

Confidential Federated Analytics for Digital Agriculture

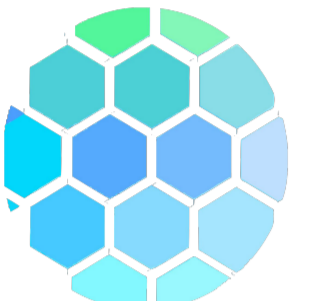
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Cornell University


MOTIVATION

The UN projects global population to reach 10 billion in 25 years. How do we protect farmers, and the environment, while scaling to feed these 10 billion people by 2050?

APPROACH

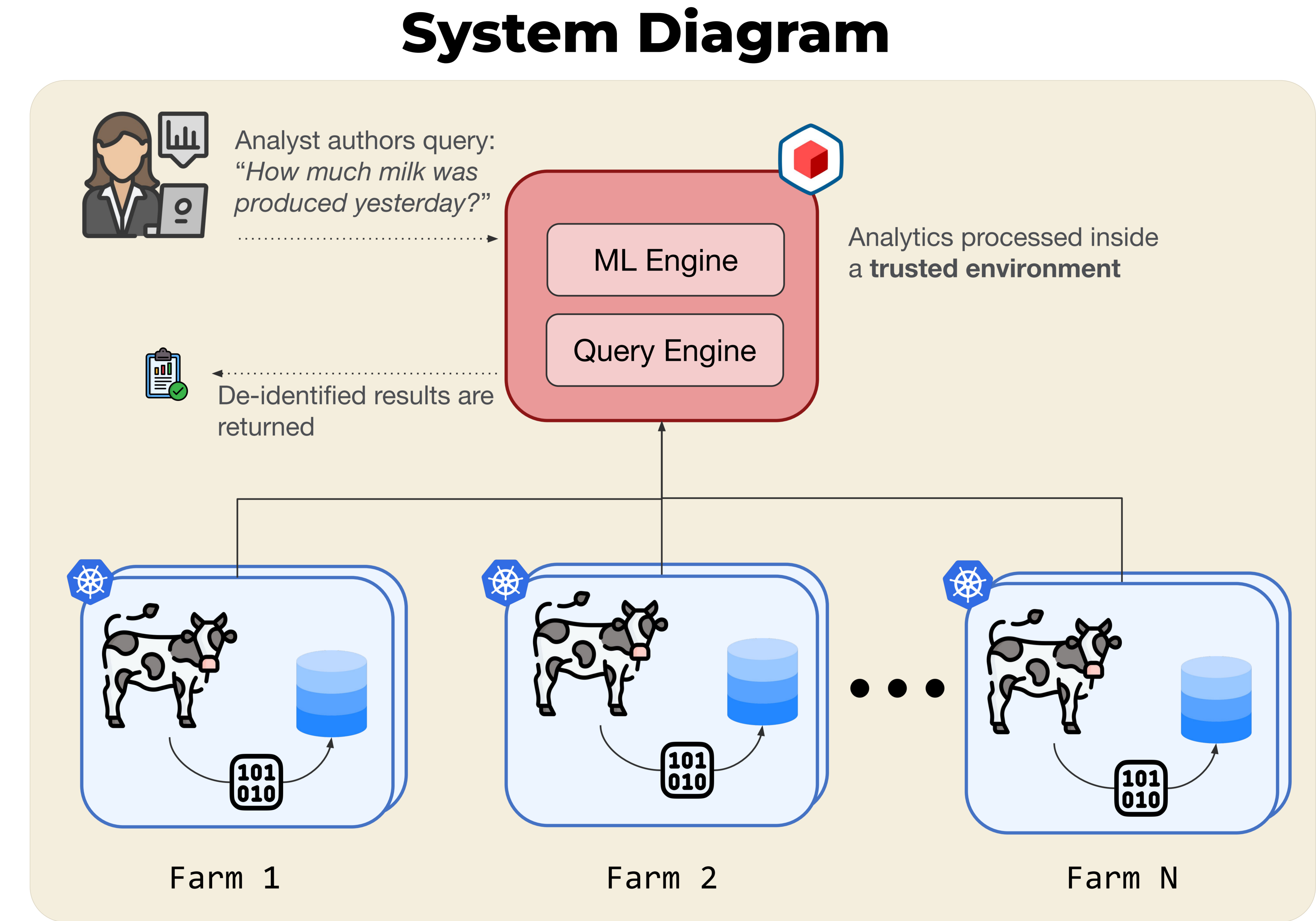
We use KubeStellar and Confidential Containers to build a framework to protect farmers, their data, and the environment.

1  KubeStellar allows for multi-cluster orchestration with offline support.

2  Confidential Containers run unmodified applications in a Trusted Execution Environment (TEE) on the cloud.

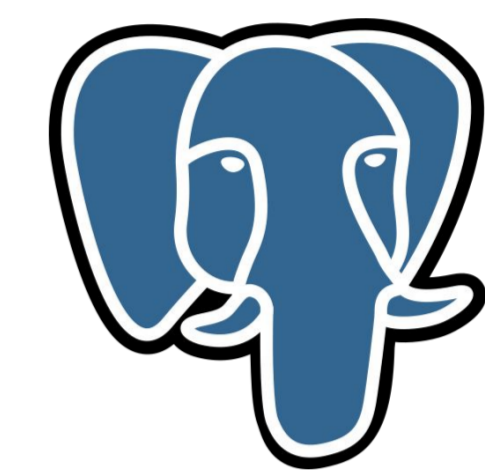
INTEGRATING KUBESELLAR AND CONFIDENTIAL CONTAINERS

```
apiVersion: apps/v1
kind: Deployment
metadata:
  name: edge-deployment-v0
  labels: {app: "ipp-edge"} 1
  namespace: edge-ns
spec:
  selector: { matchLabels: {app:
    ipp-edge} }
  template:
    metadata:
      labels: {app: ipp-edge}
    spec:
      containers:
        - name: edge-v0
          image: fa-node:latest
          ports:
            - containerPort: 3000
          imagePullPolicy: Always
          runtimeClassName: kata-remote 2
```



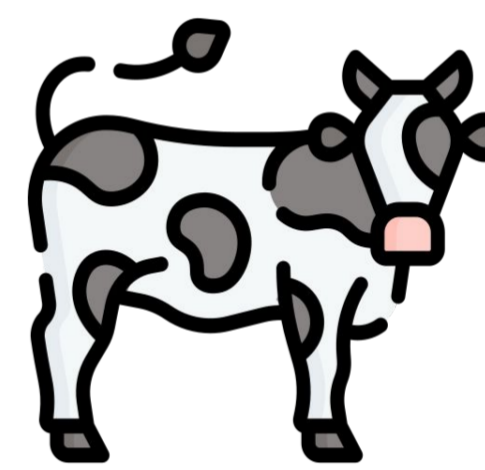
DEPLOYED USE CASE

We use data from the **Cornell Agricultural Systems Testbed and Demonstration Site (CAST) for the Farm of the Future**. We feature live predictions on data collected from Oct 2024 - Apr 2026.



POSTGRES DATASTORE

- ~360K rows
- 100+ columns
- date range: Oct 2024 – Apr 2026



COW DATA

- 1,706 unique cows
- 1,418 cow-lactations
- 750 eligible (require ≥ 120 days of post-calving records)



FEDERATED API

POST /tasks/stats

Federated statistics. Each node computes locally and returns {mean, std, min, max, total_count}

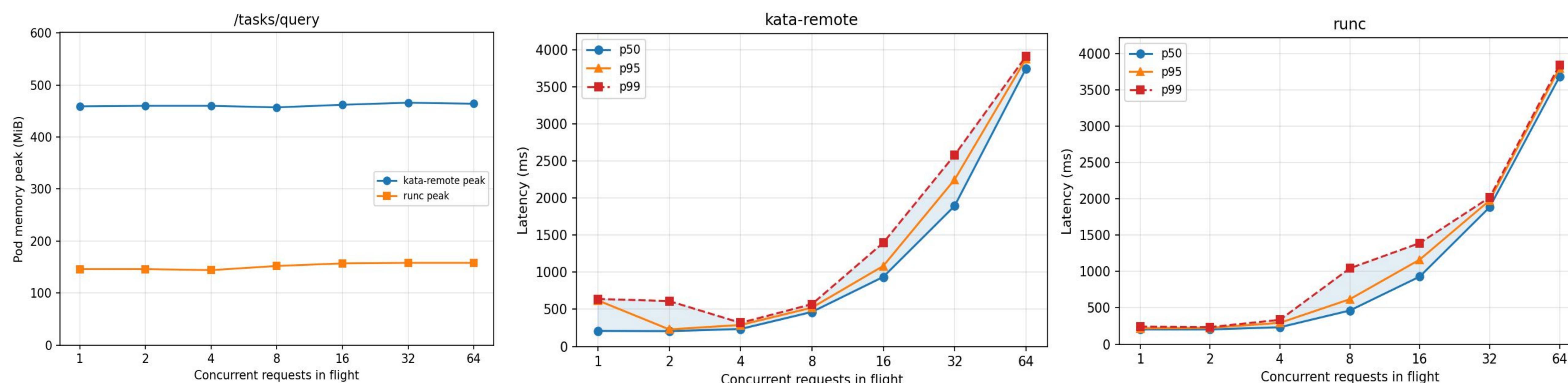
POST /tasks/anomaly

Federated z-score outlier detection. Each node flags outliers locally; coordinator returns the union.

POST /tasks/predict-cows

Score cows for early-lactation exit risk. Returns {station_id, animal_id, probability, at_risk}

Measuring Confidential VM Overhead



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