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Phoenix, AZ

The Energy-Smart Farm:

Distributed Intelligence Networks for Highly Variable and Resource Constrained Crop Production Environments

Dr. Robin Lougee

CENTER FOR COMPUTATIONAL AND STATISTICAL LEARNING
AI AND BLOCKCHAIN SOLUTIONS
INDUSTRY RESEARCH: IBM RESEARCH

IBM's global research network

3,000 researchers
\$5.75B in R&D (2016)





Weather Means Business™

Mapping The Atmosphere: A Big Data And IoT Approach To Precise Weather

The Weather Company delivers 26 billion forecasts per day



Up to
2.2 Billion
weather forecast
locations



15 Million
pressure
readings from
mobile devices



Atmospheric
data from
50,000 flights
per day



> 300,000
worldwide
weather stations



> 160
forecast
models serve
as inputs to
forecast

The Weather Company Data

Probabilistic forecast data can drive better decisions at threshold levels

Public & Private Data
Product, soil, yield, regulations, etc.



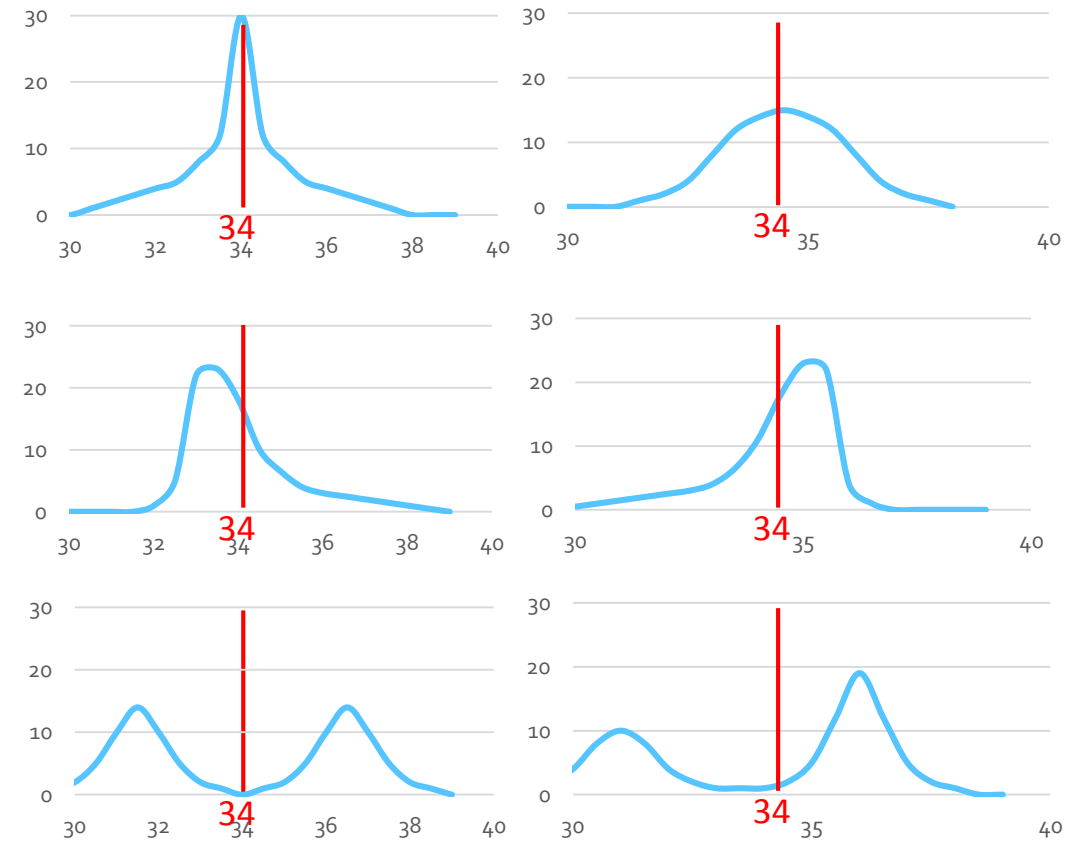
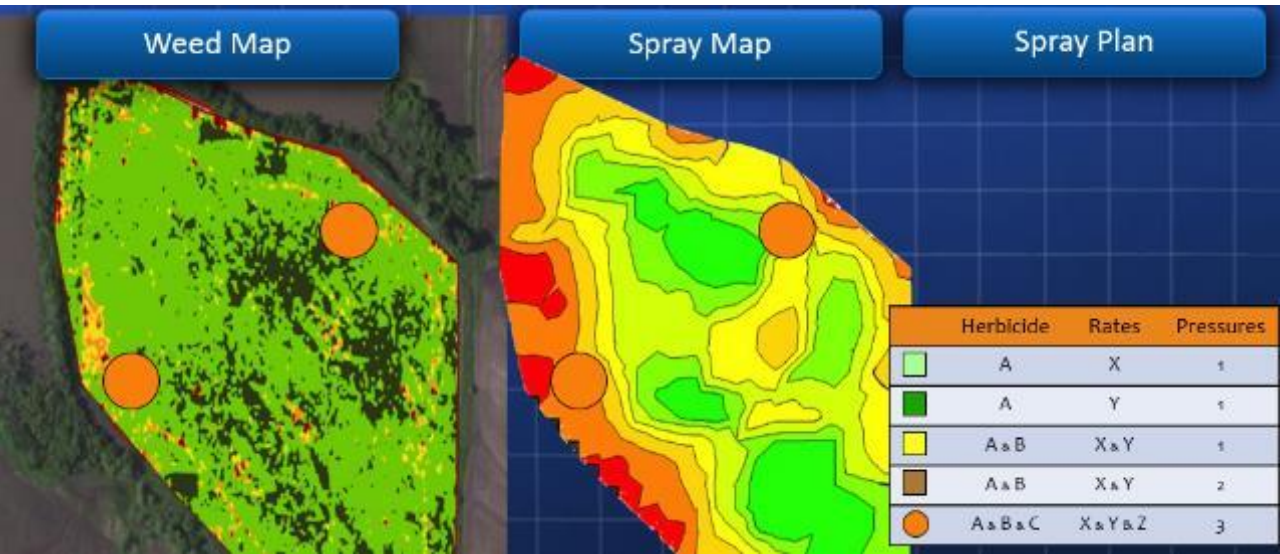
Frost prevention: What is the probability temperatures will fall below freezing for at least two hours tonight?



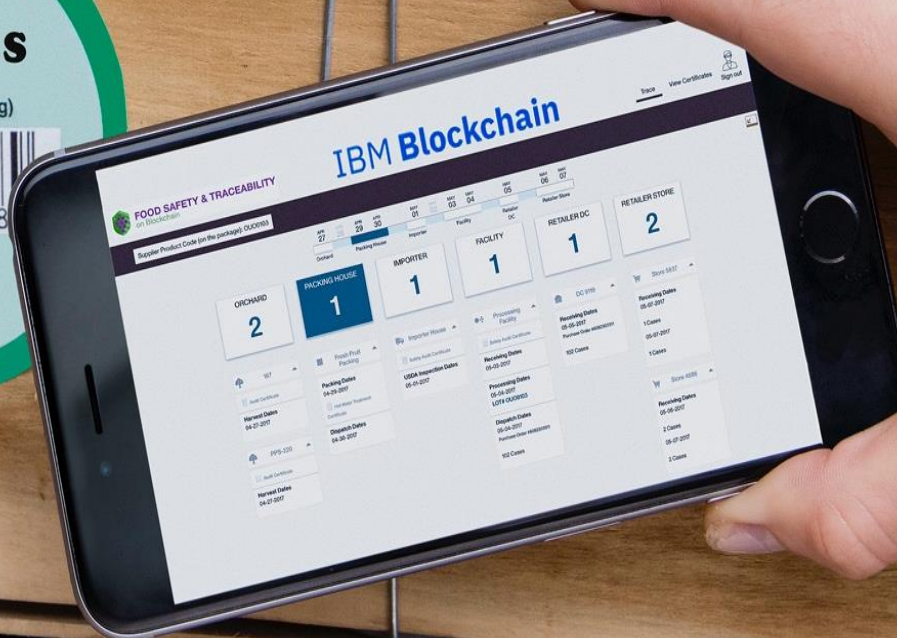
Product application: What is the chance that winds will rise above 10mph within the next 3 hours?



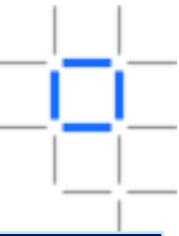
Irrigation: What is the chance I will get less than 0.5” of rain in the next 3 days?



IBM Global Food Safety Blockchain Consortium



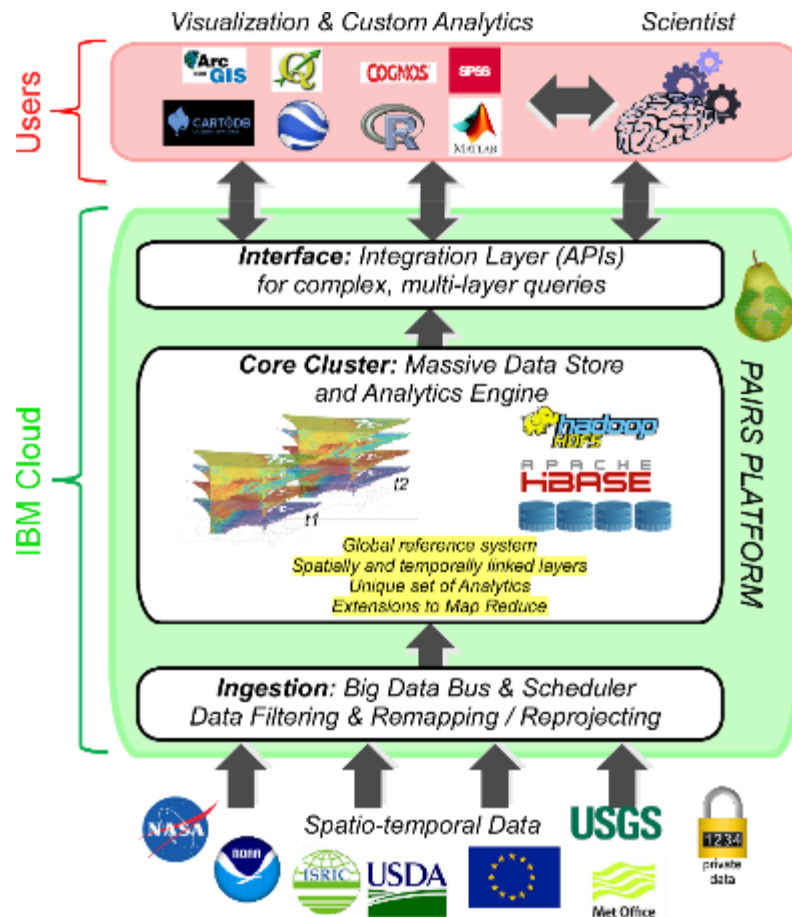
IBM is making Blockchain real for business with diverse engagements delivered across industries



Trade Finance	Pre and Post Trade	Complex Risk Coverage	Commercial Real Estate
Identity/ Know your customer (KYC)	Unlisted Securities / Private Equity Funds	Loyalty Program Mgt.	Distributed Energy & Grid Mgt.
Medical Health Data Exchange	Anti-Fraud & Port Mgt.	Carbon Credit Mgt.	Asset Tracking
Supply Chain & Logistics	Food Safety	Audit	Digital Rights & Copyright Mgt.

IBM PAIRS: Platform for spatio-temporal data curation and analytics

IBM PAIRS is an organized big data store, which curates and indexes public and private datasets from a large number of sources



Example data includes:

Data Set Name
Elevation (USA)
Soil properties (USA)
Landsat 7
Landsat 8
Landsat 8(SR)
Crop planting map (USA)
MODIS Aqua (13) (global)
MODIS Aqua (09) (global)
MODIS Terra (13) (global)
MODIS Terra (09) (global)
30 years historical weather – Daymet(USA)
California weather measurements (CA)
PRISM weather Measurement (USA)
USA Weather Forecast (USA)
Reference Evapotranspiration (Global) - IBM
SMT – ML weather product (USA) - IBM
European Model–ECMWF(Global)
Global Weather Forecast (Global)
Seasonal Forecast – SMT (Global) – IBM
EU Sentinel 1, 2A etc



PAIRS - The IBM Macroscopic

Pairing Big Geospatiotemporal Data with AI

Get started



Environmental Monitoring and Management

Real-time, event driven, active, intelligent distributed analytics



The Jefferson Project
at Lake George

A state-of-the-art systems approach

- Monitoring
- Modeling
- Simulation
- Forecasting
- Experimentation

Smart decision-making to secure ecosystem resilience in the face of long-term pressures from climate change and intensifying human use.

Requirements

- Multiple **sensing** platforms must be deployed to gather data; to monitor weather, water chemistry and quality, lake currents and stream flows (~40 sensor platforms and 200 million observations)
- **Analytics** platform for consolidating and analyzing all of the data and for reporting the results
- Scientific **collaboration**, working with historical and new observational data

A comprehensive "cyberinfrastructure"

- The technology "fabric" of the Jefferson Project
 - Sensors
 - Communications/telemetry
 - Computational platforms
- The ability to collect, store, monitor, analyze, share, and access complex data by a wide variety of users



Leveraging AI & Cognitive for Agri-Food insights

Crop Vigor	Soil Moisture	Plant Pathologist	Crop Identification, Acreage Estimation	Fruit Count	Yield Estimation
<ul style="list-style-type: none"> ▪ Crop health monitoring ▪ Crop type inference ▪ Fertilizer, pesticide and irrigation advisory 	<ul style="list-style-type: none"> ▪ Irrigation Scheduling ▪ Drought Monitoring ▪ Farm quality monitoring ▪ Arable land prospecting ▪ Human health monitoring 	<ul style="list-style-type: none"> ▪ Pesticide and fungicide advisory ▪ Mitigation of crop loss ▪ Automated monitoring in high-risk areas 	<ul style="list-style-type: none"> ▪ Acreage estimation ▪ Yield forecasting ▪ For crop insurance: fraud detection, crop-cutting expts. 	<ul style="list-style-type: none"> ▪ Crop-yield estimates for farmers ▪ Estimate fruit ripeness and health ▪ Evaluate shape and dimension of fruit for grading 	<ul style="list-style-type: none"> ▪ Yield forecasting ▪ Fertilizer chain management ▪ Logistics management after harvest ▪ Yield price estimation

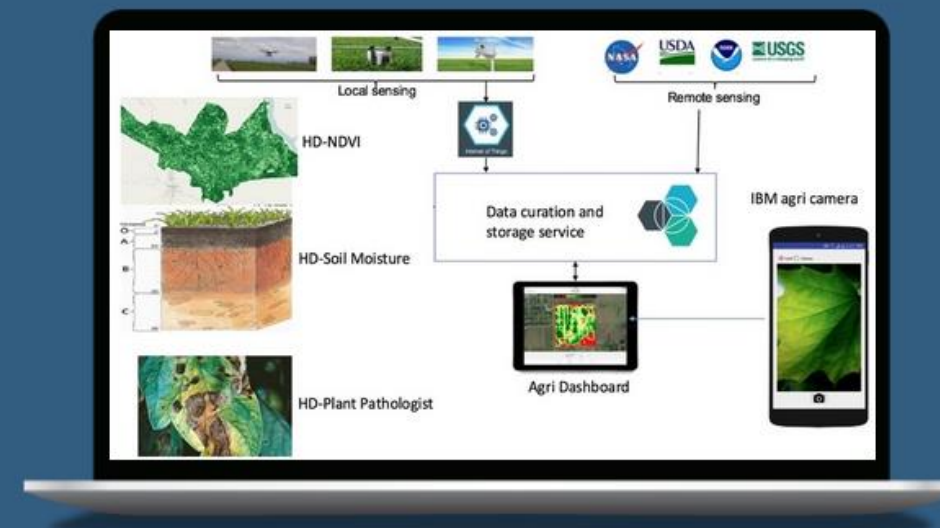
On IBM Cloud, Watson IoT, PAIRS, IBM Weather Company

Source: Alpha versions available and geographies being added

IBM Research Precision Agriculture

IBM Research Innovation for Agriculture starts with three baseline services namely high definition vegetation index, soil moisture, and plant pathology.

Start your free trial

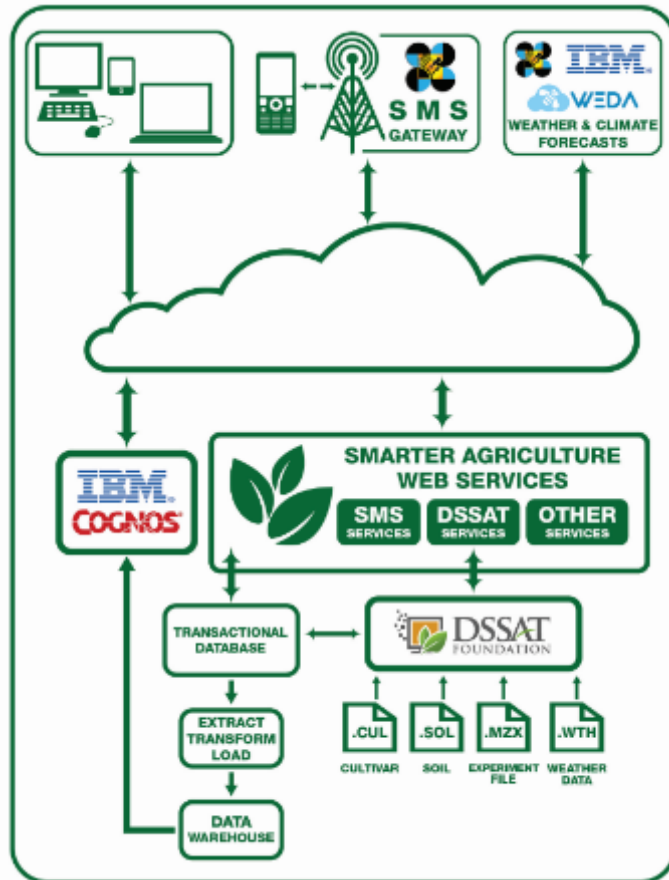


Precision Agriculture

High definition NDVI service will provide real time vegetation health/growth status of any farm or a group of farms at a resolution of 30m by 30m. This will help the growers to pinpoint the pockets not growing well in the field. This helps farmers to take prevention actions (e.g. pesticide application, fertilizer or nutrient application, etc). High definition soil moisture service can be used to maximize the yield through precision irrigation. High definition plant pathologist app can help farmers to detect the type of crop and pest/diseases attacks at an early stage of infestation.

Philippines

Farmer Decision Support System



Farmers can query or the information can automatically be pushed to their phones via SMS



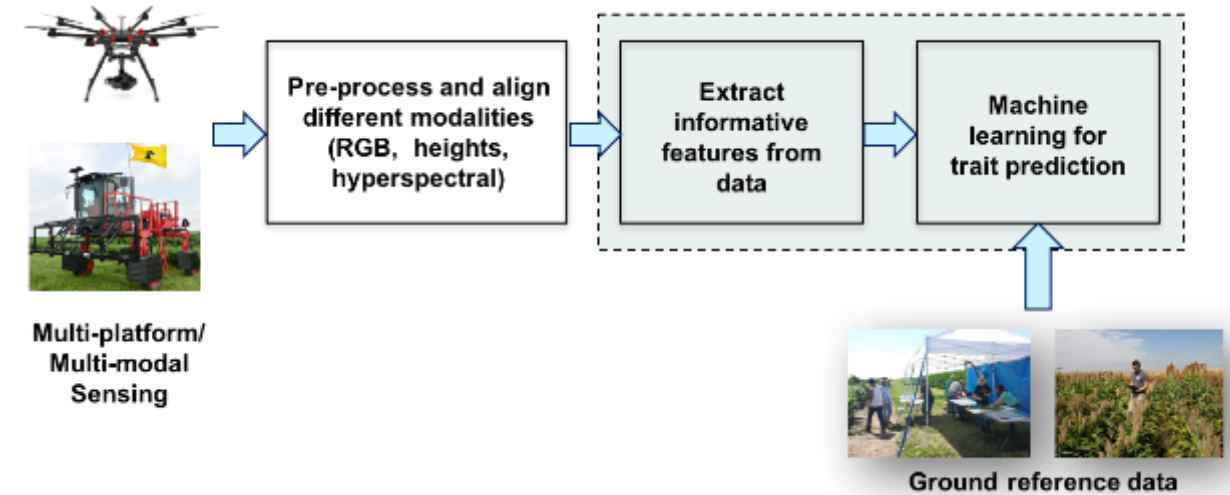
- When is the best date to start planting?
- How much will I harvest?
- When will the growth stages occur?
- When do I apply fertilizer and by how much?
- When do I water the plants and by how much?
- When do I harvest?
- Is it going to rain in the next 7 days?



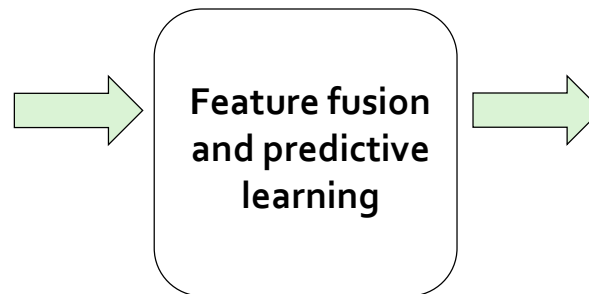
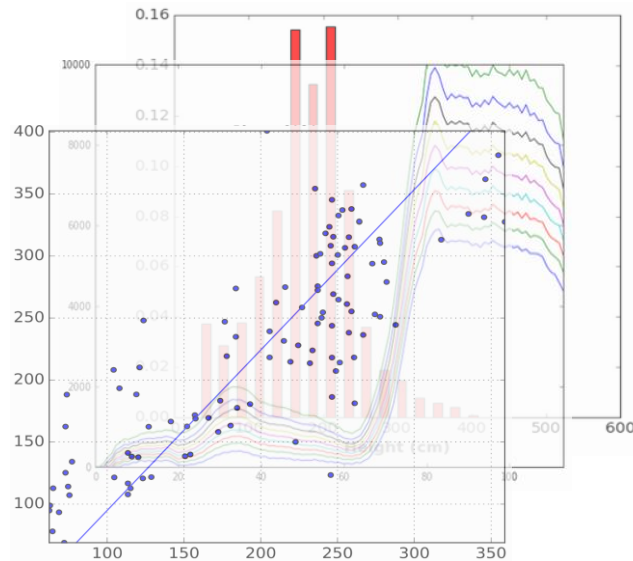
<http://ieeexplore.ieee.org/document/7238049/>

Accurate Phenotyping by Multi-Modal Feature Fusion

- As part of ARPA-E TERRA project, we have been developing and applying Machine Learning technology for multi-modal automated phenotyping
- Fusing spectral indices, height histograms, and the raw spectra improves predictive accuracy significantly compared to using individual features as predictors (from R^2 of 0.26, 0.10, 0.0)



Context of our work in the Automated Phenotyping Pipeline (TERRA)

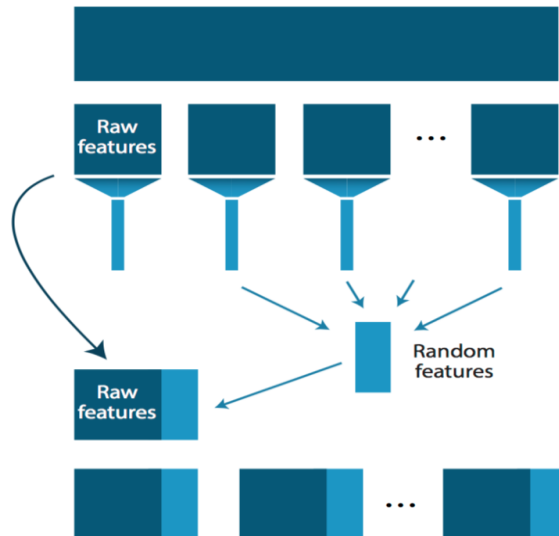


Phenotype	RMSE	R^2	Bias (%)
Height	32.44 cm	0.80	3.05
Diameter	3.01 mm	0.52	0.50
Volume (DE)	80.56 cm ³	0.23	5.27
Volume (PE)	71.01 cm ³	0.25	6.38

Distributed Learning for Energy-Efficient Feedstock Supply Chain

Motivation: The feedstock supply chain today accounts for a significant portion of energy waste in the world. Improving the efficiency of the feedstock supply chain will have a major impact on the energy efficiency of the world.

Technical problem : Need to develop distributed machine learning capabilities that can be used to model, monitor and optimize energy efficiency of food supply chain, by analyzing large amount of distributed transaction data, without bringing them together in centralized location and respecting privacy of participating parties



Relevant Technology Areas: We have expertise in advanced machine learning techniques applicable to various scenarios e.g.

1. Modeling common global model from multiple sources;
2. Modeling multiple, related models via multi-task learning;
3. Communication-efficient distributed learning from disjoint feature sets via random projection "sketching" (c.f. <https://xdata-skylark.github.io/>)
4. Computationally efficient distributed modeling via distributed optimization techniques

Artificial Intelligence

partnerships

ibm watson

MIT

IBM

IBM and MIT pen 10-year, \$240M AI research partnership

Posted Sep 6, 2017 by [Ron Miller \(@ron_miller\)](#)



IBM is making significant investments in AI

Thank you

QUESTIONS?

