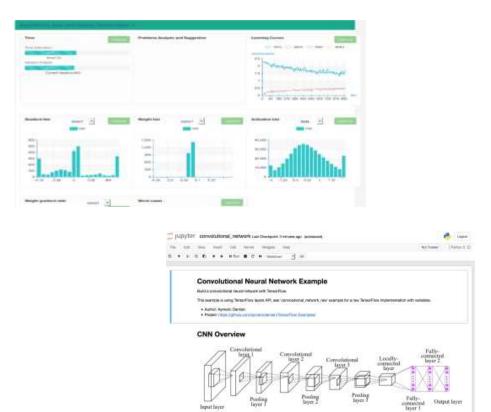
Watson Machine Learning Accelerator

Watson Machine Learn – Accelerator

- IBM PowerAI is a packaging of ML/DL frameworks for Linux on Power systems
 - Tensorflow, Caffe, Pytorch....
 - Compiled and optimized for IBM Power Systems
 - Growing number of frameworks since first release
- IBM WML-A is PowerAI + cluster management framework and deep learning platform:
 - IBM Spectrum Conductor and Deep Learning Impact
 - Notebooks, Docker, Distributed Deep Learning, Fabric algorithms





Apache Spark

- Apache Spark is an open-source clustercomputing framework.
- Spark facilitates the implementation of iterative algorithms and exploratory data analysis.
- Spark schedules jobs through a cluster management system and requires a distributed filesystem.
- Why Spark?
 - Unified Analytics Platform
 - Multi-language (Python, Scala, R, SQL...)
 - Performance: faster than MapReduce
 - Diverse ecosystem
 - Very active open source project

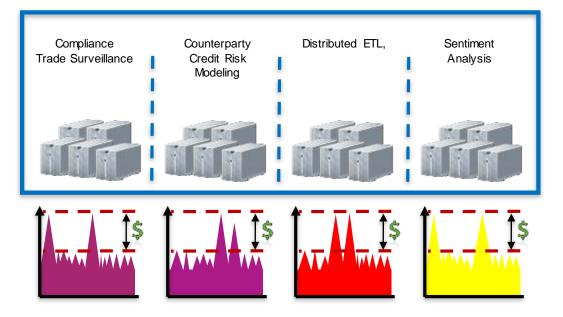


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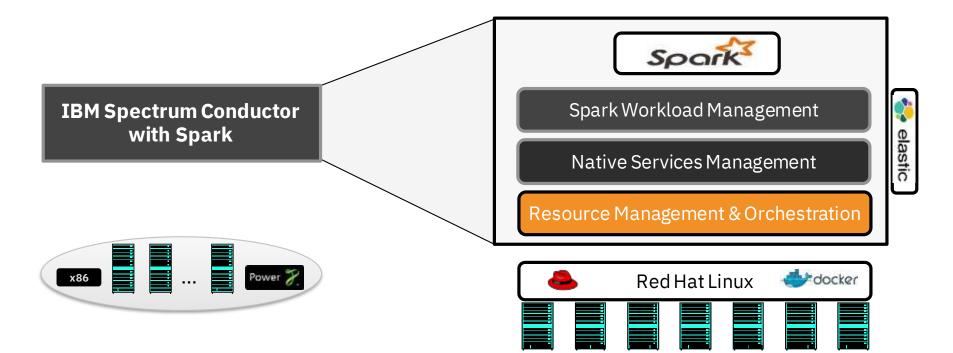
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Challenges managing spark applications

- In a word: siloed environments
- Different Lines of Business
- Multiple Spark versions
- Multiple notebooks and versions
- Security, governance
- SLAs
- Development, test, production
- Diverse data sources



Low utilization \rightarrow Higher cost



 ${\it Spectrum\,Conductor\,with\,Spark}$

Key concepts

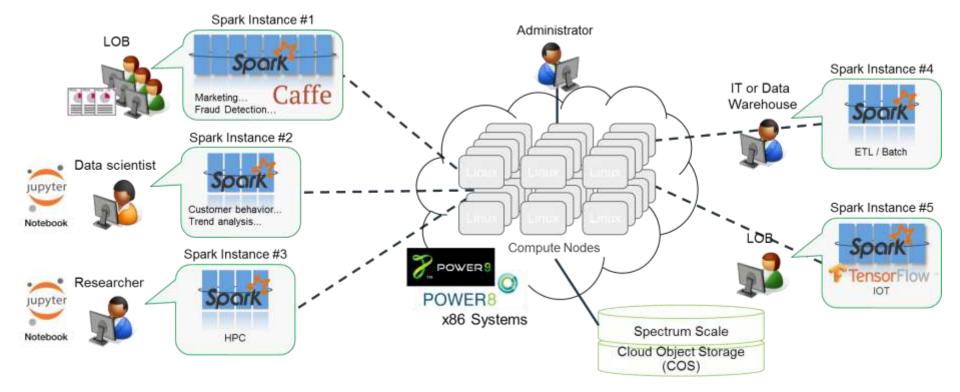
- Instance groups
 - Defines a spark cluster
 - Introduces multi-tenancy
 - Isolates environments (security)

- Resource groups
 - Defines a pool of resources
 - » CPU resources
 - » GPU resources
 - Defines slots for resource management

- Users and consumers
 - How binding is done at the OS level
 - Impersonation of a consumer

- Resource plans
 - Sharing of resources
 - Reduced silos

Instance groups

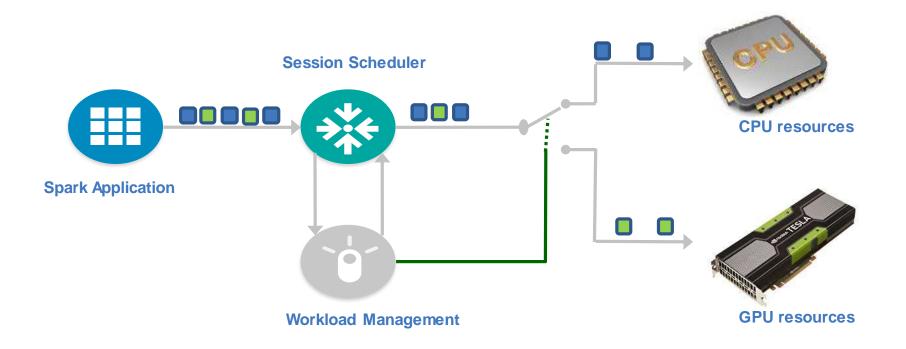


Resource plans

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Balance							

- Sharing of resources while preserving ownership
- Change plan on-the-fly
- Allocations happen in runtime (dynamic allocation)
- Enables SLA management

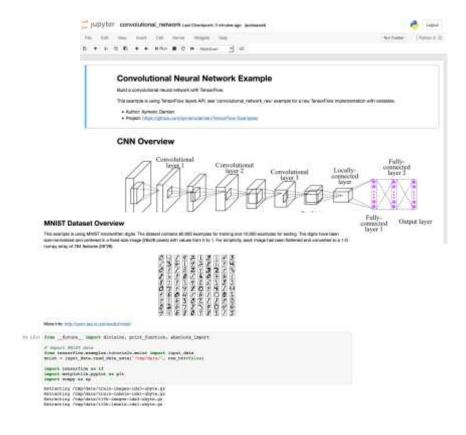
GPU support



- Accelerating Spark applications with GPUs
 - Conductor scheduler interfaces with Spark scheduler to ensure that GPU resources are assigned to the applications that can use them.

Jupyter Notebooks | Docker

- Notebooks are created within an instance group
- Created for a user
- May leverage collaboration
- Fired off from Conductor



- Spectrum Conductor includes full integration with Docker
- Instance groups / notebooks may run in a Docker container

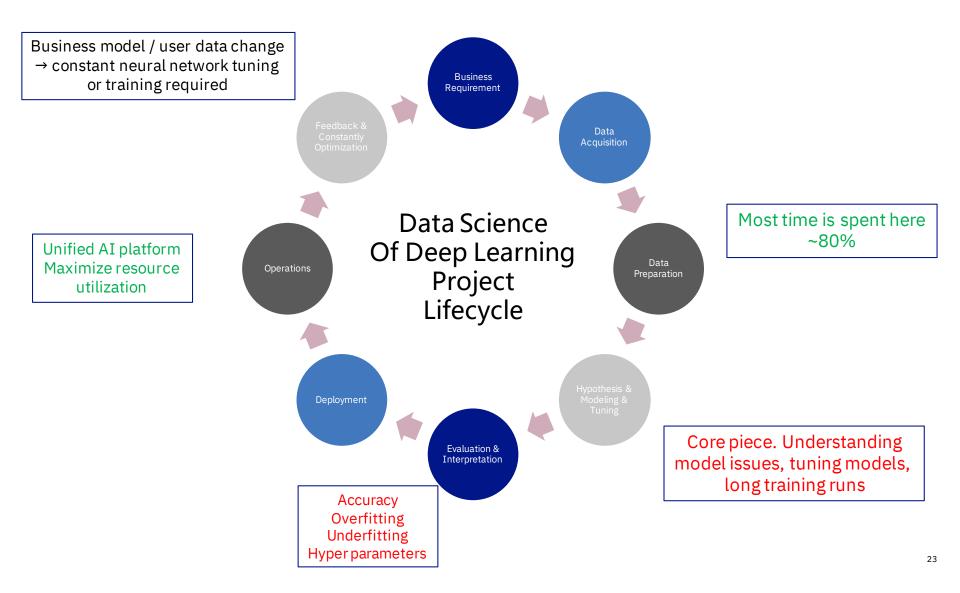


${\it Spectrum\,Conductor\,with\,Spark}$

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- Integrated Elastic Search, Logstash, Kibana for customizable monitoring
- Built-in monitoring Metrics
 - Cross Spark Instance Groups
 - Cross Spark Applications within Spark Instance Group
 - Within Spark Application
- Built-in monitoring inside Zeppelin Notebook

Challenges of deep learning



Spectrum Conductor DLI



Faster time to results

Distributed training on multiple servers and GPUs includes optimized software and frameworks to accelerate training times.



Improve ROI with shared resources

Better ROI with multi-tenant access to shared resources, which allow multiple data scientists to run different models at the same time on the same resources.



Improve accuracy

Greater neural network model accuracy with hyper-parameter search and optimization, and with training visualization and tuning assistance.



Simplify administration

A consolidated framework for deep learning, monitoring and reporting enables you to achieve faster time to results with simplified management.



Reduce time preparing data

Less time spent importing, transforming and preparing data. Use Spark to manage data sources and imports.



Add to IBM Spectrum Conductor

Add a deep learning solution to IBM Spectrum Conductor. This highly available multitenant framework is designed to build a shared, enterprise-class Apache Spark environment.

Parallel data preparation

Deep Learning

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Models Score Application

Format

Other

Datate

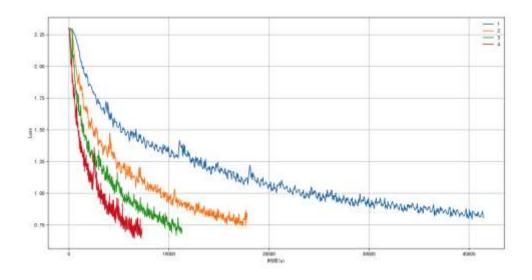
- Transform Data
 - Different Data dimension processing
 - Resize data to fit the network input layer
- Algorithm to keep the distribution of data
 - Rescaling by cross-entropy loss method
 - Hold-out vs Cross validation vs Bootstrapping
- Parallel Data Import
 - Integrate with ETL
 - Parallel transfer huge raw data to lmdb or tensor record format

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Parallel training

- Different optimizers in parallel
- Relationship among:
 - Iteration Number(τ)
 - Node number(K)
 - GPU Number(n)
 - Communication Overhead(s)
 - Accuracy
 - Ma(b,K,n, τ) vs single node

Model name:	afar10-TF-model-DemoConsumer	
Training dataset:	citar-TF-DemcConsumer	5
Model description:		
Training engine:	Distributed training with IBM Fabric and	auto-scaling
Hyperparameter		
Learning rate policy:	Fixed	



Hyper parameters

- Search:
 - Random
 - The optimal solutions is above 5% in the whole space
 - 600 800 search may find a solution near the optimal solutions
 - Tree-structured Parzen Estimator
 - Modeled by generative process of hyper-parameters, replacing the distributions of the configuration prior with non-parametric densities
 - 10% additional calculation effort than random with around 30% accuracy improvement
 - Bayesian Estimator
 - Widely sample data and leverage multivariate Gaussian distribution get the $\boldsymbol{\theta}$
 - Calculate EI and choose new sample point
 - Bayesian provide better method than TPE to jump out a local optimal solution
 - Better accuracy with massive trained result
- Parameter setting: optimizer, learning rate, weight decay, momentum.
- Workload setting: # of workers and GPUs, iterations, and so on.

Tune Hyperparameters for model:cifar10-single-caffe

A tuning task will aunch multiple jobe to search hyperparameters. A new model will be created that contains the tuned hyperparameters

uting job:	citer10-single-caffe tarring-20171204140301 (i) The new model will be tarring-20171204140301 The new model will be tarring to the to occurrence of the tarring to the tarri
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Tuning Parameter Settings

" Name of 5

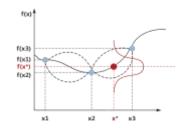
* Hypercere

Input the parameters that will be turn	d	
* Optimizer (select at least 1)	SGD AdeDeta AlaCent AlaCent Neelarrov RMSProp	
* Learning rate range	0.05-0.1	
* Weight decay range	0.1-05	
* Monentum range:	0.6-0.8	
* Must batch stee.	64	

Tuning Workload Setting

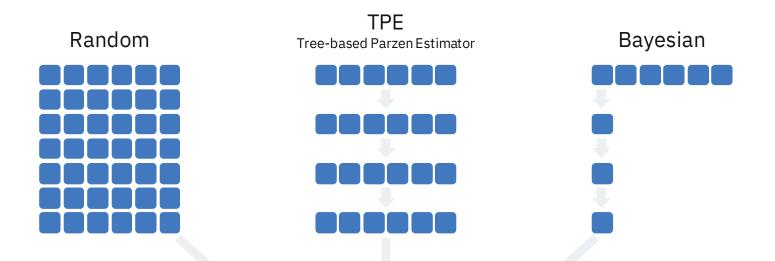
Input the parameters to control turing jutie and process

Number of workers:	*	
GPUs per worker	1	×
Max bendlore:	900	
Total kuning jobs number.	4	
Max turing jobs in parellel	2	
Max running time(minutes)	60	



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Hyper parameter search



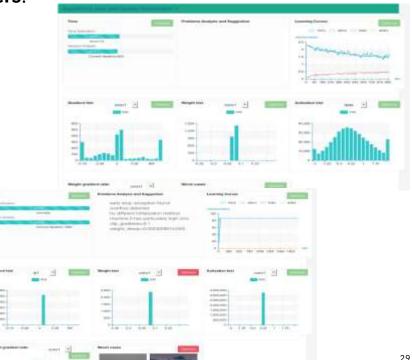
Spark search jobs are generated dynamically and executed in parallel

Multitenant Spark Cluster

IBM Spectrum Conductor with Spark

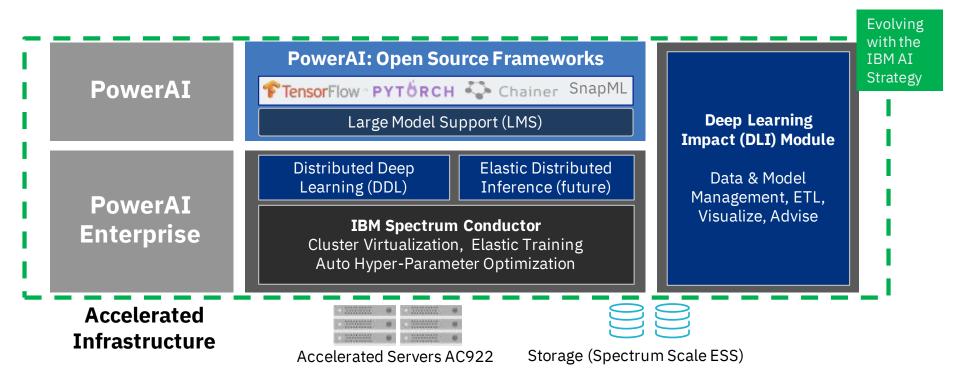
Monitoring, Advisor, Optimizer

- Neural network has the property of long time to train, easy to cause exception and communication overhead when considering distributed DL service.
- Neural network takes long time to search a good combination of **hyper-parameters**, the consumption time will be exponential increase with the size of hyper-parameters and its range.
- Neural network is so complex that it is hard for users to build an **end to end solution** including determining performance metrics, choosing the baseline models, deciding whether to gather more data, when to early stop, and selecting hyper-parameters.
 - DLI can detect issues:
 - Gradient Explosion
 - Overflow
 - Saturation
 - Divergence
 - Overfitting
 - Under fitting
 - And suggest parameter tuning!



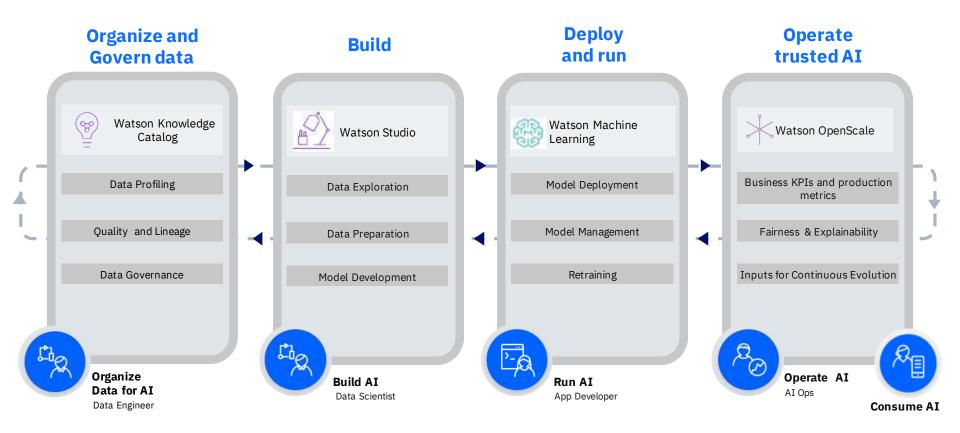
Recent announcements

Recent announcements @ THINK

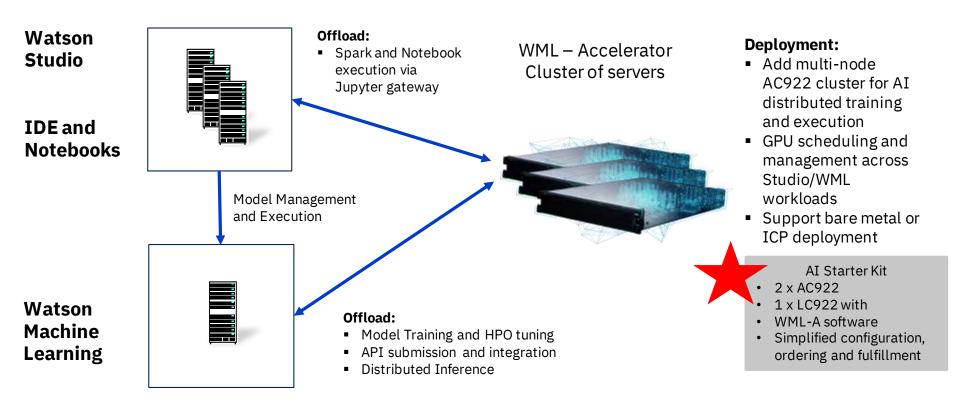


PowerAI Enterprise → Watson Machine Learning – Accelerator Integration with Watson suite

Recent announcements @ THINK



Recent announcements @ THINK



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