



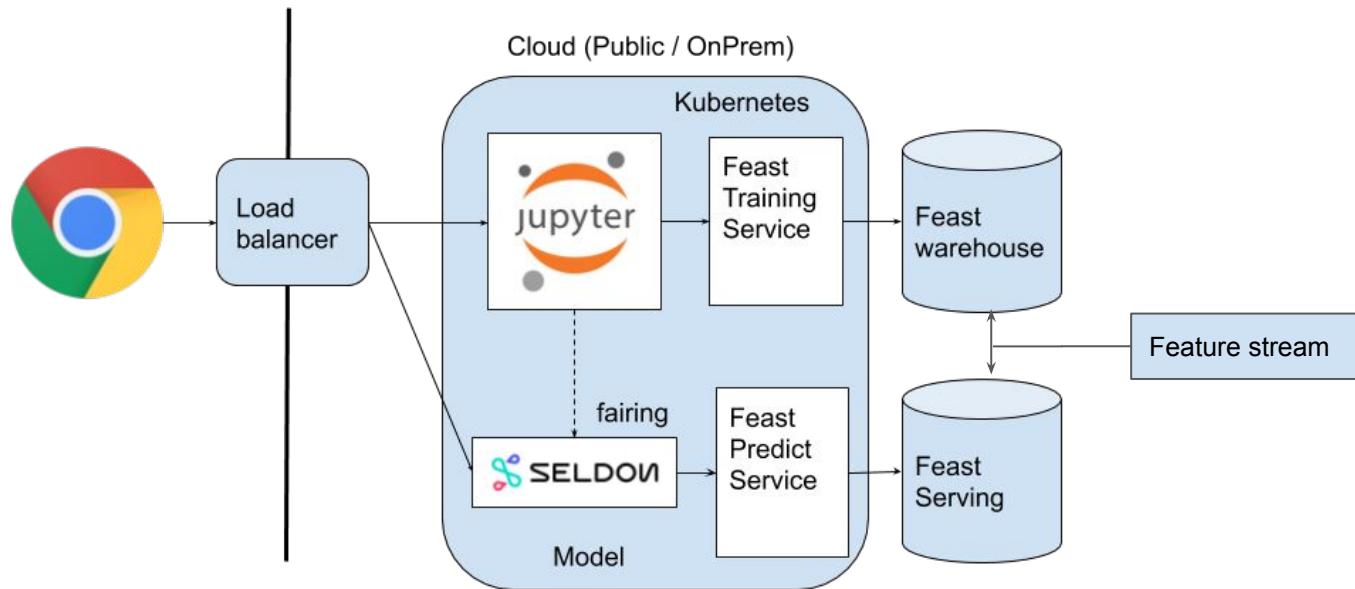
Kubeflow

Moving People and Products with ML on Kubeflow

Jeremy Lewi (jlewi@) Google
Willem Pienaar GOJEK
2019-05-23

Takeaway Message

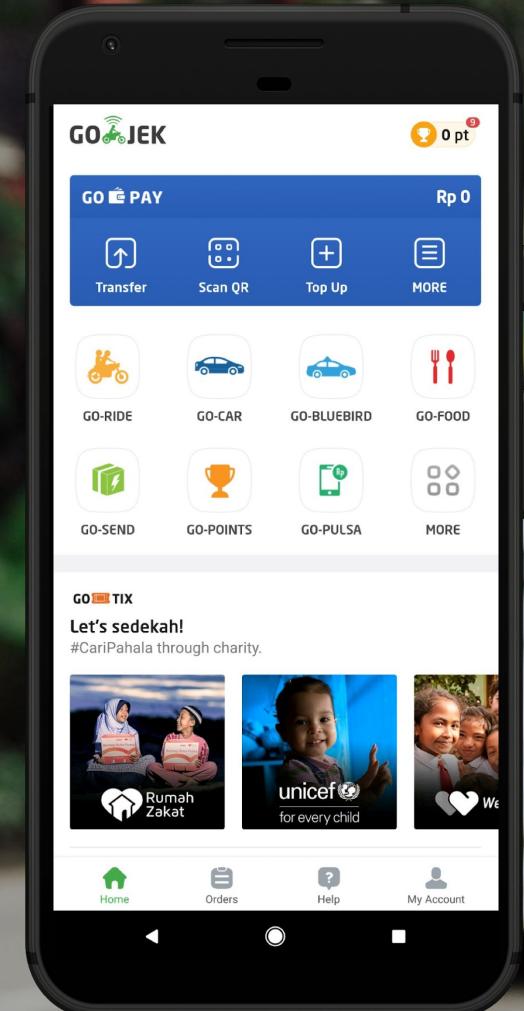
1. Kubernetes + Kubeflow is a really good platform for ML
2. Feast (Feature Store) + Kubeflow lets data scientists rapidly iterate on models



Agenda

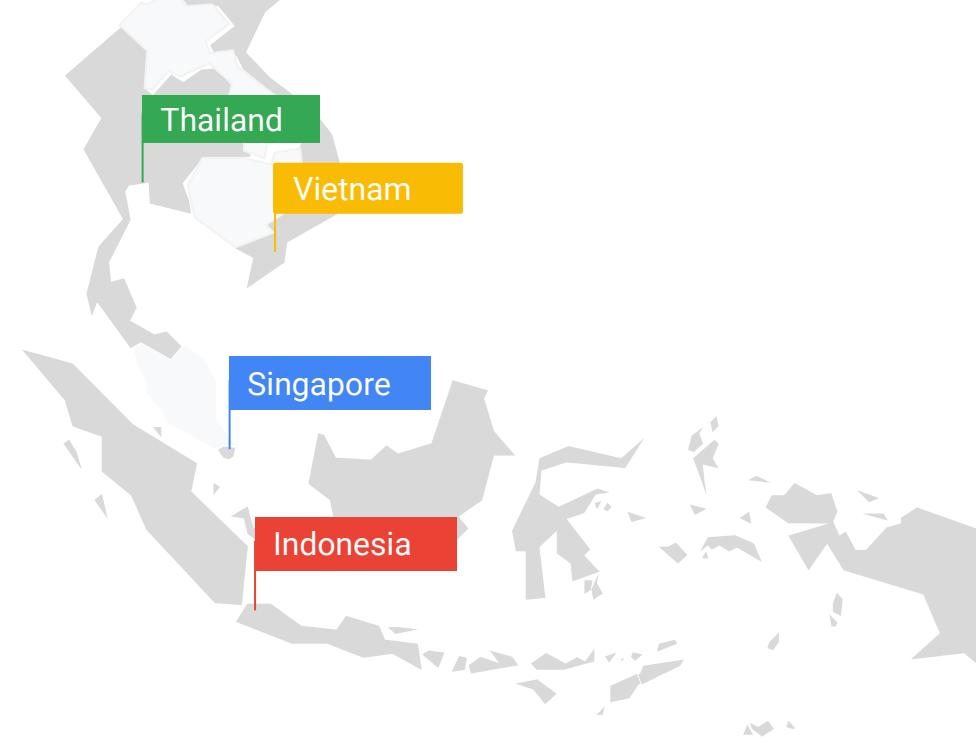
- How K8s and Kubeflow empower companies like GOJEK to build ML platforms
- Demo - Using Feast + Kubeflow to build & deploy from notebooks
- What is Kubeflow





Our scale

Operating in 4 countries throughout Southeast Asia



 125m+
app downloads

 +400k
merchants

 4
countries

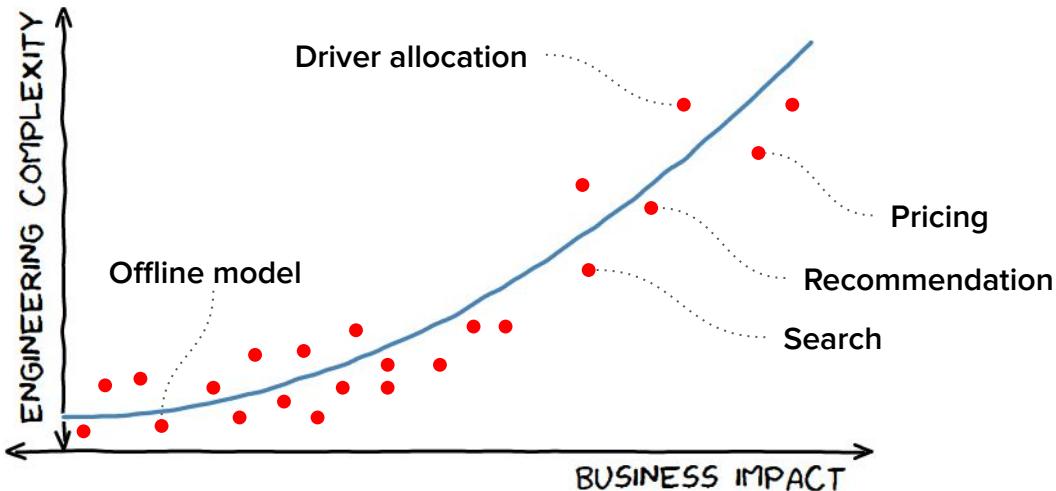
 2m+
drivers

 100m+
monthly bookings

Our Data



ML PROJECTS



Data science requirements

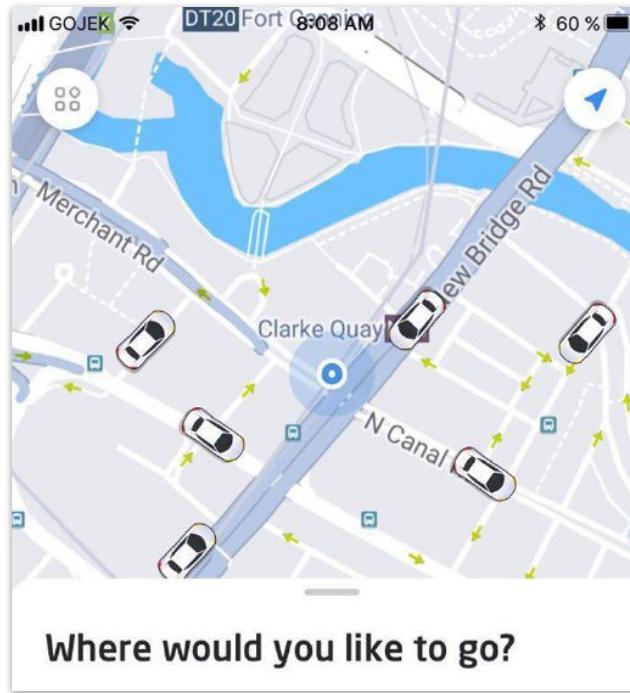
- High abstraction
- Rapid iteration and experimentation
- Customizable workflows

Engineering requirements

- Integrates with existing systems
(requires escape hatches)
- Able to operate at scale
- Easy to maintain and debug
- Easy to extend and build on

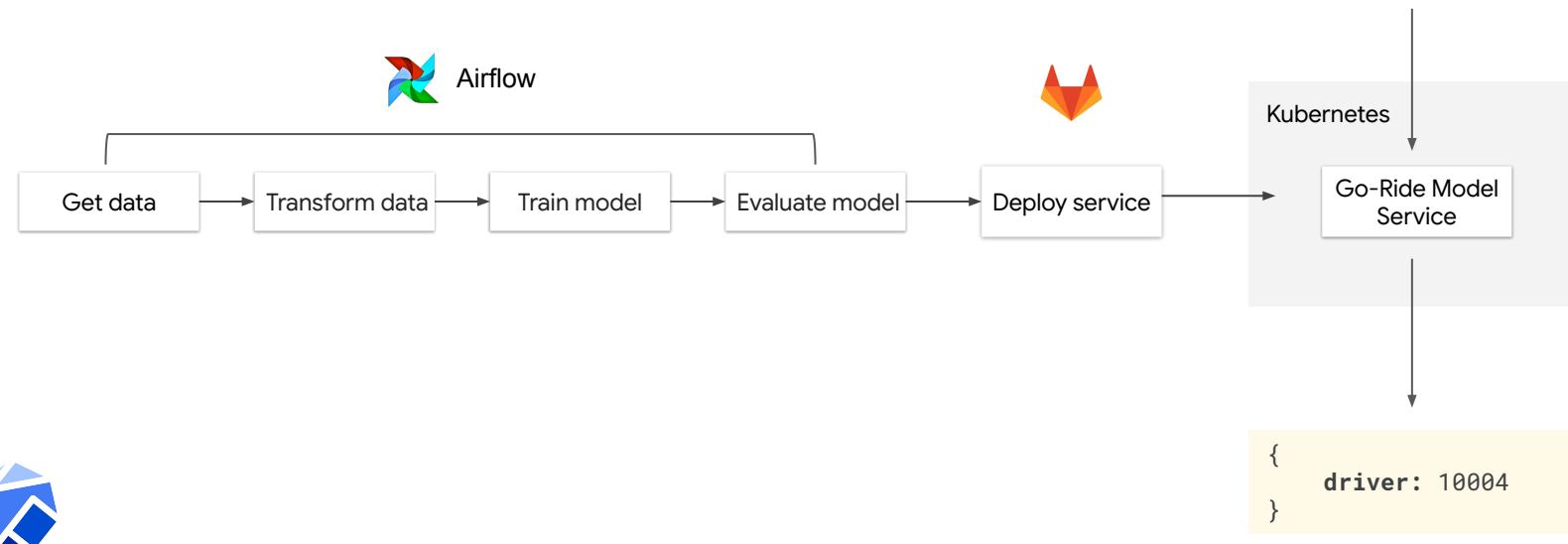


Finding the right driver



Let's use Kubernetes

- Dependency management
- Container orchestration
- Process isolation

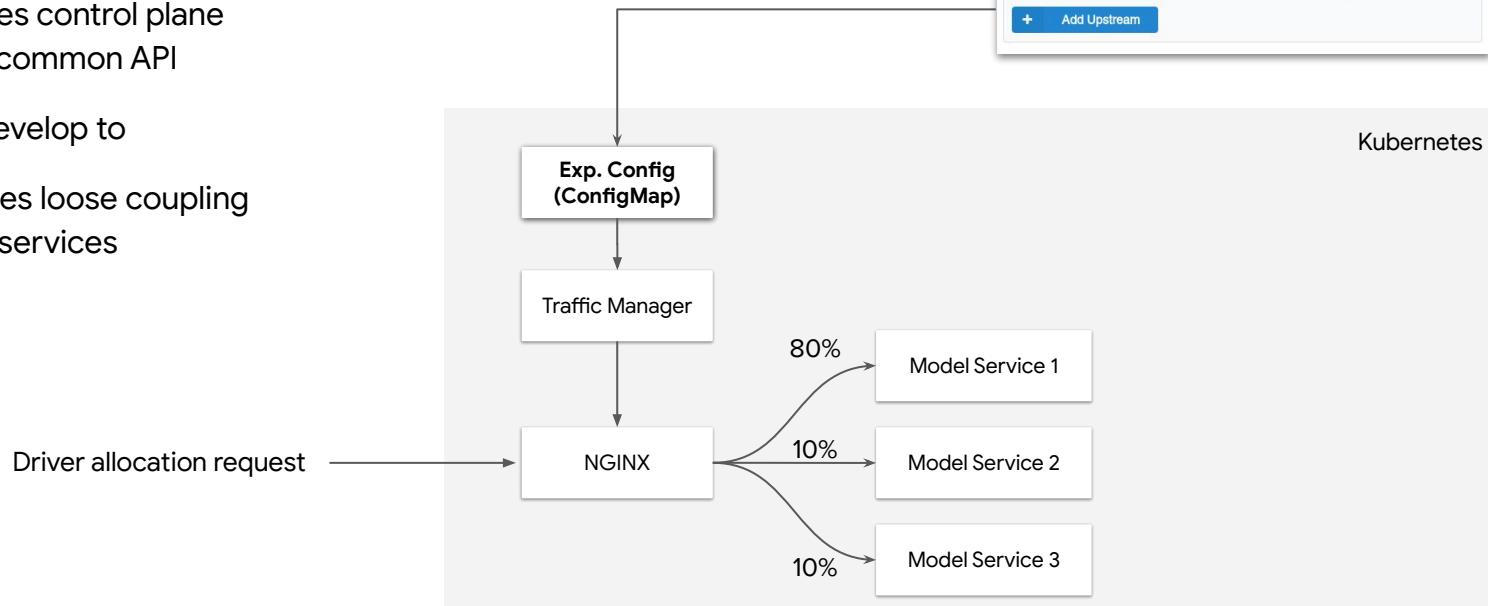


ML on K8s: Experimentation

- Experimentation manager required interface with ingress
- Kubernetes control plane provides common API
- Easy to develop to
- Encourages loose coupling between services

User configures experimental traffic

The screenshot shows a user interface for managing experimental traffic. At the top, there's a header with the path 'Path for ds-production :80' and a 'Path' input field containing '/v2/allocation/jaeger/control/'. Below this is a toggle switch labeled 'Enable Logging'. Under 'Traffic Split Config', a dropdown menu is set to 'round_robin'. There are 'Update' and 'Delete' buttons. A table lists a single entry: 'jaeger-control.allocation.svc.cluster.local' at port 80 with weight 1. A 'HOST' column header is present, and a 'HOST' row header is shown above the entry. A 'PORT' column header is also present. A 'HOST' row header is shown above the entry. A 'PORT' column header is also present. A 'WEIGHT' column header is also present. An 'UPDATED AT' column header is also present. A 'Add Upstream' button is located at the bottom left of the table area.



ML on K8s: Orchestration

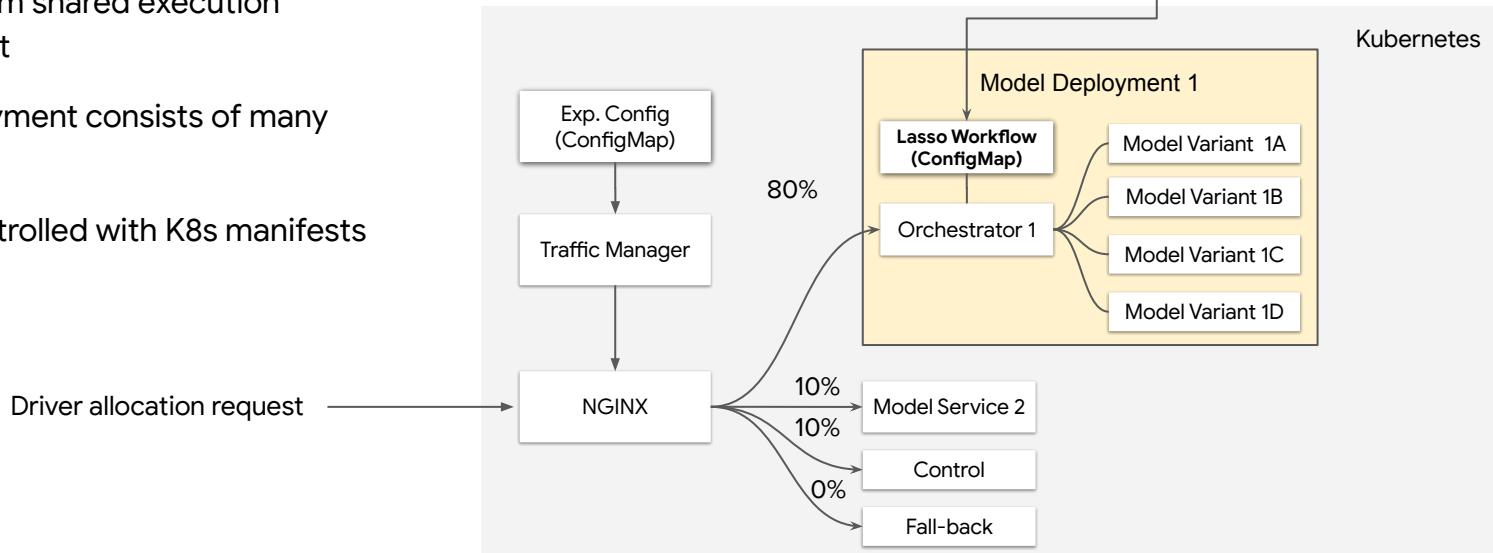
- Lasso orchestrates services through workflow configurations (see also Seldon)
- Benefits from shared execution environment
- Each deployment consists of many models
- Version controlled with K8s manifests

Lasso workflow
YAML

```
apiVersion: v1
name: ja[REDACTED]
endpoint: /ja[REDACTED]
timeout: 140

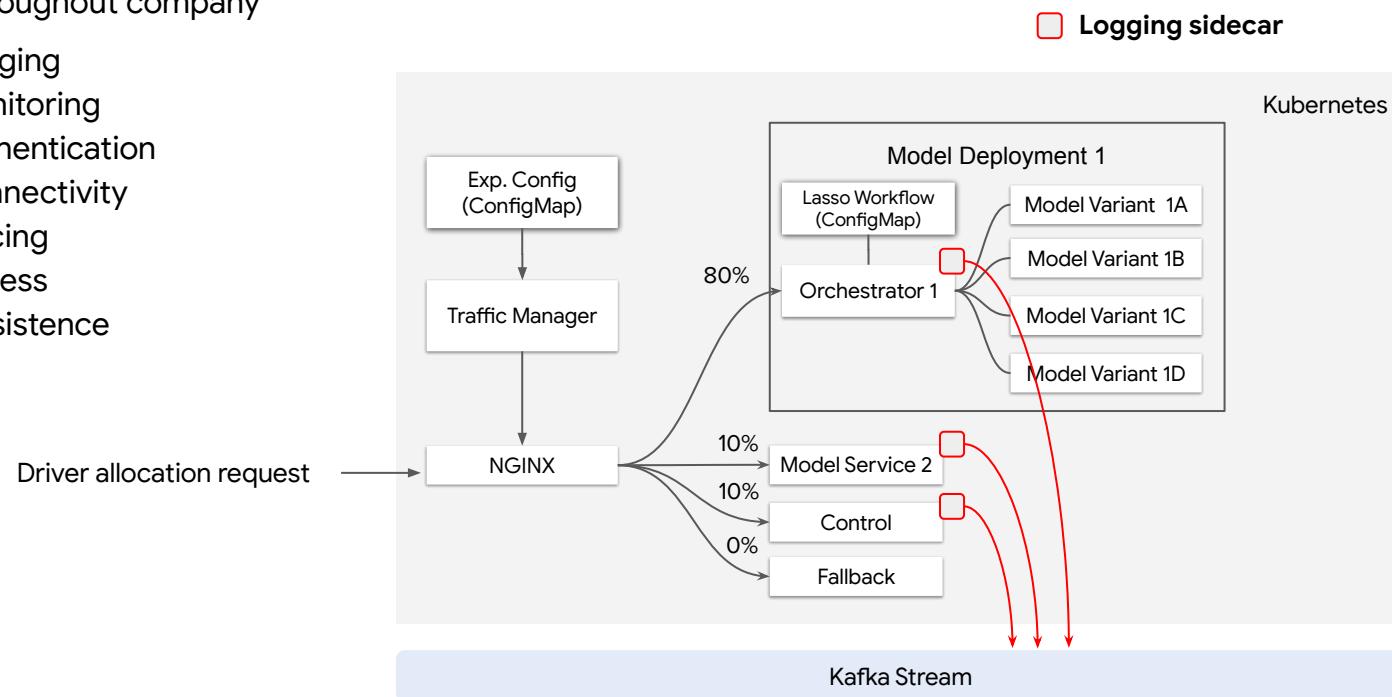
tasks:
  control:
    type: http
    inputs:
      address: http://ja[REDACTED]control.allocation.svc.cluster.local/predict
      timeout: 140
      retries: 0
      method: POST
      body: '{{ .request }}'
    output:
      path: response.body
      write: ignoreIfExists
```

Kubernetes



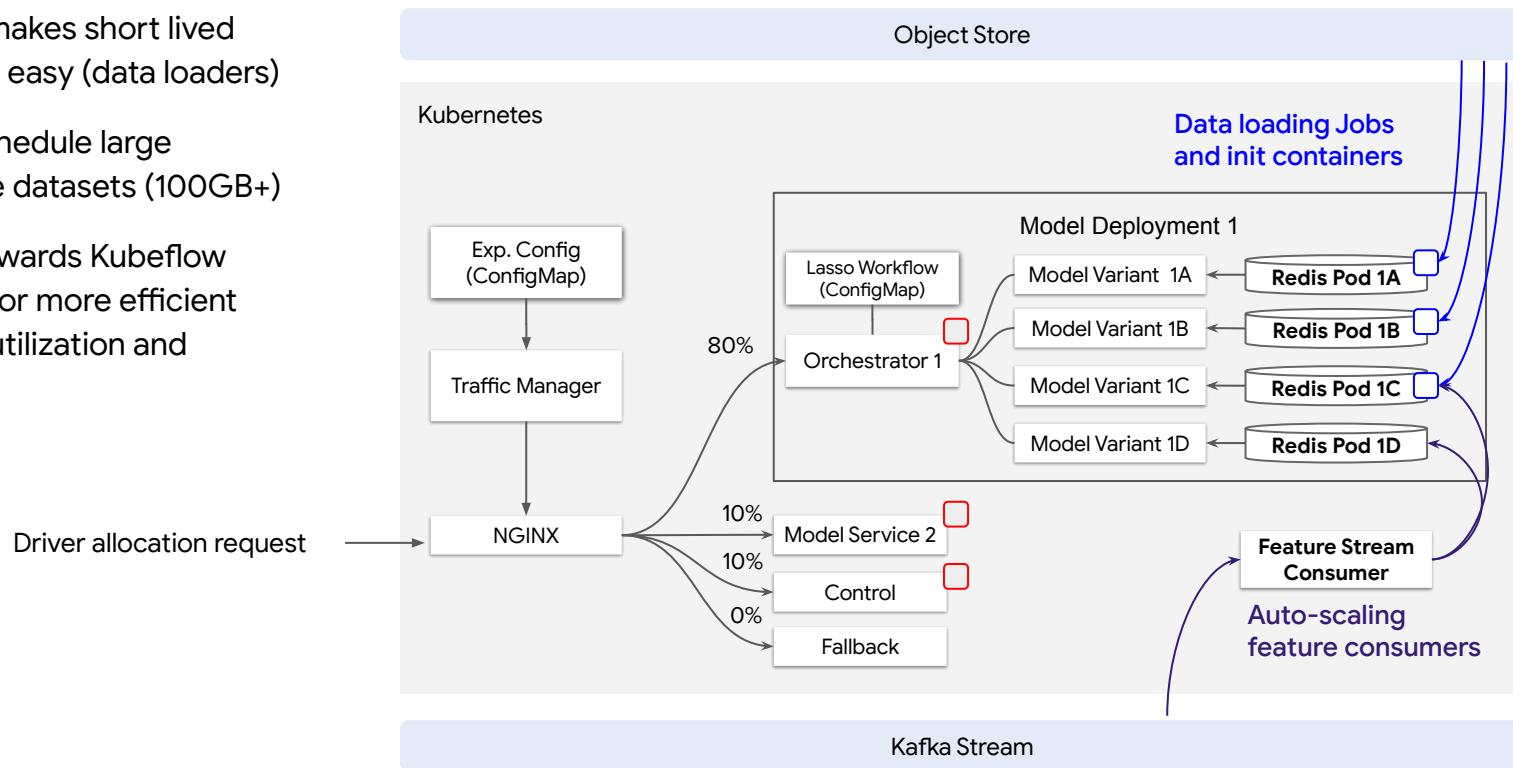
ML on K8s: Economies of scale

- Leverage components and tooling throughout company
 - Logging
 - Monitoring
 - Authentication
 - Connectivity
 - Tracing
 - Access
 - Persistence

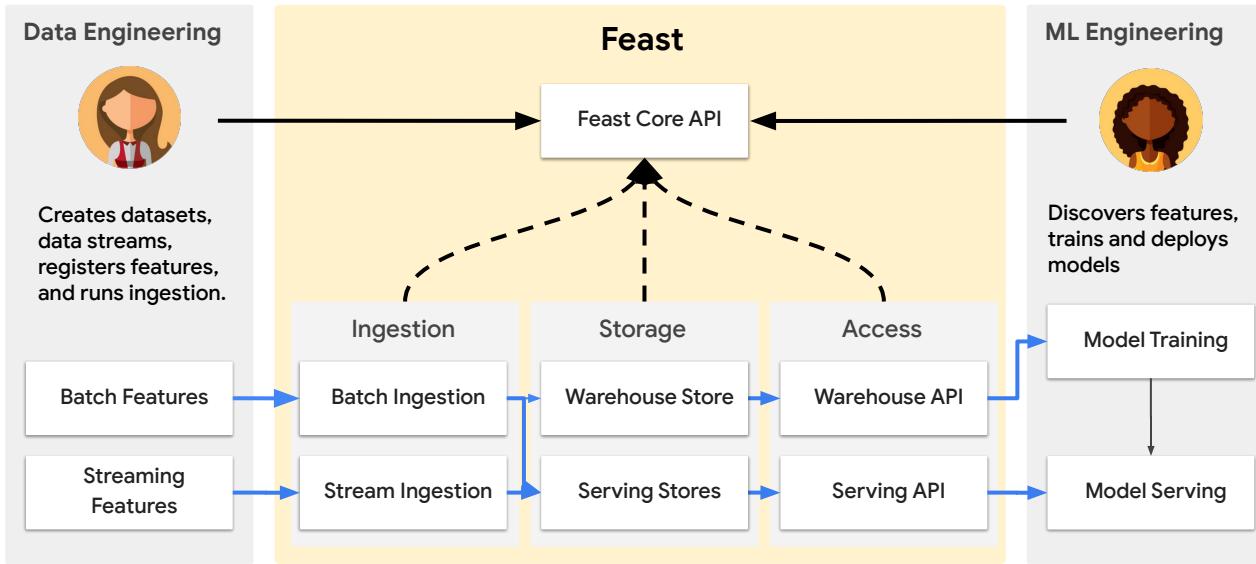


ML on K8s: Workloads

- Jobs API makes short lived processes easy (data loaders)
- Able to schedule large immutable datasets (100GB+)
- Moving towards Kubeflow Pipelines for more efficient resource utilization and tracking



ML on K8s: Feature Store (Feast)



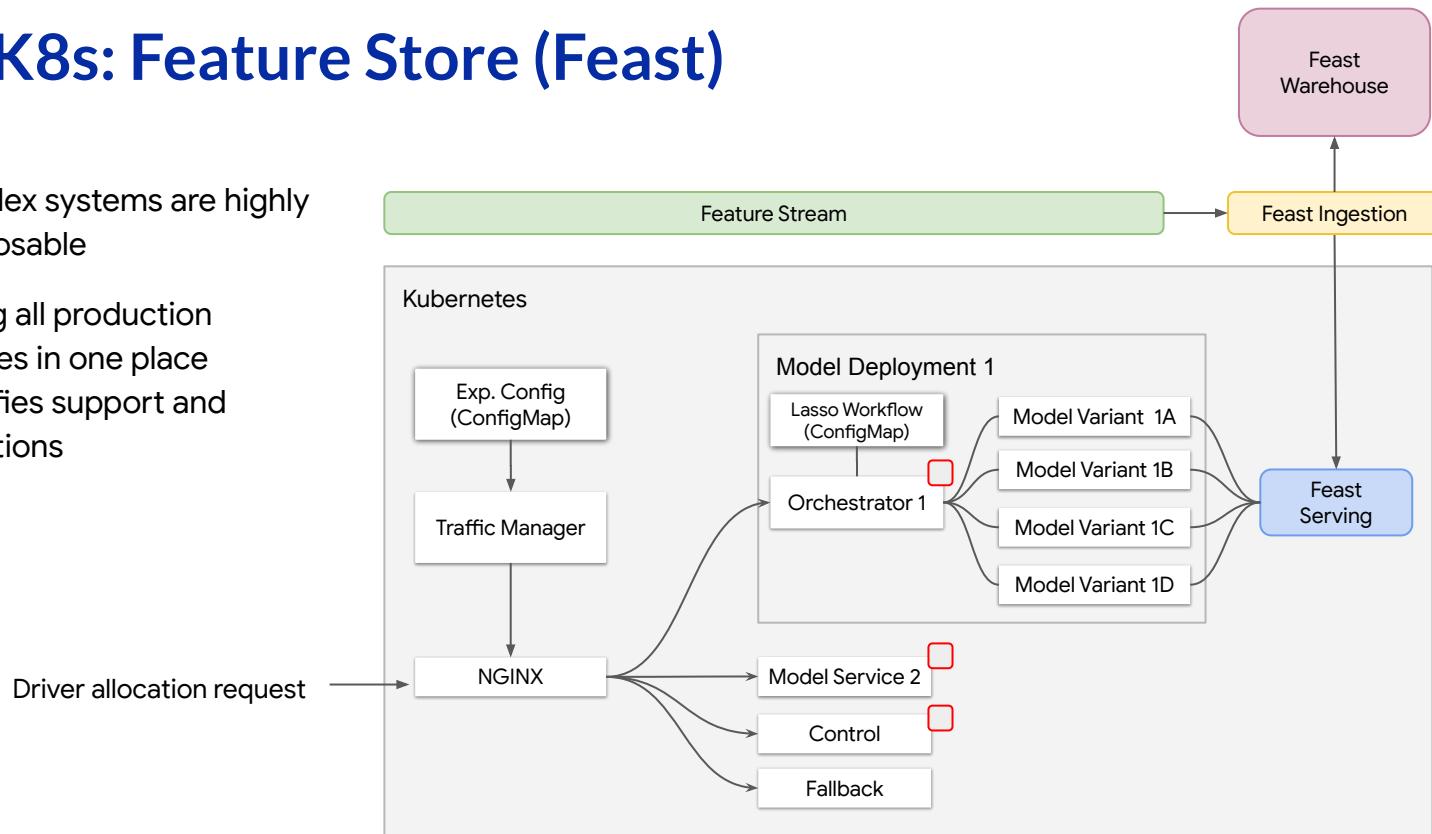
- Encourages feature discovery and reuse through centralization
- Prevents training-serving skew
- Provide scalable storage of feature data for serving and training



github.com/gojek/feast/

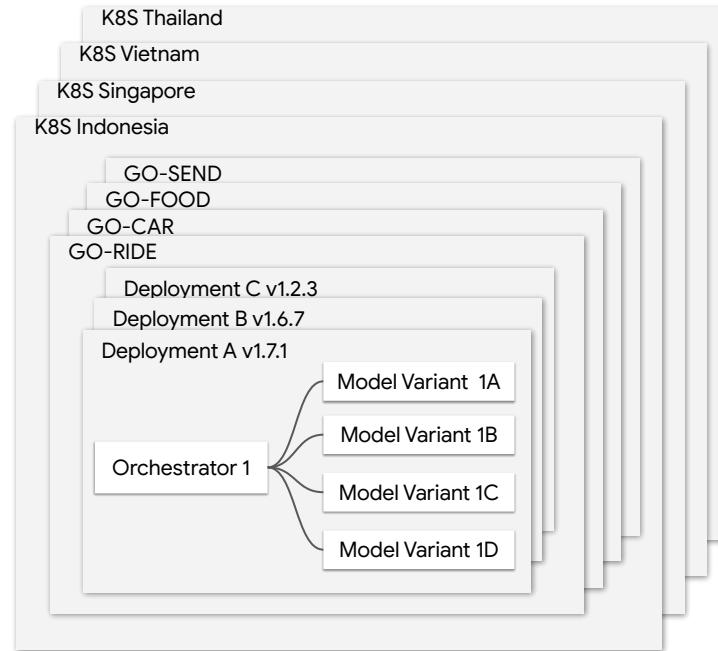
ML on K8s: Feature Store (Feast)

- Complex systems are highly composable
- Having all production services in one place simplifies support and operations



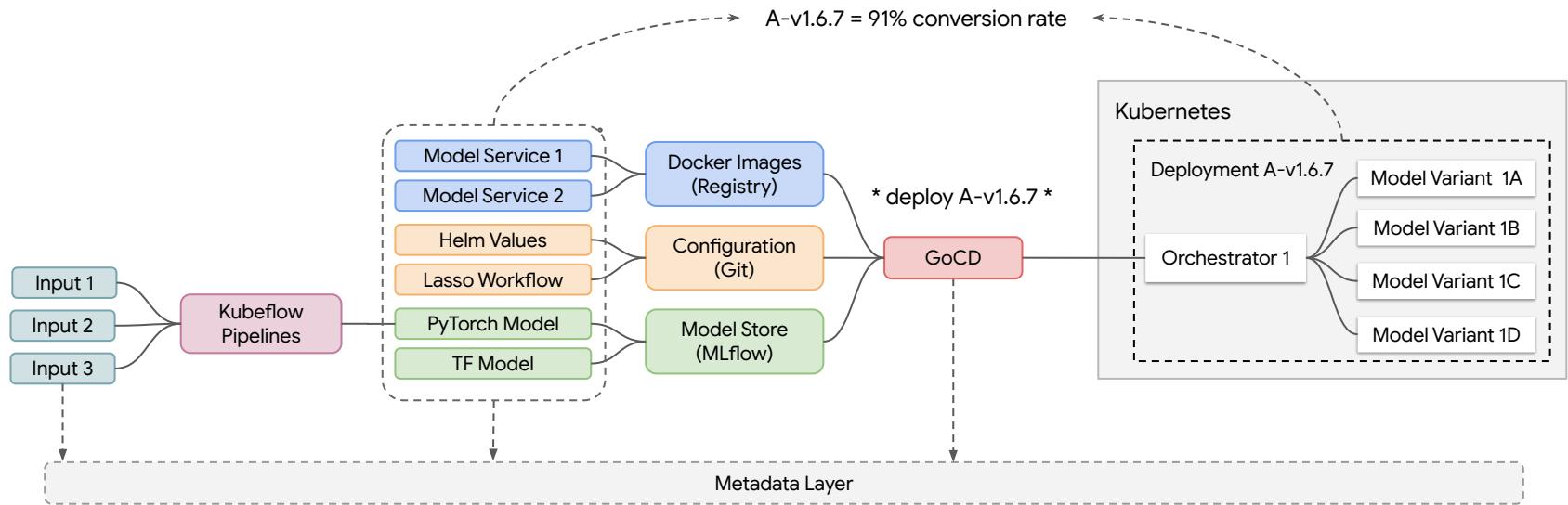
ML on K8s: Rapid expansion

- Scaling to new markets required very large service-to-engineer ratio
- GitOps approach allowed us to increase our leverage and expand to new markets
- Terraform for all infrastructure (even Helm deployments)
- CD for model deployments



ML on K8s + Kubeflow: Traceability

- Generalize & parameterize complete ML life cycle
- Track artifact combination as deployment version
- Measure version against experiment



ML on K8s: The good parts

- Large ecosystem of ML frameworks built on top of Kubernetes
- Consistent API simplifies developing complex systems
- Workloads benefit from intelligent scheduling, resource utilization, and dependency management.
- Single production environment simplifies operations
- GitOps allows for high leverage and portability
- Artifact based versioning and tracking allows for traceable experiments



ML on K8s: The rough parts

- Multi tenancy
- Stateful systems aren't there yet
- Leaky abstractions (CRDs / annotations exposed to users)



ML on K8s: What's next

- Simplify the end-to-end user experience
- Metadata tracking (Kubeflow)
- Istio integration





Kelsey Hightower @kelseyhightower



Kubernetes is a platform for building platforms. It's a better place to start; not the endgame.

10:04 PM · Nov 27, 2017

237 Retweets 676 Likes



**Kubeflow is an open,
Kubernetes native
platform for ML**



**Make it Easy for Everyone
to Develop, Deploy and Manage
Portable, Distributed ML
on Kubernetes**



Demo setup

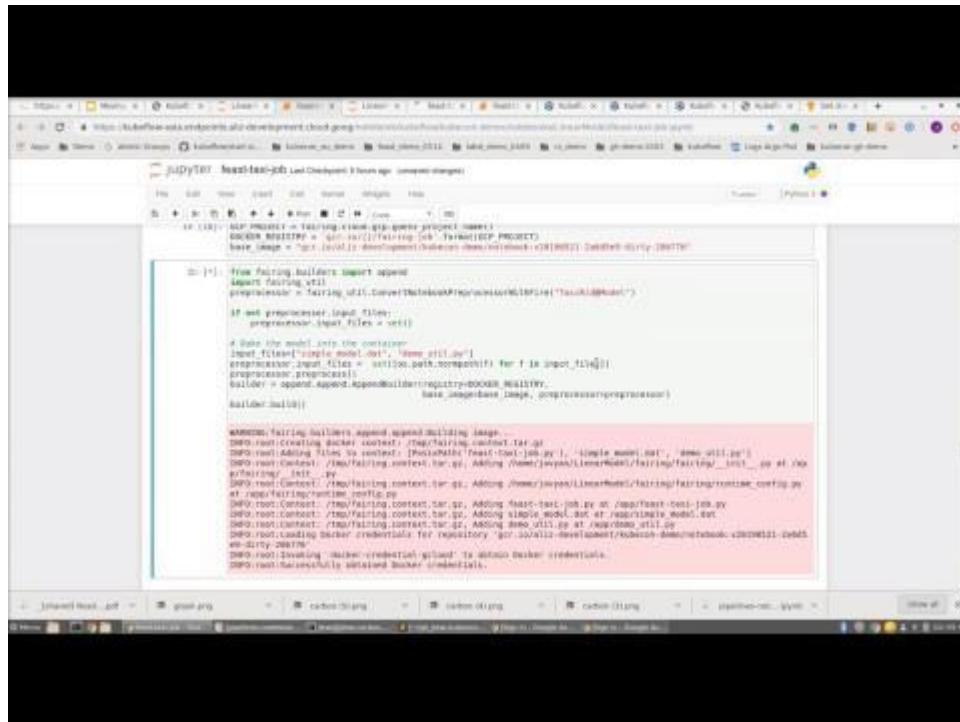


Using Feast and Kubeflow to build and deploy models

- Fetch data from feast for training
- Develop models in a notebook
- Deploy models on K8s
- Fetch data at serving time for inference



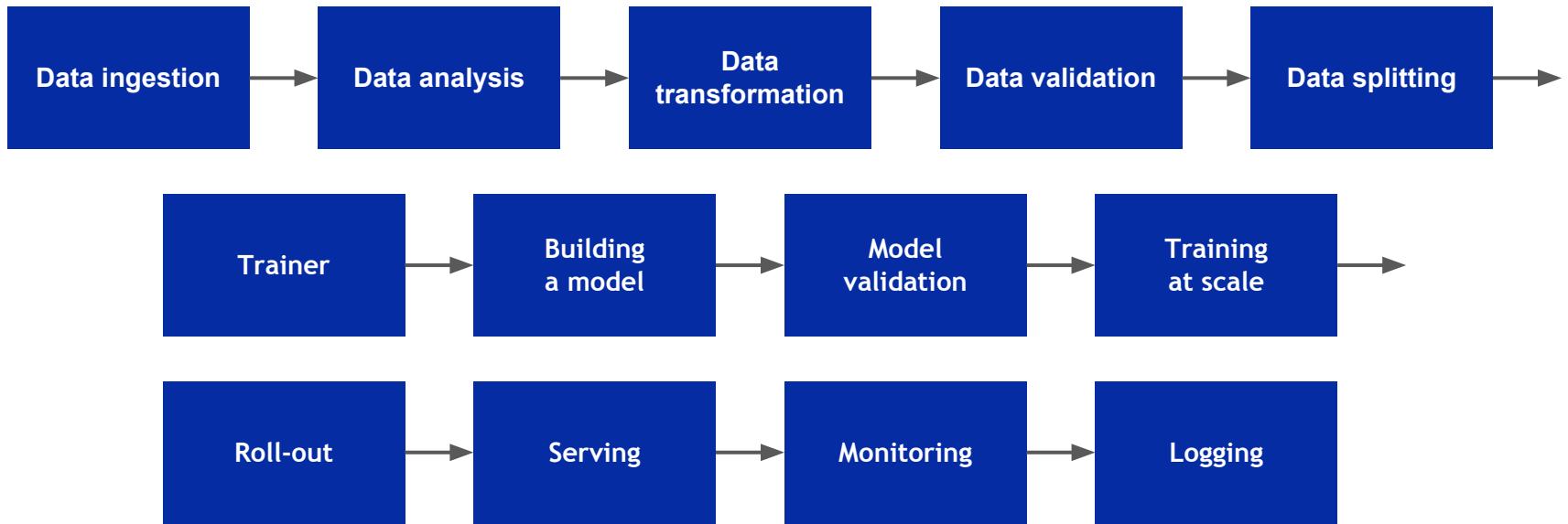
Video of Demo



Kubeflow



ML Development Workflow



**Kubeflow makes it easy to
run these steps on
Kubernetes**



Core Tenets

- Kubeflow makes it easy to run ML applications on Kubernetes
 - e.g. notebooks, HP tuning, pipelines, model servers, etc...
- **Composable** - Use the libraries/frameworks of your choice
- **Scalable** - number of users & workload size
- **Portable** - on prem, public cloud, local



Katib UI | Menu ▾

Create StudyJob

Study Name:

Owner:

OptimizationType:

Optimization Goal:

Objective Value Name:

Metrics (space separated):

Request Count:

Generated StudyJob YAML

```
apiVersion: kubeflow.org/v1alpha1
kind: StudyJob
metadata:
  name: job
spec:
  studyName: ''
  owner: ''
  optimizationType: ''
  objectiveValueName: ''
  optimizationGoal: 0
  metricNames: []
  parameterConfigs: []
  requestCount: 0
  suggestionConfig:
    suggestionAlgorithm: random
    requestNumber: 0
    suggestionParameters: []
  workerSpec:
    goTemplate:
      template: ''
    metricsCollectorSpec:
      goTemplate:
        templatePath: defaultMetricsCollectorTemplate.yaml
```

Pipelines

Pipelines

Filter pipelines

<input type="checkbox"/> Pipeline name	Description	Uploaded on
<input type="checkbox"/> [Sample] Basic - Condition	A pipeline shows how to use dsl.Condition. For source code, refer to https://github.com/kubeflow/pipelines/blob/main/samples/basic/dsl/condition.ipynb	4/8/2019, 5:26:04 AM
<input type="checkbox"/> [Sample] Basic - Exit Handler	A pipeline that downloads a message and print it out. Exit Handler will run at the end. For source code, refer to https://github.com/kubeflow/pipelines/blob/main/samples/basic/dsl/exit_handler.ipynb	4/8/2019, 5:26:02 AM
<input type="checkbox"/> [Sample] Basic - Immediate Value	A pipeline with parameter values hard coded. For source code, refer to https://github.com/kubeflow/pipelines/blob/main/samples/basic/dsl/immediate_value.ipynb	4/8/2019, 5:26:01 AM
<input type="checkbox"/> [Sample] Basic - Parallel Join	A pipeline that downloads two messages in parallel and print the concatenated result. For source code, refer to https://github.com/kubeflow/pipelines/blob/main/samples/basic/dsl/parallel_join.ipynb	4/8/2019, 5:26:00 AM
<input type="checkbox"/> [Sample] Basic - Sequential	A pipeline with two sequential steps. For source code, refer to https://github.com/kubeflow/pipelines/blob/main/samples/basic/dsl/sequential.ipynb	4/8/2019, 5:25:58 AM
<input type="checkbox"/> [Sample] ML - TFX - Taxi Tip Prediction	Example pipeline that does classification with model analysis based on a public taxi BigQuery dataset. For source code, refer to https://github.com/kubeflow/pipelines/blob/main/samples/ml/tfx/taxi_tips.ipynb	4/8/2019, 5:25:57 AM
<input type="checkbox"/> [Sample] ML - XGBoost - Training with Keras	A trainer that does end-to-end distributed training for XGBoost models. For source code, refer to https://github.com/kubeflow/pipelines/blob/main/samples/ml/xgboost/training_with_keras.ipynb	4/8/2019, 5:25:56 AM

Rows per page: 10

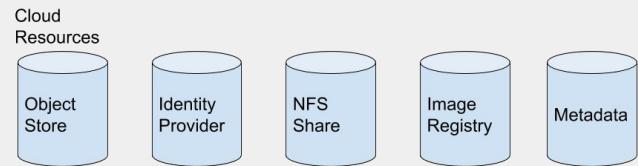
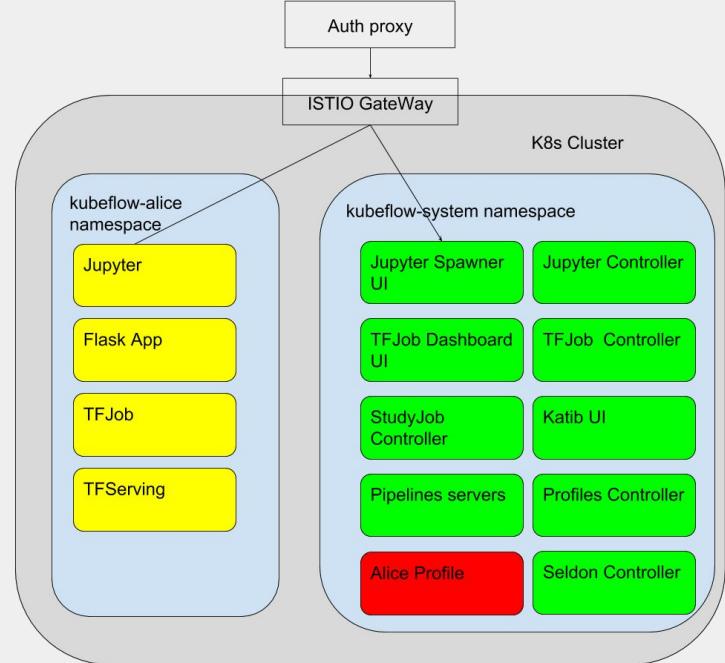
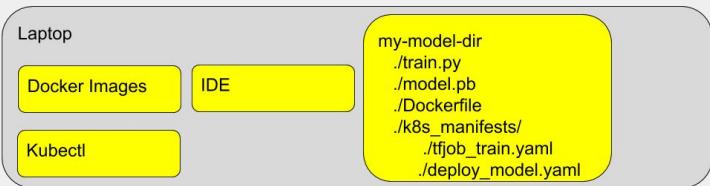
Build commit: c938247

Kubeflow Architecture



System Diagram

- Kubeflow is a collection of microservices
 - Will use ISTIO for service mesh in 0.6
- Users/teams consume Kubeflow in their own namespace



OSS Momentum!



New PRs Last 28 Days



Unique PR Authors Last 28 Days



Goal: low bar; high ceiling

- Day 0 focus on model development
 - Use UIs to launch notebooks
 - Python SDK (fairing) for training / deploying models
- Day 0 start with the infrastructure (Kubernetes, ISTIO, etc...) that you can ride into production
- Day N leverage K8s to scale
 - Use the same infrastructure as non-ML applications
 - Build a single infrastructure team

The screenshot shows the Kubeflow UI interface. At the top, there's a navigation bar with the Kubeflow logo and a 'Namespace' dropdown set to 'kubeflow'. Below it, a search bar is set to 'Select Namespace kubeflow'. The main area is titled 'Notebook Servers' and contains a table with columns: Status, Name, Created, Image, CPU, Memory, Volumes, and Actions. One row is visible, showing a green checkmark icon, the name 'jlew1', '1 day ago', 'tensorflow-1.13.1-notebook-cpu', 32 CPU, 32Gi Memory, and a 'CONNECT' button. A modal dialog titled 'New Notebook Server' is open, prompting for 'Name' (set to 'notebook'), 'Image' (set to 'Standard'), 'CPU' (set to '0.5'), 'Memory' (set to '1.0Gi'), 'Workspace Volume' (set to 'notebook-workspace'), 'Data Volumes' (empty), and 'Extra Resources' (empty). Buttons at the bottom of the dialog are 'SAVE' and 'CANCEL'.



Call To Action

- Install Kubeflow - <https://www.kubeflow.org/docs/started/>
- Install Feast - <https://github.com/gojek/feast/blob/master/docs/install.md>
- Try Fairing + Feast:
 - <https://github.com/gabrielwen/LinearModel>



Kubeflow Talks ([bit.ly/kf calendar](https://bit.ly/kf_calendar))

- **Tutorial Introduction to Pipelines** - Tuesday May 21 14:00-15:25; Michelle Casbon, Dan Sanche, Dan Anghel & Michal Zylinski Google (<https://sched.co/MPgr>)
- **Kubeflow BOF** - Tuesday May 21 15:55-16:30; David Aronchick, Microsoft & Yaron Haviv, Iguazio (<https://sched.co/PiUF>)
- **Toward Kubeflow 1.0, Bringing a Cloud Native Platform for ML to Kubernetes** - Wednesday May 22 11:55 - 12:30; David Aronchick, Microsoft & Jeremy Lewi Google (<https://sched.co/MPax>)
- **Building Cross-Cloud ML Pipelines with Kubeflow with Spark & TensorFlow** - Wednesday May 22 14:00 - 14:35; Holden Karau, Google & Trevor Grant, IBM (<https://sched.co/MPaZ>)
- **Managing Machine Learning Pipelines In Production with Kubeflow with Devops** - Wednesday May 22 14:40-14:35 - David Aronchick, Microsoft (<https://sched.co/MPaZ>)
- **Large Scale Distributed Deep Learning with Kubernetes Operators** - Wed May 22 15:55 - 16:30; Yuan Tang, Ant Financial & Yong Tang MobileIron (<https://sched.co/MPaT>)
- **Moving People and Products with Machine Learning on Kubeflow** - Thursday May 23 14:00 -14:35; Jeremy Lewi, Google & Willem Pienaar, GO-JEK (<https://sched.co/MPac>)





Kubeflow

Thank You

www.kubeflow.org

github.com/gojek/feast

github.com/gabrielwen/LinearModel

