

10th
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Pipeline Probe: A Tool for Automated Quality Assessment in MLOps

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- Novel, open-source tool developed for automated quality assessments in MLOps.
- Developed within IML4E, an ongoing ITEA project.
- 12 partners from 3 countries.
- For more info: <https://itea4.org/project/iml4e.html>



- Principles of DevOps applied to machine learning for effective development, deployment, monitoring and maintenance of ML models.
- In ML-based systems, behavior is influenced by code + data.
 - Quality assurance needs to include data, model, and code.

Introduction: MLOps

- In the context of MLOps, evolving nature of data and model demands consistent quality checks.

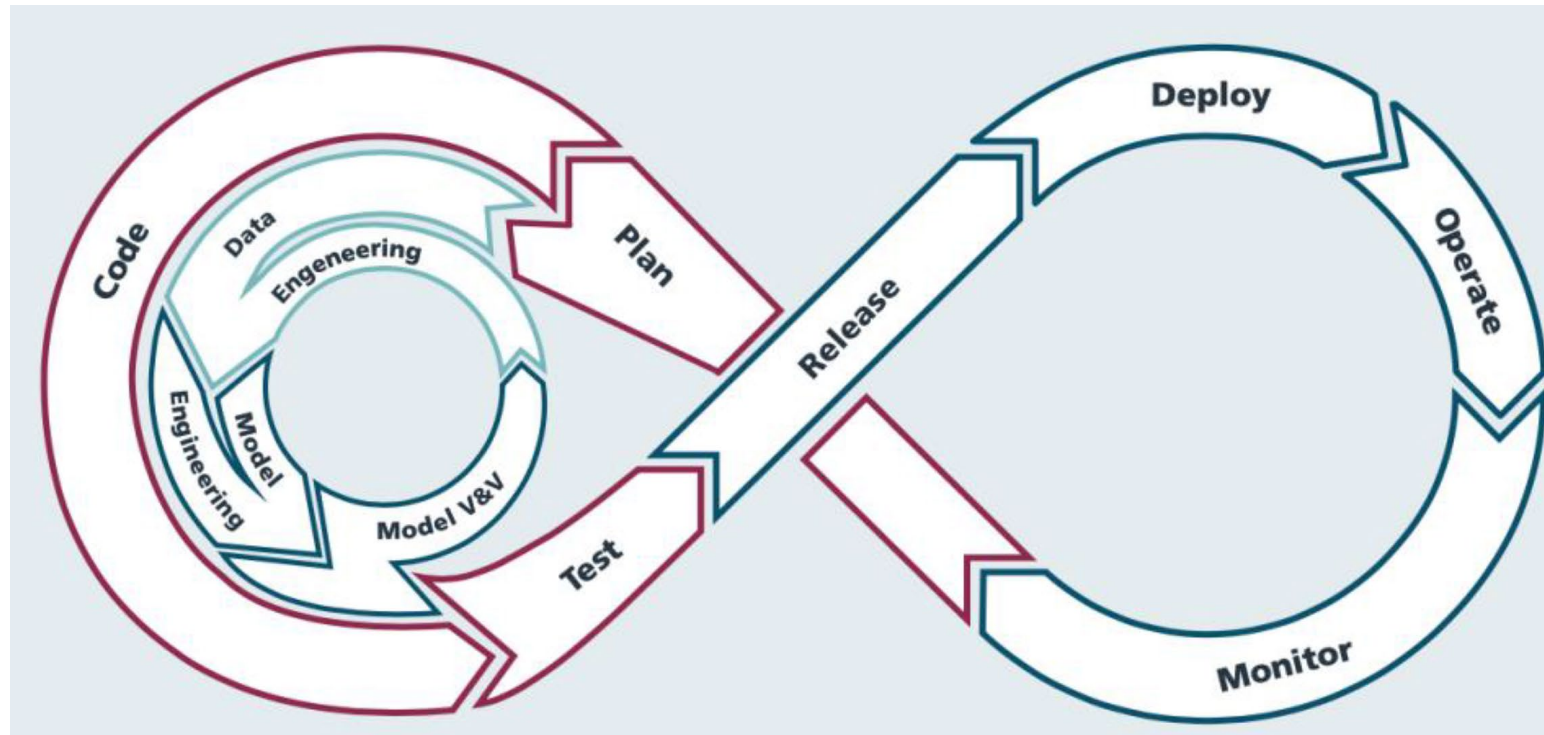


Fig 1. The IML4E MLOps life cycle.

Quality assessment in MLOps

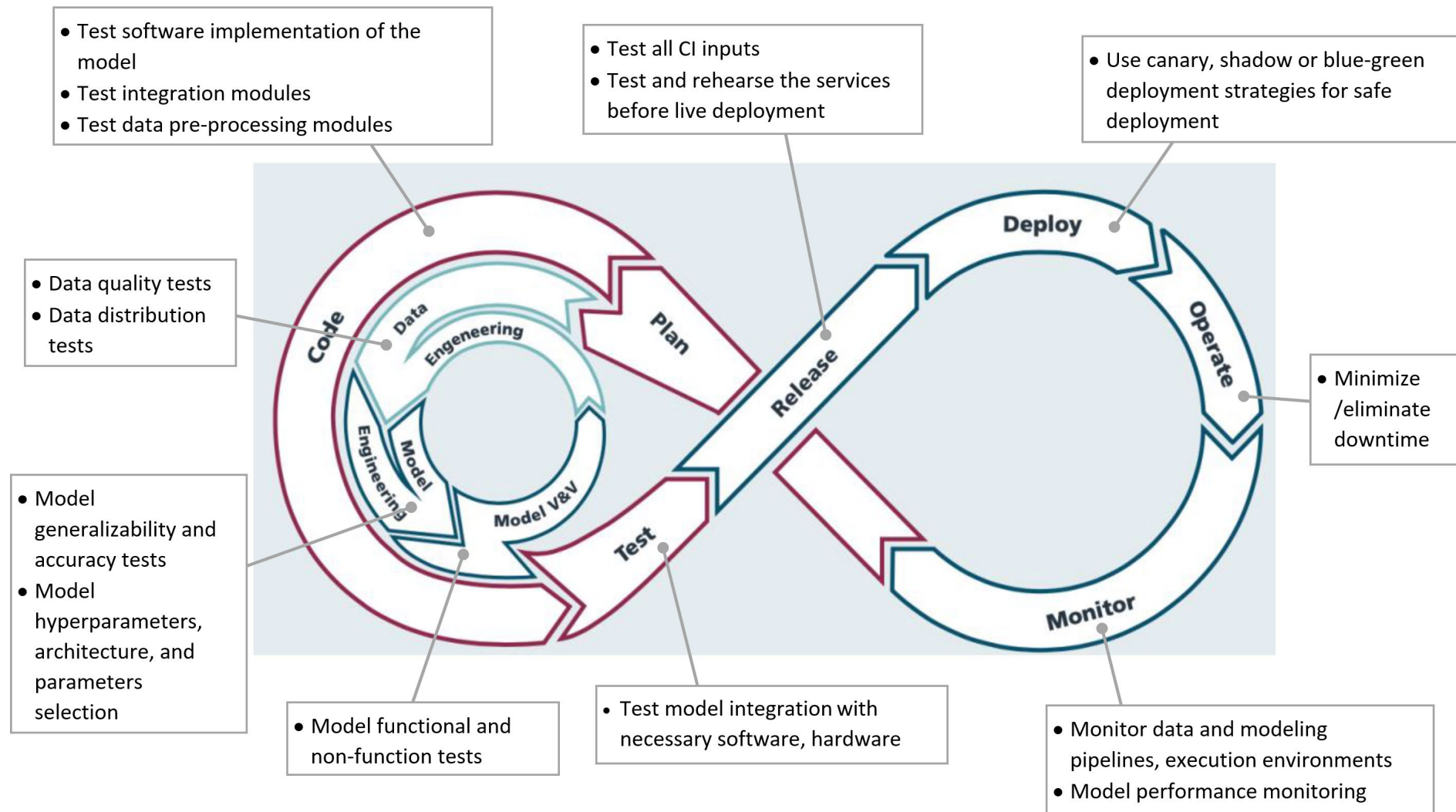


Fig 2. Continuous quality assessments throughout the life cycle.

- Manual assessments fall short because:
 - DNNs are inherently complex
 - frequency of updates can be overwhelming

- Coping with complexity and repeated tests requires automation.

- Enabled by tools and processes to programmatically test, validate, and monitor models.

- Benefits:
 - reduces manual effort
 - consistent performance
 - improved efficiency
 - reliable results

Automated quality assessments

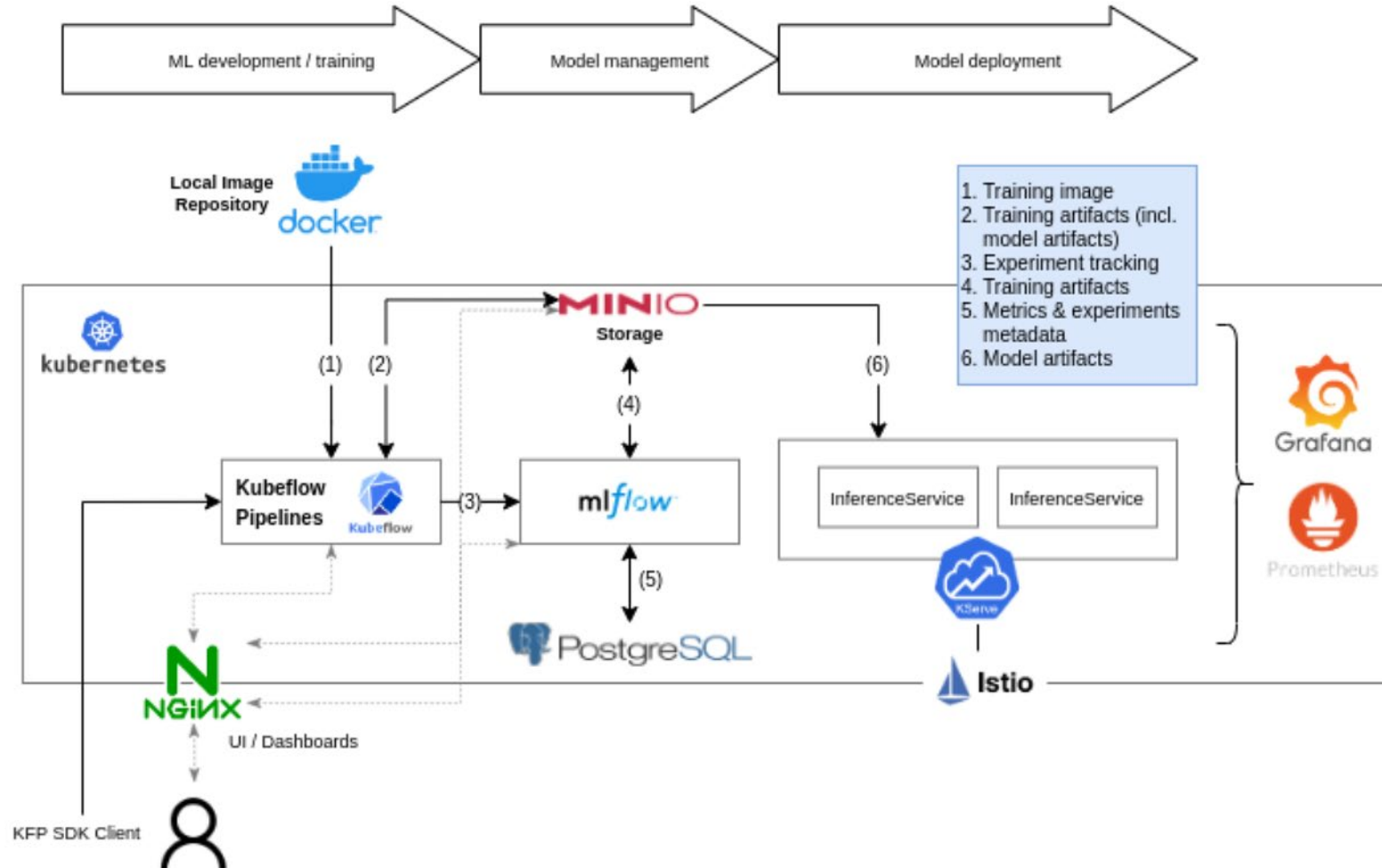


Fig 3 . Experimentation platform developed by SILO AI¹ within the IML4E project.

1. <https://www.silo.ai/>

Integrating tools in the MLOps pipeline

- Specific workflow has to be followed for each implementation.

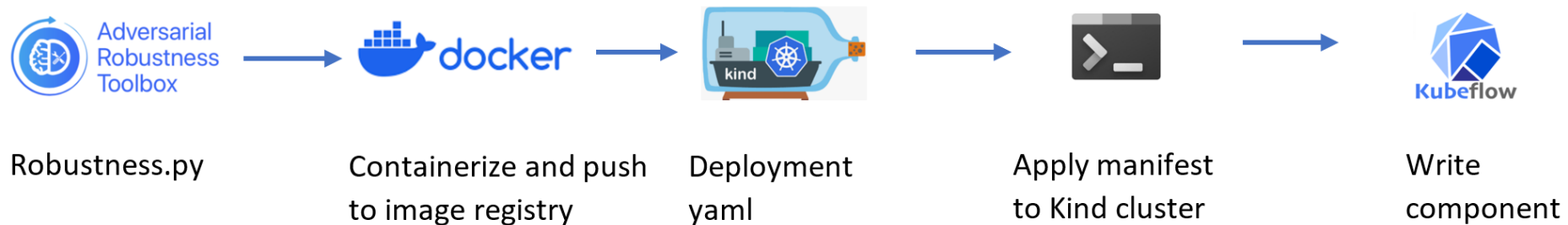


Fig 4.a. Steps to add a robustness test application to a Kubeflow pipeline.



Fig 4.b. Steps to add a data quality evaluation test suite to a Kubeflow pipeline.

Integrating tools in the MLOps pipeline

- Significant code adaptations are required for each use case.

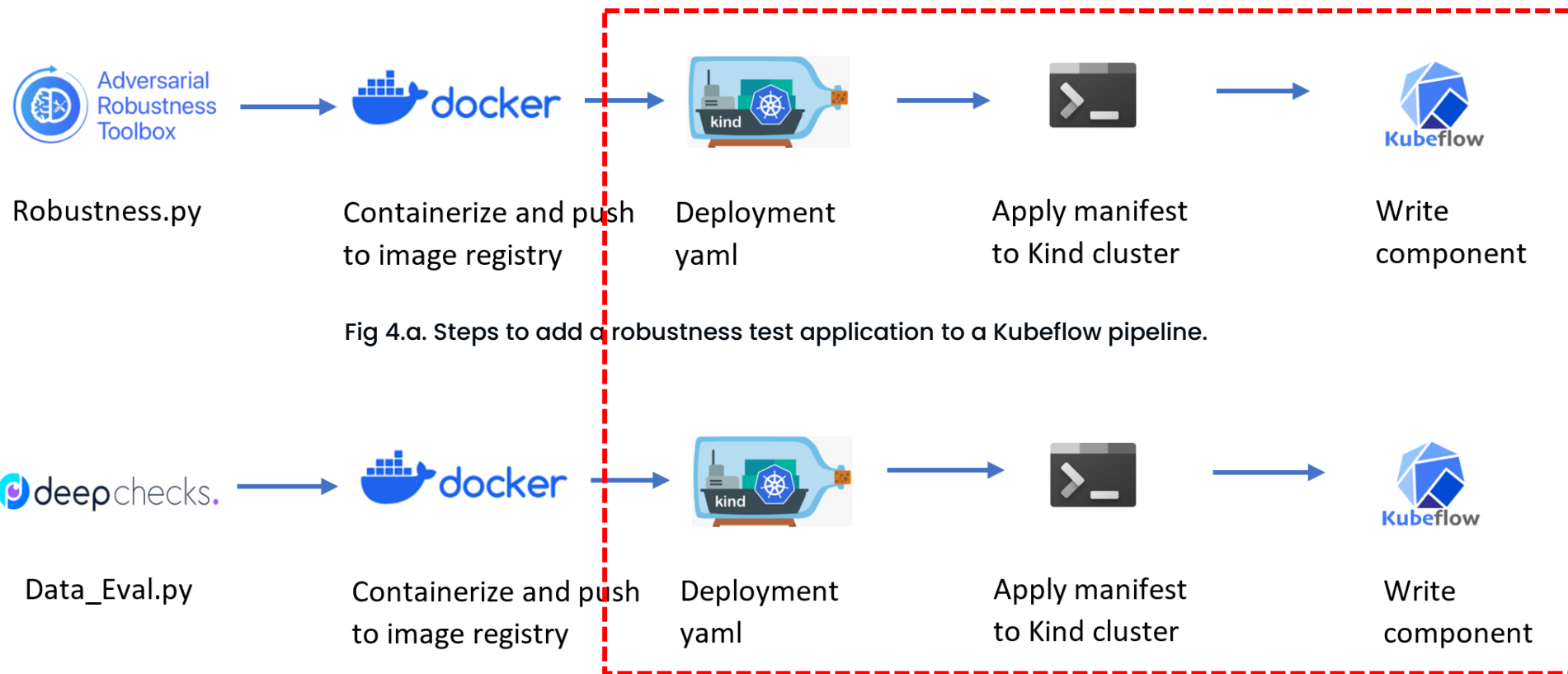


Fig 4.a. Steps to add a robustness test application to a Kubeflow pipeline.

Fig 4.b. Steps to add a data quality evaluation test suite to a Kubeflow pipeline.

- Pipeline Probe provides a thorough evaluation of ML models by analyzing various artifacts produced during MLOps cycle.
- Implements a unique plugin mechanism that:
 - allows seamless integration with popular MLOps pipelines like Kubeflow
 - incorporates existing assessment tools without having to make substantial changes to your current implementation

Pipeline Probe: Architecture

- Plugins are used to collect, analyze, and evaluate artifacts throughout the life cycle.
- Each plugin is a separate program running on a particular port.
- The core and the plugins use gRPC calls to communicate.
- The core registers, manages, and has information about status of all the plugins.

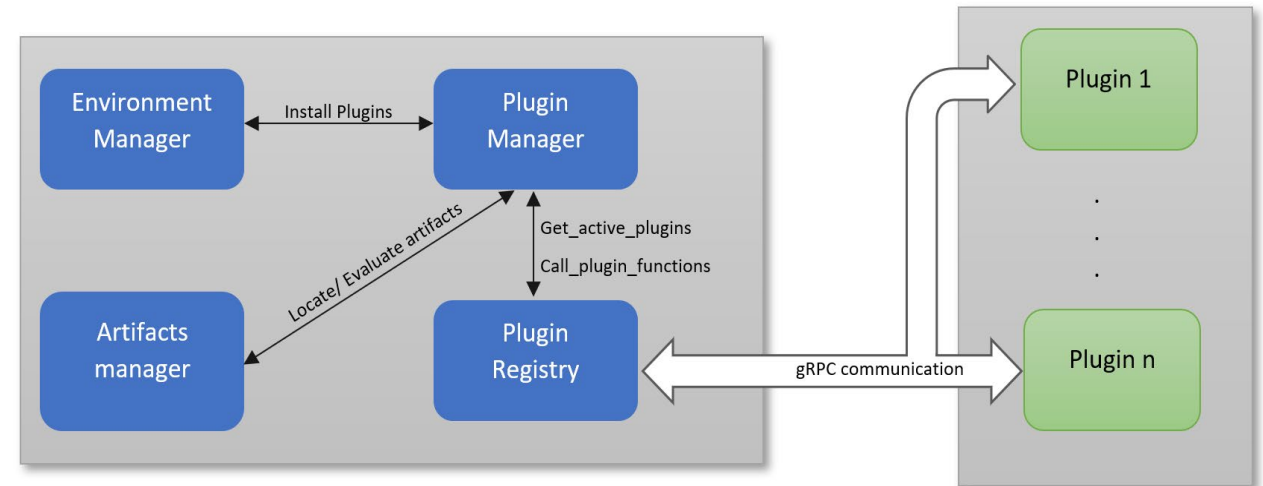


Fig 5. Pipeline Probe component diagram.

Pipeline Probe: Value proposition

- Integration through plugins provides more flexibility and requires less effort.

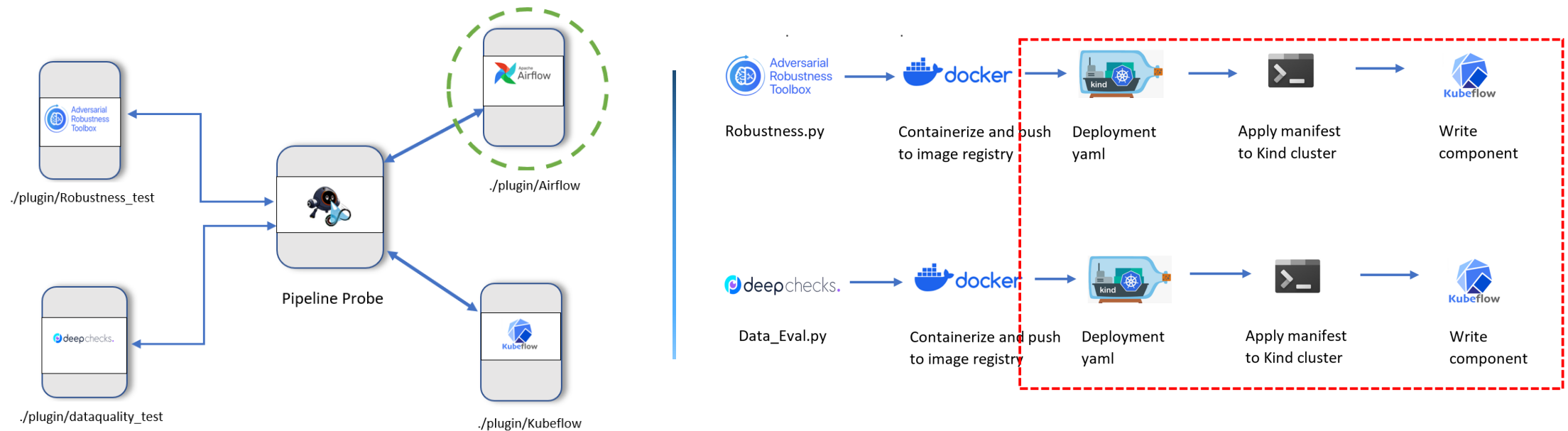


Fig 6. Easily integrate multiple tools within the pipeline.

Pipeline Probe: Value proposition

- Root cause analysis using integrated tools:
 - provides better understanding of issues
 - enables data and model problem isolation

- Test automation:
 - guided by pre-defined test strategies
 - dynamically triggered by assessment results from other integrated tools

Industrial use case

- Siemens case study: Continuous monitoring of image quality.
 - Custom data quality evaluation tool integrated to Pipeline Probe via a plugin.
 - Data quality evaluations based on ISO 25012/24 on the TTPLA (Transmission Towers and Power Lines) dataset¹.
 - Includes various quality measures like semantic and syntactic accuracy, risk of data inconsistency, and completeness, among others.

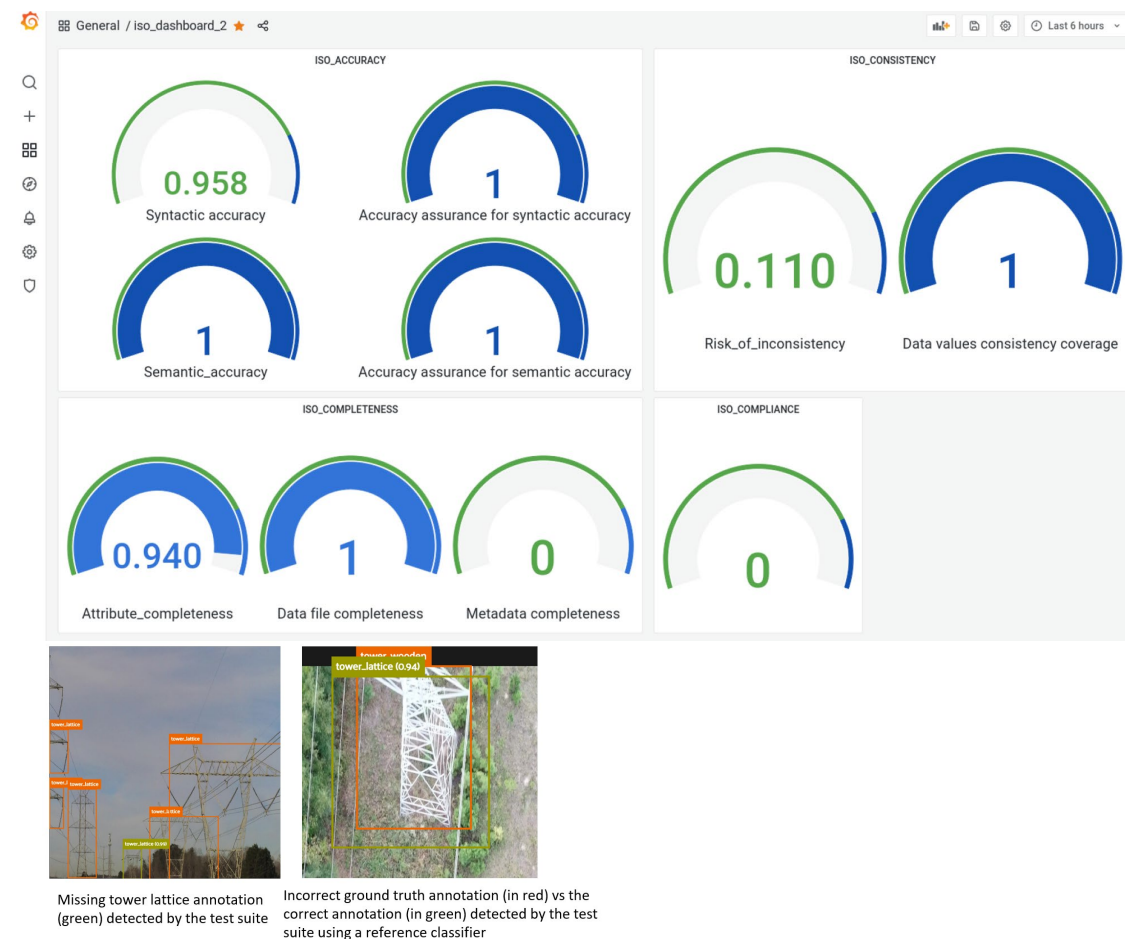


Fig 7. Visualizing data quality evaluation results from TTPLA run on Grafana dashboard (above). Visualizing results from logs (below).

1. https://github.com/r3ab/ttpla_dataset

The open-source initiative

- Our efforts on building plugins:
 - Kubeflow
 - Data quality evaluation tool
 - batch data streaming from delta tables
 - Adversarial Neural Network Toolbox
- Pipeline Probe along with the plugins will be open-sourced.
- An open and collaborative repository of plugins.
- Developers can write plugins for their preferred tools. Additionally, if they wish, they can make their plugins available for use by others.

- Quality assurance of ML systems is essential to ensure reliability and performance of ML models.
- Currently available tools require specific rigid changes for each implementation.
- Pipeline Probe is designed to address these challenges. The automation capabilities offered by Pipeline Probe allows for efficient and comprehensive quality assessments.
- The open-source nature and the plugin mechanism make the Pipeline Probe accessible and customizable to a wide user-base.

Any further questions?

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