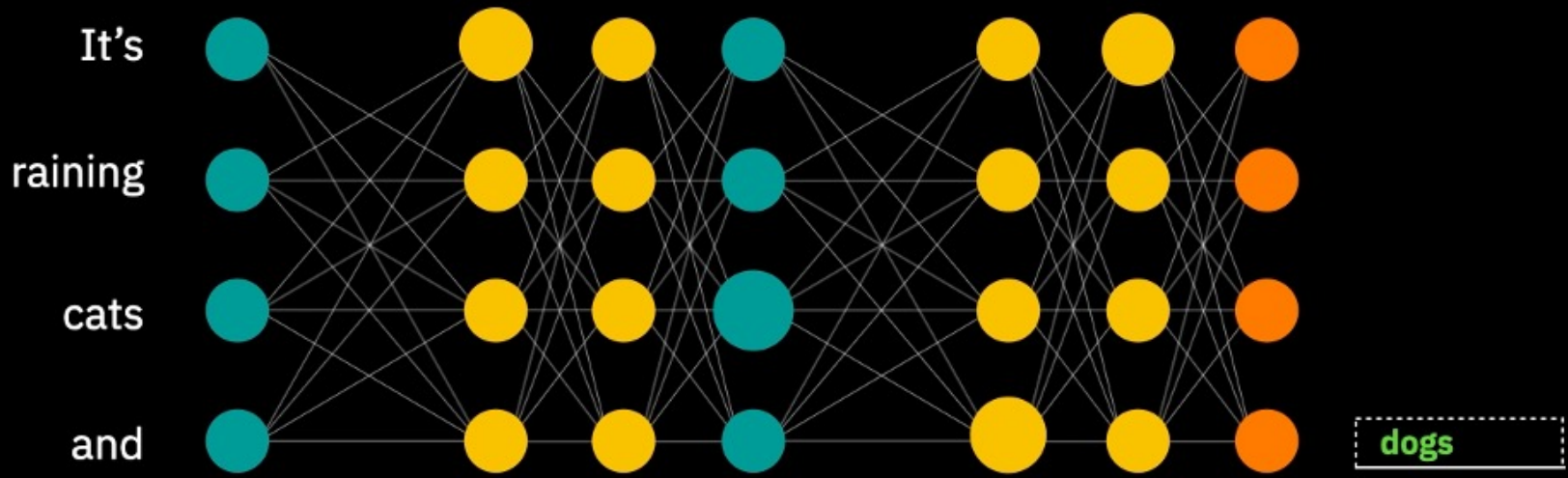
Foundation model training:

a lot of unlabeled data + a little labeled data

Unlabeled data for training:
100 billion sentences

Labeled data for fine tuning:
1000 examples

Training a foundation model: Self-supervision



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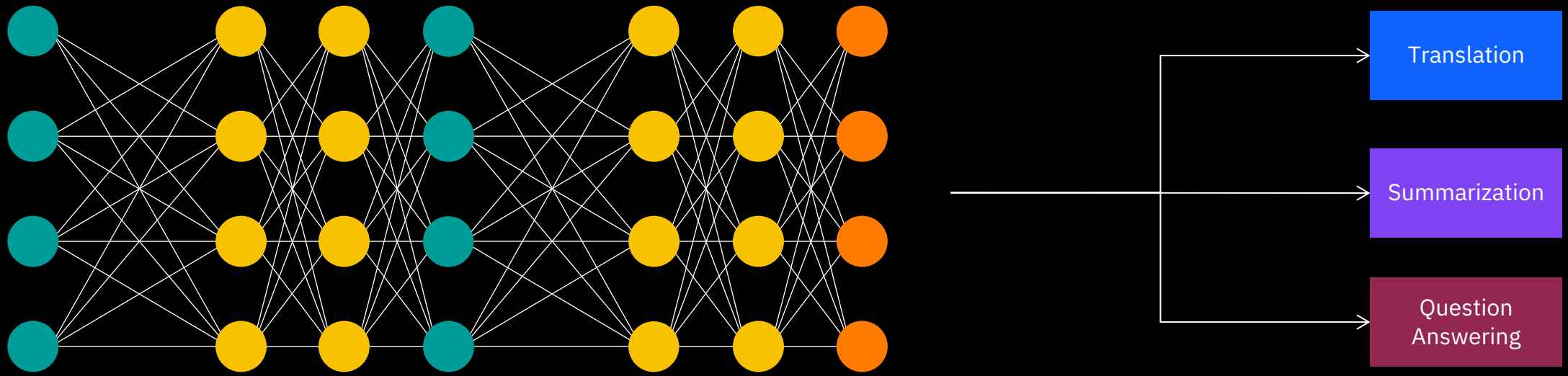
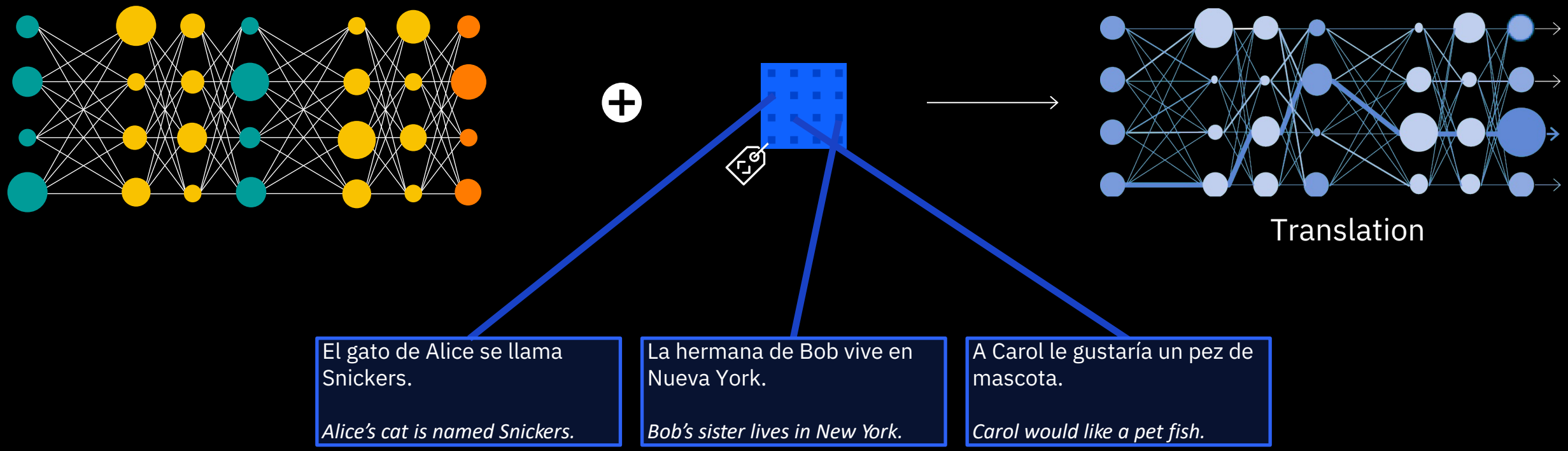
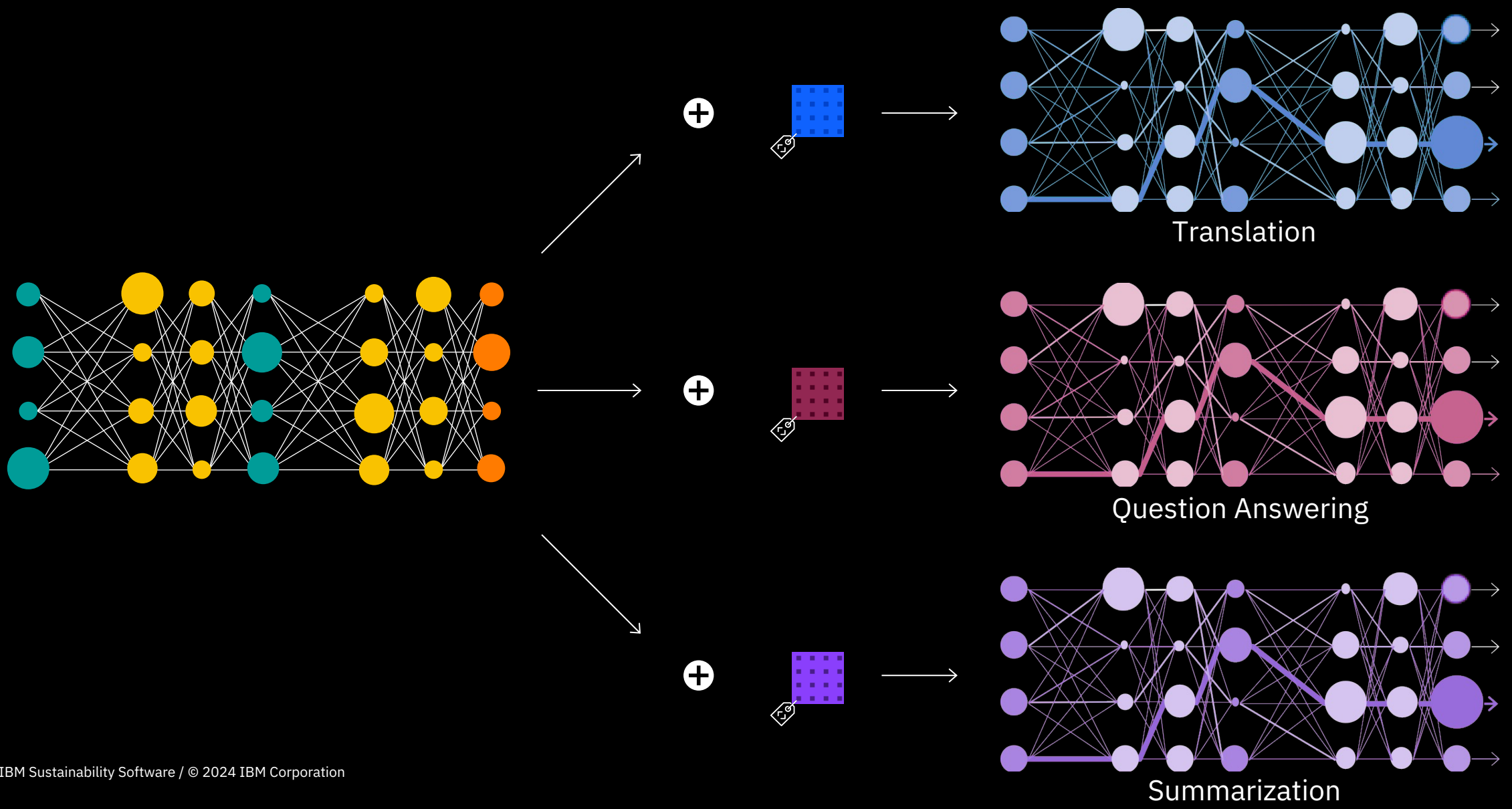
Foundation models



Fine tuning a trained Foundation Model



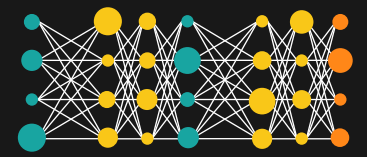
Fine tuning: One trained Foundation Model for many tasks



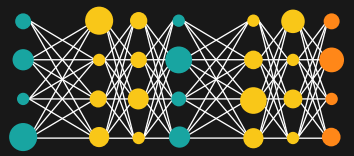
Foundation models: How do they work?

Self-supervised training

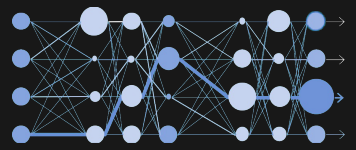
Foundation model



Task-specific fine-tuning

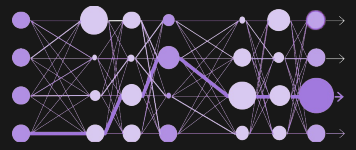


Translation model

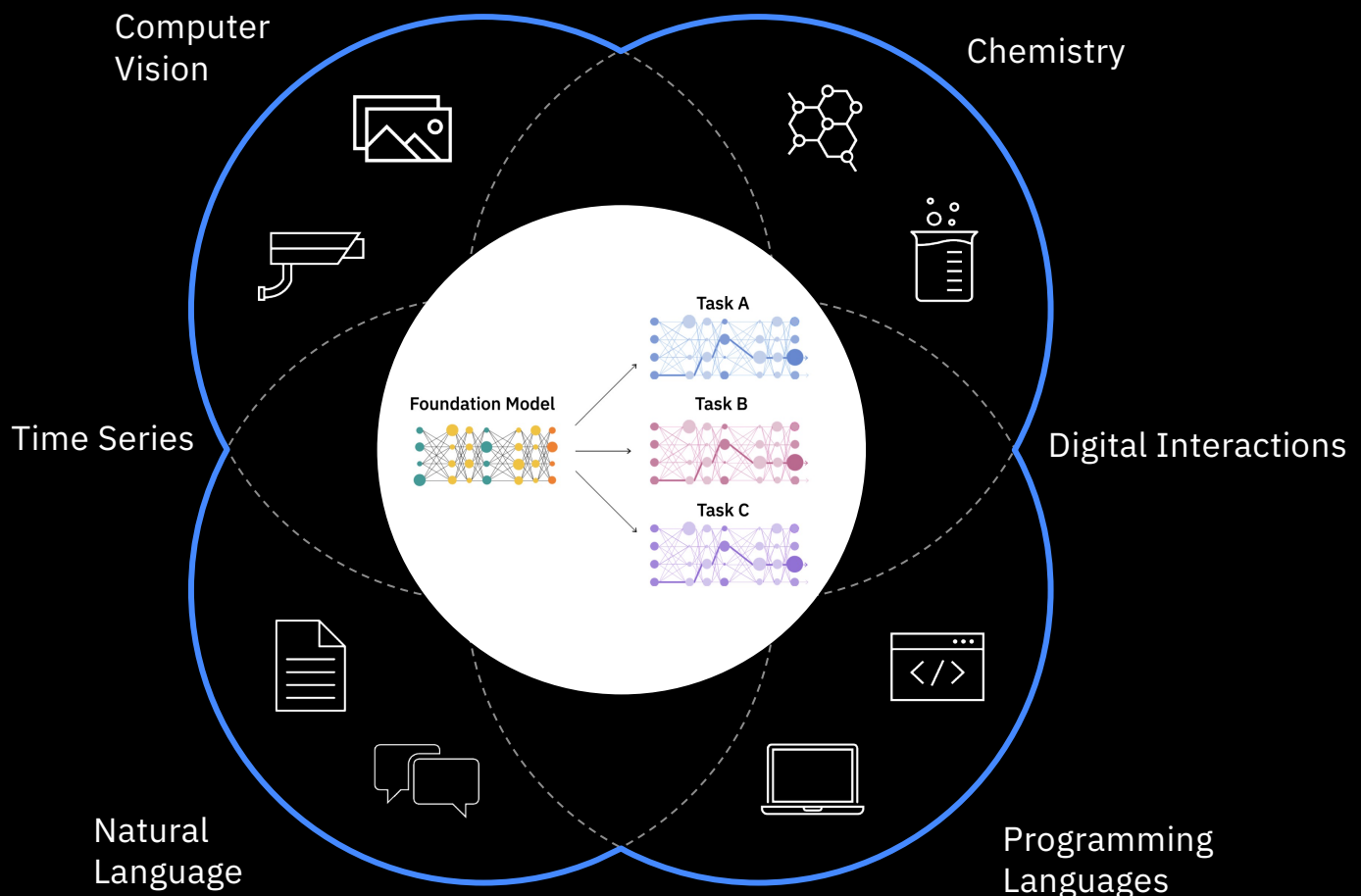


Summarization model

Answer finding model



But the implications of foundation models go well beyond Large Language Models (LLMs)



We collaborated with NASA to develop a Geospatial foundation model trained on HLS data.

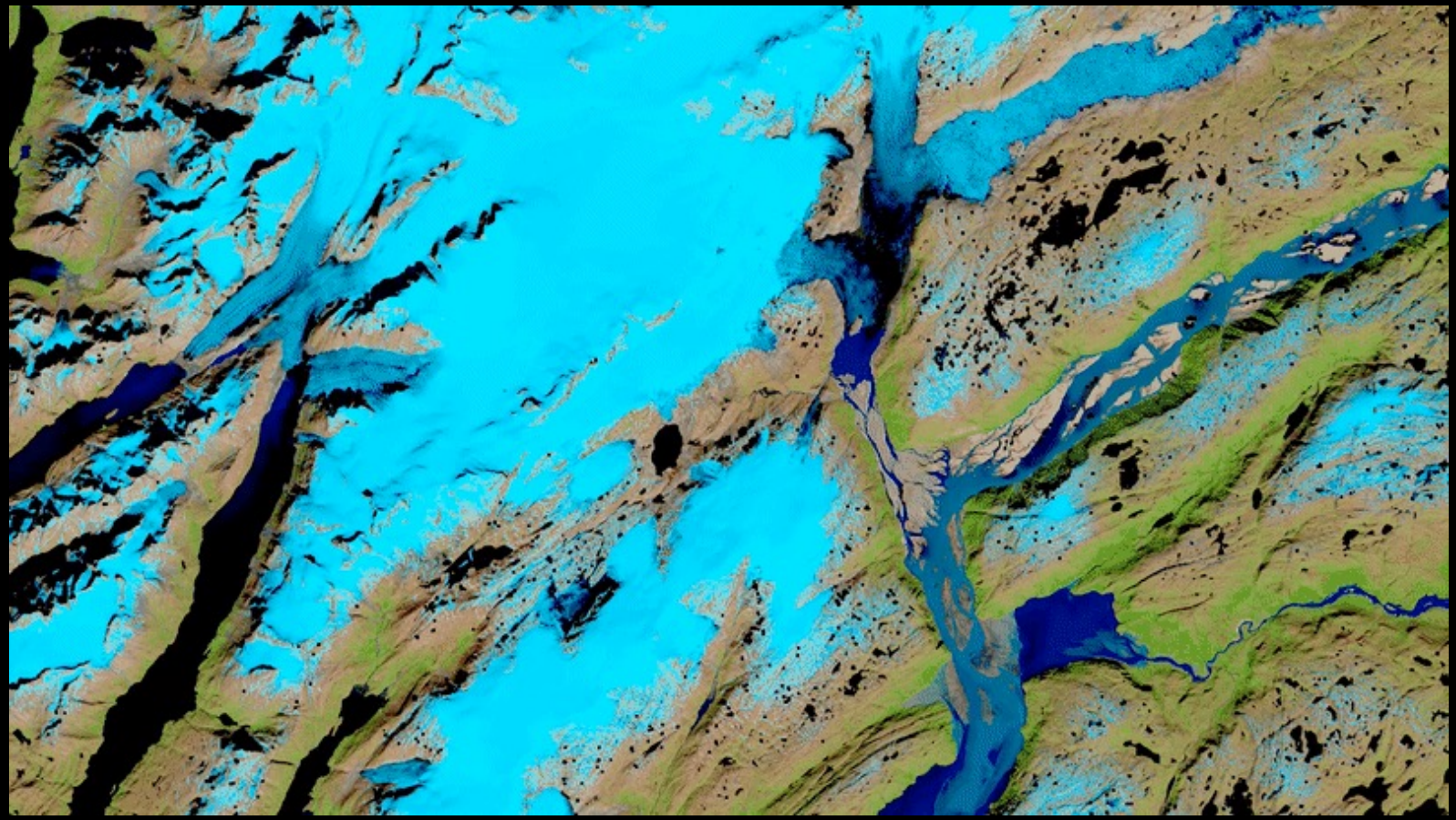
The Harmonized Landsat Sentinel-2 (HLS) dataset provides global land observations every 2-3 days at 30 meter resolution.

NASA - IBM Partnership

IBM's AI will now help NASA analyze Earth data
Fast Company

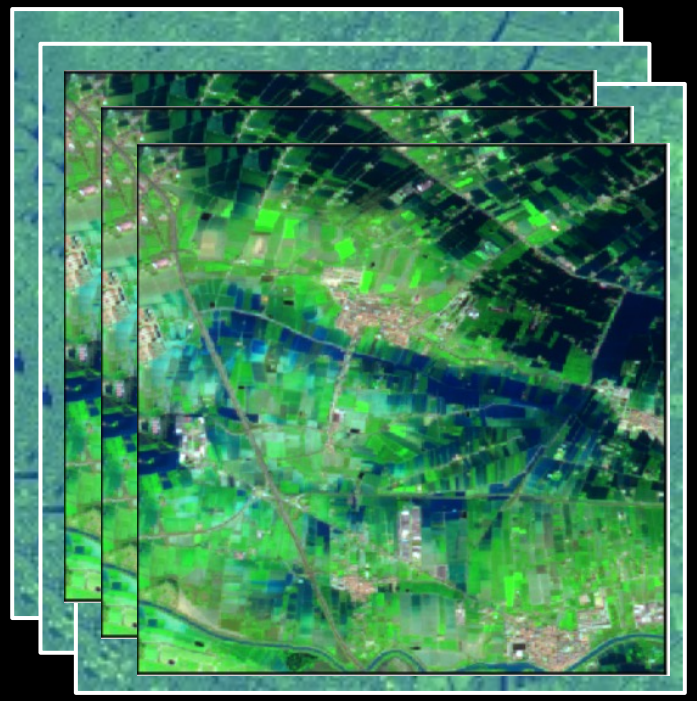
NASA partners with IBM to build AI foundation models to advance climate science
Venture Beat

NASA, IBM Join Forces to Advance Earth Science Research With Artificial Intelligence and Tackle Climate Change
Science Times



Short-wave infrared (SWIR) false color composite of glacial retreat near Innarsuit, Greenland from 2013 – present. (Source: NASA IMPACT)

Fine tuning a trained Foundation Model

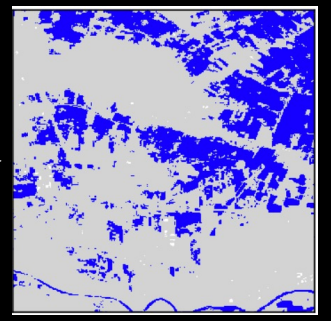


Encoder
(Large Transformer)

Foundation Model

Flood Mapping

Semantic Segmentation

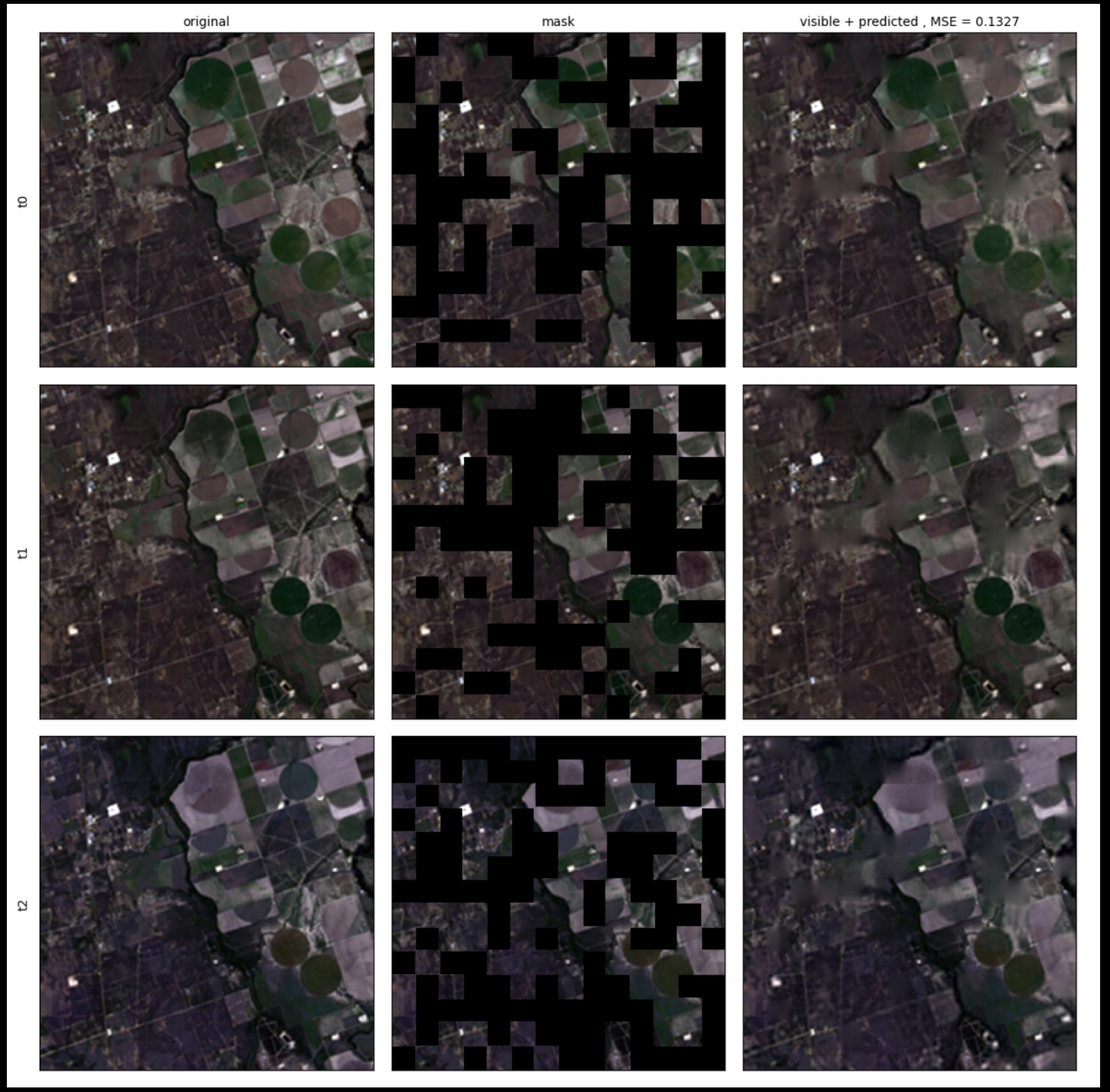


Biomass Detection

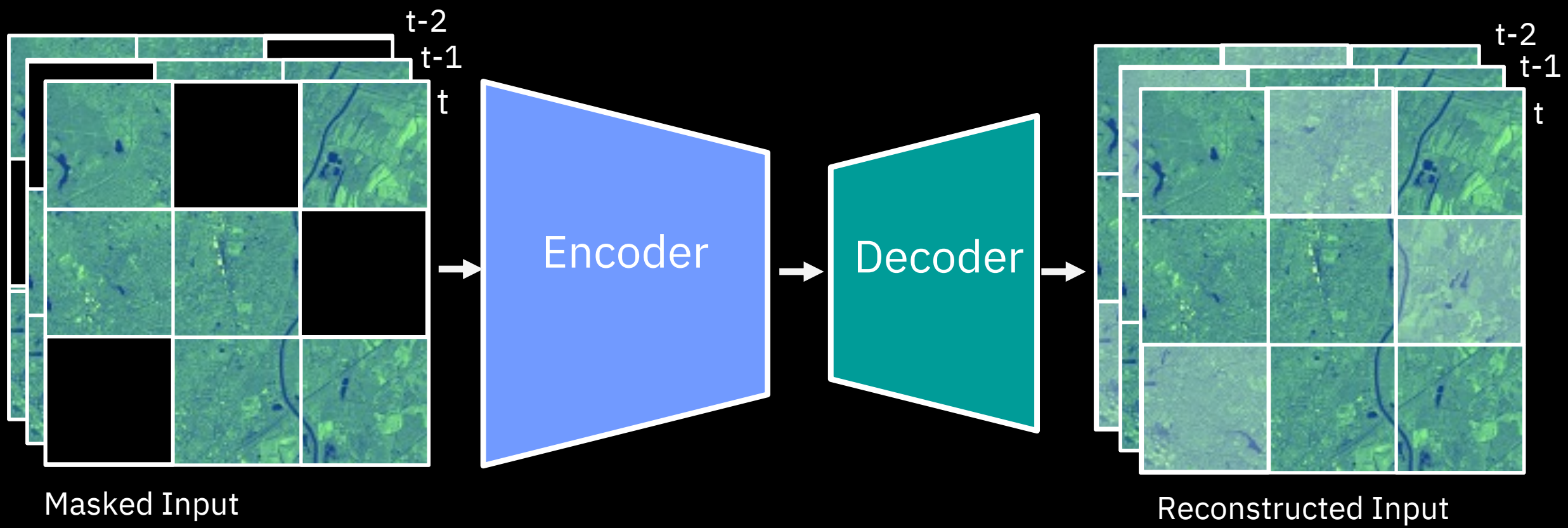
Classification

Bare
Developed
Forest
Herbaceous
Shrub
Water

Geospatial Foundation Model Training Result



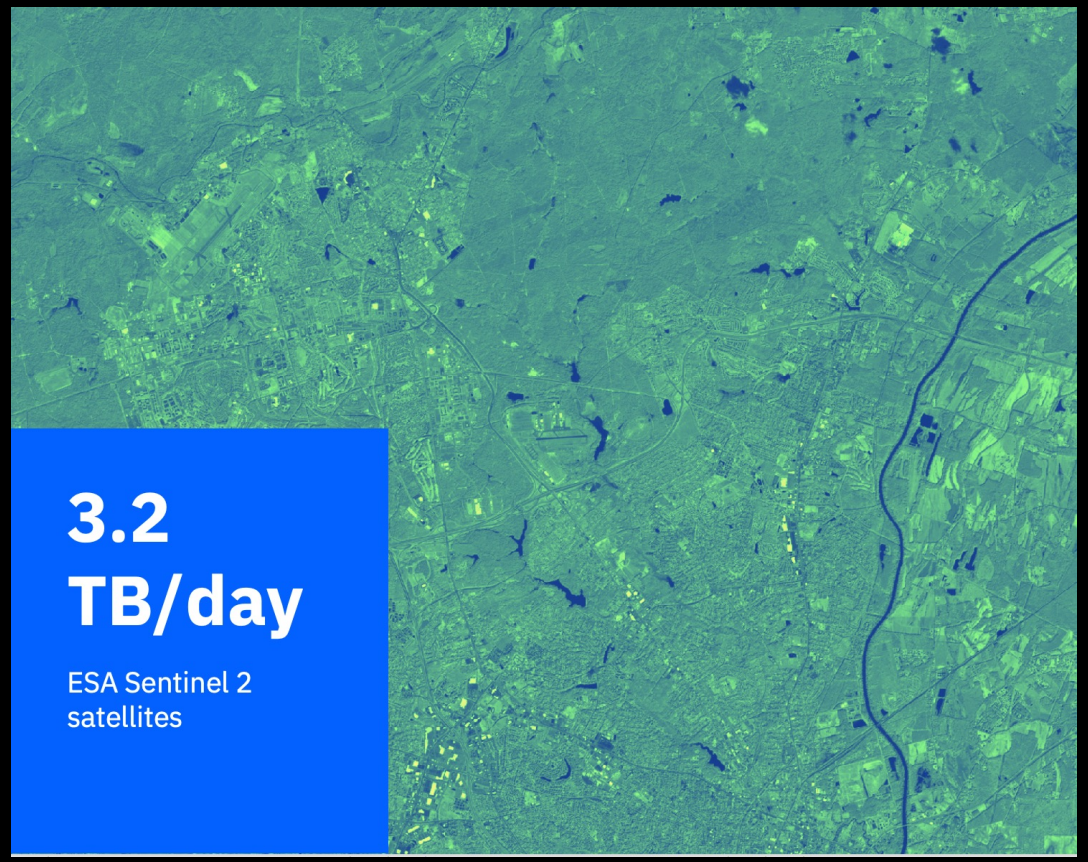
Training a foundation model: Self-supervision



Two core types of geospatial data relevant for sustainability

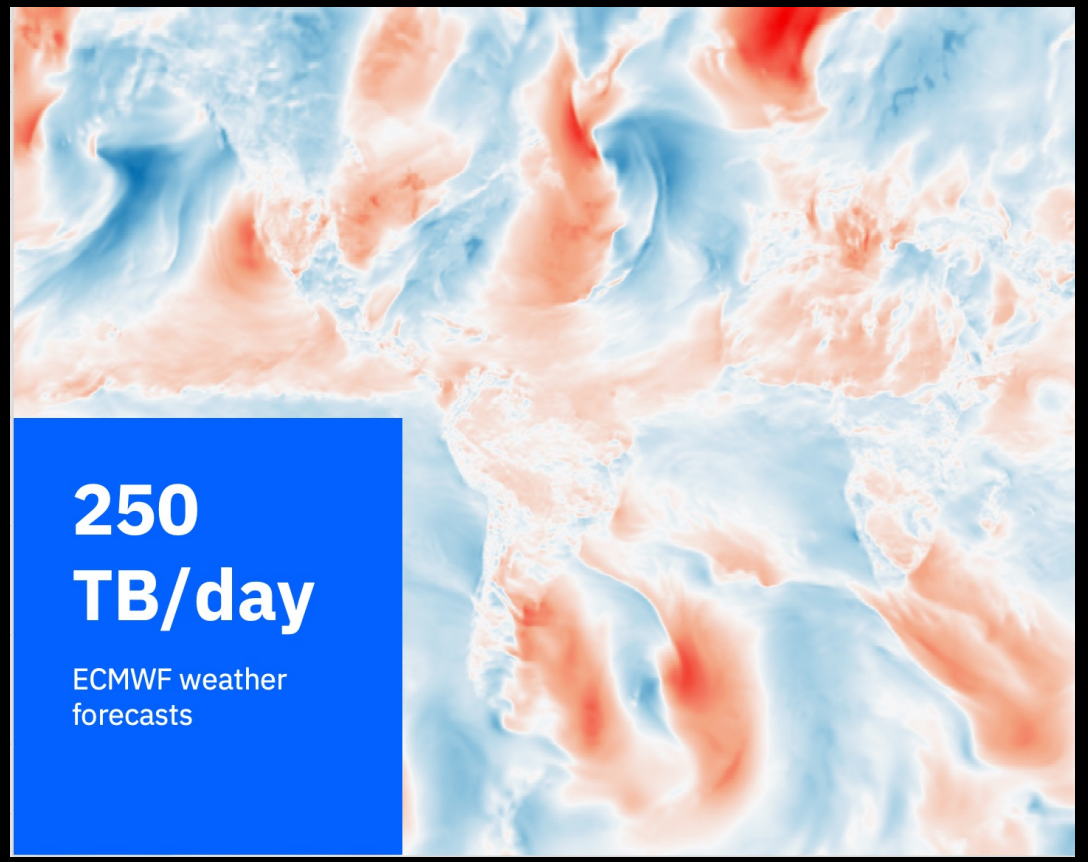
Satellite and aerial imagery

- Multimodal – images from multiple satellites representing different spectral bands



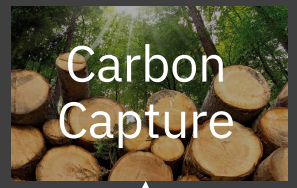
Weather measurements & forecasts

- Multimodal – time series from different processes (temperature, precipitation, wind,...)



Foundation models for sustainability

Image Segmentation Use Cases



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Task Specific Model

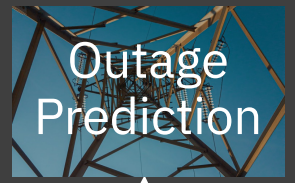
Task Specific Model

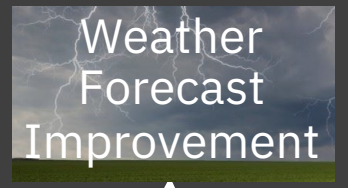
Task Specific Models

Foundation Model (Spatiotemporal Transformer)

Satellite & Aerial Data

Weather Use Cases





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Task Specific Model

Task Specific Models

Task Specific Model

Foundation Model (Temporal Patch Transformer)

Weather Observations/Forecasts Data

Why NASA, IBM, And Hugging Face's Open Source Model Is A Big Deal

Ted Schadler, VP, Principal Analyst AUG 16 2023

What do you get when you combine an open source platform, a massive and critically useful dataset, and an ability to open-source an AI foundation model?

If you're NASA, IBM, and Hugging Face, you get a massive opportunity to make geospatial data available to all through an open source geospatial AI foundation model. We like this open source geospatial intelligence resource and commitment for three reasons:

Data is the lifeblood of AI

Harmonized Landsat Sentinel-2

Harmonized Landsat Sentinel-2 (HLS-2) provides consistent global observations of the land.

- Data available in tiles, aligned with the Military Grid Reference System (MGRS).
- Global 30m resolution imagery every 2-3 days
- Each tile has 3660 x 3660 pixels, corresponding to ~110 x 110 km.

Near Infrared (NIR)

In remote sensing applications, the near-infrared (NIR) band, together with the visible spectrum (RGB), provide abundant information about ground objects

Near Infrared (NIR) is a subset of the infrared band of the electromagnetic spectrum, covering the wavelengths ranging from 0.7 to 1.4 microns. This wavelength is just outside the range of what humans can see and can sometimes offers clearer details than what is achievable with visible light imaging.

Short-wave infrared (SWIR)

defines a specific wavelength range over which optical and electronic components are designed and coated. SWIR imaging offers a number of advantages compared to visible when used for inspection, sorting, surveillance, quality control, and host of other applications.

Short Wave IR (SWIR) is a subset of the infrared band in the electromagnetic spectrum, covering the wavelengths ranging from 1.4 to 3 microns. This wavelength is not visible to human eyes and as a result can often offer a better image than what is achievable with visible light imaging

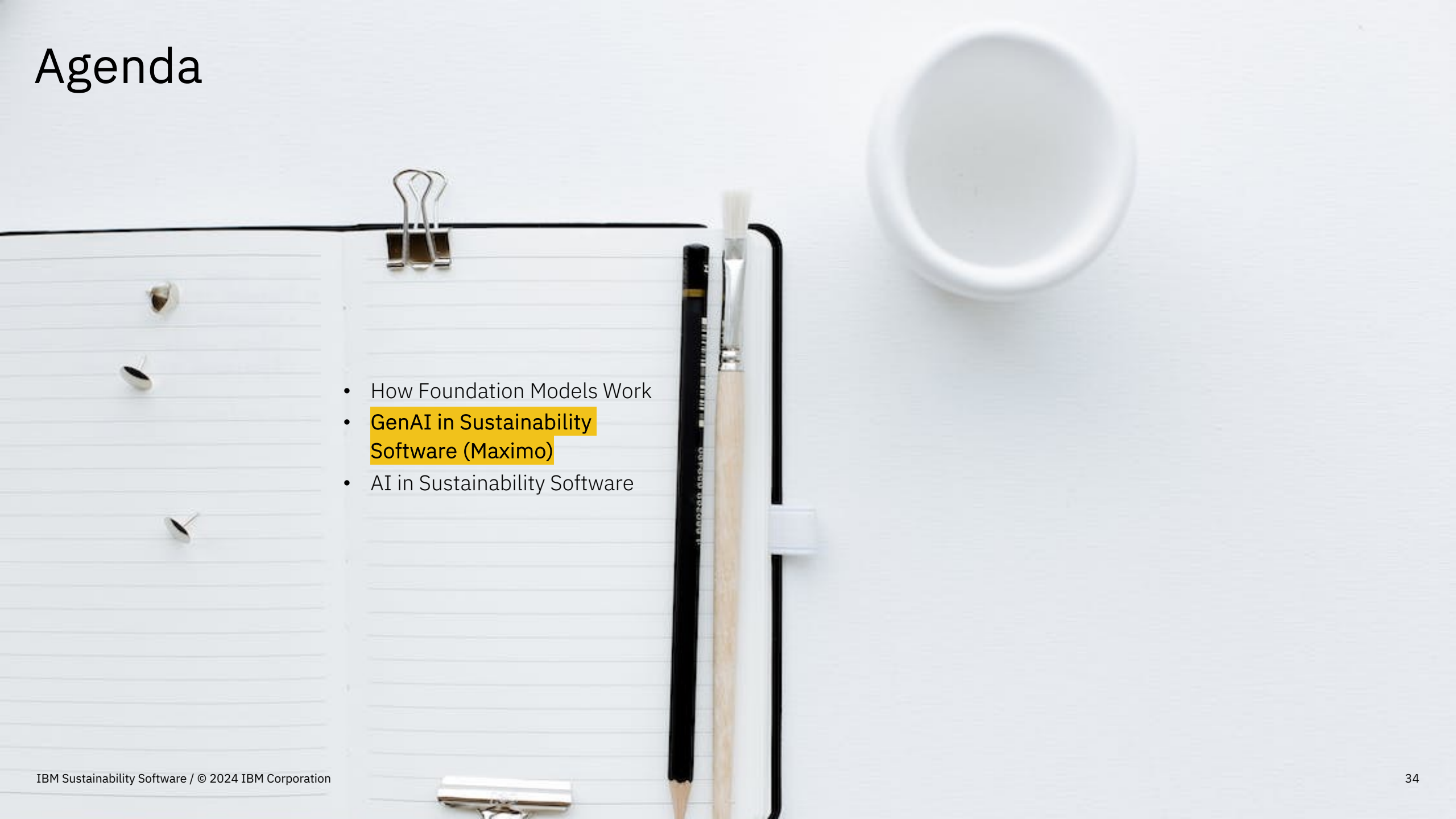
NIR and SWIR

This is also a great reminder to technology executives that you will incorporate many intelligences into your genAI-fueled applications. Do not expect or plan to rely solely on a large language model from Microsoft or Google. Most of the specific value will lie in these domain-specific genAI intelligences.

You will create real applications by orchestrating the intelligences you need (including your own knowledge foundation models and your machine-learning models and software).

Source: https://www.forrester.com/blogs/why-nasa-ibm-and-hugging-faces-open-source-model-is-a-big-deal/

Agenda



- How Foundation Models Work
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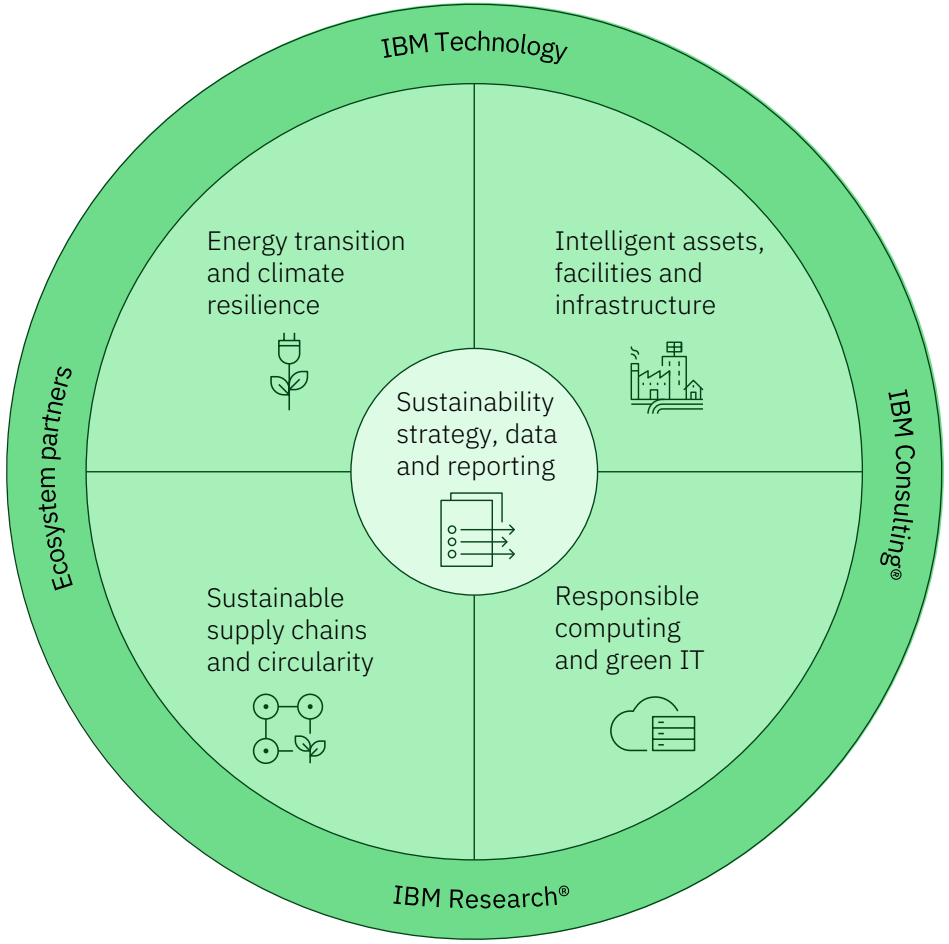
- AI in Sustainability Software

IBM Sustainability: Turning ambition into action

IBM helps companies achieve their sustainability goals by infusing data with AI into daily operations enabled by expertise to deliver profit and purpose.



Sustainability strategy, data and reporting

Co-create roadmaps that capture business value and leverage the power of generative AI to accelerate clients' realization of their sustainability agendas. Curate, report and operationalize data to unlock competitive insights, improve performance and meet regulatory requirements.

IBM® Envizi™ ESG Suite
IBM OpenPages® platform | IBM Planning Analytics

Energy transition and climate resilience

Support electrification with grid efficiency and modernization of energy infrastructure to expedite transition to renewables and build resilience to climate impacts.

IBM Environmental Intelligence Suite
IBM Maximo®

Intelligent assets, facilities and infrastructure

Build more efficient physical operations to increase productivity, advance decarbonization and reduce cost, waste and emissions.

IBM Maximo
IBM TRIRIGA®

Responsible computing and green IT

Optimize infrastructure and computing with AI at the core to enable more efficient, less energy-intensive IT and drive social impact.

Apptio
IBM Turbonomic®
IBM z16™ mainframes
IBM LinuxONE
IBM Power® servers
IBM Storage
IBM Cloud®

Sustainable supply chains and circularity

Design and manage intelligent workflows for transparent and trusted supply chains to enable just transition, circularity and Scope 3 emissions management.

IBM Sterling® Order Management
IBM Engineering Lifecycle Management
IBM Envizi Scope 3 Supply Chain Intelligence

IBM Technology

Scale and accelerate impact with hybrid cloud and the IBM watsonx™ platform.

IBM Consulting®

Embed strategy, experience, technology, thought leadership and provision of managed services.

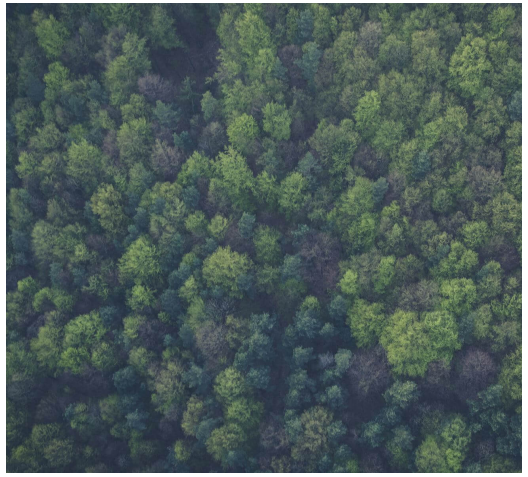
IBM Research®

Explore AI and climate research and accelerated sustainable materials discovery.

Ecosystem partners

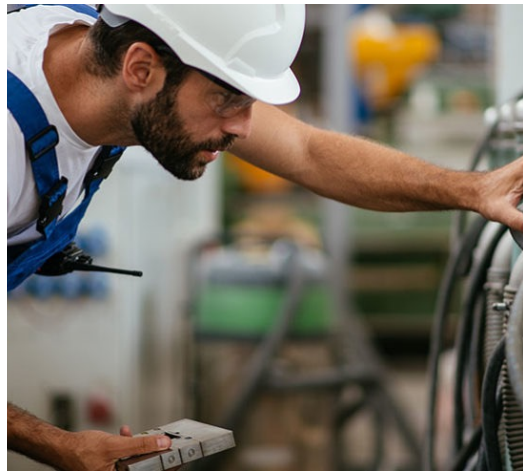
Collaborate with a diverse network of strategy, technology and services partners.

Generative AI use cases in Sustainability Software

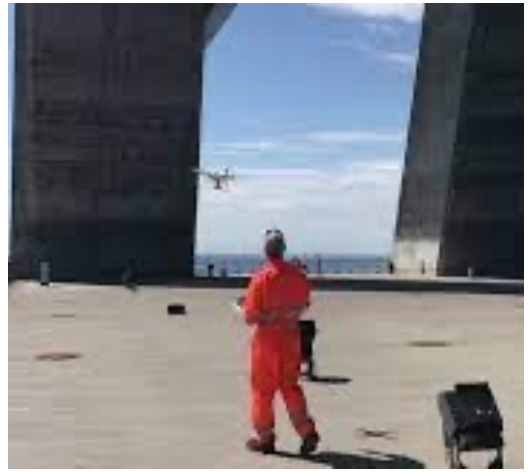


Above ground biomass

Scope 3 estimation



Work order intelligence

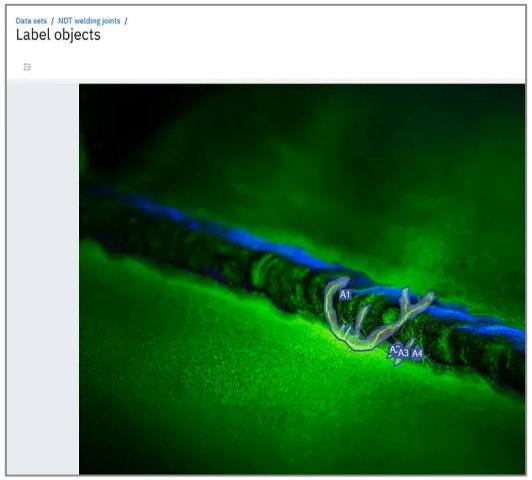


MVI anomaly detection

Wildfire and flood detection

Failure mode understanding

MAS onboarding assistant



MVI visual prompt tuning

Failure Mode Context Understanding

Identify common failure points and paths to failure for new assets to improve predictive maintenance and reliability programs

Challenges

- Understanding how assets fail is crucial in providing preventative maintenance and reducing asset downtime.
- Failure Mode and Effects Analysis provides key insights into this area
- However, FMEA data is not available for many kinds of assets, and it can take time to acquire

Solution

- Train a generative model of Uptake data to understand failure points and modes on common assets
- Use the generative model to produce data for assets that we have not worked with in the past
- Auto-populate FMEA rules and maintenance strategies in Maximo Health for new clients
- Identify new tags that can be used for anomaly detection and failure event analysis

Products and Technology:
Maximo Manage, Maximo Health, Maximo Predict, Maximo Monitor and watsonx.ai

Benefits

- Reduced time to value for asset classes where we have less experience
- More accurate failure assessments and preventative maintenance plans
- Automated creation of maintenance strategies for new assets & clients
- Improved Anomaly Detection and Event Prediction capabilities in Maximo Health and Predict

Work Order Intelligence.

Automatically identify and correct inaccurate failure codes in Maximo work orders

Challenges

- Understanding why a work order was created is key in finding patterns and in optimizing operations
- The collection of failure code information in work orders is typically manual and very error prone.
- Clients often do not collect data for all their asset classes, and it can take a significant amount of time to build up an adequate history of failure data

Solution

- Train an LLM to do classify and recommend work order failure codes
- Use that model to verify, correct or suggest the proper failure code for a given work order
- Find similar work orders to identify near-duplicate items and understand first time fix efficiency
- Enable automatic approval of work orders based on work order characteristics

Products and Technology:
Maximo Manage, watsonx.ai

Benefits

- Dramatically reduce the effort required to capture and maintain accurate failure code data
- Better understanding of the patterns of failures and potential problem parts
- Automatic approval of typical workorders enabling technicians to focus on solving the problems

MVI Foundation Models

Leverage foundation models to dramatically improve the anomaly detection capabilities in Maximo Visual Inspection and Maximo for Civil Infrastructure

Challenges

- Maximo Visual Inspection is currently based primarily on open-sourced convolutional neural network models
- We have seen that these models are not very accurate for Few-Shot Anomaly Detection problems for visual inspection use cases.
- The current models are also not as performant as they could be in production environments

Solution

- Migrate from CNN-based models to Transformer-based foundation models for anomaly detection

Products and Technology:
Maximo Visual Inspection, Maximo for Civil Infrastructure, watsonx.ai

Benefits

- Increase MVI supported use cases by ~50% leading to more sales opportunities
- Improved ease of use when creating a detection model
- Time to Value – removes the need for a large sample of training data for specific defects
- “Wow” factor with few-shot learning support for PLG

MVI Visual Prompt Tuning

Reduce the effort and training time required to produce a model for Maximo Visual Inspection

Challenges

- Maximo Visual Inspection uses the classic AI pattern of labeling data, training the model and then deploying the model to provide its capabilities
- Even though it does use transfer learning, it still requires several labelled examples for each type of defect that the client wants to detect
- Labeling these examples is time consuming and requires expert knowledge

Solution

- Use a combination of foundation models and prompt-tuning to dramatically reduce the effort required to effectively train the model

Products and Technology:
Maximo Visual Inspection, Maximo for Civil Infrastructure

Benefits

- Significant cost savings to customer in terms of reduced time of experts spent of data labelling
- Ability to use the same foundation model as a basis for prompt-tuning models for other assets and other types of defects

Agenda

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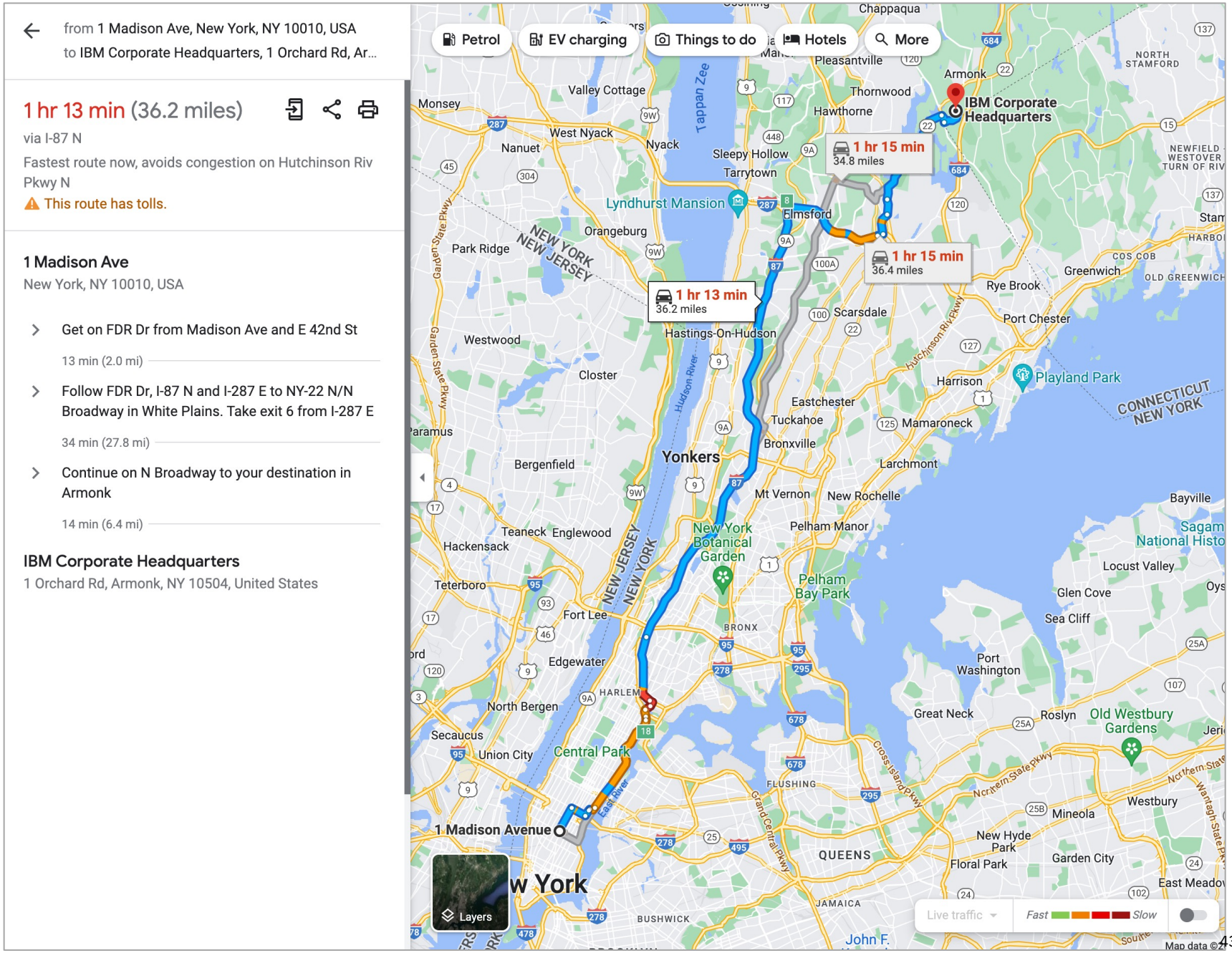
- AI in Sustainability Software

Where is AI in Sustainability Software?

Route maps

Directions in Route planners

- Provide origin
- Provide destination
- Planner plots points between
- Shows route options



AI+ Offering Map

Offering	Business Imperative	AI Type	AI Method	AI Model	AI Capability	Application / Use Case
Above Ground Biomass	Sustainability Strategy and Roadmap	Decision Mgmt	Constraint Satisfaction	Classification	Anomaly Detection	Action Recognition
EIS Outage Prediction	ESG Data, Reporting and Risk Management	Interaction	Dynamic Programming	Closed Form Optimization	API Task Orchestration	Anomaly removal from data for KPIs
EIS Thematic Change Maps	Intelligent assets, facilities and infrastructure	Deep Learning	Motion & Manipulation	Clustering	Association Rules	Anomaly detection from asset sensors
EIS Vegetation Mgmt	Responsible Computing and Green IT	Machine Learning	Optimization	Constraint Propagation	Augmentation for Supervised Learning	Anomaly detection for doc flows
ELM RQA	Sustainable supply chain and circularity	Generative/FM	Perception	Constraint Satisfaction	Computer Vision	Apportionment
Envizi			Probabilistic Models	Dimension Reduction	Data Augmentation	Asset Failure Probability Prediction
Maximo Assist			Reinforcement Learning	Direct Policy Search	Data Compression	Asset Failure Date Prediction
Maximo Monitor			Rules Engine	Distributional Methods	Factor analysis	Asset Failure Progression Prediction
Maximo Predict			Self-Supervised Learning	Dynamic Programming	Failure Detection	Business Milestone Interval Prediction
Maximo Scheduler			Simulation	Linear Programming	Forecasting and Prediction	Demand and Inventory Prediction
Maximo Visual Insights			Supervised Learning	Mixed Integer Programming	Fraud Detection	Finds documents associated with a business transaction flow
MRO IO			Unsupervised Learning	Nonlinear Programming	Gradient Boosted Decision Trees	Fulfillment optimization
SCIS Research Asst				Regression	Hierarchy Discovery	Image Classification for assets
SCIS Watson Asst				Search	Image Classification	Inventory Optimization
Sterling BTI				Simulation	Image Generation	Object Detection for assets
Sterling BTI Doc Corr				Structure Discovery	Language Understanding	Power Outage Forecasting
Sterling FO				Time Series Analysis	Movement Planning	Product Requirements Quality Analysis
TRIRIGA Building Insights				Value Function Estimation	Multi-objective Optimization	Product Usage forecasting
					Object Detection	Q & A Assistant on client data
					Pixel Segmentation	Scheduling optimization
					Product Segmentation	Scope 3 emissions estimation
					Recommendation Systems	Vegetation proximity to Power Lines
					Relationship Discovery	Visual Change Detection for Satellite Imagery
					Sales Forecasting	Visual Defect Detection for assets
					Scheduling optimization	
					Spam Detection	
					Text Generation	
					Time Series Forecasting	
					Time to Failure	
					Video classification	
					Video Generation	
					Visualization	

Reach out to us for all off the details of specific “Route Maps of AI” in our offerings!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