# Open-Source Robotic Manipulation and Benchmarking: Current Gaps and Future Solutions

ROS-Industrial Consortium Americas 2023 Annual Meeting

May 25, 2023 Detroit, Michigan

https://www.robot-manipulation.org/

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# How to Enhance the Open-Source Ecosystem?

For Better Performance Benchmarking in Robotics

For Better Comparison Between Methods

Boosting Use of Datasets and Open-Source Tools

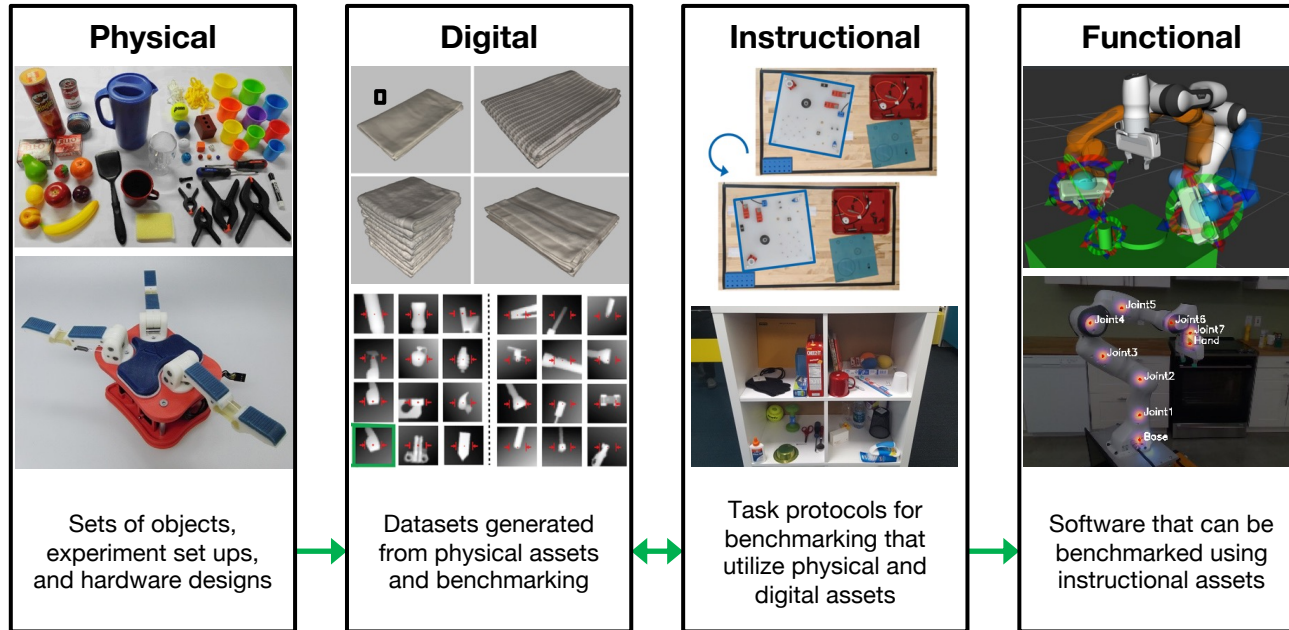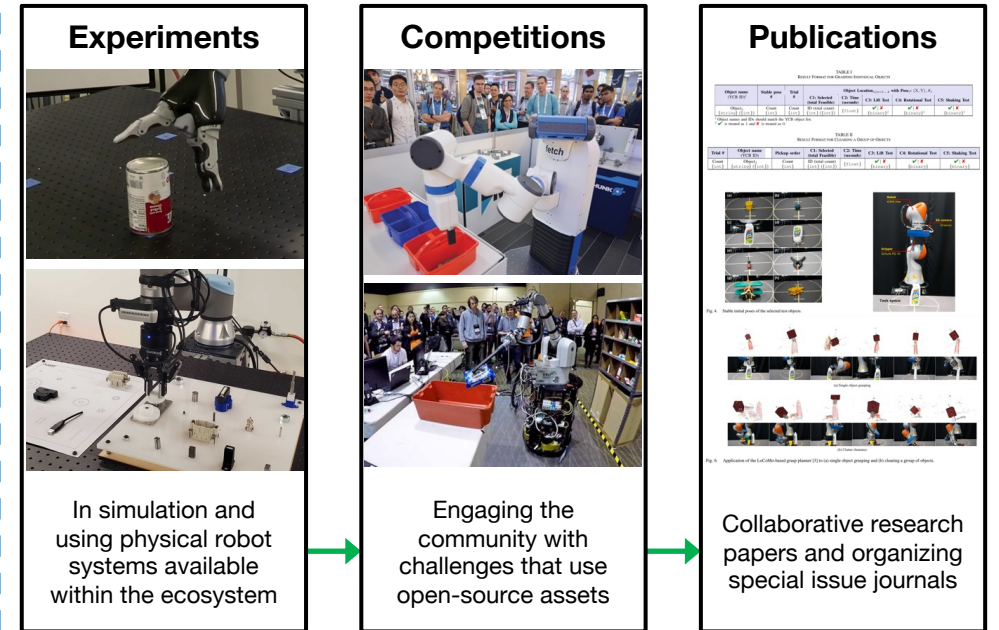Enhance Communication Between Researchers

# Ecosystem

## Open-Source Assets

### Physical



Sets of objects, experiment set ups, and hardware designs

### Digital



Datasets generated from physical assets and benchmarking

### Instructional



Task protocols for benchmarking that utilize physical and digital assets

### Functional



Software that can be benchmarked using instructional assets

## Development and Benchmarking

### Experiments



In simulation and using physical robot systems available within the ecosystem

### Competitions



Engaging the community with challenges that use open-source assets

### Publications



Collaborative research papers and organizing special issue journals

# Survey on Open-Source and Benchmarking for Robotics

- **Feedback on the current landscape**
  - Benchmarking
  - Open-source
  - Simulation and hardware
  - Limitations and barriers

- **Feedback on proposed solutions**

- **Open response for suggestions**

# Open-Source Robotic Manipulation and Benchmarking: **Current Gaps**

## **Barriers** (highest to lowest frequency)

1. <mark>My research is limited by a lack of relevant comparable benchmarks in the field</mark>
2. My research is limited by current robot simulation capabilities
3. I face barriers when attempting to integrate open-source assets into my research
4. My research is limited by a lack of relevant open-source assets in the field
5. My research is limited by access to robotic hardware

## **Activity** (highest to lowest frequency)

1. I learn about the availability of new open-source assets
2. I utilize open-source assets (e.g., YCB Object Set, Cornell Grasp Dataset, GPD) in my research
3. I benchmark my robotic manipulation research to others in the field
4. <mark>I contribute to open-source for robotic manipulation</mark>

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# Open-Source Robotic Manipulation and Benchmarking:
# **Future Solutions**

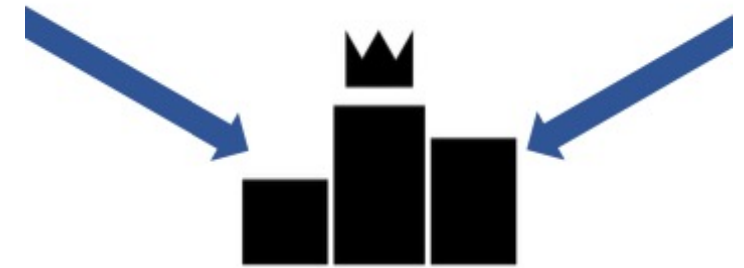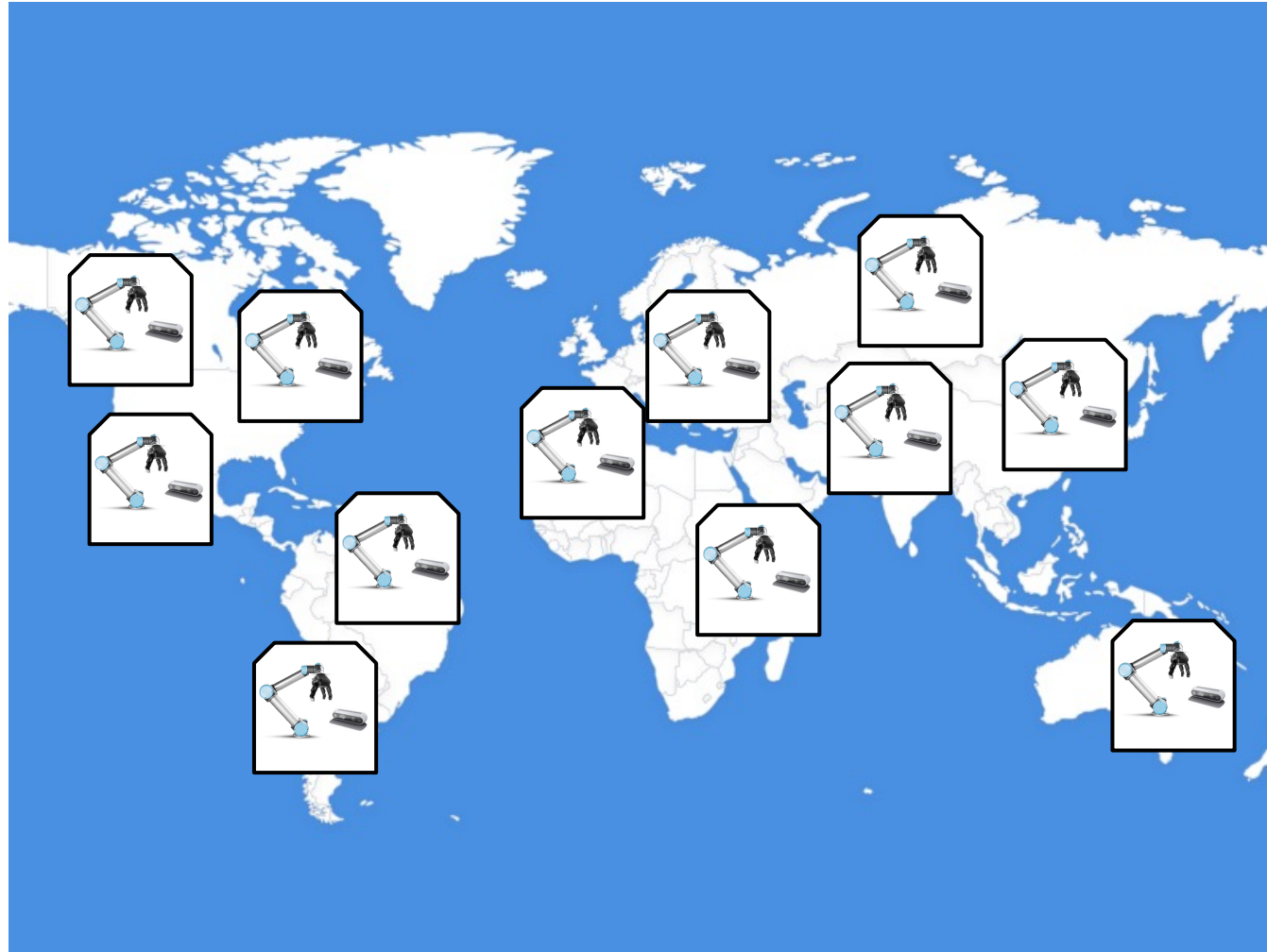| **Modular Benchmarking Software Pipelines** | **Distributed Physical Benchmarking Facilities** | **Online Community Resources** | **Working Groups and Advocacy** |

Perception → *Grasp Detection** → Motion Planning → Robot Control
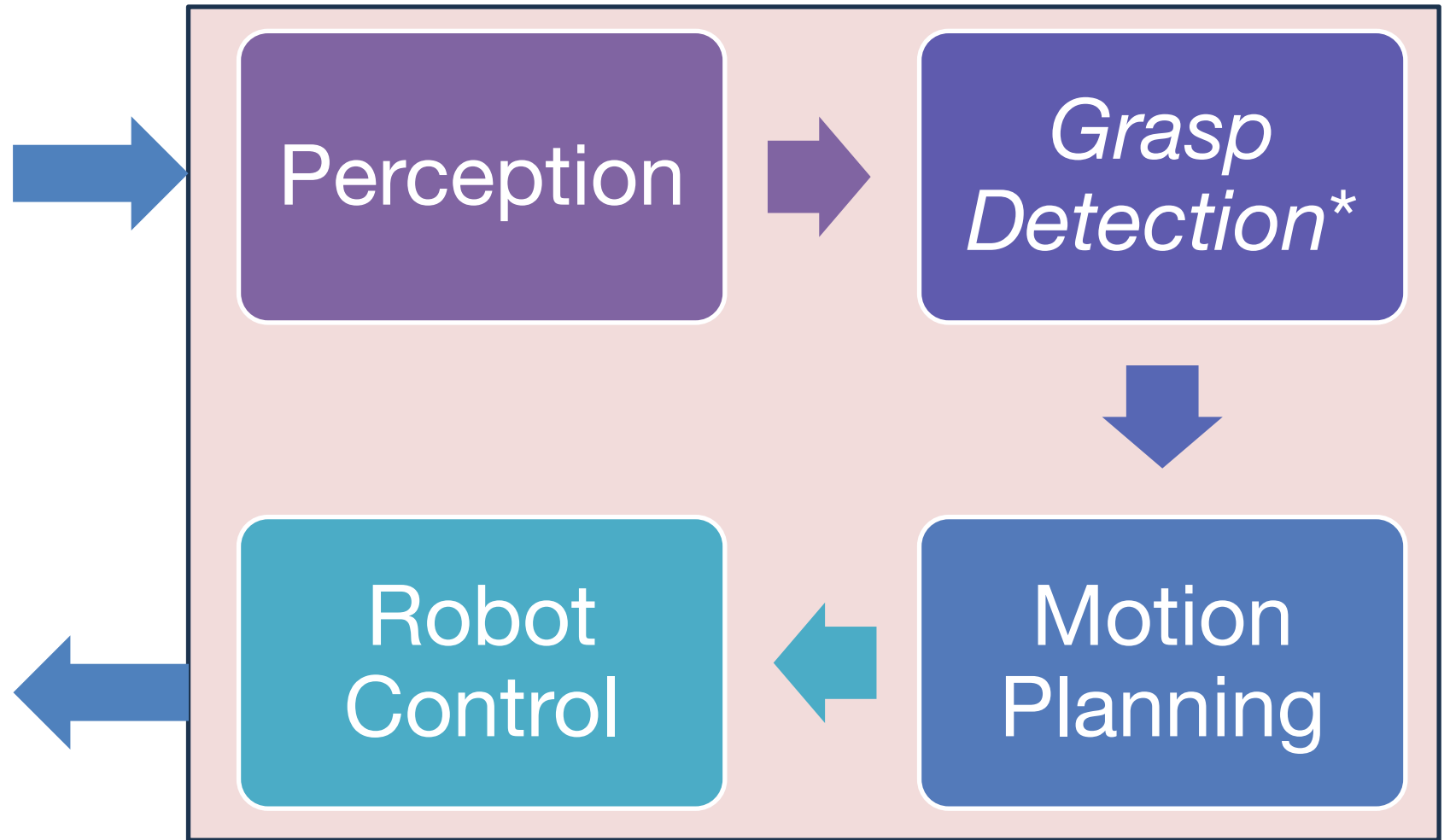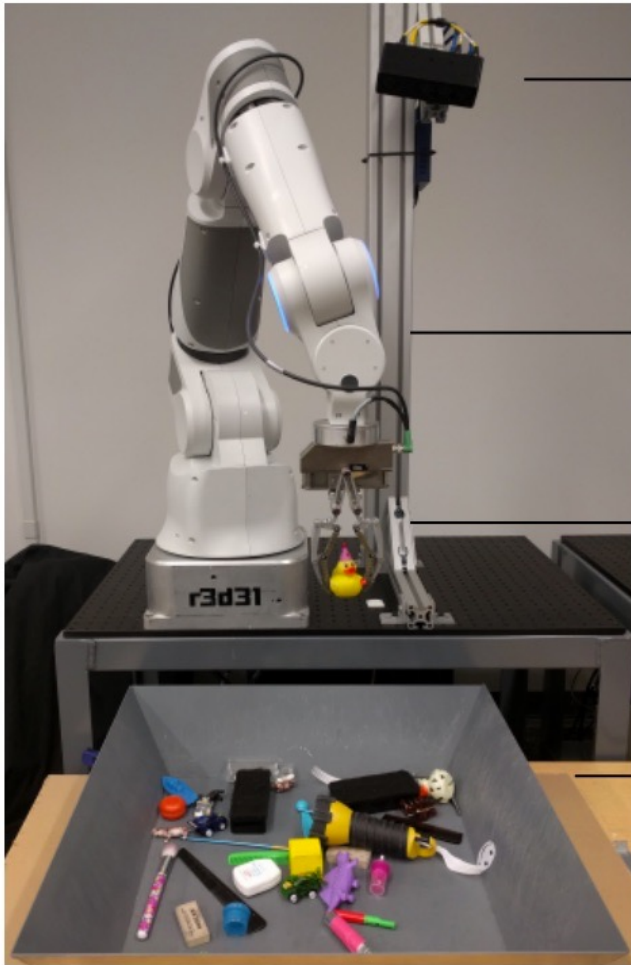
*Example application

# Future Solution:
# **Distributed Physical Benchmarking Facilities**



Global Leaderboard

*"Benchmarking with a Twist" Paper*

# Future Solution:
# **Online Community Resources**

| | |
|---|---|
| **1) Organized repositories of open-source assets** | E.g., object sets, 3D models, datasets, hardware designs |
| **2) Organized repositories of benchmarking results of robotic manipulation solutions** | E.g., similar to Papers with Code |
| **3) Online forums for discussion and coordination of community efforts** | E.g., ROS Discourse, Reddit upvote/ downvote for prioritization |
| **4) Organize efforts to integrate benchmarking results into existing resources** | E.g., ROS Enhancement Proposal (REP) for coupling performance data with packages |

# Future Solution:
# **Working Groups and Advocacy**

| | |
|---|---|
| **1) Establishing advisory committees and working groups** | E.g., reviewing contributed open-source assets and benchmarks to meet community standards |
| **2) Advocacy of open-source and benchmarking best practices into existing working groups** | E.g., IEEE technical committees, ASTM standards committees |
| **3) Advocating for conference/journal submission acceptance criteria to favor best practices** | E.g., criteria including comparative benchmarking and leveraging of open-source assets |