

Machine Learning @ Bloomberg

Building on Kubernetes

Engineering

Bloomberg

GPU Technology Conference (GTC) 2019 [S9810]
March 19, 2019

Ian Hummel, Data Architect, Office of the CTO
David Eis, Senior Software Engineer, AI Group

TechAtBloomberg.com

Agenda

- Finance and technology
- Machine Learning at Bloomberg
- Data Science Platform infrastructure
- Results and future work

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Bloomberg

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

About Bloomberg

- Founded in 1981
- 325,000 Terminal subscribers
- Customers in 170 countries
- Over 19,000 employees in 192 locations
- Over 5,000 software engineers/programmers
- More reporters than The New York Times + Washington Post + Chicago Tribune

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.



Finance and technology

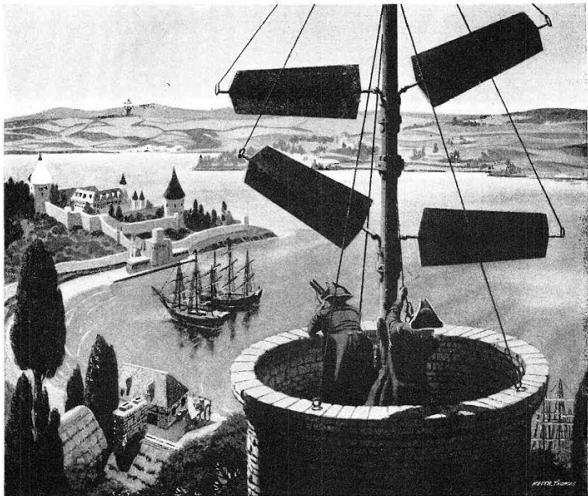
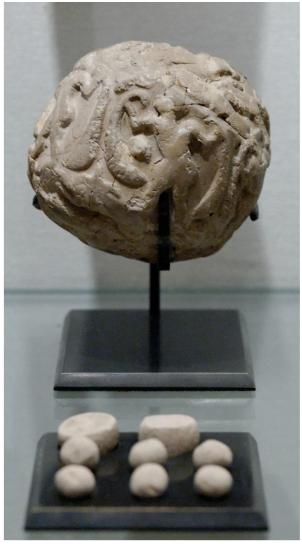


TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Finance and technology



[https://en.wikipedia.org/wiki/Bulla_\(seal\)](https://en.wikipedia.org/wiki/Bulla_(seal))

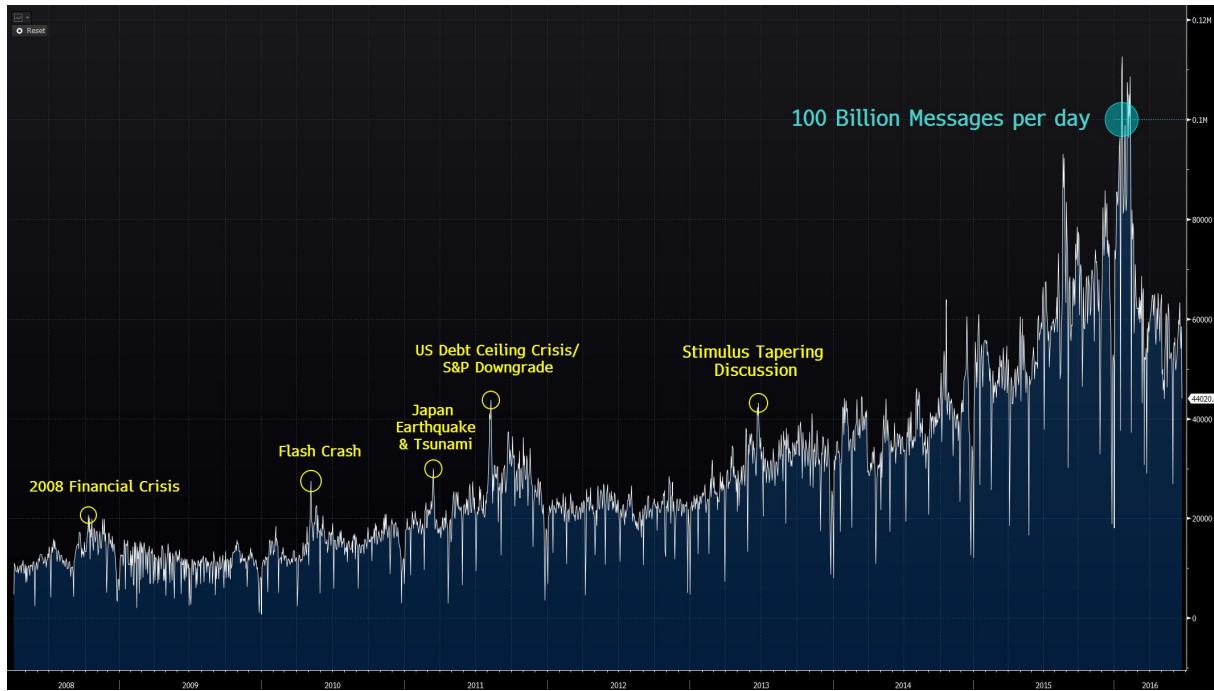
https://en.wikipedia.org/wiki/Semaphore_telegraph

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Finance and technology today



TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Understanding what's going on out there

The screenshot shows a Bloomberg News search interface with the query "Coffee". The results are displayed in two sections: "Top Ranked News" and "Time Ordered News".

Top Ranked News

- 1) Engelhart Hires Former Sucden's Donovan to Bolster Coffee Team BN 12:10
- 2) SOFTS: Cocoa Advances on El Nino Concerns; Coffee, Sugar Climb BFW 10/25
- 3) Tata Coffee Earnings Teleconference TCO IN BT 05:19

Time Ordered News

- 4) *SEC Short Sale Rule 201 is in Effect : YGYI (NASDAQ) BSS 12:10
- 5) Engelhart Hires Former Sucden's Donovan to Bolster Coffee Team BN 12:10
- 6) Mena Report: Tender For Sale Of Dried Coffee Berries. NS8 11:36
- 7) Mena Report: Supply Of Coffee. NS8 09:45
- 8) Mena Report: Coffee, Tea And Accompanying Products. NS8 09:28
- 9) The Columbian: Food & Drink: Kaflex celebrates global coffee village NS1 09:09
- 10) Mena Report: Food, Beverages, Tobacco And Related Products (coffee Beverage, ... NS8 09:05
- 11) Stewart & Mackertich Research_WEEKLY Dossier 26-10-2018 SMK 08:46
- 12) Tuoi Tre: Tea-based drinks outplay coffee in caffeine-loving Vietnam: report NS6 08:18
- 13) Intl Coffee Org: Visit from Ambassador of Angola IN9 06:51
- 14) AGRICULTURE WEEKLY AGENDA: Sugar Ethanol; Bali; Soy Crush; Bunge BFW 05:45
- 15) Asian News: GreenBrew all set to dominate Indian market with flavored green c... RE6 05:28
- 16) Tata Coffee Earnings Teleconference TCO IN BT 05:19
- 17) Commodity Online: India Coffee exports may fall as floods dent production NS1 04:19
- 18) *SEC Short Sale Rule 201 Not In Effect : YGYI (NASDAQ) BSS 03:58
- 19) Tata Coffee Earnings Q2 2019 Earnings Call Teleconference TCO IN BT 02:38

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg

Engineering

Natural Language Processing & Events



TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

The risks of being wrong

AP The Associated Press  

Breaking: Two Explosions in the White House and Barack Obama is injured

Reply Retweet Favorite Buffer More

3,242 RETWEETS 153 FAVORITES

12:07 PM - 23 Apr 13



<https://www.bloomberg.com/news/articles/2013-04-23/a-fake-ap-tweet-sinks-the-dow-for-an-instant>

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

The future is ripe for ML

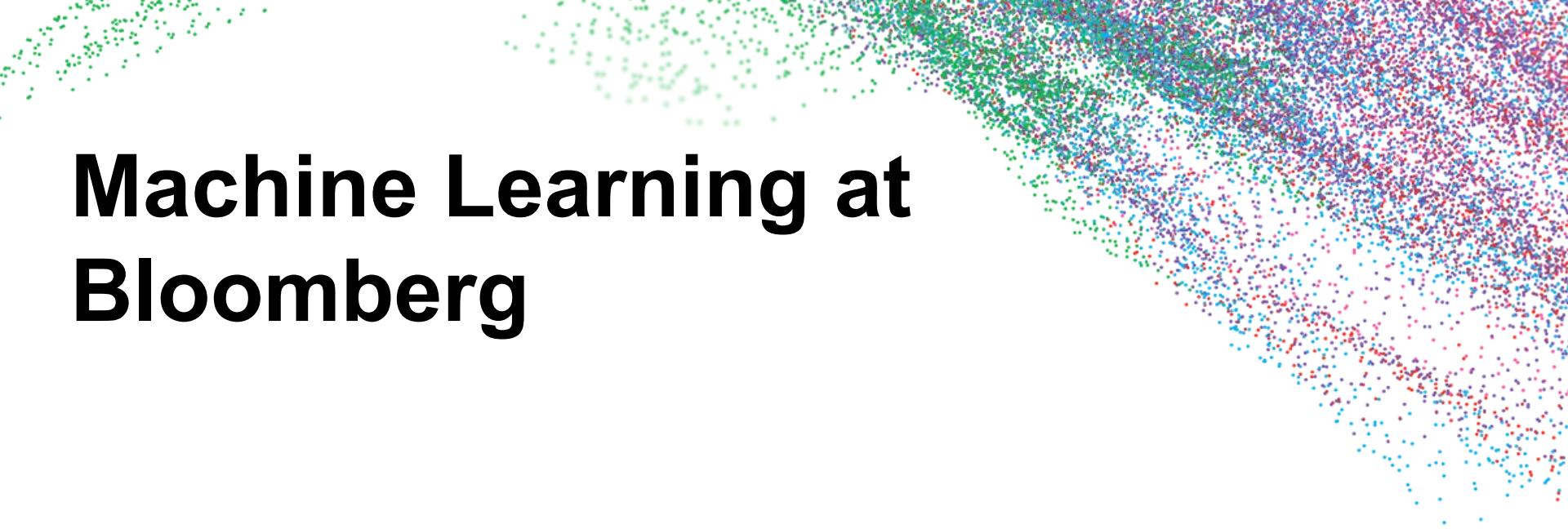


TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Machine Learning at Bloomberg

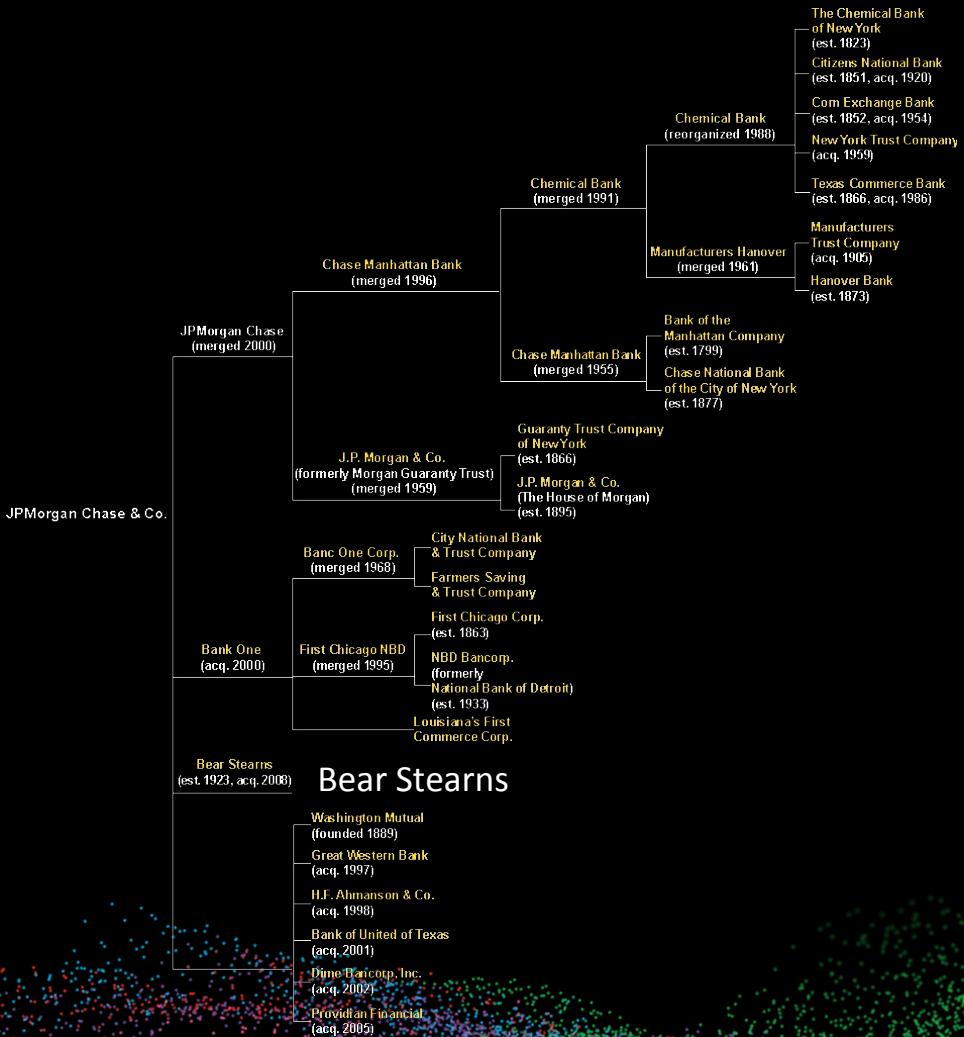


TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Financial named entity extraction



TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Explaining Knowledge Graph relationships



In 1971, Siegl, Bowker and Baldwin established the Starbucks Coffee Company.

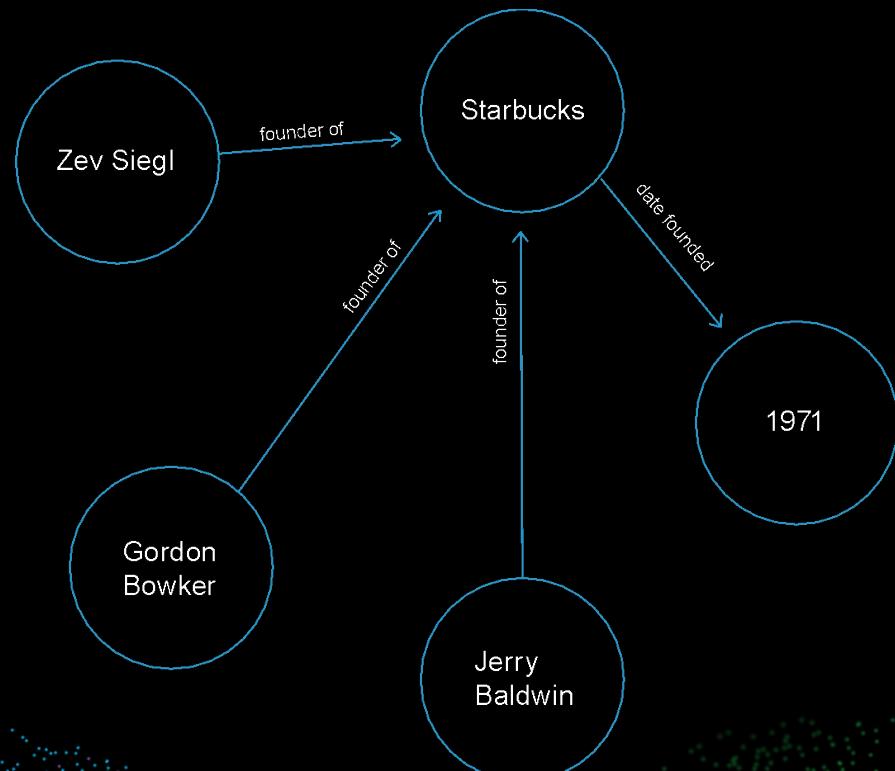


Table Extraction

NVIDIA CORPORATION AND SUBSIDIARIES CONSOLIDATED STATEMENTS OF INCOME (In millions, except per share data)			
	Year Ended		
	January 27, 2019	January 28, 2018	January 29, 2017
Revenue	\$ 11,716	\$ 9,714	\$ 6,910
Cost of revenue	4,545	3,892	2,847
Gross profit	7,171	5,822	4,063
Operating expenses			
Research and development	2,376	1,797	1,463
Sales, general and administrative	991	815	663
Restructuring and other charges	—	—	3
Total operating expenses	3,367	2,612	2,129
Income from operations	3,804	3,210	1,934
Interest income	136	69	54
Interest expense	(58)	(61)	(58)
Other, net	14	(22)	(25)
Total other income (expense)	92	(14)	(29)
Income before income tax	3,896	3,196	1,905
Income tax expense (benefit)	(245)	149	239
Net income	\$ 4,141	\$ 3,047	\$ 1,666
Net income per share:			
Basic	\$ 6.81	\$ 5.09	\$ 3.08
Diluted	\$ 6.63	\$ 4.82	\$ 2.57
Weighted average shares used in per share computation:			
Basic	608	599	541
Diluted	625	632	649

NVDA US \$ ↓ 148.25 -1.01 Z148.25 / 148.29Q 1x1 At 11:12 d Vol 3,856,684 0 145.660 H 149.33Z L 144.80Q Val 618.983 Financial Analysis

NVDA US Equity Actions Export Settings BQL Periods 10 Annuals Cur FRC (USD) +

NVIDIA Corp Key Stats I/S B/S C/F Ratios Segments Add ESG Custom Shared

Adj Highlights GAAP Highlights Earnings Enterprise Value Multiples Per Share Stock Value

In Millions of USD except Per Share Months Ending 2016 Y 2017 Y 2018 Y 2019 Y 2020 Y Est 2021 Y Est

01/31/2016 01/29/2017 01/28/2018 01/27/2019 01/31/2020 01/31/2021

Revenue

Consensus Estimate	4,922.0	6,849.6	9,473.6	11,712.3	11,181.8	13,400.6
Comparable Actual	5,030.0	6,910.0	9,714.0	11,716.0		
Revenue Surprise %	1.8	0.0	2.5	0.0		
GAAP Actual	5,010.0	6,910.0	9,714.0	11,716.0		
Adjusted Actual	5,010.0	6,910.0	9,714.0	11,716.0		

Earnings Per Share

Consensus Estimate	1.58	2.94	4.47	6.60	5.36	7.13
Comparable Actual	1.67	3.06	4.92	6.64		
EPS Surprise %	5.9	4.1	10.1	0.7		
GAAP Actual	1.08	2.57	4.82	6.63		
Adjusted Actual	1.36	2.60	4.63	6.10		

EBIT

Consensus Estimate	1,055.6	2,157.6	3,361.6	4,406.3	3,717.2	5,028.8
Comparable Actual	1,125.0	2,221.0	3,617.0	4,407.0		
EBIT Surprise %	6.6	2.9	7.6	0.0		
GAAP Actual	747.0	1,934.0	3,210.0	3,804.0		
Adjusted Actual	968.0	1,953.0	3,224.0	3,850.0		

Automating the news

DEEP ECO: Starbucks Pressured, Industry Sales Slowest in 8 Yrs

By Bloomberg Automation [Feedback?](#)

(Bloomberg) -- Starbucks Corp.'s revenue may be pressured after a U.S. Census Bureau report showed limited-service eating places nominal retail sales fell 0.1 percent in November, the first decrease in eight years.

- The monthly report may provide an indication of the performance of companies in the industry Bloomberg classifies as limited service restaurants; Starbucks gets 89 percent of its revenue from this industry.
- Analysts estimate the company's revenue will rise 8.2 percent in the current fiscal quarter.
- This retail sales index was up 1 percent in the first two months of the company's current fiscal quarter.
- Starbucks' first quarter started on Oct. 2, 2017.
- In the past six years, Starbucks' revenue has had a 0.7 correlation with this index, according to data compiled by Bloomberg.

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Starbucks Shares Fall After Chain's U.S. Sales Disappoint Again

By Leslie Patton



By Jaclyn Peiser

Feb. 5, 2019

As reporters and editors find themselves the victims of layoffs at digital publishers and traditional newspaper chains alike, journalism generated by machine is on the rise.

Roughly a third of the content published by Bloomberg News uses some form of automated technology. The system used by the company, Cyborg, is able to assist reporters in churning out thousands of articles on company earnings reports each quarter.

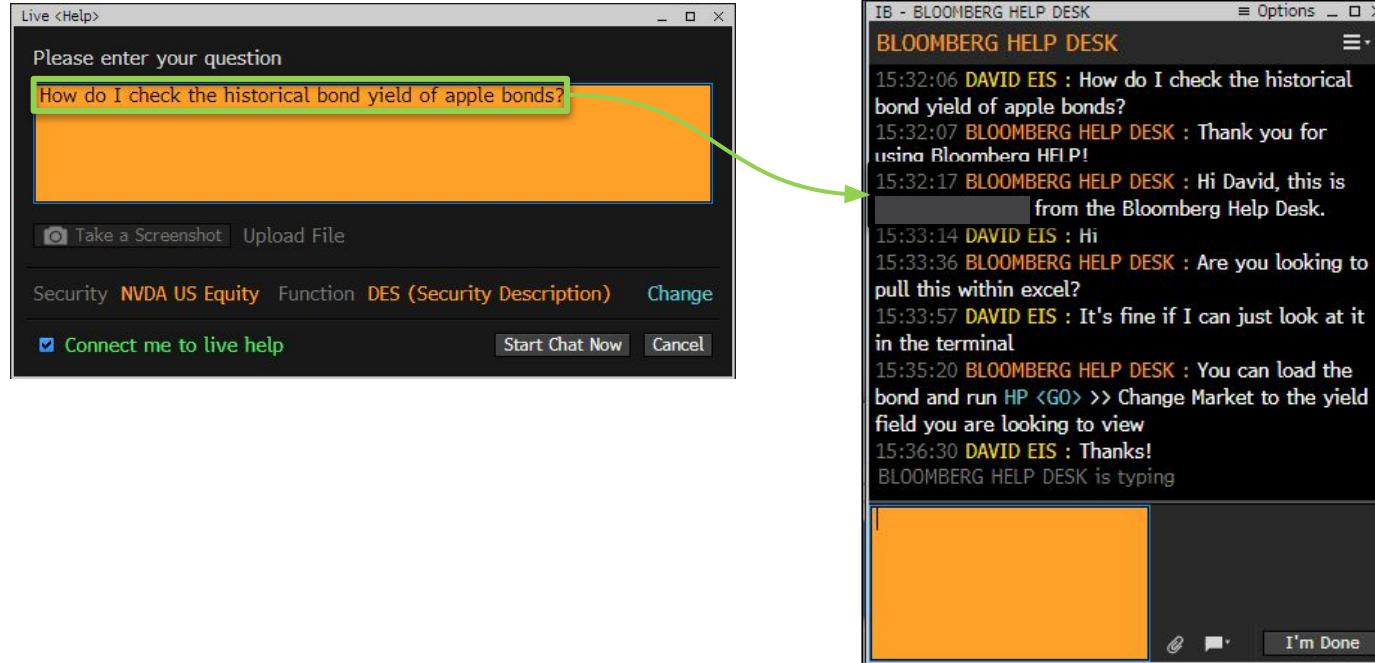
The program can dissect a financial report the moment it appears and spit out an immediate news story that includes the most pertinent facts and figures. And unlike business reporters, who find working on

[Subscribe to The New York Times.](#)

SUBSCRIBE >

Bloomberg
Engineering

HELP HELP - Query routing



TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

News QA

The screenshot shows the Bloomberg News & Research interface. A green arrow points from the search bar at the top left to the search results table on the right. The search bar contains the query "news on brexit from the financial times last thursday". Below the search bar, the "News Search Options" section displays the search terms with wildcards: "NEWS" AND "ON" AND "BREXIT" AND "FROM" AND "THE" AND "FINANCIAL" AND "TIMES" AND "LAST" AND "THURSDAY". The search results table lists 19 news items, each with a title, source (FTI), and date (02/07). The titles include various Brexit-related stories from the Financial Times.

Rank	Title	Source	Date
1)	FastFT: Theresa May pushes back against Tusk's sharply-worded comments	FTI	02/07
2)	FastFT: May and Juncker promise talks to find path through Brexit impasse	FTI	02/07
3)	Mideast investors shun commercial property	FTI	02/07
4)	May and EU agree on talks to break deadlock	FTI	02/07
5)	Plans hatched in secret to revive economy after a no-deal Brexit	FTI	02/07
6)	Brexit/property funds: cash test dummies	FTI	02/07
7)	Mideast investors shun commercial property	FTI	02/07
8)	Brexit/property funds: cash test dummies	FTI	02/07
9)	Mideast investors shun commercial property	FTI	02/07
10)	Brexit/property funds: cash test dummies	FTI	02/07
11)	Brexit/property funds: cash test dummies	FTI	02/07
12)	Brexit/property funds: cash test dummies	FTI	02/07
13)	Mideast investors shun commercial property	FTI	02/07
14)	May and EU agree to reopen talks to break Brexit impasse	FTI	02/07
15)	Jeremy Corbyn's shift on Brexit heightens Labour tensions	FTI	02/07
16)	The Brexit delusion of creating 'Singapore upon Thames'	FTI	02/07
17)	Bank of England pulls back on multiple rate rise plans	FTI	02/07
18)	FastFT: Kellogg swings to fourth-quarter loss as Brexit planning costs bite	FTI	02/07
19)	UK draws up secret plan to boost economy after no-deal Brexit	FTI	02/07

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Charts QA



TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg

Engineering



Why build a Data Science Platform?

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

ML opportunities

What questions do teams ask before starting a new project?

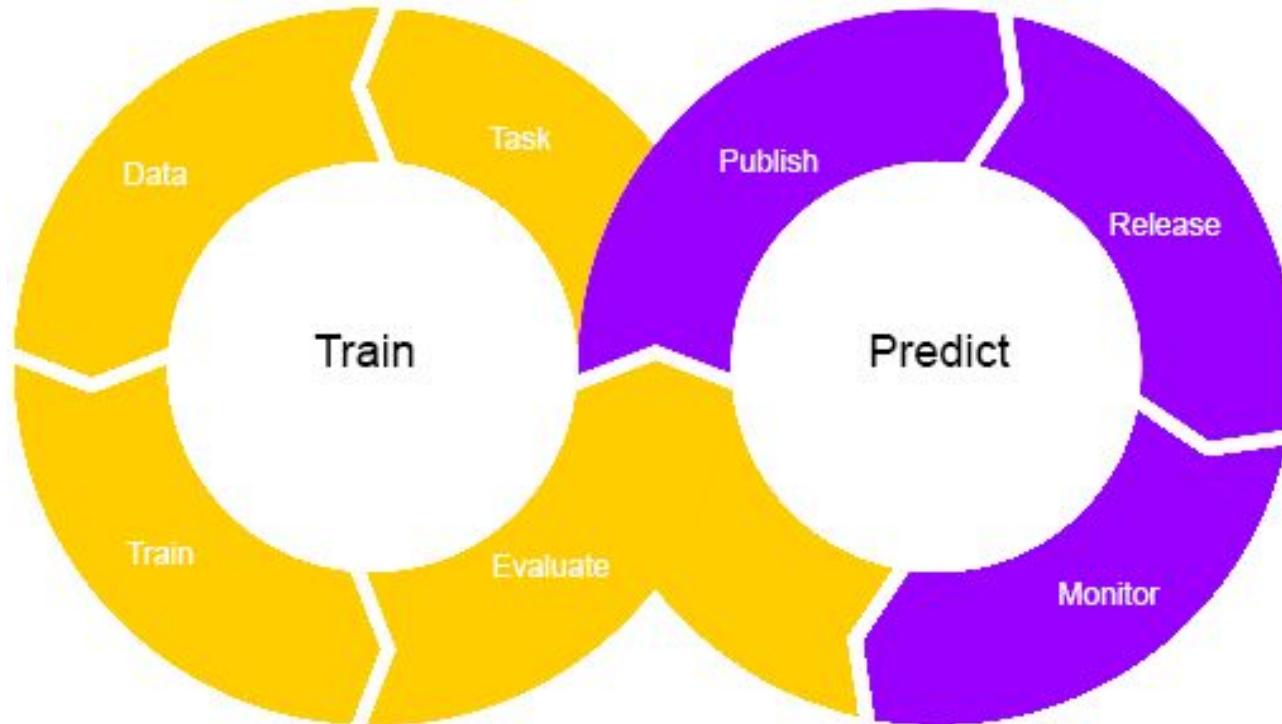
- What **data** is relevant to my business problem?
- What does the data **look** like?
- What **features** should I create from my data?
- What metric should I use to **measure** my model performance?
- What **algorithms** or **parameters** should I test out?
- How is my model doing on live data in **production**?

Challenges for ML projects

Even in an established enterprise, ML teams face the same challenges again and again...

- Where is my data **located**?
- How do I get **permissioned** for my data?
- How do I load this data in a native **visualization** tool?
- How do I get this **toolkit** installed and operational?
- How do I **schedule** my long-running job?
- How much **compute power** is available for me to exploit?
- How do I **deploy** my model?

The model development lifecycle



Different roles, different priorities

ML Practitioners

- Keep up with latest trends in academia and forefront of Deep Learning innovations
- Access to specialized hardware
- Rapid iteration over research ideas
- Focus on business problem, not building infrastructure

Engineers

- Less operational burden
- Support for multi-tenancy
- Ease of data access
 - But also secure and properly privileged
- Avoid duplicated code
- Reproducibility of results

Customers

- Smarter Functionality
- Privacy
- Correctness
- Uptime/Stability

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Blueprint for an ML infrastructure...

Foundational Building Blocks

- Specialized Hardware
- Standardized Runtimes
- Batch Scheduling

Developer Experience

- Ease of Use
- Rapid Iteration
- Native Tooling

Data Liquidity

- Data Access
- Security

ML Specifics

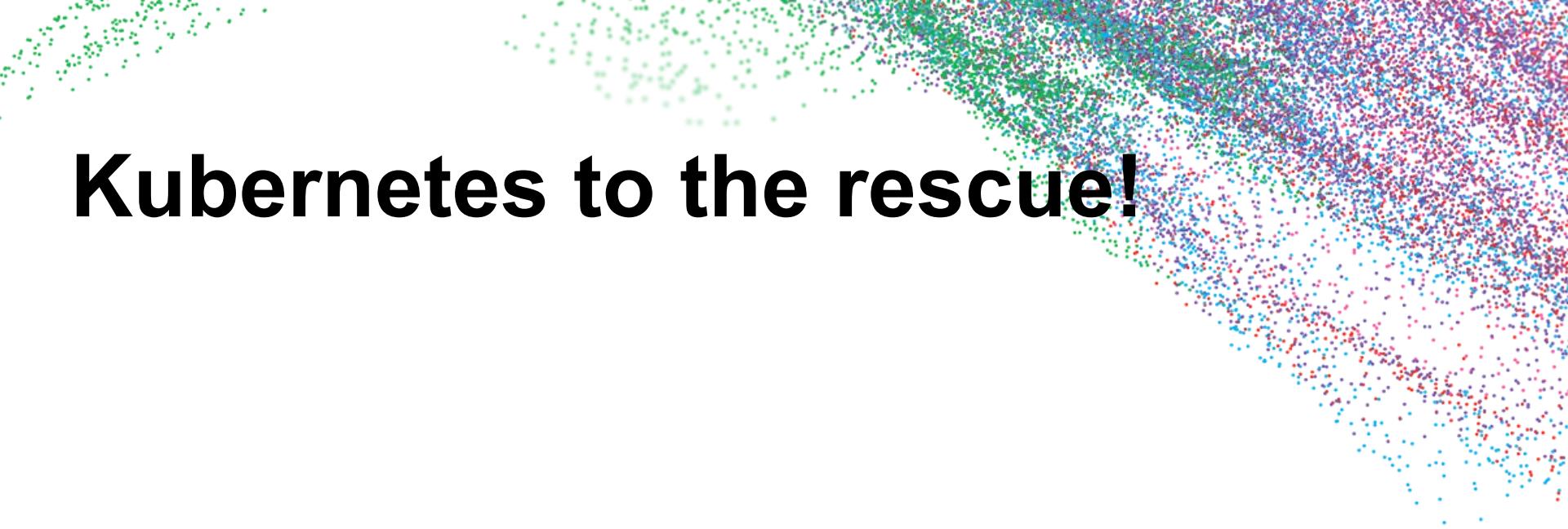
- Experiment Management
- Hyperparameter Tuning
- Result Reproducibility

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Kubernetes to the rescue!

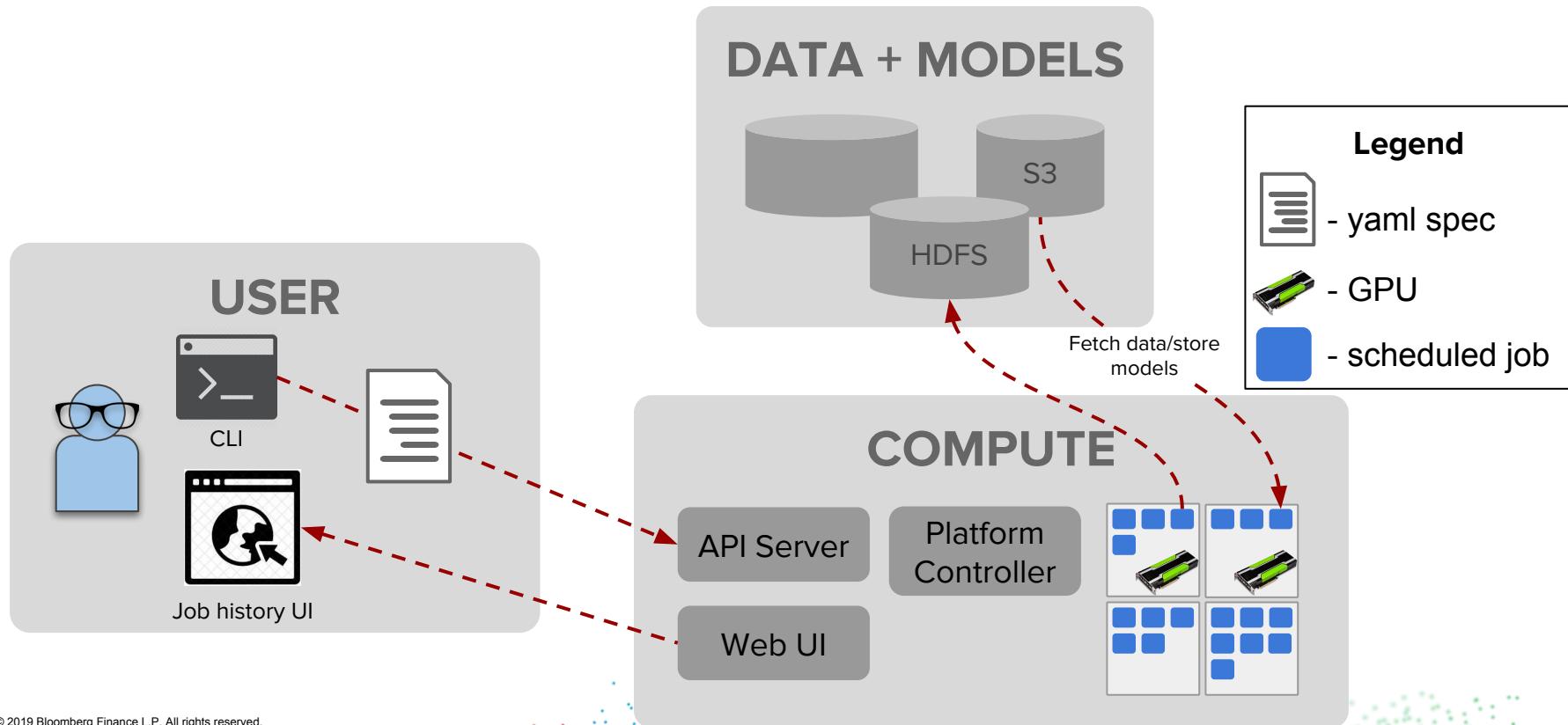


TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

DS Platform architecture

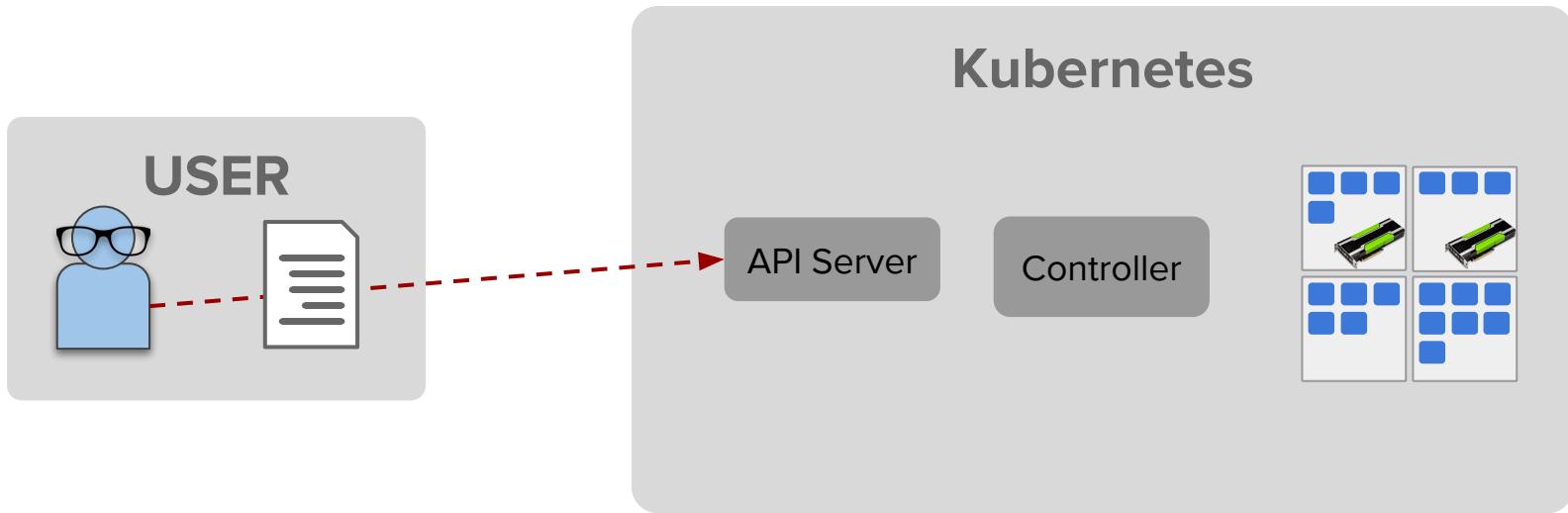


What is Kubernetes?

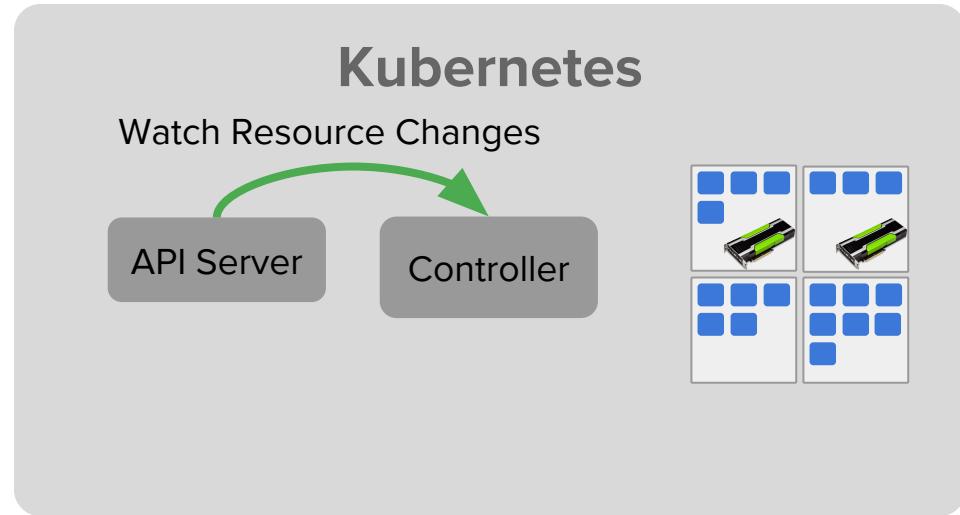
“Kubernetes is an open-source system for automating deployment, scaling, and management of containerized applications.”

- <https://kubernetes.io/>

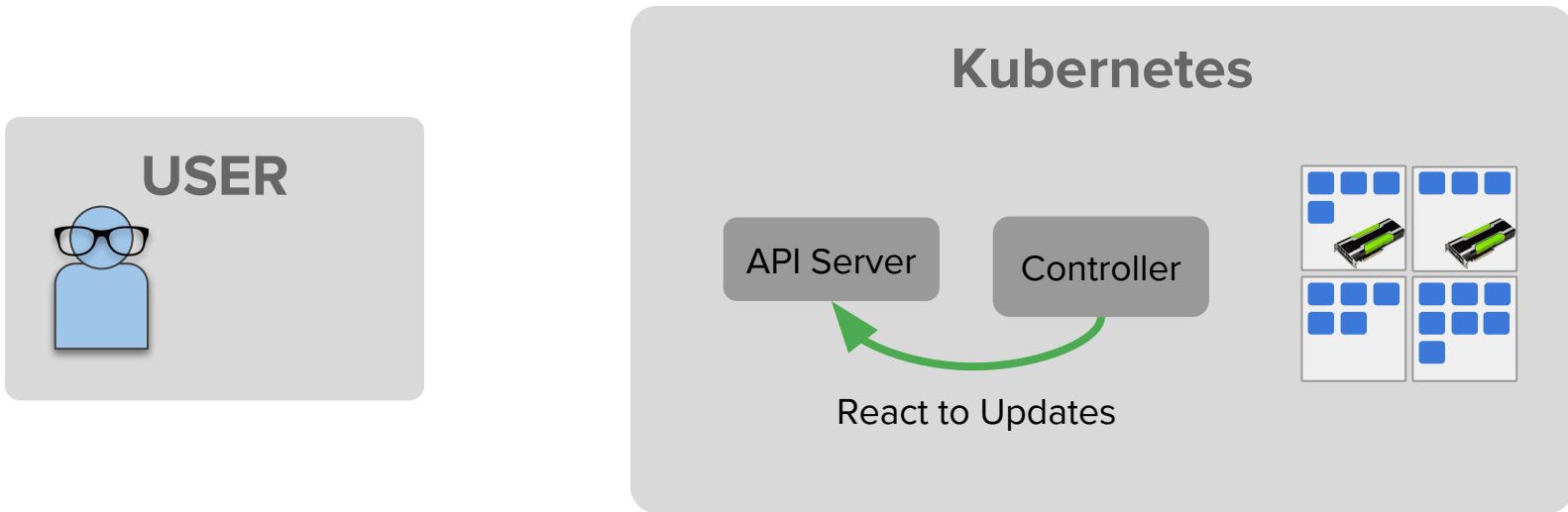
Kubernetes life cycle



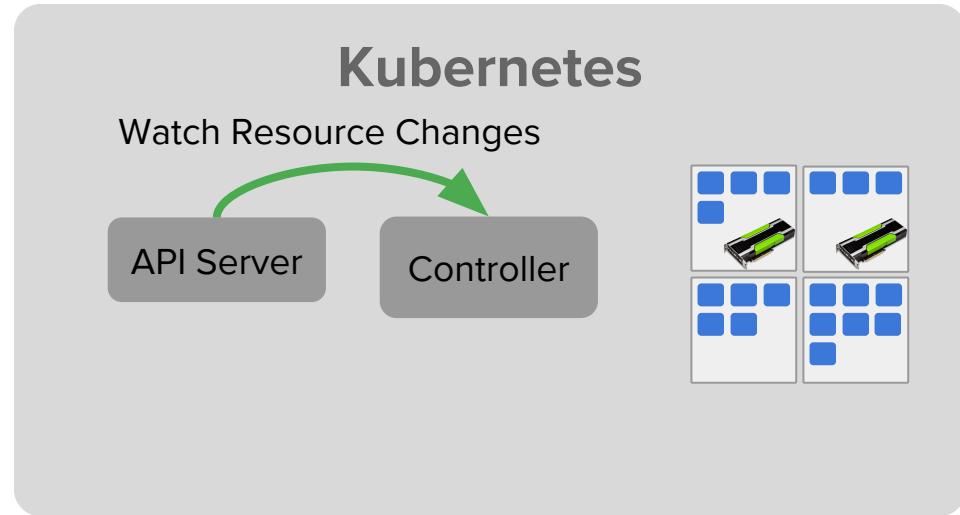
Kubernetes life cycle



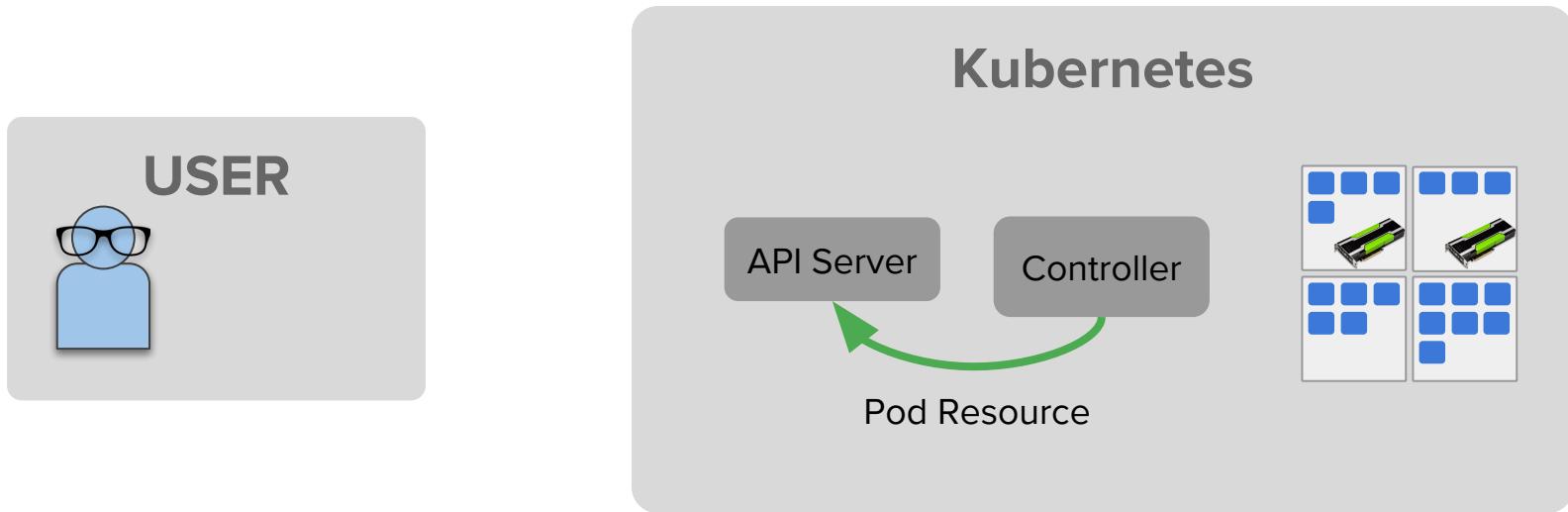
Kubernetes life cycle



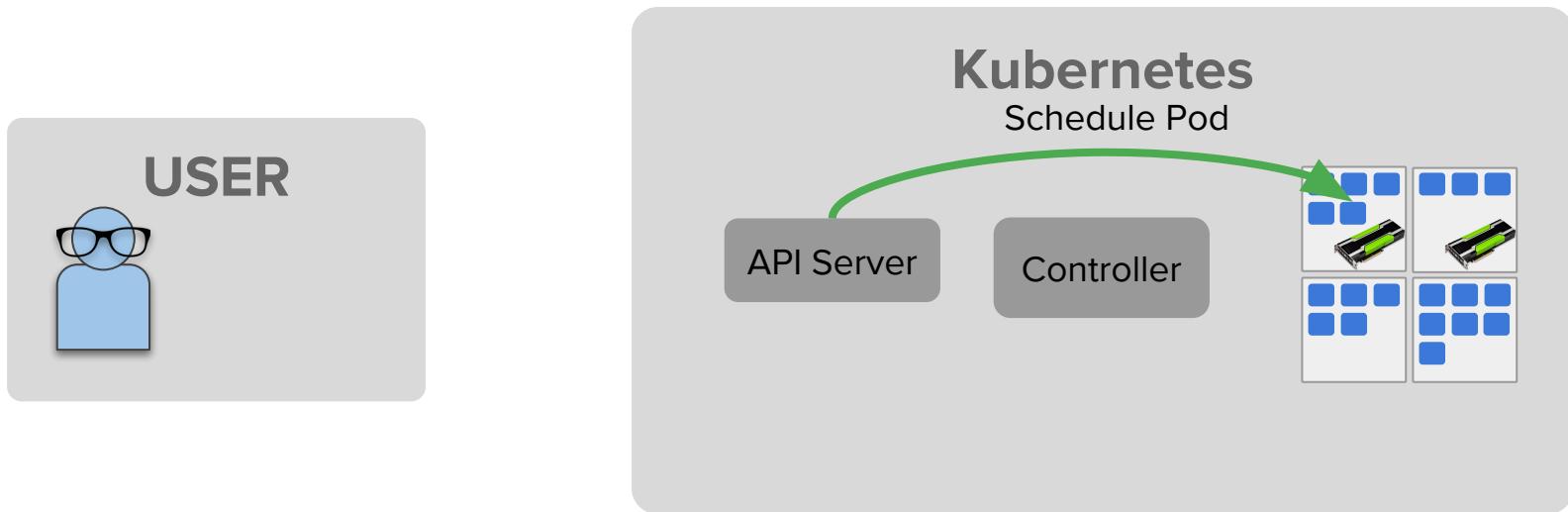
Kubernetes life cycle



Kubernetes life cycle



Kubernetes life cycle



Deployment resource (YAML)

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  replicas: 3
  template:
    spec:
      containers:
        - name: nginx
          image: nginx:1.7.9
          ports:
            - containerPort: 80
```

<https://kubernetes.io/docs/concepts/workloads/controllers/deployment/>

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Deployment resource: kind

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  replicas: 3
  template:
    spec:
      containers:
        - name: nginx
          image: nginx:1.7.9
          ports:
            - containerPort: 80
```

<https://kubernetes.io/docs/concepts/workloads/controllers/deployment/>

© 2019 Bloomberg Finance L.P. All rights reserved.



Deployment resource: spec (replicas)

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  replicas: 3
  template:
    spec:
      containers:
        - name: nginx
          image: nginx:1.7.9
          ports:
            - containerPort: 80
```

<https://kubernetes.io/docs/concepts/workloads/controllers/deployment/>

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Deployment resource: spec (pod template)

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: nginx-deployment
spec:
  replicas: 3
  template:
    spec:
      containers:
        - name: nginx
          image: nginx:1.7.9
          ports:
            - containerPort: 80
```

<https://kubernetes.io/docs/concepts/workloads/controllers/deployment/>

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Benefits of Kubernetes

- Declarative deployment
- Hardware indifference
- Monitoring
- Replication
- Autoscaling
- Security Extensions
 - Ingress + SSL termination
 - Istio service mesh

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Custom resources

- **Resource** - a set of API objects in Kubernetes, such as Deployments or Pods.
- **Custom Resource** - an extension of the Kubernetes API defined by a user that declares new types of API Objects.

Kubernetes meets ML: TensorFlowJob

```
apiVersion: ds.bloomberg.com/v1
kind: TensorFlowJob
metadata:
  name: tf-test
  annotations:
    ai.bloomberg.com/project: foo
    ai.bloomberg.com/experiment: abcde
spec:
  framework: tensorflow-1.13-python-3
  identities:
    - hadoop:
        id: davideis
  pipPackages: [ai.bloomberg.com.myteam.gpu_tftraining, numpy]
  module: gpu_tftraining
  size: GpuLarge
  args:
    --data-dir hdfs://CLUSTER/projects/news/news_index
    --output-dir hdfs://CLUSTER/users/deis/fancy_model
```

Kubernetes meets ML: TensorFlowJob

```
apiVersion: ds.bloomberg.com/v1
kind: TensorFlowJob
metadata:
  name: tf-test
  annotations:
    ai.bloomberg.com/project: foo
    ai.bloomberg.com/experiment: abcde
spec:
  framework: tensorflow-1.13-python-3
  identities:
    - hadoop:
        id: davideis
  pipPackages: [ai.bloomberg.com.myteam.gpu_tftraining, numpy]
  module: gpu_tftraining
  size: GpuLarge
  args:
    --data-dir hdfs://CLUSTER/projects/news/news_index
    --output-dir hdfs://CLUSTER/users/deis/abcde/foo/1
```

Kubernetes meets ML: TensorFlowJob

```
apiVersion: ds.bloomberg.com/v1
kind: TensorFlowJob
metadata:
  name: tf-test
  annotations:
    ai.bloomberg.com/project: foo
    ai.bloomberg.com/experiment: abcde
spec:
  framework: tensorflow-1.13-python-3
  identities:
    - hadoop:
        id: davideis
  pipPackages: [ai.bloomberg.com.myteam.gpu_tftraining, numpy]
  module: gpu_tftraining
  size: GpuLarge
  args:
    --data-dir hdfs://CLUSTER/projects/news/news_index
    --output-dir hdfs://CLUSTER/users/deis/abcde/foo/1
```

Kubernetes meets ML: TensorFlowJob

```
apiVersion: ds.bloomberg.com/v1
kind: TensorFlowJob
metadata:
  name: tf-test
  annotations:
    ai.bloomberg.com/project: foo
    ai.bloomberg.com/experiment: abcde
spec:
  framework: tensorflow-1.13-python-3
  identities:
    - hadoop:
        id: davideis
  pipPackages: [ai.bloomberg.com.myteam.gpu_tftraining, numpy]
  module: gpu_tftraining
  size: GpuLarge
  args:
    --data-dir hdfs://CLUSTER/projects/news/news_index
    --output-dir hdfs://CLUSTER/users/deis/abcde/foo/1
```

Kubernetes meets ML: TensorFlowJob

```
apiVersion: ds.bloomberg.com/v1
kind: TensorFlowJob
metadata:
  name: tf-test
  annotations:
    ai.bloomberg.com/project: foo
    ai.bloomberg.com/experiment: abcde
spec:
  framework: tensorflow-1.13-python-3
  identities:
    - hadoop:
        id: davideis
  pipPackages: [ai.bloomberg.com.myteam.gpu_tftraining, numpy]
  module: gpu_tftraining
  size: GpuLarge
  args:
    --data-dir hdfs://CLUSTER/projects/news/news_index
    --output-dir hdfs://CLUSTER/users/deis/abcde/foo/1
```

Kubernetes meets ML: TensorFlowJob

```
apiVersion: ds.bloomberg.com/v1
kind: TensorFlowJob
metadata:
  name: tf-test
  annotations:
    ai.bloomberg.com/project: foo
    ai.bloomberg.com/experiment: abcde
spec:
  framework: tensorflow-1.13-python-3
  identities:
    - hadoop:
        id: davideis
  pipPackages: [ai.bloomberg.com.myteam.gpu_tftraining, numpy]
  module: gpu_tftraining
  size: GpuLarge
  args:
    --data-dir hdfs://CLUSTER/projects/news/news_index
    --output-dir hdfs://CLUSTER/users/deis/abcde/foo/1
```

Kubernetes meets ML: TensorFlowJob

```
apiVersion: ds.bloomberg.com/v1
kind: TensorFlowJob
metadata:
  name: tf-test
  annotations:
    ai.bloomberg.com/project: foo
    ai.bloomberg.com/experiment: abcde
spec:
  framework: tensorflow-1.13-python-3
  identities:
    - hadoop:
        id: davideis
  pipPackages: [ai.bloomberg.com.myteam.gpu_tftraining, numpy]
  module: gpu_tftraining
size: GpuLarge
args:
  --data-dir hdfs://CLUSTER/projects/news/news_index
  --output-dir hdfs://CLUSTER/users/deis/abcde/foo/1
```

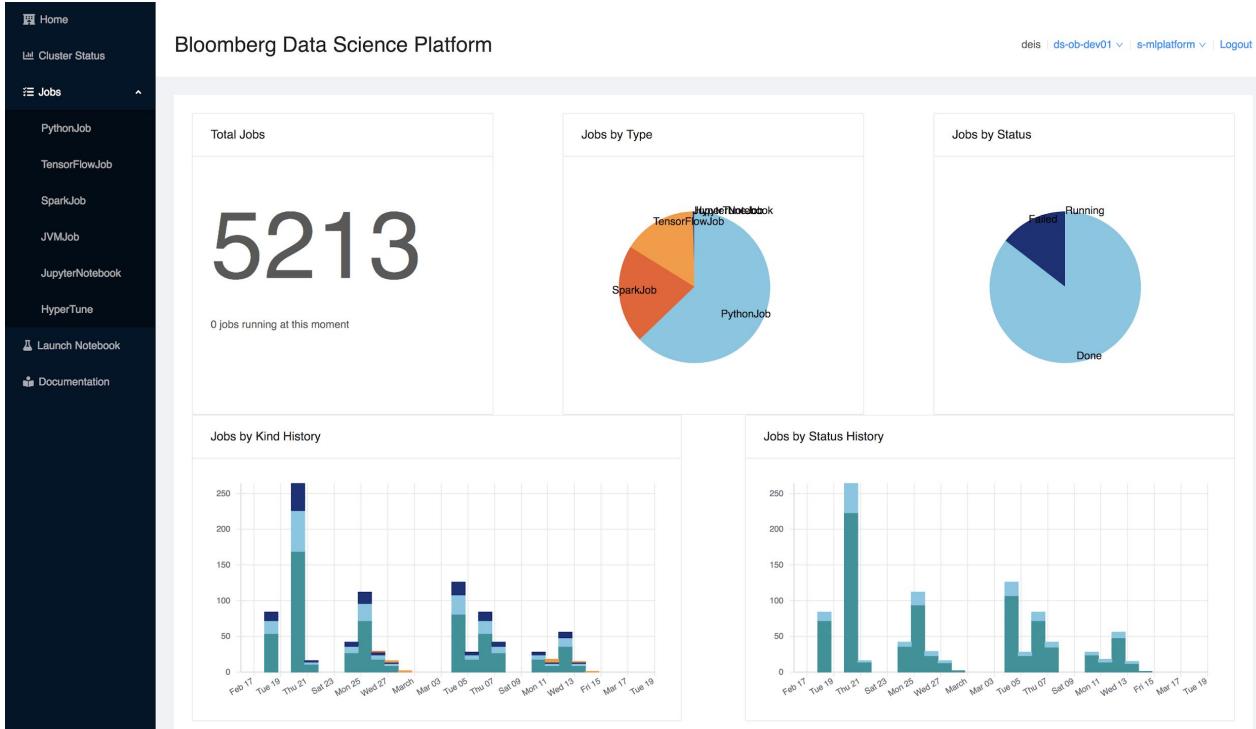
Kubernetes meets ML: TensorFlowJob

```
apiVersion: ds.bloomberg.com/v1
kind: TensorFlowJob
metadata:
  name: tf-test
  annotations:
    ai.bloomberg.com/project: foo
    ai.bloomberg.com/experiment: abcde
spec:
  framework: tensorflow-1.13-python-3
  identities:
    - hadoop:
        id: davideis
  pipPackages: [ai.bloomberg.com.myteam.gpu_tftraining, numpy]
  module: gpu_tftraining
  size: GpuLarge
args:
  --data-dir hdfs://CLUSTER/projects/news/news_index
  --output-dir hdfs://CLUSTER/users/deis/abcde/foo/1
```

A model for the ML ecosystem

- Other Types of Custom Resources
 - Spark
 - Python
 - JVM
 - Jupyter Notebook
 - Hyperparameter Tuning
- Foundation for reproducibility and automation

Tooling



TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Achieving nirvana (reprise)

Foundational Building Blocks

- Specialized Hardware
- Standardized Runtimes
- Batch Scheduling

Developer Experience

- Ease of Use
- Rapid Iteration
- Native Tooling

Data Liquidity

- Data Access
- Security

ML Specifics

- Experiment Management
- Hyperparameter Tuning
- Result Reproducibility

Helping teams succeed with the DS Platform



TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Building infrastructure is not for the faint-hearted

- Demanding users
- Multi-tenancy is hard
- New hardware designs hard to incorporate
- ML projects require consulting
- Effective tooling means team requires broad skill set
- Open source moving incredibly fast
- What's your value-add??

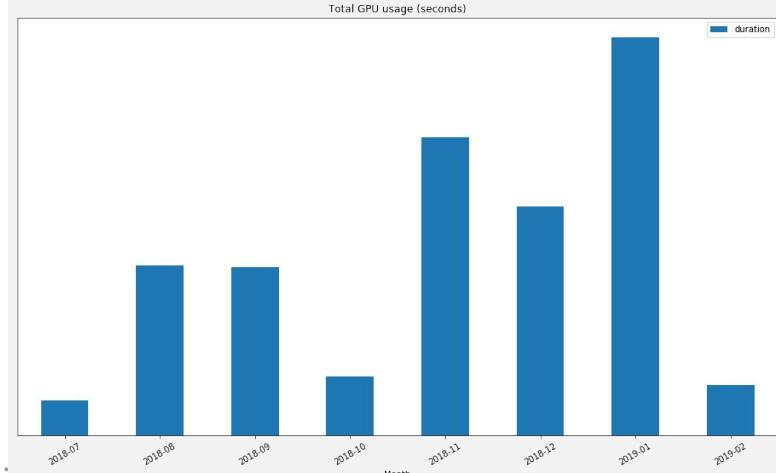
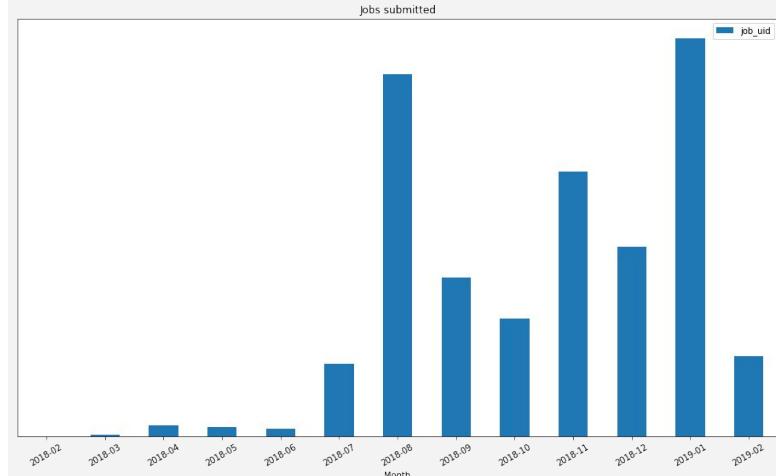
TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Strong emphasis on metrics

- Number of teams using the platform
- Number of users using the platform
- How often they submit jobs
- Duration of jobs
- Types of jobs submitted
- Hardware utilization
- Net Promoter Score (NPS) surveys



TechAtBloomberg.com

What's next for us?

- More tooling
- Kubernetes batch/job queueing
- KNative serving
- Dataset and model management
- Additional ML services like data drift detection

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering

Thanks!

Reach out to us at
ihummel@bloomberg.net and deis@bloomberg.net

TechAtBloomberg.com

© 2019 Bloomberg Finance L.P. All rights reserved.

Bloomberg
Engineering