

IceCube - Neutrinos in Deep Ice

Final Presentation

Group 13

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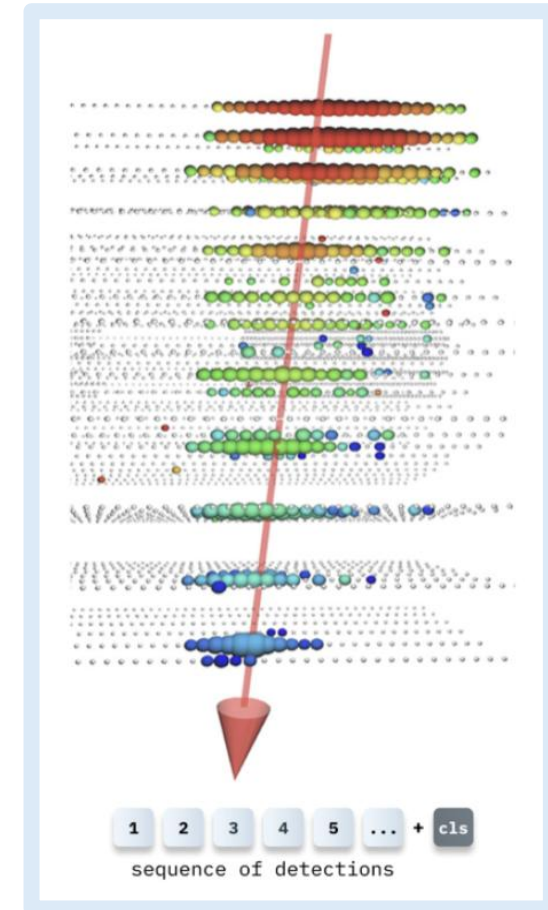
Machine Learning Operations

FS 2025



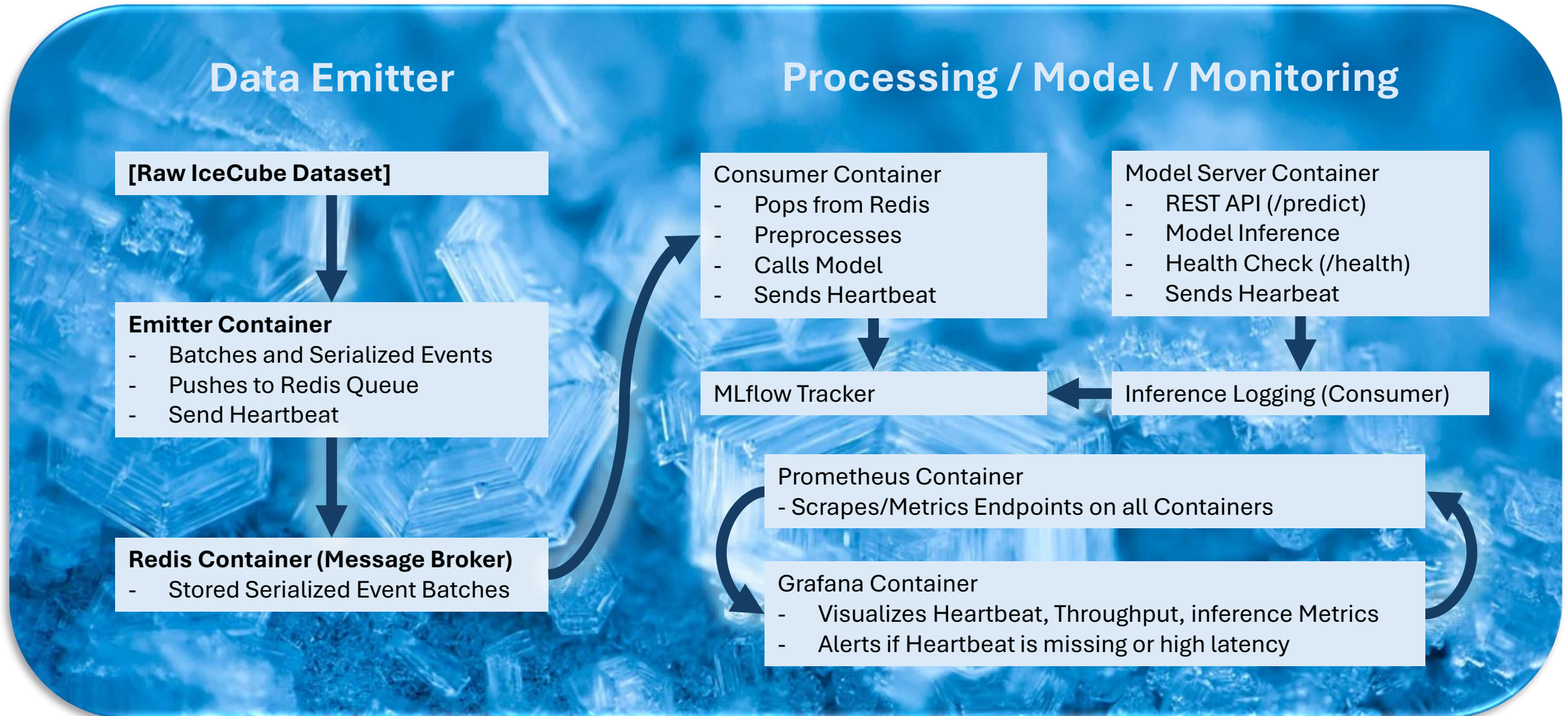
Purpose/Task of the ML System

- Neutrinos are abundant particles in our universe emitted by violent astrophysical events
- Hard to detect since they rarely interact with matter
- The [IceCube Neutrino Observatory](#)
 - A detector array spanning a cubic kilometer of Antarctic ice
 - Detects the directions of neutrino traces using photon detections (3D Unit Vector)
 - Enables determination of the neutrinos' origin, thereby helping locate astrophysical events
- Disclaimer: Our aim is NOT to optimize ML performance, but to explore how the IceCube data processing might be structured



3D Unit Vector

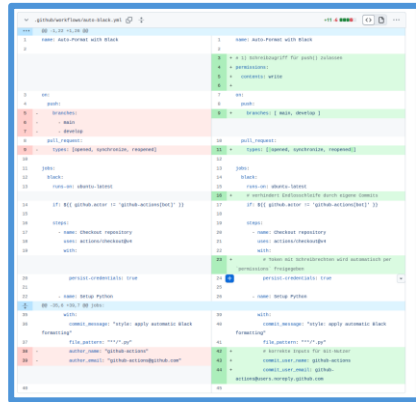
Overview of Components/Pipeline/System Setup



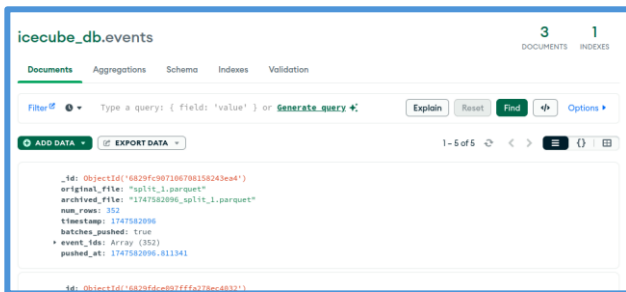
Key Features of the MLOps Pipeline [1/2]

Tool	Raison d'être
GiHub Actions	<ul style="list-style-type: none">• Automatic Checks of Code Quality
Docker	<ul style="list-style-type: none">• Easy to deploy• Ensures reproducibility• Allows containerization of each component
Redis Community Edition	<ul style="list-style-type: none">• Easy to use and performant que system• Relatively fast deployment
MongoDB	Used to track Events
Prometheus	<ul style="list-style-type: none">• Scrapes metrics (total requests, latency, etc.) from the different containers (including heartbeat)• Can define alert rules
Grafana	<ul style="list-style-type: none">• Dashboard build upon Prometheus• Displays Real Time Metrics
Flask	Server used to serve the model via REST API

Key Features of the MLOps Pipeline [2/2]



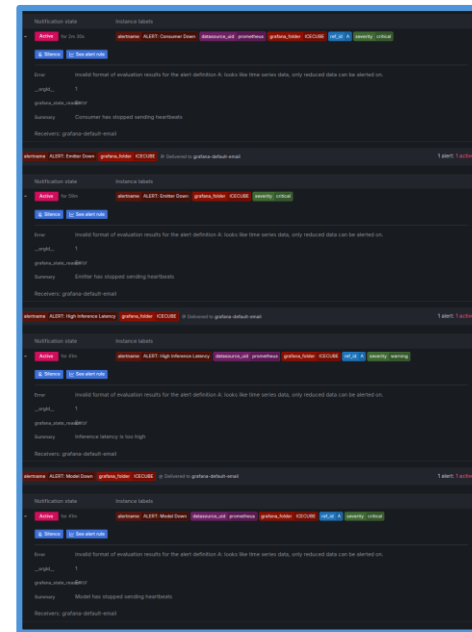
GitHub Actions



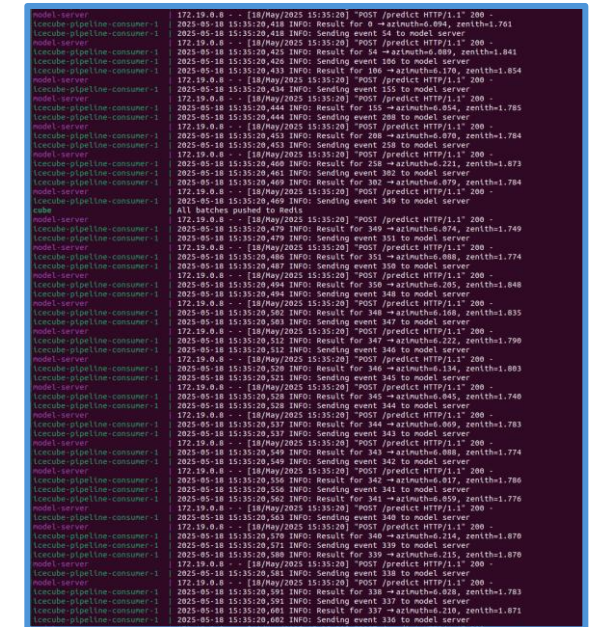
MongoDB for tracking Evenents



Grafana Dashboard with Real Time Insights



Prometheus (Eg. Automatic Alerts



«Behind the Scenes» Info Flow

Sources

- [Title Slide Picture](#) [Slide 1]
- [3D Unit Vector](#) [Slide 3]
- [Ice Pattern](#) [Slide 3]