Flyte

Open Source Cloud Native Machine Learning and Data Processing Platform

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Agenda

Motivation

What motivated us to build Flyte?

Goals

Desirable properties of an ideal production ML system

Introducing Flyte

Principle offering & architecture

Demo

Everyone loves demos!

Conclusion

Learn more, get involved, & get started

Motivation

Developing large-scale, complex ML & Data pipelines is hard.

The overhead of **infrastructure** and **difficulty collaborating** adds significant friction.

Motivation

Data and machine learning are **converging**.

There is increasing need for a **single tool** for both.

lyft

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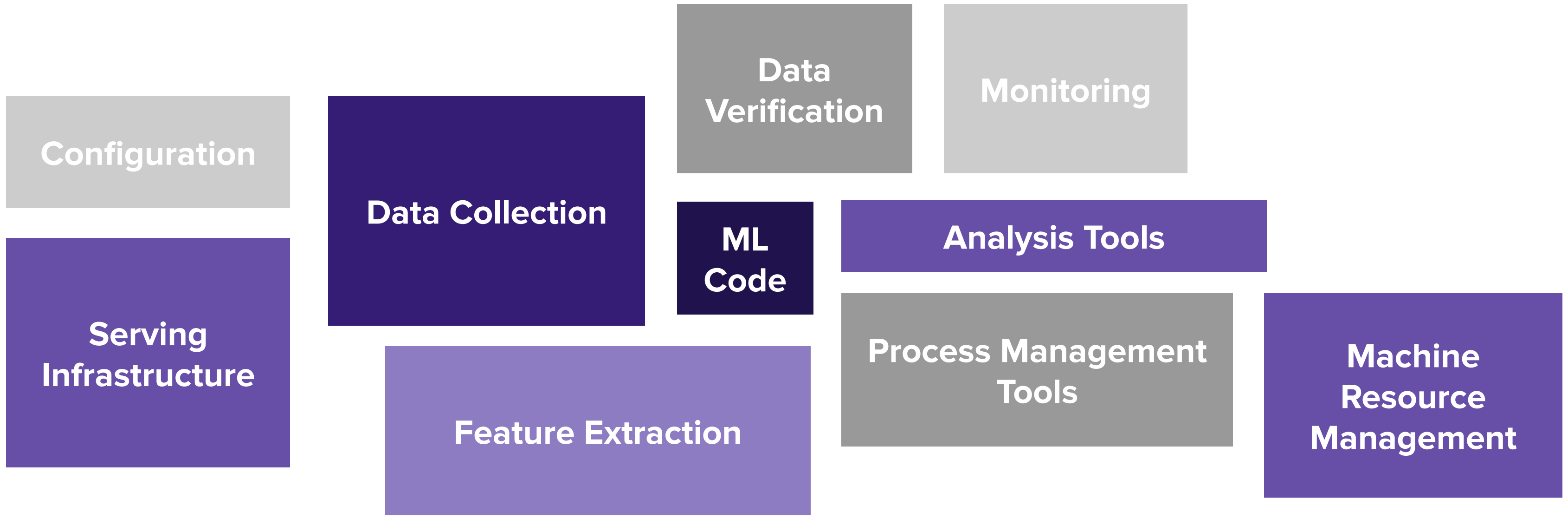
Motivation

ML is more than just the model

Motivation

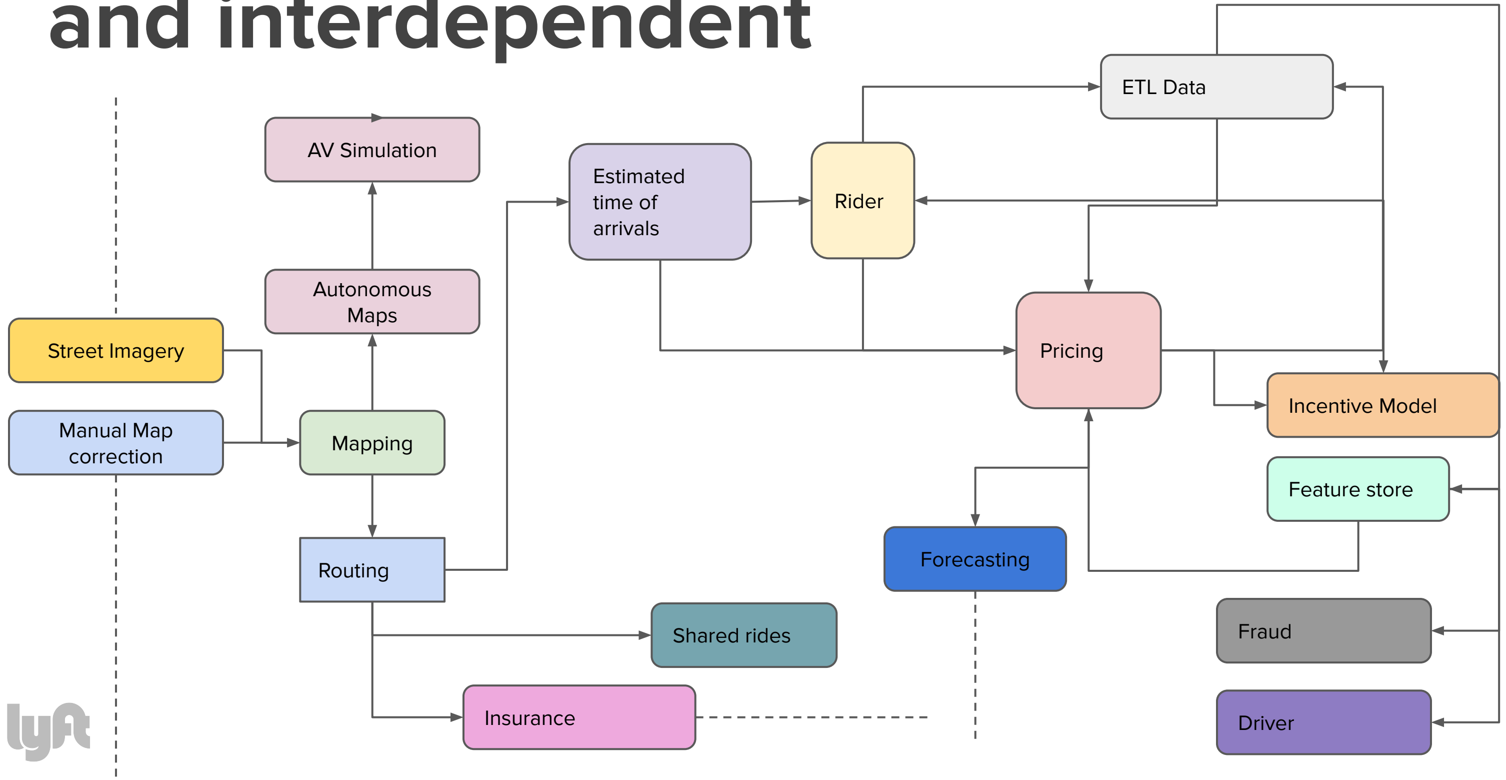
Data & infrastructure are big hurdles



Source: Sculley et al: Hidden Technical Debt in Machine Learning Systems

Motivation

ML & Data services are increasingly complex and interdependent



3500+ Unique Workflows

300k+ Workflow executions per month

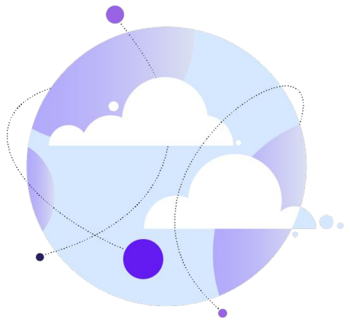
1 million+ task executions per month

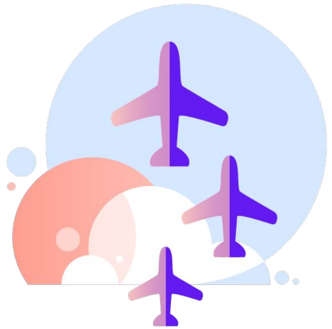
10 million+ containers executed per month

Flyte

Goals

Flyte wants to make it easy to





Orchestrate ML & Data Workflows

Collaborate, Reuse, and perform ML Ops Across Teams

Introducing Flyte

Hosted, scalable and serverless Orchestration Platform

Fabric that connects disparate compute technologies

Extensible and Observable

Integrates best of the breed open source solutions

Auditable and Secure

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Tasks

Atomic unit of work & entrypoint to user code

- Explicitly **versioned**
- Strongly typed **Interface**
- ***Arbitrarily complex***: can be single process, multi-process, distributed or remote executions
- **Extensible**
- **Declarative** Specified in *Protocol Buffers*

```
@inputs(rides=Types.Schema[...], k=Types.Integer)
@outputs(dest=[Types.String])
@spark_task(spark_conf={...})
def find_topk_destinations(ctx, spark_ctx, rides,
k, dest):
  '''
  Find the top k destinations for the given set
of rides ordered by frequency
  '''
```

```
run_shell_sort = ContainerTask(metadata=..,
   interface={inputs:{file:.}, outputs:{.}},
   container=Container(
   image=...,
   command=["/bin/sort", "-n"],
   args=["{{.inputs.file}}"],
   resources=Resources(req,limit),
   env={}, config={}))
```

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Workflows

Specify the data dependency between tasks (as DAGs)

- Strongly typed **Interface**
- **Composable** & **Dynamic** Workflows can be extended by composition of other workflows statically or dynamically
- **Versioned** @Lyft by git commits
- **Declarative** Specified in *Protocol Buffers*

Decoupled **Scheduling,** scheduler triggers executions at a scheduled time passing the time as input

ML Model Train example

```
@workflow_class
class TrainModel(object):
 # Accept inputs
 data = Input(Types.Schema[...])
 hyperparam = Input(Types.Float)
 # Split the dataset
 split = split8020(data=data)
 # Fit the model
 model = fit_xgboost(
             data=split.train,
             hyperparam=hyperparam)
 # Evaluate the model
 pred = eval_xgboost(data=split.val,
             m=model.outputs.v)
 # Compute the metrics
 metrics = compute_metrics(
             data=split.val,
             pred=pred.y_pred)
 # Create outputs
 model = Output(model.outputs.v)
 accuracy = Output(metrics.outputs.acc)
```

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Serverless for users

User should only worry about business logic

- They only specify **resource requirements** like CPU, GPU, memory, number of spark executors etc
- They can work on **multiple versions of code**
- Their code is containerized
- **Multi-tenancy** They do not worry about other users
- ***Resource pooling and Quota*** Downstream resource are protected from Brown-outs
- All of Flyte’s power is available using a simple **gRPC/REST** interface
- They can use multiple languages, with first class support for **Python - Flytekit**

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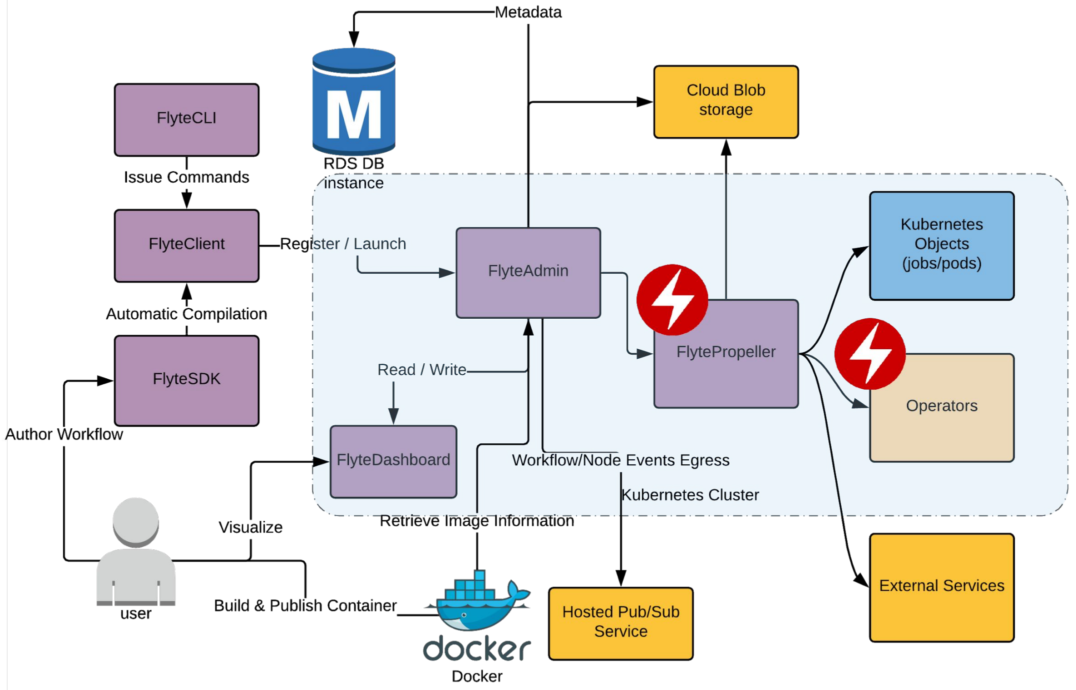
Architecture Overview

Default: Single Kubernetes cluster with scale-out options to cloud services like AWS Batch.



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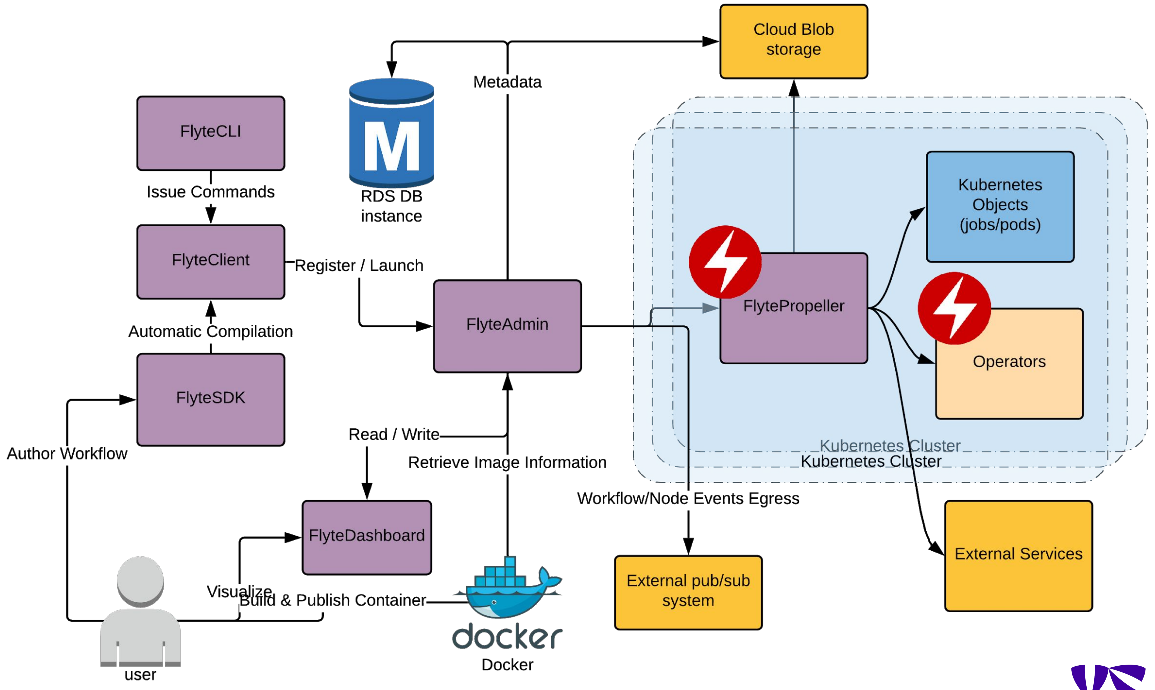
Architecture Overview @Lyft MultiCluster

@Lyft: we use **multiple Kubernetes clusters** to isolate multiple failure domains and scale-out.

FlyteAdmin **supports** this mode **out of the box**.



Grouping & Sharing

Projects, Domains & Versions

- Projects offer **logical grouping** of Workflows & Tasks and can be split across one or more repositories, one or more containers
- Domains and Versions provide **CI/CD like semantics** to Workflows & Tasks
  - Users can **push new** versions to production, **rollback** to previous version etc.
  - Users can have workflows in **integration/staging** env
- Domains are **configured globally** for the system (by administrators)

Sharing & Accounting

- Workflows can **refer to tasks and workflows** from other projects
- Executions **accounted/billed** under the **requesters project & domain (*Infraspend*)**

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Shareability: Flytekit Example

Project: ProjectA

```
@workflow_class
class PipelineA(object):
   in1 = Input(Types.Integer)
   in2 = Input(Types.Integer)
   …
   out1 = Output(print2.outputs.out)
```

Project: ProjectA

```
@inputs(x=Types.Integer, y=Types.Integer)
@outputs(z=Types.Integer)
@task
def my_model(x, y):
   ….
```

Project: ProjectB

```
@workflow_class
class CompositePipeline(object):

  composed_wf = lps.fetch(
                "ProjectA",
                "Production",
                "PipelineA",
                "1.0.2"
                )(in1, in2)

  t1 = local_task(composed_wf.outputs.out)

  t2 = tasks.fetch(
                  "ProjectA",
                  "Production",
                  "my_model",
                  "2.0.0"
                  )(x=t1.outputs.x, y=10)
```

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Data Catalog: Lineage & Memoization

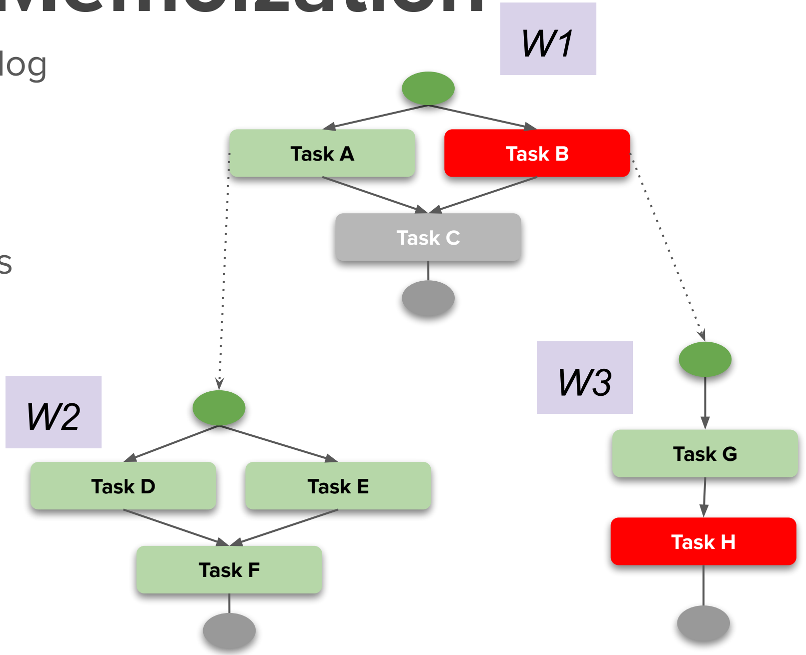
Every task execution in Flyte is **recorded** by default in Catalog Service. This enables Flyte executions to have,

Artifact Lineage

- **Causal** dependencies between data and processes is tracked

Memoization

- Each task execution has a **unique signature**, which includes the input values & version of code
- **Repeated** executions with matching signatures are cached



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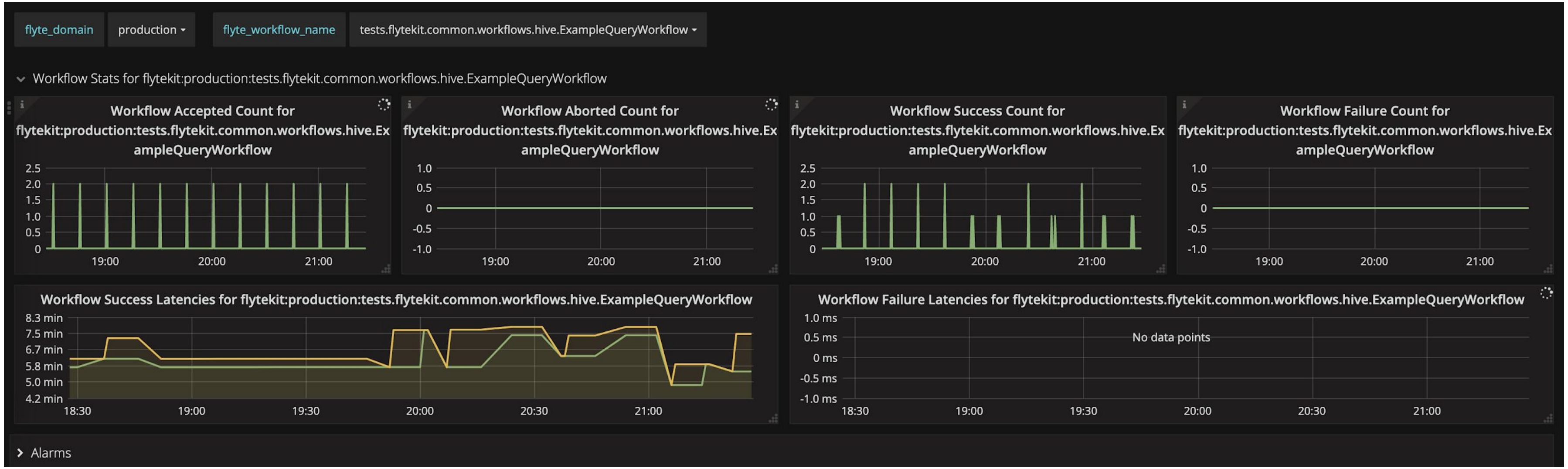
Observability for the User

Extensive **user** visibility (per workflow, per project etc) - **e.g grafana macro @ Lyft**


flyte_domain
production
flyte_workflow_name
tests.flytekit.common.workflows.hive.ExampleQueryWorkflow
Workflow Stats for flytekit:production:tests.flytekit.common.workflows.hive.ExampleQueryWorkflow
Workflow Accepted Count for flytekit:production:tests.flytekit.common.workflows.hive.ExampleQueryWorkflow
Workflow Aborted Count for flytekit:production:tests.flytekit.common.workflows.hive.ExampleQueryWorkflow
Workflow Success Count for flytekit:production:tests.flytekit.common.workflows.hive.ExampleQueryWorkflow
Workflow Failure Count for flytekit:production:tests.flytekit.common.workflows.hive.ExampleQueryWorkflow
Workflow Success Latencies for flytekit:production:tests.flytekit.common.workflows.hive.ExampleQueryWorkflow
8.3 min
7.5 min
6.7 min
5.8 min
5.0 min
4.2 min
Workflow Failure Latencies for flytekit:production:tests.flytekit.common.workflows.hive.ExampleQueryWorkflow
No data points
18:30
19:00
19:30
20:00
20:30
21:00
Alarms

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Designed for ease of operations

Alerting and notifications
Customizable notifications, with existing integrations - **pagerduty**, **slack** and **email**
Coming soon **Subscribable notifications** for Workflows & node state transitions

Security
Per execution access controls using ServiceAccounts, IAM Roles
Oauth2 auth flow

Ofcourse we have Deep **platform** level visibility for Admins

Introducing Flyte

Extensible: Container-Only Flytekit Plugins

What: Flytekit offers easy extensibility, takes care of the boilerplate and provides tooling for development, testing, and deployment.

How: These plugins are executed in containers. Find @flytekit/contrib

Why: Useful in rapidly extending capabilities of Flyte

```
@sensor_task
def my_test_task(ctx):
  '''
  E.g. sensor that waits for a hive partition
  to land. This is added as a contrib.
  '''
  return MyHivePartitionSensor()
```

```
task = xgboost_hpo_task(
        static_hyperparameters={
            "eval_metric": "auc",
            "objective": "binary:logistic",
         },
        train=train_data,
        validation=validation_data,
    )
```

Extensible: Notebooks and Papermill

What: Flytekit makes it possible to author any task type (Spark, Hive, Python, etc.) from a Python notebook with a full set of input/outputs. Papermill notebooks can be run for any kernel with primitive inputs/outputs.

How: Flytekit provides wrappings to enter notebook environments and marshall I/O

Why: It provides an easy path from development to production with excellent debuggability.

```
task = notebook_task(
    "notebooks/train_model.ipynb",
    "inputs": {
        "train": Types.Schema(
            [("label", Types.Integer), ...]
        ),
        "validation": Types.Schema(
            [("label", Types.Integer), ...]
        ),
    },
    "outputs": {"model": Types.Blob}
)
```

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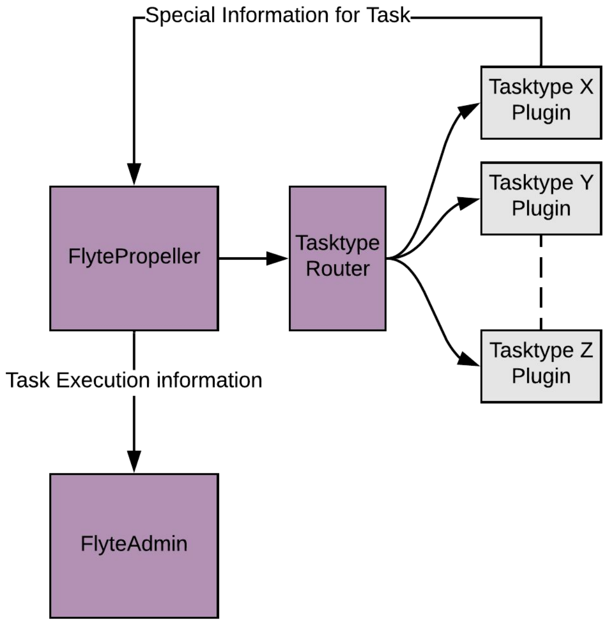
Extensible: Backend Plugins

What: Flyte backend is extensible. This provides deep integration into Flyte.

How: A Simple Golang interface available under FlytePlugins (pluginmachinery)

Why: This is great for adding tasks that need

- Special visualization
- Custom logging and other information
- Guaranteed cleanup of resources
- Perfect for managing CRD's



Demo

DAG Creation
Use Flytekit to create tasks & workflows

Registration
Register tasks, workflows & launch plans

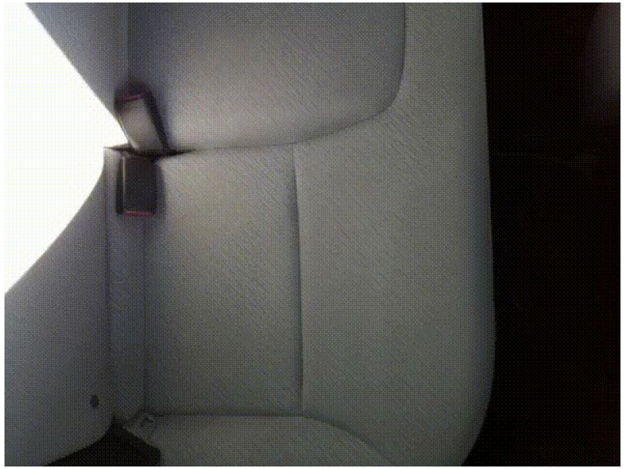
Flyte UI
Visualize, launch, & monitor Flyte workflows

Sharing Tasks & Workflows
How Flyte enables collaboration

Data Catalog & Memoization
How to increase efficiency & decrease costs with Flyte DataCatalog

Docs
Where to go to learn, get started, & do more with Flyte
Flyte.org

Demo

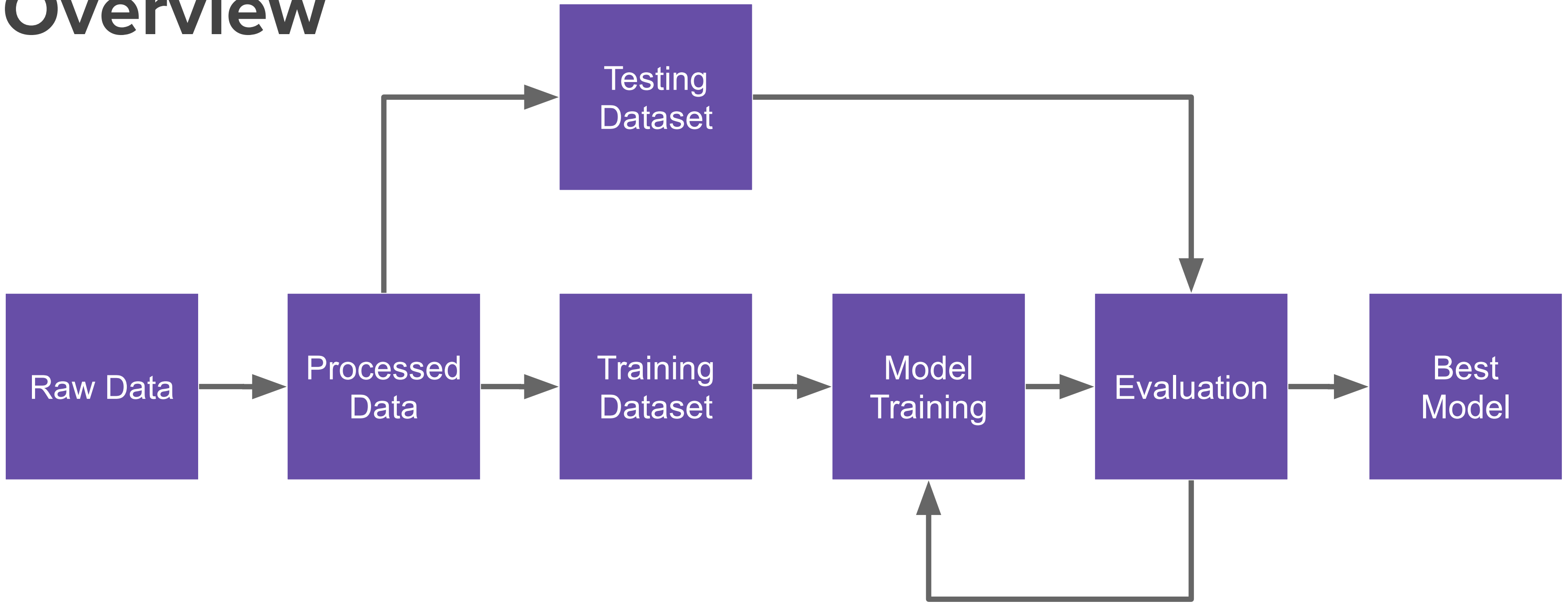


Clean

Dirty

Demo

Overview



Demo

Recap

- **Protobuf-based** language specification.
- Task and workflow interfaces are **strongly typed**.
- Tasks and workflows are **shareable** & **discoverable**.
- Workflows are **composable**.
- Task outputs can be **cached** to speed up re-execution.
- Executions are **repeatable**.

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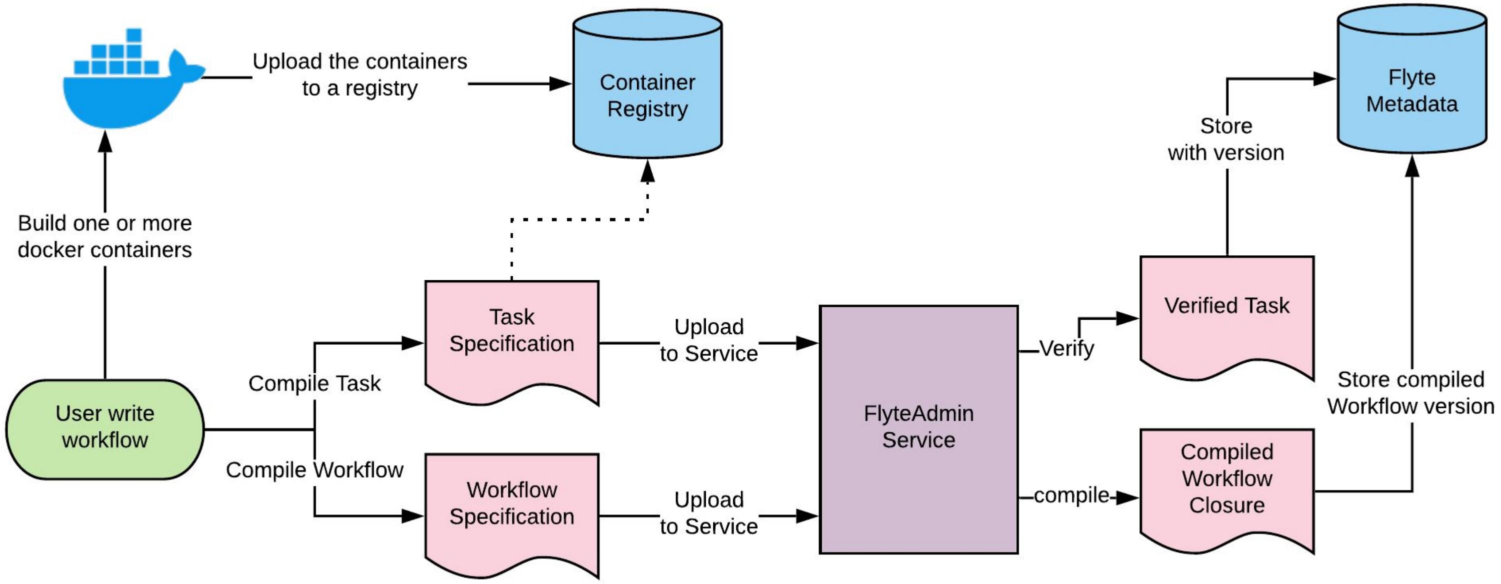
Registration Process



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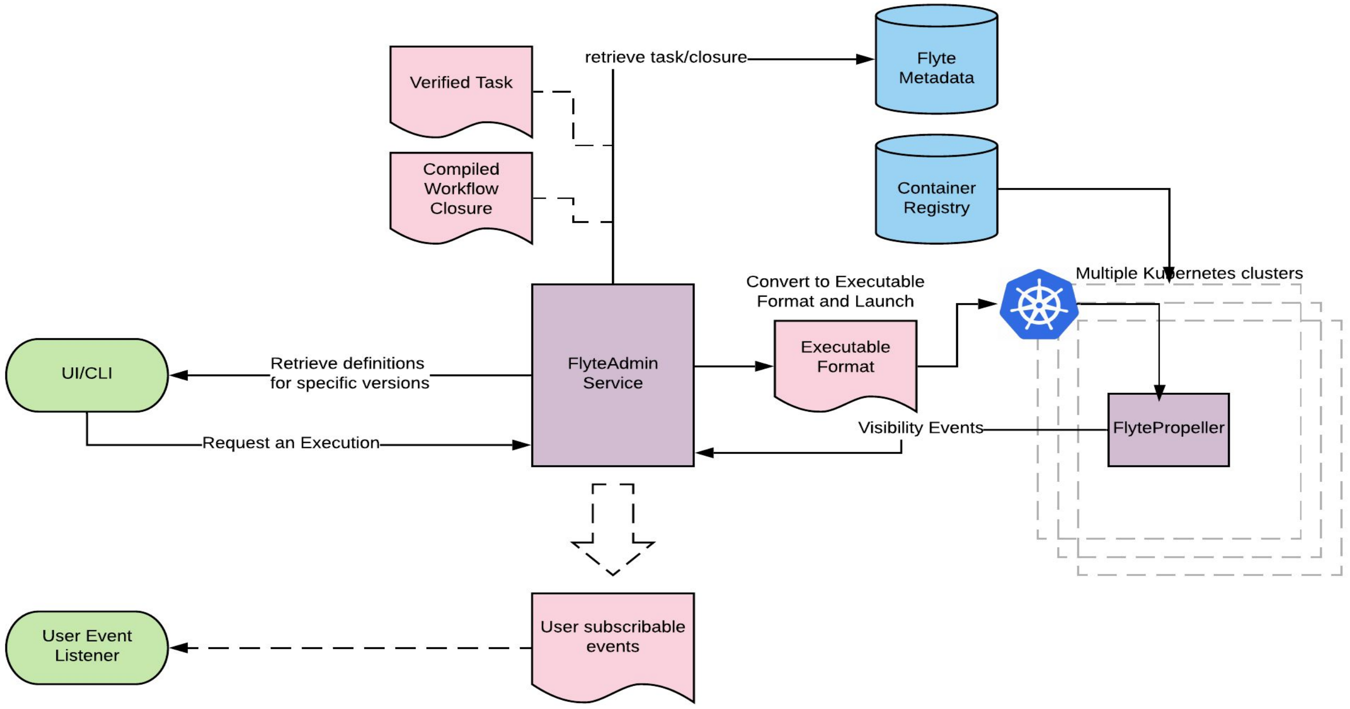
Executing a Registered Workflow



Flyte

Introducing Flyte

Ecosystem

pod

Spark

AWS Batch

aws

Google Cloud

HIVE

Qu

jupyter

Amazon SageMaker

Coming soon

pandas

$y_{i}t = \beta' x_{it} + \mu_i + \epsilon_{it}$

Parquet

Coming soon

lyft

Flyte

Conclusion

What's Next

Flyte is constantly evolving and new features are coming soon like,

- **Reactive workflows** (respond to data publication events)
- Enhancements to **type system** and **Flytekit**
- **More extensions**
- Richer **data catalog**

many more...

To find more details **visit our docs and the Roadmap section**. Also join our fledgeling community and help us shape the future of Flyte. We appreciate contributions and suggestions.

Thanks!

Learn more, get started & keep in touch at Flyte.org

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