Create3 Robot Project

Outcomes

1. Introduction to the CST8504 Create 3 Robot Project
    1. Goals of the CST8504 Robot project
    2. Choosing Hardware
    3. Choosing Software
    4. Create 3 Getting Started
2. ROS2
    1. Object Oriented Python
    2. ROS2 Introduction

Create 3 Robot Project

Why a Robotics project?

- The over-riding goal is to learn how to apply the techniques of AI to solve real-world problems in a software development context
- Robotics in general provides a wide spectrum of real-world AI problems
- Solving some of these problems for actual physical robot behaviors is
  - Educational
  - A source of real world experience (for job interview!)
  - Fun and motivating

Examples of Robots

- Amazon Astro
    - https://www.youtube.com/watch?v=Te263tgJG2Y
- Boston Dynamics
    - https://www.bostondynamics.com/products/spot
- Tesla Humanoid
    - https://spectrum.ieee.org/tesla-optimus-robot
    - https://www.youtube.com/watch?v=UXHoWNfjJYM (2022)
    - https://www.youtube.com/watch?v=gyURDZB7imo (2025)

Robot Project Goals

- Autonomous behavior/movement
- Respond to visual stimulus
    - Hand commands
    - Follow you? (train it to identify your shoes)
    - Object recognition (trash collector robot?)
- Respond to audio stimulus
    - Verbal commands (speech to text)
    - Sound recognition (door-bell, dog bark, fire engine siren, etc)
- Behaviors
    - Movement (wheels)
    - Visual outputs (lights)
    - Audio outputs (text to speech)

Robot Project Hardware

What's available?

- google "robot hardware kit"
- What do we need for our goals?
  - Wheels
  - Compute device
  - Camera
  - Microphone
  - Speaker
  - Lights

No Gripper?

- A gripper arm would add another class of problems we could solve
- A good gripper would at least double the cost
- We will have enough problems to solve, even without a gripper
- Amazon Astro is becoming our benchmark comparison
    - No gripper on the Amazon Astro robot

Choosing Hardware: Why the iRobot Create 3?

- There are various reasons the Create 3 is appropriate for our needs
    - Minimal mechanical design/assembly
    - Reputable company capable of reliable supply in volume
    - Can support more advanced projects: grippers, lidar, etc
    - Basic platform for movement/lights
        - Safety features, cliff detection, bumpers, more
    - Low cost of overall parts:
        - Create 3: CDN$500
        - Adapters: $20-40
        - Borrow Laptop (or use your own): 0$

Choosing Software: Why ROS2

- Why develop our product on ROS2?
- Create3 is powered by ROS2
- https://www.ros.org/blog/why-ros/
- ROS2 is well documented: https://docs.ros.org/en/humble/index.html
- ROS2 on Windows or Linux?
    - Ubuntu-server 22.04 for ROS2 Humble support
    - Does ROS2 support Windows? Yes Windows 10 only, but…https://docs.ros.org/en/foxy/The-ROS2-Project/Contributing/Windows-Tips-and-Tricks.html

Time to check your learning!

Let’s see how many key concepts you recall by answering the following questions!

- Why are we doing a Robotics project?
- What are some of the goals of our project?
- Why are we using the iRobot Create 3?
- What software is the iRobot Create 3 based on?
- Can we use Windows to do this development?

Irobot Create 3 docs: https://iroboteducation.github.io/create3_docs/

Coming Later: Options for controlling Create 3

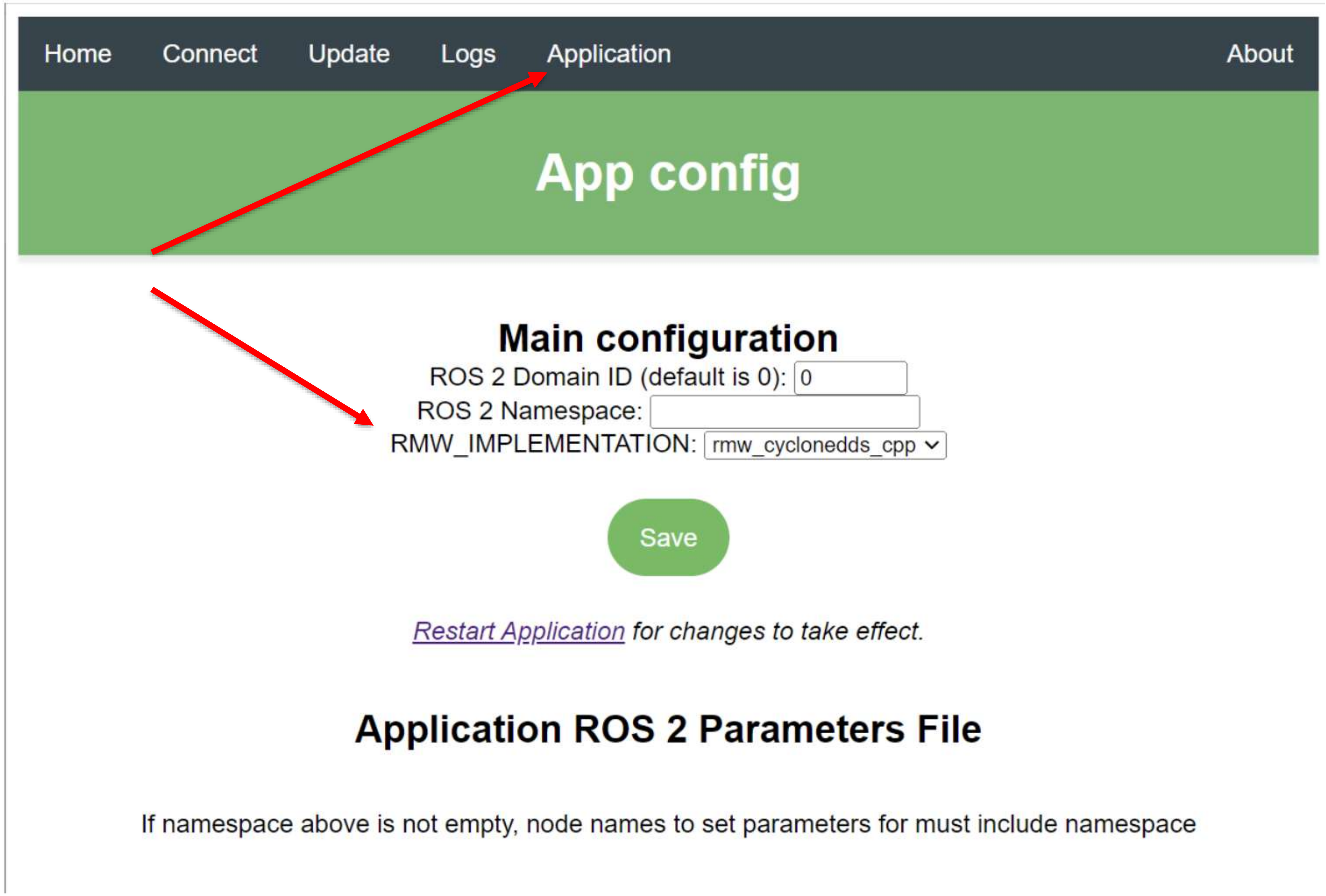
1. Python Playground for Windows
    - Works by connecting (pairing) Chrome web browser to your Create 3 over Bluetooth
    - Needs Bluetooth/USB switch to be in Bluetooth position (default)
    - Program or run Python examples: set up asynchronous events, then invoke "robot.play()" method

- URL for the Python Playground:
    - python.irobot.com

Controlling Create 3 (cont'd)

2. ROS2 Humble over Wifi (We will NOT use this option)
    - Connect Create 3 to your WIFI network
        - Hotspot mode, connect to hotspot
    - Create 3 now has IP addr on your LAN
    - Run ROS2 programs and/or commands on another ROS2-enabled device on your LAN
    - Protocol (RMW_IMPLEMENTATION) of your ROS2 environment must match setting on Create 3 – see next slide

Controlling Create 3 (cont'd)



App config

Main configuration

ROS 2 Domain ID (default is 0): 0

ROS 2 Namespace:

RMW_IMPLEMENTATION: rmw_cyclonedds_cpp

Restart Application for changes to take effect.

Application ROS 2 Parameters File

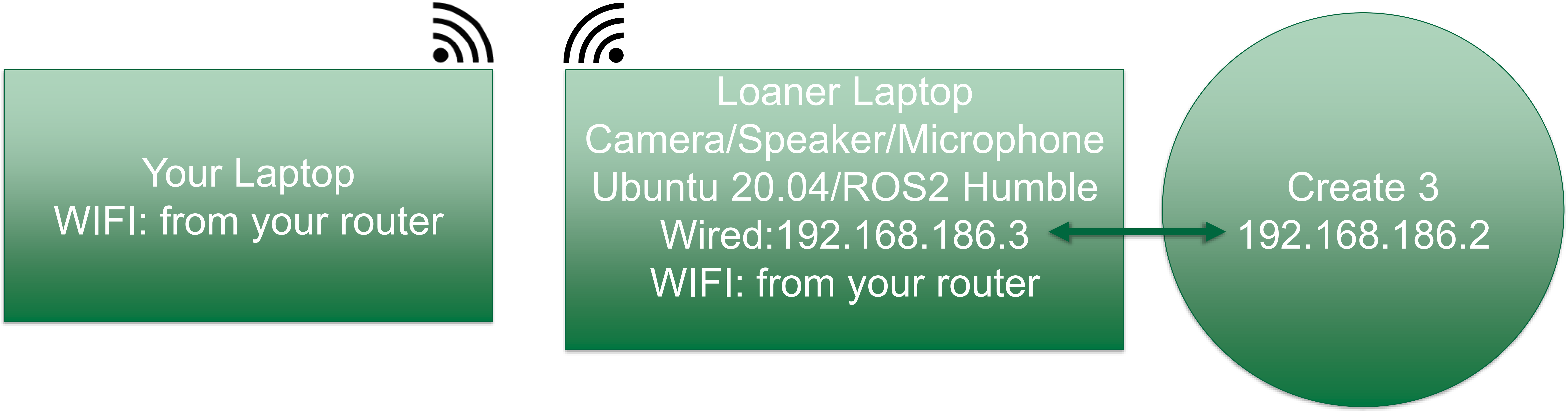
If namespace above is not empty, node names to set parameters for must include namespace

Controlling Create 3 (cont'd)

3. ROS2 over dedicated Wired Network (YES: our ultimate setup)

- Best to disable WIFI on Create 3 (factory settings)
- Bluetooth/USB switch must be on USB
- Static IP address of Create 3: 192.168.186.2
- Static IP address of Wired port on Laptop: 192.168.186.3
- Laptop runs ROS2 on Ubuntu 20.04
- Run ROS2 python programs and commands on Laptop -> Create 3 responds

Our Create 3 Setup (Summary)



Your Laptop
WIFI: from your router

Loaner Laptop
Camera/Speaker/Microphone
Ubuntu 20.04/ROS2 Humble
Wired:192.168.186.3
WIFI: from your router

Create 3
192.168.186.2

Anticipated Questions

- Can I run ROS2 on my Windows Laptop natively?
    - Maybe, but there might be issues: it might not be worth your time to try

- Can I use my own laptop instead of a loaner laptop
    - Maybe, but you'll need ROS2 Humble on Ubuntu 22.04 to be able to keep up with everyone else.

ROS2: Object Oriented Python

When we look at the ROS2 source code templates, or some of the iRobot Python Playground example programs, we'll see new things:

- Decorators: https://realpython.com/primer-on-python-decorators/
- Classes: Deitel 10.2
- Constructors: Deitel 10.2
- Properties (getters/setters) Deitel 10.3—10.5
- Inheritance Deitel 10.7—10.8
- Asynchronous methods: https://docs.python.org/3/library/asyncio-task.html

Python Playground Code

In Chrome, we visit https://python.irobot.com

Notice it doesn't take long to find decorators, and async/await keywords