RustNL GOSIM 2024 EUROPE

dora-rs

Modern Dataflow Framework for Robotics

Haixuan Xavier Tao, Founder of ⚡ 1ms.ai

Motivation

- Make creation of robotic applications fast and simple
- Super easy integration with latest technologies (e.g. DL models, Cloud, DBs ...)

Use Case

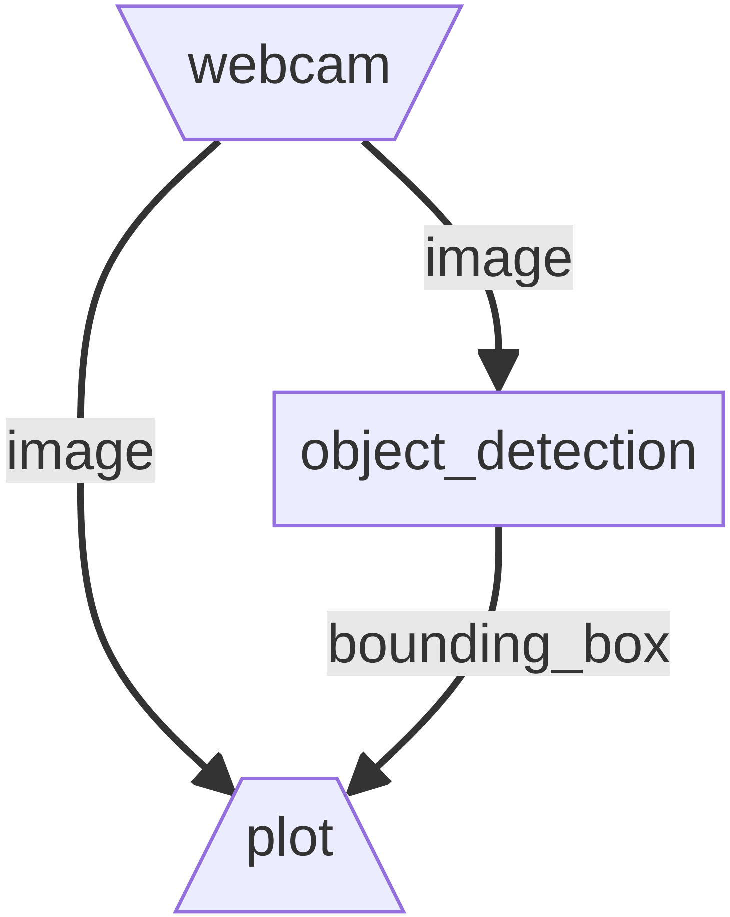
- DIY off-the-shelf robotics hardware
- Research

Audience

- Robotics Enthusiasts
- Masters Students
- Phds

What is a robotic application?

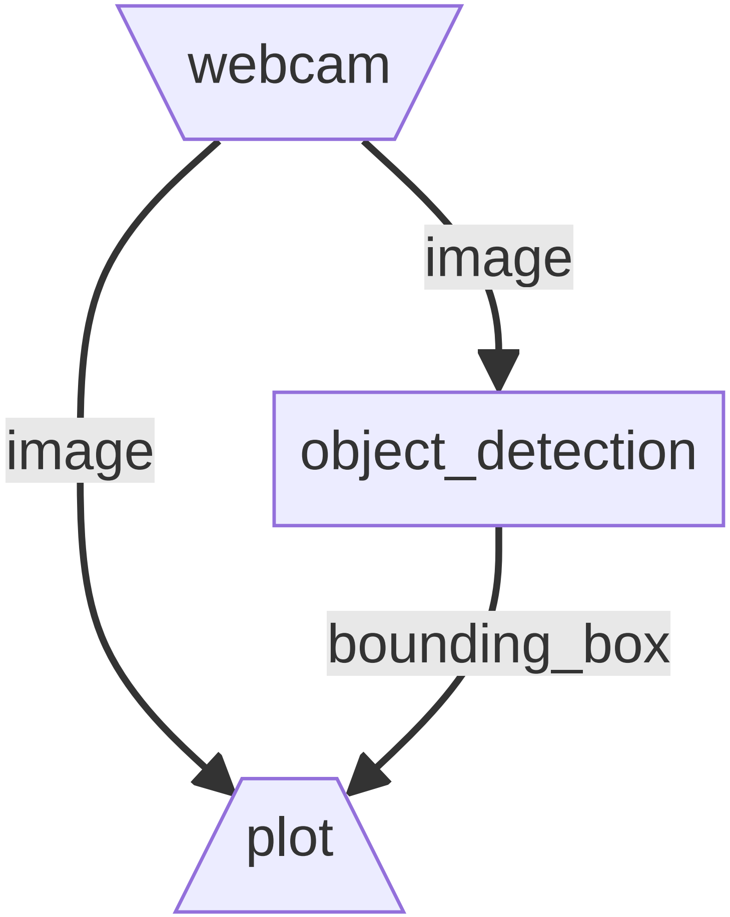
Programming a robot can be summed up as bringing together hardwares, algorithms, and AI models, each with their main loop and make them communicate with each others.



Design

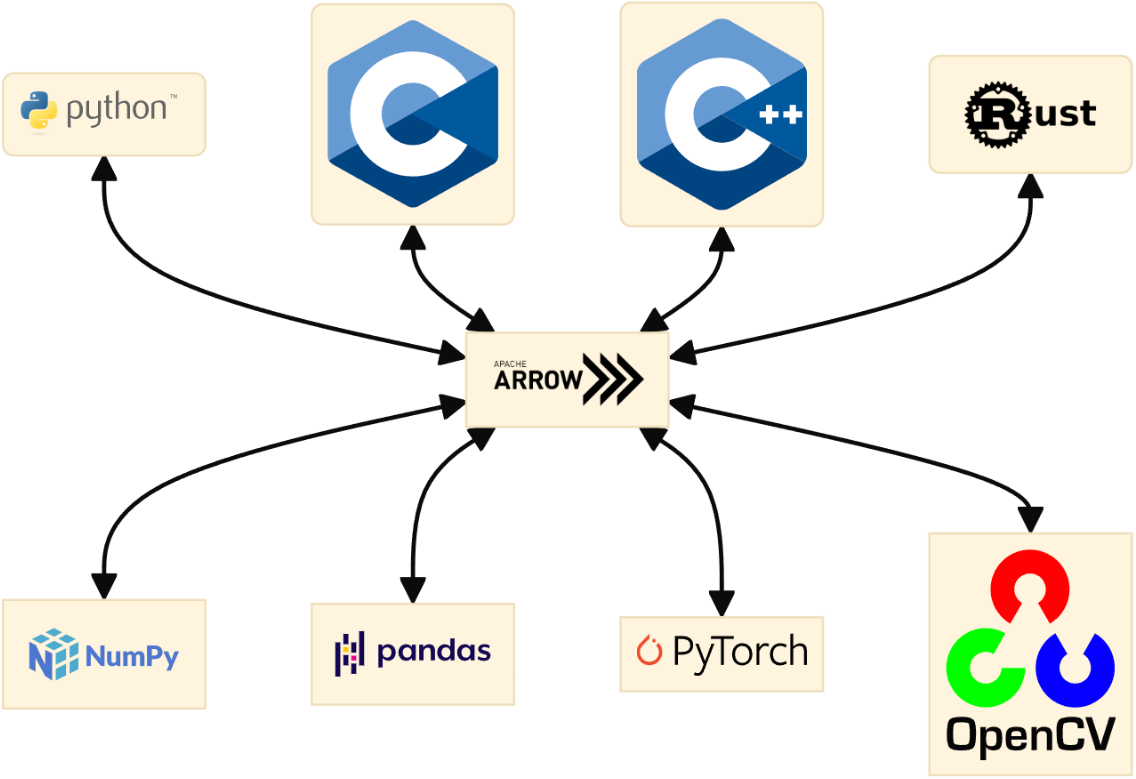
- Application are defined as dataflow graph
  - Nodes are separate process → isolation, flexibility
  - Each node defines a set of inputs and outputs

```
nodes:
- id: webcam
  path: webcam.py
  outputs:
    - image
- id: object_detection
  path: yolov8.py
  inputs:
    image: webcam/image
  outputs:
    - bounding_box
- id: plot
  path: dora-rerun
  inputs:
    bounding_box: object_detection/bounding_box
    image: webcam/image
```



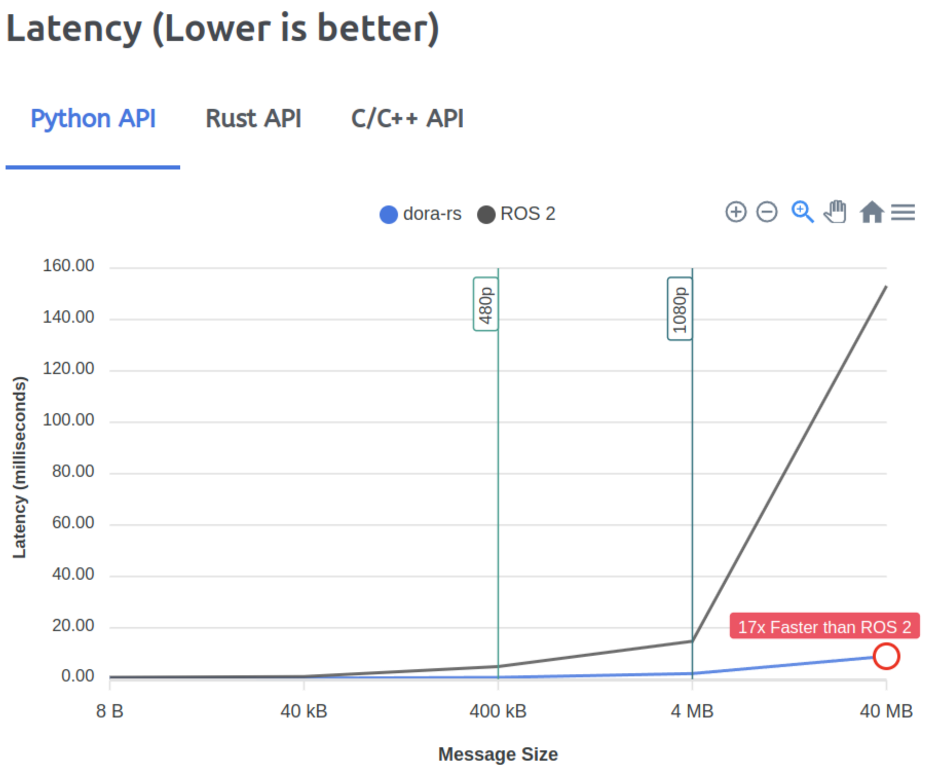
Communication

Arrow based communication using zero copy and shared memory already integrated in your favorite libraries.



Performance

Over 20x improvement compared to existing open source solutions in Python



Latency (Lower is better)

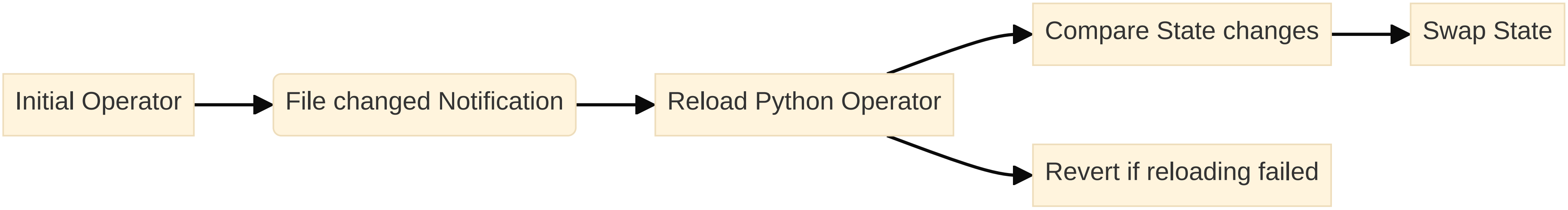
Deep Learning Models

- Simple integration with AI models:

Model	Functionality	Latemcy	GPU RAM
openai/whisper	Speech to Text	1.5s	0.7GB
huggingface/idefics2-8B	Image to Text	1.5s	8GB
huggingface/parler-600M	Text to Speech	1.5s	3GB
ultralytics/yolov8n	Image recognition	2ms	0.7GB
deepseek-ai/DeepSeek-Code-7B	Text to Code	3.5s	7GB

Python hot-reloading

- Great developer experience with runtime code change.
- Removes the need for reset at each iteration step.
- Contains fail-safe methods for avoiding big undefined behavior.
- Integrates well with Large Language Models(LLMs).



Initial Operator

File changed Notification

Reload Python Operator

Compare State changes

Swap State

Revert if reloading failed

Comparative Table

	dora-rs	ROS 2 (Humble)
Tier 1 Support	Python, Rust	C, C++
Tier 2 Support	C, C++, ROS2	Python, Rust
Compilation	No Compilation	Colcon
Hot-reloading	Python	
Message Format	Arrow	ROS Message (Protobuf)
Local Communication	Shared Memory	Shared Memory for C/C++
Remote Communication	TCP (experimental)	DDS
Metrics, Tracing, and Logging	Opentelemetry	ROS2 custom tooling
Data archives	Parquet	Rosbag
Supported Platforms	Windows, macOS, Linux (All Platform)	Windows 10, Ubuntu 22.04
Configuration	YAML	XML

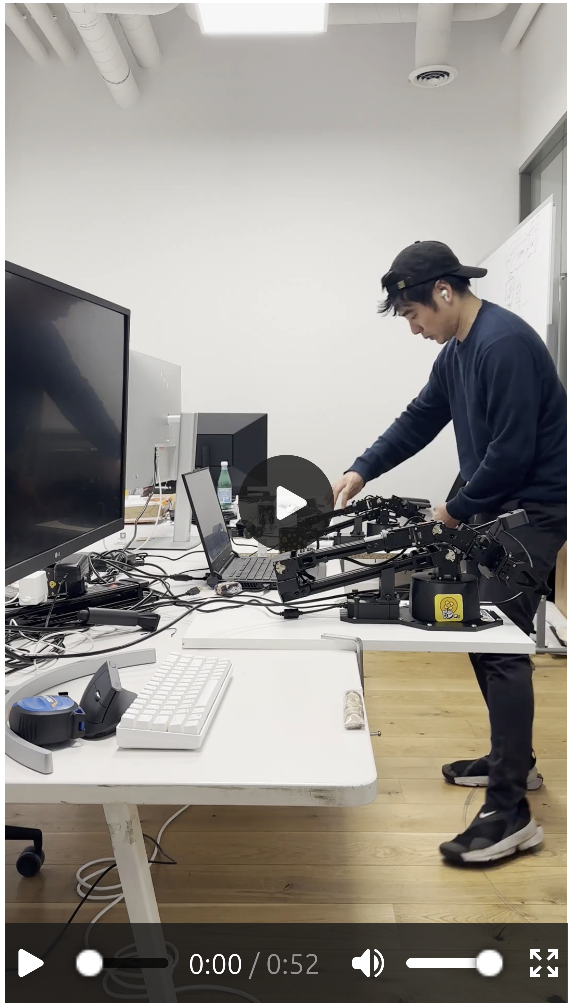
Coming up!

🤗

Partnership with Huggingface that brings the help of:

- Thomas Wolf, cofounder of Hugging Face, one of the leading AI Startups
- Remi Cadene, Prinicpal at HuggingFace, and ex-Tesla that used to lead the team that build Optimus

dora-arms: Powering robotics arms



dora-arms: Powering robotics arms

Promising result:

- Increase by 10x the frequency (from 50Hz to 500Hz) on teleoperation from SOTA aloha robotic arms, amd reduced the latency to 2ms of communication between the 2 arms by having only a single process.
- Fine-grained teleoperation data for training as well as providing better control on teleop, which should lead to better dataset and models.
- Removed the need for complex installation and instead use `cargo`
- Making robotic cross-platform: Linux, MacOS, Windows and available on: Rust, C, C++, Python

Thanks for listening 😃

- github.com/dora-rs/dora Stars 1k

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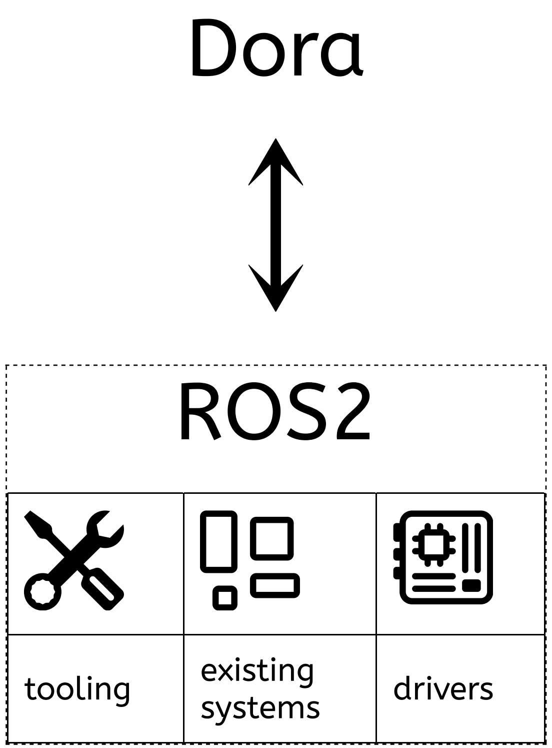
ROS2 Bridge

- Allows gradual migration of existing ROS2 applications
- Makes it possible to use ROS2 tooling with Dora

Current Work in Progress:

- Communication via DDS middleware
- Autogenerate Rust and C++ bindings for ROS2 message files.
- Automatic type conversions between ROS2 type, Arrow Type and Native Type



Dora

ROS2

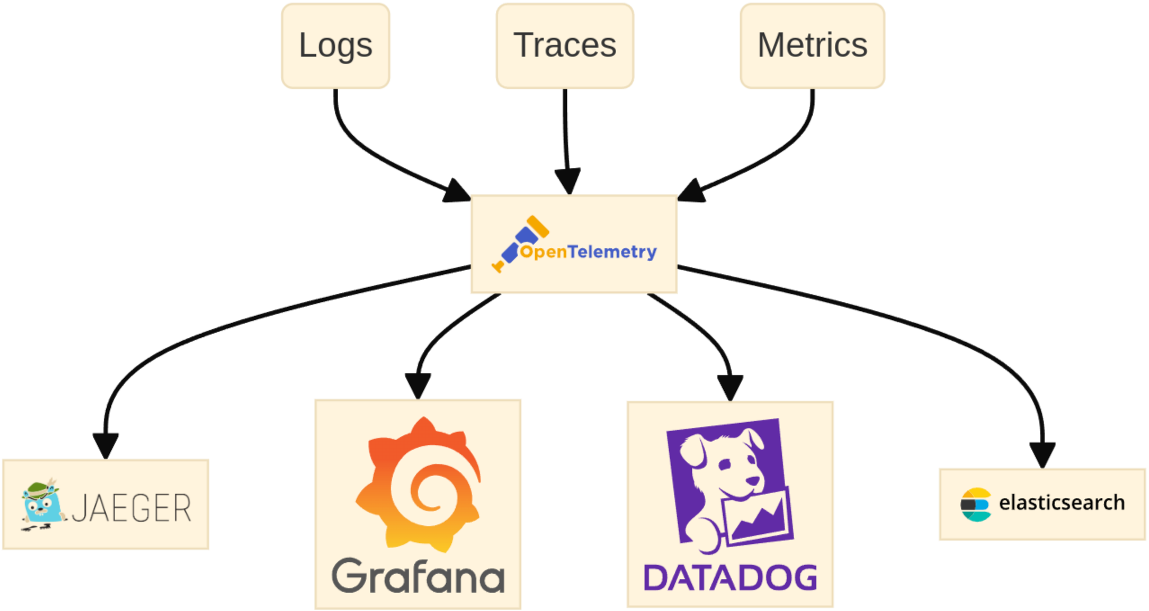
tooling

existing systems

drivers

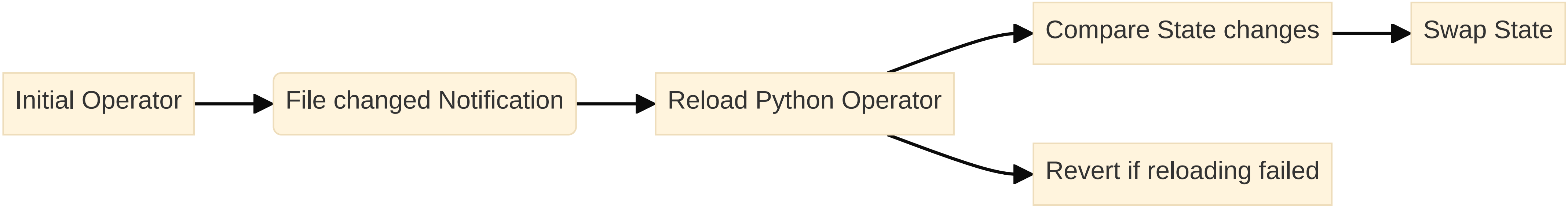
Opentelemetry

- Uses Opentelemetry for logs, tracing and metrics
- Language agnostic, Backend agnostic, and handles distributed systems
- Linking logs, traces and metrics with a same abstraction.



Hot Reloading for Python

- Enables code change at runtime keeping current states intact.
- Removes the need for reset at each iteration step.
- Contains fail-safe methods enabling to fail fast.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