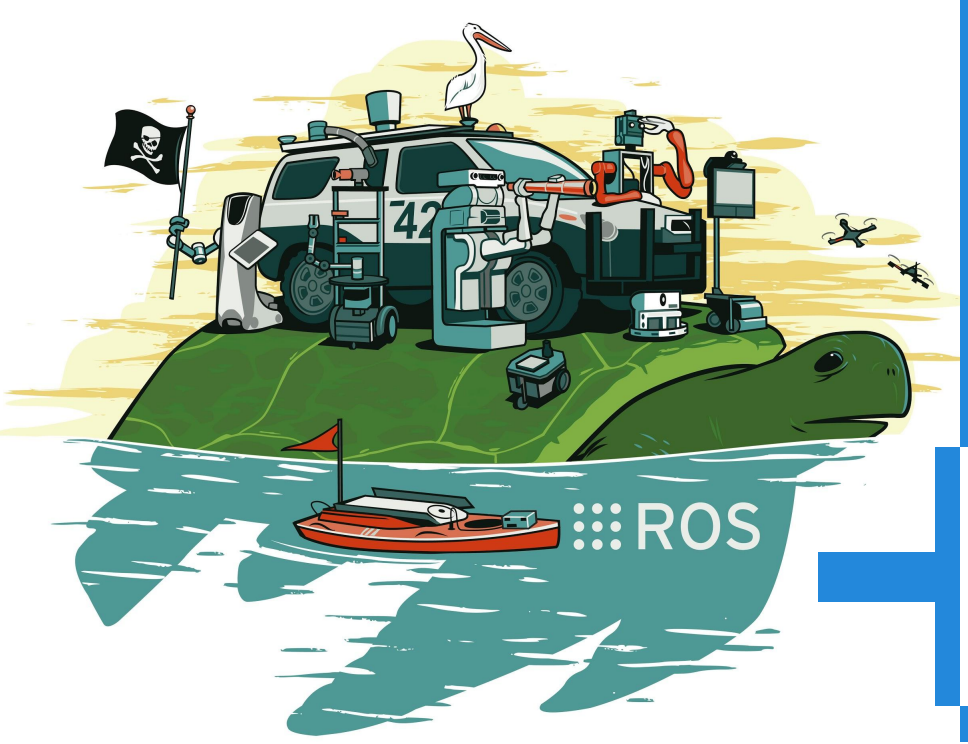
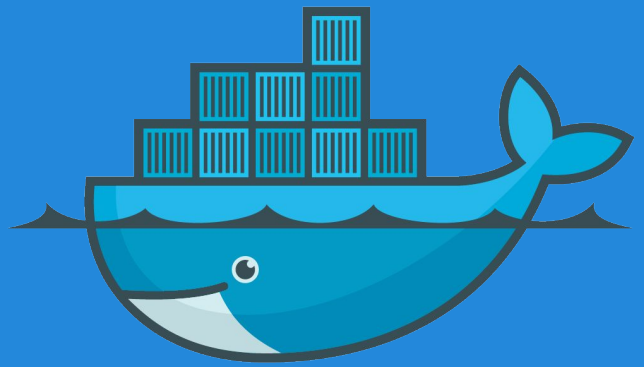




docker

Enabling Docker for Robotic Applications

Open Source Robotics Foundation

By Ruffin White

Motivation

Repeatable

Reproducible

(and Deployable!)

Robotics

“Amigoni et al. [8] showed that not a single paper among the top cited ones in SLAM and navigation met all the basic criteria listed in the GEM guidelines. We may have clearly improved since then, but probably not enough.”

Open source, interactive data science and scientific computing across over 40 programming languages.

Pérez, F.; Granger, B.E., "IPython: A System for Interactive Scientific Computing," in Computing in Science & Engineering , vol.9, no.3, pp.21-29, May-June 2007

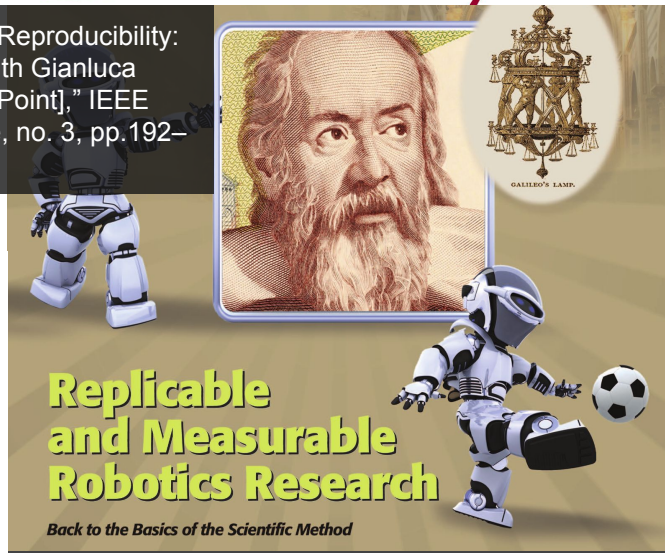
Ragan-Kelley, M., et al. "The Jupyter/ IPython architecture: a unified view of computational research, from interactive exploration to communication and publication." AGU Vol. 1. 2014.

C. Boettiger, “An introduction to docker for reproducible research,” ACM SIGOPS Oper. Syst. Rev., vol. 49, no. 1, pp. 71–79, Jan. 2015.

Chamberlain, Ryan, and Jennifer Schommer. Using Docker to support reproducible research. Technical report, Invenshure, LLC. figshare. 1101910, 2014.

IEEE Robotics & Automation Society

“On Research Reproducibility: An interview with Gianluca Setti [Turning Point],” IEEE R&A Magazine, no. 3, pp.192–191, Sep.



F. Bonsignorio and A. P. del Pobil, “Toward Replicable and Measurable Robotics Research” IEEE R&A Magazine, no. 3, pp. 32–35, Sep

E. Guglielmelli, “Research Reproducibility and Performance Evaluation For Dependable Robots” IEEE R&A Magazine, no. 3, pp. 4–4, Sep.

Docker... What?

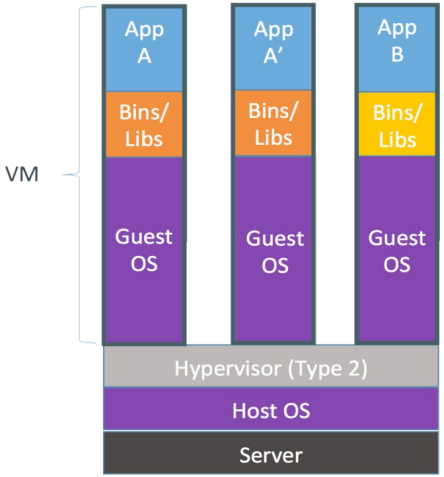
LINUX FOUNDATION COLLABORATIVE PROJECTS

amazon web services · APCERA · at&t · cisco · ClusterHQ · CoreOS · DATERA · docker · EMC² · FUJITSU · hp · HUAWEI · IBM · intel · Joyent · Kyup · KISMATIC · THE LINUX FOUNDATION · Google · MESOSPHERE · Microsoft · midokura · NUTANIX · ORACLE · Pivotal · POLYVERSE · RANCHER · redhat · resin.io · SUSE · sysdig · Verizon Labs · vmware

OPEN CONTAINER INITIATIVE

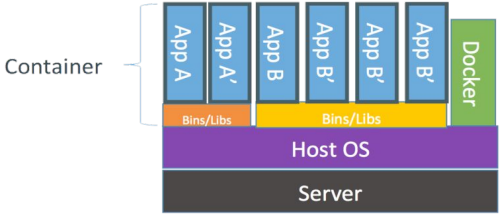
is not:

a Virtual Machine



is:

more like a chroot *on steroids!*

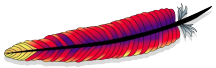


Containers are isolated, but share an OS, and where appropriate, bin/libraries

… resulting in portable RR&D software

Goal: (Open Source) Rapid Prototyping

Web:



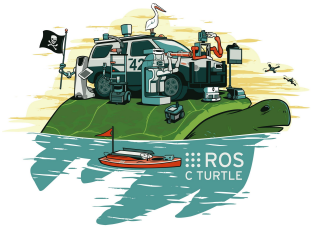
Robotics:

Open Source Robotics Foundation

Recent History

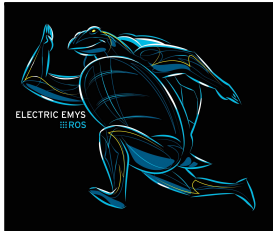
2010

2010

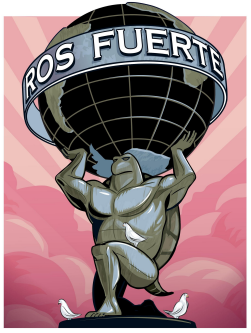


2010

2011



2011



2012

2012

2013

2014

2015

ROS Tools: Hardware Drivers

cameras
depth cameras
laser scanners
robots
audio
inertial units
GPS
joysticks
etc...

ROS Ecosystem: Variety

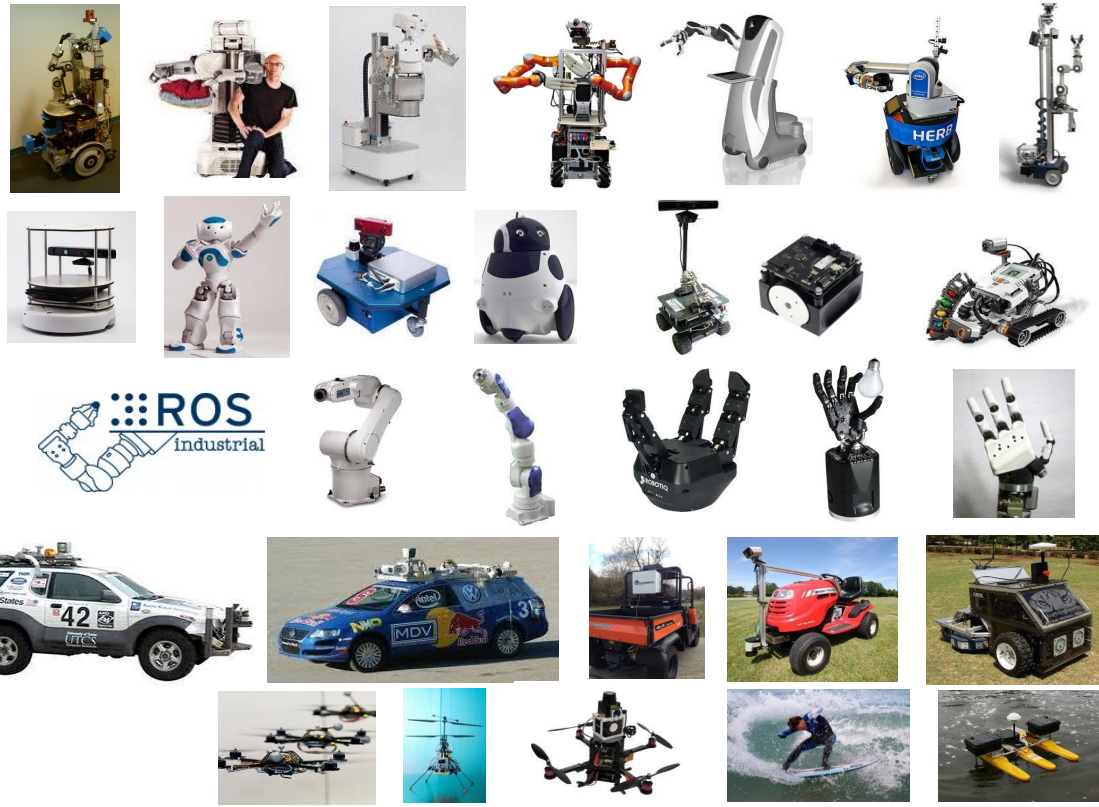
Big

Small

Industrial

Vehicles

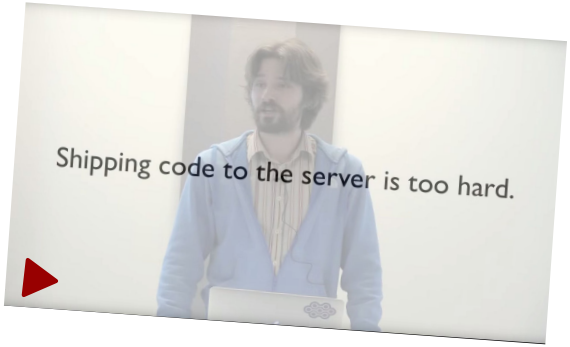
Air/Water



Matrix from Hell

	Development VM	QA Server	Single Prod Server	Onsite Cluster	Public Cloud	Contributor's laptop	Customer Servers
Static website	?	?	?	?	?	?	?
Web frontend	?	?	?	?	?	?	?
Background workers	?	?	?	?	?	?	?
User DB	?	?	?	?	?	?	?
Analytics DB	?	?	?	?	?	?	?
Queue	?	?	?	?	?	?	?

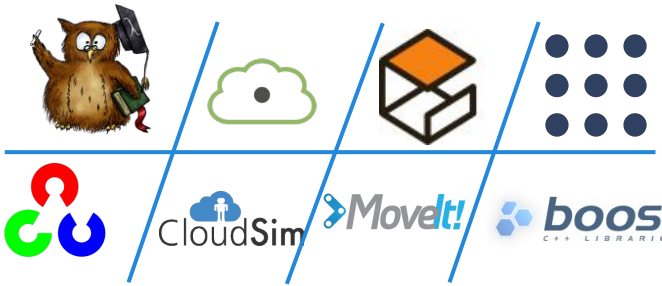
Look how small it is, it's so cute



Multidimensional Matrix from Hell ^{n} !!?

Platforms x Distros x Peripherals = n

The Curse of Dimensionality continues to plague us everywhere



Opps... forgot the about n+1 Libraries

But wait, there's more!

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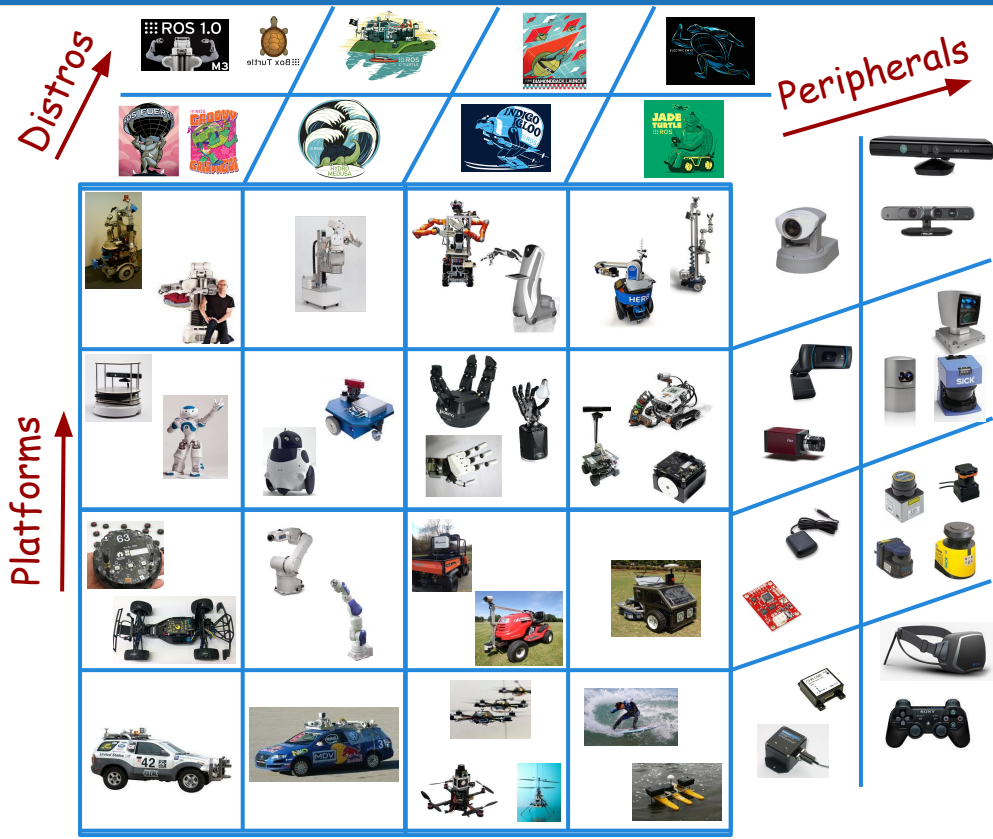


ROS + Docker… Why?

Because who loves going in circles?

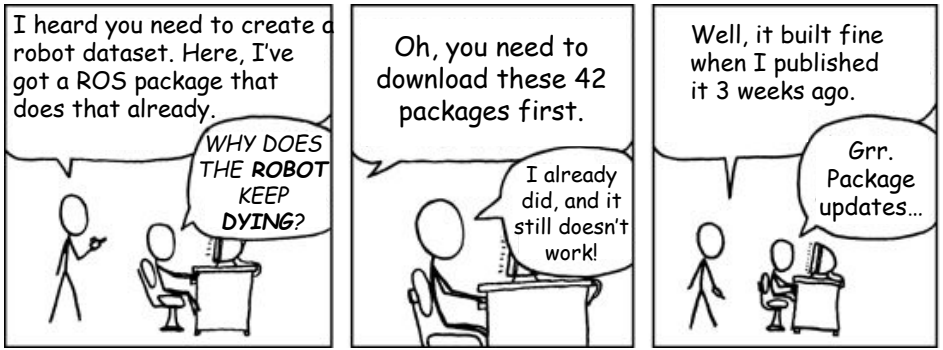
Repeatability & Reproducibility

for robotic research and industry “is hard…

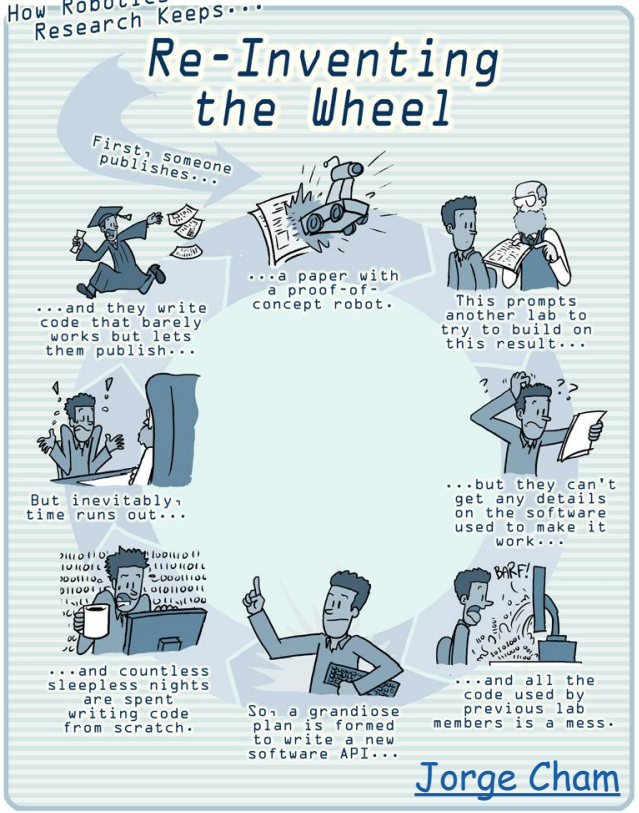
It should not be hard…”

Make robotic **research**
within and between labs simpler and more collaborative

Make robotic **industrial**
deployments maintainable with Continuous Integration



adapted from xkcd



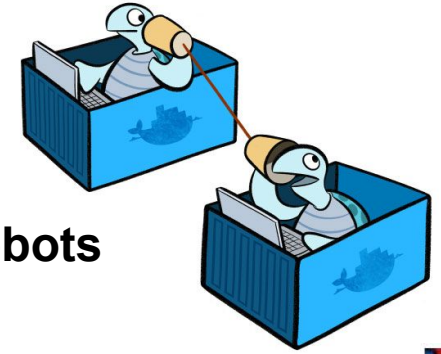
ROS + Docker… Why?

Let's Simplify

cross compilation complexity

managing **custom dependencies**

pushing new app and changes **for multiple robots**



Pushing new
Services and Containers


Team RoboSimian


Tartan Rescue


Team NimbRo Rescue


Team IHMC Robotics

Education

ROS Launch Demo

From stock linux install to course development environment, provide students a working setup.

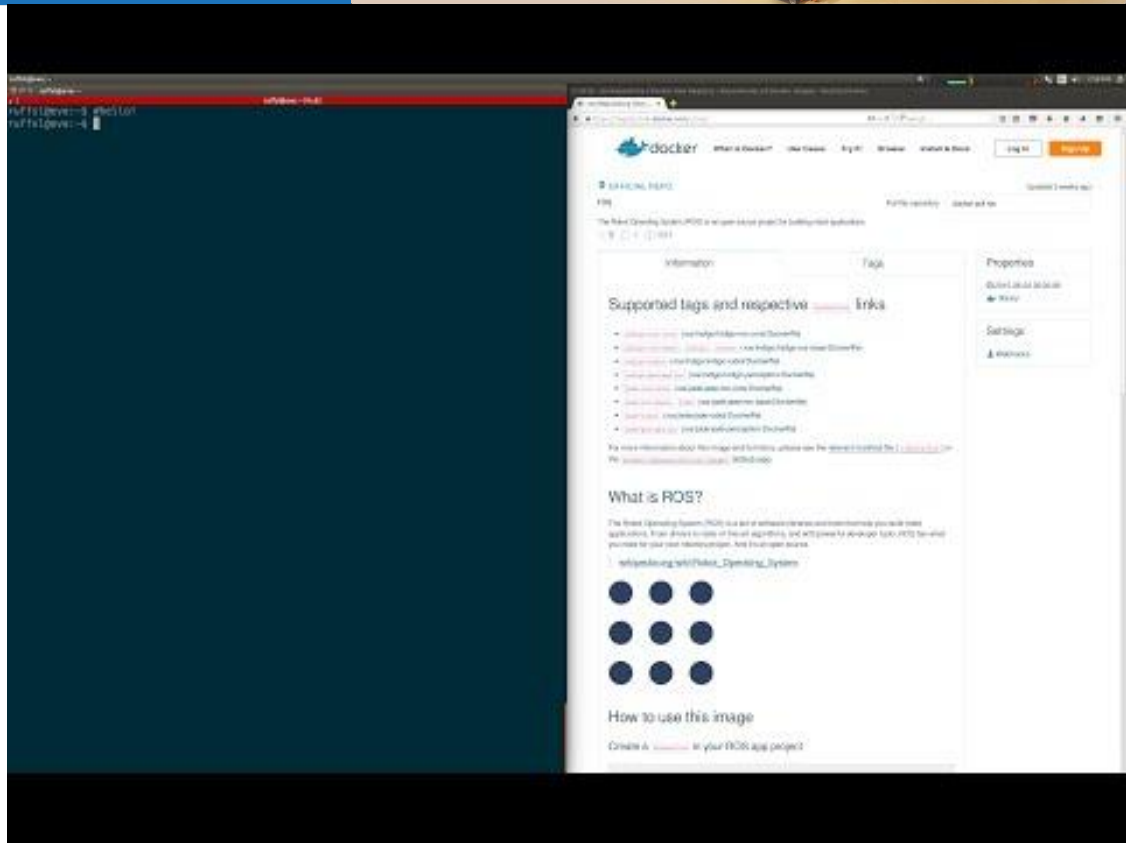
Share and submit **running** ROS apps with instructors and teammates using Dockerfiles and images.

Share and submit **broken** ROS apps for collaborative debugging sessions, even keep errors reproducible.

Providing fail-fast learn-fast disposable workspaces, students should experiment without hesitation.

Uses Docker Compose to keep something, that may have many moving parts, simple others to launch

libnetwork + ros_docker_demos



Research

Sharing Demos Demo

Two ROS nodes, e.g. mage publisher and a subscriber using Caffe Deep Learning

Nodes run in isolated linux containers on host, yet share exposed cam and GPU hardware.

Repeatable, Reproducible publications, share not only source, but secret sauce to build, run, and ship!

From reading papers to tweaking complex demos locally in the time it takes to download the image.

Use free registries like Docker Hub to share images to inspect and contribute back to build recipes.

[ros_caffe/docker]

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Industry

Cloud Swarm Demo

Deploy multiple nodes from different cloud computing cluster and different networks

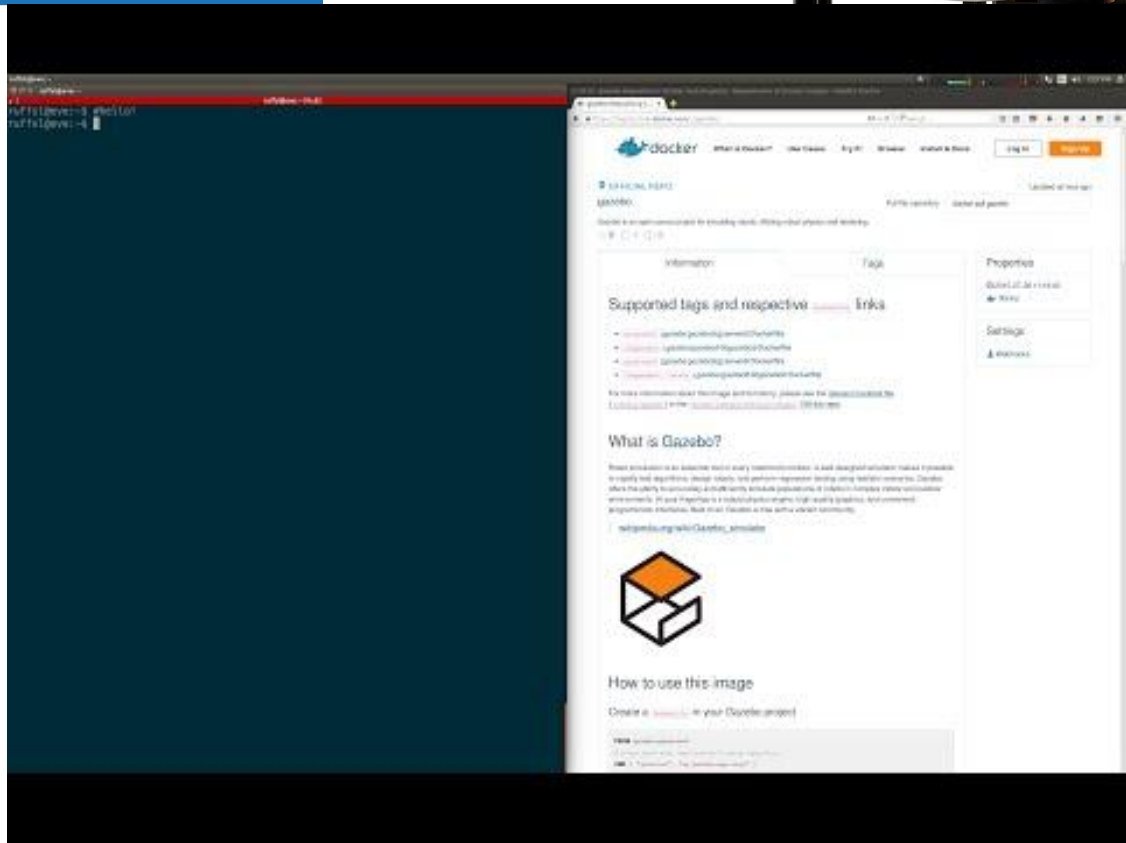
Take advantage of the Docker ecosystem to build, ship and orchestrate swarm of nodes.

Run ROS nodes on AWS, Azure, or Google to finally bring about that singularity of cloud robotics we were promised all those years ago!

Run heavy Gazebo simulations for continuous integration faster and cheaper on clusters.

Orchestrate deployed swarms or field robots and how they network we eachother.

[gazebo_docker_demos]



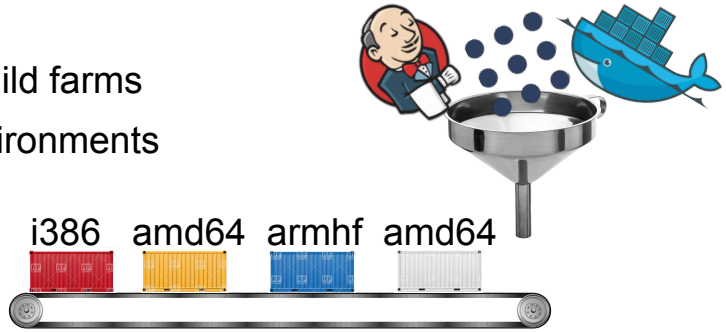
ROS + Docker... But How?

with turtles!
turtles all the
way down

Currently

leveraging Docker for CI and ROS build farms

as well as sharable development environments



Future

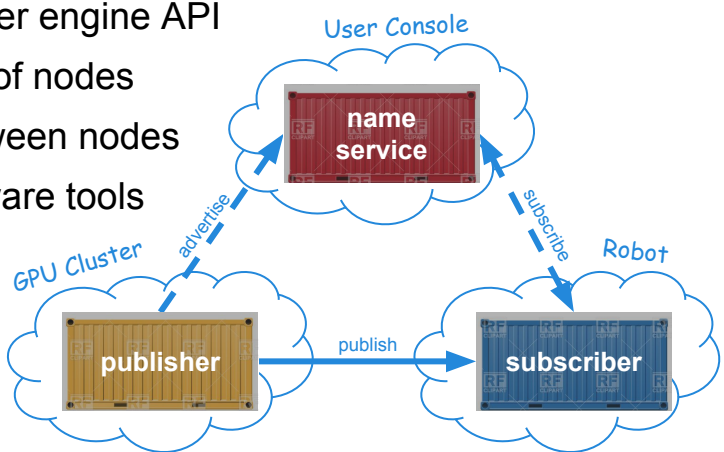
ROS runtime integration with Docker engine API

Launching and managing swarms of nodes

Large scale virtual networking between nodes

Blending of cloud and robotic software tools

```
>_ roslaunch
&& docker-compose
=the_future!
```



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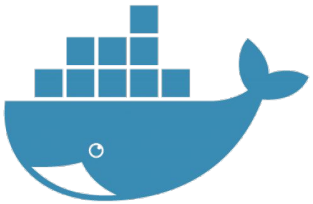
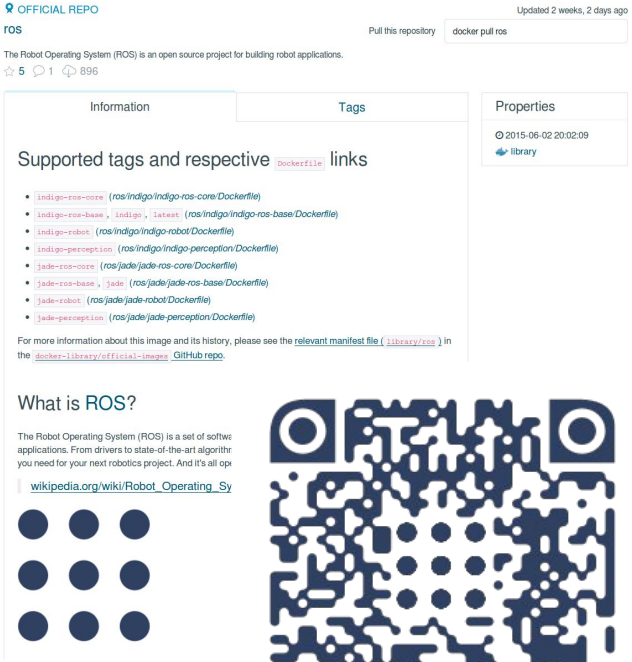
Official Repos for ROS & Gazebo

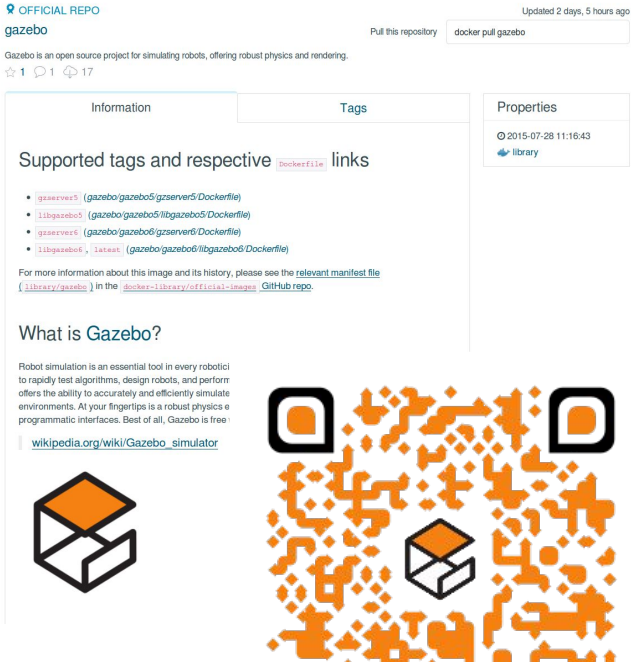
OSRF maintained base images for your robotic docker projects

Available now on Docker Hub



OFFICIAL REPO





Open Source Robotics Foundation

hub.docker.com/_/ros

hub.docker.com/_/gazebo

A tip of the hat to OSRF & IRIM

Open Source Robotics Foundation

"...to support the development, distribution, and adoption of open source software for use in robotics research, education, and product development."

DARPA NASA NSF Sandia National Laboratories

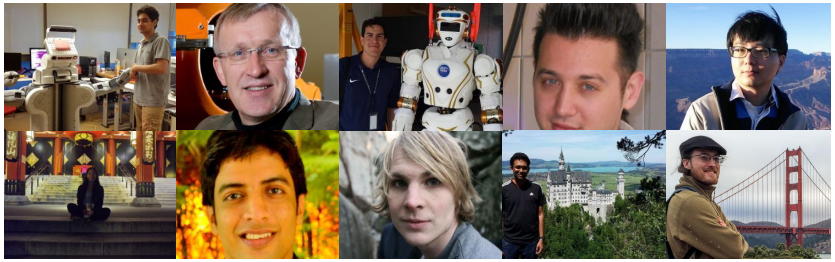
YUJIN ROBOT BOSCH rethink robotics ROS Industrial consortium

QUALCOMM ATAP SICK Sensor Intelligence.

Open Source Robotics Foundation

Georgia Tech Institute for Robotics and Intelligent Machines

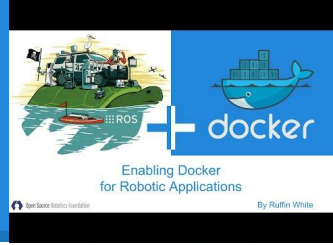
Cognitive Robotics



"...to create new collaborative opportunities for faculty, strengthen partnerships with industry and government, and maximize the societal impact of the transformative robotics research conducted at Georgia Tech.."

Robot Resources!

My other OSRF Video



More on ROS + Docker:

wiki.ros.org/docker

Official Docker Library for ROS:

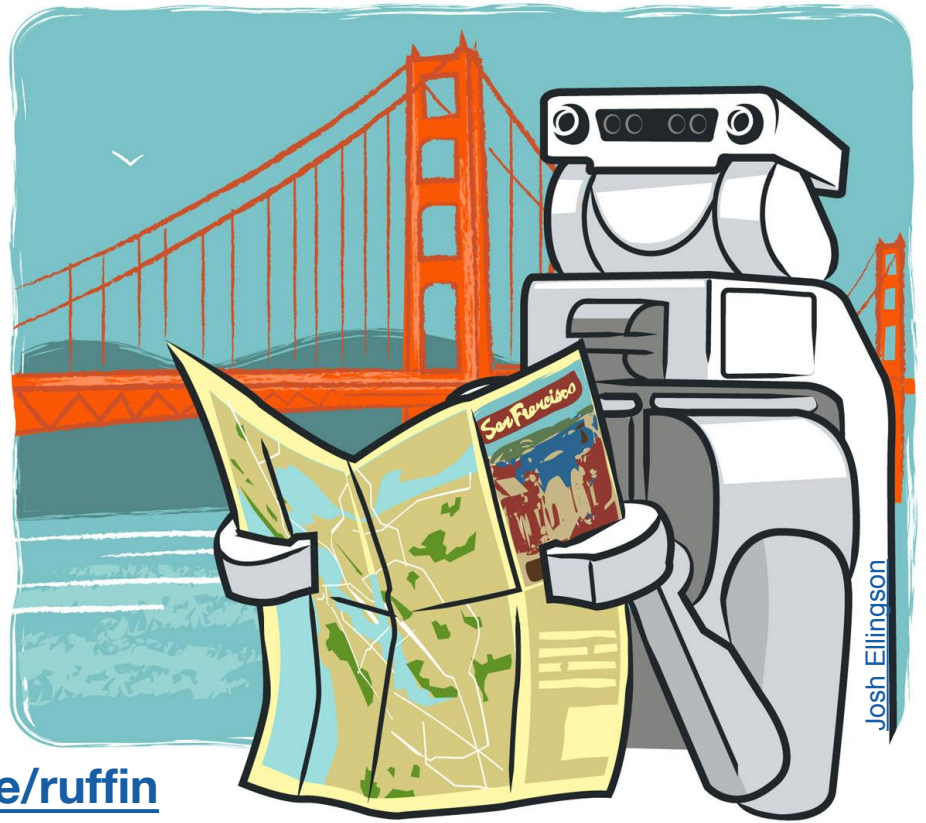
hub.docker.com/_/ros

ROS Answers Tags:

Docker | Container

Slack channel:

rosorg/messages/docker



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About Me: about.me/ruffin