Deep Learning & Us

Indy Azure User Group Meetup

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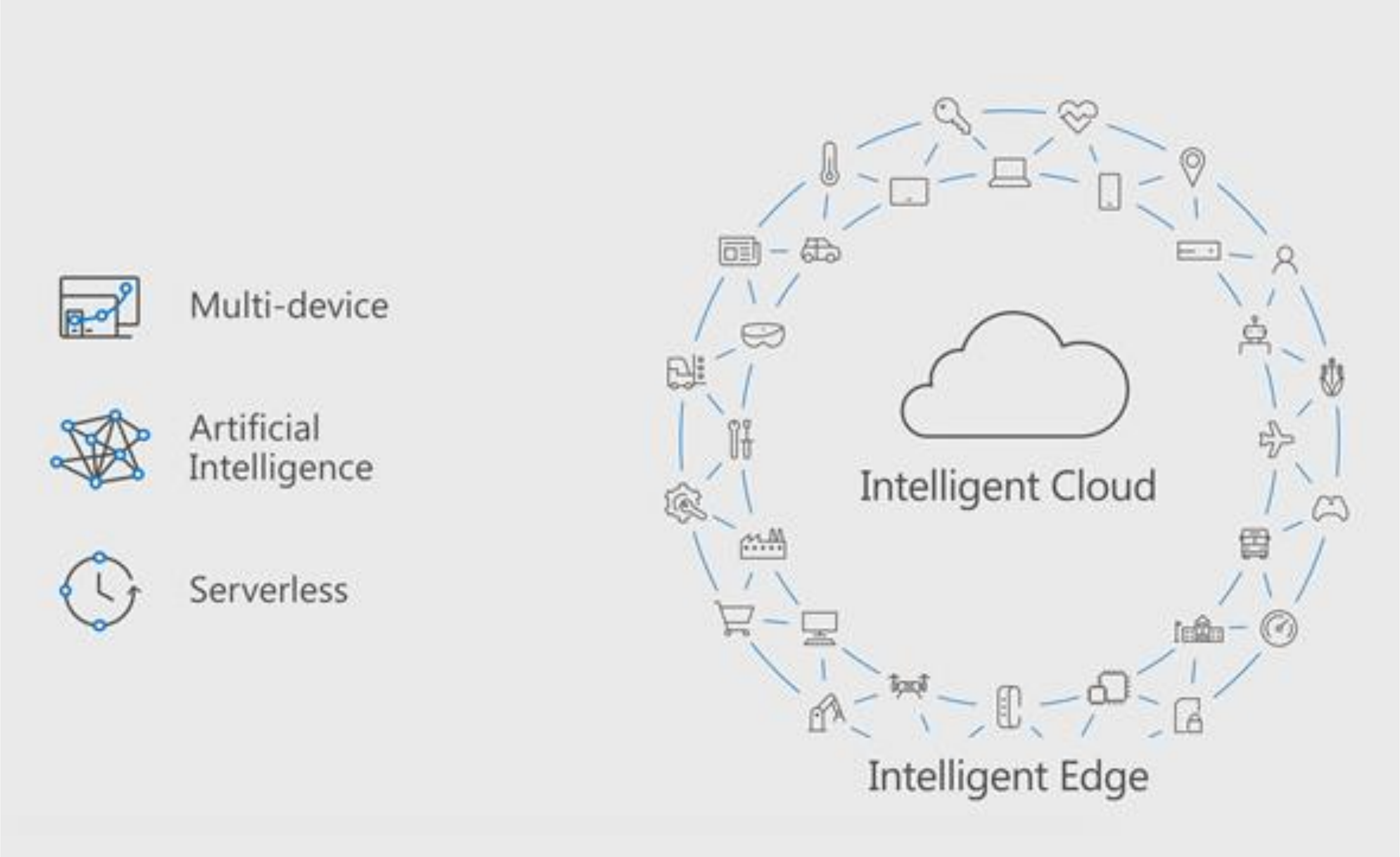
June 28, 2018

Microsoft

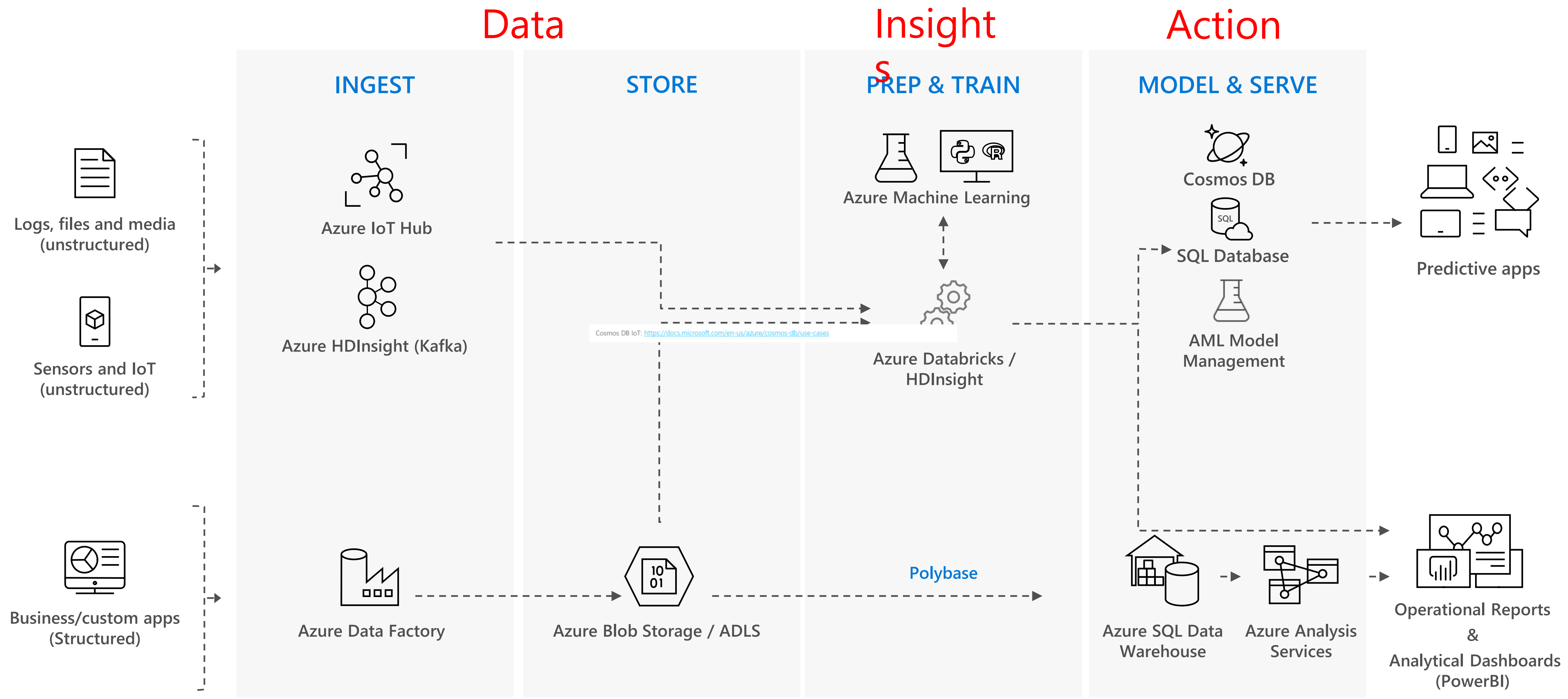
Agenda

- ❑ Intelligent Application Architecture and Services
- ❑ Deep Neural Networks
- ❑ DNN DevOps Environments
- ❑ Recurrent Neural Network
- ❑ Long Short Term Memory Network
- ❑ LSTM for Predictive Maintenance
- ❑ LSTM in Python

Intelligent Cloud & Intelligent Edge



INTELLIGENT APPLICATIONS



Cosmos DB IoT: https://docs.microsoft.com/en-us/azure/cosmos-db/use-cases

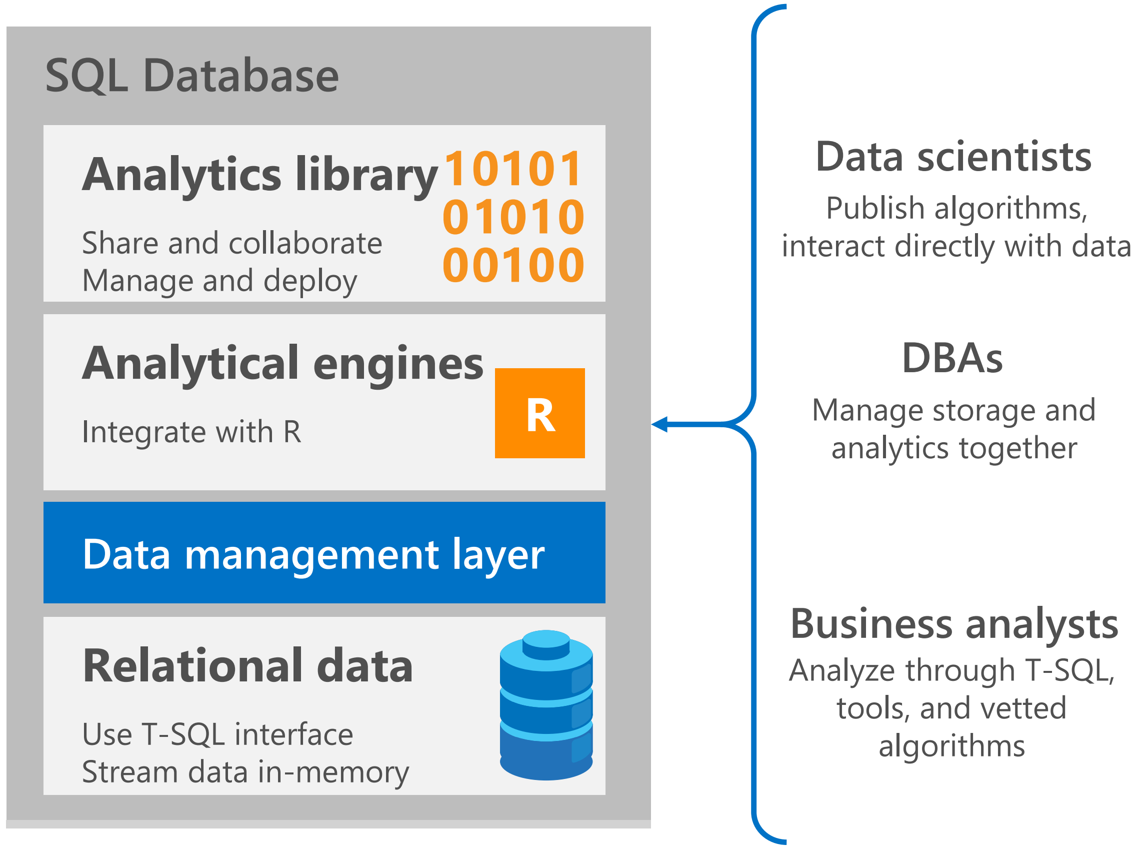
SQL Database with Machine Learning Services

R integration enables end to end machine learning in Azure SQL Database – without moving data

Operationalize your machine learning scripts and models directly in a fully managed database in the cloud.

Expose predictions to any application using your database, easily and seamlessly.

Take advantage of predictions via simple stored procedures for apps connecting to SQL Database.



https://docs.microsoft.com/en-us/sql/advanced-analytics/r/r-services

GA
Released @ //BUILD
May ‘18

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

https://azure.microsoft.com/en-us/blog/turbocharge-cloud-analytics-with-azure-sql-data-warehouse/

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

Fast
Unlimited scale & performance

Flexible
Fits your needs

Secure
Trusted. Compliant. Reliable.

Seamlessly compatible across Microsoft and other leading BI & Data Integration services

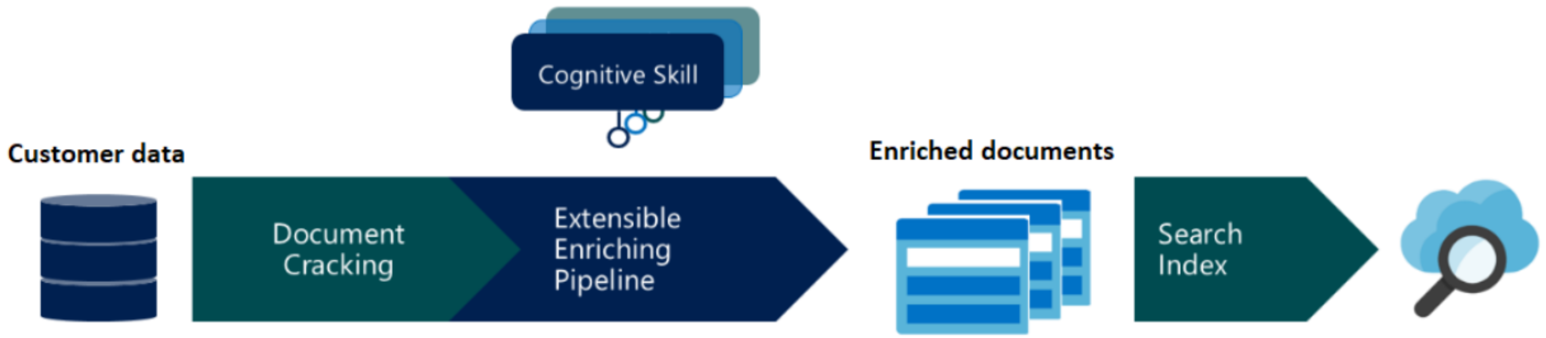
Cognitive Search

Public Preview
Released @ //BUILD
May '18

Cognitive Search is an enrichment pipeline that transforms raw, unstructured content into rich searchable content in an Azure Search index

- Find structured information from unstructured data
- Powered by cognitive skills, such as natural language processing and computer vision capabilities
- Extracts structure and semantics from unstructured and non-textual data, and feeds it into a search index

https://go.microsoft.com/fwlink/?linkid=872897



AI Translation & Application: Cognitive Services

Use AI to solve business problems

Vision

Image-processing algorithms to smartly identify, caption and moderate your pictures.

Speech

Convert spoken audio into text, use voice for verification, or add speaker recognition to your app.

Knowledge

Map complex information and data in order to solve tasks such as intelligent recommendations and semantic search.

Search

Add Bing Search APIs to your apps and harness the ability to comb billions of webpages, images, videos, and news with a single API call.

Language

Allow your apps to process natural language with pre-built scripts, evaluate sentiment and learn how to recognize what users want.

Demo

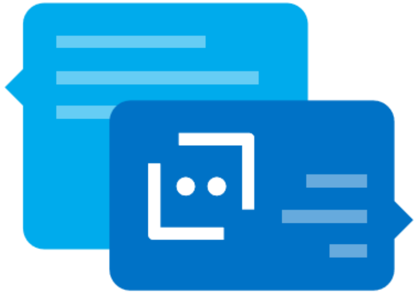
AI Face for Your Company: BOT

Accelerated development

Azure Bot Service speeds up development by providing an integrated environment that's purpose-built for bot development with the Microsoft Bot Framework connectors and BotBuilder SDKs. Developers can get started in seconds with out-of-the-box templates for scenarios including basic, form, language understanding, question and answer, and proactive bots.

Give your bot intelligence with Cognitive Services

Give your bot some super powers. Go beyond a great conversationalist to a bot that can recognize a user in photos, moderate content, make smart recommendations, translate language and more. Cognitive Services enable your bot to see, hear, and interpret in more human ways.



Engage your audience, wherever they are

Your users talk in many places, your bot should too. Azure Bot Service can be integrated across multiple channels to increase interactions and reach more customers using your website or app to email, GroupMe, Facebook Messenger, Kik, Skype, Slack, Microsoft Teams, Telegram, text/SMS, Twilio, Cortana, and Skype for Business.

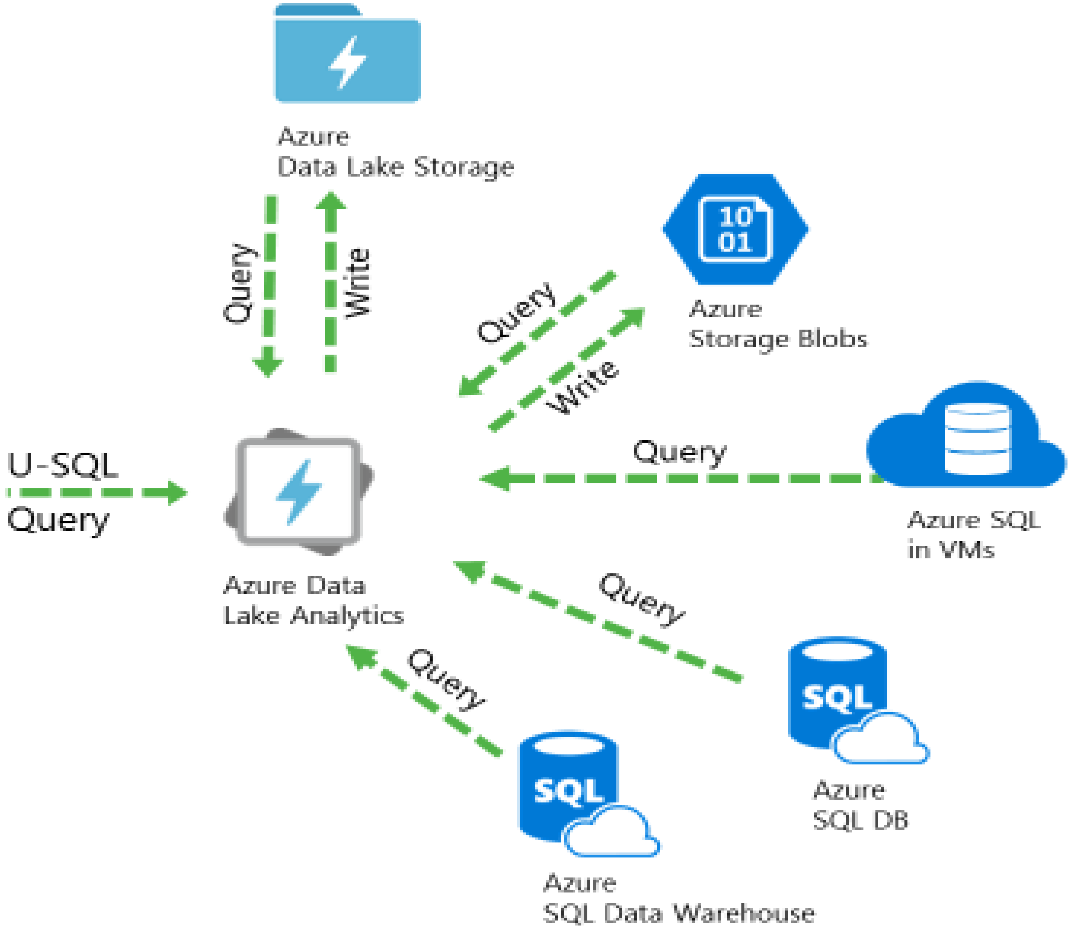
Data Lake Store & Analytics

Query data where it lives

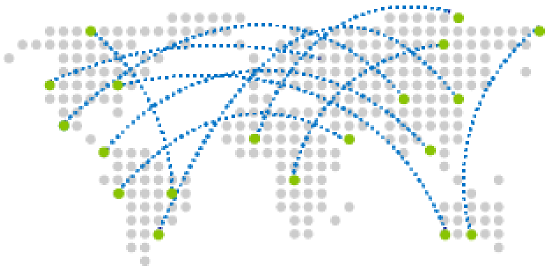
Easily query data in multiple Azure data stores without moving it to a single store

Benefits

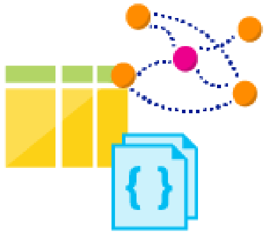
- Avoid moving large amounts of data across the network between stores
- Single view of data irrespective of physical location
- Minimize data proliferation issues caused by maintaining multiple copies
- Single query language for all data
- Each data store maintains its own sovereignty
- Design choices based on the need
- Push SQL expressions to remote SQL sources
  - Filters
  - Joins



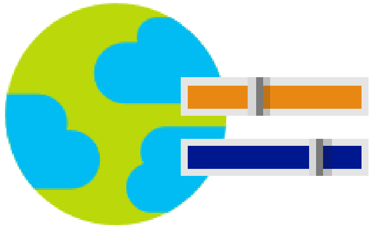
Cosmos DB



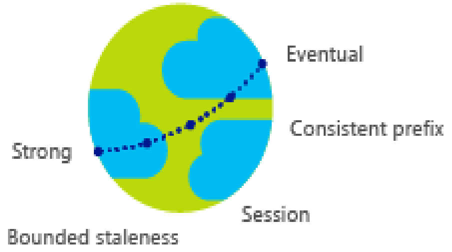
Turnkey global distribution



Multi-model + multi-API: SQL, JavaScript, Gremlin, MongoDB, Cassandra



Limitless elastic scale around the globe



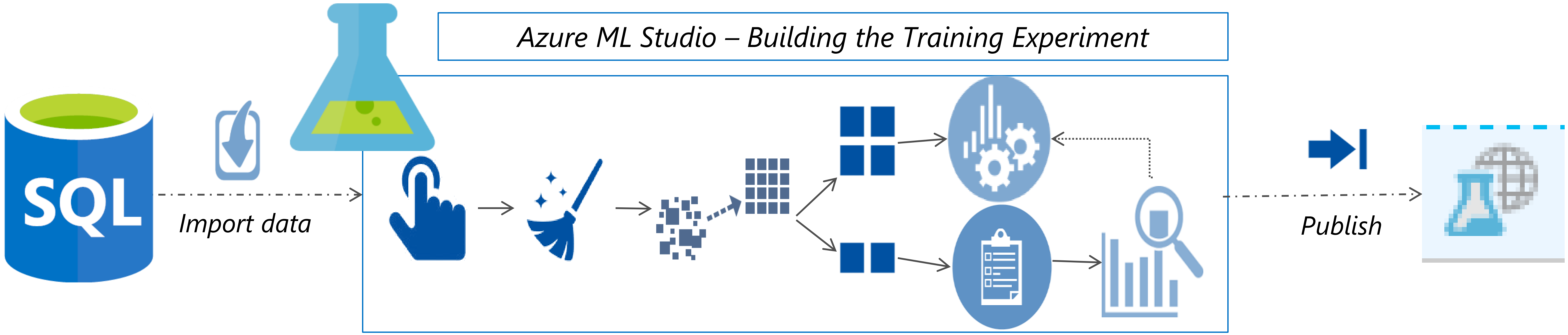
Multiple, well-defined consistency choices

Guaranteed low latency worldwide: R/W: 10/15 millisecond at 99 percentile

Industry-leading, enterprise-grade SLAs

Azure Machine Learning Studio/Workbench

Objective: Predict engine failure for preventive maintenance based on sensor data and failure history data

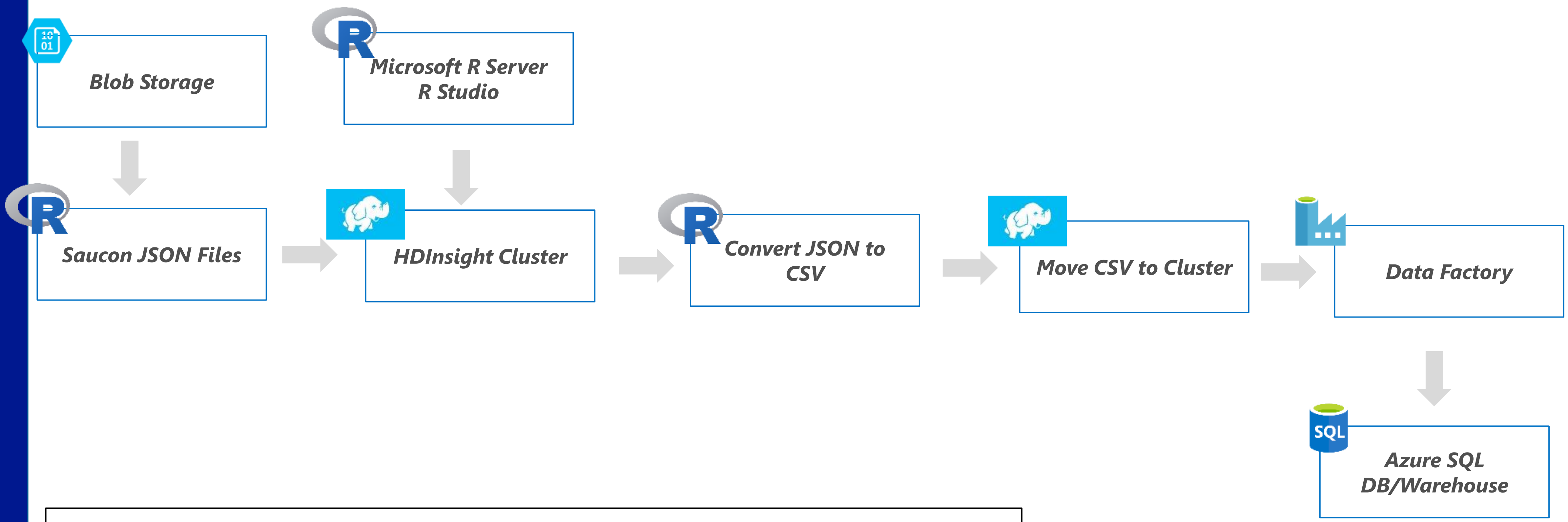


Select -> clean -> transform -> split -> train -> score -> evaluate

- ✓ Front End tool for doing Predictive Modelling
- ✓ Automatic Algorithm Selection
- ✓ Use of Open source languages like R and Python

Demo

Azure HDInsight with R Studio



- ✓ How raw data is stored and managed
- ✓ How the raw data is ingested, cleansed, transformed and prepared
- ✓ Performance of Large Datasets

Demo

Introducing Microsoft Power BI

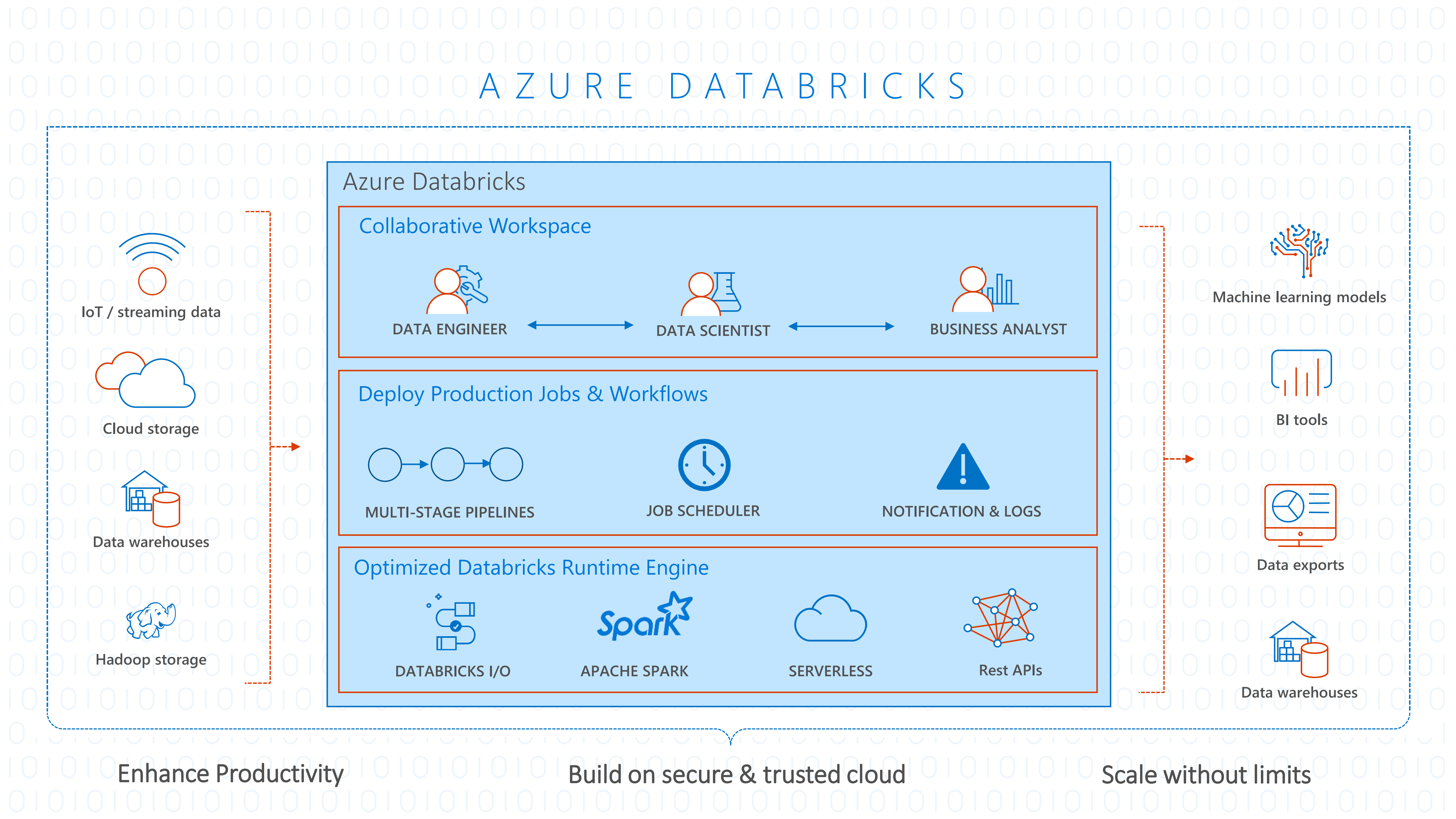
Key benefits and differentiators

- Pre-built content packs, consisting of dashboards and reports, for popular SaaS solutions
- Real-time dashboard updates
- Secure, live connection to your data sources, on-premises and in the cloud
- Intuitive data exploration by using natural language query
- Integration with familiar Microsoft products, and commitment for scale and availability in Azure
- Fast deployment, hybrid configuration, secure, and integrated with existing IT systems

Demo

Demo

Microsoft


AZURE DATABRICKS
IoT / streaming data
Cloud storage
Data warehouses
Hadoop storage
Azure Databricks
Collaborative Workspace
DATA ENGINEER
DATA SCIENTIST
BUSINESS ANALYST
Deploy Production Jobs & Workflows
MULTI-STAGE PIPELINES
JOB SCHEDULER
NOTIFICATION & LOGS
Optimized Databricks Runtime Engine
DATABRICKS I/O
Spark
APACHE SPARK
SERVERLESS
Rest APIs
Machine learning models
BI tools
Data exports
Data warehouses
Enhance Productivity
Build on secure & trusted cloud
Scale without limits

AZURE DATABRICKS ACCESS CONTROL

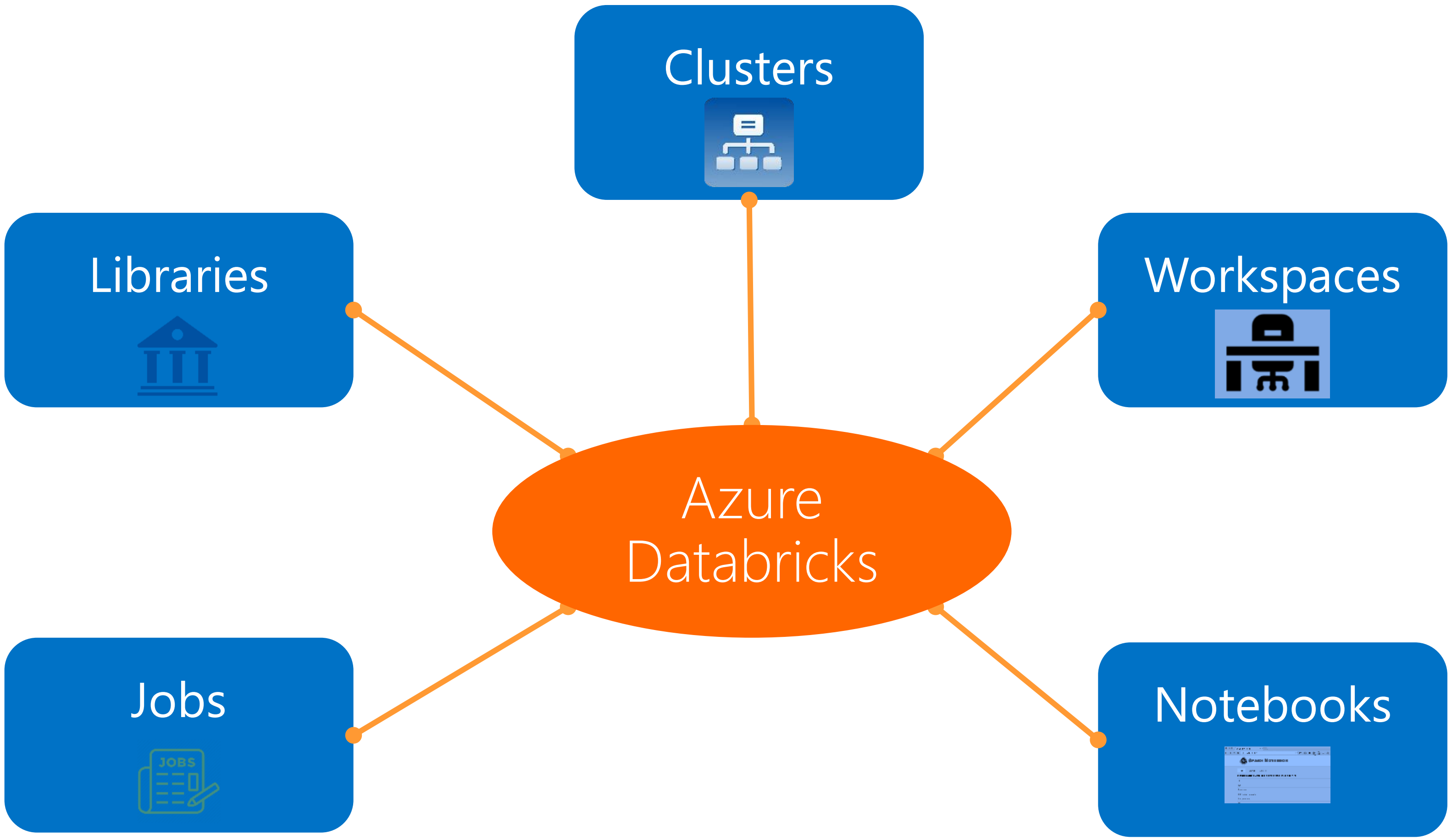
Access control can be defined at the user level via the AAD

Databricks Access Control

Access Control can be defined for Workspaces, Clusters, Jobs and REST APIs

Workspace Access Control	Defines who can who can view, edit, and run notebooks in their workspace
Cluster Access Control	Allows users to who can attach to, restart, and manage (resize/delete) clusters. Allows Admins to specify which users have permissions to create clusters
Jobs Access Control	Allows owners of a job to control who can view job results or manage runs of a job (run now/cancel)
REST API Tokens	Allows users to use personal access tokens instead of passwords to access the Databricks REST API

AZURE DATABRICKS CORE ARTIFACTS



Deep Neural Network

- DNNs for speaker recognition in the 1990s.
- Speech recognition around 2009-2011
- LSTM around 2003-2007
- Today: accelerated progress in eight major areas.
  - CNN (Convolutional neural networks) and how to design them to best exploit domain knowledge of speech/image
  - RNN (Recurrent Neural Networks) and its LSTM(Long Short Term Memory) variants

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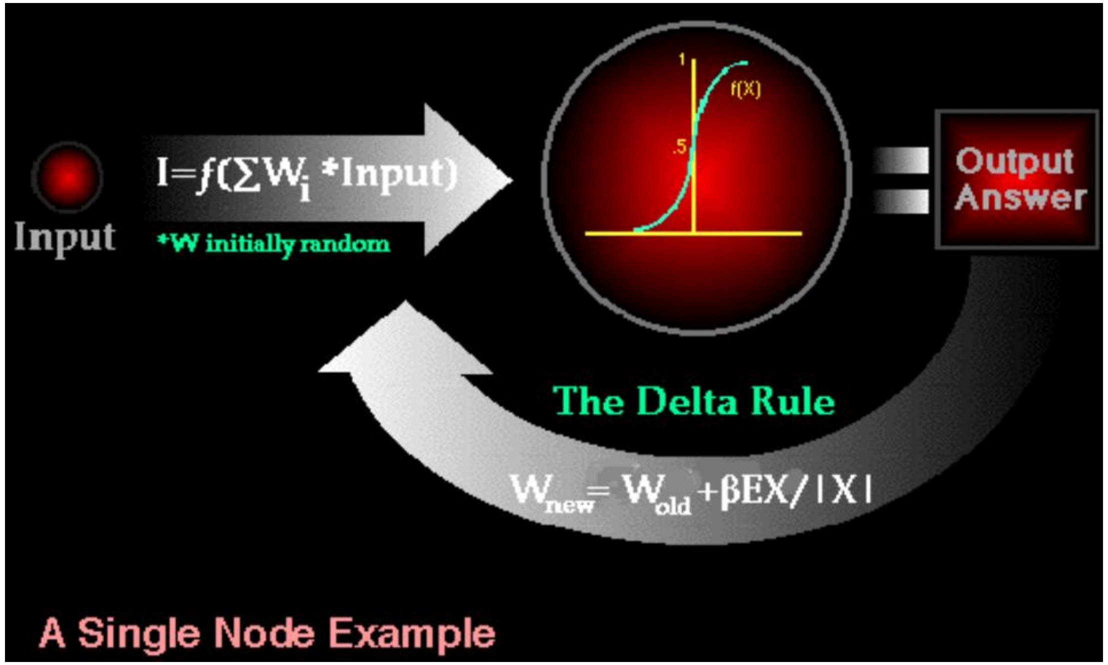
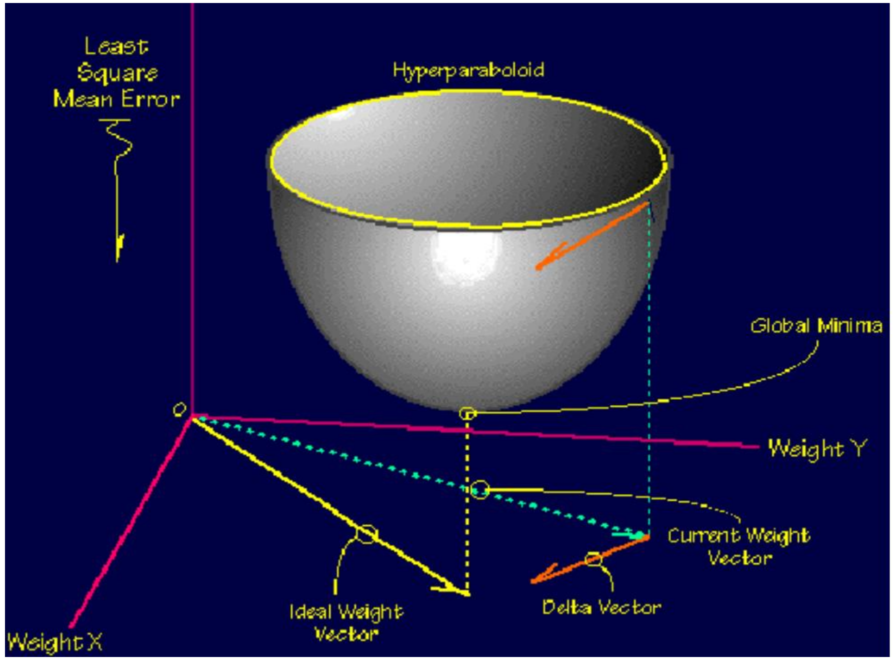
Artificial Neuron Network (1960-1998)

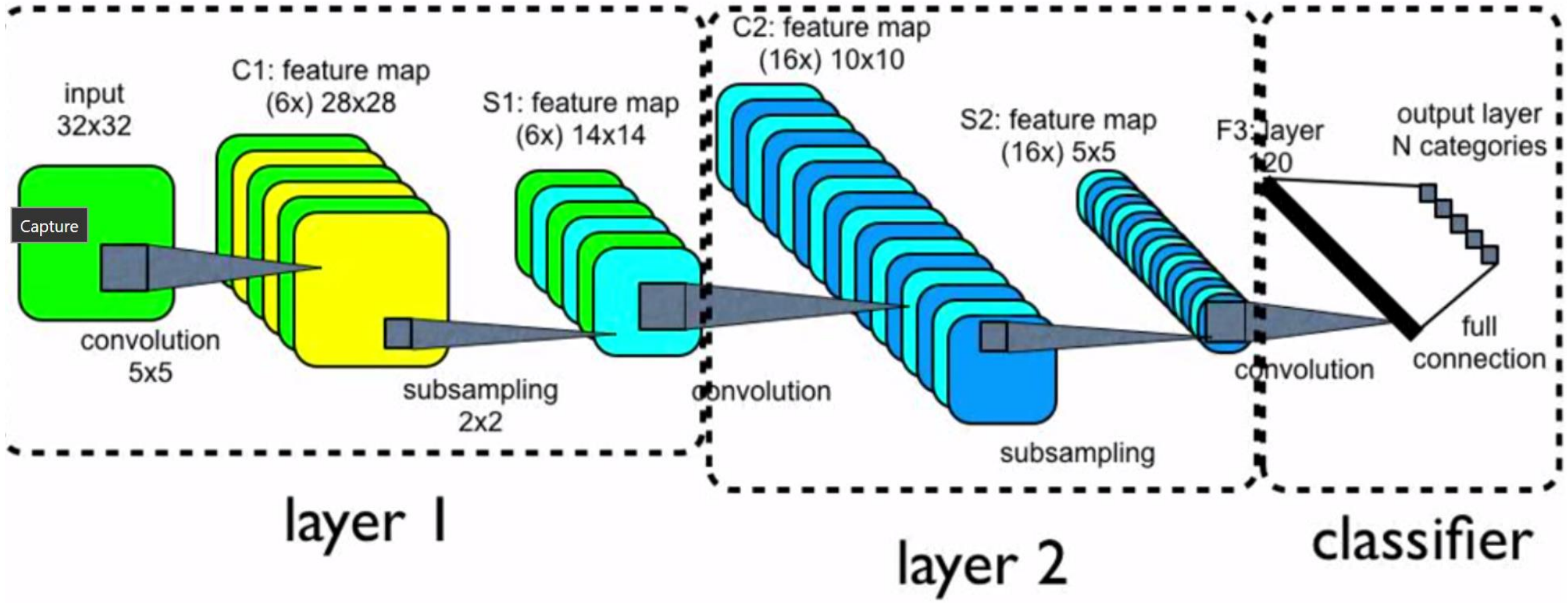
- ANNs are organized in layers and made up of a number of interconnected 'nodes' which contain an 'activation fun
- ANNs contain some form of 'learning rule' which modifies the weights.





Convolutional Neural Networks (CNN)

- Individual *neurons* respond to *stimuli* only in a restricted region of the *receptive field*.
- The receptive fields of different neurons *partially overlap* and cover entire visual field.



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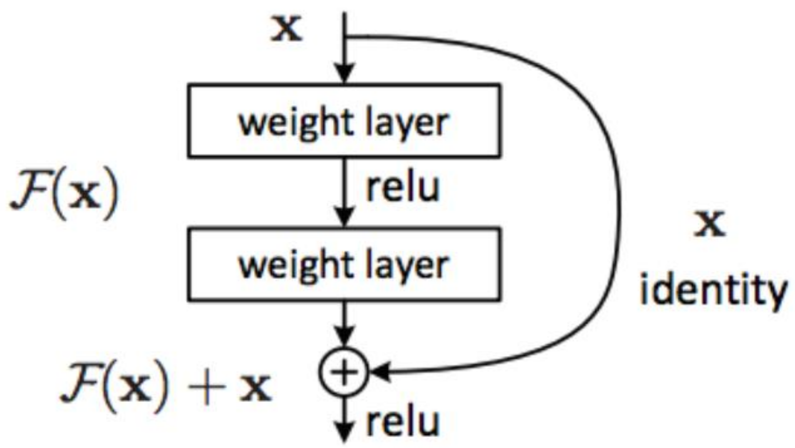
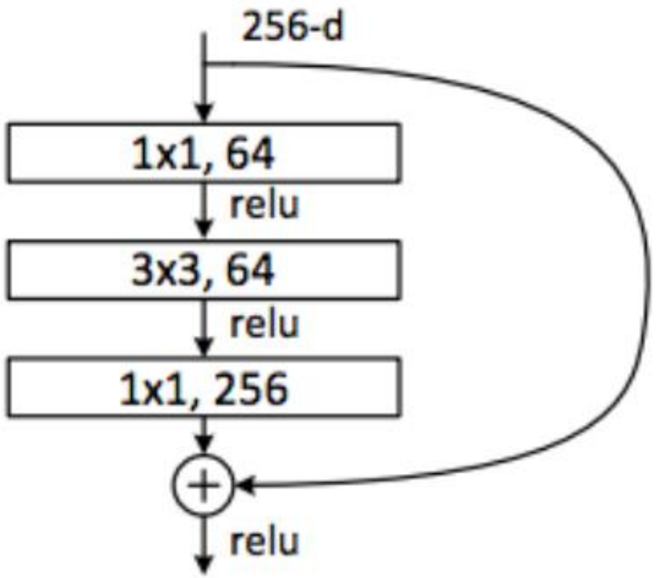
Residual Neural Networks (ResNet)

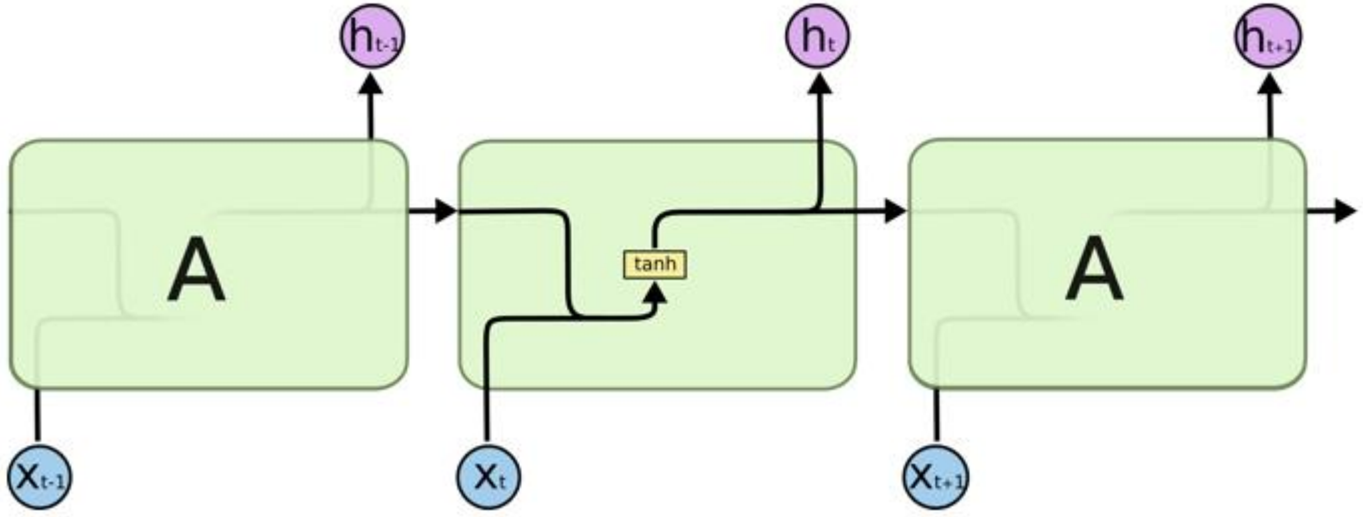
- ResNets *skip connections* or *short-cuts* to jump over some layers.
- With several parallel skips it is referred to as *DenseNets*.





Recurrent Neural Networks (RNN)

- All RNNs have the form of a chain of repeating modules of neural network.
- This repeating modules have a very simple structure, such as a single tanh layer.



The repeating module in a standard RNN contains a single layer.

Basic Theorems: 1 of 3

- Neural Networks define a class of "universal approximators" (Cybenko 1989 and Hornik 1991)

Theorem [C'89, H'91] Let $\rho()$ be a bounded, non-constant continuous function. Let I_m denote the m-dimensional hypercube, and $C(I_m)$ denote the space of continuous functions on I_m. Given any $f \in C(I_m)$ and $\epsilon > 0$, there exists $N > 0$ and v_i, w_i, b_i, $i = 1 \ldots, N$ such that

$$F(x) = \sum_{i \leq N} v_i \rho(w_i^T x + b_i) \quad \text{satisfies}$$

$$\sup_{x \in I_m} |f(x) - F(x)| < \epsilon \; .$$

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Basic Theorems: 2 of 3

- Neural Network Estimation Theory (Barron 1992)

Theorem [Barron'92] The mean integrated square error between the estimated network $\hat{F}$ and the target function f is bounded by

$$O\left(\frac{C_f^2}{N}\right) + O\left(\frac{Nm}{K}\log K\right) \quad ,$$

where K is the number of training points, N is the number of neurons, m is the input dimension, and C_f measures the global smoothness of f.

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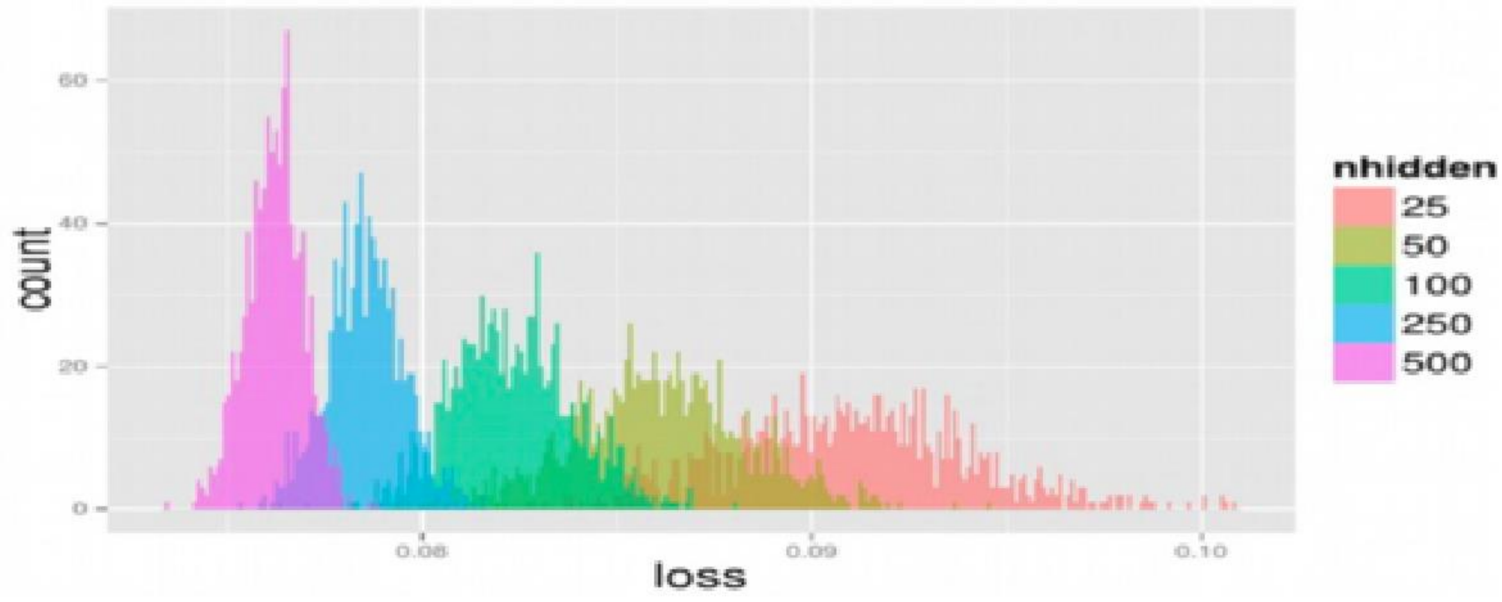
Basic Theorems: 3 of 3

- Using tools from Statistical Physics to explain the behavior of stochastic gradient methods when training DNN (Dauphin @ ICML 2015)



Demo

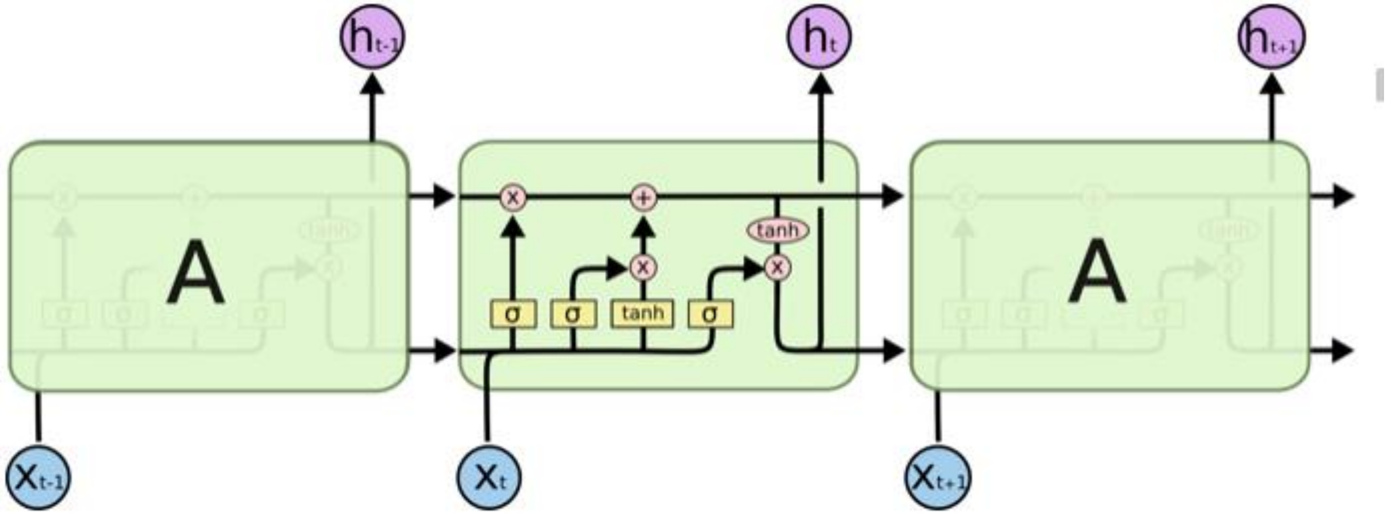
- We run the same example in three ways
  - Aero engine failure prediction
    - Public dataset
    - Has been modeled with multi-class classification models
    - RUL-emphasized (Remaining Useable Life Time – TTNF Time to the Next Failure)
  - On my PC, thus stand alone Python 3 (DSVM) with keras and cntk
  - On AMLW on my pc with keras and cntk
  - On Azure Databricks with keras & TensorFlow

DNN DevOps Environments

- Software: Python 3
  - DNN framework package: keras.
  - Open source DNN package: TensorFlow, scikit
  - Microsoft DNN package: Cognitive Toolkit – CNTK
- Hardware: CPU/GPU or cluster
  - DSVM
  - Machine Learning Workbench
  - Databricks cluster

Long Short Term Memory Networks

- LSTMs also have this chain like structure, but the repeating module.
- There are four, interacting in a very special way in the repeating module.



The repeating module in an LSTM contains four interacting layers.

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LSTM for Predictive Maintenance

- Dr. F B Uz: https://azure.microsoft.com/en-us/blog/deep-learning-for-predictive-maintenance/
- Predictive Maintenance: Data is collected over time to monitor the state of an asset with the goal of finding patterns to predict failures.
- LSTMs are appealing to the predictive maintenance since they are very good at learning from sequences.

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LSTM in Python

```
# build the LSTM network
nb_features = seq_array.shape[2]
nb_out = label_array.shape[1]

model = Sequential()

model.add(LSTM(
         input_shape=(sequence_length, nb_features),
         units=100,
         return_sequences=True))
model.add(Dropout(0.2))

model.add(LSTM(
          units=50,
          return_sequences=False))
model.add(Dropout(0.2))

model.add(Dense(units=nb_out, activation='sigmoid'))
model.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
```

Deep Learning is everywhere. Which one is yours?

Microsoft

www.Microsoft.com