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Observability for GenAI Apps: Logging, Metrics, & Tracing on GCP

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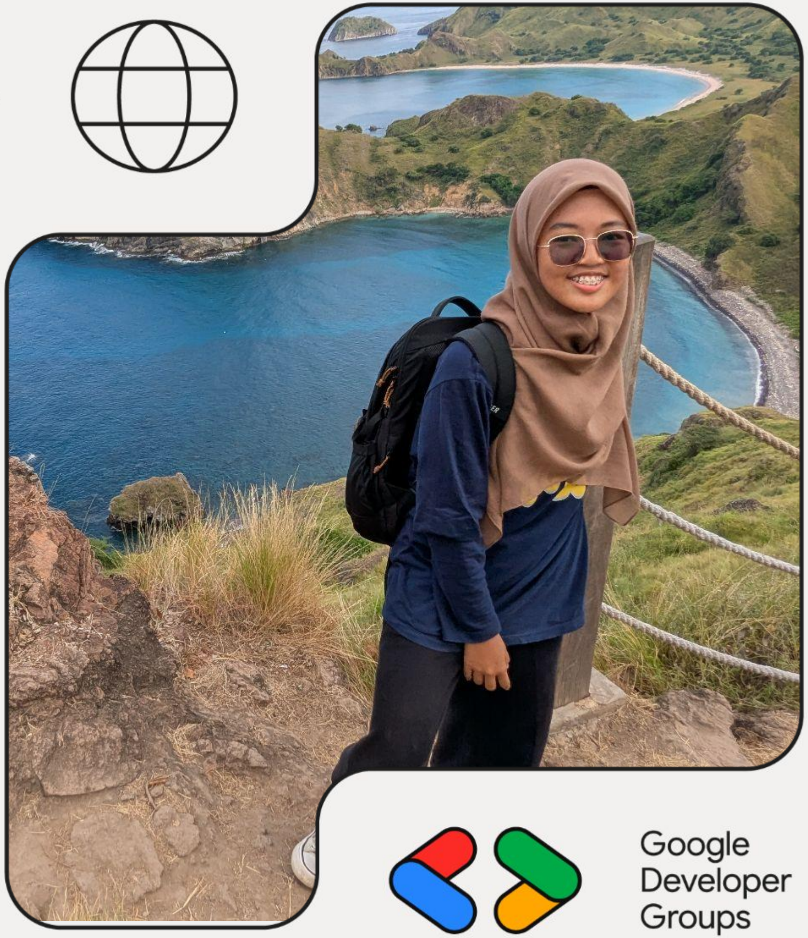

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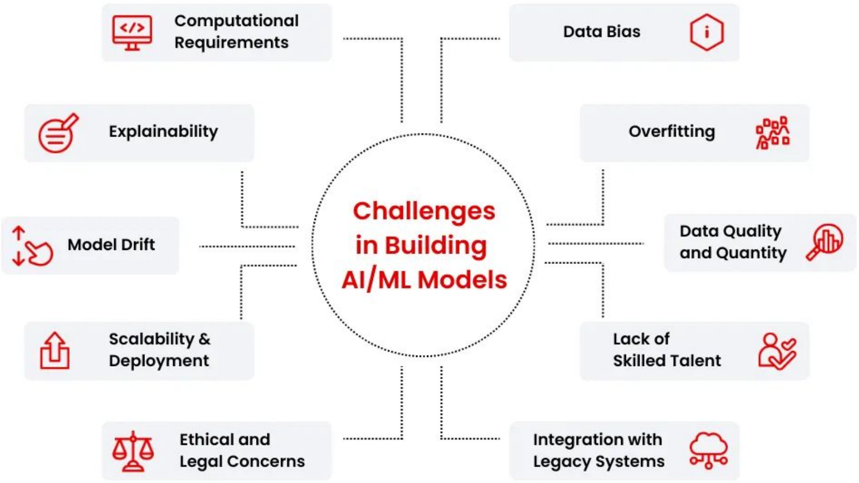
Operating ML models, presents several challenges:

- **Model drift**: As real-world data changes, models become less accurate, requiring frequent retraining.
- **Resource management**: ML workloads have varying demands, making efficient allocation crucial.
- **Data quality**: Consistent, reliable input data is essential for model performance.
- **Compliance**: Meeting governance and regulatory requirements is challenging.
- **Versioning**: Tracking models, datasets, and experiments is difficult at scale.



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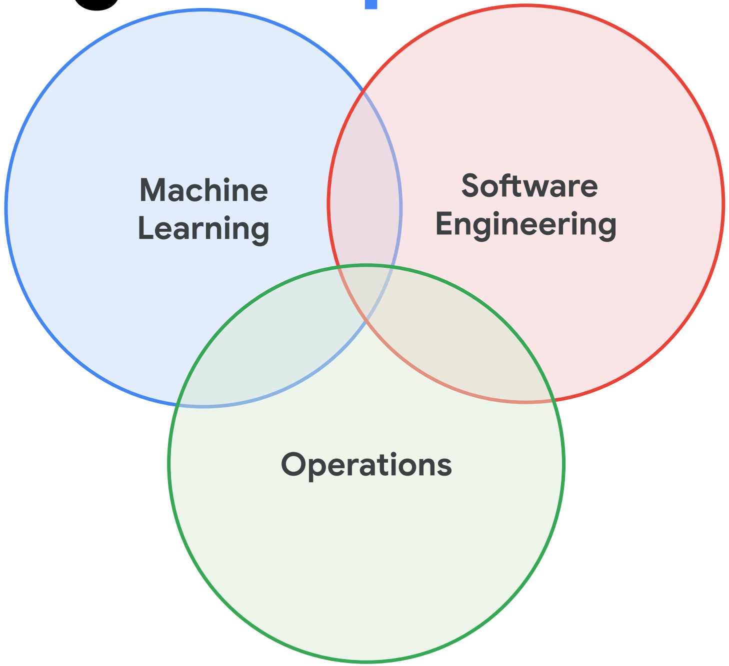
Introducing MLOps

- Model development
- Model evaluation
- Parameter tuning



- Data engineering
- Pipeline development
- Integration of model into business application

- Model deployment
- Metadata management
- Logging and monitoring

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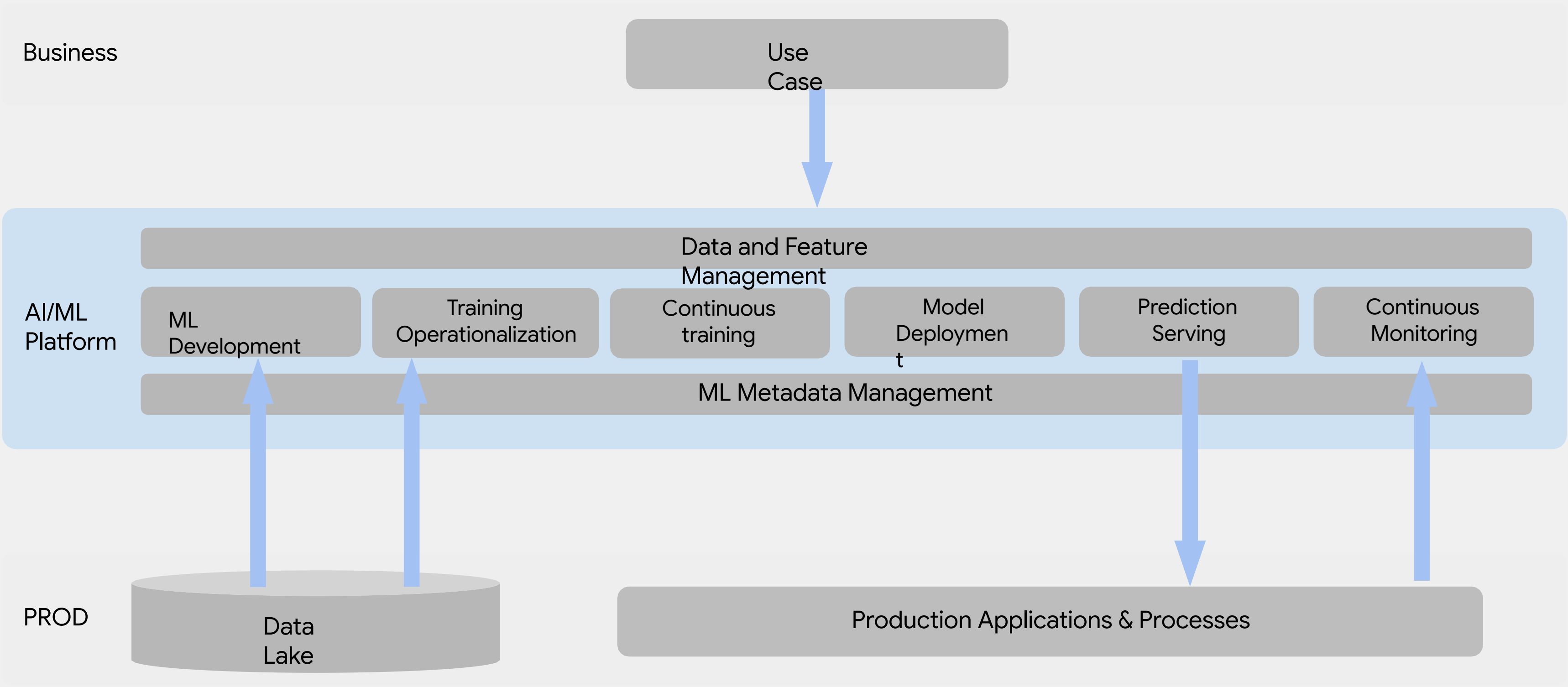
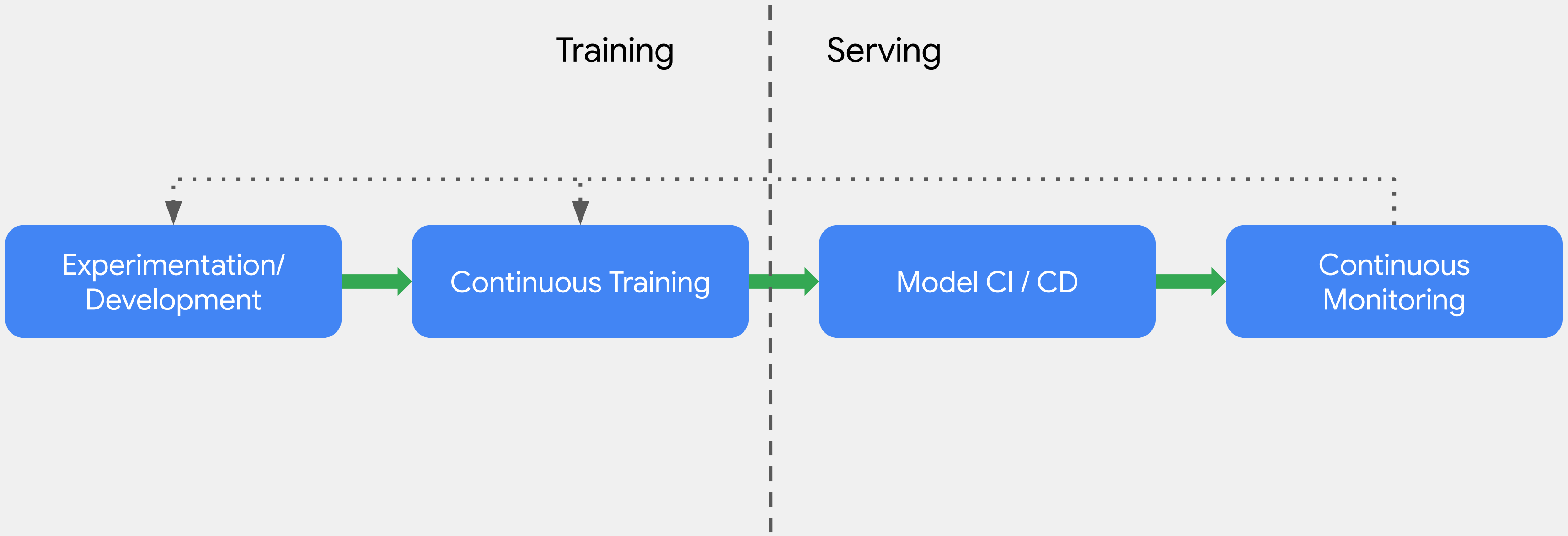
MLOps: quick recap

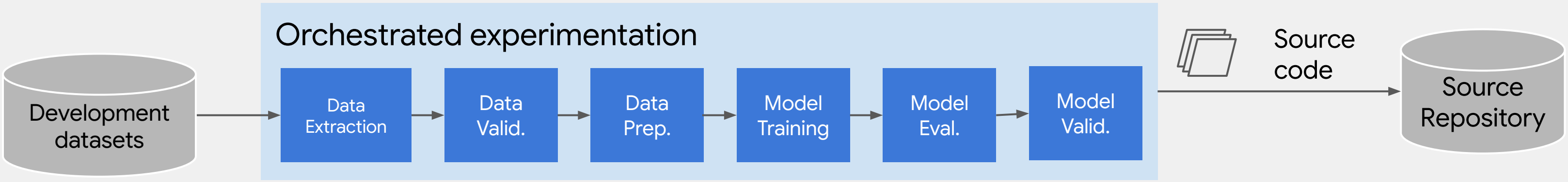


ML Solution Lifecycle



Reliable and repeatable training

Automated E2E Pipelines



Reliable and repeatable training

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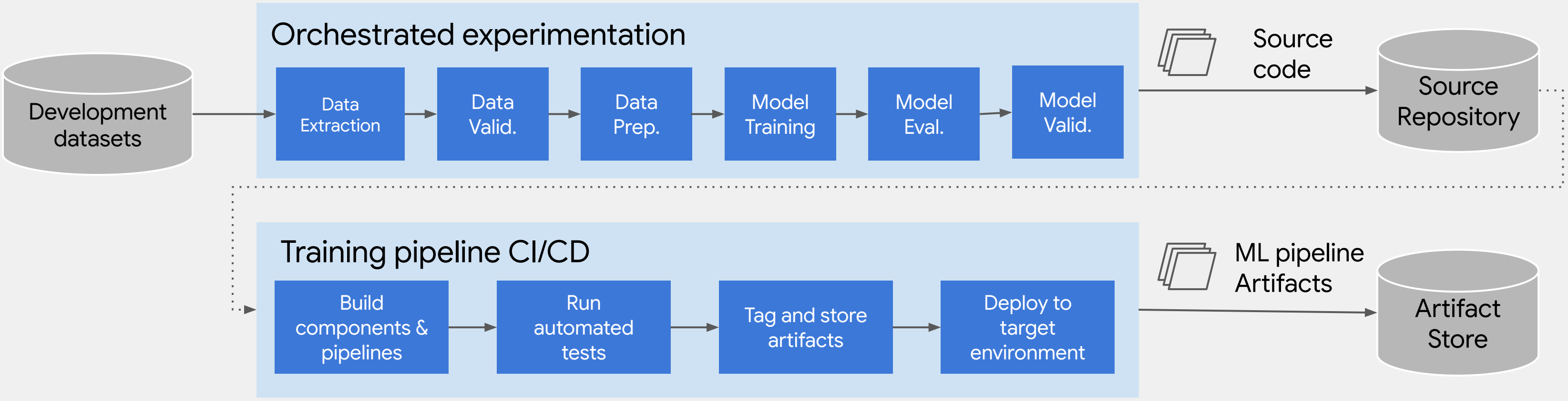

Reliable and repeatable training

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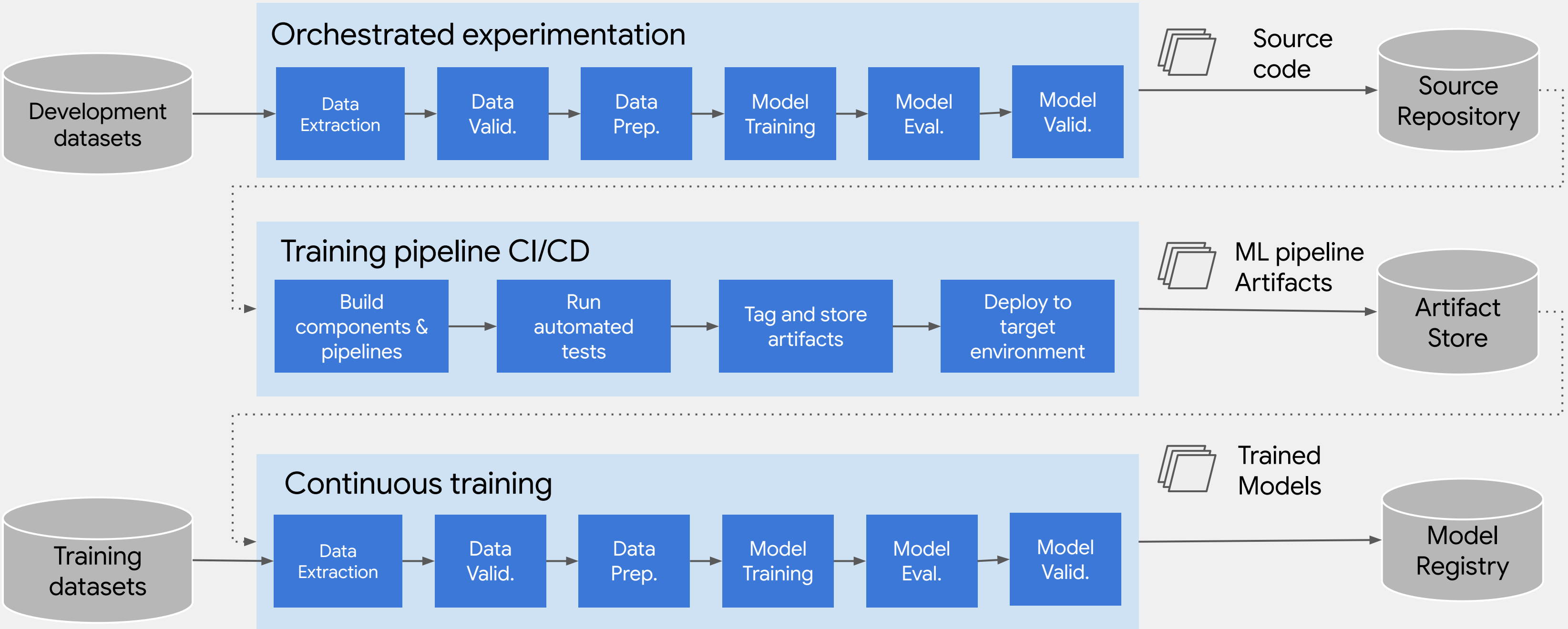
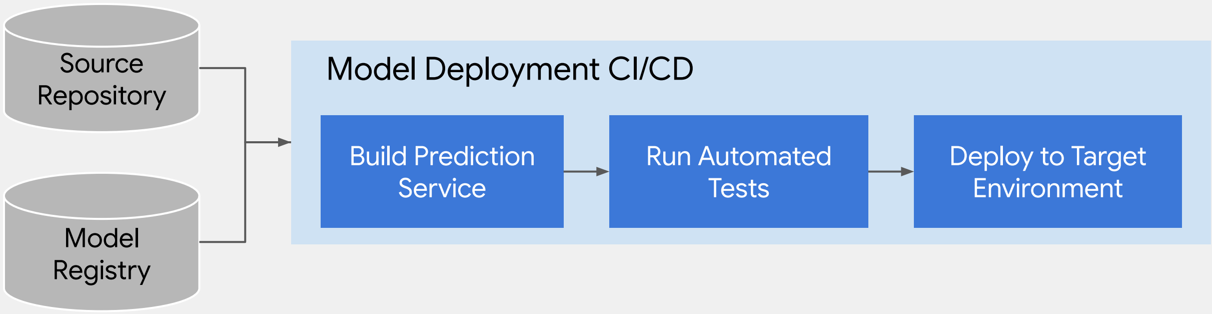


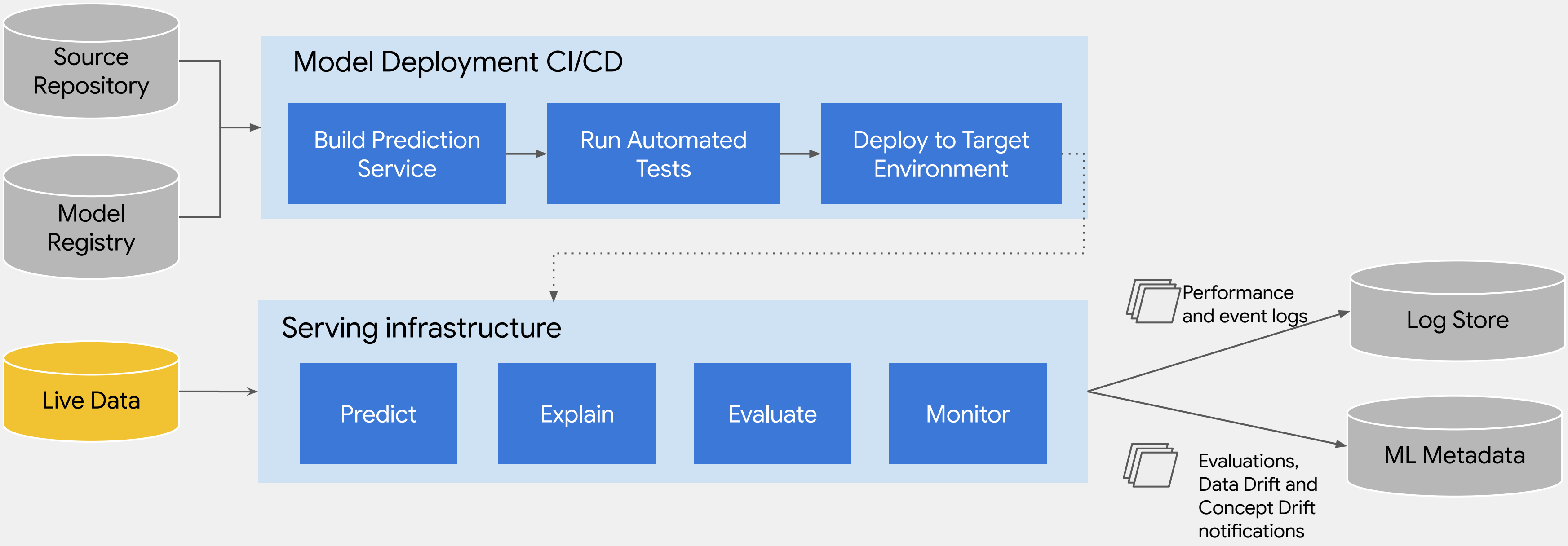
Reliable and monitored serving

Automated E2E Pipelines



Reliable and monitored serving

Automated E2E Pipelines



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"In control theory, **observability** is a measure of **how well** internal states of a system can be inferred from knowledge of its external outputs."

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"**Monitoring** tells you whether a system is working; **Observability** lets you understand why isn't working."

Unique ML Characteristics

Resource Patterns:

- Sustained high GPU usage during training vs consistent CPU usage in traditional apps
- Specialized GPU node scheduling vs typical short-lived batch jobs
- Variable computational demands requiring dynamic resource allocation

Monitoring Focus:

- **Model-specific metrics**: Accuracy, F1 scores (irrelevant for standard applications)
- **Data drift monitoring:** Track shifts in user preferences and data patterns
- **Continuous feedback loops:** Analyze interactions for targeted improvements
- **Granular observations**: Sometimes per-prediction monitoring vs standard application metrics

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Observability

Observability = **gaining insights into ML model behavior & infrastructure**.

Enables Teams to:

- Quickly identify and diagnose issues
- Optimize resource usage
- Ensure compliance
- Monitor model performance and detect drift
- Track data quality and integrity

Feedback Loop:

- Continuous monitoring and retraining using real-world data
- Helps models adapt to user behavior, new data patterns, and emerging trends
- Drives better decision-making, user experience, and business value

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The Need for ML Observability in MLOps

Pillar	What It Covers	GCP Services / Methods
Data Quality	Detect schema mismatches, cardinality shifts, out-of-range values; track distribution drift in features.	**Vertex AI Feature Monitoring** for feature drift & anomalies; batch & streaming ingestion via **BigQuery**, **Dataflow**, or **Cloud Storage**; establish baseline datasets with **Vertex AI Data Labeling** and **Data Quality checks**.
Fairness / Bias	Pre- and post-training bias detection; monitor predictions' distribution across sensitive groups.	**Vertex AI Fairness Indicators** to compute fairness metrics across facets; integrate with model evaluation pipelines in **Vertex AI Experiments**.
Explainability	Understand which features drive predictions (global & local); detect unjustified dependencies.	**Vertex AI Explainable AI** using SHAP/LIME-like methods; feature attribution for global & local explanations; visualize top features, heatmaps, and partial dependence plots.
Model Performance / Drift	Monitor model accuracy, recall, F1, etc.; detect concept drift; compare predictions vs ground truth.	**Vertex AI Model Monitoring** for drift detection and performance metrics; optionally use **TensorFlow Data Validation (TFDV)** or open-source libs like **nannyML**.

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Observability checks

Concept drift

Monitor changes in Performance metrics

- Model accuracy
- Model score drifts
- Monitor drift between train baseline and production scoring

Bias metrics drift

Monitor changes in bias metrics

- Model fairness

Data drift

Monitor changes in data distribution

Monitor changes in embeddings distribution for images or text

- Monitor feature drifts across tabular (structured) and unstructured (images, video) data

Feature attribution drift

Track changes in feature contribution

- Explainability

Let’s Demo

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Thank you!

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