watsonx workshop

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Prepared for:

Institute for
Data Science & Informatics
University of Missouri

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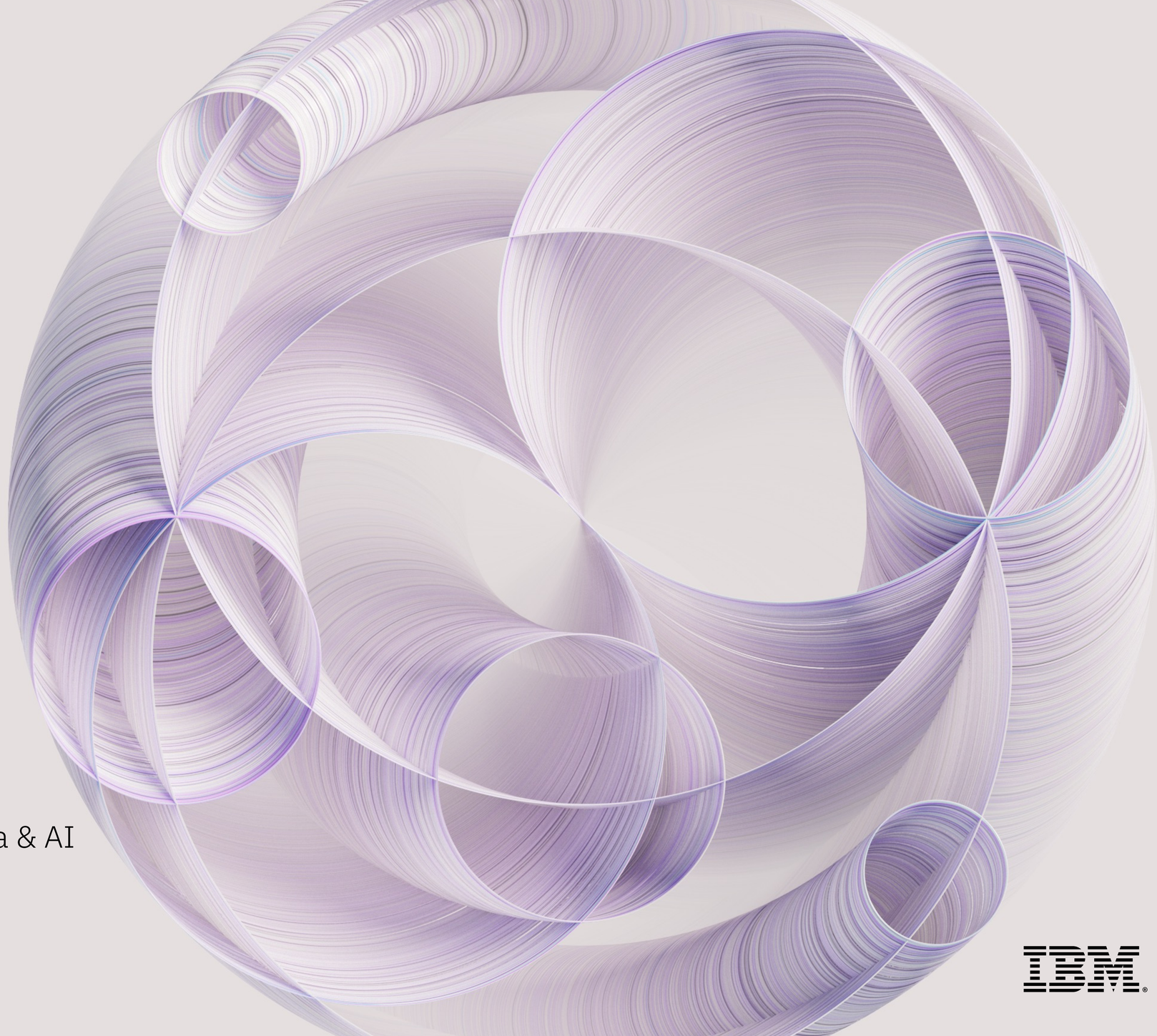


Agenda

- The impact of generative AI:
  The opportunity
- AI Development: From +AI to AI+
- Enterprise considerations
- What IBM offers:
  Open, trusted, targeted,
  empowering AI solutions
- Getting started

The speed, scope, and scale of generative AI impact is unprecedented

Massive early adoption

80%

of enterprises are working with or planning to leverage foundation models and adopt generative AI

Broad-reaching and deep impact

Generative AI could raise global GDP by

7% within 10 years

Critical focus of AI activity and investment

Generative AI expected to represent

30%

of overall market by 2025

Sources: Statista; Reuters; Goldman Sachs; IBM Institute for Business Value; Gartner. Scale Zeitgeist: AI Readiness Report, a survey of more than 1,600 executives and ML practitioners

The most common generative AI tasks implemented today

Retrieval-Augmented Generation

Based on a documents or dynamic content, create a chatbot or question-answering feature.

Building a Q&A resource from a broad knowledge base, providing customer service assistance

Summarization

Transform text with domain-specific content into personalized overviews that capture key points.

Conversation summaries, insurance coverage, meeting transcripts, contract information

Content Generation

Generate text content for a specific purpose.

Marketing campaigns, job descriptions, blog posts and articles, email drafting support

Named Entity Recognition

Identify and extract essential information from unstructured text.

Audit acceleration, SEC 10K fact extraction

Insight Extraction

Analyze existing unstructured text content to surface insights in specialized domain areas.

Medical diagnosis support, user research findings

Classification

Read and classify written input with as few as zero examples.

Sorting of customer complaints, threat and vulnerability classification, sentiment analysis, customer segmentation

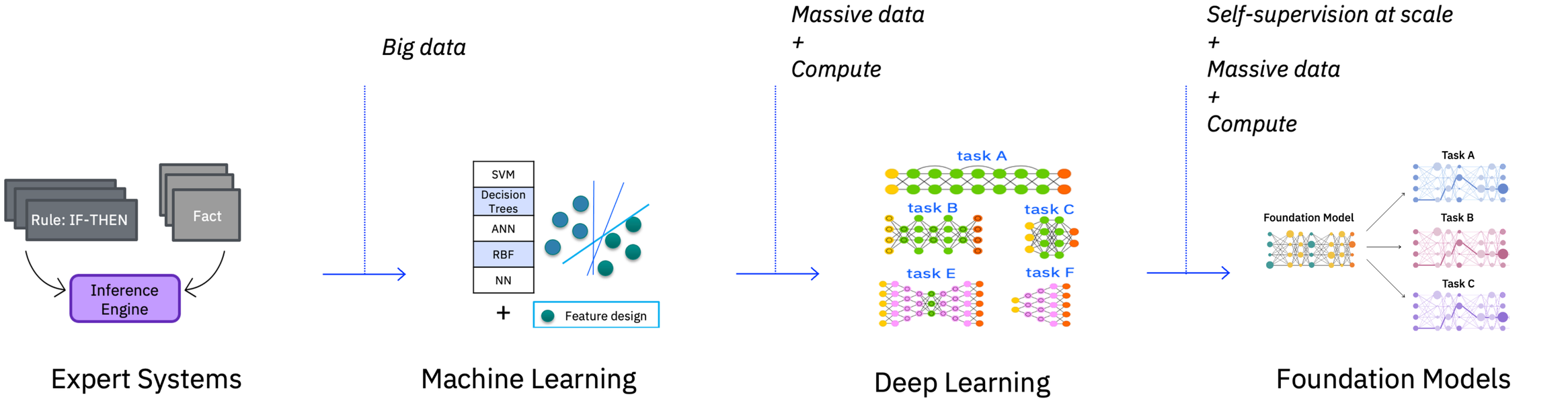
The impact of generative AI
| +AI to AI+

IBM is actively engaging with enterprise clients across a broad set of business domains

NON-EXHAUSTIVE

Customer-facing functions and experiences	HR, Finance, and Supply Chain functions	IT development and operations	Core business operations
Customer service Empower customers to find solutions with easy, compelling experiences. Automate answers with 95% accuracy	**HR automation** Reduce manual work and automate recruiting, sourcing and nurturing job candidates. Reduce employee mobility processing time by 50%	**App modernization, migration** Generate code, tune code generation response in real time. Deliver faster development output	**Threat management** Reduce incident response times from hours to minutes or seconds. Contain potential threats 8x faster
Marketing Increase personalization, improve efficiency across the content supply chain. Reduce content creation costs by up to 40%	**Supply chain** Automate source to pay processes, reduce resource needs and improve cycle times. Reduce cost per invoice by up to 50%	**IT automation** Identify deployment issues, avoiding incidents, optimize application demand to supply. Reduce mean time to repair (MTTR) by 50%+	**Asset management** Optimize critical asset performance and operations while delivering sustainable outcomes. Reduce unplanned downtime by 43%
Content creation Ex. Enhance digital sports viewing with auto-generated spoken AI commentary. Scale live viewing experiences cost effectively	**Planning and analysis** Make smarter decisions, focus on higher value tasks with automated workflows and AI. Process planning data up to 80% faster	**AIOps** Assure continuous, cost-effective performance and connectivity across applications. Reduce application support tickets by 70%	**Product development** Ex. Expedite drug discovery by inferring structure with AI from simple molecular representations. Faster and less expensive drug discovery
Knowledge worker Enable higher value work, improve decision making, and increase productivity. Reduce 90% of text reading and analysis work	**Regulatory compliance** Support compliance based on requirements / risks, proactively respond to regulatory changes. Reduce time spent responding to issues	**Data platform engineering** Redesign the approach for data integration using generative AI. Reduce data integration time by 30%+	**Environmental intelligence** Provide intelligence to proactively plan and manage impact of severe weather and climate. Increase manufacturing output by 25%

Foundation models can help accelerate enterprise AI adoption



- No use of data
- Manually authored rules
- Brittle

- Less brittle but labor intensive
- Demanding data prep and feature engg.

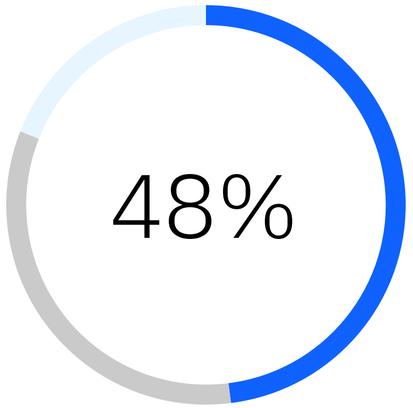
- Automatically learn if you have enough labeled data
- Enterprise adoption limited by availability of labeled data

- Learn from lots of data without requiring labels
- Adapt quickly to many tasks
- Accelerate enterprise adoption

Generative AI adoption considerations, inhibitors and fears

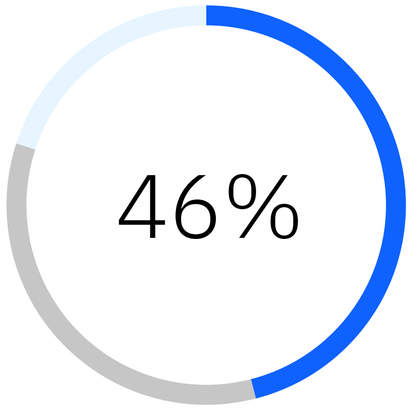
80% of business leaders see at least one of these ethical issues as a major concern

Explainability



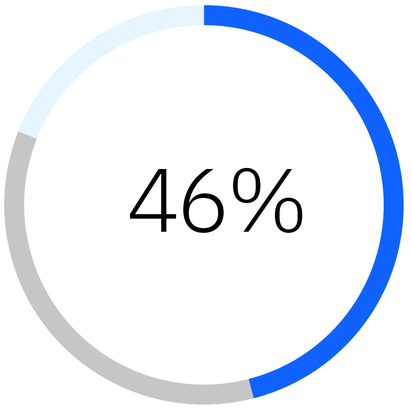
Believe decisions made by Generative AI are not sufficiently **explainable**.

Ethics



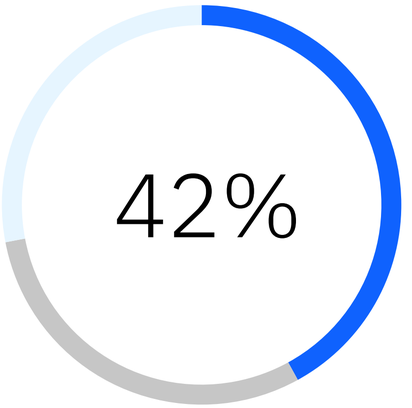
Concerned about the safety and **ethical** aspects of Generative AI.

Bias



Believe that Generative AI will propagate established **biases**.

Trust



Believe Generative AI cannot be **trusted**.

Source: IBM IBV “Generative AI: The state of the market”, June 2023

Agree Neutral Disagree

Simpler Times

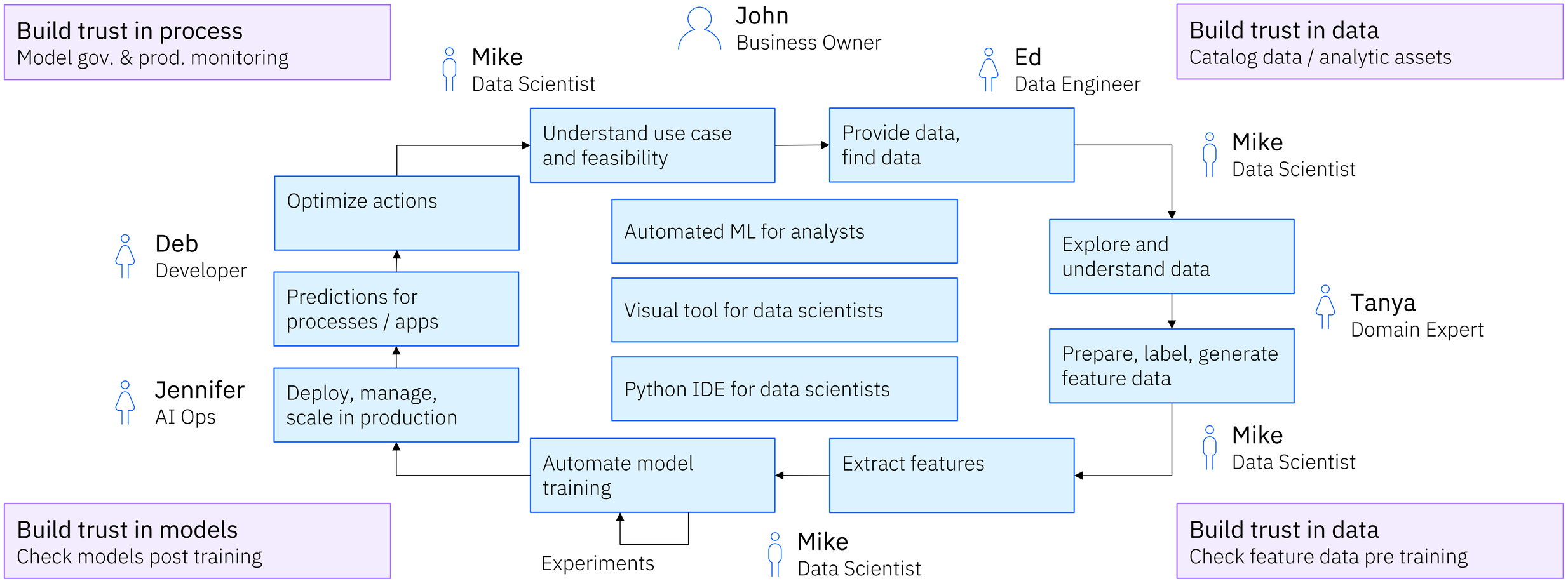
Data Science is now a team sport.

Data and ML landscapes have evolved.

Factors to Account

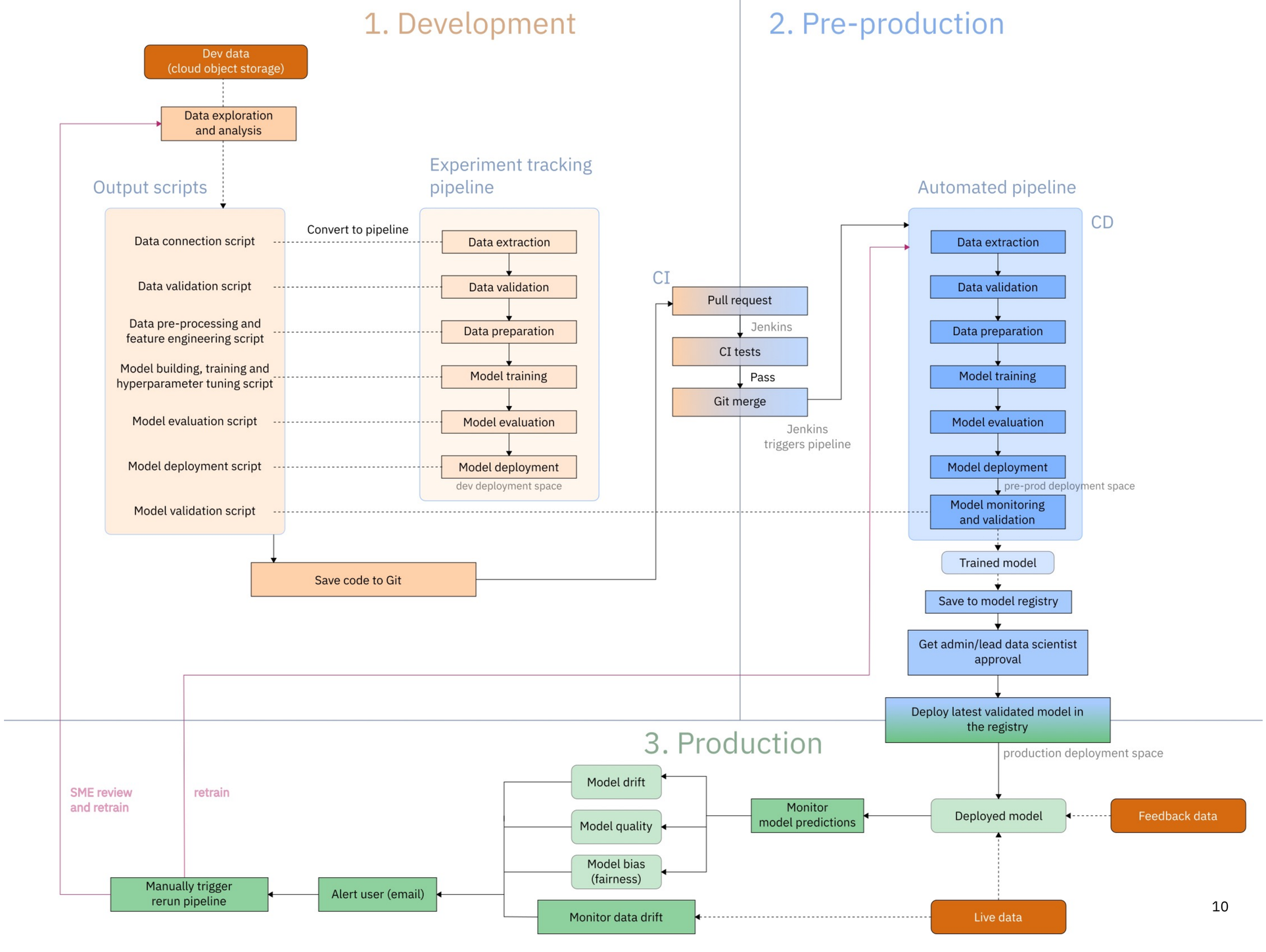
- Repeatability
- Accountability
- Transparency
- Explainability
- Risk Exposure
- Robustness
- Performance

DS Process
CRISP-DM NIST Methodology

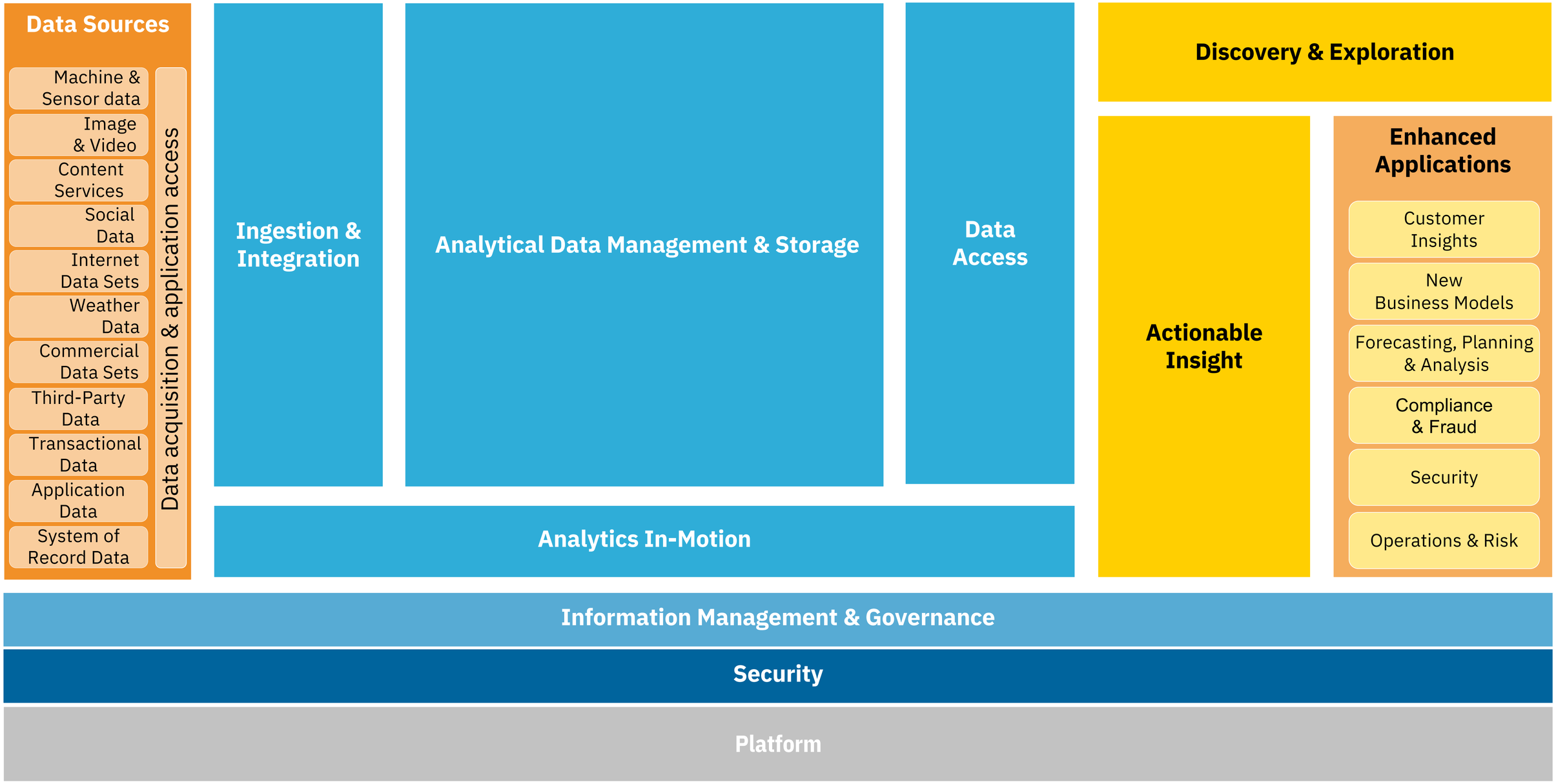


MLOps

Modern Watson Studio MLOps Workflow from Dev to Prod with CI-CD



Data & Analytics Reference Architecture



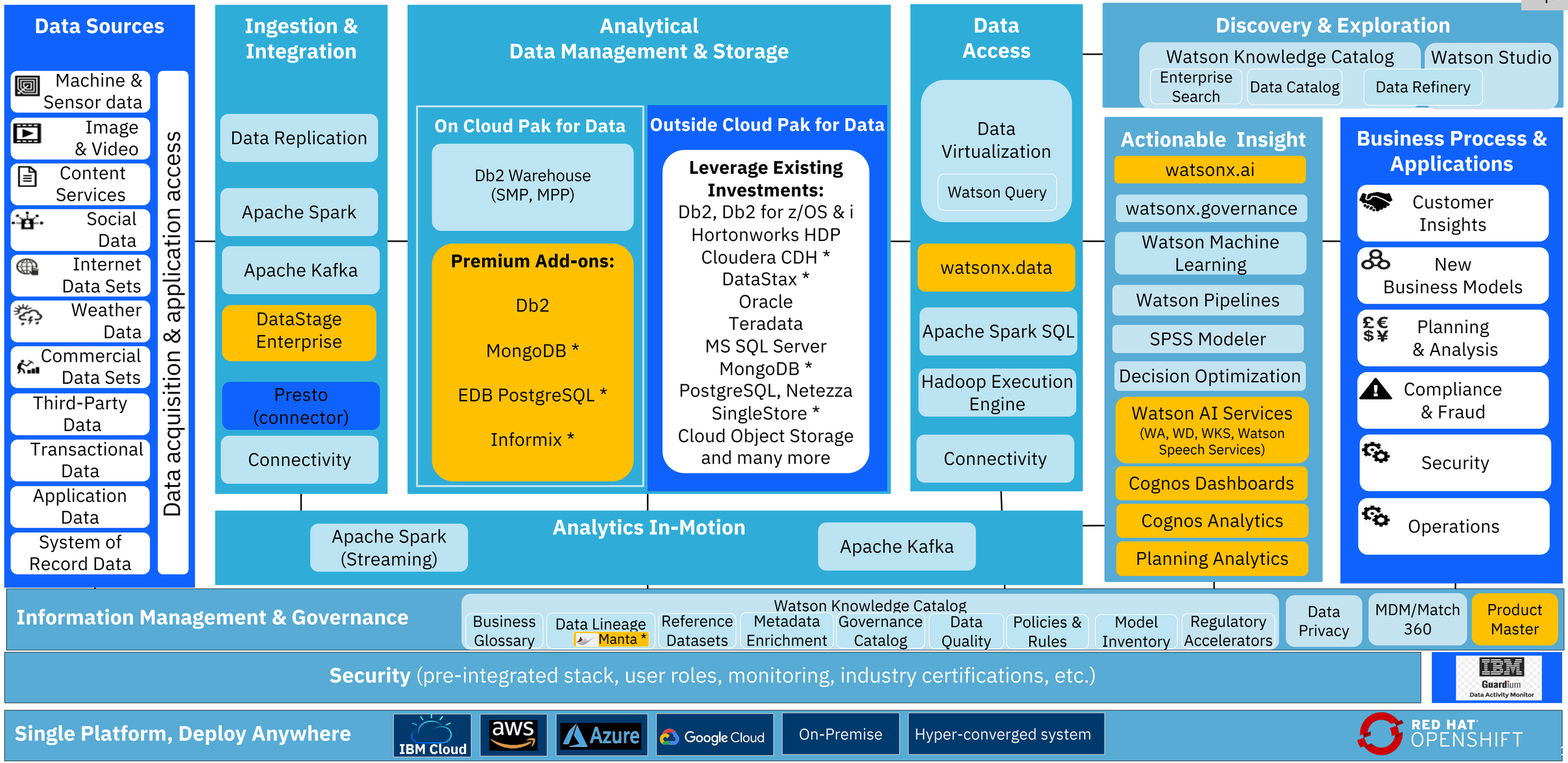
Reference Architecture – Product View

IBM Cloud Pak for Data (Base)

IBM Cloud Pak for Data – Premium Add-ons

Customer Investments Outside Cloud Pak for Data

* partner



IBM’s Evolution and Leadership in AI:

2008: IBM **Watson brand created** to align to innovation in AI

2011: IBM debuts system to compete against long standing **Jeopardy** champions Ken Jennings and Brad Rutter

2014-2015: : IBM debuts partnership with Mayo Clinic and **launches Watson Health** for health-related data, assets and AI applications

2017: IBM embarks on creating a standard set of **NLP/Speech/Dialog libraries**.

2018: Watson Assistant is launched, IBM’s **conversational AI** technology

2019: IBM builds, **Project Debate**r, an AI powered system to debate a human in a live debate competition using deep NLP and generative AI capabilities

2019: IBM **introduces standard libraries** that will power all "Watson" products going forward. These libraries contain foundation models, Language Model compression, proprietary models and open source components.

2020: IBM **infuses Foundational models Into AI applications** like Watson Assistant and Watson Discovery

2023: **IBM launches WatsonX** - an AI built and infused platform for working with, customizing, tuning, deploying and governing foundation models.

2024: Governance and trust permeate AI

2025: AI becomes more energy and cost efficient

2027: Foundation models in production scale uniquely

2029: Trustworthy and explainable AI starts to reason

2030: Fully multi-modal AI gives enterprises unprecedented scale

Generative AI must be tailored to the enterprise (TOTE)

Trusted

→ Offering security and data protection.

→ Built with governance, transparency, and ethics that support increasing regulatory compliance demands.

Open

→ Based on the best open technologies available.

→ Giving access to the innovation of the open community and multiple models.

Targeted

→ Designed for targeted for business use cases, that unlock new value.

→ Including models that can be tuned to your proprietary data.

Empowering

→ On a platform to bring your own data and AI models that you tune, train, deploy, and govern.

→ Running anywhere, designed for scale and widespread adoption.

The platform for AI and data

watsonx

Scale and accelerate the impact of AI with trusted data.

watsonx.ai

Train, validate, tune and deploy AI models

A next generation enterprise studio for AI builders to train, validate, tune, and deploy both traditional machine learning and new generative AI capabilities powered by foundation models. It enables you to build AI applications in a fraction of the time with a fraction of the data.

watsonx.data

Scale AI workloads, for all your data, anywhere

Fit-for-purpose data store optimized for governed data and AI workloads, supported by querying, governance and open data formats to access and share data.

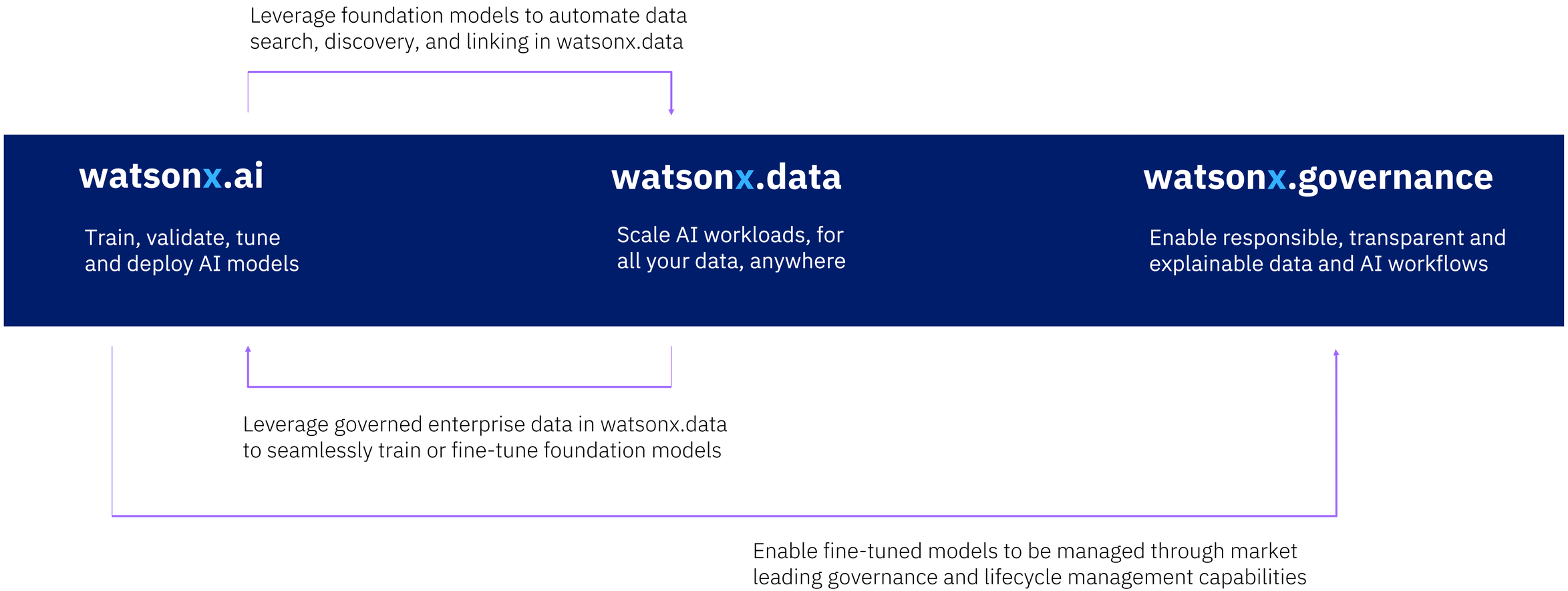
watsonx.governance

Enable responsible, transparent and explainable data and AI workflows

End-to-end toolkit encompassing both data and AI governance to enable responsible, transparent, and explainable AI workflows.

Put AI to work with **watsonx**

Scale and accelerate the impact of AI with trusted data.



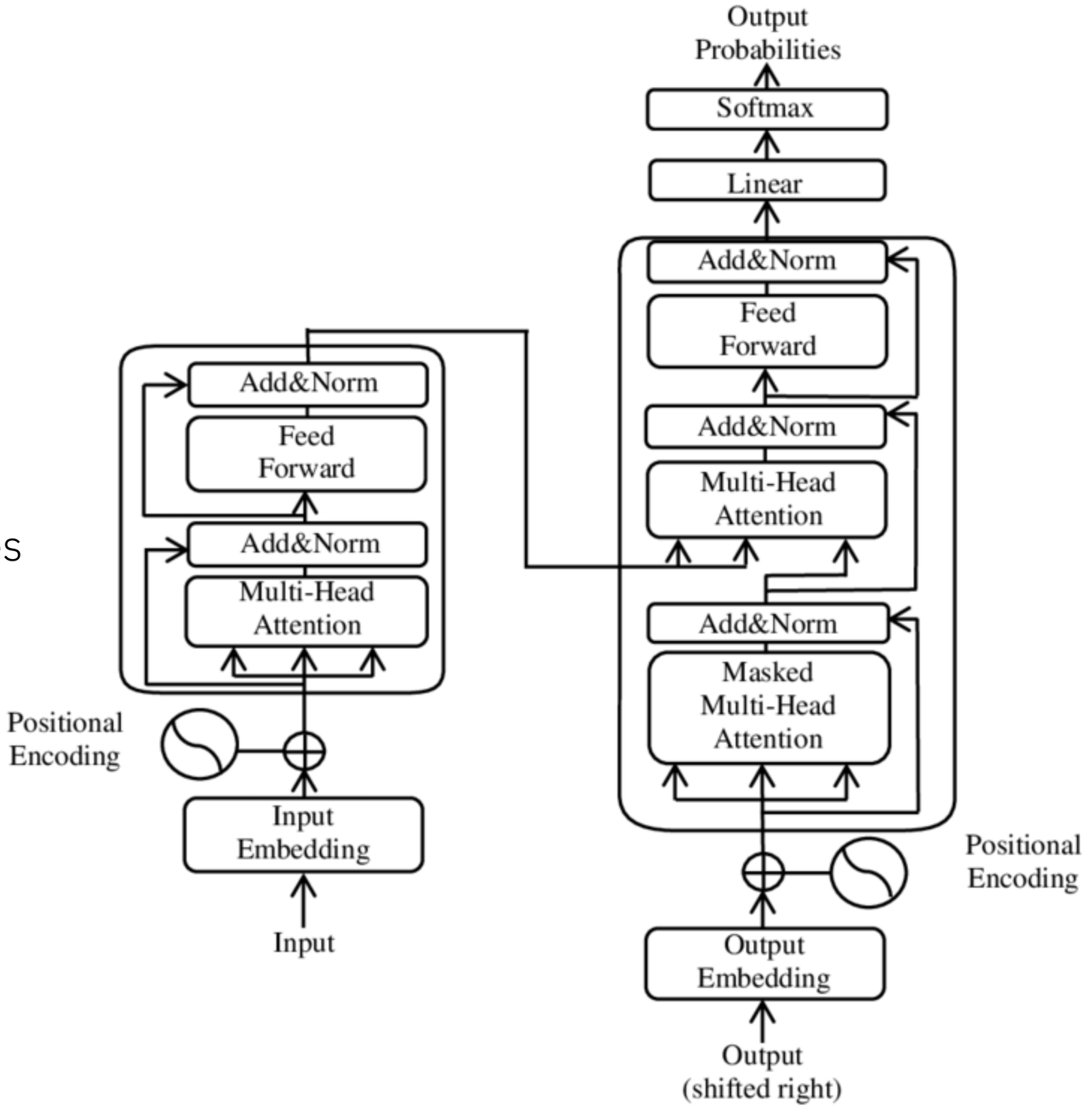
Transformer Model Architecture

- NLP: Transformer Based Architecture

Encoding and Decoding Neural Stages

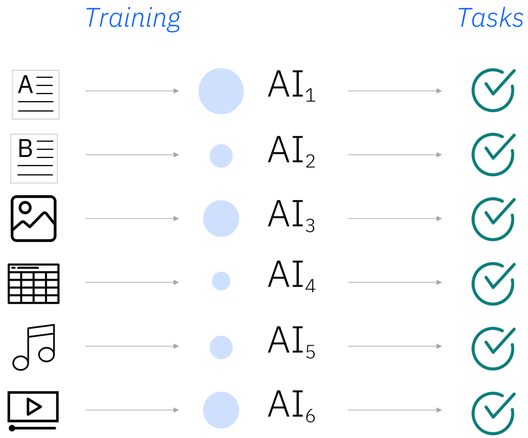
Operates with Embeddings and Attention

Two Papers:
“Attention Is All You Need”
“BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding"



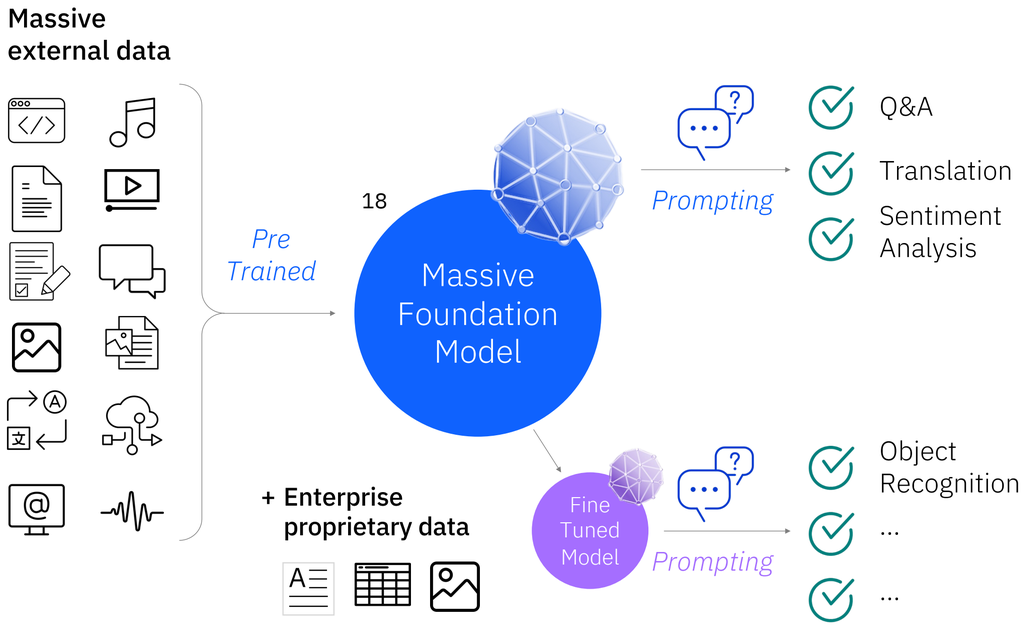
Foundation models establish a new paradigm for AI capabilities

Traditional AI models



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

Foundation Models



- Massive multi-tasking model
- Adaptable with little or no training
- Pre-trained unsupervised learning

Enhanced capabilities

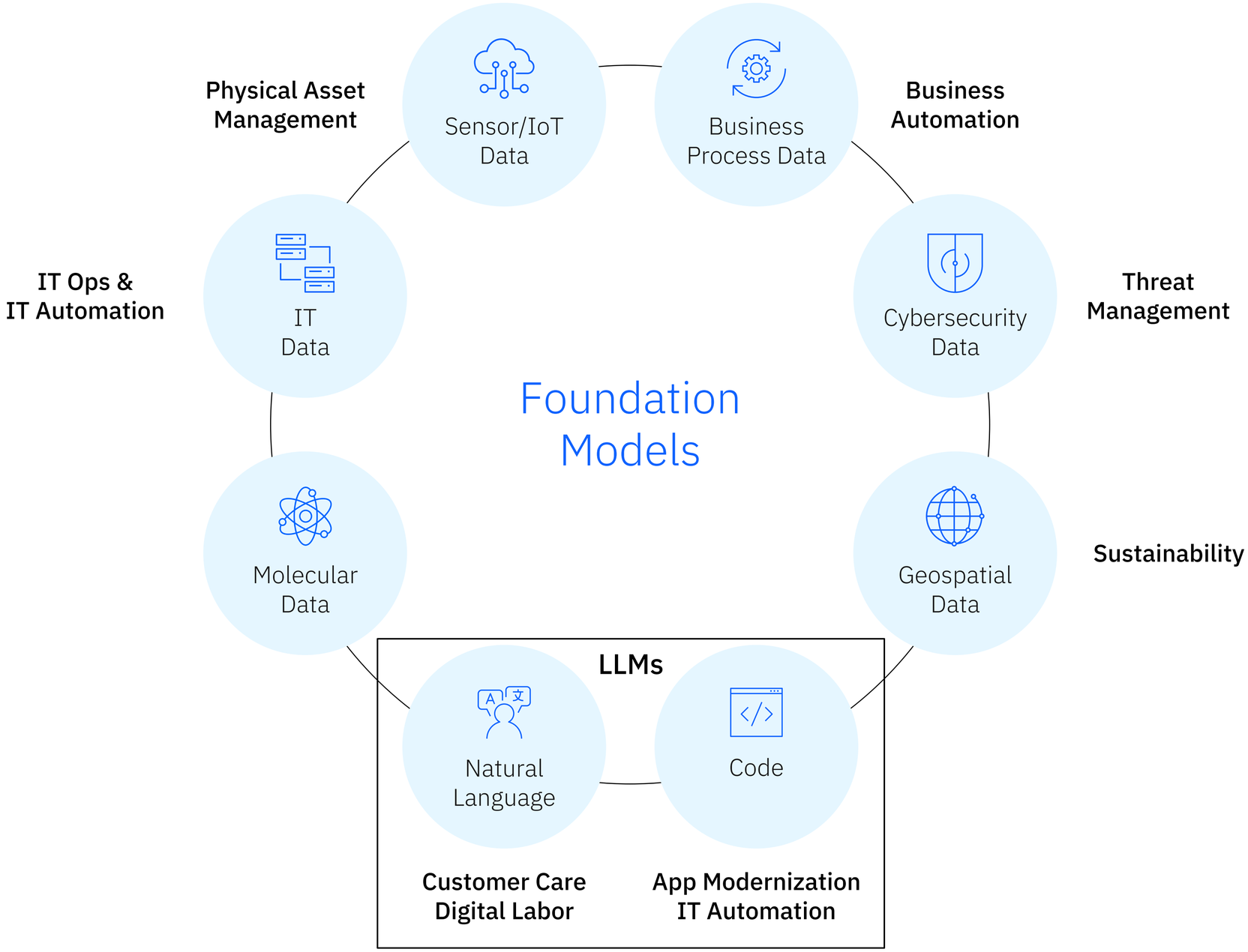
- Summarization
- Conversational Knowledge
- Content Creation
- Code Co-Creation

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

Opportunity to unlock business advantage with foundation models trained across the breadth of enterprise data



Foundation Model Library

Model variety to cover enterprise use cases and compliance requirements

IBM models

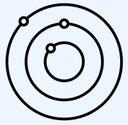
IBM's suite of foundation models are designed to ensure model trust and efficiency in business applications. Our suite of models feature:

Transparent Pre-Training on IBM's trusted Data Lake

- Largest known repository of enterprise-relevant training data
- Verified legal and safety reviews by IBM
- Full, auditable data lineage available for any IBM Model

Compute-Optimal Model Training and Architectures

- Granite
  Decoder only transformers
- Sandstone
  Encoder-decoder transformers
- Obsidian (in progress)
  Sparse universal transformers



Efficient Domain and Task Specialization

Models Coming Soon:

- fm.geospatial
- granite.3b.finance
- granite.3b.cybersecurity
- And more! (legal, climate, etc.)

Opensource models

Experiment with opensource models

IBM and Hugging Face partnership demonstrates our shared *commitment to delivering to clients an open ecosystem approach* that allows them to define the best models for their business needs.

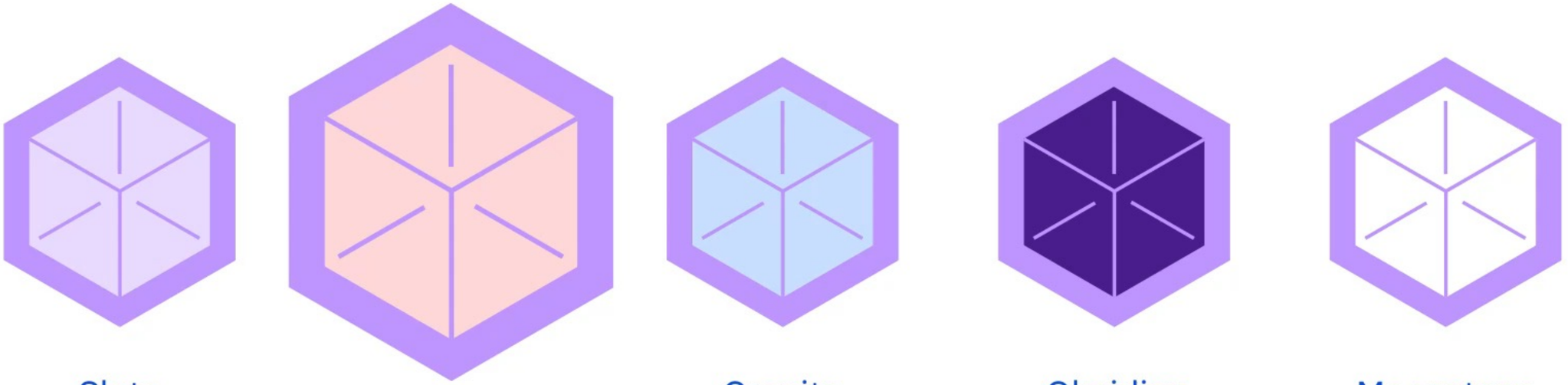
BYO models (optional add on)

Partner with IBM Research to pre-train your own foundation models.

→ watsonx

watsonx.ai | .data | .governance

Model architectures



Slate

Non-generative encoder-only architecture

Sandstone

Lightweight encoder-decoder architecture

Granite

Decoder-only architecture

Obsidian

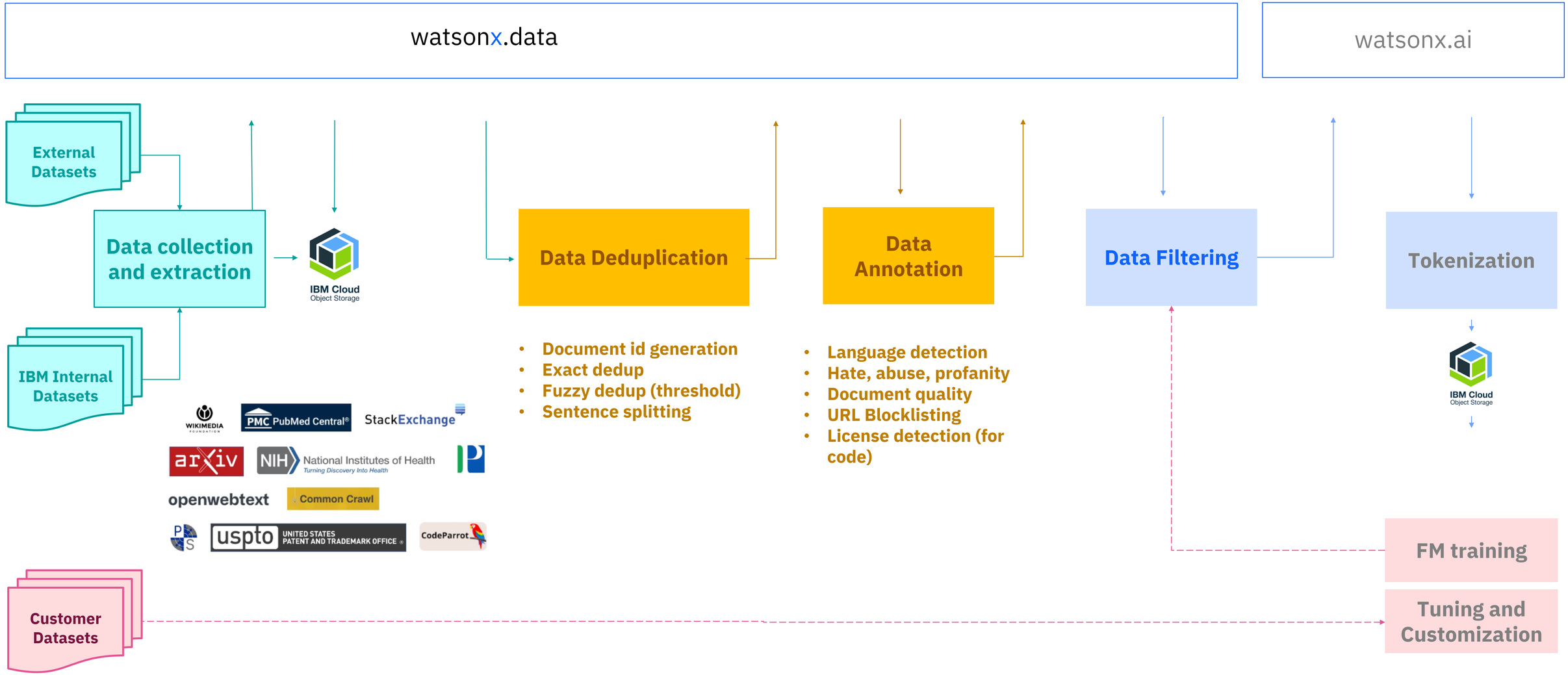
Novel-sparse universal transformer architecture

Moonstone

Novel architecture based on dense associative memory

watsonx IBM Data Pile

Enterprise-ready data acquisition, curation, provenance, and governance

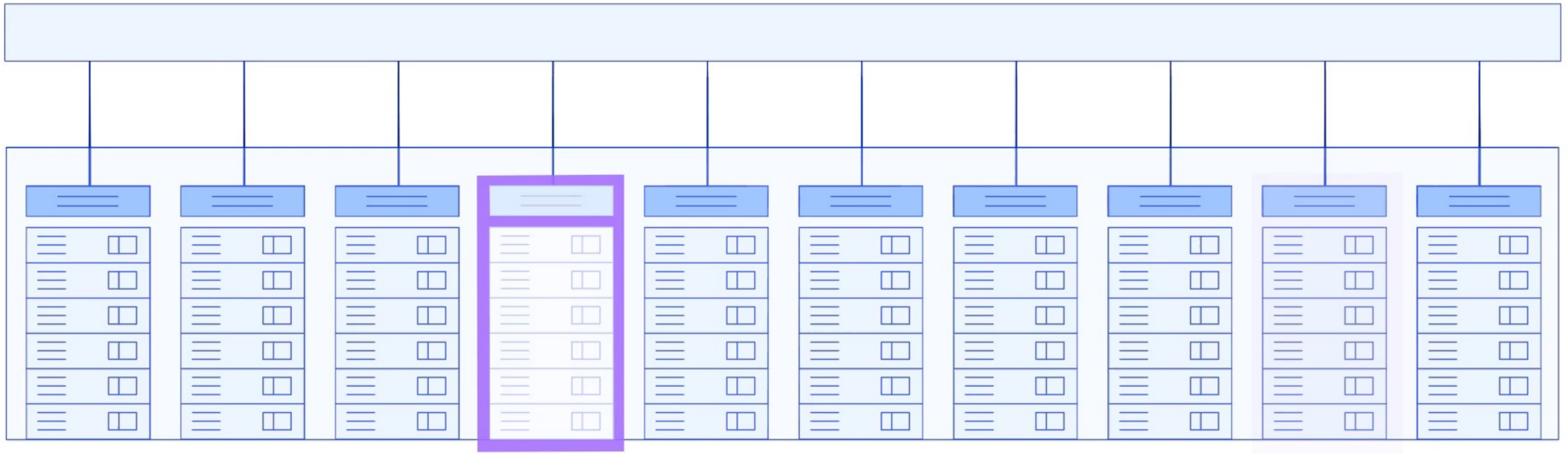


IBM Vela

→ Bare-metal performance in the cloud

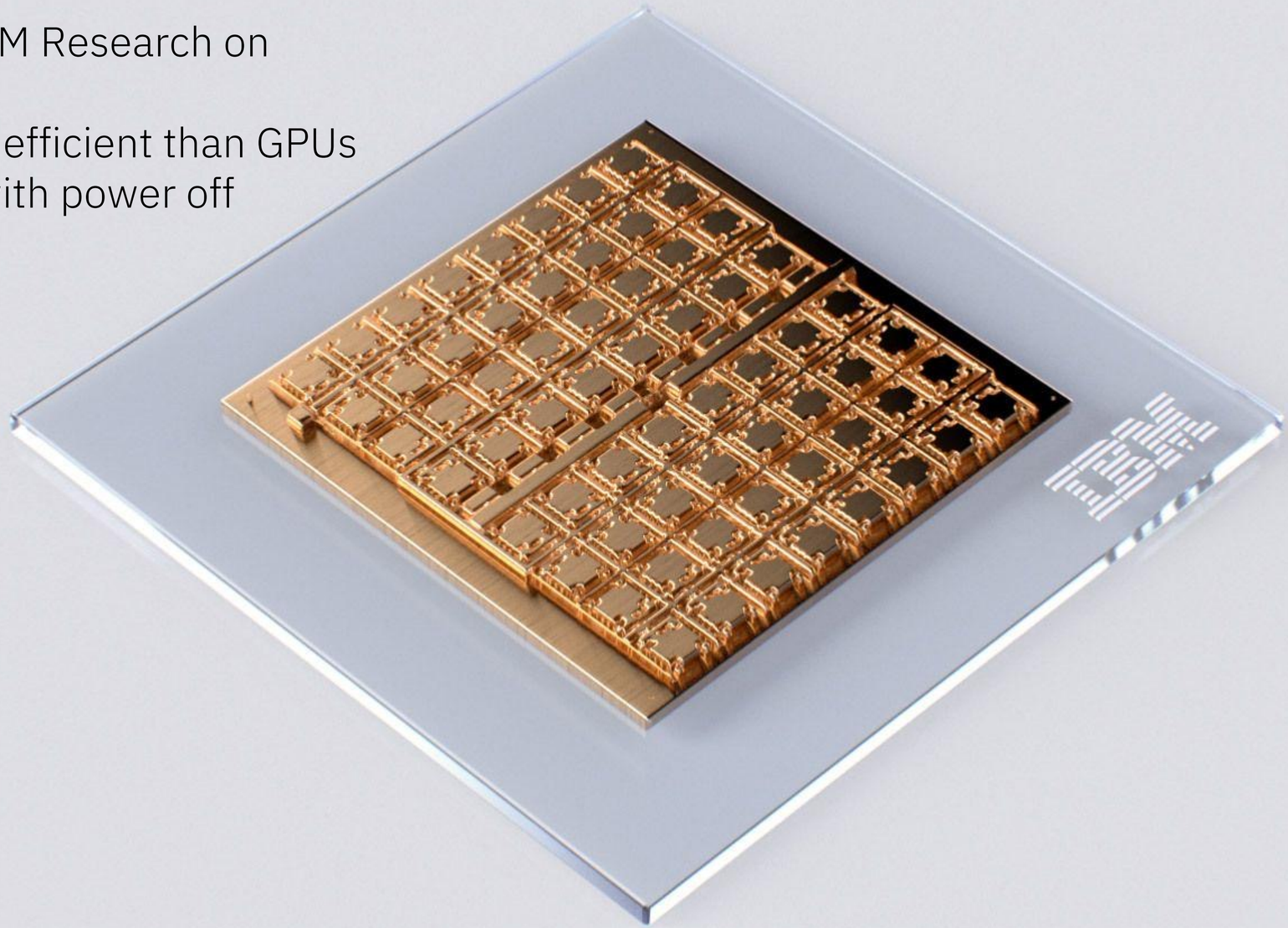
→ < 5% virtualization overhead

→ 90%+ GPU efficiency



IBM Analog AI Chip

- Announced by IBM Research on August 23, 2023
- 14x more energy efficient than GPUs
- Maintains state with power off
- Edge enabler

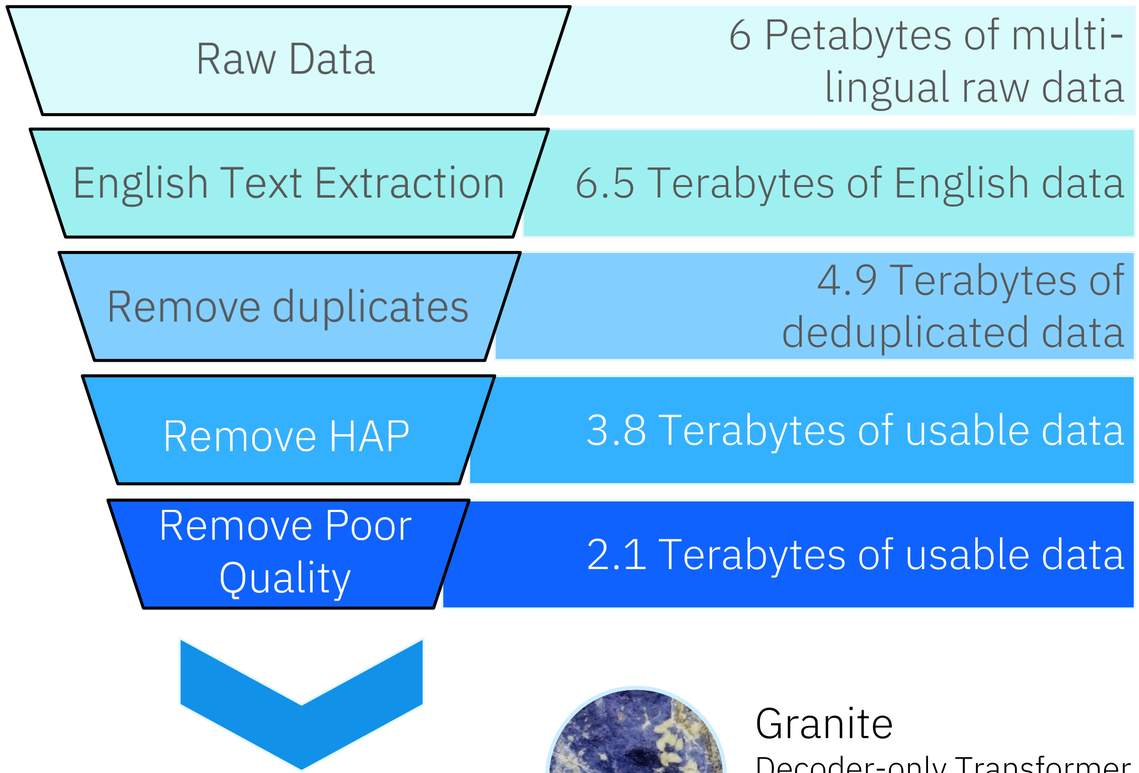


Granite on watsonx.ai

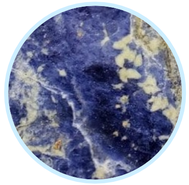
Trusted

IBM's approach to AI model development is grounded in core principles of trust and transparency.

What were the datasets and sources used?



1T Tokens of data for training granite.13b



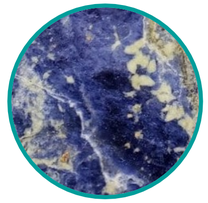
Granite
Decoder-only Transformer Model

e.g. Llama, Falcon, GPT-3

What makes IBM models safe for enterprise use?

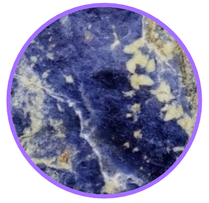
- Models were reviewed against IBM's extensive data governance practices, corresponding to data clearance and acquisition; document quality checks; pre-processing data pipelines, including tokenization, data de-duplication, etc.
- Granite models were trained on data scrutinized by IBM's own HAP detector – to detect and root out objectionable content, benchmarked against internal and public models
- IBM deploys regular, ongoing data protection safeguards, including monitoring for websites known for piracy or other offensive materials, and avoid those websites

granite.13b.instruct



Supervised Fine Tuned

granite.13b.chat



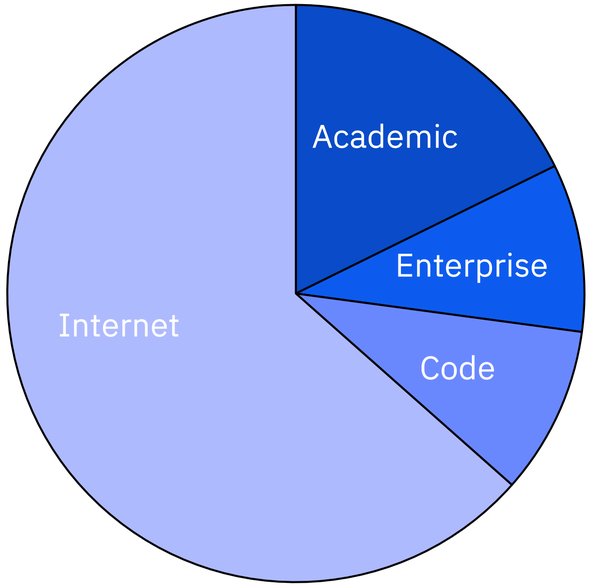
Contrastive Fine Tuned

HAP – Hate Abuse and Profanity

Granite Model Paper

IBM Granite models – Enterprise performance delivered faster

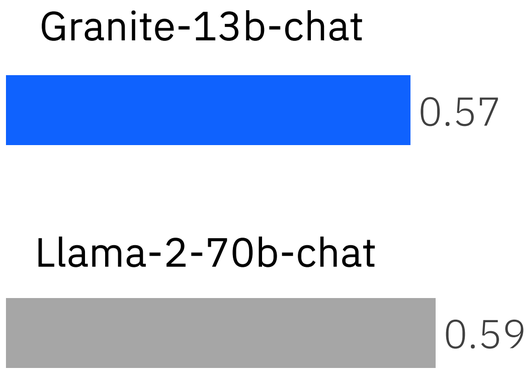
Enterprise



~10% of the data used to train granite is aligned to enterprise tasks including legal and *finance*

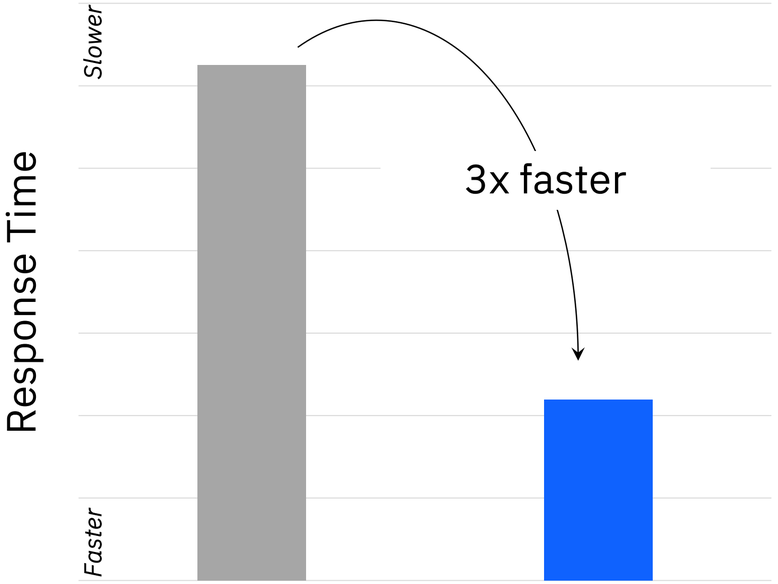
Performance

Financial Acumen
(Avg of 11 Financial Tasks)



Granite-13b performance is similar to the much larger Llama-2-70b-chat across 11 different *finance* related tasks

Delivered Faster



In production, Granite-13b can be up to 3x faster than Llama-2-70b for 1000 tokens

(IBM-internal development tests)

Note: See full performance benchmark details on next slide
Source: Granite Foundation Model Report, IBM Research

IBM Research Finance Evaluation

Finance Panel (11 tasks)

IBM Research Finance Panel

Sentiment analysis
- Financial Phrase Bank
- Stock and Earnings Call Transcripts
- Financial Question Answering

Classification
- News Headline Classification

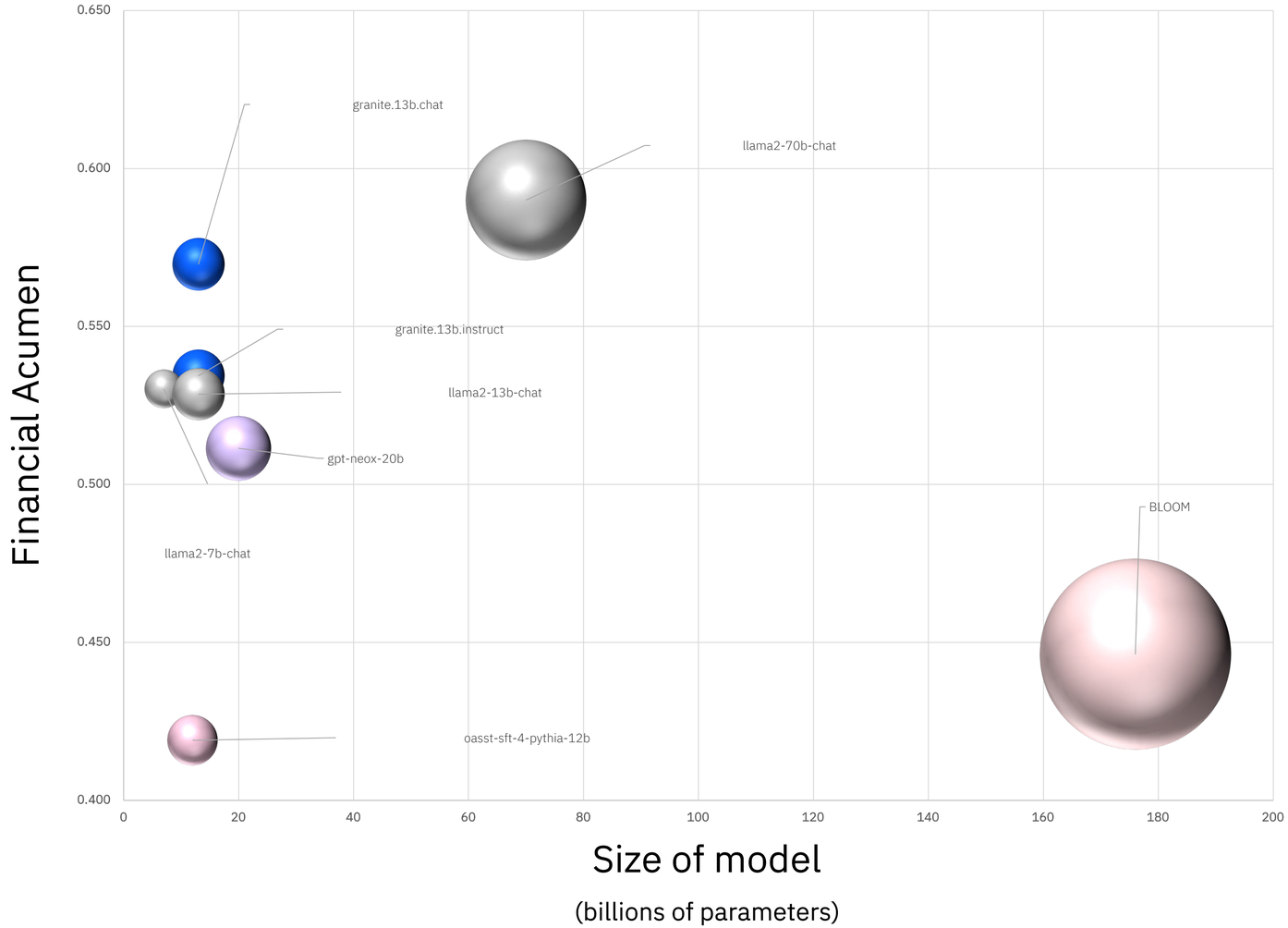
Entity Extraction
- Edgar SEC Filings (x2)
- Financial Credit Risk Assessment

Question and Answering
- Financial Question Answering (x2) • Insurance

Summarization
- Corporate Event Detection

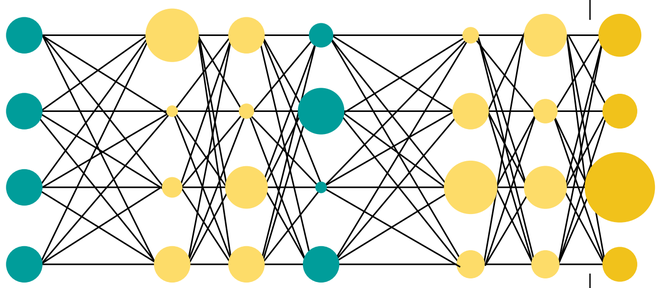
Model Performance on Finance Tasks

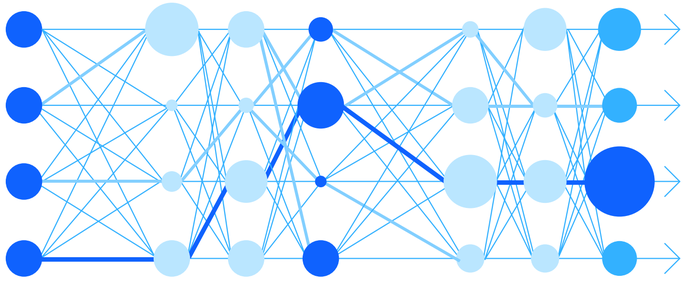
(average of 11 Financial tasks)



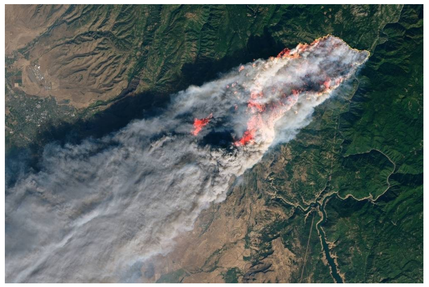
Source: Granite Foundation Model Report, IBM Research

Geospatial Foundation Model for many tasks



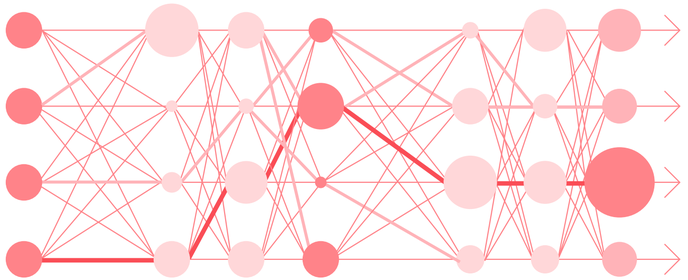


Semantic segmentation



Detecting wildfires

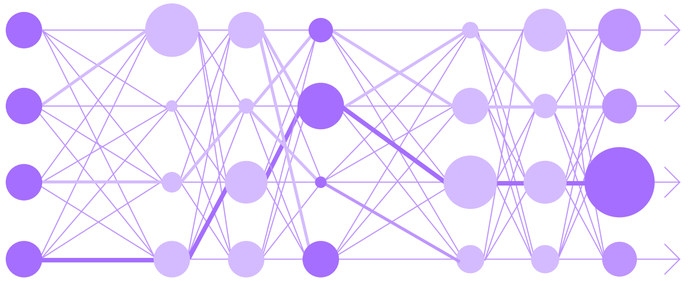
Detecting floods



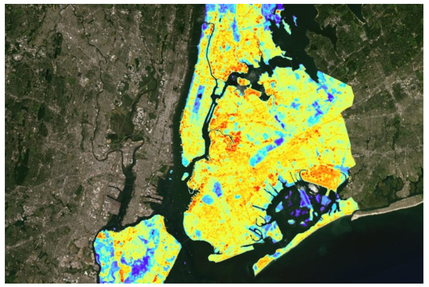
Classification

Classifying trees

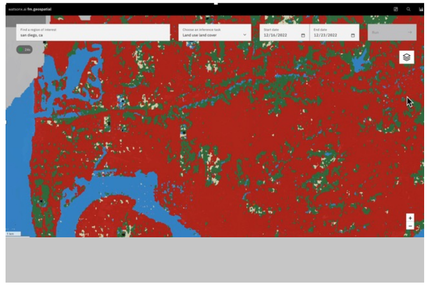
Classifying species



Regression



Observing urban heat



Land Use Land Change

Harmonized Landsat Sentinel-2

Geospatial foundation models focused on **remote sensing** data.

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

–Data available in **tiles**, aligned with the Military Grid Reference System (MGRS).

–30m resolution

–Revisited every **2-3 days**

–Each tile has **3660 x 3660 pixels**, corresponding to ~110 x 110 km.

Model architecture

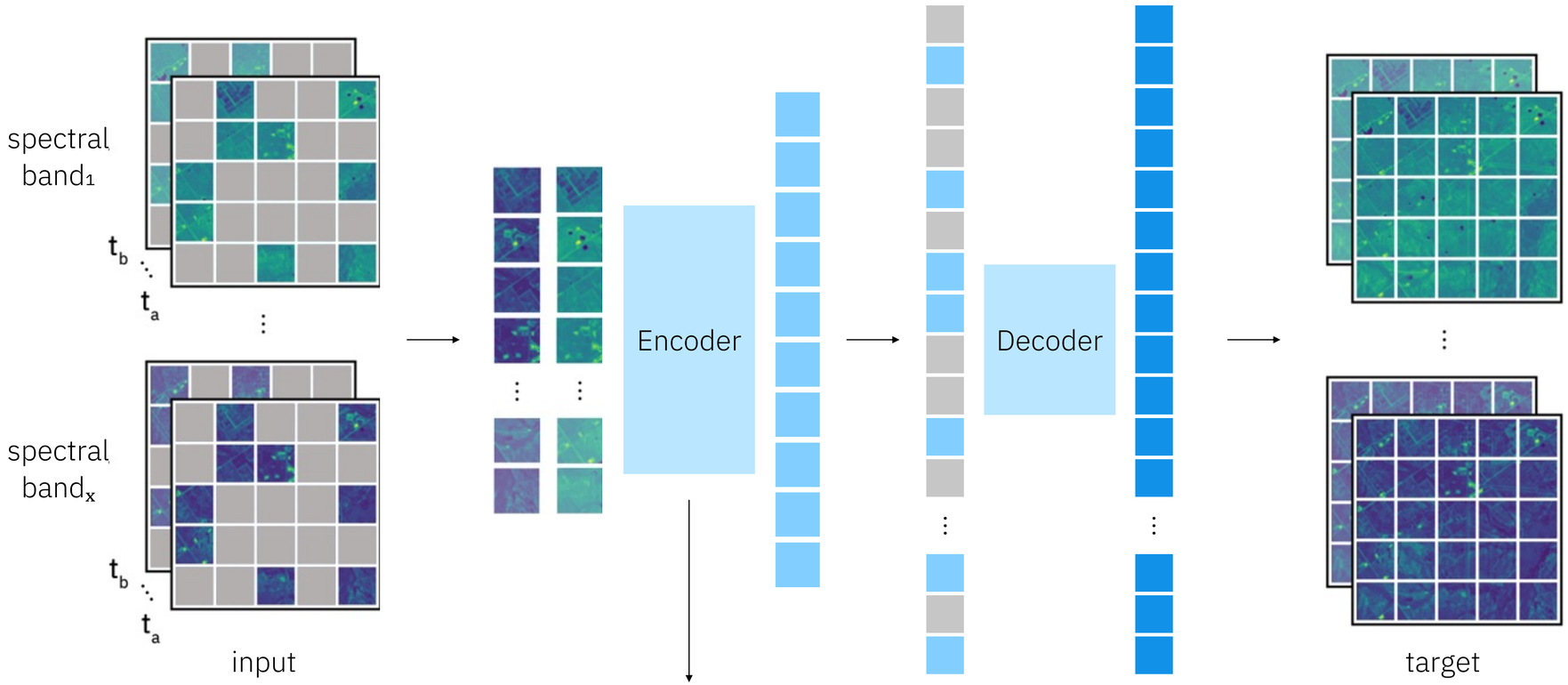
MAE → Masked AutoEncoder

- Pre-training task: reconstruct masked patches → target = original data.
- MSE loss on masked patches.

Encoder → Vision transformer (ViT) for multispectral 3D data.

- 3D patch embeddings
- 3D positional encoding

Decoder → Transformer blocks + linear projection layer to match the target patch size.

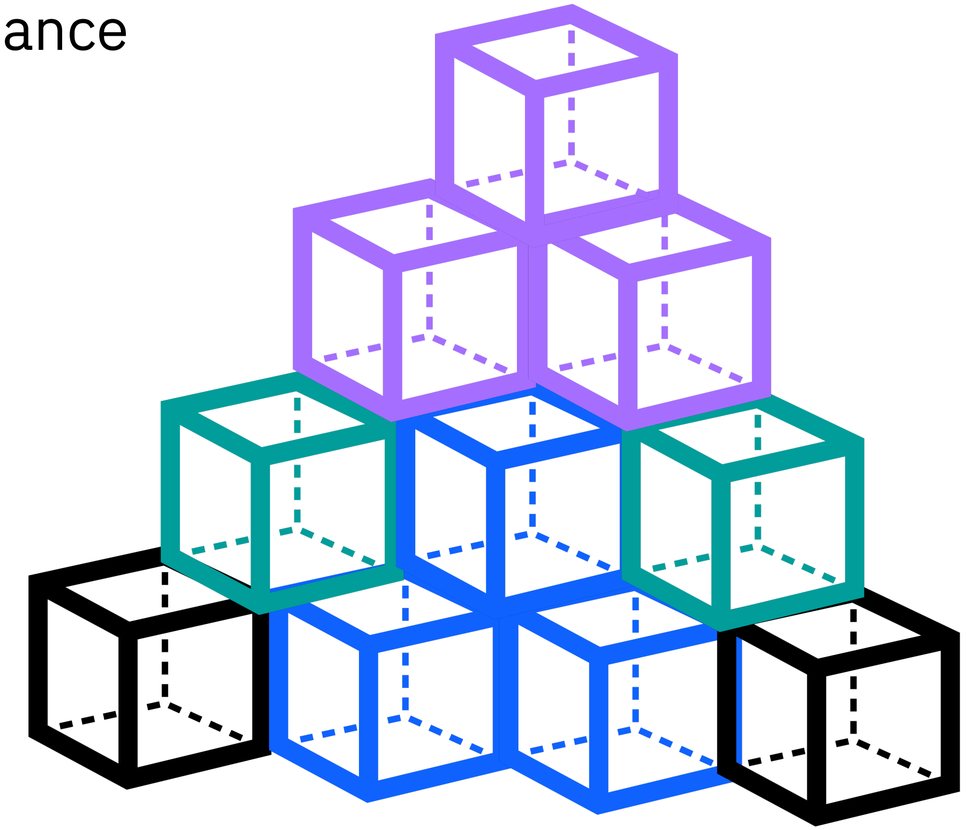


ViT architecture +
3D Patch embedding +
3D positional encoding

Our approach to selecting third-party models in watsonx.ai

Technical considerations

- Model performance
- Research
- Ethics
- Legal and data



Workflow

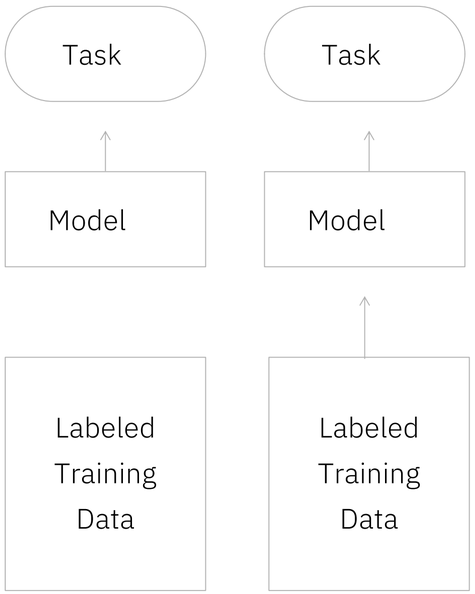
1. Review technical papers
2. Model Information
3. Performance Benchmark
4. Internal IBM use
5. Commercial Applicability
6. Licensing
7. Reputation
8. Use Case Alignment
9. Training Data
10. Infrastructure

Architecture model

Take advantage of both traditional and Next-Gen AI Models in watsonx.ai

Traditional AI

1000s — 1000000s labeled data points / task



Generative AI

Zero-shot Prompting

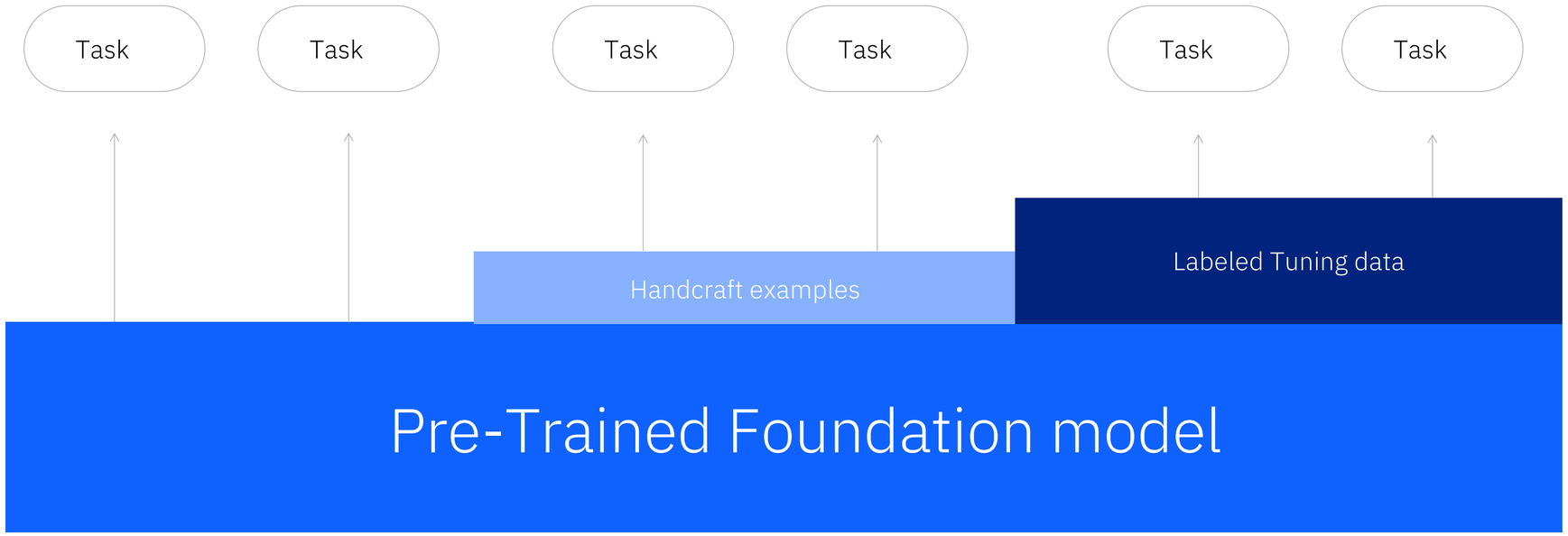
No labeled data needed

Few-shot Prompting

1-10 labeled data points / task

Data-driven Tuning

100s - 1000s labeled data points / task



Supports both conventional NLP tasks and new human + AI, iterative workflows

[Multitask Prompt Tuning (MPT)]

IBM’s approach for AI: Unleash the intelligence in your business

Consulting for AI	Center of Excellence for Generative AI and Client Engineering for watsonx					System Integrators, Software, and SaaS partners
AI products	**Digital Labor** watsonx Orchestrate watsonx Assistant watsonx Code Assistant	**IT Automation**	**Security**	**Sustainability**	**Application Modernization**	
AI and data platform	**watsonx** watsonx.ai watsonx.data watsonx.governance					
Hybrid cloud platform	**Red Hat** OpenShift AI Ansible Lightspeed					
Infrastructure for AI	zSystems Distributed Infrastructure		AWS/Azure/Other			

watsonx.ai

Powered by Red Hat OpenShift AI

Red Hat OpenShift AI

An AI-focused portfolio that provides tools across the full lifecycle of AI/ML experiments and models and helps build, train, test, and deploy models optimized for hybrid cloud environments.

Red Hat OpenShift AI builds and expands upon the proven capabilities of Red Hat OpenShift and Red Hat OpenShift Data Science, to:

- Provide a unified platform for data scientists and intelligent application developers.
- Scale to handle workload demands of foundation models (volume of data, duration of training run, size of model, acceleration required, and scalability).
- Deliver consistency, ease-of-use, and cloud-to-edge deployment options.

Red Hat OpenShift

Red Hat OpenShift Data Science

What is watsonx.ai

Train, validate, tune, and deploy AI models with confidence

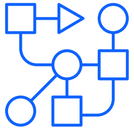
Generative AI capabilities

Foundation model Libraries

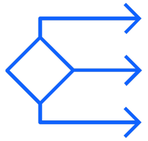
Prompt Lab

Tuning Studio

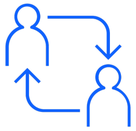
+ a proven studio for Machine Learning



ModelOps



Automated Development



Team Collaboration

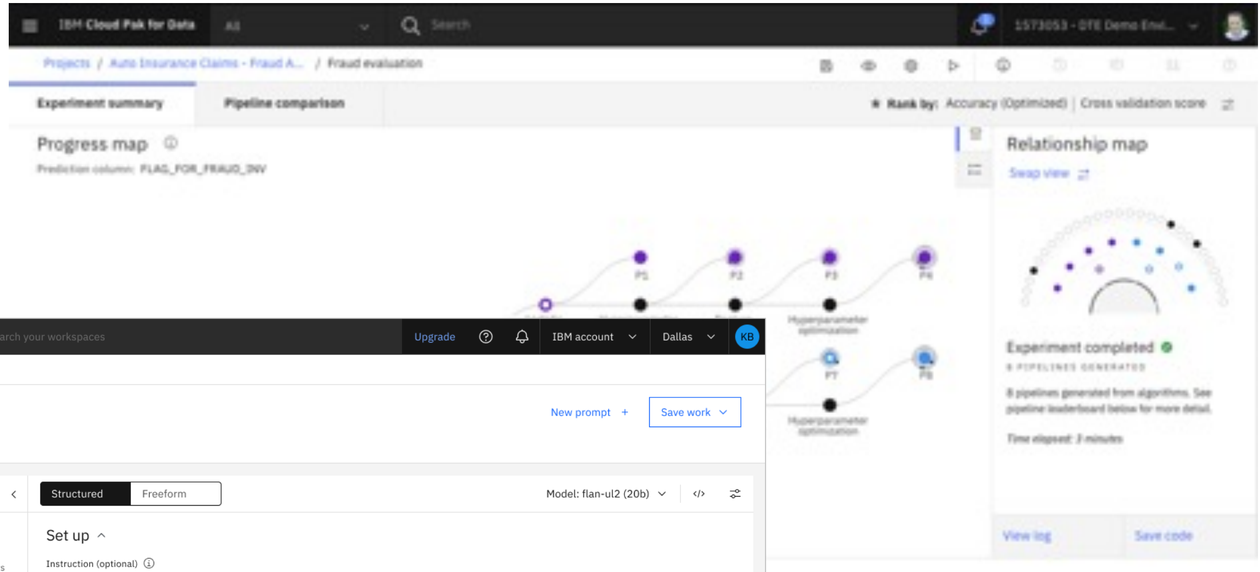
Decision Optimization

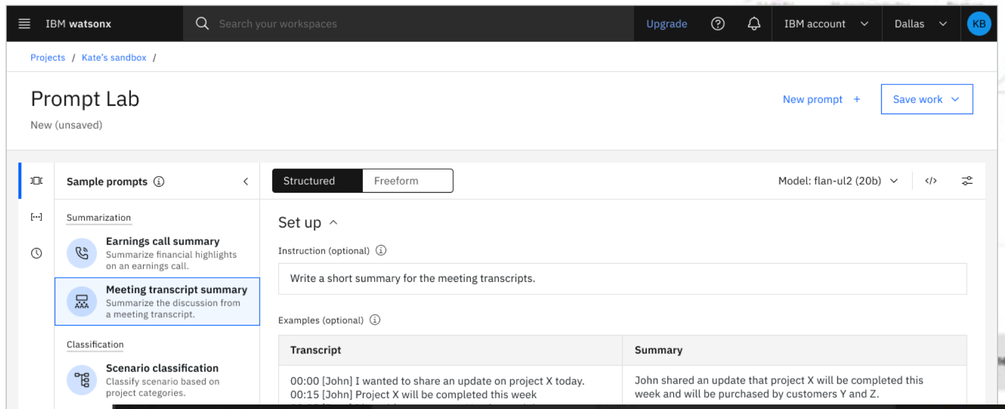
Leveraged foundation models to train AI to create commentary. Generated informative and engaging video clip narrations with varied sentence structures and vocabulary.

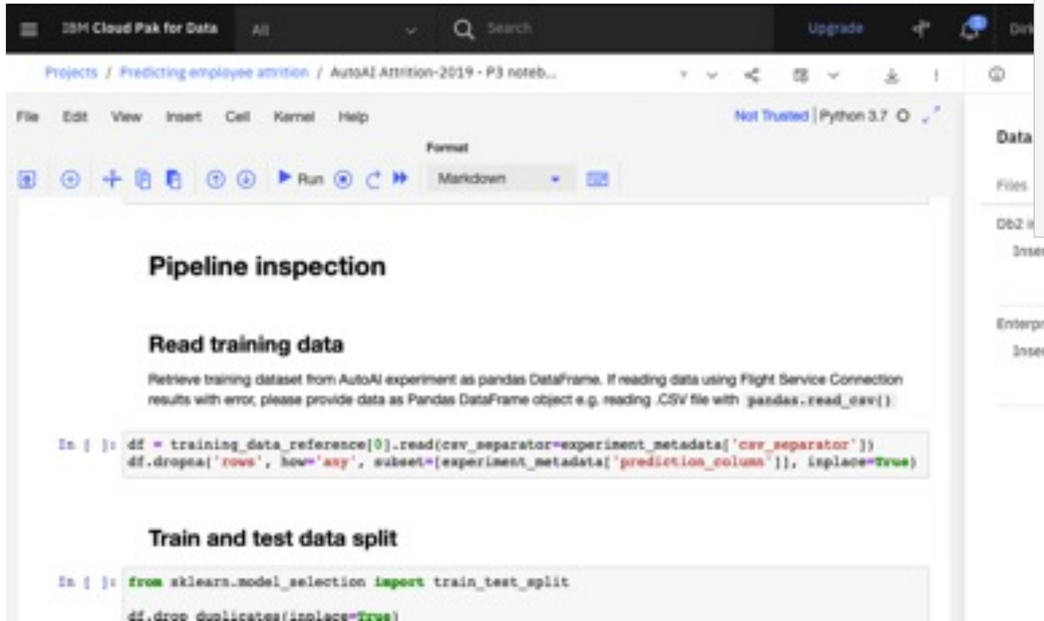
With Watson Orders, McDonalds uses AI to automate drive thru order taking, enabling employees to increase focus on food delivery and customer service.

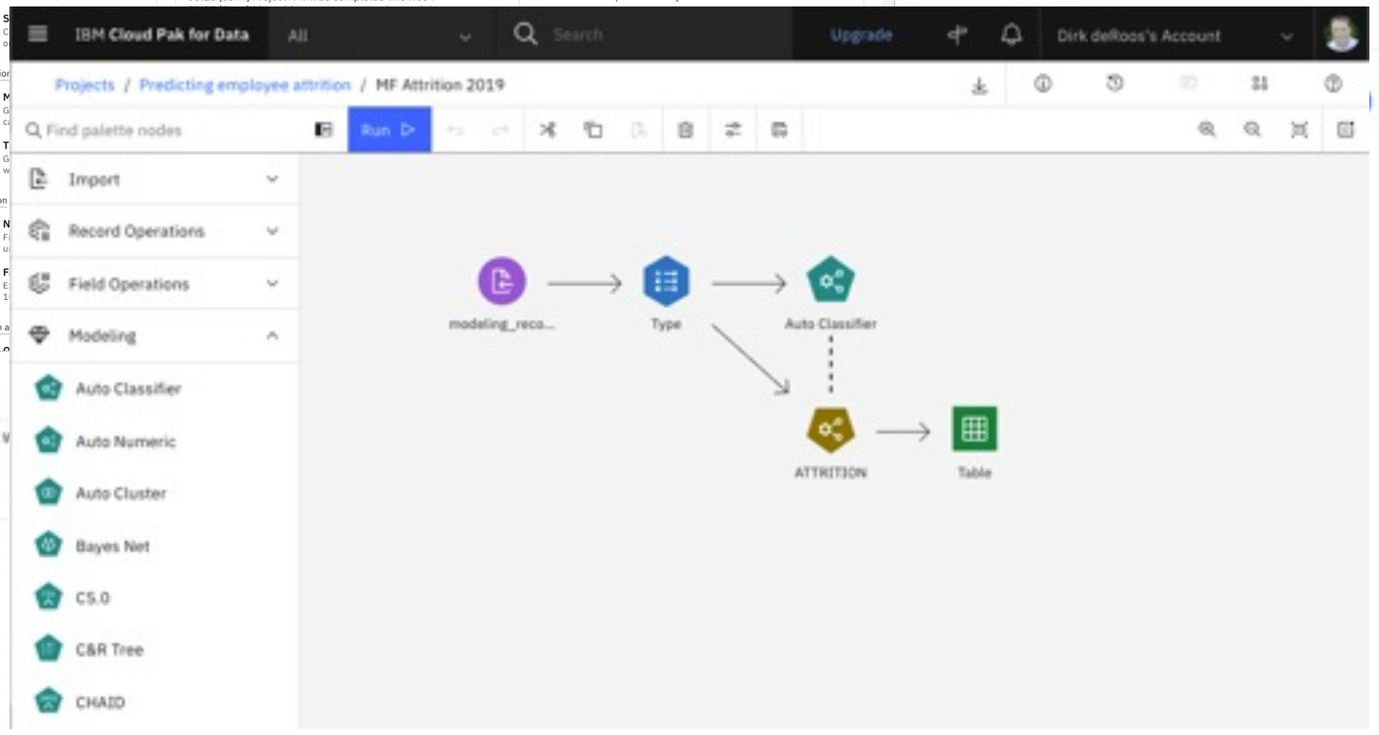
Disparate AI Modeling Patterns

- Wizard tooling: AutoAI - no-code
- Drag/drop canvas: Visual - low-code
- Notebooks / IDEs: Programmatic -all-code
- Distributed Compute and DL
- Prompt, Tuning, Foundational Models





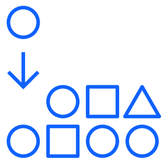




watsonx. governance

Enable responsible, transparent and explainable AI workflows

An end-to-end toolkit for AI governance



Govern across the AI lifecycle by automating and consolidating tools, applications and platforms.

Manage risk and protect reputation by automating workflows to better detect fairness, bias and drift.

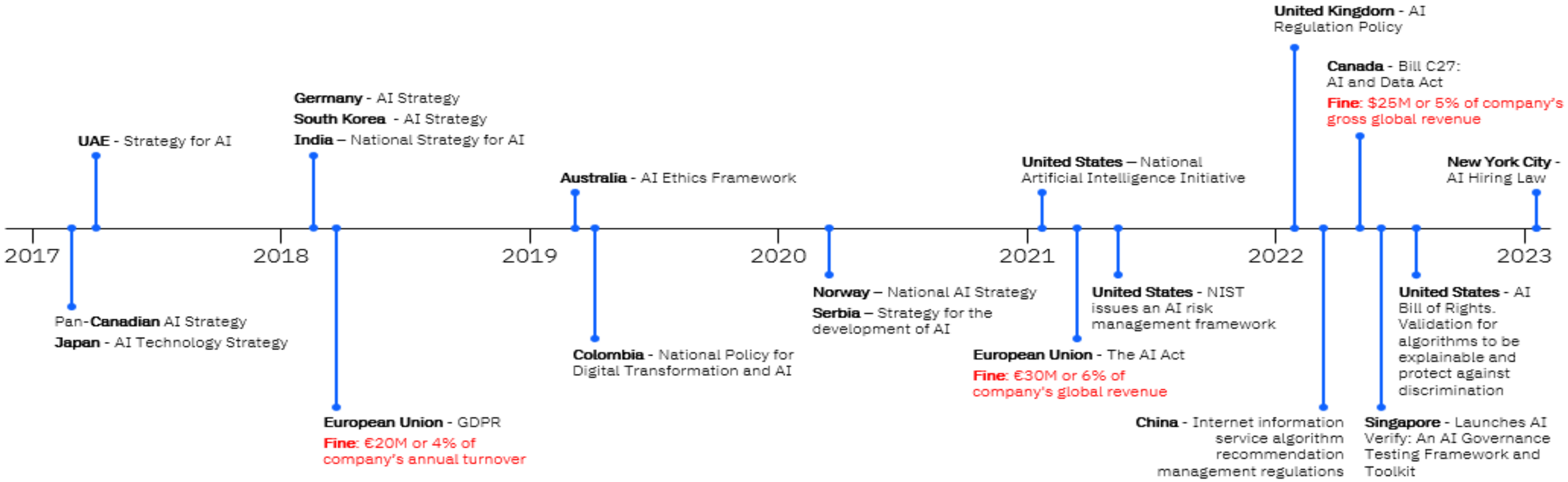
Help adhere to regulations by transl ating growing regulations into enforceable policies.

Comprehensive
Govern the end-to-end AI lifecycle with metadata capture at each stage

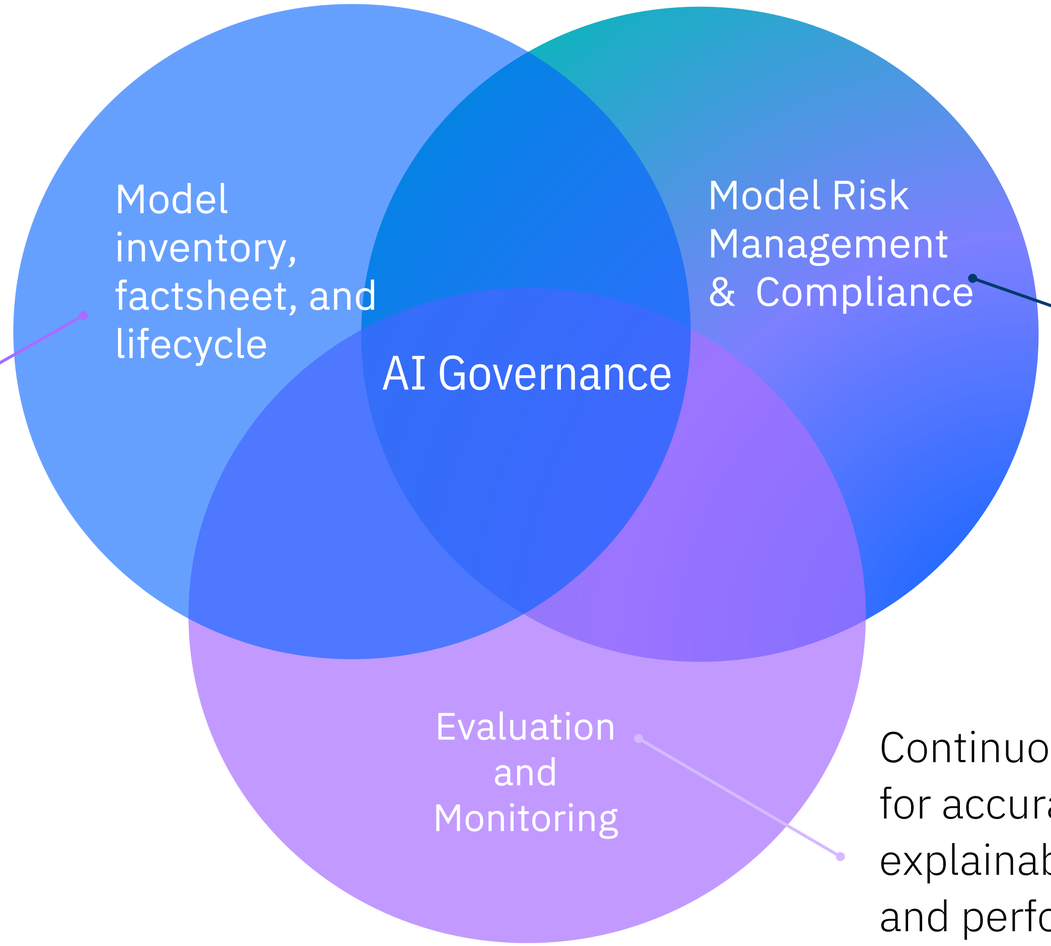
Open
Support governance of models built and deployed in 3rd party tools.

Automatic metadata
and data transformation/lineage capture though Python notebooks.

Changing AI regulations



AI Governance is imperative



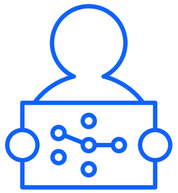
Capture model facts throughout the entire lifecycle

Workflows, dashboards for risk & incident management

Continuous monitoring for accuracy, drift, bias, explainability, and performance

Security & Privacy

Pillars of Trust



Explainability

An AI system’s ability to provide a human-interpretable explanation for its predictions and insights

Fairness

Equitable treatment of individuals or groups by an AI system

Depends on the context in which the AI system is used

Robustness

An AI system’s ability to effectively handle exceptional conditions, such as abnormalities in input

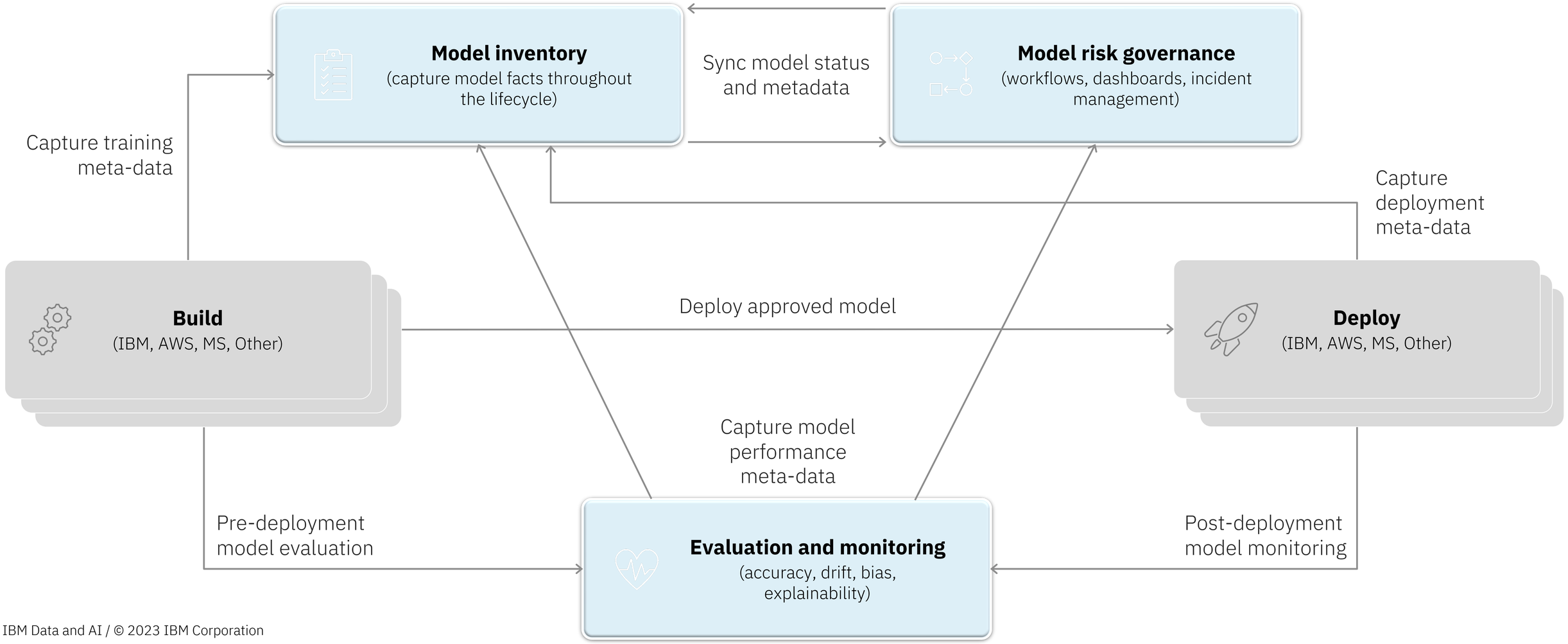
Transparency

An AI system’s ability to include and share information on how it has been designed and developed

Privacy

An AI system’s ability to prioritize and safeguard consumers’ privacy and data rights

IBM watsonx.governance integrates and augments your existing ML development and deployment tools and processes



Three ways to get started with **watsonx.ai** today

IBM’s investment in partnering with you

FREE TRIAL

Experience **watsonx.ai** and test out core capabilities yourself with a free trial

Try our free trial

CLIENT BRIEFING

Discussion and custom demonstration of IBM’s generative AI **watsonx** point-of-view and capabilities. Understand how **watsonx.ai** can be leveraged in your AI strategy.

2-4 hours

Onsite or virtual

PILOT PROGRAM

watsonx.ai pilot developed with IBM AI engineers. Prove **watsonx.ai** value for the selected use case(s) with a plan for adoption.

1-4 weeks

Workshop - Hands On Lab

https://github.com/krondor/missouridatasciencesymposium2023

Before we Begin

Create Project or Import Project

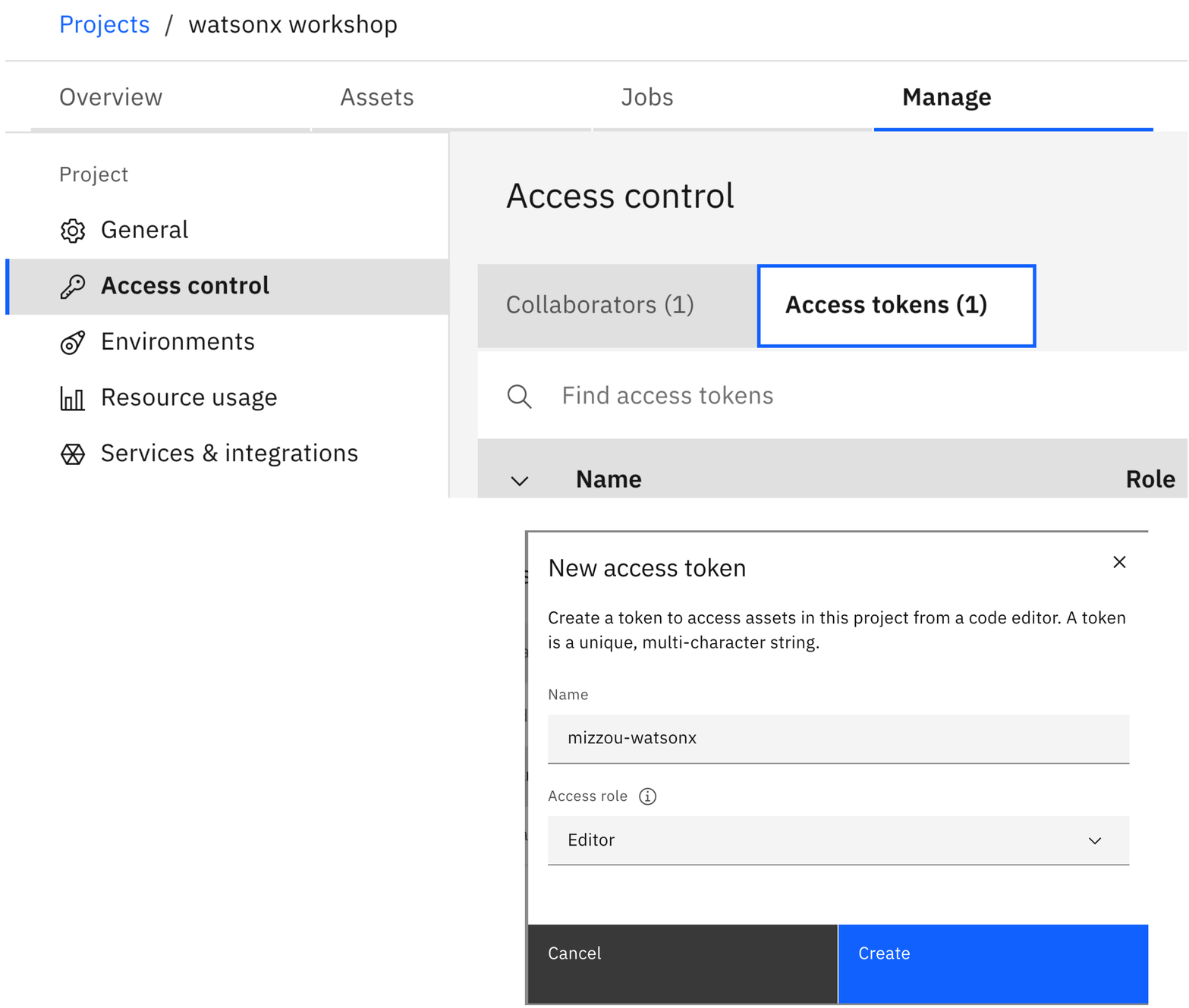
Associate Machine Learning Instance to Project

Define Access Token

Define IAM API Key

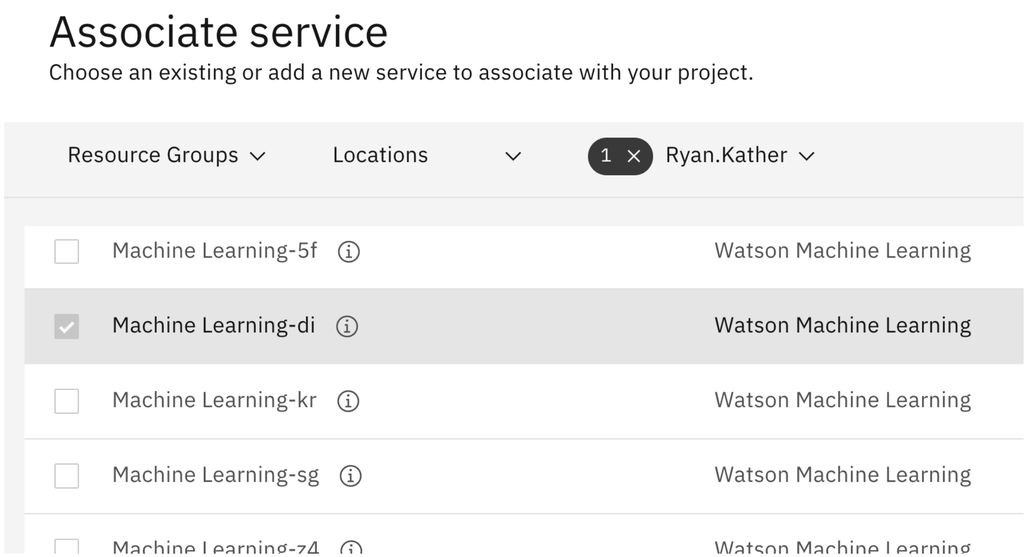
Create Access Token

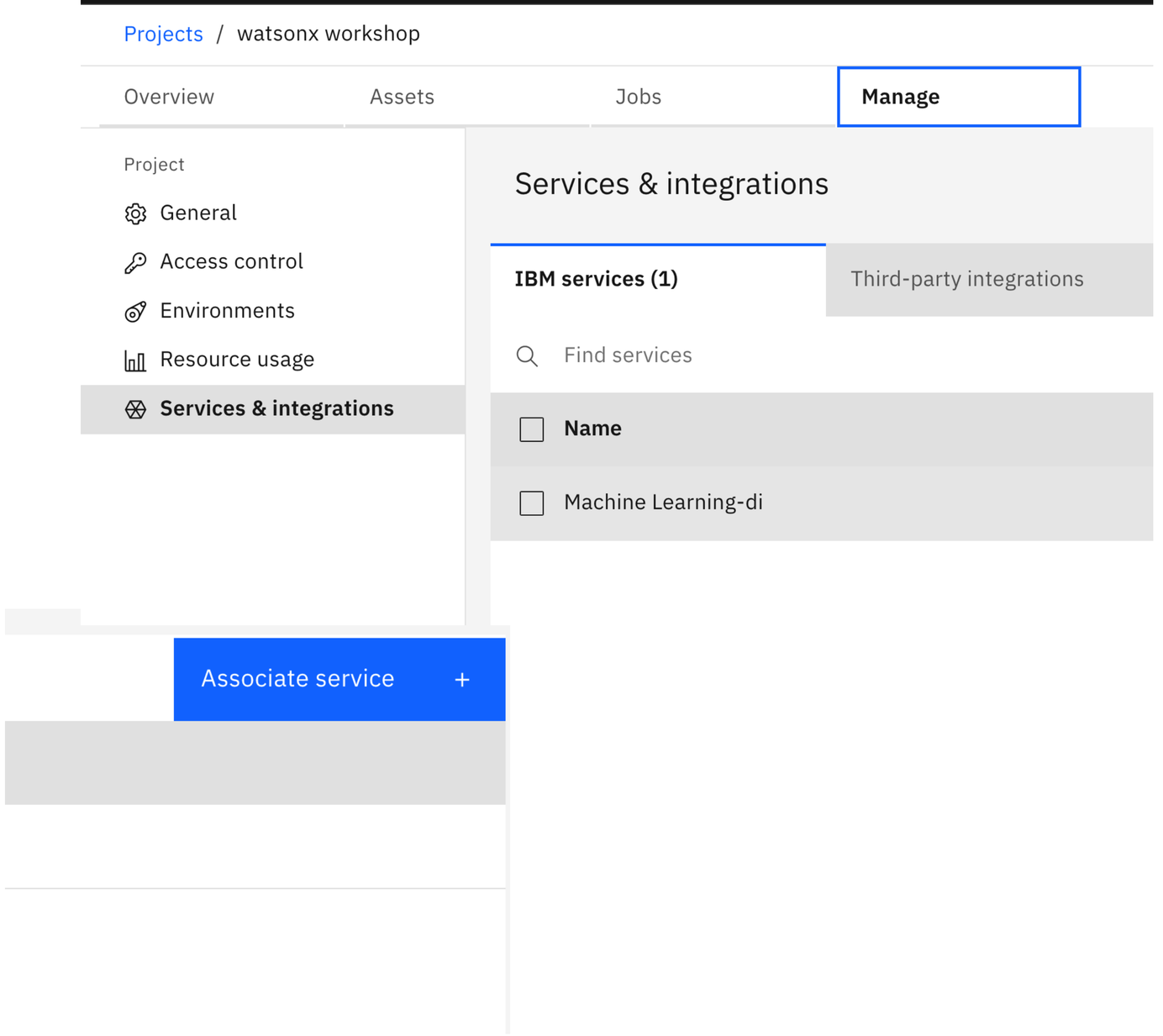
Programmatic Access with Project Interfacing Libraries



Associate Machine Learning Instance

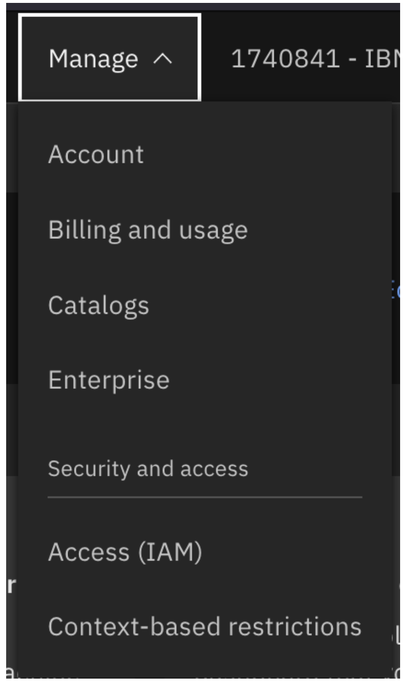
Add instance to project for inferencing



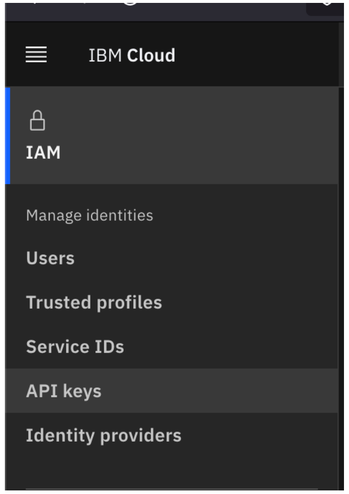


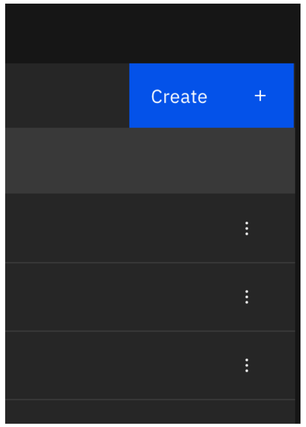
IAM API Key

Login to https://cloud.ibm.com and click Manage and then Access (IAM)

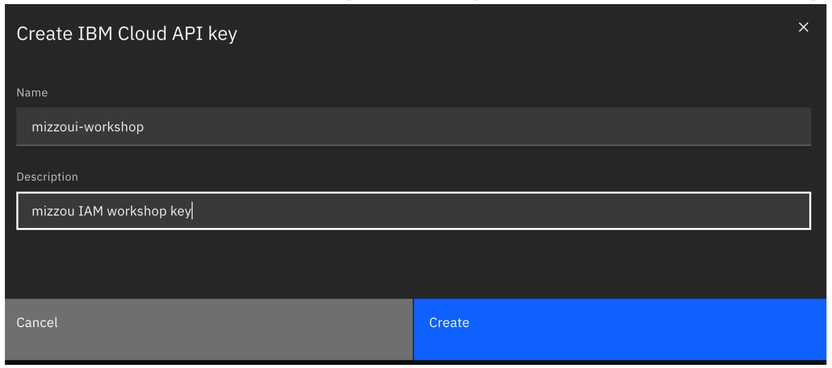


In the IAM side menu select API Keys and click create

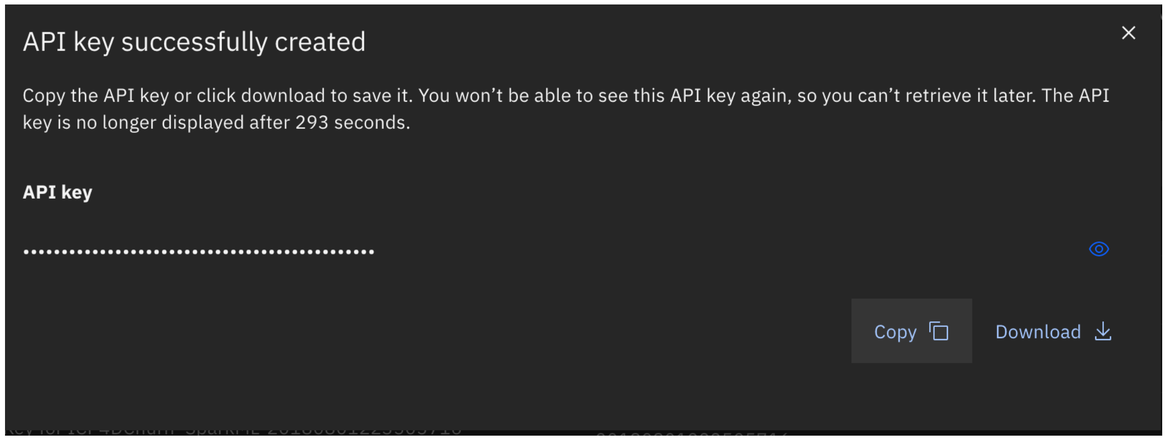




– Name the key and provide a description.

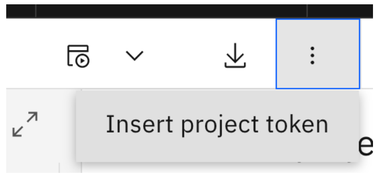


– Save the Key



Watson Studio & WML APIs and SDK

Related but Different Purposes



Programmatically interface with projects, data, and assets within project spaces.

```
# @hidden_cell
# The project token is an authorization token that is used to access proje
from project_lib import Project
project = Project(project_id='FFFFFFFF-027c-4e8a-94c7-f0c7a6e39301', proje
pc = project.project_context

from ibm_watson_studio_lib import access_project_or_space
wslib = access_project_or_space({'token':'p-FFFFFFFFFFFF198813818918'})
```

Samples Repo: https://github.com/IBMDataScience/sample-notebooks/blob/master/CloudPakForData/notebooks/4.0/IPYNB/Working%20with%20ibm-watson-studio-lib%20in%20CPD.ipynb

Documentation: https://dataplatform.cloud.ibm.com/docs/content/wsj/analyze-data/using-ibm-ws-lib.html?context=wx&audience=wdp

Programmatically instantiate models, package metadata, manage deployments, and deployment spaces.

Samples Repo: https://github.com/IBM/watson-machine-learning-samples

Documentation: https://ibm.github.io/watson-machine-learning-sdk/

- Persist Data without Exposing in UI: `wslib.storage.save_data()` `wslib.upload_file()` `wslib.save_data()`

Metrics for evaluating Large Language Models

Text Summarization Metrics

- ROUGE
- SARI
- WIKI_SPLIT
- BLEURT
- METEOR
- Sentence Similarity - Jaccard Similarity
- Sentence Similarity - Cosine Similarity

Content Generation, Q&A Evaluation Metrics

- BLEU
- exact_match
- Perplexity**
- rl_reliability**

Text Classification Metrics

- Accuracy
- Precision
- Recall
- ROC AUC
- F1 Score
- Brier Score
- GLUE metrics
- Matthews Correlation Coefficient
- Label Skew

Watson NLP

- HAP Detection**
- PII Detection**

Entity Extraction Metrics

- Seq eval

Language Translation Evaluation Metrics

- Character
- charcut_mt
- Chrf
- google_bleu
- super_glue
- TER
- nist_mt
- Poseval
- sacrebleu
- XTREME-S

Reference-Free Metrics from Haifa Research Labs

- Levenshtein distance based Diversity metrics
- Textstat toolkit based flesch metrics to determine readability, complexity, and grade level.
- blanchelp**
- Shannon**
- BartScore - Exploring
- Rquge - Exploring

Under Exploration from SVL Research Labs

- Stigma Detection**
- Social Bias/Values Detection**
- Faithfulness / Hallucination**

** Uses Metrics Computation Model

Reinventing how work gets done | Application modernization solution

Watson Code Assistant

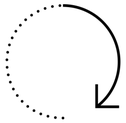
Write code faster with AI-generated recommendations based on natural language inputs

Proven results:

30%

Productivity gain in application modernization

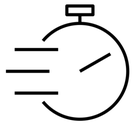
Accelerate code development through AI-powered natural language processing and increase developer productivity



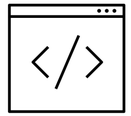
Enhance the quality of code, with greater efficiency and improved accuracy

Narrow the IT skills gap by accelerating developer onboarding, making software development more accessible

Reduce time to value for automation and improve development cycles with AI code recommendations



Maintain high levels of accuracy and transparency through data-source attribution



Tune the **watsonx** foundation model with your own data set to apply organizational best practices

Sample code conversion from Cobol to Java using Generative AI

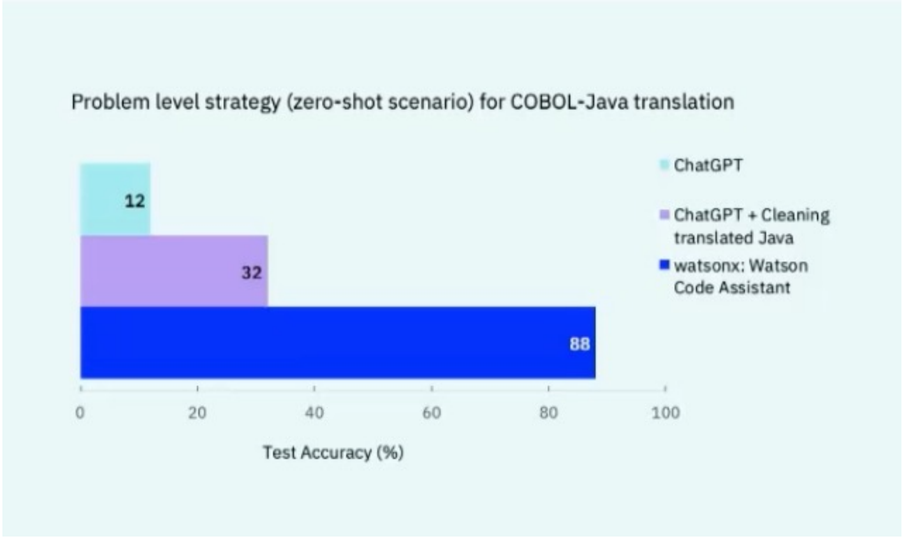
COBOL

```
IDENTIFICATION DIVISION.
PROGRAM-ID. HELLO.

DATA DIVISION.
WORKING-STORAGE SECTION.
01 ARGS_tbl OCCURS 100 TIMES .
05 ARGS PIC X(100).
01 N PIC S9(10).
01 G PIC S9(10).
01 MIN PIC S9(10).
01 COUNT1 PIC S9(10).
01 SUM1 PIC S9(10).
01 I PIC S9(10).
01 X PIC S9(10).
01 TEMP_0 PIC S9(10).
01 DIVCOBOL PIC S9(10).

PROCEDURE DIVISION.
 ACCEPT N
 ACCEPT G
 MOVE G TO MIN
 MOVE 0 TO COUNT1
 MOVE 0 TO SUM1
 PERFORM VARYING I FROM 0 BY +1
      UNTIL (I >= N)
  ACCEPT X
  ADD X TO SUM1
  IF (MIN > X) THEN
   MOVE X TO MIN
  END-IF
 END-PERFORM
 SUBTRACT SUM1 FROM G GIVING SUM1
 PERFORM UNTIL ((SUM1 - MIN) < 0)
  SUBTRACT MIN FROM SUM1
  ADD 1 TO COUNT1
 END-PERFORM
 ADD N COUNT1 GIVING TEMP_0
 DISPLAY TEMP_0
STOP RUN.
EXIT PROGRAM.
```

Java

```
import java.util.*;

public class Main {
 public static void main(String[]
     args) {
  Scanner sc = new
      Scanner(System.in);
  int n = sc.nextInt();
  int g = sc.nextInt();
  int min = g;
  int count = 0;
  int sum = 0;
  for(int i = 0; i < n; i++){
   int x = sc.nextInt();
   sum += x;
   if(min > x){
    min = x;
   }
  }
  sum = g - sum;
  while(sum - min >= 0){
   sum -= min;
   count++;
  }
  System.out.println(n + count);
 }
}
```

Purpose-built foundation models with quality at the core drives better performance and more efficiency



Reinventing how work gets done | Application modernization solution

Accelerate hybrid cloud automation
Red Hat Ansible Lightspeed with IBM Watson Code Assistant

Watson Code Assistant (commercially available as Ansible Lightspeed from Red Hat) being developed in collaboration with Red Hat and IBM Research, infuses generative AI capabilities into Red Hat Ansible Automation Platform. It simplifies the process of Ansible playbook creation through "Pair Programming" with an AI in the "navigator" seat, providing AI-generated recommendations.

Generative AI + RED HAT ANSIBLE = Ansible Lightspeed with IBM Watson Code Assistant

Open-Source IT Automation Tool

Automates IT infrastructure management and application deployment

Uses simple, **human-readable YAML** language for configuration and automation tasks

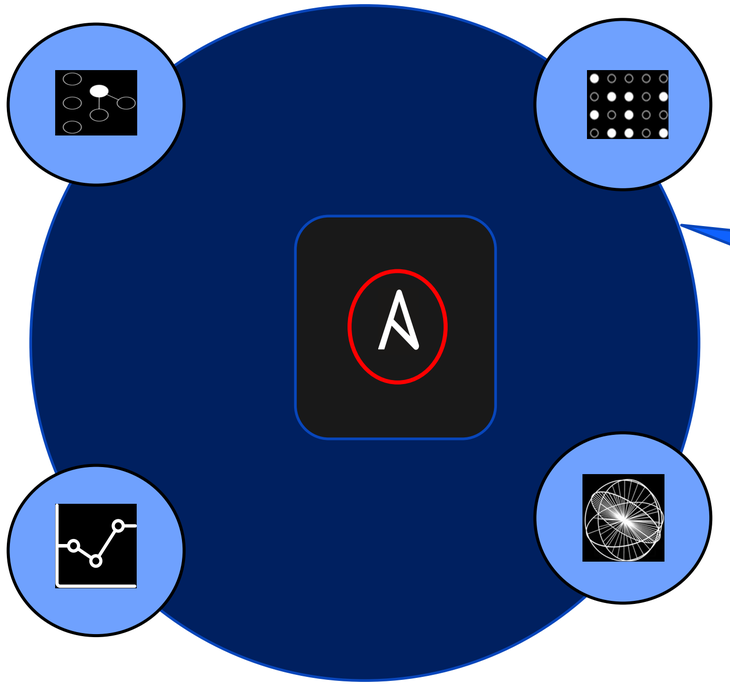
Scalable for managing hundreds or thousands of servers from a single control machine

Orchestrates **complex workflows**, including configuration management and application deployment

Agentless architecture means no software installation on target machines, making setup and use easy.

Playbook Generation
'Generate a playbook or role'

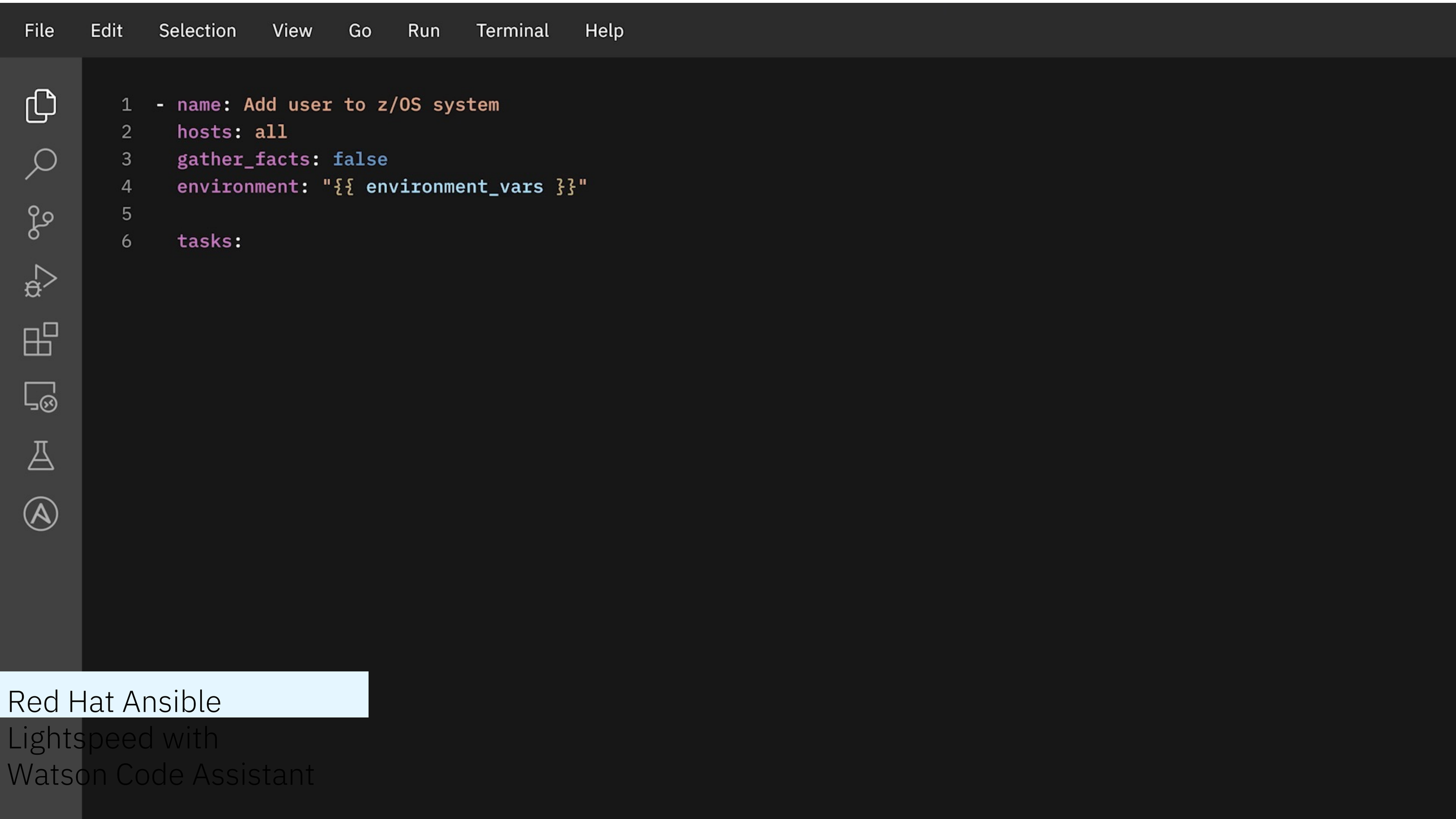
Code Optimization
'Review my Playbook and help me make it better'



Content Discovery
'Find me a playbook or role similar to what I am writing'

Red Hat & IBM curated Ansible content

Code Explanation
'Tell me what this Playbook is doing and its impact'; 'Tell me where the generated code came from'


File
Edit
Selection
View
Go
Run
Terminal
Help
1 - name: Add user to z/OS system
2 hosts: all
3 gather_facts: false
4 environment: "{{ environment_vars }}"
5
6 tasks:
Red Hat Ansible
Lightspeed with
Watson Code Assistant

watsonx.ai drives new IBM innovation and Red Hat OpenShift enhancements for AI workloads