AWS re:Invent

NOV. 29 – DEC. 3, 2021 | LAS VEGAS, NV

ROB402

Building AI-enabled Robots for pick-and-place operations

Matt Bollinger (he/him)
Senior Solutions Architect
AWS

Adi Singh (he/him)
Senior Prototyping Architect
AWS

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Agenda

What we’re building

How we’re building it

Get hands on

Wrap-up

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

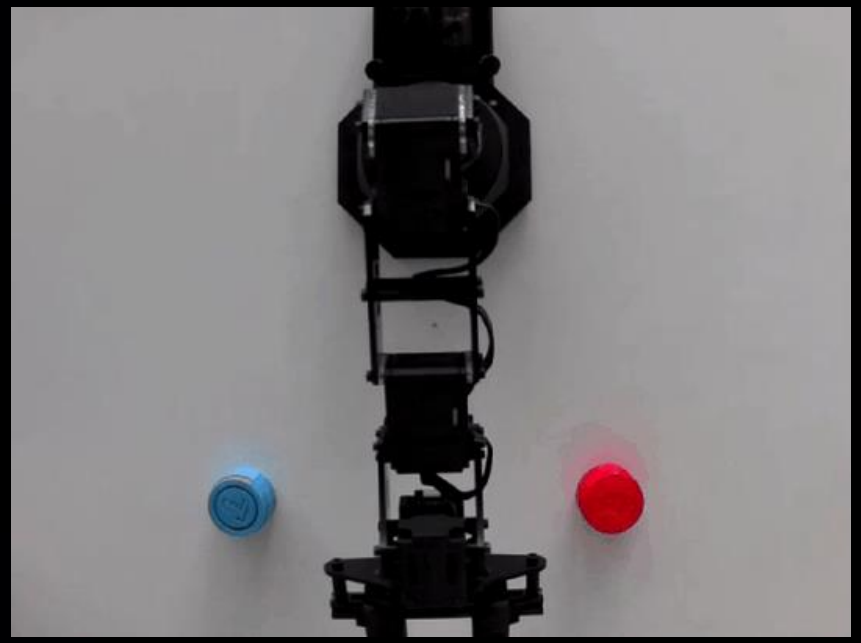
What we’re building

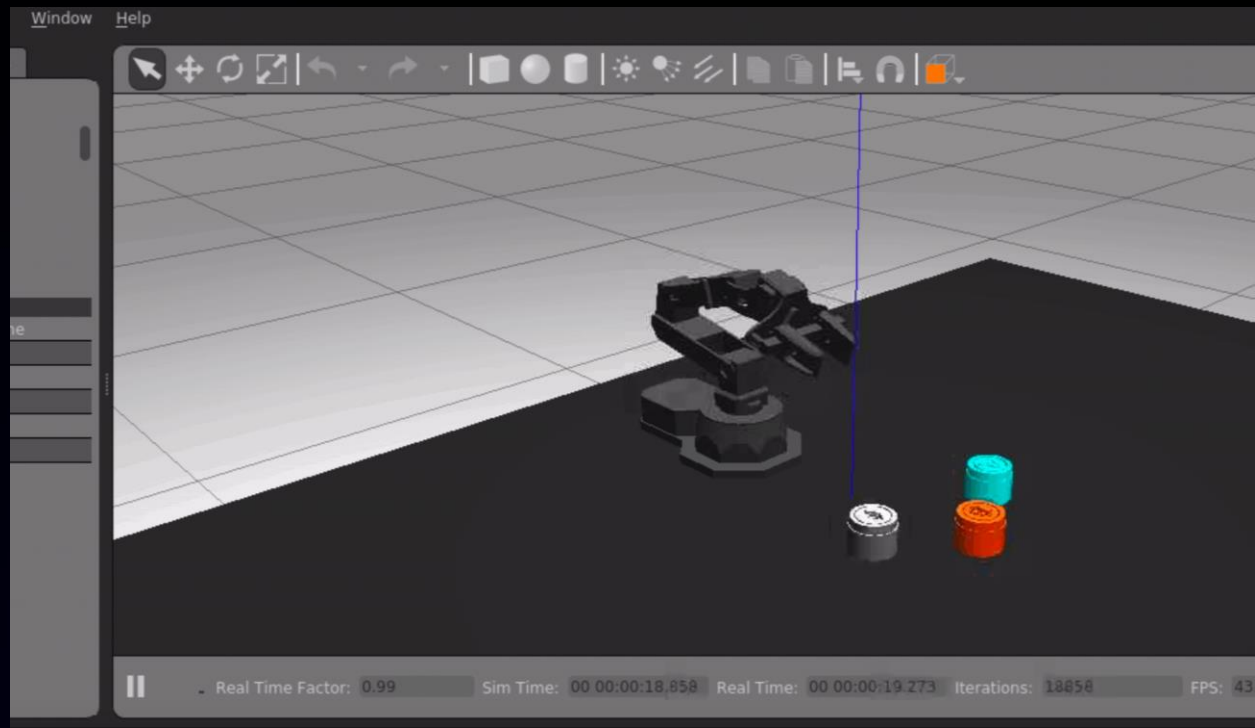
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

What we're building

A Robot Operating System (ROS) application to enable a robot to autonomously identify and fetch objects placed randomly in its environment

A realistic 3D physics simulation of the ROS application





© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

How we’re building it

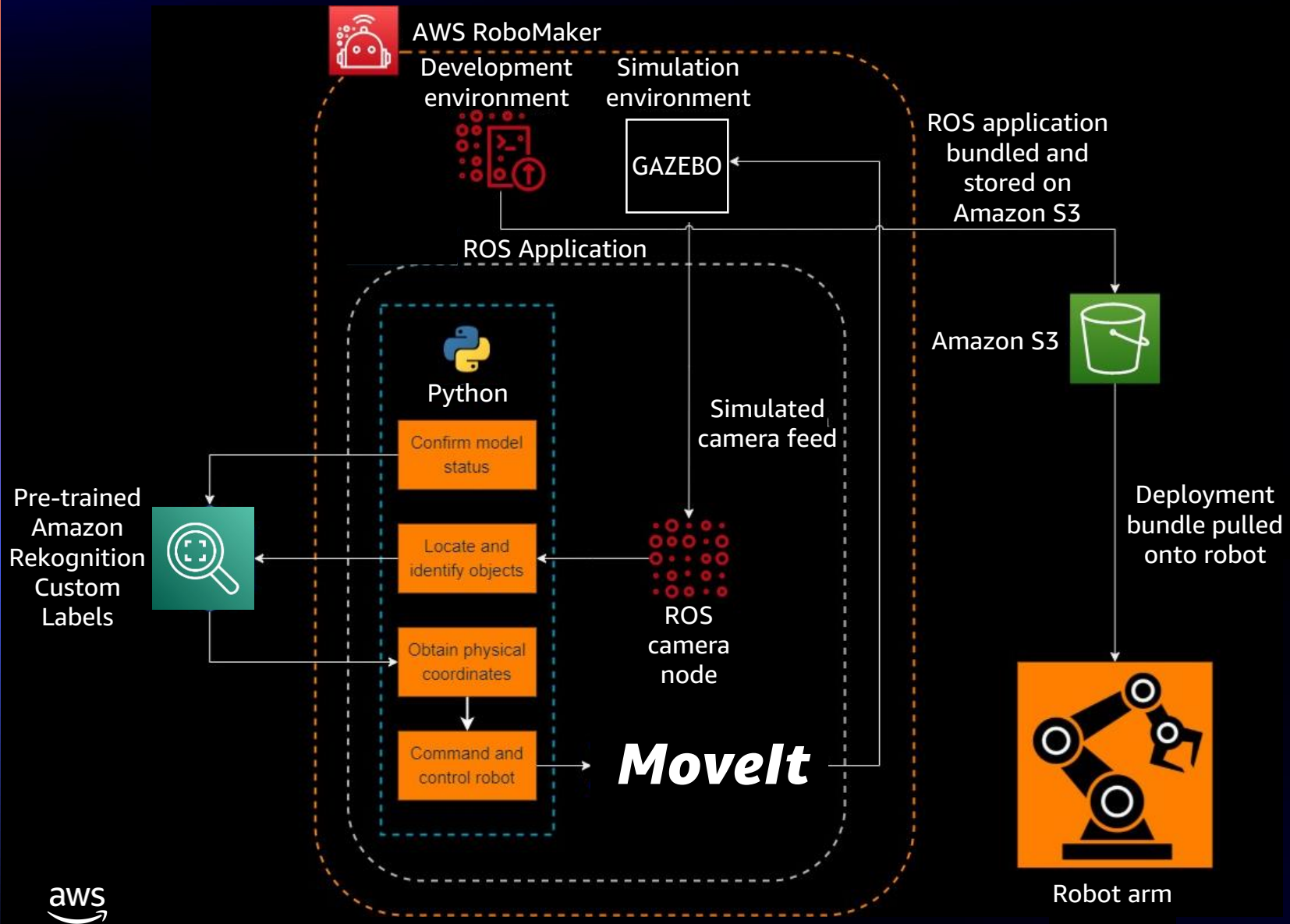
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

How we’re building it

- Set up workshop environment
- Build simulation world
- Connect Amazon Rekognition
- Test robot intelligence in simulation
- Run ROS application on real hardware
- (Extra) Fine tune robot operation

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

How we're building



Major components

- Robot Operating System
- Gazebo
- AWS RoboMaker
- Amazon Rekognition
- Amazon Simple Storage Service (Amazon S3)

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Robot Operating System - ROS

Open-source middleware developed at Stanford for prototyping robots

Set of useful tools for robotics development

Sensor interfaces, common algorithms, visualization tools, package management

Language-agnostic communication framework

Facilitates structured information sharing between loosely-coupled modules

- Built primarily in C++ and Python
- ROS2 being developed for greater reliability in production environments

aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

ROS Terminology

Nodes

Independent pieces of executable code built to accomplish a single task

Topics

Named channels that allow publication and subscription of data streams

Parameters

Key-value pairs used for setting and altering system configuration

Package

A logical container for closely related nodes and their associated utilities

Launch File

XML file used to set parameters and execute multiple nodes at once

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Why simulate?

Validate feasibility of ideas at low cost

Debug by breaking bits, not atoms



Continue development without robot hardware

Generate training data for machine learning

Stress test robots in varied environments

Conduct functional testing at scale

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Gazebo

Open-source 3D simulation engine

- Model robot dynamics with high-quality graphics rendering
- Simulate sensor data across a variety of sensing modes
- Build worlds reflecting real-world operational environments
- Tightly integrated with ROS



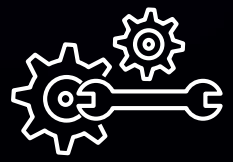
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

AWS RoboMaker: Bring cloud benefits to simulations



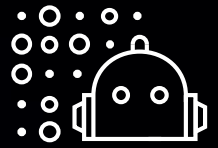
Cloud scale

Run concurrent simulations with a single API call



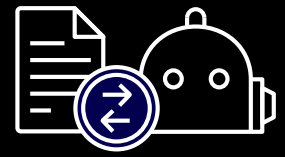
Fully managed

Scale simulations without managing infrastructure



World creation

Generate user-defined simulation worlds quickly



Flexible software

Use any robot and simulation software

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Let’s get started!

https://dashboard.eventengine.run/

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

How we're building it

- Set up workshop environment
- Build simulation world
- Connect Amazon Rekognition
- Test robot intelligence in simulation
- Run ROS application on real hardware
- (Extra) Fine tune robot operation

aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

How we're building it

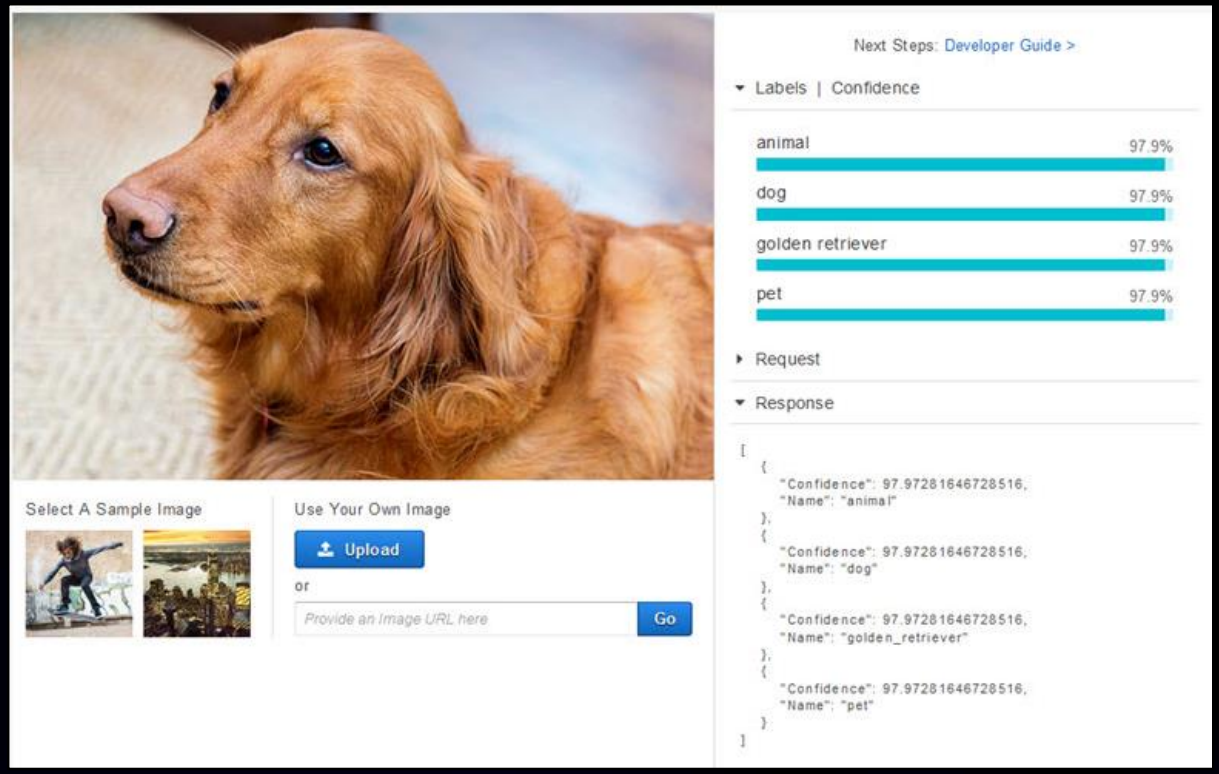
- ~~Setup workshop environment~~
- ~~Build simulation world~~
- Connect Amazon Rekognition
- Test robot intelligence in simulation
- Run ROS application on real hardware
- (Extra) Fine tune robot operation

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Amazon Rekognition

Zero-code artificial intelligence service from AWS that focuses on computer vision

- Easily add image and video analysis to applications
  - Identify objects, people, text, scenes, faces, expressions, and activities
- Allows for custom object identification to suit your specific business case
  - Rekognition Custom Labels



Simply supply images, mark out your objects of interest, and Rekognition builds you a model

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

How we're building it

- ~~Setup workshop environment~~
- ~~Build simulation world~~
- Connect Amazon Rekognition
- Test robot intelligence in simulation
- Run ROS application on real hardware
- (Extra) Fine tune robot operation

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Continue workshop

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

How we're building it

- ~~Setup workshop environment~~
- ~~Build simulation world~~
- ~~Connect Amazon Rekognition~~
- ~~Test robot intelligence in simulation~~
- Run ROS application on real hardware
- (Extra) Fine tune robot operation

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Challenge – Fine tuning

Prioritizing the order in which the robot attempts to fetch the coins

Experimenting with the confidence threshold parameter for each of the models

Fine-tuning the mathematical formula which converts Amazon Rekognition output into physical coordinates

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Wrap-up

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Summary

- ROS basics
- How to use AWS RoboMaker development environment and simulation
- How to leverage AWS AI services like Amazon Rekognition within a robotic application

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Thank you!

Matt Bollinger

https://www.linkedin.com/in/mattbol/



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.