

# Automating Netflix ML Pipelines With Meson

| QCon SF 2017 | Eugen Cepoi, Davis Shepherd

**NETFLIX**



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NETFLIX ORIGINAL  
**STRANGER THINGS**

98% Match 2016 TV-14 1 Season

Season 2 Coming October 27

When a young boy vanishes, a small town uncovers a mystery involving secret experiments, terrifying supernatural forces and one strange little girl.

Starring: Winona Ryder, David Harbour, Finn Wolfhard,  
Millie Bobby Brown, Gaten Matarazzo

Creator: The Duffer Brothers

Genres: Halloween Favorites, Scary Halloween Favorites, TV Shows



MY LIST



OVERVIEW

EPISODES

TRAILERS & MORE

MORE LIKE THIS

DETAILS

Popular on Netflix



# Goal

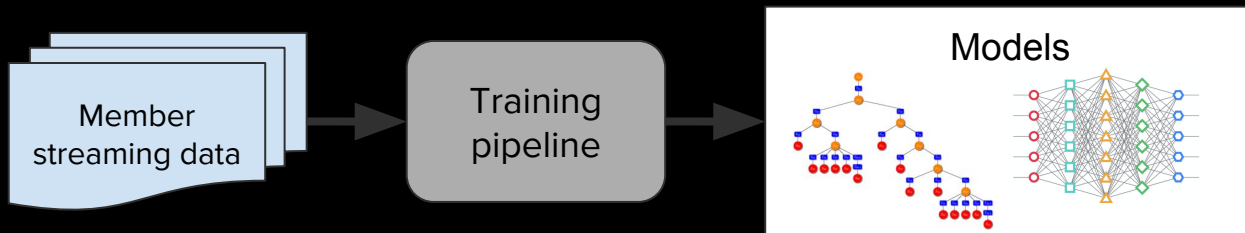
Create a **personalized experience** to help members find content to **watch** and **enjoy**

# Recommendation Context

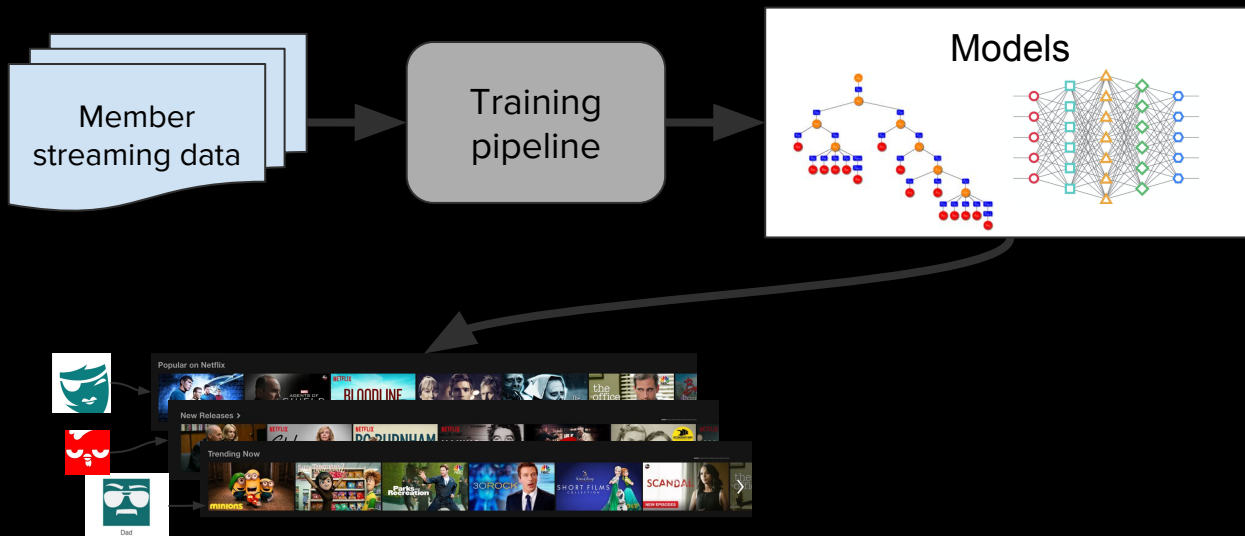
Member  
streaming data



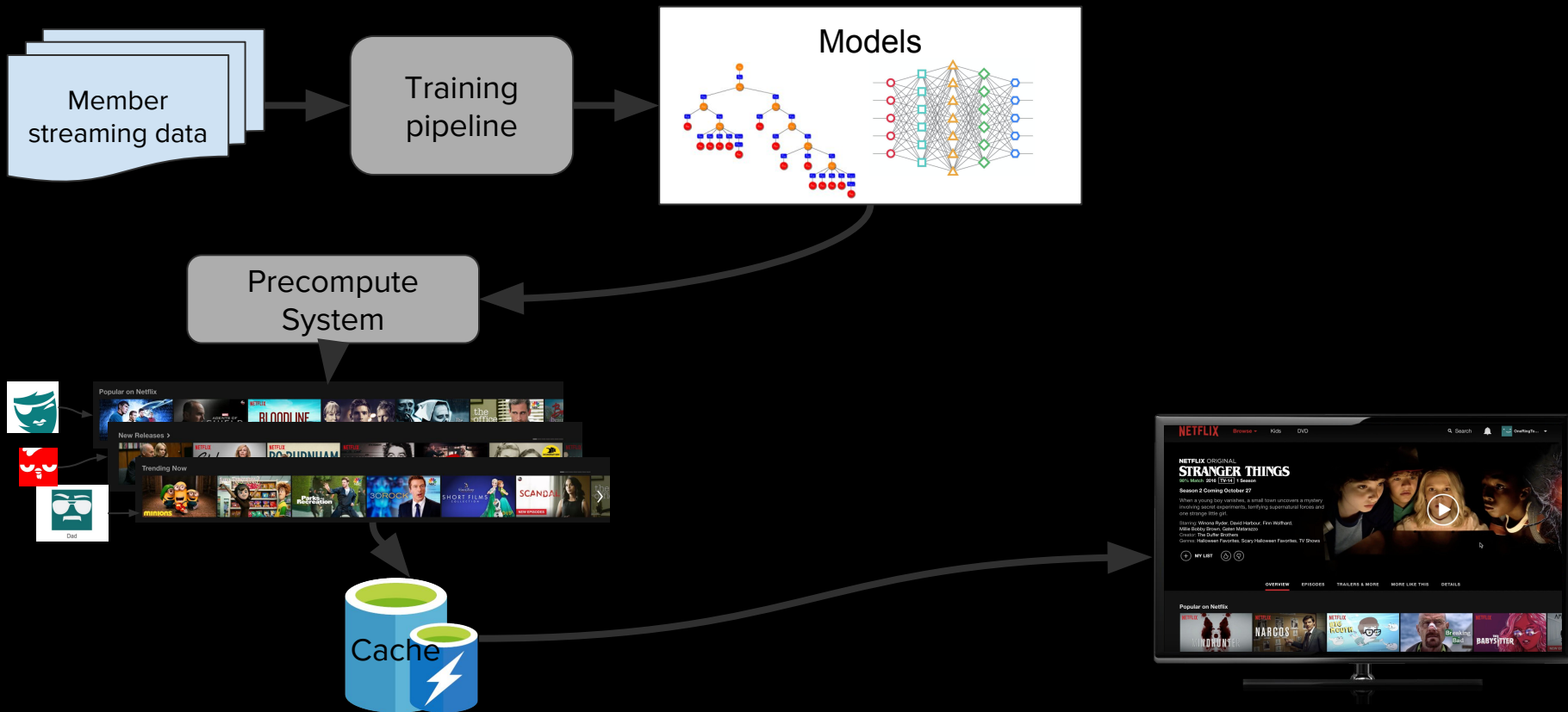
# Recommendation Context



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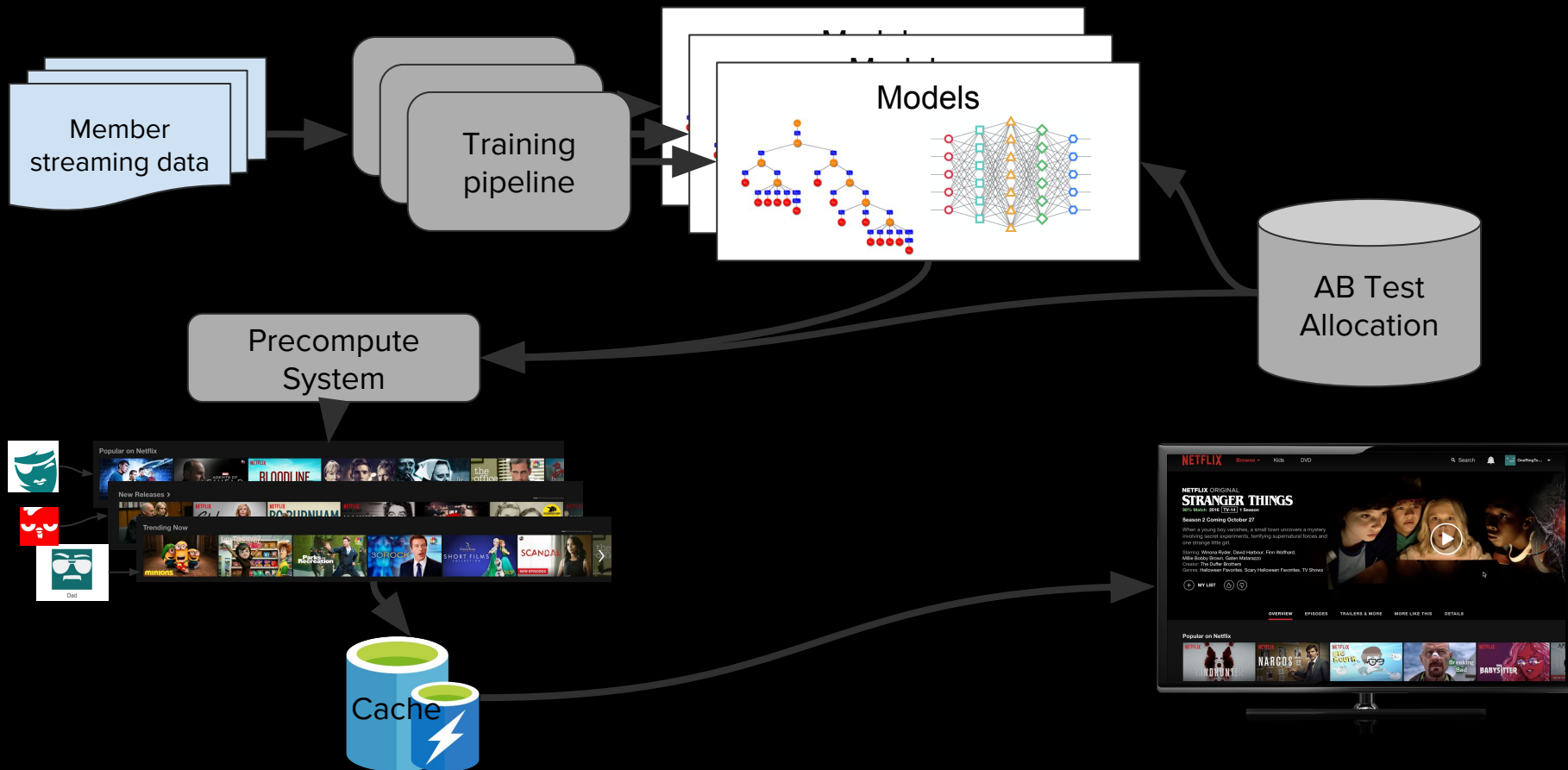


# Recommendation Context



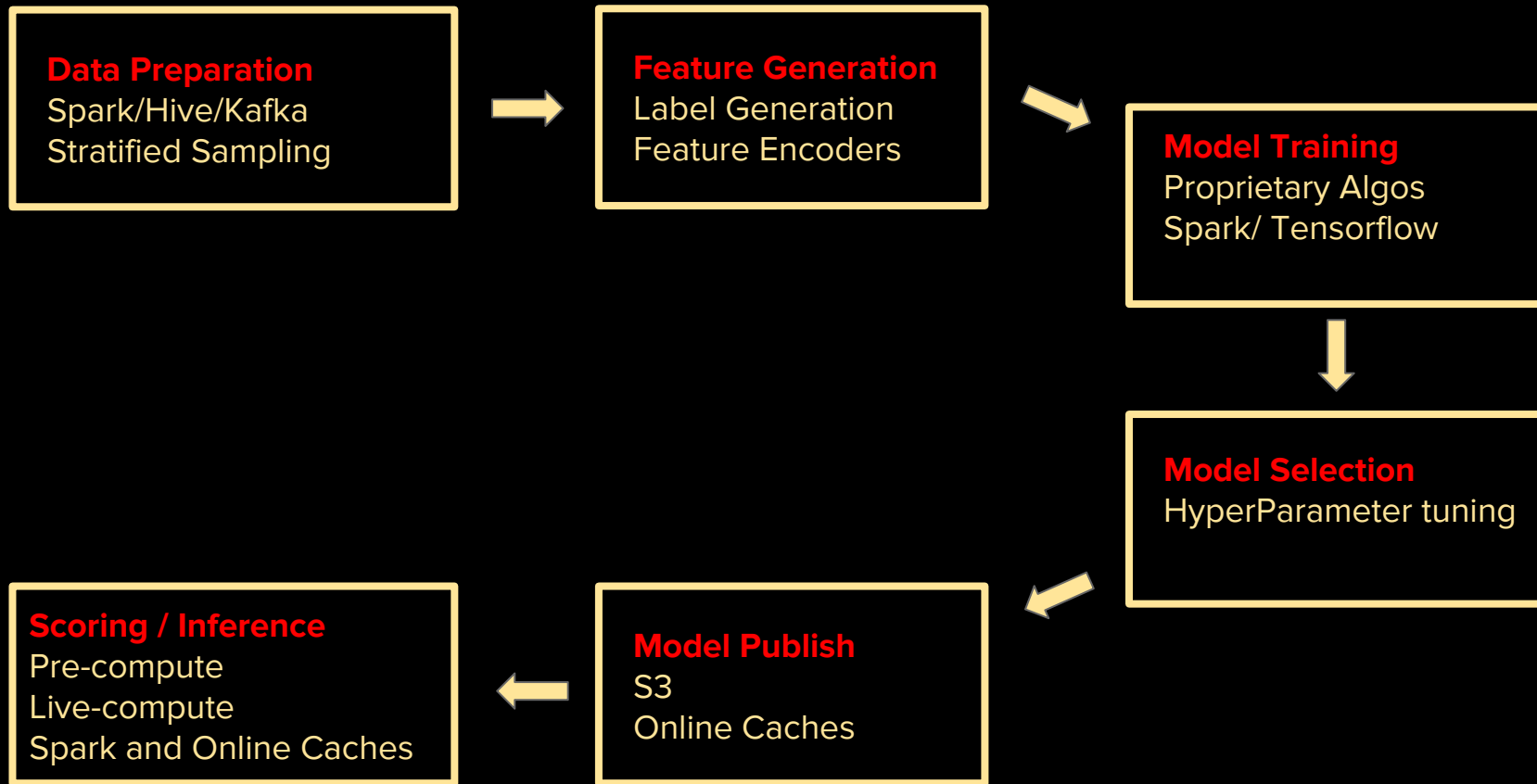


# Recommendation Context



Innovation is driven by experimentation

# Training Pipelines



# Before Meson

- A collection of operators
- Little to no orchestration
- Often limited to single machine

# Desired Properties

- Support Heterogeneous systems
- Highly flexible generic orchestration
- Handle failures
- Provide Reproducibility
- Support Multi-tenancy
- Support External Triggers

# Why didn't an out of the box solution work?

- Spark and Scala support was paramount
- Options available didn't have the flexibility and scalability that we needed

# Meson overview

# Meson Overview

General purpose workflow orchestration engine

Delegates execution to Mesos

Initially built for Machine Learning pipelines for personalization

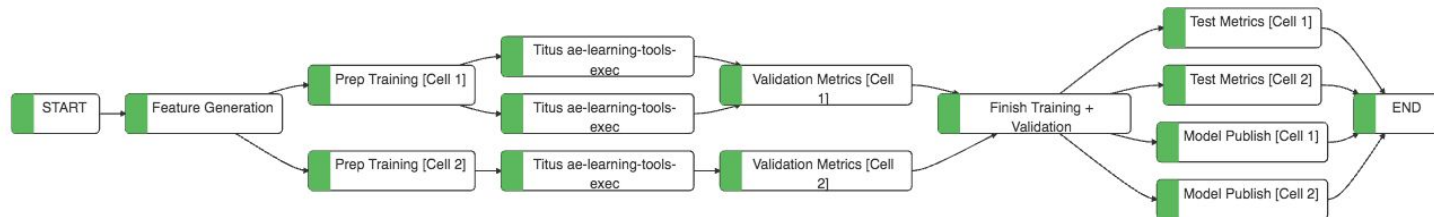
Supports complex workflow patterns (branching, loops, foreach)



# Concepts

**Workflow** Directed Graph of steps, global parameters, triggers...

**Step** Describes a job and its configuration



# Defining workflows

Scala DSL

Python DSL

UI

REST API

```
val sparkStep = Spark(
  jobClass = "netflix.MySparkJob",
  sparkArgs = Seq("--driver-memory" -> "8g")
)

val cpStep = DistCp(from = "...", to = "...")

Workflow(
  id = "my-cool-workflow",
  triggers = Seq(Trigger.CRON("0 0 0 1/1 * ? *")),
  notification = Notification(
    whenStart = true, whenFinish = true, whoCustom = Option("me@gmail.com")
  ),
  parameters = Seq(Parameter.STRING(name = "country", value = "US")),
  definition = sparkStep.sequence(cpStep).end()
)
```

# Parameters

Used to configure steps, job arguments, and step transitions

MVEL expression to derive parameter values at runtime

Predefined macros

```
Workflow(  
  id = "my-cool-workflow",  
  parameters = Seq(Parameter.LONG(name = "dateint", expression = Option("tsToDateInt(RUN_TS)"))),  
  definition = Step(  
    name = "jobX",  
    parameters = Seq(  
      Parameter.LONG(name = "day", expression = Option("dayFromDateInt(dateint)"))  
    ).end()  
  )  
)
```

# Workflow patterns

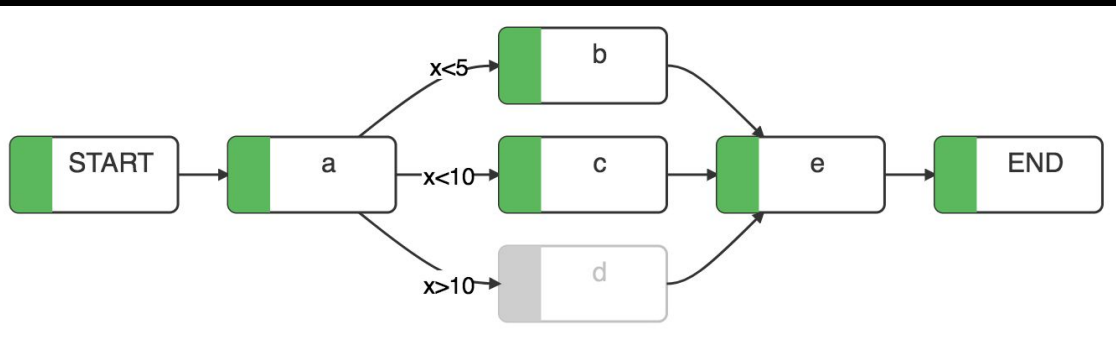
Branches (OR, XOR, AND)

Loops with XOR

Foreach

```
Step("a").or(  
    Condition("x<5").branch(Step("b")),  
    Condition("x<10").branch(Step("c")),  
    Condition("x>10").branch(Step("d"))  
).sequence(Step("e"))
```

Using parameters and  
MVEL



# Data artifacts

Data artifact defined by a name and a set of partitions (parameters)

Cross workflow  
dependencies

External triggers

```
Step(  
  name = "someJob",  
  inputs = Seq(  
    DataArtifact(  
      name = "views",  
      params = Seq(Parameter.STRING(name = "country", value = "US"))  
    )  
  ),  
  outputs = Seq(  
    DataArtifact(  
      name = "aggViews",  
      params = Seq(  
        Parameter.STRING(name = "ts", value = "$RUN_TS"),  
        Parameter.STRING(name = "country", value = "US")  
      )  
    )  
  )  
)
```

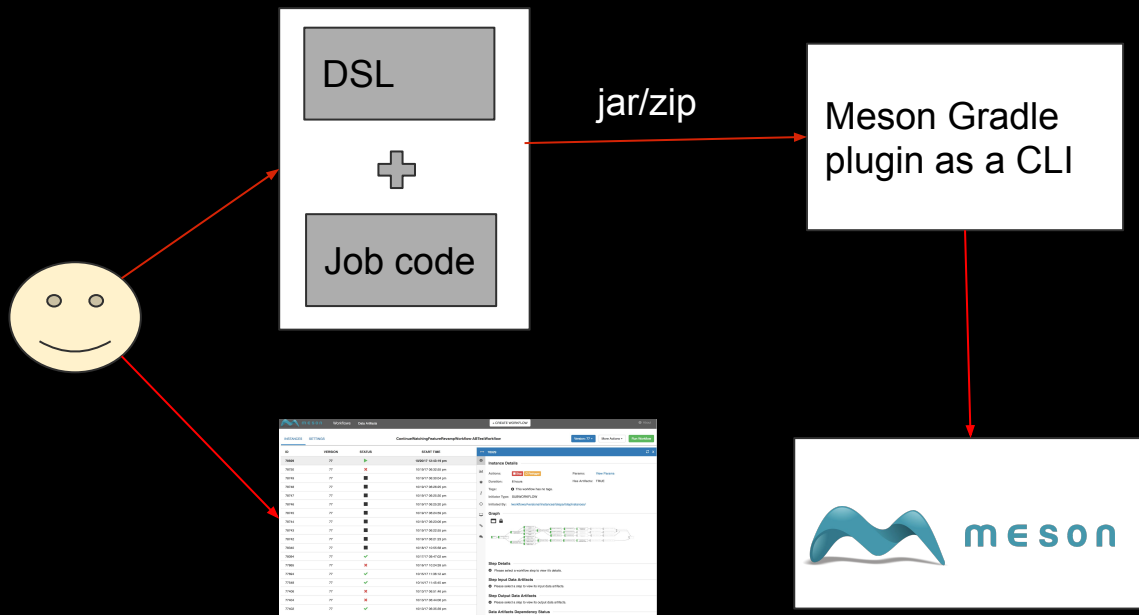
# Workflow versions

Workflows have immutable versions

Enables:

- Better collaboration
- Rollbacks
- Reproducibility

# Deploying workflows with the Gradle plugin



Link and version  
workflow with job  
code

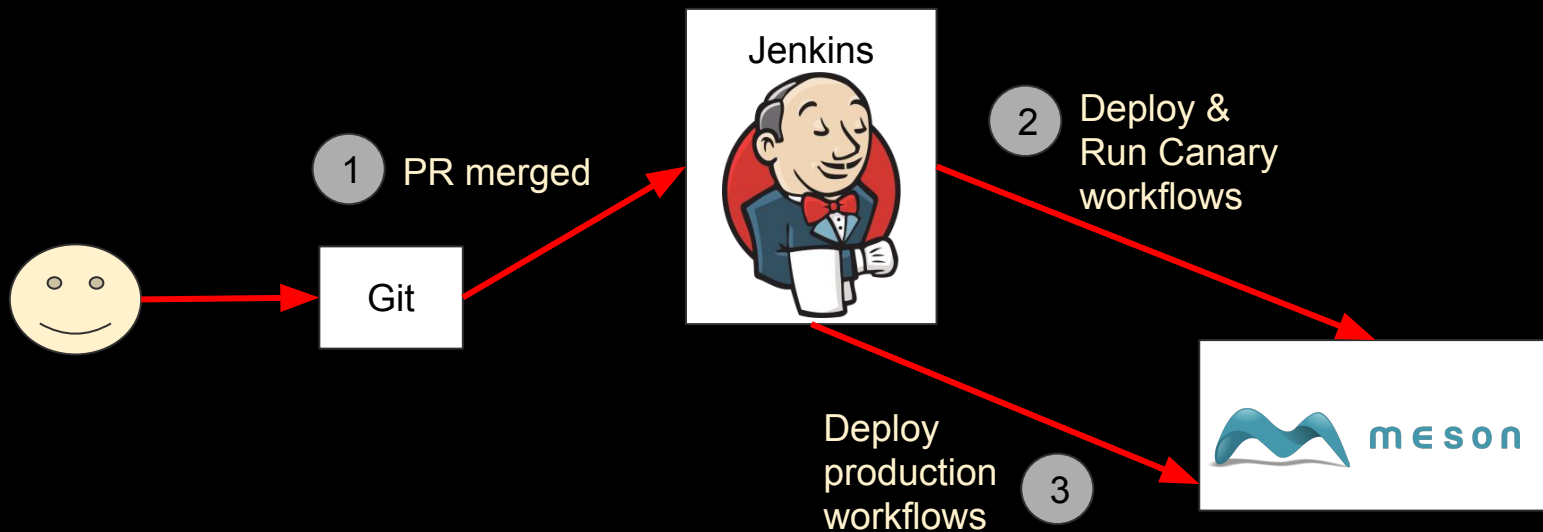
Add metadata (SCM)

Validate

Deploy

Run

# Automated releases with canary workflows





# Monitor & Debug

Meson Workflows Data Artifacts + CREATE WORKFLOW About

INSTANCES SETTINGS ContinueWatchingFeatureRevampWorkflow-ABTestWorkflow Version: 77 More Actions Run Workflow

ID	VERSION	STATUS	START TIME
78929	77	▶	10/20/17 12:43:19 pm
78750	77	✖	10/19/17 06:32:55 pm
78749	77	■	10/19/17 06:30:04 pm
78748	77	■	10/19/17 06:26:25 pm
78747	77	■	10/19/17 06:25:30 pm
78746	77	■	10/19/17 06:25:20 pm
78745	77	■	10/19/17 06:24:59 pm
78744	77	■	10/19/17 06:23:06 pm
78743	77	■	10/19/17 06:22:55 pm
78742	77	■	10/19/17 06:21:23 pm
78340	77	■	10/18/17 10:55:58 am
78094	77	✓	10/17/17 09:47:02 am
77865	77	✖	10/16/17 10:24:39 am
77694	77	✓	10/15/17 11:36:12 am
77548	77	✓	10/14/17 11:45:45 am
77406	77	✖	10/13/17 06:51:46 pm
77404	77	✖	10/13/17 06:44:06 pm
77402	77	✓	10/13/17 06:35:39 pm

78929

Instance Details

Actions: **Stop** **Retrigger** Params: View Params

Duration: 6 hours Has Artifacts: TRUE

Tags: ⓘ This workflow has no tags.

Initiator Type: SUBWORKFLOW

Initiated By: /workflows/versions/instances/steps/stepinstances/

Graph

Step Details

ⓘ Please select a workflow step to view its details.

Step Input Data Artifacts

ⓘ Please select a step to view its input data artifacts.

Step Output Data Artifacts

ⓘ Please select a step to view its output data artifacts.

Data Artifacts Dependency Status

54043

Step Input Data Artifacts

1. dataArtifacts/prodhive\_dss\_user\_interaction\_day\_agg/2b77f86b506c31aa12f234ed6b0409ce33bd546da0135b76b/ Announced Time: 11/08/17 11:45 pm Params: partition: 20171107
2. dataArtifacts/prodhive\_dss\_login\_member\_allocation\_d/f8dcba3247b9826d44bdf10b2c5c6f0844a243325f0dc6f1/ Announced Time: 11/08/17 04:23 am Params: partition: 20171107

Step Output Data Artifacts

ⓘ No output data artifacts for this step.

Data Artifacts Dependency Status

ⓘ Dependency status is populated only for the steps in WAITING\_PRE\_CONDITION

Step Links

▼ MILESTONE: 54043:2 (JSON)

Titus-4107039 Queued 11-09-17, 17:11:24 Titus-4107039 Running 11-09-17, 17:11:54 Titus-4107039 Finished 11-09-17, 17:31:25

► execution report: 54043:2:0 (HTML)

► execution script: 54043:2:0 (HTML)

Step Links

▼ full\_command: 83226:2:0 (HTML)

```
spark-submit --ver 2.0 --conf spark.cores.max=64 --conf spark.executor.cores=2 --driver-
```

► mesos\_sandbox\_link: 83226:2:0 (URL)

► spark\_history\_server\_url: 83226:2:0 (URL)

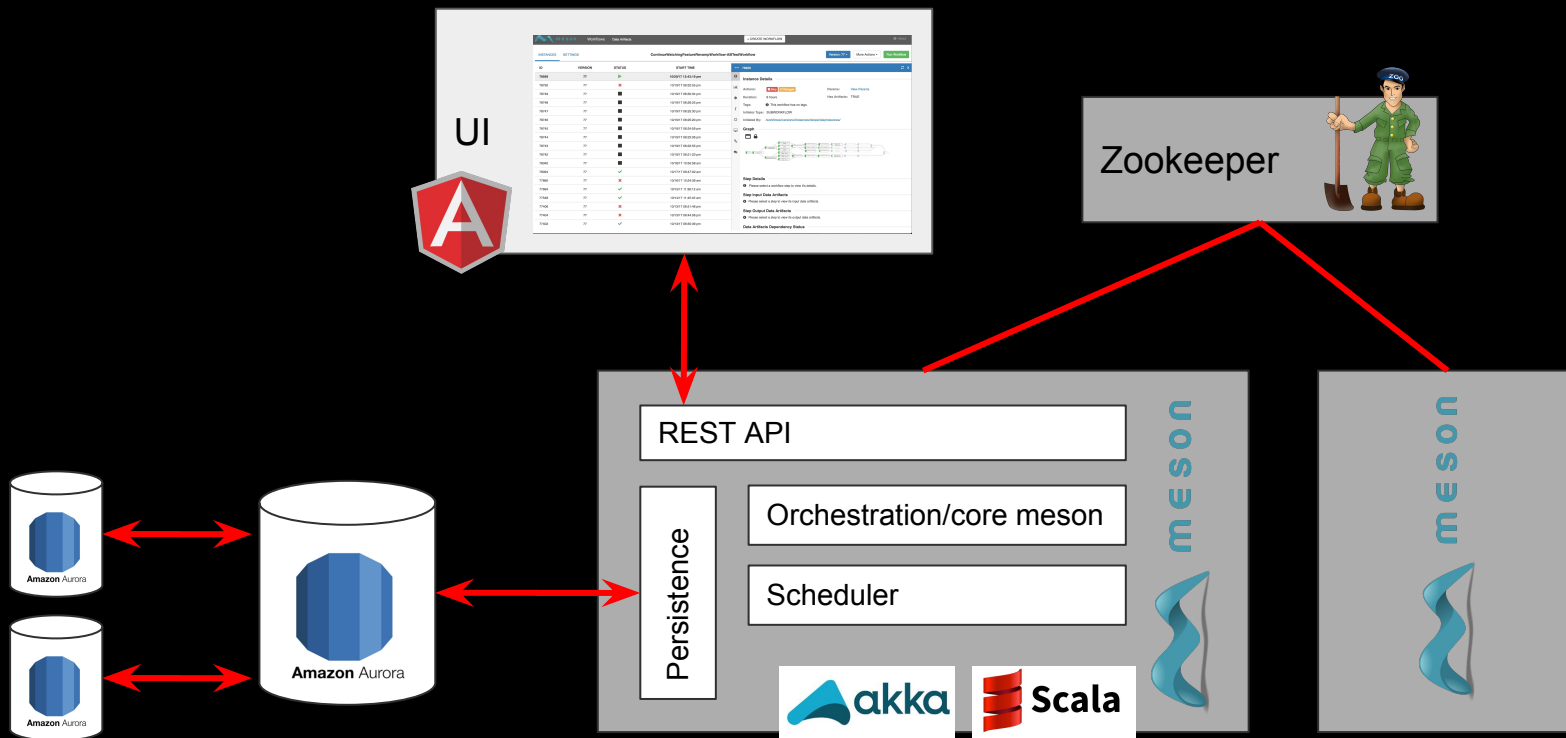
► spark\_mesos\_framework: 83226:2:0 (URL)

► spark\_ui\_url: 83226:2:0 (URL)

Step Messages

ⓘ No messages for this step.

# Architecture

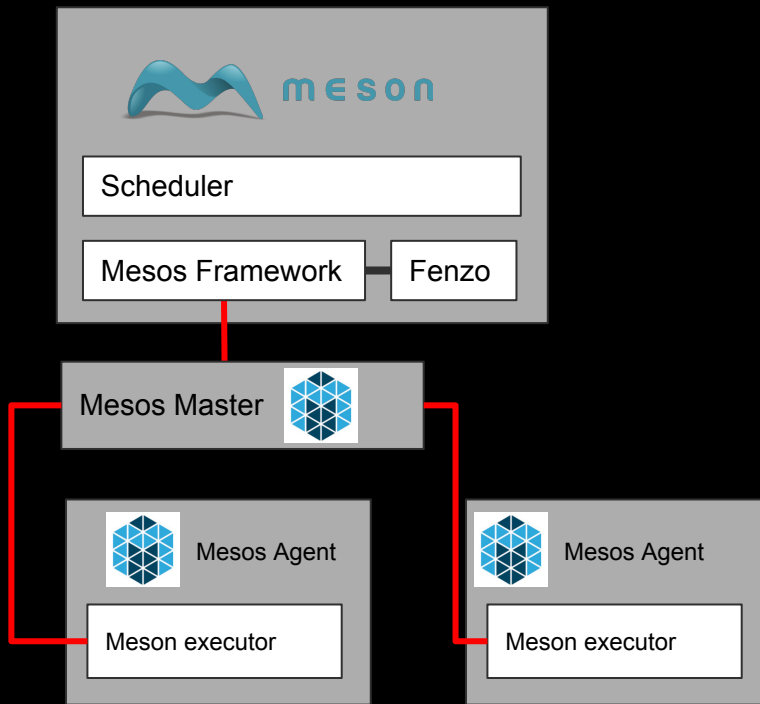


# Scheduling

Meson as a Mesos Framework

Mesos offers resources and runs the steps

Fenzo (Netflix OSS) makes scheduling decisions

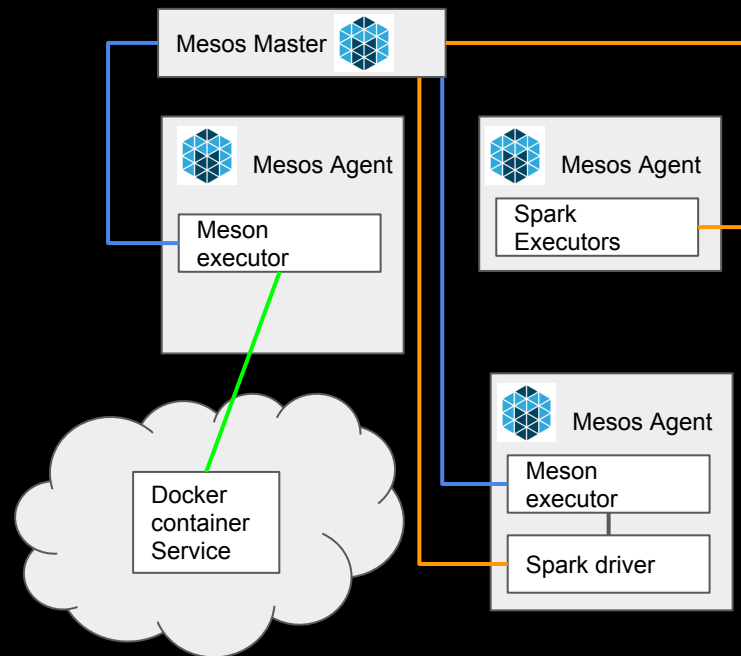


# Execution

Custom executor code for different runtime systems (spark, bash...)

Publish runtime debug infos (logs, url to monitoring UIs...)

Meson executors survive Meson scheduler failure



**Looking Forward**

# Closing the loop

Interact with Meson from the running job

Output parameters to leverage loops and foreach

Expose debugging information through Artifacts

Progress Milestones, Links, Counters, Images, etc.

# A day in the life of a workflow...

Backfills, work prioritization and parallelism

Avoid re-doing work after fixing a bug and re-deploying a workflow

Explicit (data) lineage

**Looking back**



# Adoption

2+ years in production

10+ managed and self-service deployed clusters

1000+ daily Production and A/B Test ML pipelines

2000+ EC2 instances in Spark/Mesos compute pool

20000+ of steps run per day

# *One Abstraction doesn't fit all*

Evidenced by the many names:

- Workflow
- ProcessFlow
- Pipeline
- DAG
- DataFlow

Over specialization will inevitably weaken other use cases.

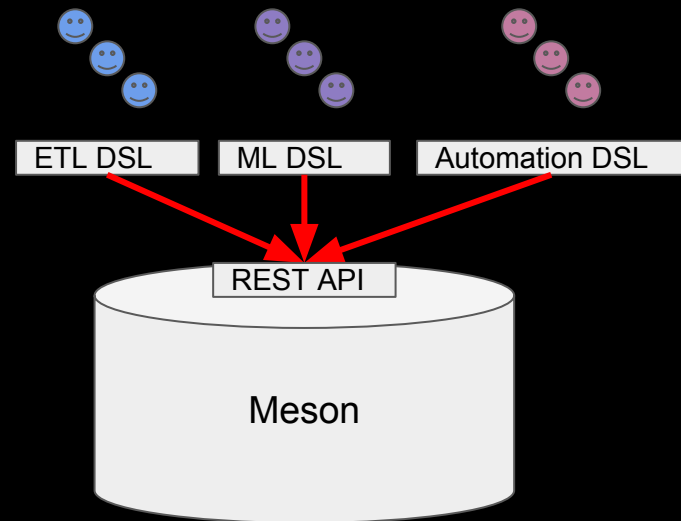


# *One Abstraction doesn't fit all*

With the REST API Meson provides “workflows as a service”.

Enables many domain specialized abstractions:

- A/B test orchestration
- ML orchestration
- ETL pipelines
- Notebook Automation
- And more..



**Questions?**