Machine Learning the Kubernetes Way

KubeCon + CloudNativeCon North America 2018 December 13, 2018

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About Us

- Ania Musial
 - Senior Software Engineer
 - Machine Learning Platform, AI Group
- Keith Laban
 - Senior Infrastructure Engineer
 - Data & Analytics Infrastructure
- <u>https://www.techatbloomberg.com/post-topic/data-science/</u>



How to Build a Data Science Platform



https://knowyourmeme.com/memes/how-to-draw-an-owl

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Machine Learning at Bloomberg

https://www.techatbloomberg.com/post-topic/data-science

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The Bloomberg Terminal (1982)



https://www.bloomberg.com/professional/blog/look-back-bloomberg-keyboard/





The Bloomberg Terminal (2018)





The Bloomberg Terminal

delivers a diverse array of information on a single platform to facilitate financial decision-making.

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Example Function: News Trends

TREN News Trends 🕸	¢ C₁, ¶· ?· C
Set Alert Set View as Default	
Companies Security List Topics	Trend Period 8 Hours
News Reader Activity News Sentiment	Twitter Sentiment News Volume Twitter Volume
Largest Increase Largest Total	
News Topic	A Pub. 1 NT Representative Tweet
Agricultural Chemicals	🖉 🗠 A. Smith: German Beer Industry in Shock Over Monsanto Glyphosate Contamination (deadly mutagenic Roundup) _
2 Fertilizer	🛛 🗠 Livemint: RT @livemint_m2m: Is India turning the corner on usage of fertilizers?Urea sales till 20 March stood at
Iceland	🗾 🗠 Skift: In parts of Iceland, you're more likely to meet a tourist than you are a local. The country doesn't want to
Health Care Facilities & Svcs	🖉 Richard James: These Women Suffering Complications From Mesh Implants Were Let Down By The Health System,
9 Hospitals, Clinics	Manhattan Institute: "@CPopeHC: What can the NHS learn from the American healthcare system, and vice versa? h.
Space Exploration	
D Env. Protection Agency	MorthJersey.com: EPA and Honeywell on Edgewater Superfund site https://t.co/Z43drJHzPr https://t.co/Dmp652L
Pakistan Government	Govt of Pakistan: #AlbertEinstein #Ouoteoftheday #00TD #guote #Pakistan https://t.co/u3C72mVCg9
Pakistan Prime Minister	KRT: Pakistani PM forced to undergo security check at US airport as Trump reportedly mulls sanctions against #Isl.
10 Chile Government	WYT National News: The Chilean government said it would start an inquiry into whether the remains of a tiny bab.
10 Korea Economy	Bloomberg Markets: #5Things- North Korea andJapan?- Tech drama- Indonesia's new central bank chief- Upwa
10 Copyrights	W ITWeb News Publication: Appeals court sends multibilion-dollar Java copyright case between Oracle and Google b.
1 Hybrid Bonds	
19 Canada	Calgary Herald: Fog Week: The absolutely official completely objective not biased at all definitive ranking of w
19 East African Community	The African Voice: US President Donald Trump nominates Illinois Senator Kyle McCarter to serve as Ambassador o

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Engineering

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Natural Language Processing & Events



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Over \$136 Billion Wiped Out in Minutes



The Possibilities are Infinite!

- Text Processing
- Anomaly Detection
- Image Processing
- Quant/Financial Risk Modeling
- Market Data Forecasting
- Audio Transcriptions
- Search Result Relevance & Ranking
- And more...



Embarking on a New Problem: What?

- What **data** is relevant to my business problem?
- What does the data **look** like?
- What **features** should I create from my data?
- What metric should I use to **measure** my model performance?

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- What **algorithms** or **parameters** should I test out?
- How is my model doing on live data in production?



What ML Practitioners Say They Want

Compute Infrastructure

ML Workflow & Ease of Use

Data Liquidity





What ML Practitioners Say They Want



Who is Involved in Building Such a System?

- ML Practitioners
- Dev Ops
- Infrastructure Engineers
- Business
- Security Officers
- And remember our (paying!) Bloomberg Terminal clients
 - Smarter Functionality, Privacy, Correctness, Uptime/Stability



Life Before Platform Era

Failures Prior Work

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Rules-based Systems \rightarrow ML: Status Report

Data

- Applicationspecific databases
- Small-ish

Compute

- Age of monolithic servers
- Resource squatting
- import multiprocessing

ML Workflow

- Interactive
- Custom tooling around SDLC
- Lack of infrastructure composability
- Lack of cross-team model sharing

Support

- Self-regulated, but contained
- Left up to full-stack application teams or machine owners





Big Data Era: Status Report

Data

- Data lake in HDFS/Hadoop
- Highly secured
- But what about joining on data not in the lake?

Compute

- Larger, more distributed
- Limited by data locale

ML Workflow

- Spark ML only gets you so far
- Subject to cluster-wide dependencies
- Auth protocols :(

Support

- Self-regulated, subject to workflows
- Distributed systems or Spark experts, but not ML folks

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GPU Era: Status Report

Data

Okay now how do

 I get this data
 lake stuff from
 one network over
 to this box over
 here...

Compute

- Access to blazing fast hardware
- Stop running so many notebooks, I need those devices

ML Workflow

- Interactive
- Neural network packages
- But what about ETL?

Support

- Scheduling is self-regulated, and on more expensive hardware
- Drivers; hardware/software coupling

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This is the "We Chose Kubernetes" Slide





kubernetes

CLOUD NATIVE COMPUTING FOUNDATION

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Platform 101

Custom Resources

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```
apiVersion: ds.bloomberg.com/v1
kind: TensorFlowJob
metadata:
  name: tf-test
  namespace: keithlaban
spec:
  framework: tensorflow-1.7-python-3
  pipPackages: [ai.bloomberg.com.myteam.gpu tftraining, numpy]
  module: gpu tftraining
  identities:
    - hadoop:
        id: keithlaban
  size: GpuLarge
  args:
    --data-dir hdfs://CLUSTER/projects/news/news index
    --output-dir hdfs://CLUSTER/users/klaban1/abcde/1
```



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    - hadoop:
        id: keithlaban
size: GpuLarge
args:
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- hadoop:

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```
size: GpuLarge
```

args:

```
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```

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apiVersion: ds.bloomberg.com/v1 kind: TensorFlowJob

name: tf-test

namespace: keithlaban

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module: gpu_tftraining

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- hadoop:

id: keithlaban

size: GpuLarge

args:

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```

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A Platform Needs More (CRDs)

- Single node
 - PythonJob
 - JVMJob
- Distributed ETL
 - SparkJob
- GPU
 - TensorFlowJob
- Hyperparameter Tuning
 - HypertuneJob
- Foundational Components
 - Data access, privacy, other multitenancy woes...

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Platform 101: Status Report

Data

- HDFS
- S3
- Databases
- Permission Controlled Access to Data Warehouses

Compute

- "Cloud"
- GPU
- CPU

ML Workflow

- CRDs are ML
- ETL -> GPU
- Declarative

Support

- Kubernetes
 monitoring
- Prometheus
- Cleaner split for DevOps



Nebulous and Misunderstood

Jupyter, Interactive Debugging, Tooling



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The Cloud Is Hard

- No native UNIX CLIs
- Paradigm shift for code execution and debugging
- Container-unaware applications





The Cloud Doesn't Have to be Hard

- JupyterJob
- kubectl exec
- UI
- Education





Living in the Nebula: Status Report

Data

- HDFS
- S3
- Databases
- Permission Controlled Access to Data Warehouses

Compute

- "Cloud"
- GPU
- CPU
- Interactive

ML Workflow

- CRDs are ML
- ETL -> GPU
- Declarative
- Jupyter

Support

- Kubernetes
 monitoring
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• Worry about Squatters

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Mo' People Mo' Tenancy

Namespaces, Resource Quotas, Preemption, Deadlines



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Sharing is Caring

- Workspace
 - Namespace
 - RBAC
 - Service Account
 - Resource Quotas
 - Network Policy
- Jobs
 - Priority Classes
 - Deadlines
- Tiered SLAs
 - User vs. Shared

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A Shared Status Report

Data

- HDFS
- S3
- Databases
- Permission Controlled Access to Data Warehouses

Compute

- "Cloud"
- GPU
- CPU
- Local
- Preemptable

ML Workflow

- CRDs are ML
- ETL -> GPU
- Declarative
- Jupyter

Support

- Kubernetes
 monitoring
- Prometheus
- Cleaner split for DevOps
- Worry about
 Squatters
- System handles capacity

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Model Development Life Cycle Robustness

History, Labels, Metrics, Experiment Management



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Getting More Sophisticated

- Job History
- Experiment Trial Aggregation
- Model Metrics





MDLC: Status Report

Data

- HDFS
- S3
- Databases
- Permission
 Controlled Access
 to Data
 Warehouses

Compute

- "Cloud"
- GPU
- CPU
- Local
- Preemptable

ML Workflow

- CRDs are ML
- ETL -> GPU
- Declarative
- Jupyter
- Projects
- Metrics
- Retraining

Support

- Kubernetes
 monitoring
- Prometheus
- Cleaner split for DevOps
- System handles capacity

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To Inference and Beyond

KNative, A Human-in-the-Loop, Spark Native Scheduling



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What We're Working on Now (Models)

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- Inference as a Service
 - Lambdas via KNative
- Connectivity to other components
 - Annotation Platform (Human in the Loop)





What We're Working on Now (ETL)

- Spark Native Kubernetes Scheduling (Spark 2.3)
 - <u>https://github.com/apache/spark/pull/19468</u>
- Spark Workload Autoscaling
 - <u>https://issues.apache.org/jira/browse/SPARK-25299</u>





Concluding Remarks

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Thanks!

- We hope you saw our teammates' talks (if not, watch for the videos):
 - Airflow on Kubernetes, Dynamic Workflows Simplified (Daniel Imberman)
 - Visualise Cluster Connectivity with Goldpinger: Smash it with PowerfulSeal (Mikolaj Pawlikowski)
- Be our teammate
 - <u>https://www.bloomberg.com/careers/technology/engineering/data-scie</u> <u>nce-teams/</u>

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Questions?



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