Azure Big Data & Machine Learning Overview

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Agenda

- Drivers for Analytics & ML Adoption
- (Short) Azure Overview
- Azure Data Stores and ML Services
- Processes & Pipelines
- Modern Data Warehousing
- Estimating Cloud OPEX

- Use Case + Q & A

Drivers for Analytics and ML Adoption

Evolution towards “Data Maturity”

STAGE 1:
Traditional

Query historical, relational data from a variety of sources

STAGE 2:
Operational

Gain real-time insights without impacting performance

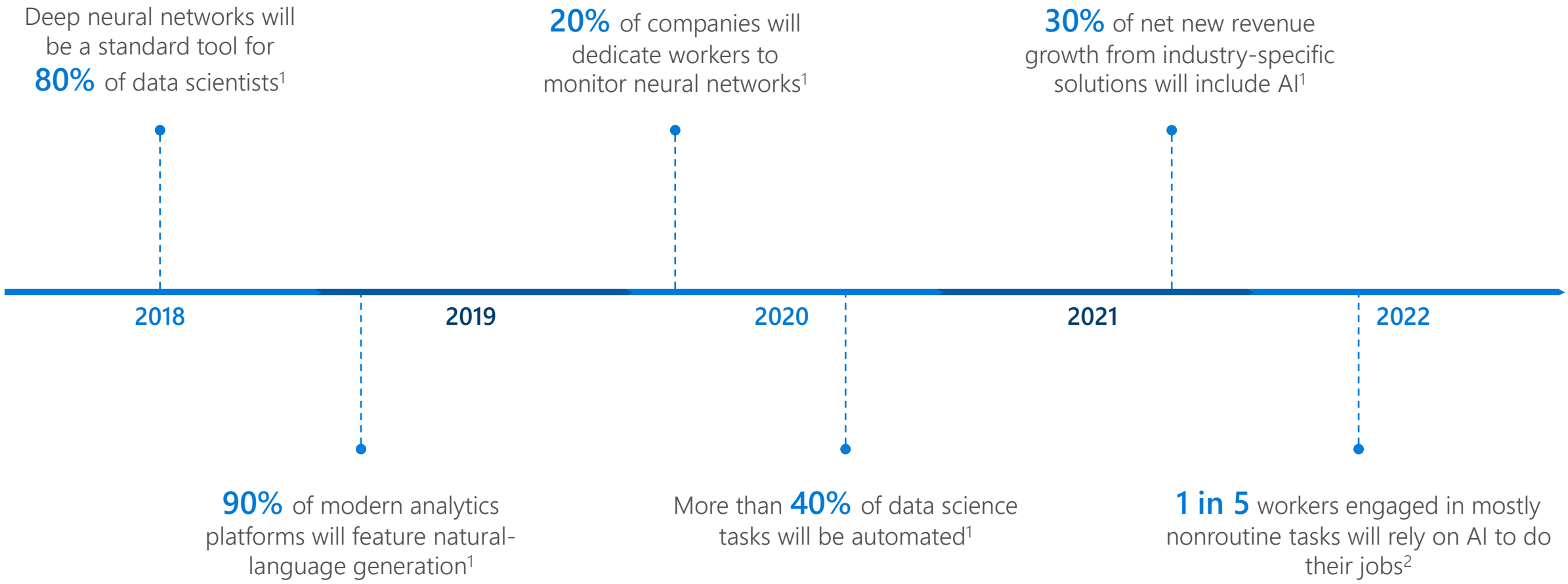
STAGE 3:
Logical

Ask questions of big data—all types, volumes and locations

STAGE 4:
Free-form

Establish enterprise-wide data lake and run advanced analytics and deep learning on unstructured data that arrives in real-time

What are companies looking to do next?



[1] "100 Data and Analytics Predictions Through 2021", Gartner, 2017. [2] "Predicts 2018: AI and the Future of Work", Gartner, 2018.

Financial services use cases (focus: retail banking)

Effective customer engagement

Customer profiles
Credit history
Transactional data
LTV
Loyalty

Customer analytics

Customer 360 degree evaluation
Customer segmentation
Reduced customer churn
Underwriting, servicing and delinquency handling
Insights for new products

Faster innovation for a better customer experience

Decision services management

Customer segmentation
CRM data
Credit data
Market data

Financial modeling

Commercial/retail banking, securities, trading and investment models
Decision science, simulations and forecasting
Investment recommendations

Improved consumer outcomes and increased revenue

Risk and revenue management

Transaction data
Demographics
Purchasing history
Trends

Risk, fraud, threat detection

Real-time anomaly detection
Card monitoring and fraud detection
Security threat identification
Risk aggregation

Enhanced customer experience with machine learning

Risk and compliance management

CRM
Credit
Risk
Merchant records
Products and services

Credit analytics

Enterprise DataHub
Regulatory and compliance analysis
Credit risk management
Automated credit analytics

Transform growth with predictive analytics

Recommendation engine

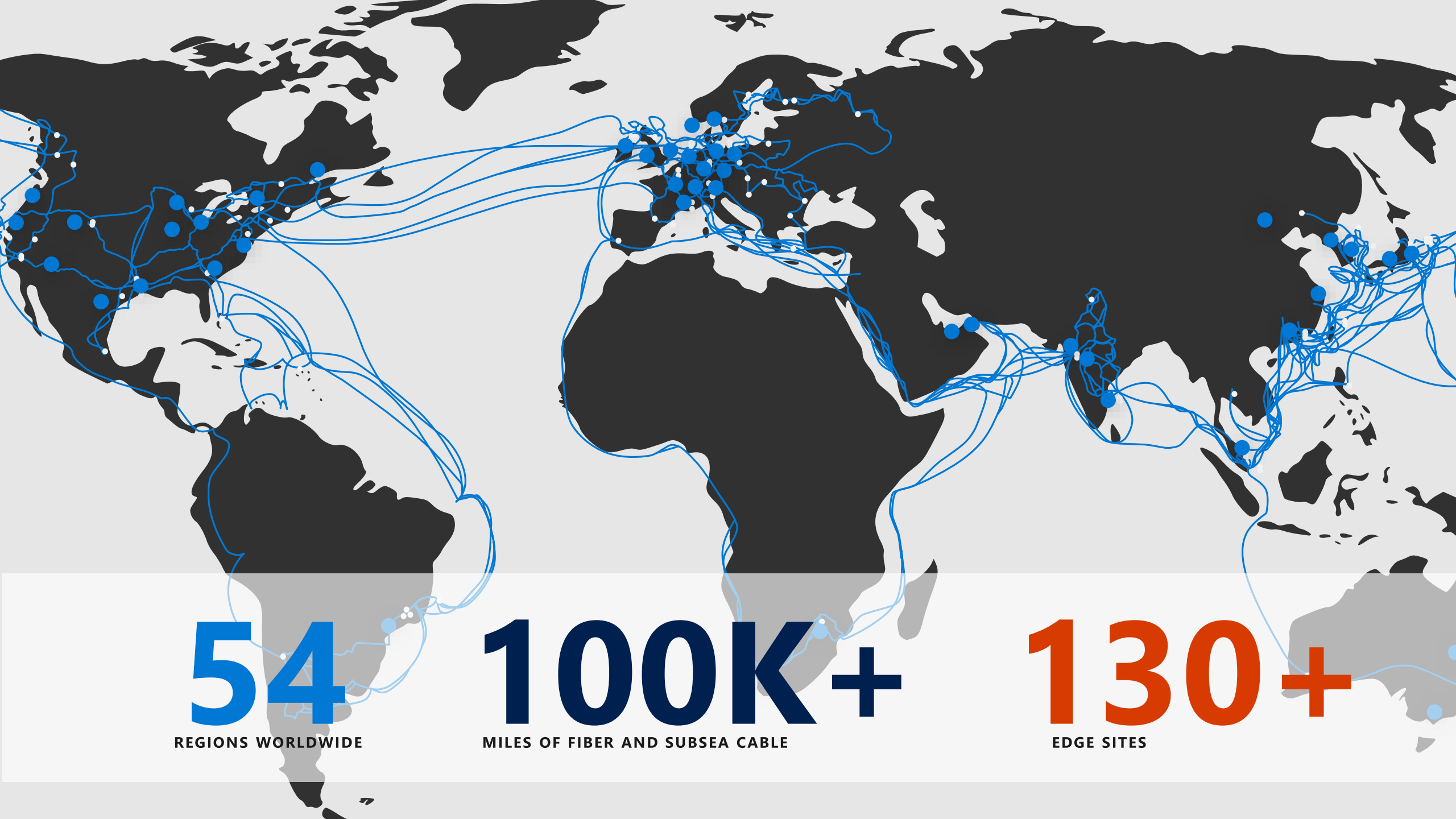
Clickstream data
Products
Services
Customer service data

Marketing analytics

Recommendation engine
Predictive analytics and targeted advertising
Fast marketing and multi-channel engagement
Customer sentiment analysis

Improved customer engagement with machine learning

Azure


54
REGIONS WORLDWIDE
100K+
MILES OF FIBER AND SUBSEA CABLE
130+
EDGE SITES

Microsoft Trusted Cloud

→ https://aka.ms/AzureCompliance

Azure has the deepest and most comprehensive compliance coverage in the industry

Global

- ☑ ISO 27001:2013
- ☑ ISO 27017:2015
- ☑ ISO 27018:2014
- ☑ ISO 22301:2012
- ☑ ISO 9001:2015
- ☑ SOC 1 Type 2
- ☑ SOC 2 Type 2
- ☑ SOC 3
- ☑ CSA STAR Certification
- ☑ CSA STAR Attestation
- ☑ CSA STAR Self-Assessment

US Gov

- ☑ FedRAMP High
- ☑ FedRAMP Moderate
- ☑ DoD DISA SRG Level 5
- ☑ DoD DISA SRG Level 4
- ☑ DoD DISA SRG Level 2
- ☑ DFARS
- ☑ DoE 10 CFR Part 810
- ☑ NIST SP 800-171
- ☑ FIPS 140-2
- ☑ Section 508 VPATs
- ☑ ITAR
- ☑ CJIS
- ☑ IRS 1075

Industry

- ☑ PCI DSS Level 1
- ☑ GLBA
- ☑ FFIEC
- ☑ Shared Assessments
- ☑ FISC (Japan)
- ☑ HIPAA BAA
- ☑ HITRUST
- ☑ 21 CFR Part 11 (GxP)
- ☑ MARS-E
- ☑ IG Toolkit (UK)
- ☑ NEN 7510:2011 (Netherlands)
- ☑ FERPA
- ☑ CDSA
- ☑ MPAA
- ☑ FACT (UK)

Regional

- ☑ Argentina PDPA
- ☑ Australia CCSL / IRAP
- ☑ Canada Privacy Laws
- ☑ China GB 18030:2005
- ☑ China DJCP (MLPS) Level 3
- ☑ China TRUCS / CCCPPF
- ☑ EU ENISA IAF
- ☑ EU Model Clauses
- ☑ EU – US Privacy Shield
- ☑ Germany IT-Grundschutz workbook
- ☑ India MeitY
- ☑ Japan CS Mark Gold
- ☑ Japan My Number Act
- ☑ Netherlands BIR 2012
- ☑ New Zealand Gov CIO Fwk
- ☑ Singapore MTCS Level 3
- ☑ Spain ENS
- ☑ Spain DPA
- ☑ UK G-Cloud

Azure Portfolio

Edge Devices

Azure Stack | Azure Data Box | Azure Sphere | Azure Kinect | HoloLens

Serverless

Web
Mobile
Mixed Reality
Containers
Events + Integration

Databases
Analytics
AI + Machine Learning
Internet of Things
Media

Infrastructure

Compute | Networking | Storage | Security | Identity

Tools

Visual Studio
GitHub
PowerApps
Power BI

Let’s Go Deeper

Azure Compute

(VM Families, pure Infrastructure as a Service)

Virtual machines

Purpose-built

Entry level
- Av2

Burstable
- B

General Purpose
- Dv2
- Dv3

Compute Intensive
- F
- Fv2

Memory Optimized
- M
- Ev3

GPU Accelerated
- NCv2
- NCv3
- NV
- ND
- NEW NVv2
- NEW NDv2

HPC
- H
- NEW HC
- NEW HB

Storage Optimized
- L
- NEW Lv2

SAP®

CRAY®

Azure Data Stores

(Platform as a Service)

Tables of related data with rows of identical records (think of an Excel sheet)

Sets of documents with similar, but not necessarily uniform fields (think of a Word document with an outline)

Relational

Non-relational

Structured

SQL Server

SQL Managed Instance (compatibility)

Azure SQL Database

Azure Database for PostgreSQL

Azure Database for MySQL

Azure Database for MariaDB

Azure Synapse Analytics (formerly SQL DW)

Azure Cosmos DB

High-Performance Analytics

Unstructured

Images, audio, video, standalone files of any type

General Purpose

Storage Accounts (Blobs, Files, Tables, Queues)

Big Data

Azure Data Lake

Machine Learning on Azure

Domain specific pretrained models
To simplify solution development

Vision | Speech | Language | Search

Familiar Data Science tools
To simplify model development

Visual Studio Code | Azure Notebooks | Jupyter | Command line

Popular frameworks
To build advanced deep learning solutions

PyTorch | TensorFlow | Scikit-Learn | ONNX

Productive services
To empower data science and development teams

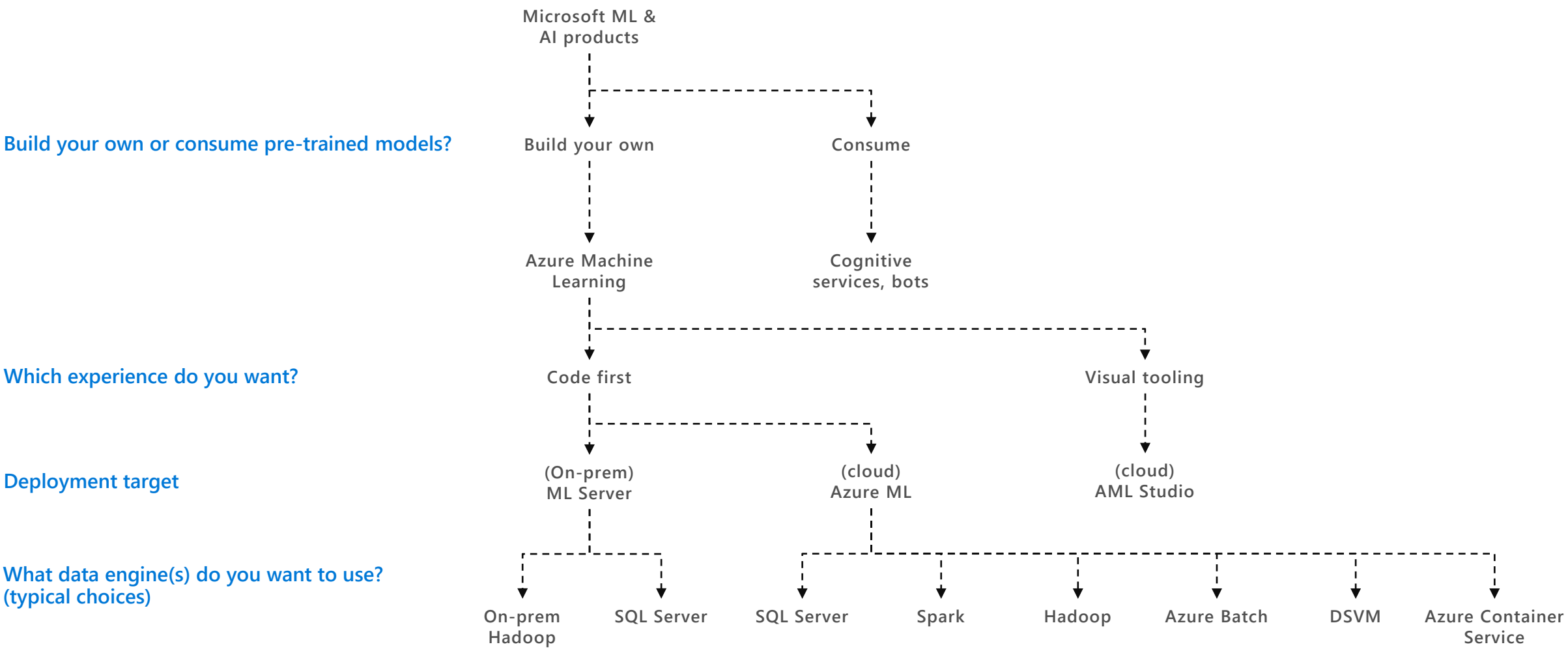
Azure Databricks | Azure Machine Learning | Machine Learning VMs

Powerful infrastructure
To accelerate deep learning

CPU | GPU | FPGA

From the Intelligent Cloud to the Intelligent Edge

That is too much stuff! Which shoud I use?



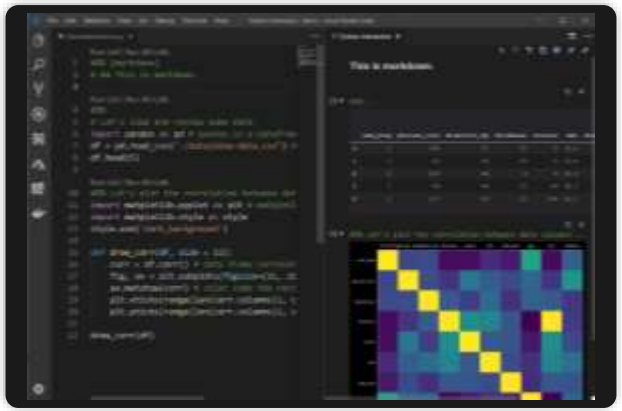
Familiar Data Science tools

Choose any python development environment

Visual Studio Code | Azure Notebooks | Jupyter | PyCharm | Zeppelin | Command line

And improve data science productivity

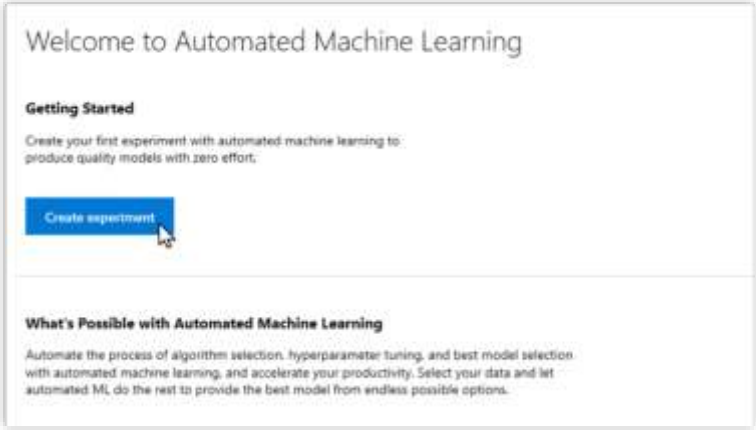
Interactive widgets for Jupyter Notebooks



Azure Machine Learning for Visual Studio Code extension

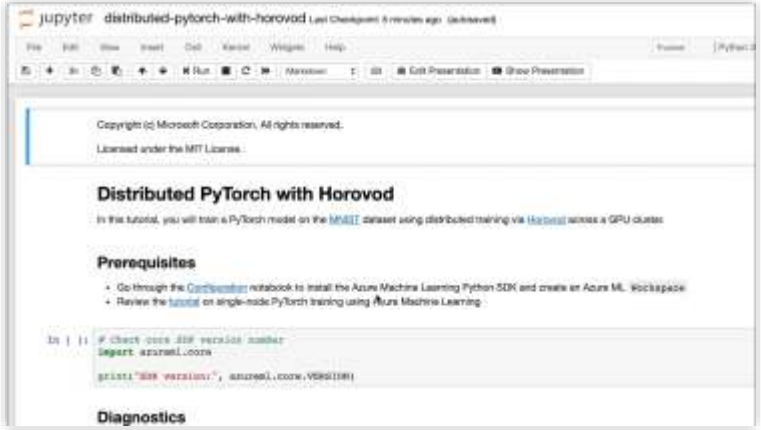
Get started with AML on Azure Notebooks: http://aka.ms/aznotebooks-aml

Machine learning for any skill level



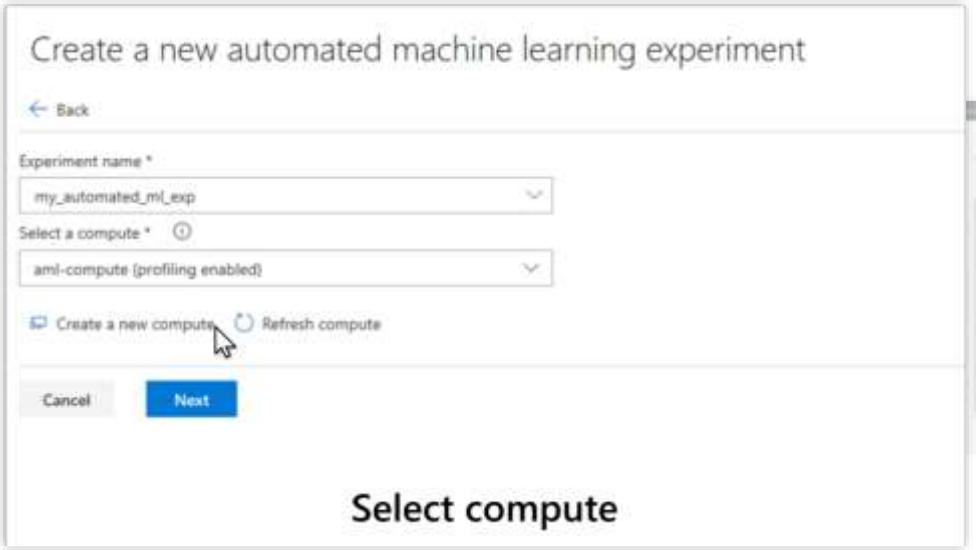
Automated machine learning UI

Visual interface



Machine learning notebooks

Machine learning for any skill level



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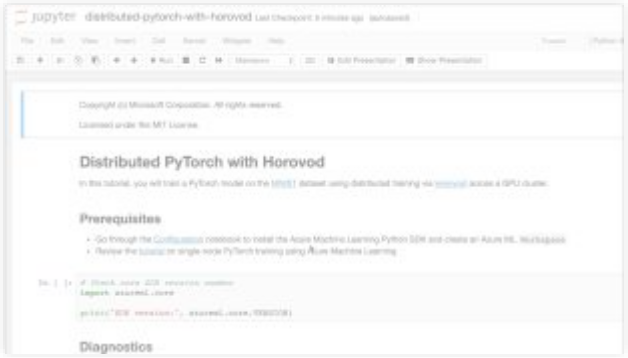
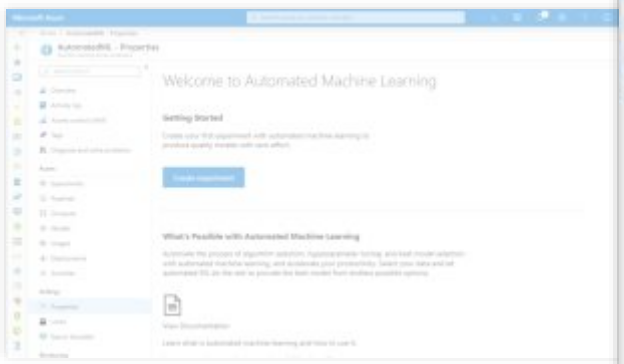
Visual interface



Machine learning notebooks

Machine learning for any skill level

New capabilities in Azure Machine Learning service



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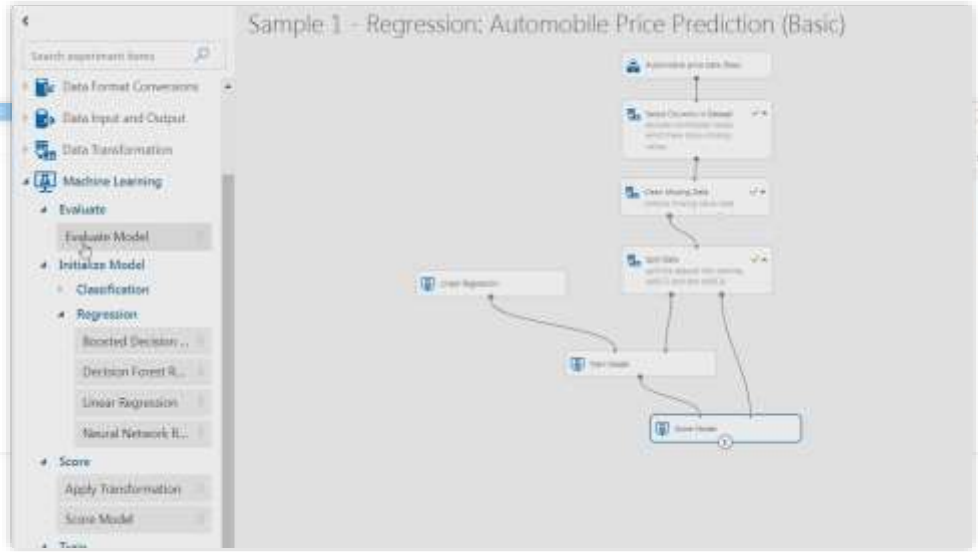

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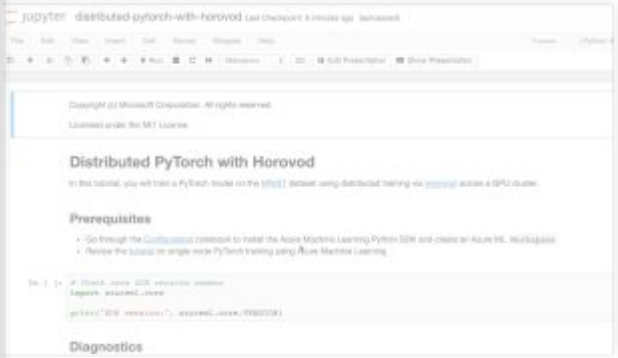

Machine learning notebooks

Machine learning for any skill level

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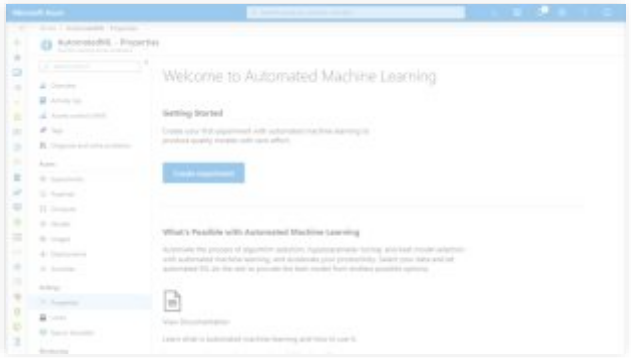

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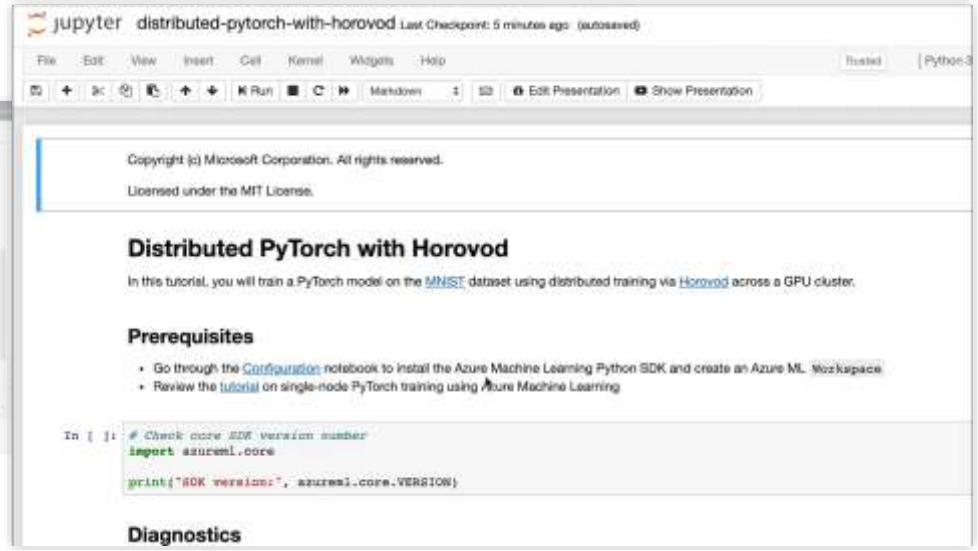
Visual interface

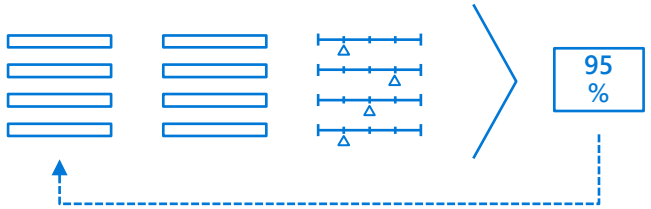


Machine learning notebooks

Differentiators

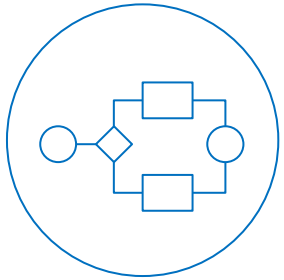
Machine Learning

Automated machine learning



Accelerated model building

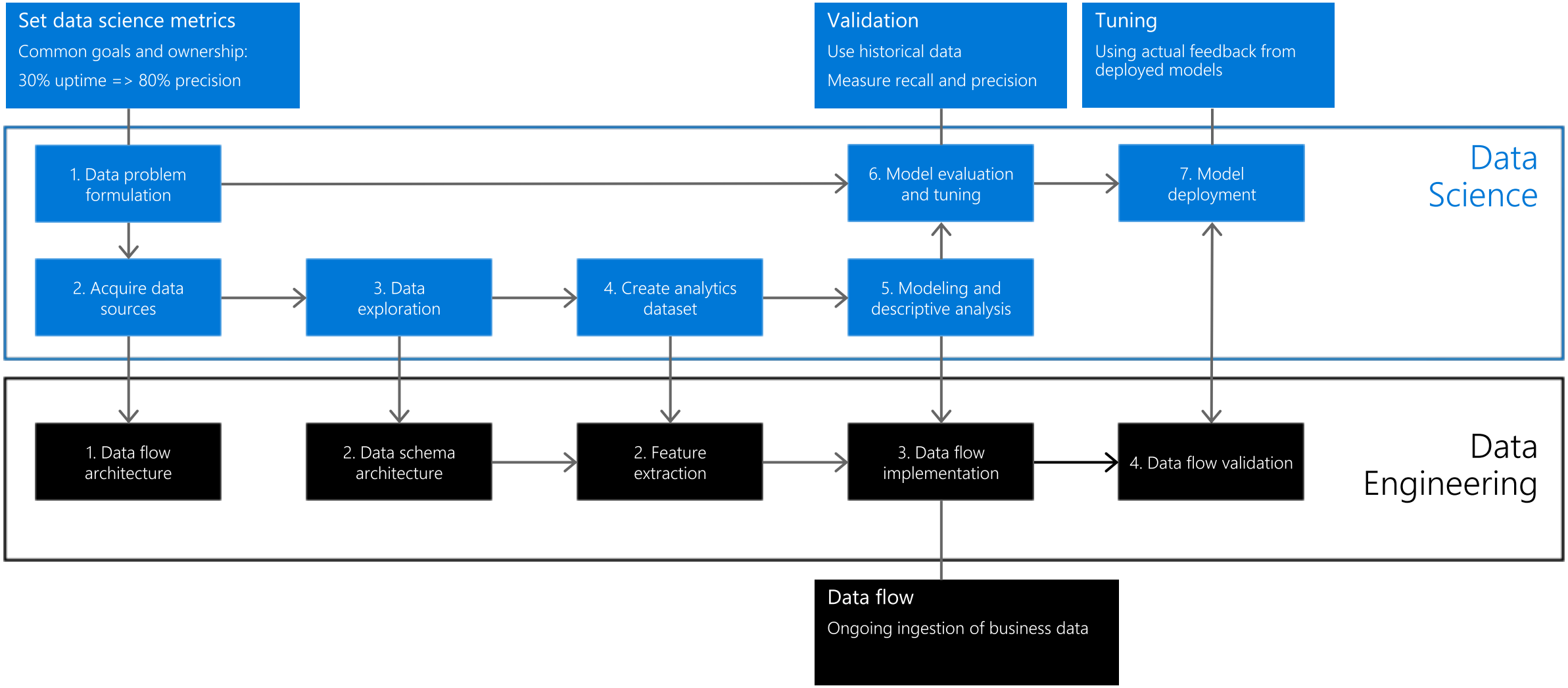
Machine learning DevOps



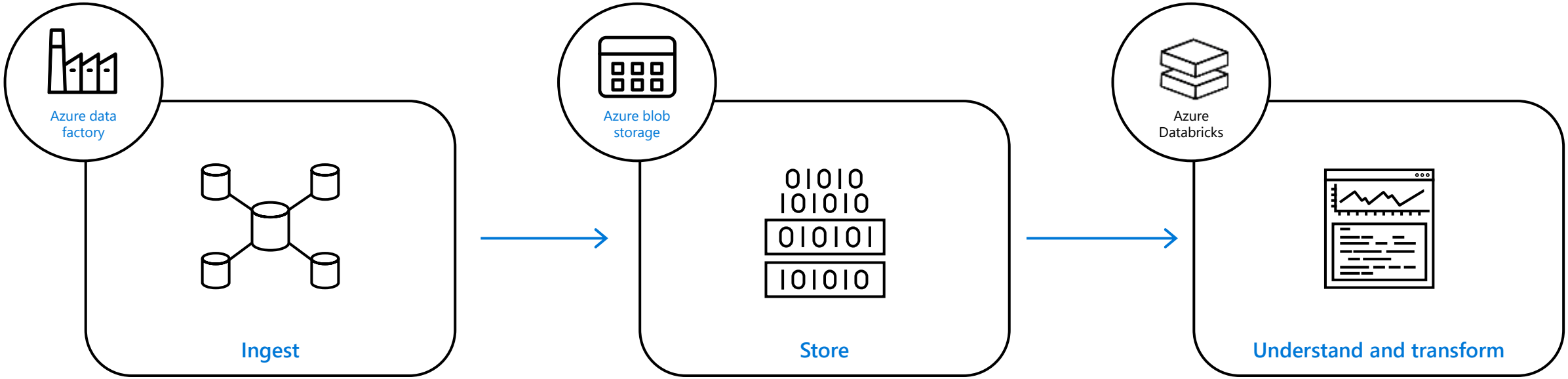
Azure DevOps integration for CI/CD

Processes & Pipelines

Data Science vs Data Engineering



Typical Pipeline (now folded into Azure DataFlow)



Connect to data from any source

Integrate with all of your data sources

Create hybrid pipelines

Orchestrate in a code-free environment

Leverage best-in-class analytics capabilities

Leverage open source technologies

Collaborate within teams

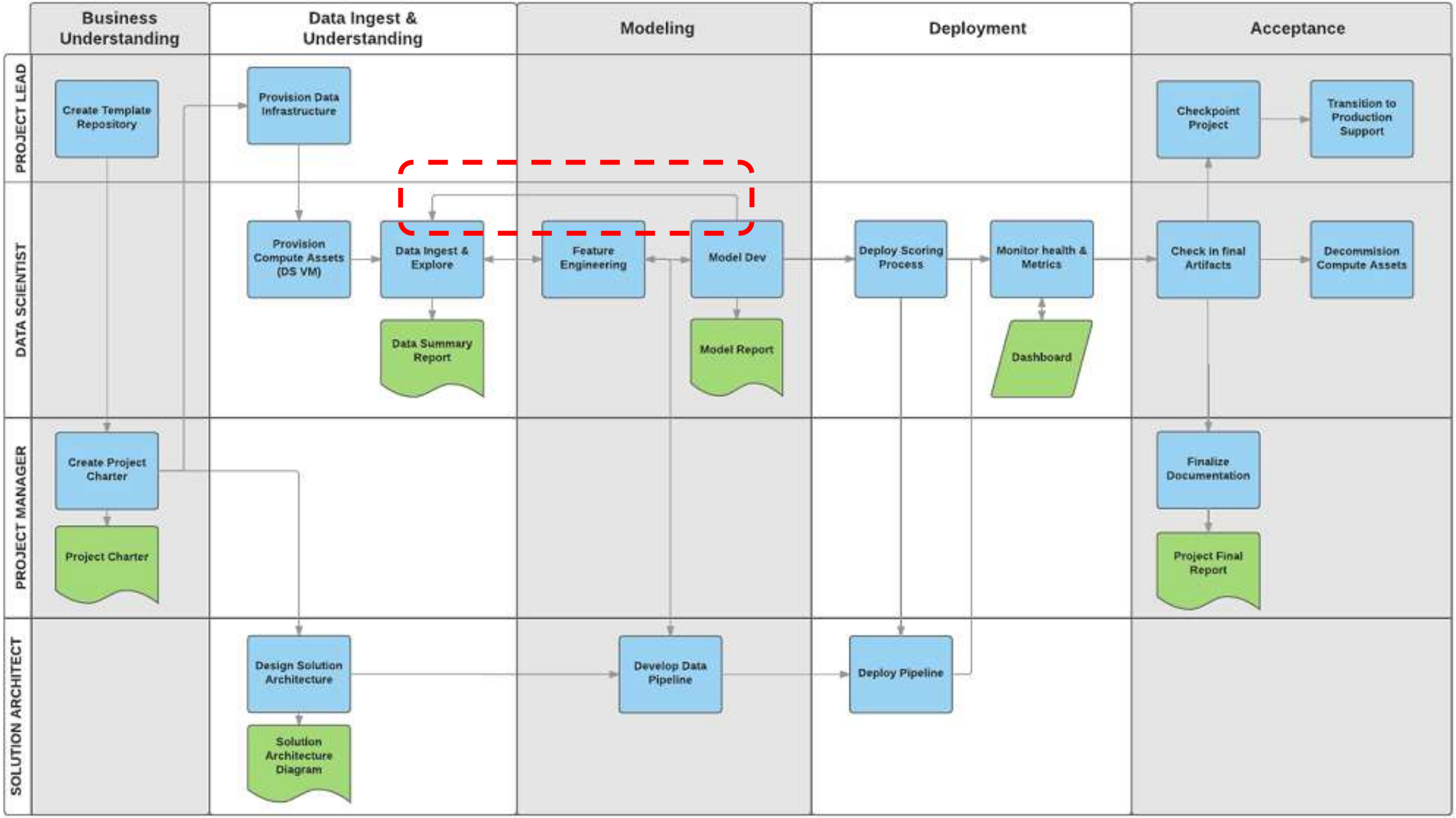
Use ML (machine learning) on batch streams

Scale without limits

Build in the language of your choice

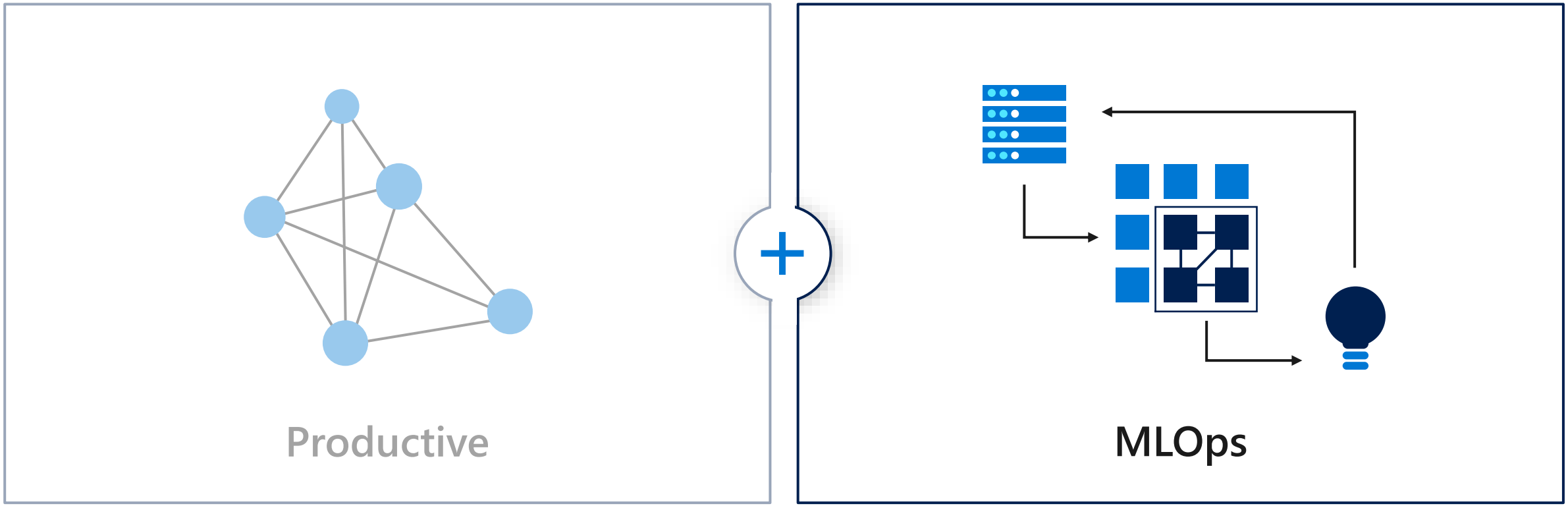
Leverage scale out topology

Scale compute and storage separately



The Microsoft Team Data Science Process - https://github.com/Azure/Microsoft-TDSP

Azure Machine Learning service



Open platform

Azure Machine Learning accelerates model development

with automated machine learning

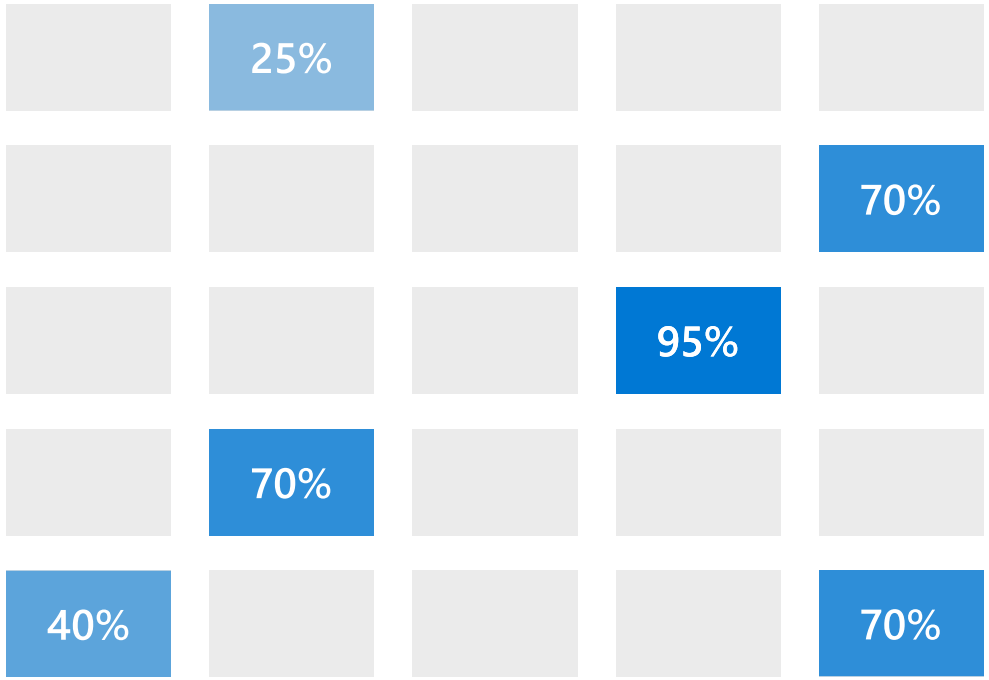
Input

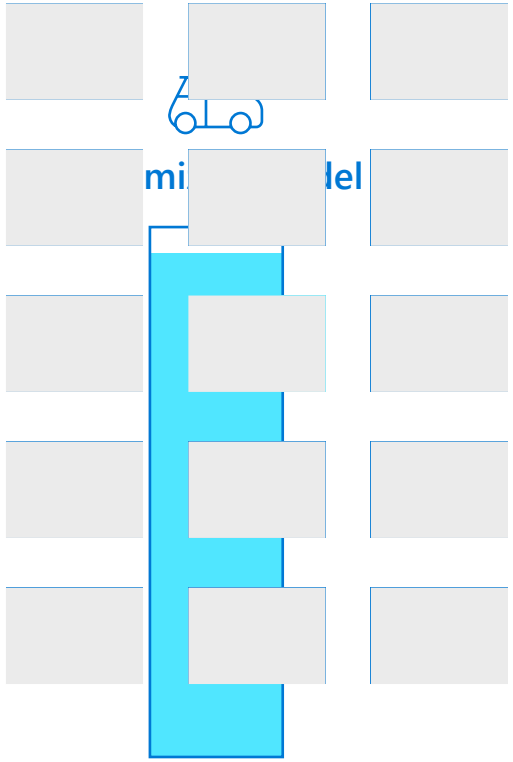
Enter data

Define goals

Apply constraints

Intelligently test multiple models in parallel





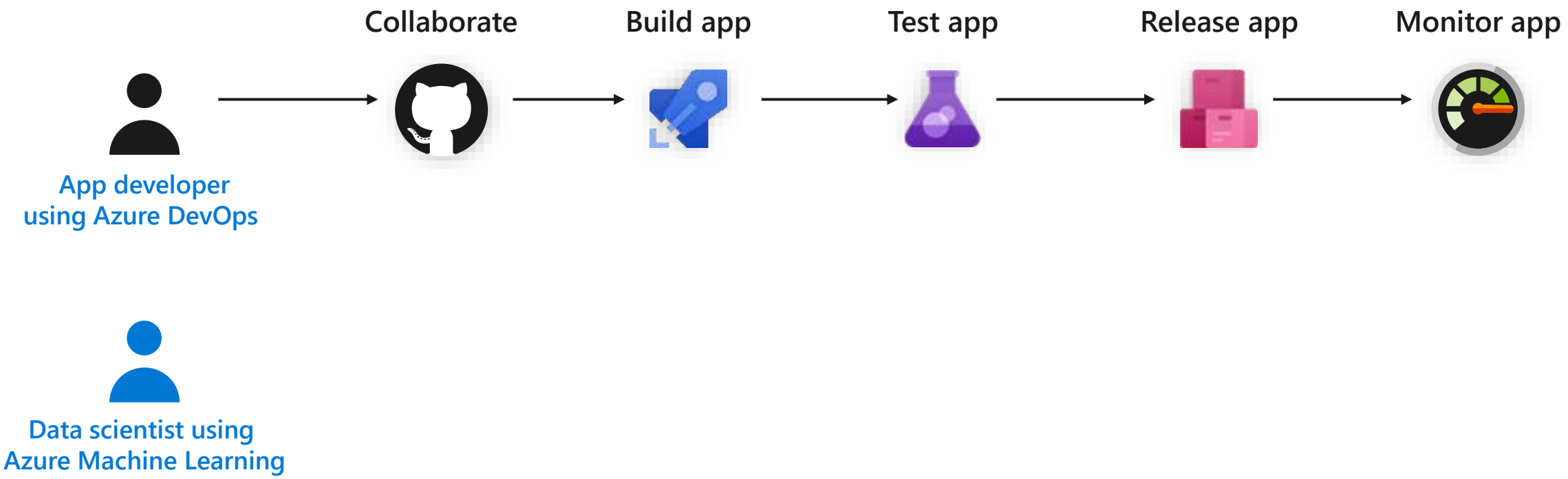
DevOps

- Code reproducibility
- Code testing
- App deployment

MLOps

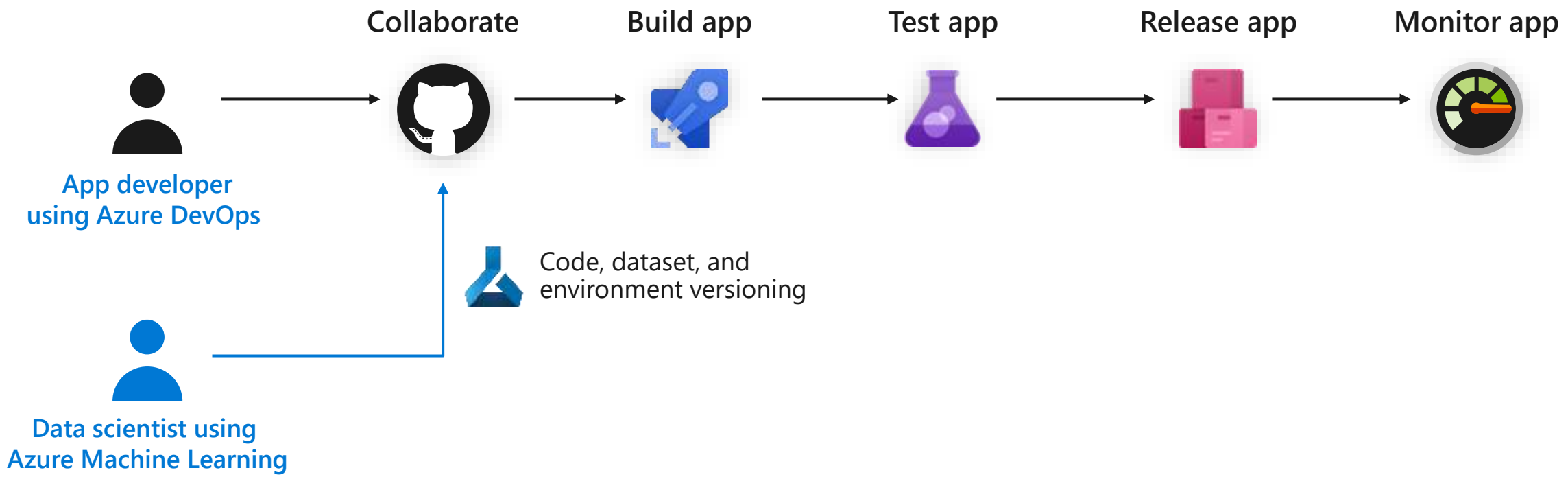
- Model reproducibility
- Model validation
- Model deployment
- Model retraining

MLOps with Azure Machine Learning



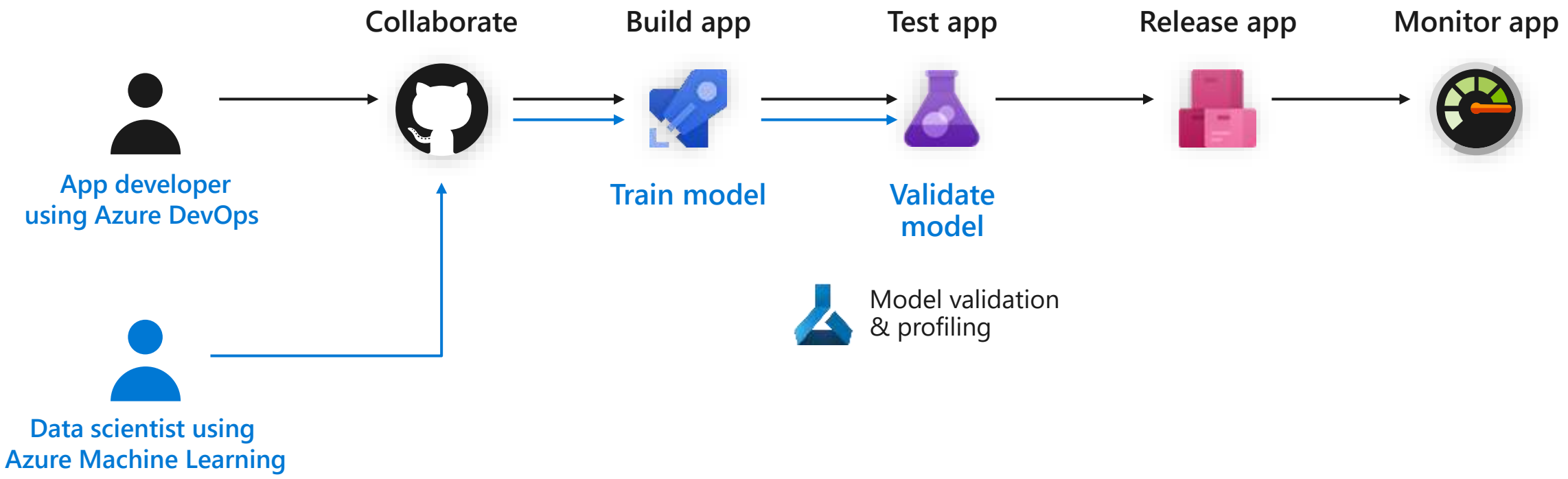
- ☐ Model reproducibility
- ☐ Model validation
- ☐ Model deployment
- ☐ Model retraining

MLOps with Azure Machine Learning



- [x] Model reproducibility
- [ ] Model validation
- [ ] Model deployment
- [ ] Model retraining

MLOps with Azure Machine Learning



- [x] Model reproducibility
- [x] Model validation
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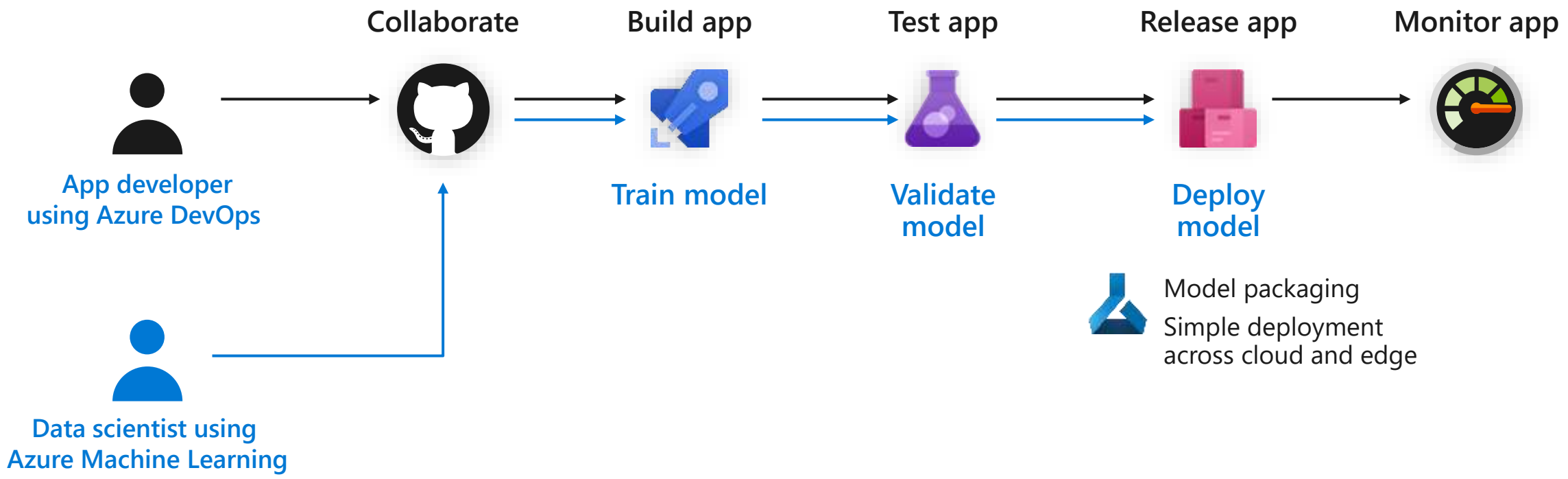
MLOps with Azure Machine Learning



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- ☑ Model validation
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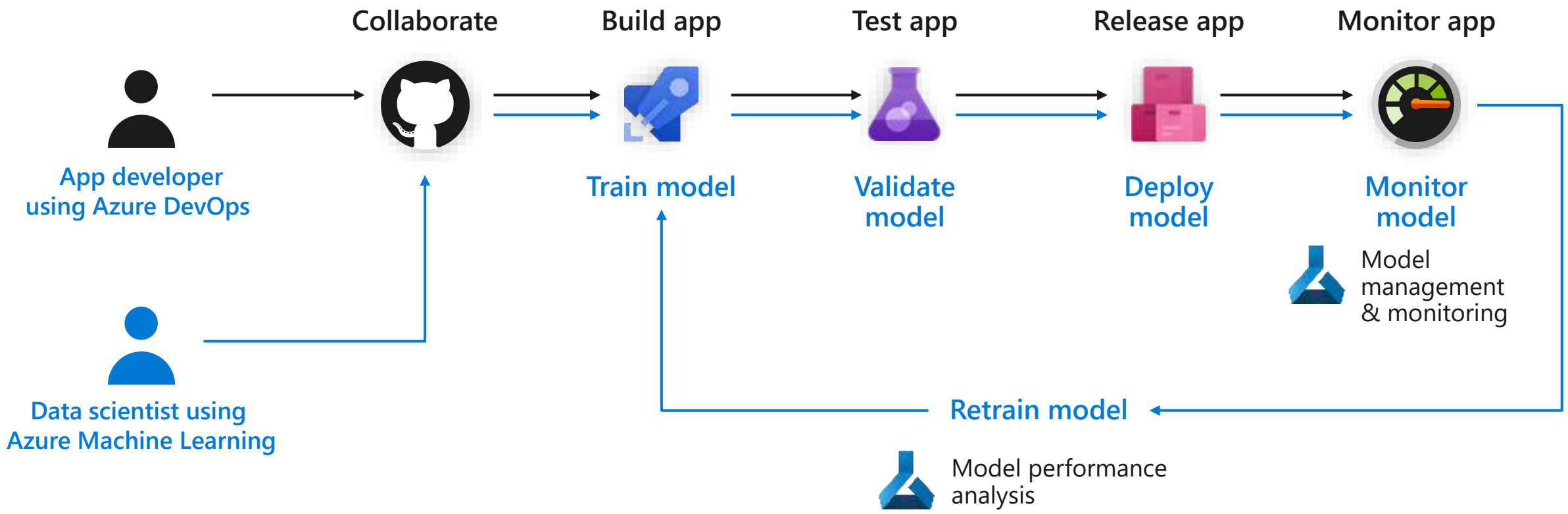
- ☐ Model retraining

MLOps with Azure Machine Learning



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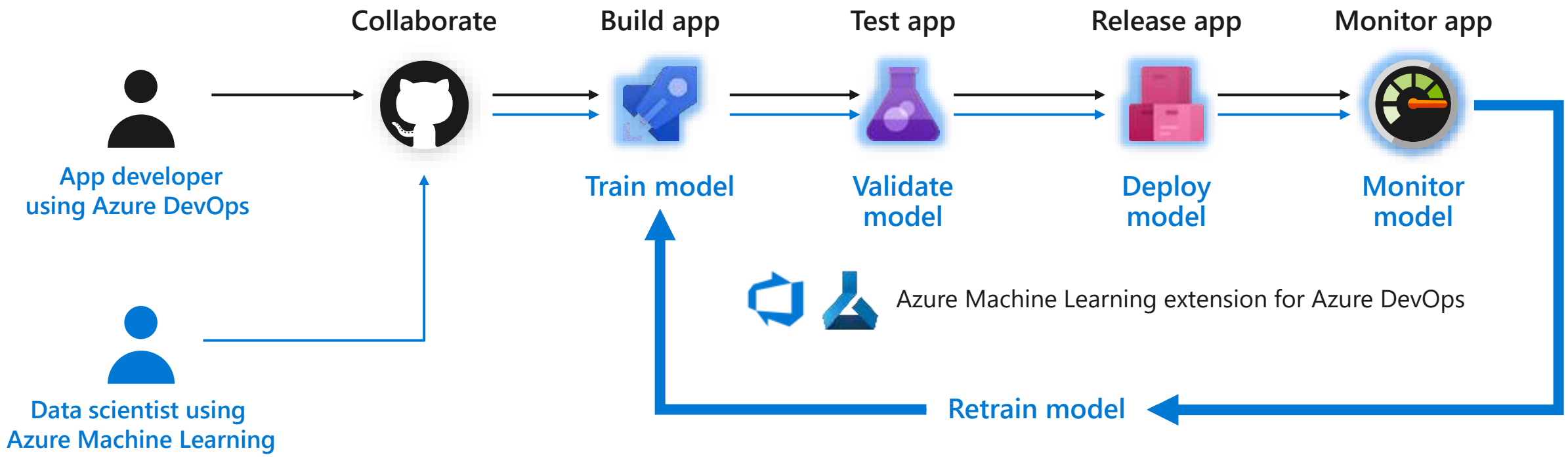

- Model reproducibility
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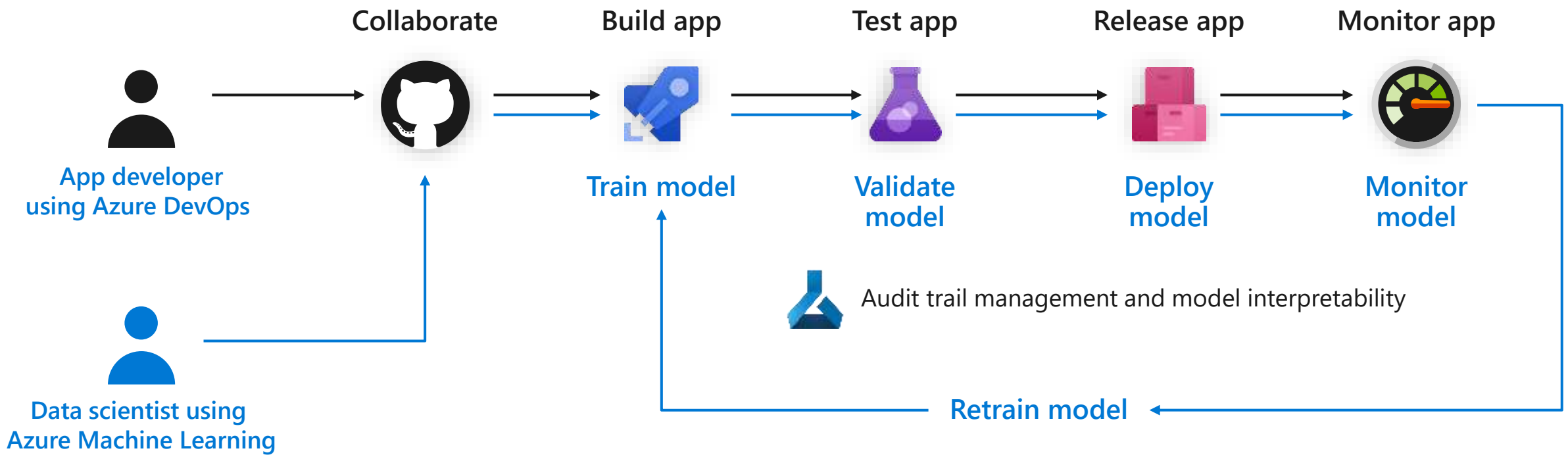
MLOps with Azure Machine Learning



- Model reproducibility
- Model validation
- Model deployment
- Model retraining

Modern Data Warehousing

BIG DATA, BIG BLOCKS

Relational data

OLTP | ERP | CRM | LOB

Non-relational data

Web | Media | Social media | Devices

Data virtualization

Data warehousing

Big Data processing

Any BI tool

Dashboards | Reporting
Mobile BI | Cubes

Advanced Analytics

Machine Learning
Stream analytics | Cognitive | AI

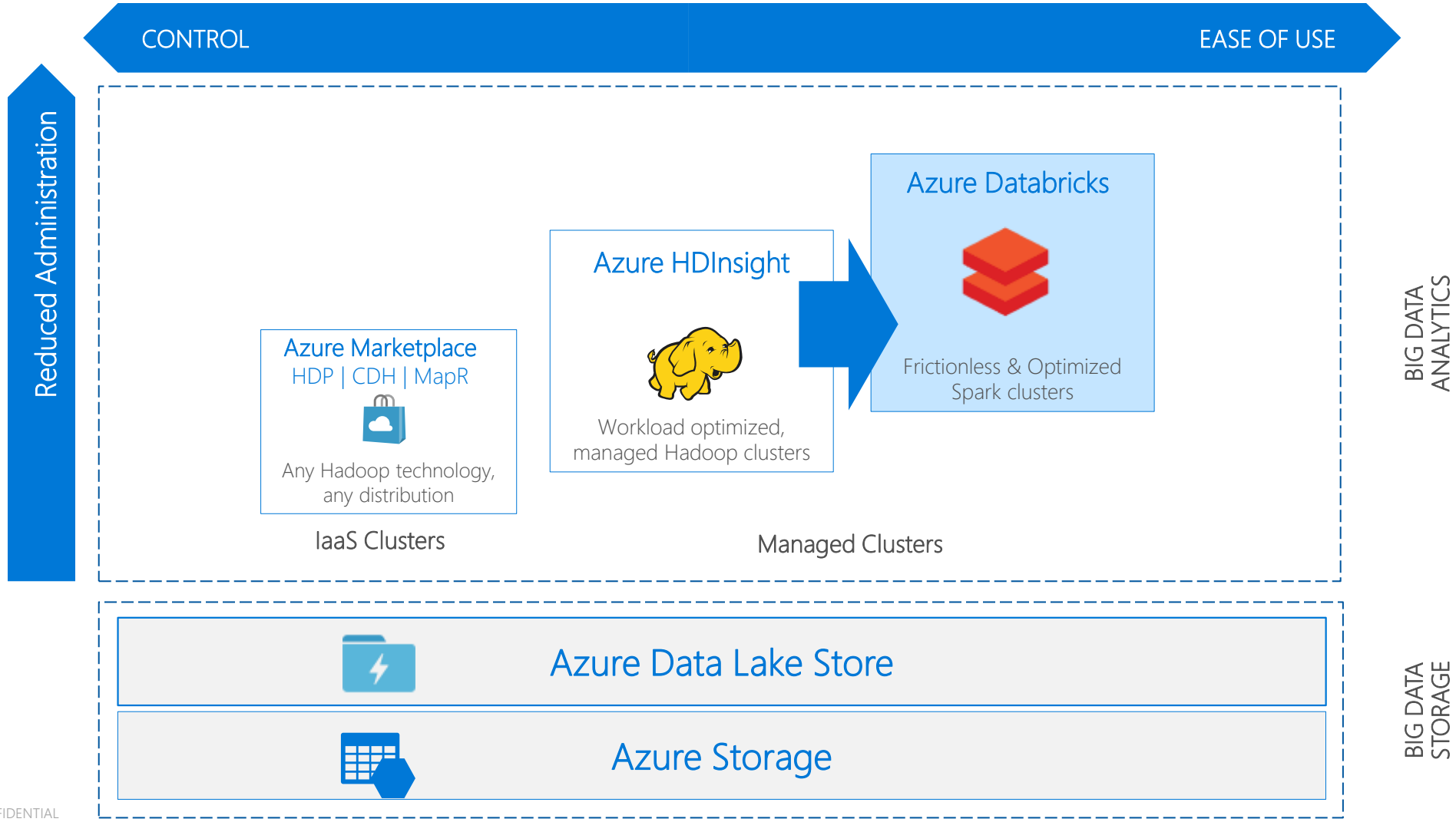
Any language

.NET | Java | R | Python
Ruby | PHP | Scala

On-premises **Cloud**

Building Blocks

How we see Big Data on Azure today



Data Warehouse Paradigms (Hadoop vs Spark)

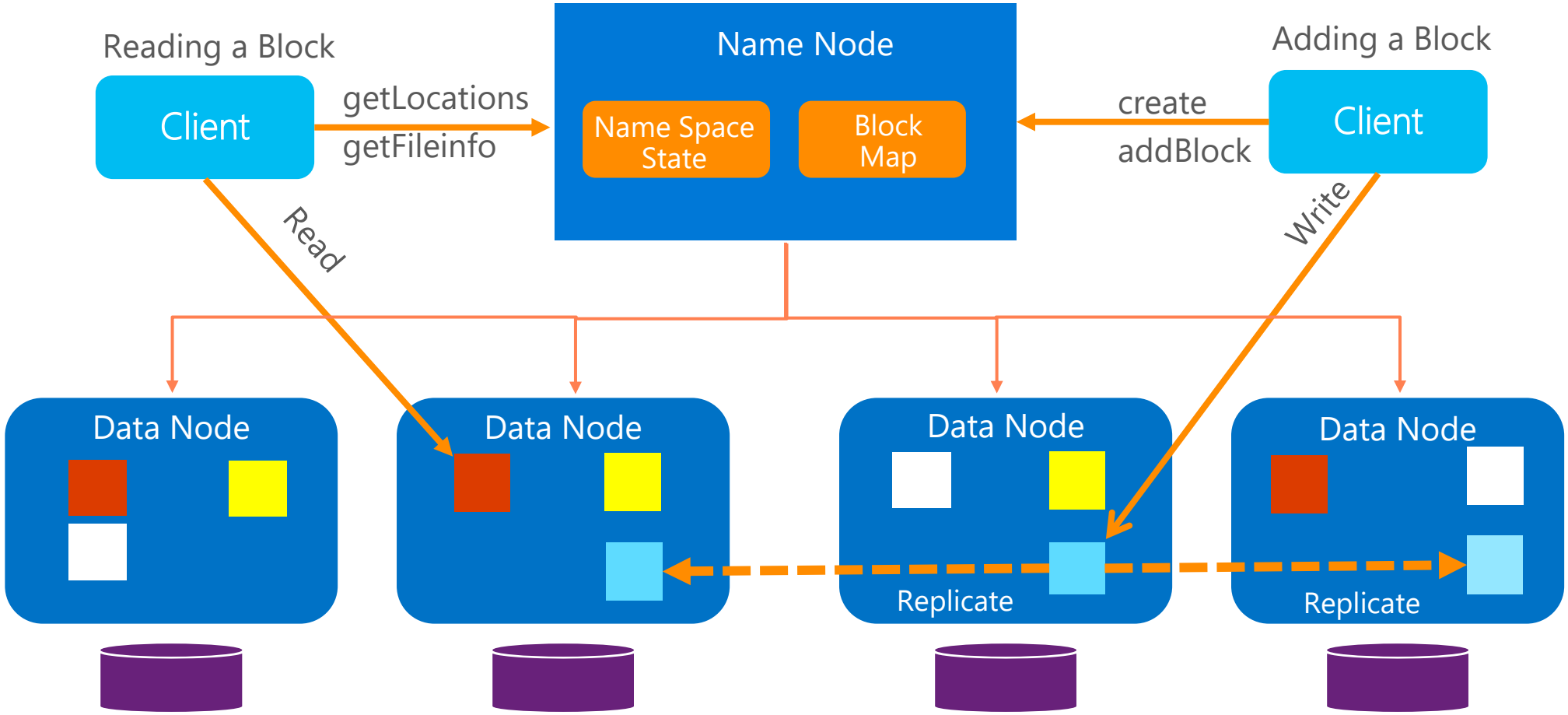
Hadoop is a good example for old-school data warehousing designed for conventional datacenters

- Designed for redundancy and built-in storage
- Clusters typically run 24/7, and it is expensive to have more than one
- Buy/build all the CPU and storage you need in advance
- Storage is (roughly) triple the amount of live data

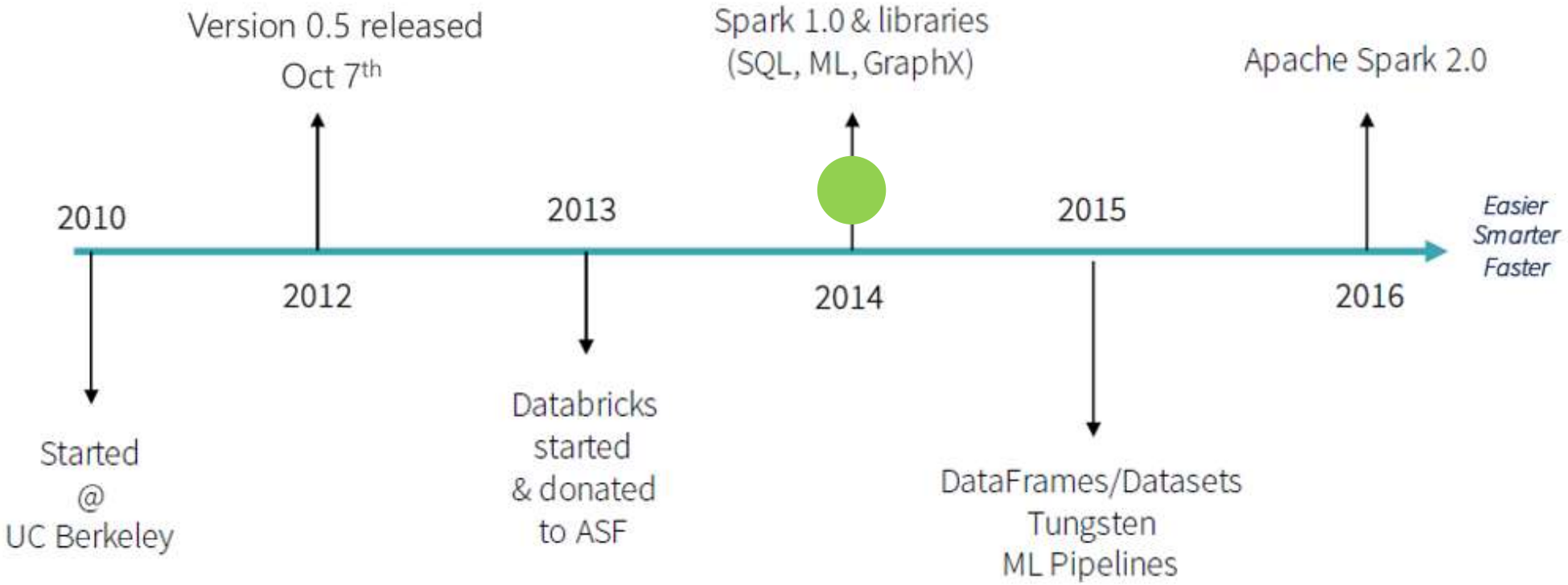
Spark/Databricks is a different paradigm that is more suited to the cloud

- Designed for performance and access to external storage
- Clusters typically run on-demand, and you can run many against the same storage
- One-click creation of “right-sized” ephemeral clusters
- Pay only for the storage you actually need for live data

Apache Hadoop Architecture

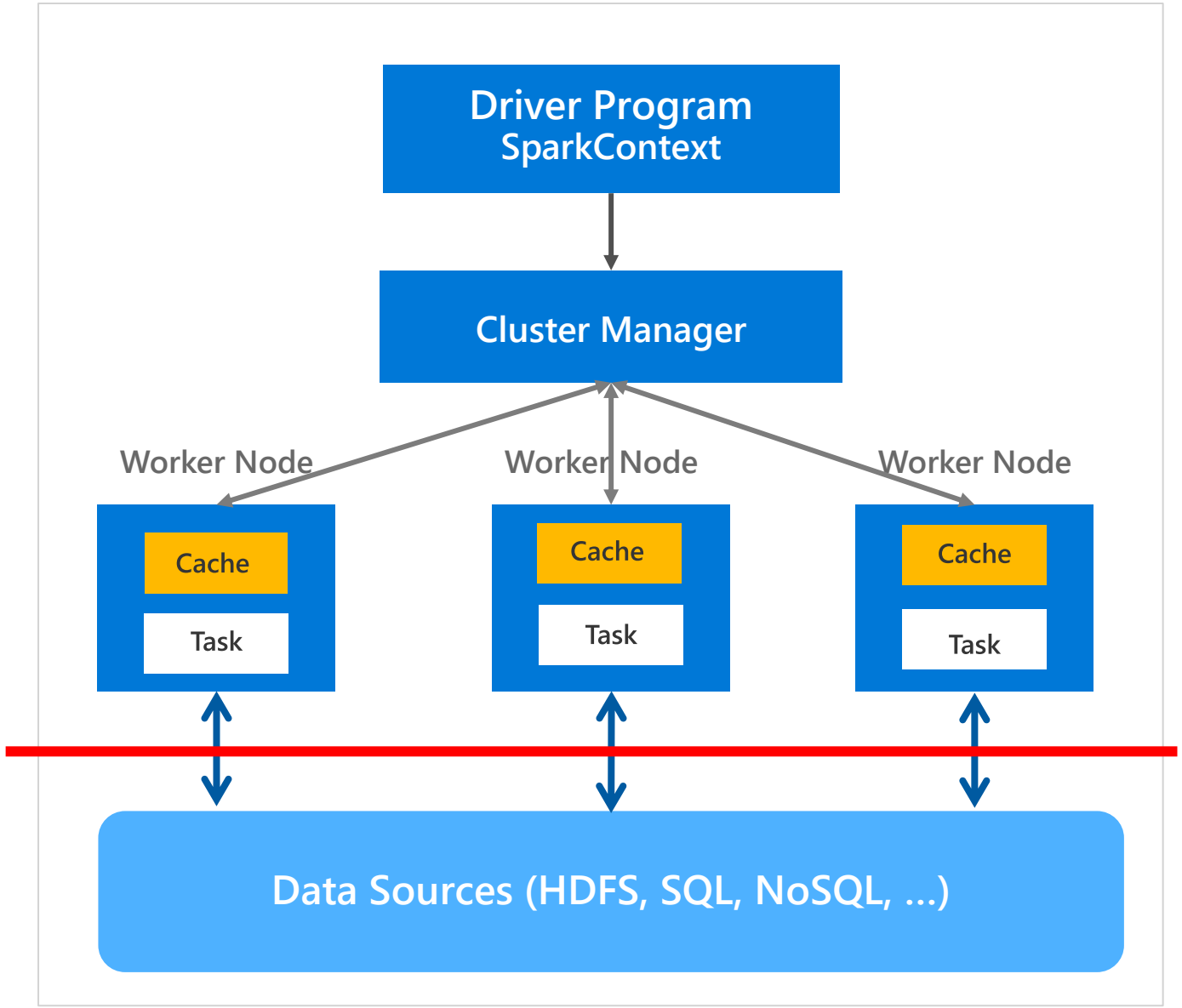


Spark: A Brief History

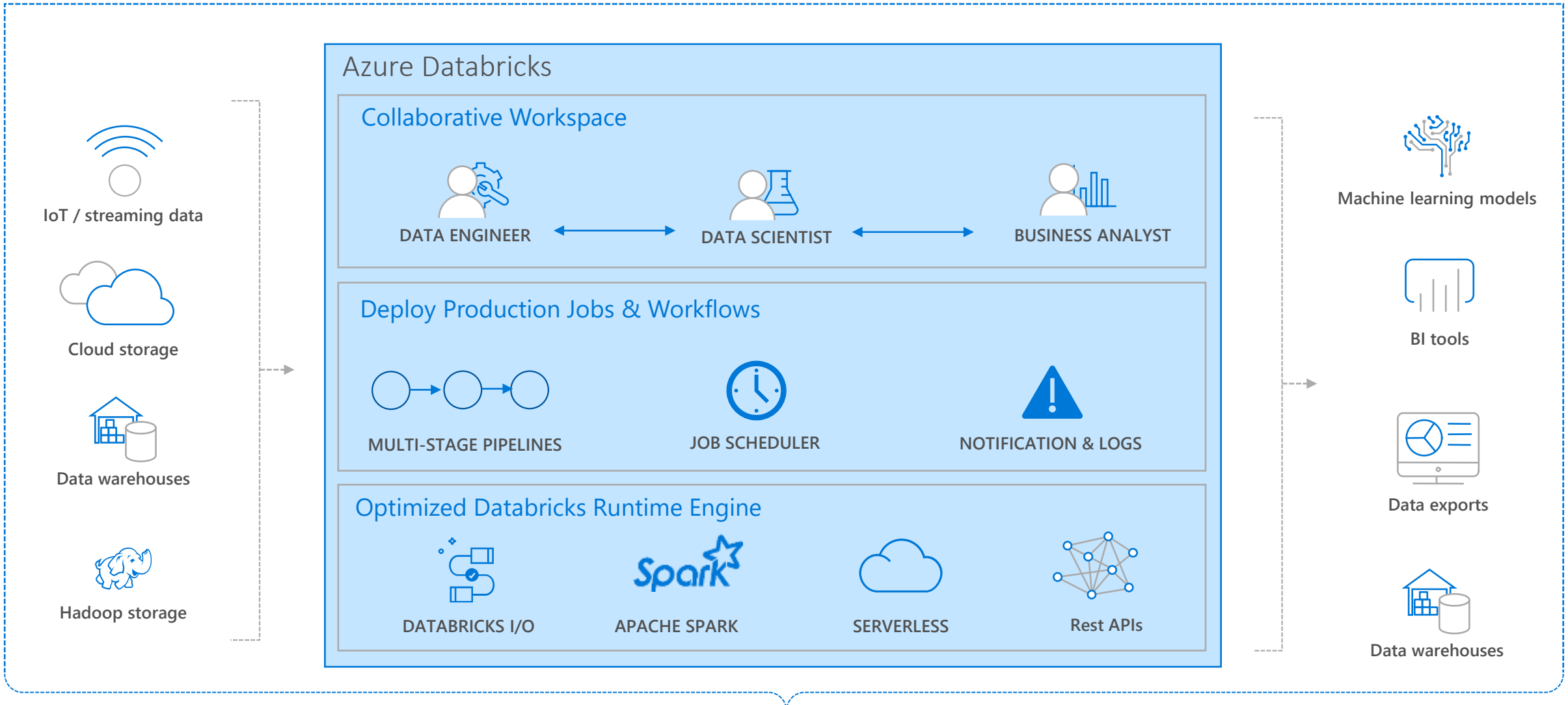


Apache Spark Architecture

- 'Driver' runs the user's 'main' function and executes the various parallel operations on the worker nodes.
- The results of the operations are collected by the driver
- The worker nodes read and write data from/to Data Sources including HDFS.
- Worker node also cache transformed data in memory as RDDs (Resilient Data Sets). Spark is especially suited for **distributed in-memory data processing.**
- Worker nodes and the Driver Node execute as throwaway VMs in the cloud
- Databricks provides a managed Spark service that allows you to build and tear down clusters automatically
- **Storage is completely separate** from the cluster when deployed on Azure



Spark/Databricks - Azure Managed Service



Enhance Productivity

Build on secure & trusted cloud

Scale without limits

Spark vs Hadoop on VMs

Databricks	Third-Party Hadoop on VMs (not HDInsight)
PaaS (zero-touch setup, scale, manage, patch, etc.)	IaaS (you maintain and patch the VMs)
Managed by Microsoft	Managed by customer
Storage is completely separate (Blob or ADLS) and can scale independently	Storage in VM (local disk), but can also have storage in Azure blob or ADLS
Delete VM keeps data	Delete VM deletes data (unless external)
Automatic, seamless auto scaling (during job execution)	Manual scaling (need to stop jobs)
Up to 30 days behind latest stable Apache Spark release	Hadoop version supplied by vendor
Microsoft supports VM and Databricks	Microsoft: VM, Hadoop: Third-Party Support
Python, R, SQL, Scala, SparkML	Impala, Hive, PiG,....
No on-prem version (build your own Spark)	On-prem version
Business continuity through globally redundant storage in Data Lake	Roll your own disaster recovery (IaaS-based)

A Standard Hadoop Deployment

VM Group	CPUxCores	RAM	Storage	VM Series	T-Shirt S	T-Shirt M	T-Shirt L
3 Head Nodes	1x14 HT	128GB	2x300GB SSD+ 2x200GB SSD	Dv3 (HT) or E (in-mem HT)	D16sv3 (64GB)	L16sv2 (128GB)	L16sv2 (128GB)
6 Worker Nodes	2x14 HT	512GB	4x200GB SSD+ 10x6TB HDD	Dv3 (HT) or E (in-mem HT), L (storage opt.)	E32v3 (256GB)	E64v3 (432GB)	L64sv2 (512GB)
4 Load Balancers	1x2	2GB	30GB HDD	B (burstable) or F (compute optimized)	B1ms (2GB)	F1 (2GB)	F1 (2GB)
2 ETL	1x16	64GB	200GB HDD+ 500GB SSD	F or Dv3	F16sv2 (32GB)	D16sv3 (64GB)	D16sv3 (64GB)
2 CM+CN	1x8	32GB	200GB HDD+ 500GB SSD	B or Dv3	B8ms (32GB)	D8sv3 (32GB)	D8sv3 (32GB)

Hadoop Storage Scenario

	Standard SSDs for mixed load	Premium SSDs or Standard HDDs for data loads
Head Nodes	E15 256GB 4x	P20 1TB 2x
Data Nodes	E15 256GB 4x	S60 8TB, S60 8TB 8x
	Total: 36xP15	Total: 48xS60 (2880 TB!)

	Standard HDDs for OS	Premium SSDs for data
Load Balancers	S4 32GB	
Other Edge Nodes	S15 256GB	P20 512GB
	Total: 4xS4, 4xS15,4xP20	

The PaaS Alternative: Spark (Databricks) Clusters

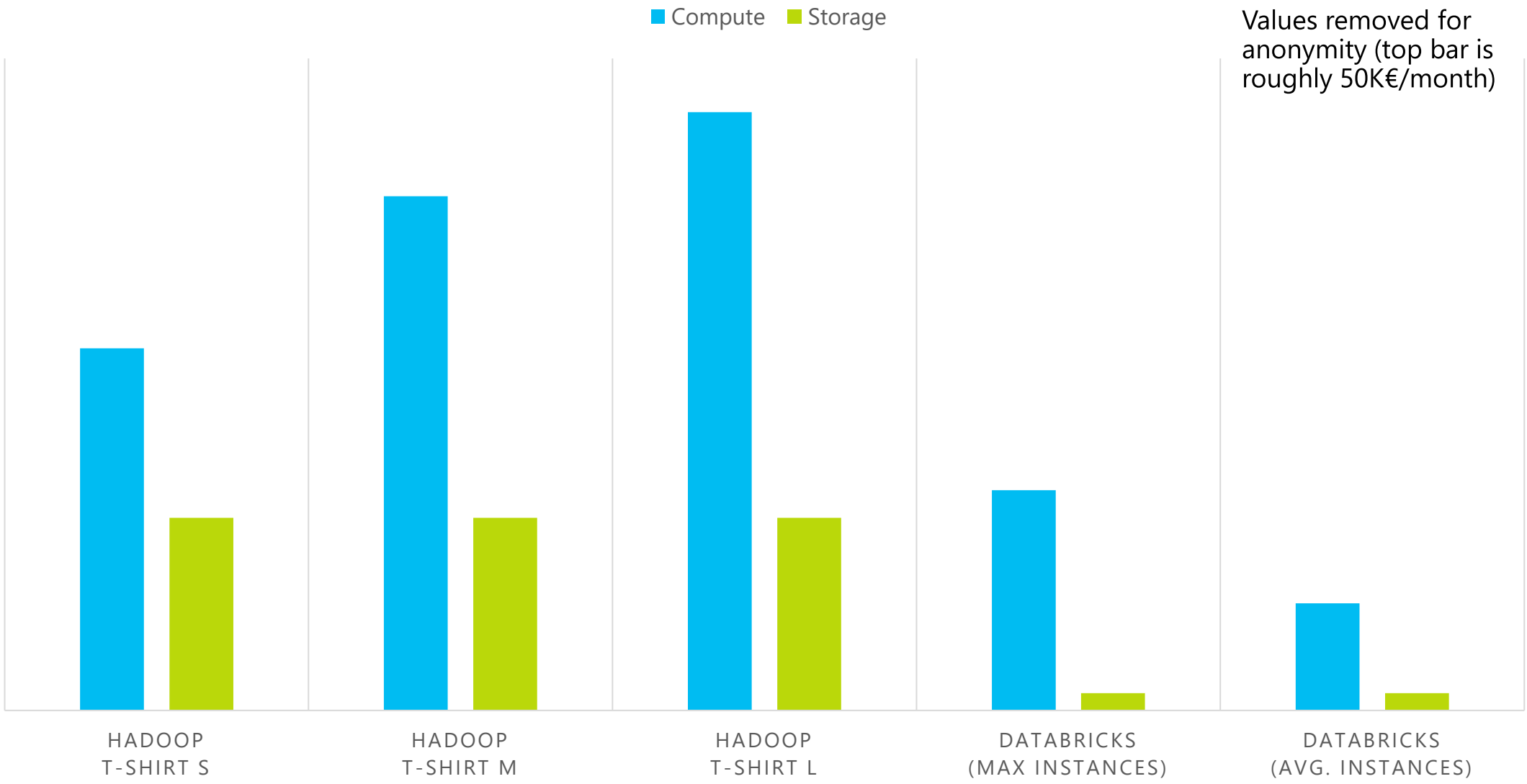
Typical Profiles

Profile	Instance Size	Average Instances	Max Instances	Hours
High-Performance batches	E32v3 (256GB)	4	9	480h (~30x16h)
Data Science	L8 (64GB)	2	6	160h (20x8h)
Data Science Light	L4 (32GB)	1	3	160h (20x8h)
Streaming (CDC, etc.)	F4 (8GB)	2	2	730h (~30x24h)

Average vs Max:

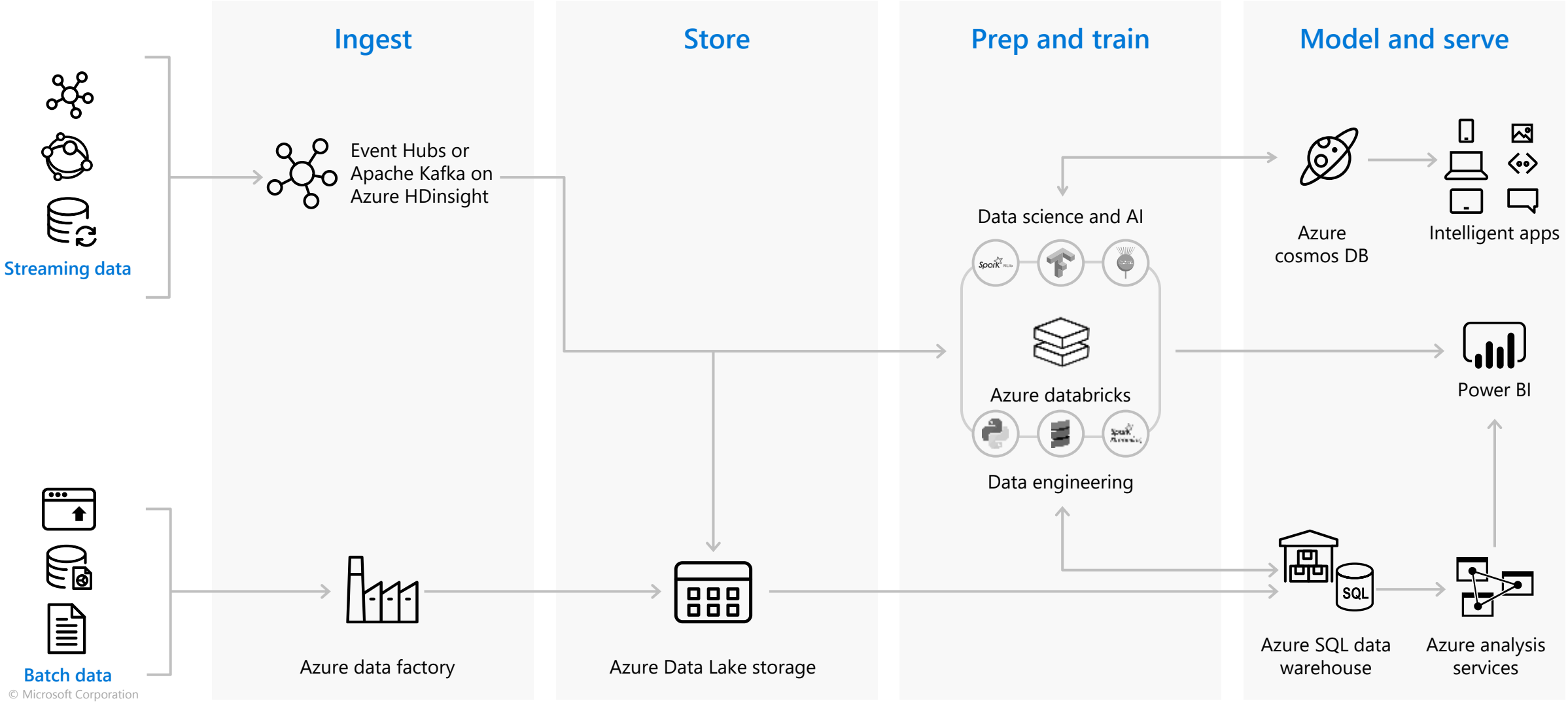
You can run more machines when required (peak usage), but you'd typically run less

Cost Comparison (Compute & Storage)

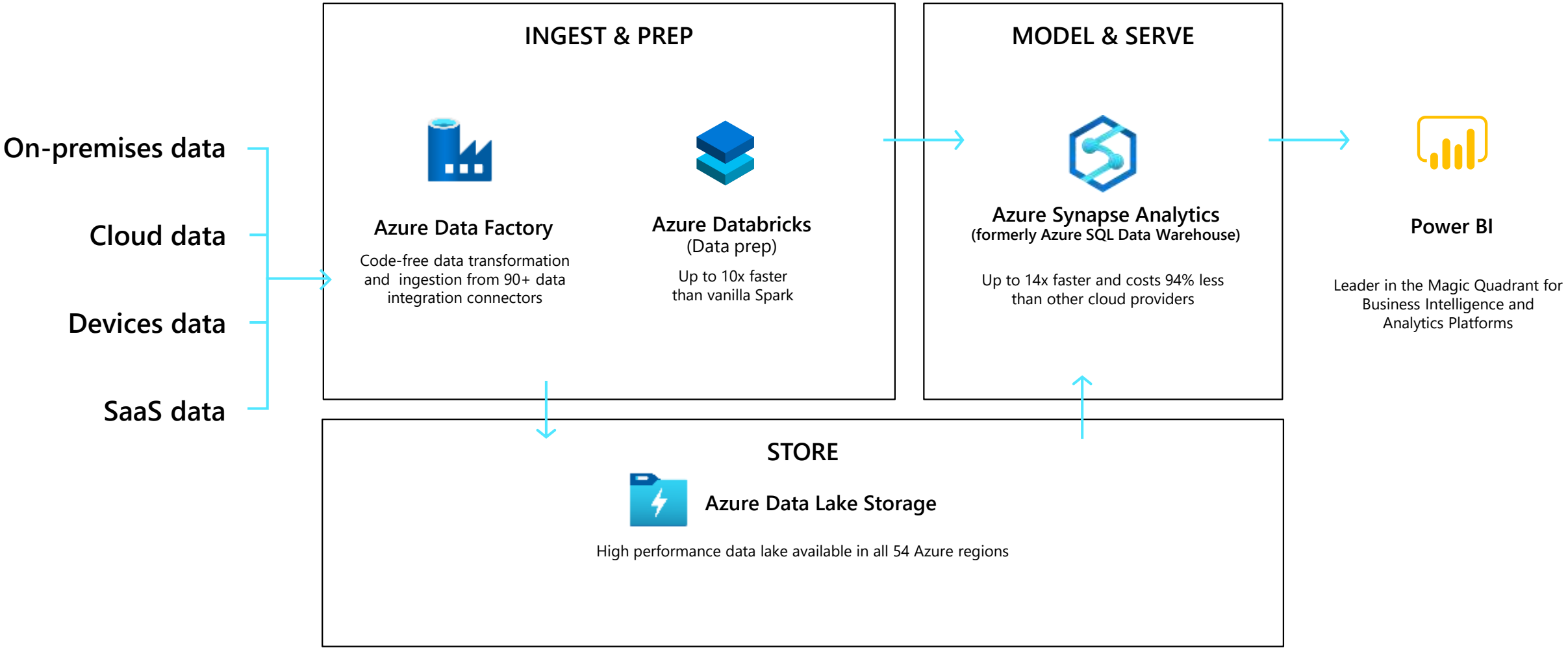


Microsoft Reference Architecture

Based on the hot/cold lambda architecture pattern



Azure Analytics



Estimating Cloud OPEX

Rule of Thumb:

1 Core × 1 GB RAM × 1 month ≈ US$14*

* West Europe Price, A-series VMs

$$1\ \text{Core} \times 1\ \text{GB RAM} \times \cancel{1\ \text{month}}\ 730\ \text{h} \approx \text{US\$}14$$

How accurate is this?

$$1 \text{ Core} \times 1 \text{ GB RAM} \times 730 \text{ h} \approx \text{US\$14}$$

How accurate is this?

$$1\ \text{Core} \times 1\ \text{GB RAM} \times 730\ \text{h} \approx \text{US\$14}$$

Not at all accurate!

(depends on location, machine type, etc.)

just a way to:

- Do quick mental calculations/ballpark figures
- Understand **three dimensions** of pricing:

$$\text{Performance} \times \text{Capacity} \times \text{Usage} \approx \text{Cost}$$

What about persistent storage?

Rule of Thumb #2:

1 TB of Standard Storage × 1 month ≈ US$19*

* West Europe Price, Locally Redundant Storage

What dimension has changed?

1 TB of Standard Storage × 1 month ≈ US$19*

1 TB of Premium Storage × 1 month ≈ US$195*

* West Europe Price, Locally Redundant Storage

What dimension has changed?

1 TB of HDD Storage × 1 month ≈ US$19*

1 TB of SSD Storage × 1 month ≈ US$195*

Performance

* West Europe Price, Locally Redundant Storage

The Fourth Dimension:

1 TB of Locally Redundant Storage × 1 month ≈ US$19*

1 TB of Globally Redundant Storage × 1 month ≈ US$39*

Redundancy

* West Europe Price

Deliver results on time (either in batches or real time)

Performance

- How Fast

Capacity

- How Much

Remember you only pay for the storage you actually use

Design Parameters

Day-to-Day OPEX

Redundancy

- How Tolerant

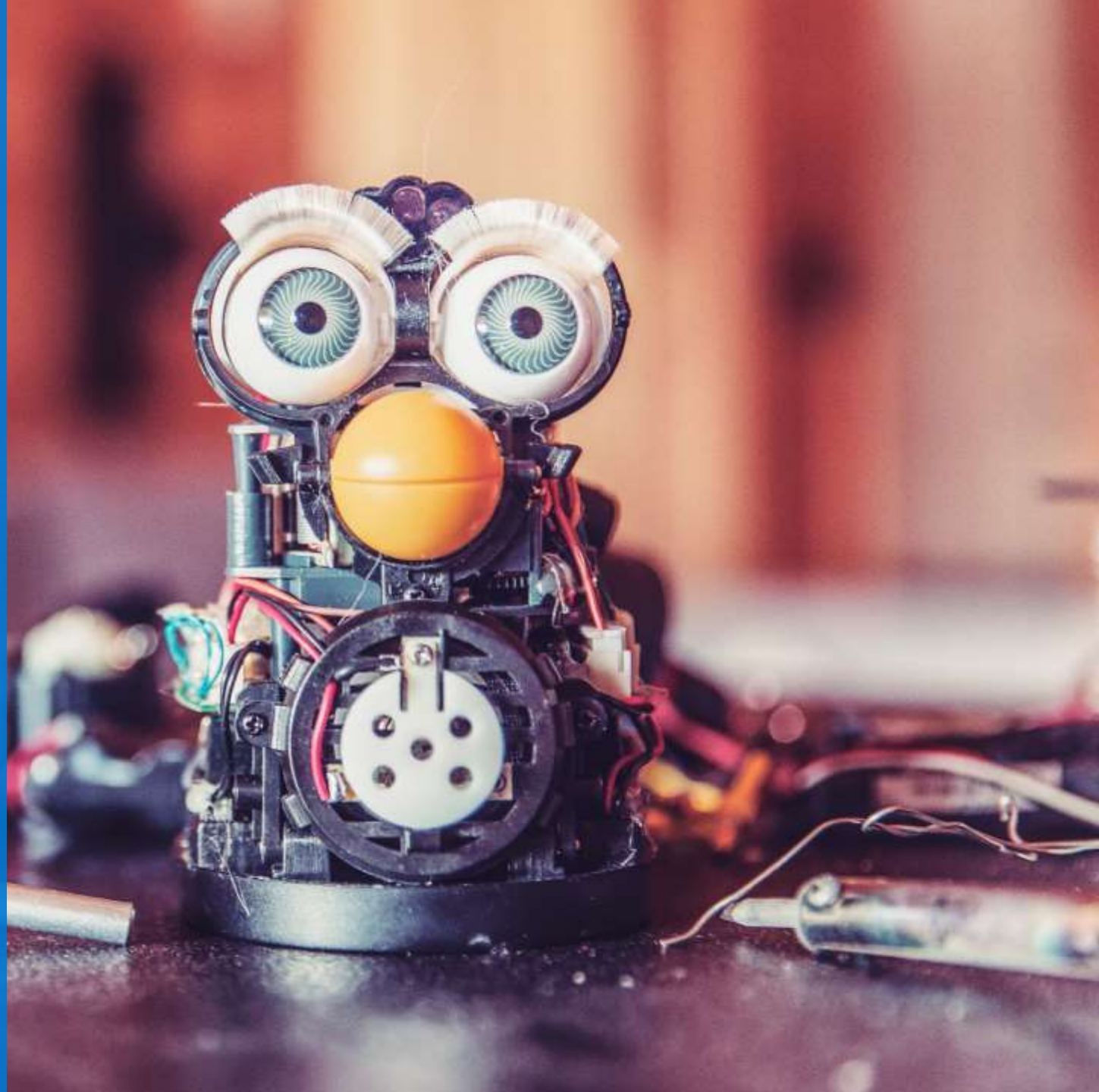
Usage

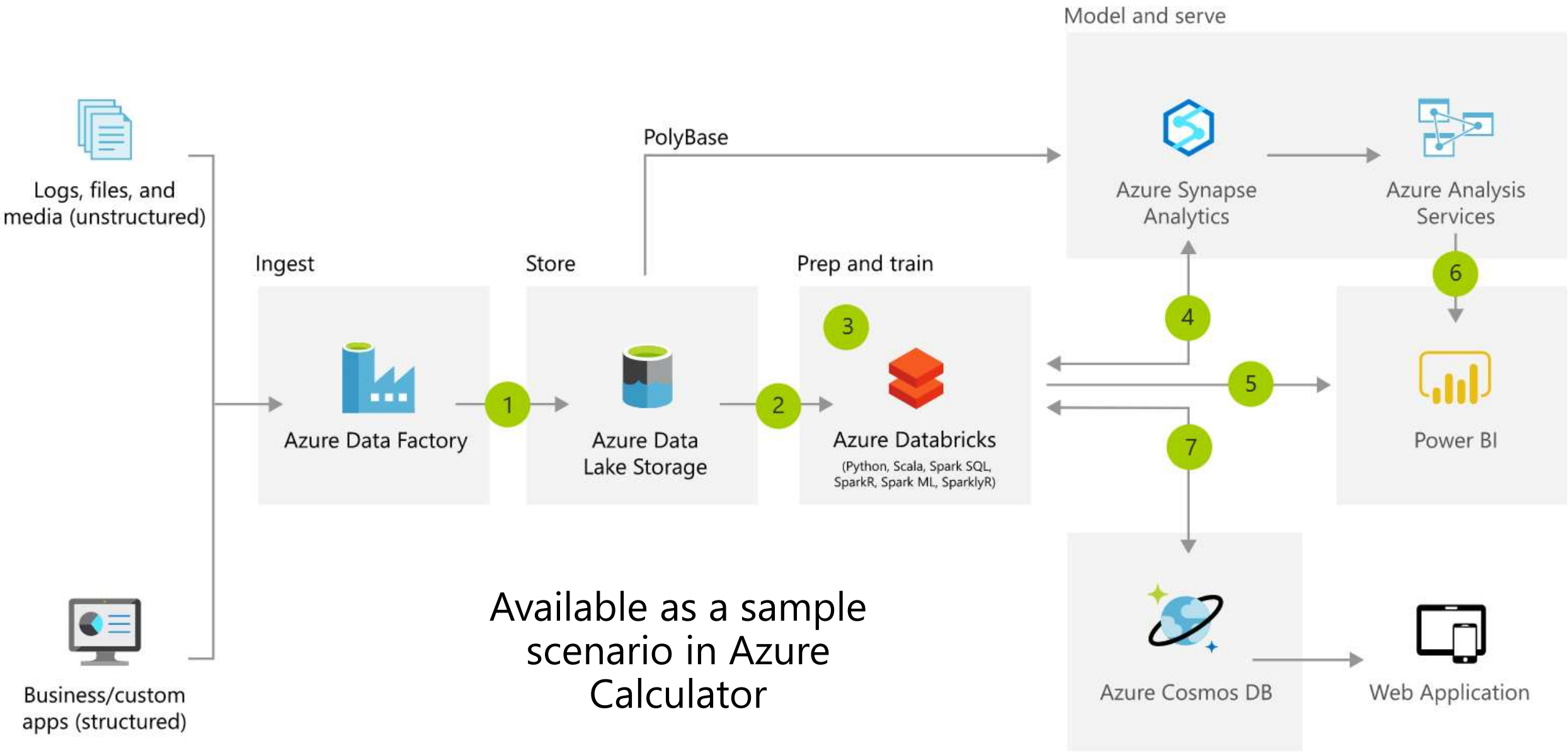
- How Long

Ensure data and processing capacity is available in case of failure

You can run business processes and turn off services when not needed

Use Case





Available as a sample scenario in Azure Calculator

https://docs.microsoft.com/en-us/azure/architecture/solution-ideas/articles/advanced-analytics-on-big-data

Products | Example Scenarios | Saved Estimates | FAQ

Select an example scenario to include in your estimate. You may add or remove products in your example scenario.

Advanced analytics on big data

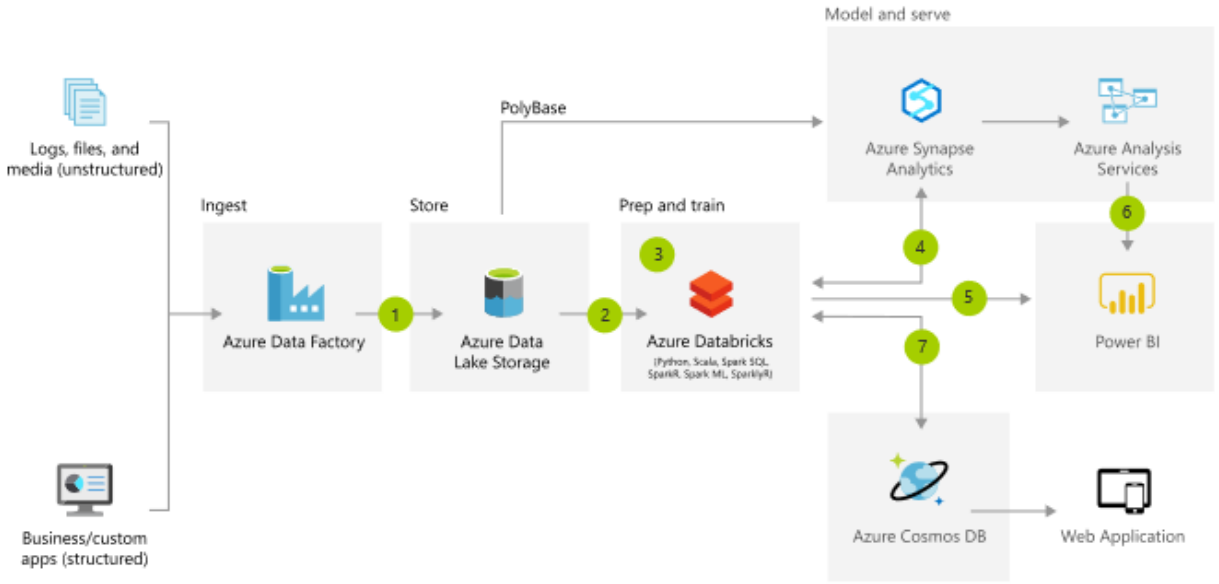
CI/CD for Azure Web Apps

CI/CD for Containers

Modern data warehouse

Real-time analytics

Transform your data into actionable insights using the best-in-class machine learning tools. This architecture allows you to combine any data at any scale, and to build and deploy custom machine learning models at scale.



Products

- Azure Analysis Services
- Azure Cosmos DB
- Data Factory
- Azure Databricks
- Power BI Embedded
- Storage Accounts

Learn more >

Add to estimate

Thank you

Appendix

Azure Data Factory

Hybrid data integration service that simplifies ETL & ELT at scale

Work efficiently

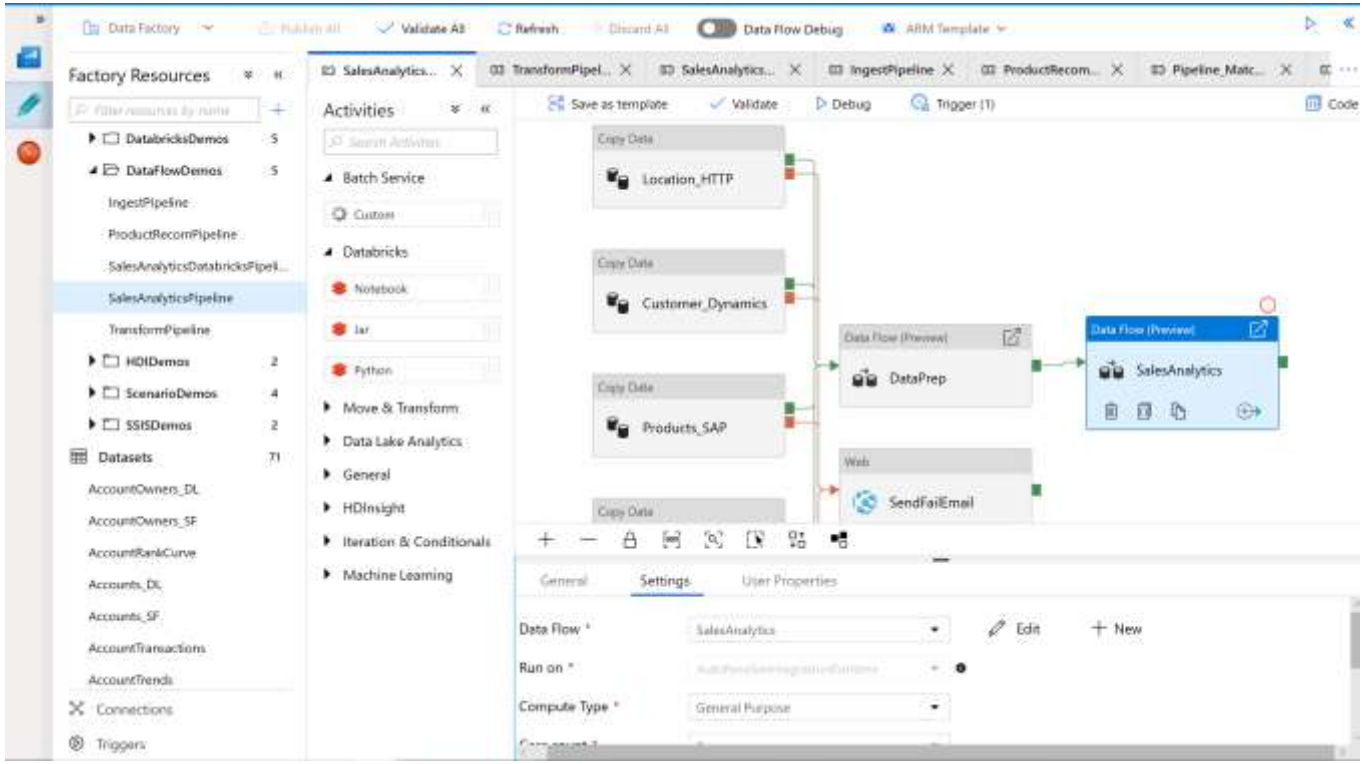
- Fully accessible visual environment
- Simplified ETL/ELT with automation, visual workflows & data prep, templates
- Continuous integration & delivery (CI/CD)

Cost-effective integration

- Serverless & fully managed, scales on demand
- Scale-out transformations via Spark
- Reduced overhead, SSIS in the cloud

Connect with confidence

- All-inclusive connectivity, >80 + connectors
- Trusted, global cloud presence
- Multiple language support for coders



[Documentation]

[Product Page]

[ADF Videos]

[Azure Data Factory Blog]

Archive Storage

Cold Storage for rarely accessed data needing long term retention

Data is expected to be stored for several months

From milliseconds (hot) to hours (archive) to retrieve

Lowest storage cost, higher access costs

Object-level tiering between hot, cool, and archive

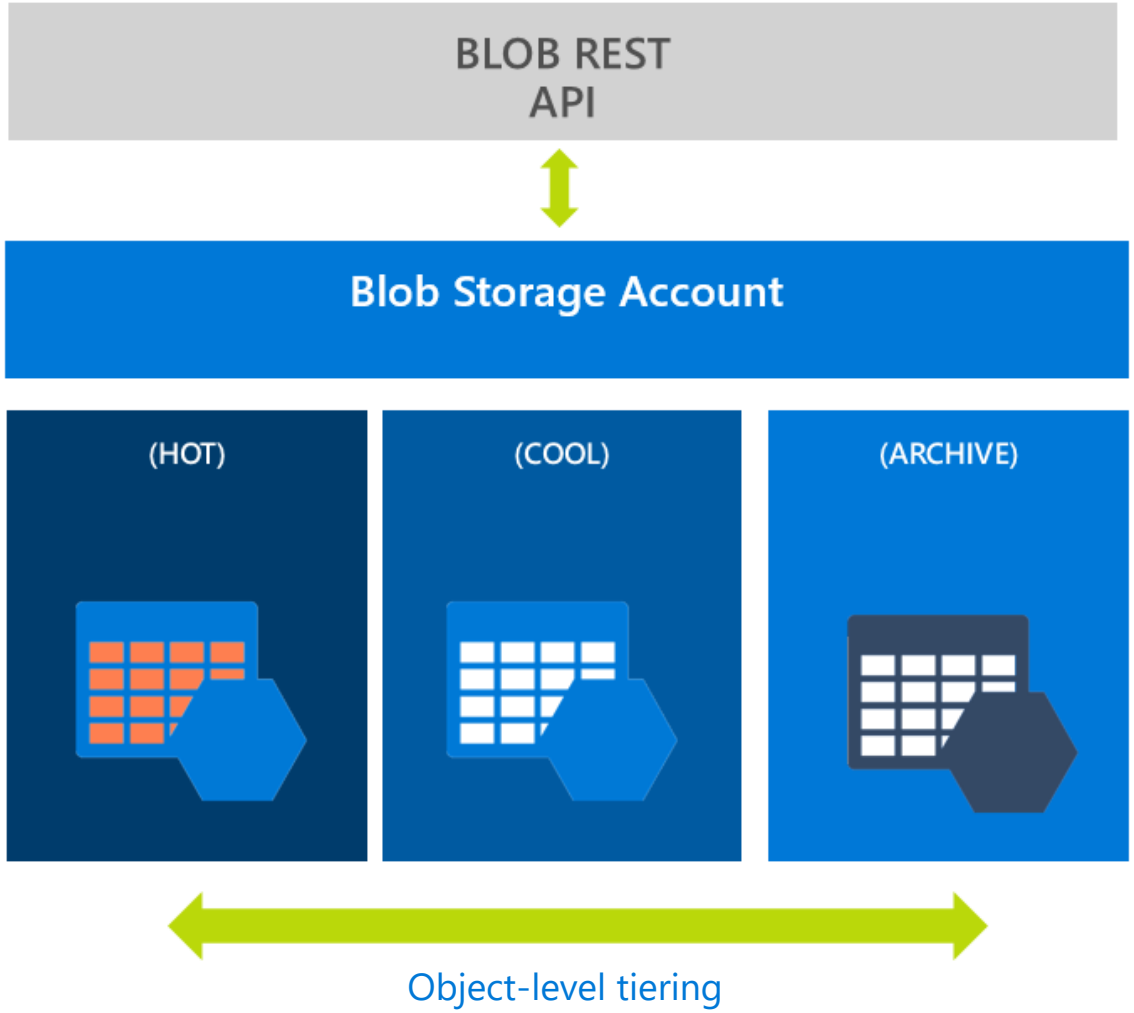
Consistent API Among Tiered Storage

Access through Blog REST API

All tiers of blobs co-exist in a storage account

Blob can move between any tiers within the storage account

[Learn more.]



Azure Data Lake Storage Gen2

Brings together the best of Azure Data Lake Store and Blob Storage

- Hadoop compatible file system interface for Azure Blob Storage
- Fine grained file and folder permissions (ACLs)
- Atomic file system operations
- Full support for all Blob features (AAD Integration, Zone Redundant and RA-Geo Redundant Storage)
- Pricing at Blob Storage levels
- Available in all 54 Azure regions

Learn more.

Azure Data Lake Storage

Scalable, secure storage that speeds time to insight

Scale and Availability	Speed to Insight
Cost Effectiveness	Rich Security

Upgrade path for existing ADLS Customers

Strong Partner Support

Optimized for performance with Spark and Hadoop analytics engines

Azure SQL Database reserved capacity

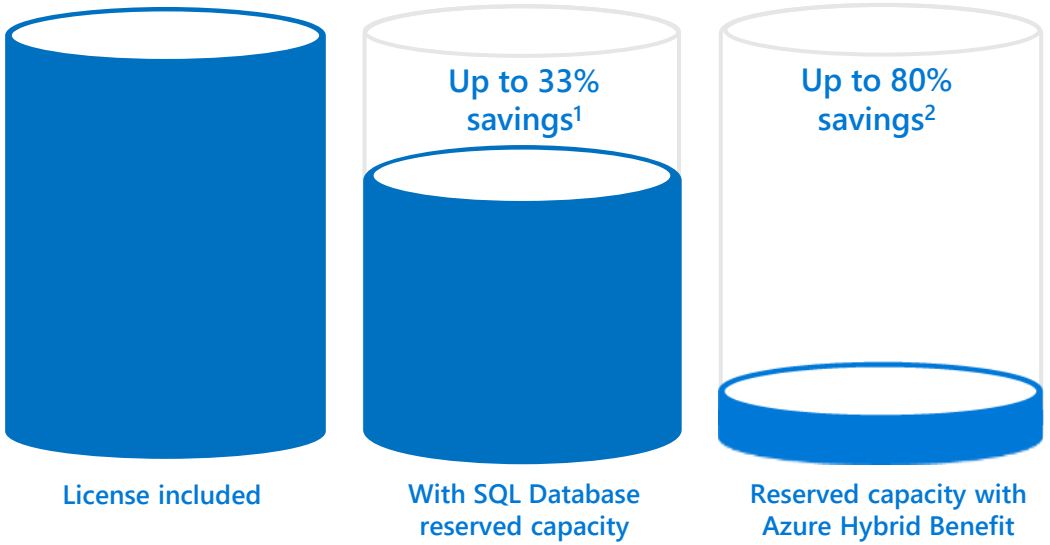
Reserve Azure SQL Database resources in advance and save up to 33%[1]

Budget and forecast better with upfront payment for one-year or three-year terms

Exchange or cancel reservations as your needs evolve

Scale up or down within a performance tier and region with auto-fit

Move SaaS apps between elastic pools and single databases and keep your reserved instance benefit



[1] *Savings based on eight vCore SQL Database managed instance general purpose in West2 US region, running 730 hours per month. Savings are calculated from on demand full price (license included) against 3-year reserved capacity license Included. Actual savings may vary based on region, instance size, and performance tier. Prices as of May 2018, subject to change.*

[2] *Savings based on eight vCore SQL Database managed instance business critical in West2 US region, running 730 hours per month. Savings are calculated from on demand full price (license included) against base rate with Azure Hybrid Benefit plus 3-year reserved capacity. Savings excludes Software Assurance cost for SQL Server Enterprise edition, which may vary based on EA agreement. Actual savings may vary based on region, instance size, and performance tier. Prices as of May 2018, subject to change.*

Learn more.

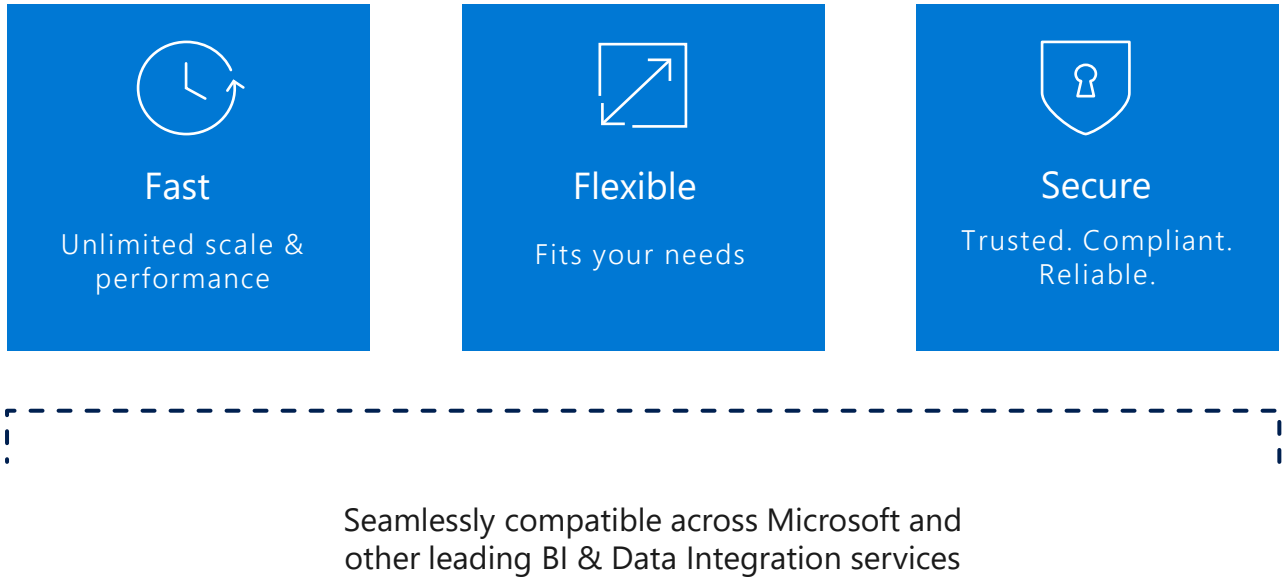
Azure SQL Data Warehouse

- Compute Optimized Gen 2 is now Generally Availble
- **5 times** the performance of our Gen1 offer
- **4 times** the concurrency up to 128 concurrent queries – the highest of any cloud data warehousing service
- **5 times** the compute headroom (over 4000 compute cores)
- **Infinite** storage of columnar data

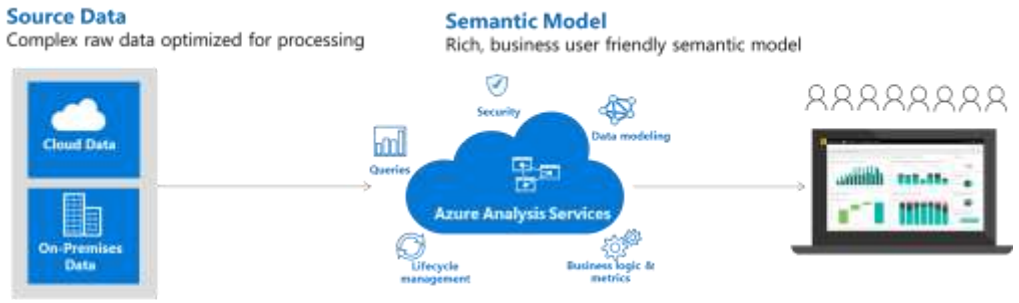
New update: Flexible restore points – GA Sept 2018

Learn more.

The fast, flexible, and secure hub for all your data



Azure Analysis Services



Azure Analysis Services is a fully managed platform as a service (PaaS) that provides enterprise-grade data models in the cloud. Use advanced mashup and modeling features to combine data from multiple data sources, define metrics, and secure your data in a single, trusted tabular semantic data model. The data model provides an easier and faster way for users to browse massive amounts of data for ad hoc data analysis.

Get up and running quickly

·In Azure portal, you can create a server within minutes. And with Azure Resource Manager templates and PowerShell, you can create servers using a declarative template. With a single template, you can deploy server resources along with other Azure components such as storage accounts and Azure Functions.

·Azure Analysis Services integrates with many Azure services enabling you to build sophisticated analytics solutions. Integration with Azure Active Directory provides secure, role-based access to your critical data. Integrate with Azure Data Factory pipelines by including an activity that loads data into the model. Azure Automation and Azure Functions can be used for lightweight orchestration of models using custom code.

The right tier when you need it

·Azure Analysis Services is available in **Developer**, **Basic**, and **Standard** tiers. Within each tier, plan costs vary according to processing power, QPUs, and memory size. When you create a server, you select a plan within a tier. You can change plans up or down within the same tier, or upgrade to a higher tier, but you can't downgrade from a higher tier to a lower tier.

Scale to your needs

·**Scale up\down, pause, and resume:** Go up, down, or pause your server. Use the Azure portal or have total control on-the-fly by using PowerShell. You only pay for what you use.

·**Scale out resources for fast query responses:** With scale out, client queries are distributed among multiple *query replicas* in a query pool. Query replicas have synchronized copies of your tabular models. By spreading the query workload, response times during high query workloads can be reduced. Model processing operations can be separated from the query pool, ensuring client queries are not adversely affected by processing operations.

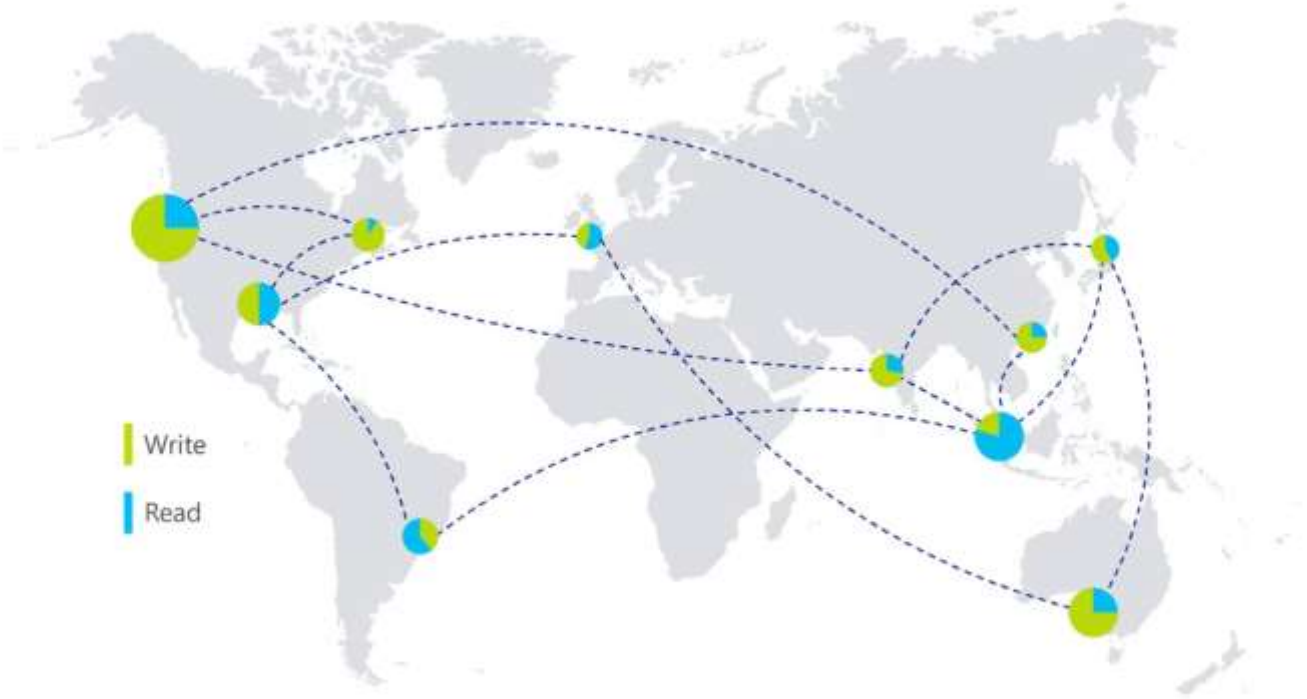
Azure Cosmos DB

Multi-Master Support

Multi-master enables developers to write data in any region, and enjoy <10ms reads and writes around the world.

- <10 ms low latency writes anywhere in the world
- High write availability >99.999%
- Comprehensive conflict resolution support
- Compatible with all existing consistency models

[Learn more.]



Azure Cosmos DB Multi-Master

Azure Databricks

A fast, easy and collaborative Apache® Spark™ based analytics platform optimized for Azure

- Designed in collaboration with the founders of Apache Spark
- Autoscaling and auto termination of Spark clusters
- Interactive workspace for data scientists, engineers, and analysts
- Native integration with Azure services like Power BI, SQL DW, Cosmos DB
- Enterprise grade Azure security (Active Directory integration, compliance, enterprise-grade SLAs)
- Faster and reliable Spark query performance and simplified batch and data pipeline with [Azure Databricks Delta]

[Learn more.]

Data serving

A side-by-side comparison of general capabilities and features

	SQL Database	SQL Data Warehouse	Azure Analysis Services
Is a managed service	Yes (Azure SQL Database)	Yes	Yes
Primary database model	Relational (columnar format when using columnstore indexes)	Relational tables with columnar storage	Tabular and MOLAP semantic models
SQL language support	Yes	Yes	No
Optimized for speed serving layer	Yes, using memory-optimized tables and hash or nonclustered indexes	No	No

Data serving

A side-by-side comparison of scalability capabilities

	SQL Database	SQL Data Warehouse	Azure Analysis Services
Redundant regional servers for high availability	Yes (Azure SQL Database)	Yes	No
Supports query scale out	No	Yes	Yes
Dynamic scalability (scale up)	Yes (Azure SQL Database)	Yes	Yes
Supports in-memory caching of data	Yes	Yes	Yes

Business Continuity

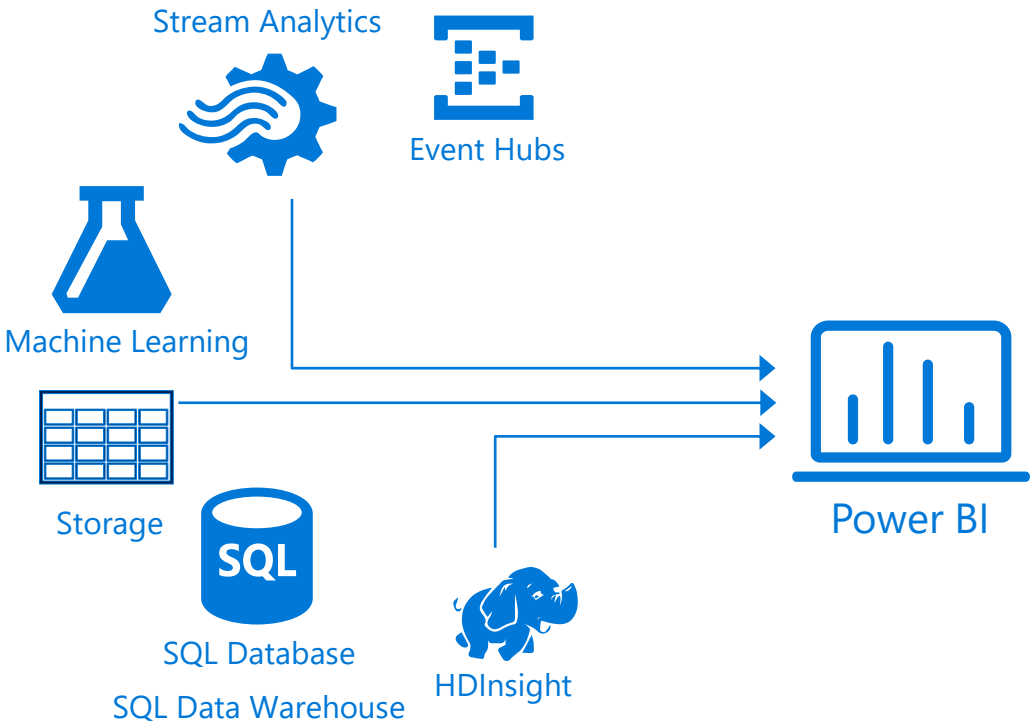
A side-by-side comparison of availability alternatives

	SQL Data Warehouse	Azure Data Lake	Data Factory + SSIS	Azure SQL DB	Azure Analysis Services	Azure Databricks
High Availability	Built-in to PaaS	Built-in to PaaS	Built-in to PaaS	Built-in to PaaS	Built-in to PaaS	Built-in to PaaS
Backups & Data Protection	7-day restore points Daily geo-backup to paired data center (on by default)	Storage Geo-replication to paired data center	N/A	Geo-backups	Need to backup data independently	N/A (storage is in Data Lake)
Geo-Redundancy	See above	See above	N/A	Active geo-replication	No	N/A
Recovery process	New DW in paired region	Manual fail-over to paired region	Rebuild DF+SSIS in paired region from Git and SSISDB	Auto-failover or restore DB	Set up new instance and restore data	Rebuild workspace from Git and deploy new cluster

Power BI

Dashboards & Visualizations

Power BI



- Analytics for everyone, even non-data experts
- Your whole business on one dashboard
- Create stunning, interactive reports
- Drive consistent analysis across your organization
- Embed visuals in your applications
- Get real-time alerts when things change