How to teach Robotics & ROS remotely

… using Zoom

The Construct

Who is this webinar for?

- Professors/Teachers/Teacher assistants of undergrads/graduate students of robotics
- You need to prepare robotics course for 2021
- You are searching for remote robotics teaching solution due to COVID-19

What do we mean by teaching robotics?

- Robot action and perception
- Arm Kinematics
- Mobile Robots Kinematics
- Robot Dynamics
- Motion Planning and Control
- Robot Navigation
- Computer Vision
- ROS

We do not mean

We do mean

About Us

- 5 years teaching on The Construct Youtube Channel
- Almost 1.000 videos uploaded
- 1 ROS Online Class every week (for 3 years)
- Delivered 3 ROS conferences online (1 each year)
- Tens of webinars (like this one)

Stay with us to take a full live teaching experience including remote real robots!

- First, we'll see how to teach ROS & Robotics with zoom
- Provide solutions to problems
- Then we will do a class all together, including real robot lab

For teaching robotics remotely you need

1. Prepare the class
2. Deliver the theory
3. Provide some practice
4. Provide off-hours support
5. Evaluate students
6. Control students progress

You need to address these problems

- Preparing curriculum is hard work
- Students don’t know Linux nor Python
- Installing ROS in students’ computer
- Make students practice is difficult
- Evaluate them remotely is difficult

STEP 1
Prepare the class

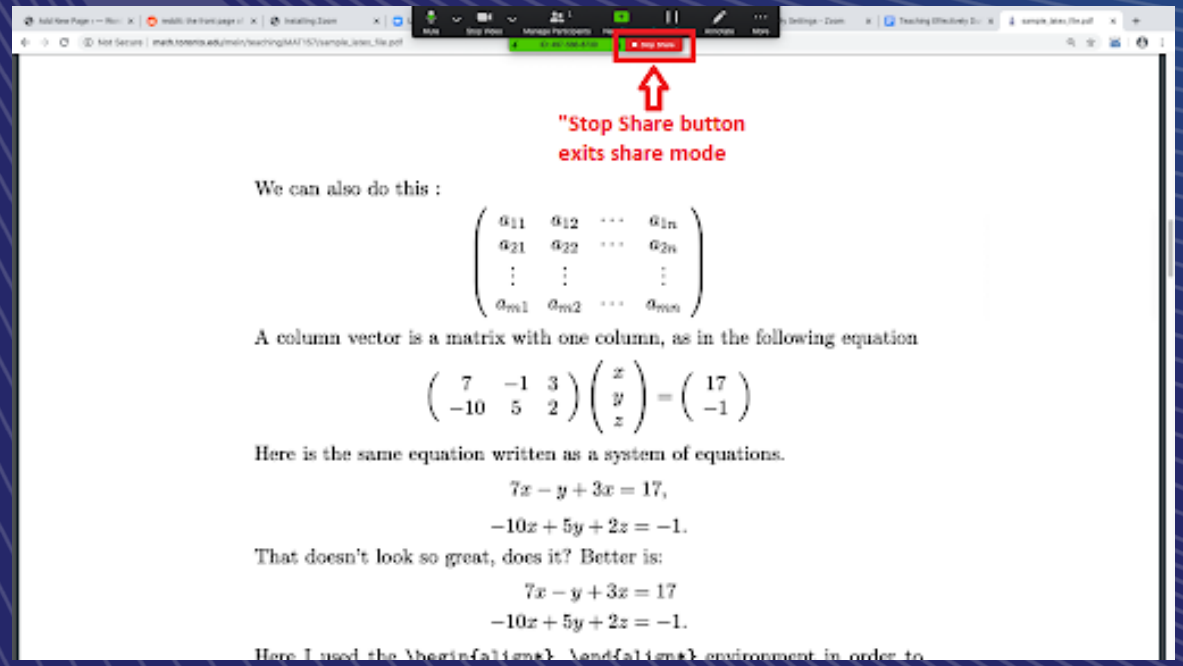
The Construct

1st requirement

A platform to deliver and communicate with students in real time

- Must allow:
  - Sharing Screen (both teacher & student)
  - Live Chat (both written & voice)

For example: Zoom



Zoom tutorial: https://youtu.be/JIRfIUH8ENw

2nd requirement

- **Students must know about:**
  - Linux
  - Python
- **Make them take these free online courses:**
  - Linux for Robotics: https://bit.ly/3gx6za7
  - Python for Robotics: https://bit.ly/36XldEs
- **Make them take the exam and send evaluation to you**

3rd requirement

Provide an environment to practice

ROS + GAZEBO

How to install ROS + Gazebo: option 1

- Install ROS on students' computer http://wiki.ros.org/ROS/Installation

ROS Installation Options

There is more than one ROS distribution supported at a time. Some are older releases with long term support, making them more stable, while others are newer with shorter support life times, but with binaries for more recent platforms and more recent versions of the ROS packages that make them up. See the Distributions page for more details. We recommend one of the versions below:

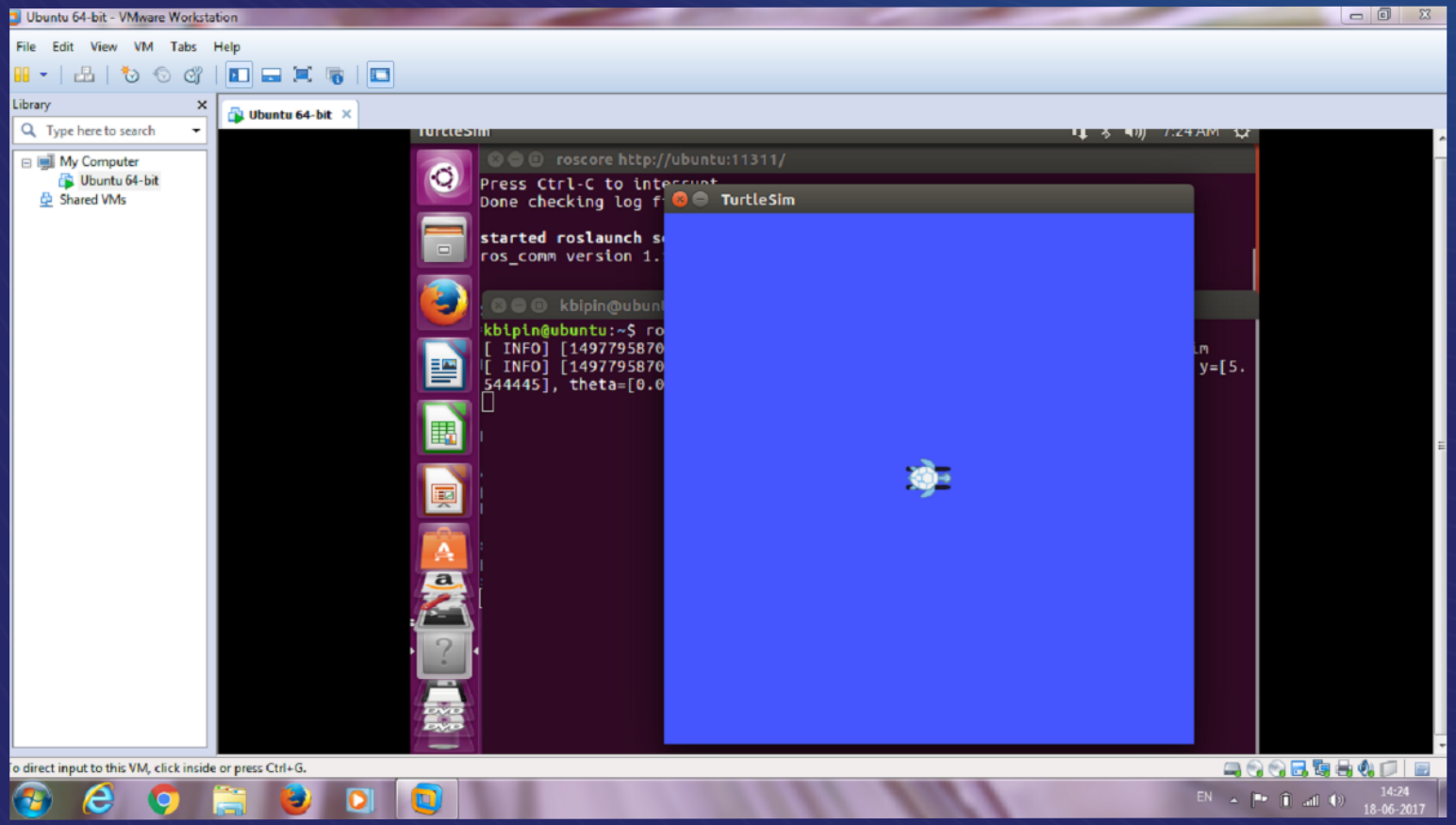
ROS Kinetic Kame
Released May, 2016
LTS, supported until April, 2021
This version isn't recommended for new installs.

ROS Melodic Morenia
Released May, 2018
LTS, supported until May, 2023
Recommended for Ubuntu 18.04

ROS Noetic Ninjemys
Released May, 2020
Latest LTS, supported until May, 2025
Recommended for Ubuntu 20.04

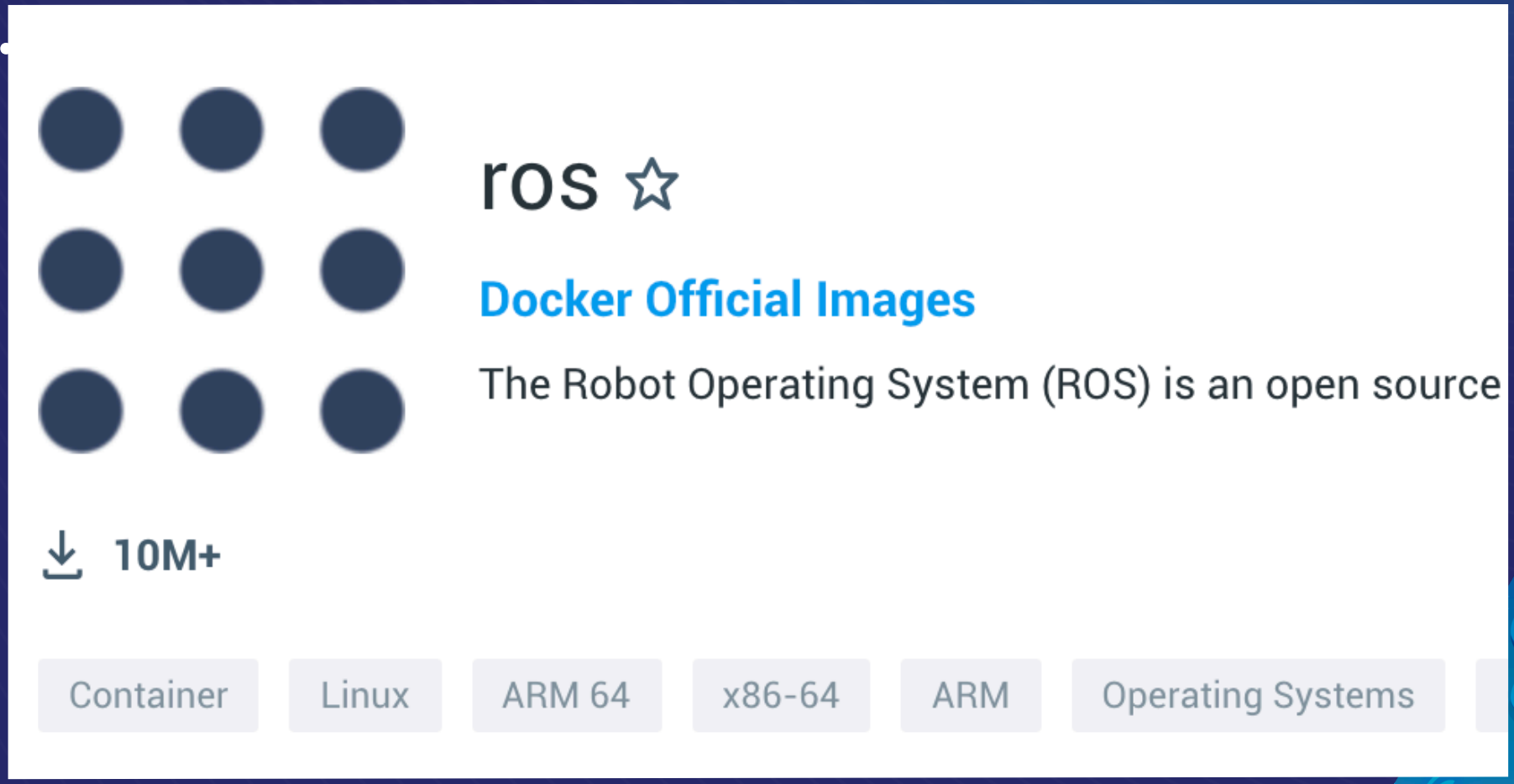
How to install ROS + Gazebo: option 2

- Provide a Virtual Machine with ROS https://youtu.be/59F6Jake_48



How to install ROS + Gazebo: option 3

- Provide a docker with ROS https://hub.docker.com/_/ros/
-



STEP 2
Teach the theory

The Construct

Option 1: create slides

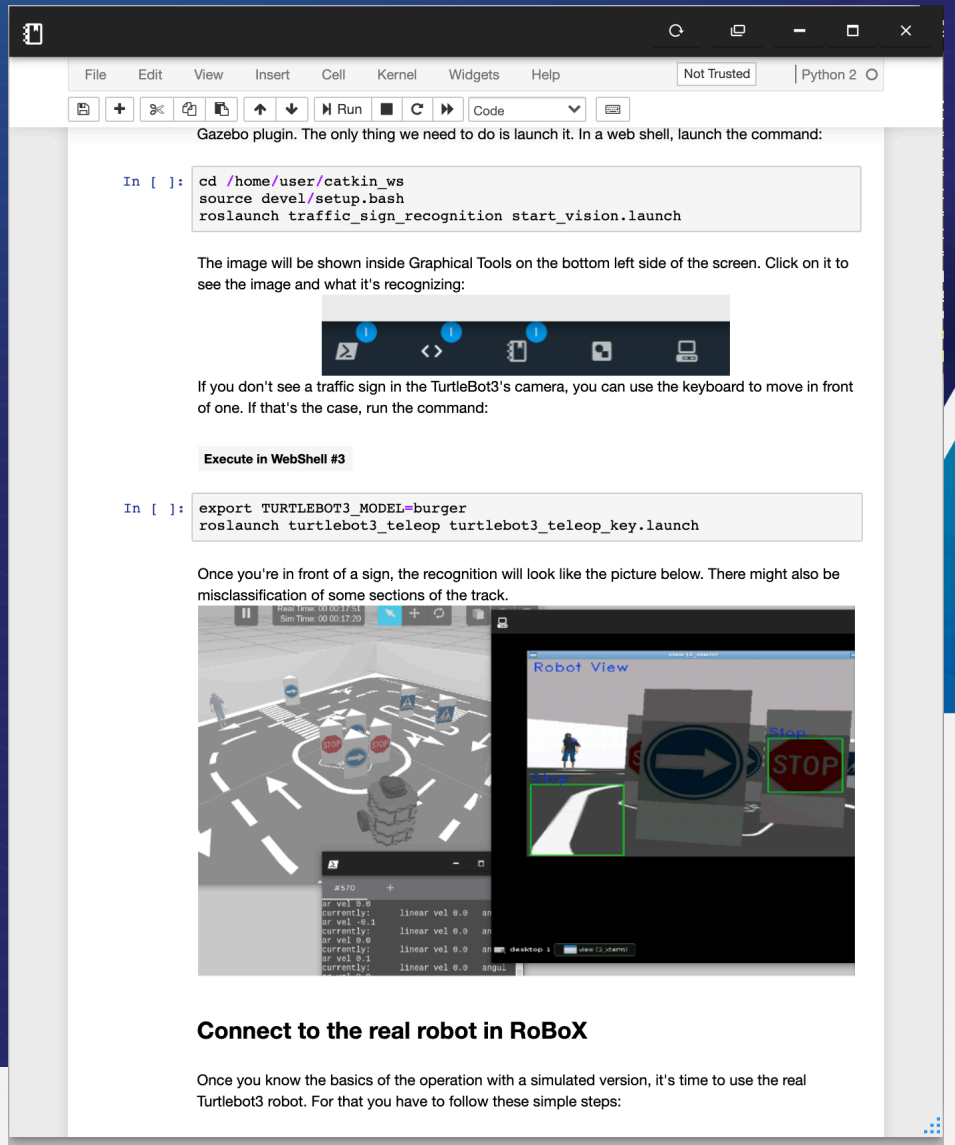
- **A fast method to create a ROS/robotics course based on slides…**
  - Just search over internet and get one of the trillions available
    - for example, this one by ETH Zurich:
      - https://bit.ly/35OqmLV
  - Adapt them to your needs

Option 2: create Jupyter notebooks

* Jupyter notebooks can include code, images, videos, etc
* Include exercises to be done during class

Jupyter how to tutorial:

https://www.dataquest.io/blog/jupyter-notebook-tutorial/



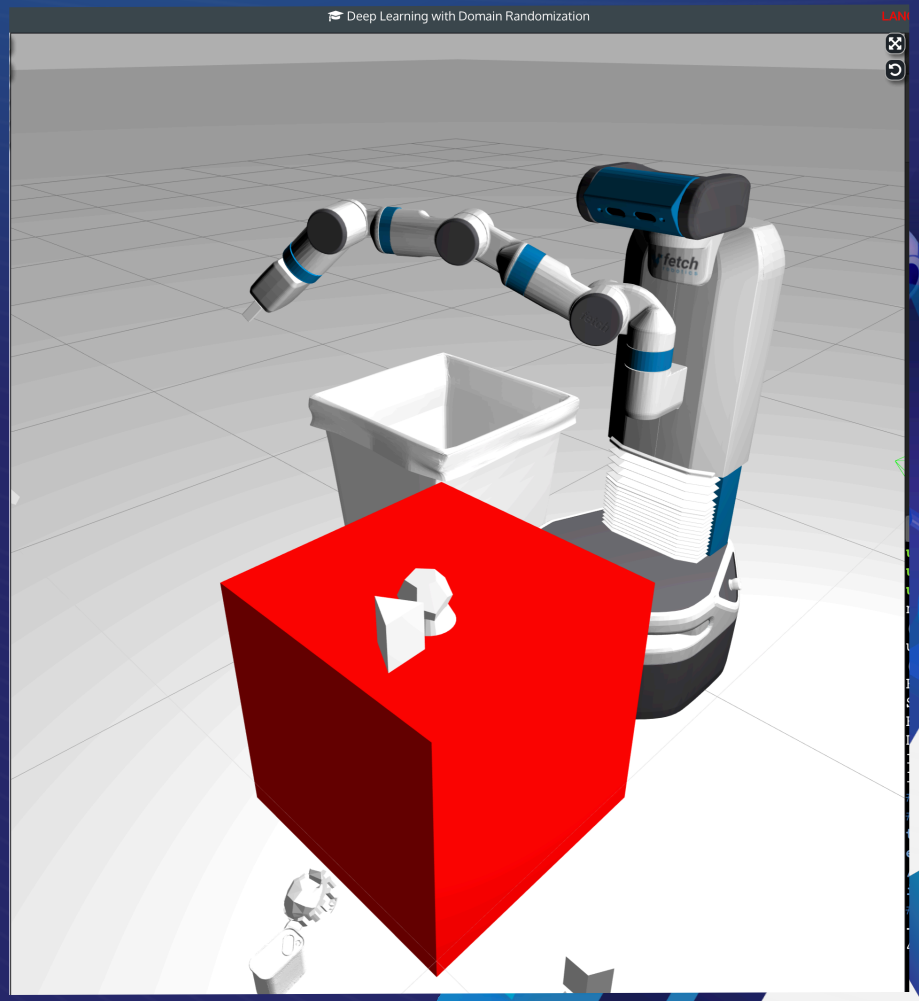
STEP 3
Provide Practice

The Construct

Simulated robots: use Gazebo/ROS robot sims

- Use the students ROS + Gazebo environment
- Check our repo of open source simulations:

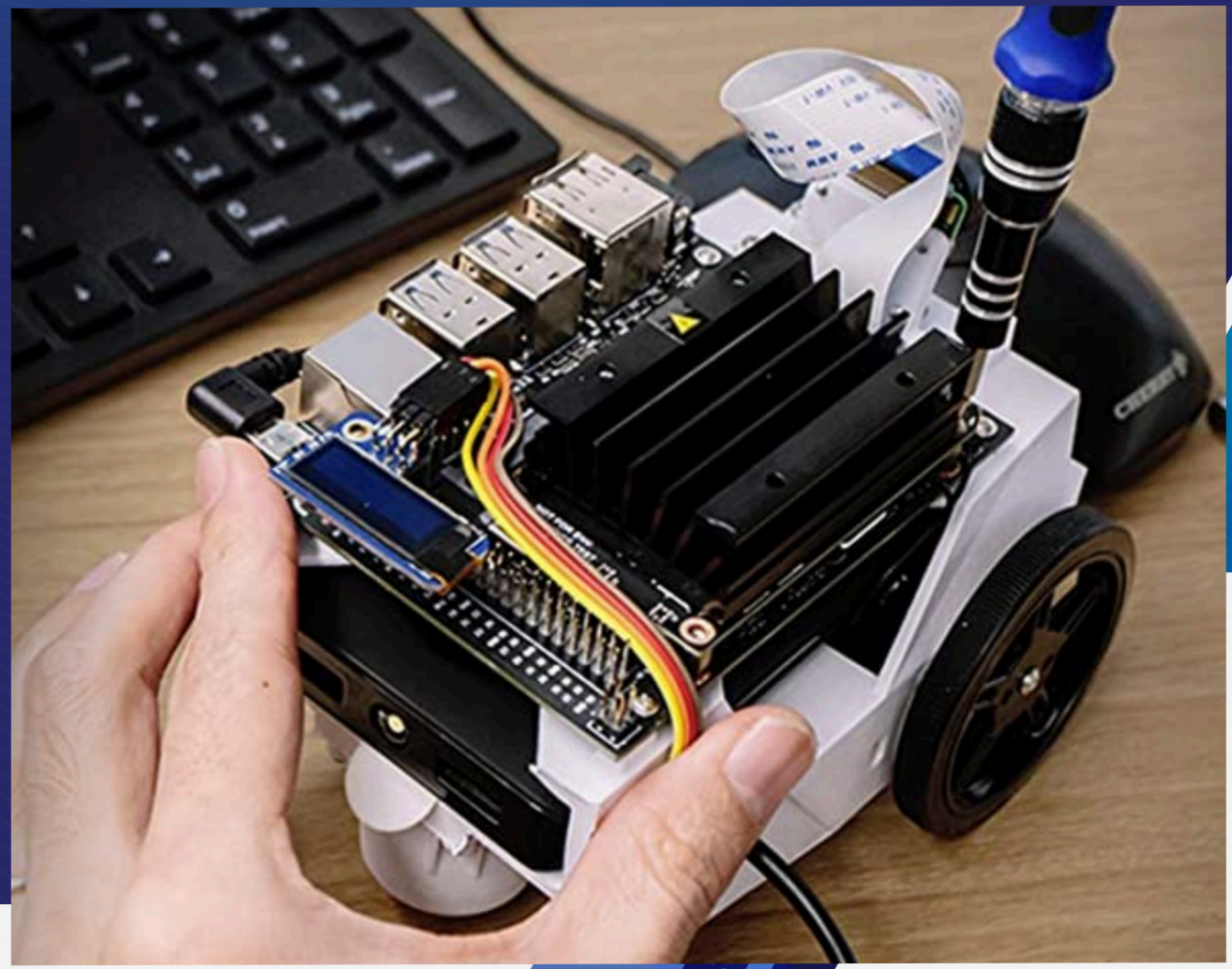
- https://bit.ly/2JRpH6U



Real robots: Provide a real robot to each student

- Jetbot (around 200$):

1. Base system (110$)
   https://amzn.to/2DBpDov
2. Additions for Jetbot (110$)
   https://amzn.to/2XwJT1G



Real robots: Provide a remote lab

1.Have a robot with internet access

2.Install a server in the robot

3.Add external camera

4.Connect to it from ROSDS

HOW TO SETUP:

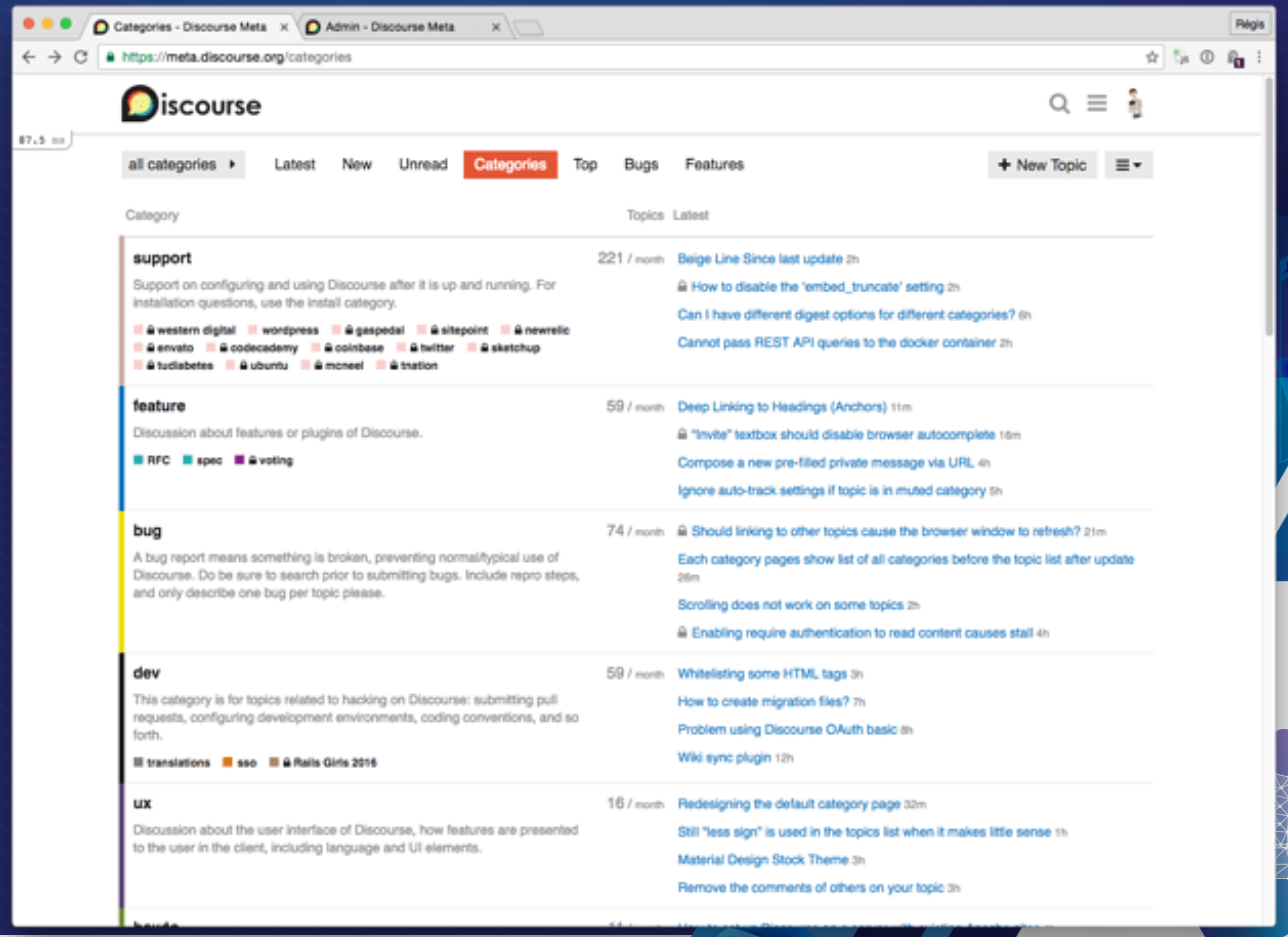
https://www.theconstructsim.com/remote-robot-lab/

STEP 4
Provide Off-Hours Support

The Construct

Provide a Forum for Q&A

- Use the one provided by the University
- Or install a Discourse: https://bit.ly/2C7vuS2
- Do not use email for Q&A!



STEP 5
Evaluate the Students

The Construct

Exams based on doing ROS code

- **Advantages**:
  - They must apply their knowledge
  - Easy to detect when they copy
- **Drawback**:
  - Requires a lot of work on the teacher's side
    - Prepare the exams
    - Correct the exams

Exams based on doing ROS code

- Create Jupyter notebook exam
- Send it to students
- Students create code
- Students send code to you
- You review the code

Exam

- Create a package named *obst_avoidof< your_name>* which depends on *rospy* in the *catkin_ws* (**0.5 points**)
- Create a Python file named *avoidanceof< your_name>.py* that will contain your ROS code (**0.5 points**)
- Create a launch file named *start_avoidanceof< your_name>.launch* to launch the Python code (**0.5 points**)
- Subscribe to the laser topic with callback function named *get_lasersof< your_name>* and get all the ranges in a variable named *all_rangesof< your_name>* (**1.5 point**)
- Get the distance measured by the laser rays at 0º, 45º and -45º and store each one in global variables named *frontof< your_name>* (for 0º), *leftof< your_name>* (for 45º) and *rightof< your_name>* (for -45º) (**1.5 point**)
- Create a publisher that will send the velocity commands to the wheels (**1.5 point**)
- Create a loop control that sends the speeds to the wheels based on the values of the three ranges you got for 0º, 45º and -45º (**4 points**)
  - If the 45º is the smallest ray, then move a little forward plus turn to the right
  - If the -45º is the smallest ray, then move a little forward plus turn left
  - If none of the above:
    - If 0º is smaller than 0.3 then move back and rotate left
    - Otherwise, just move forward

STEP 6
Control Students Progress

The Construct

Control Students Progress

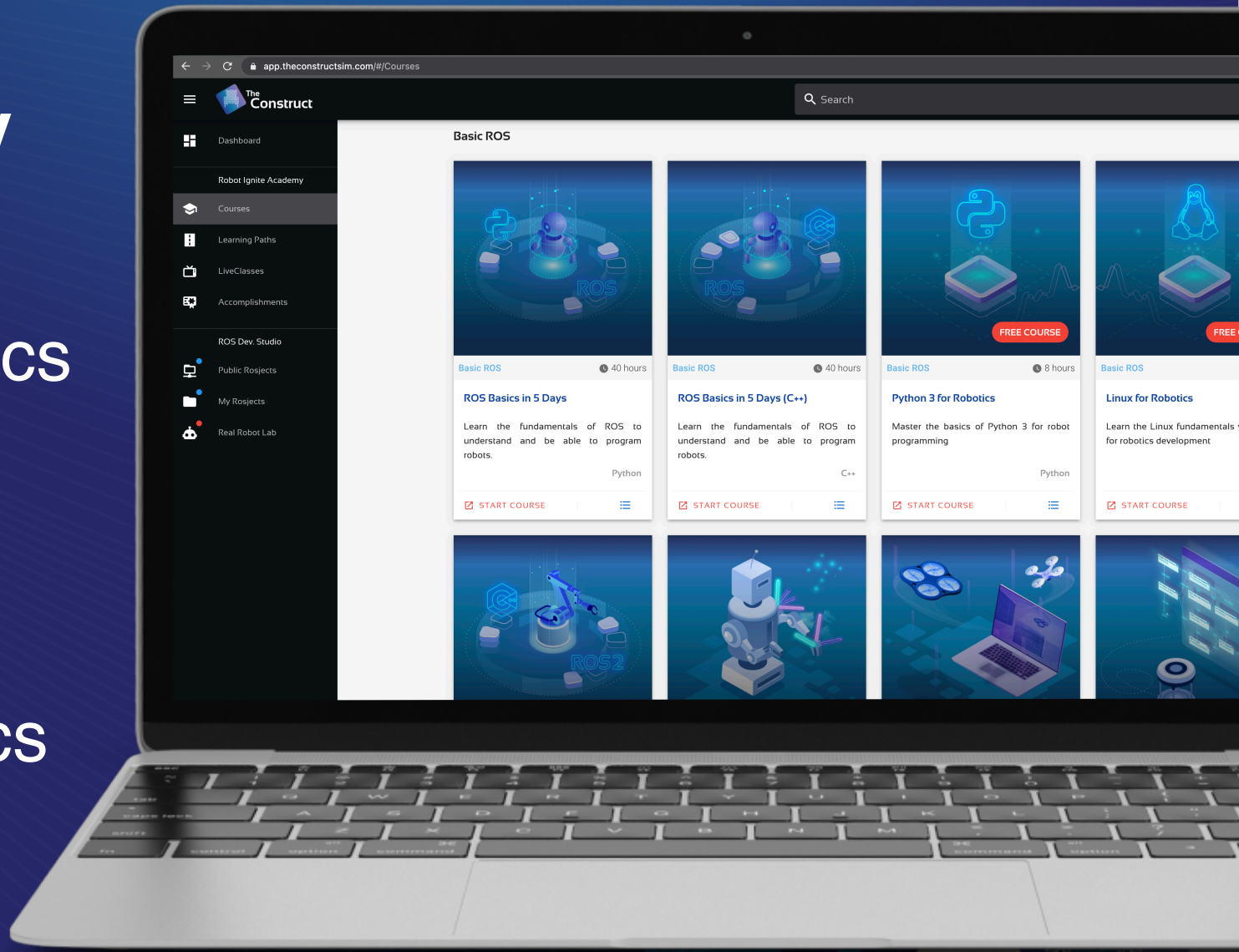
- **Manually keep a record:**
  - Who attends the class
  - Who asks questions
  - Who does the exercises

The Construct
Full Online Solution
For Teachers and Students

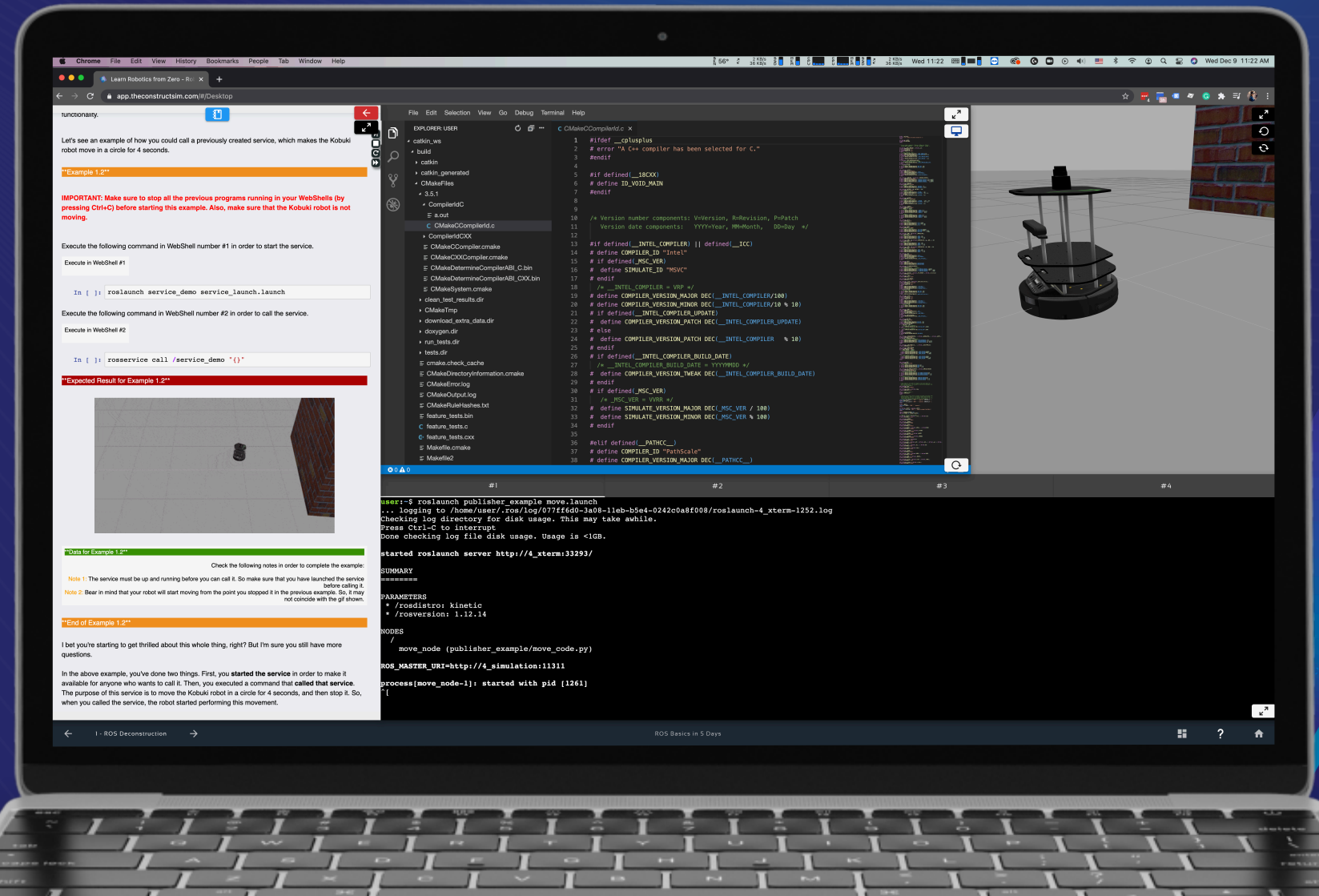
The Construct

Get all syllabus already created for you

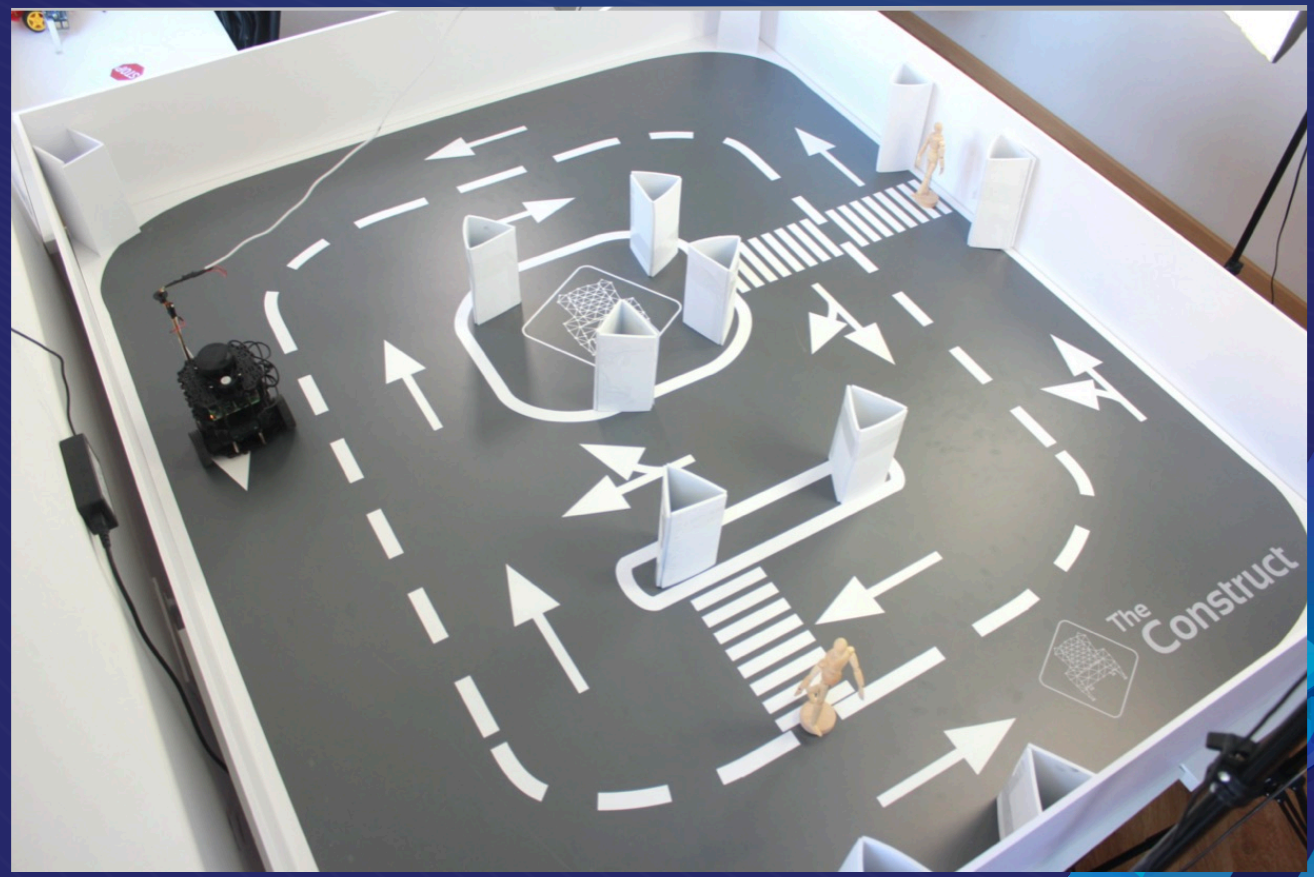
* Mathematics for Robotics
* Robot kinematics
* Robot Dynamics
* Kalman Filters
* OpenCV for Robotics
* ROS applied to Robotics
* ...



Simulated robots on a web environment: no install

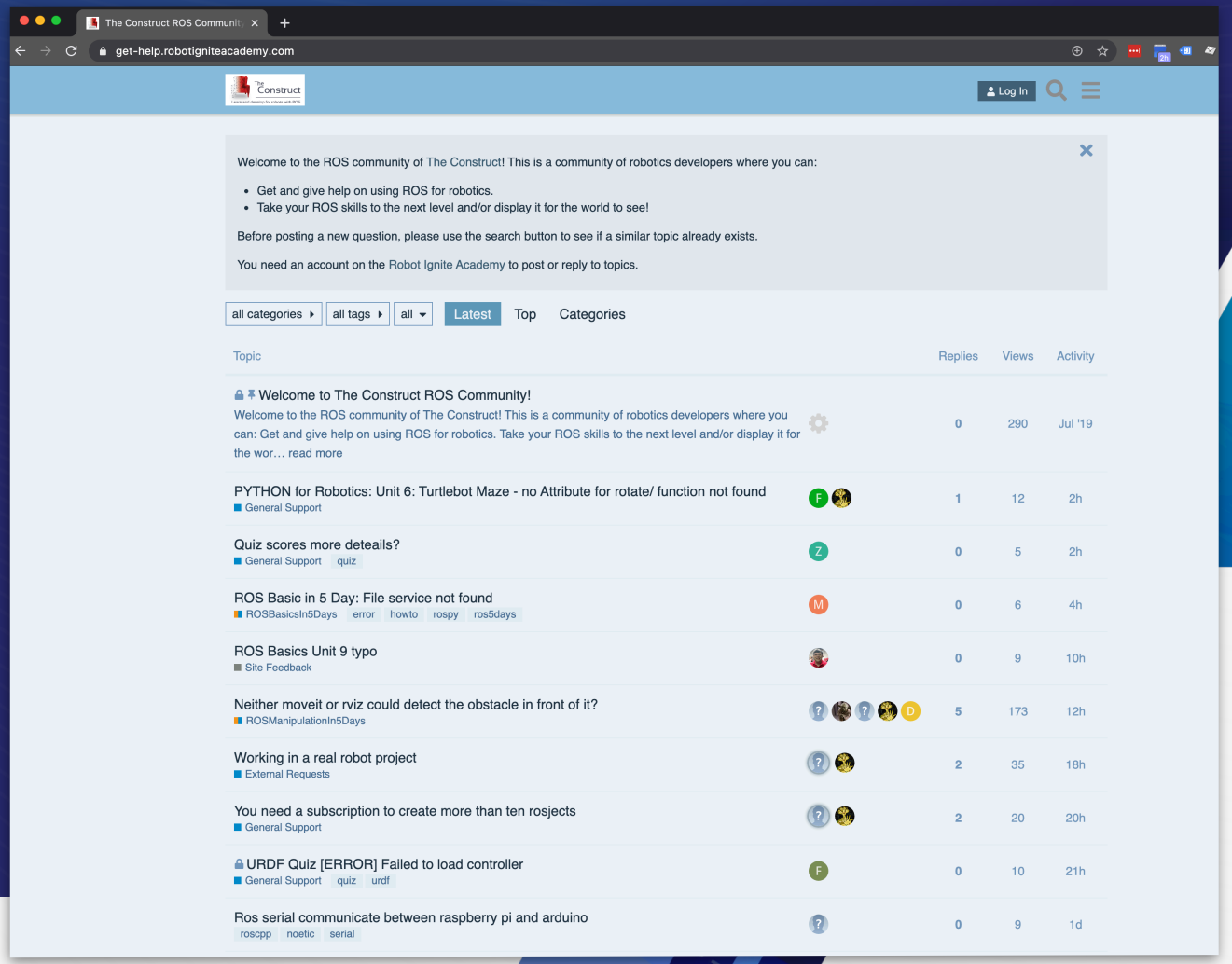


Remote Real Robot Lab Available



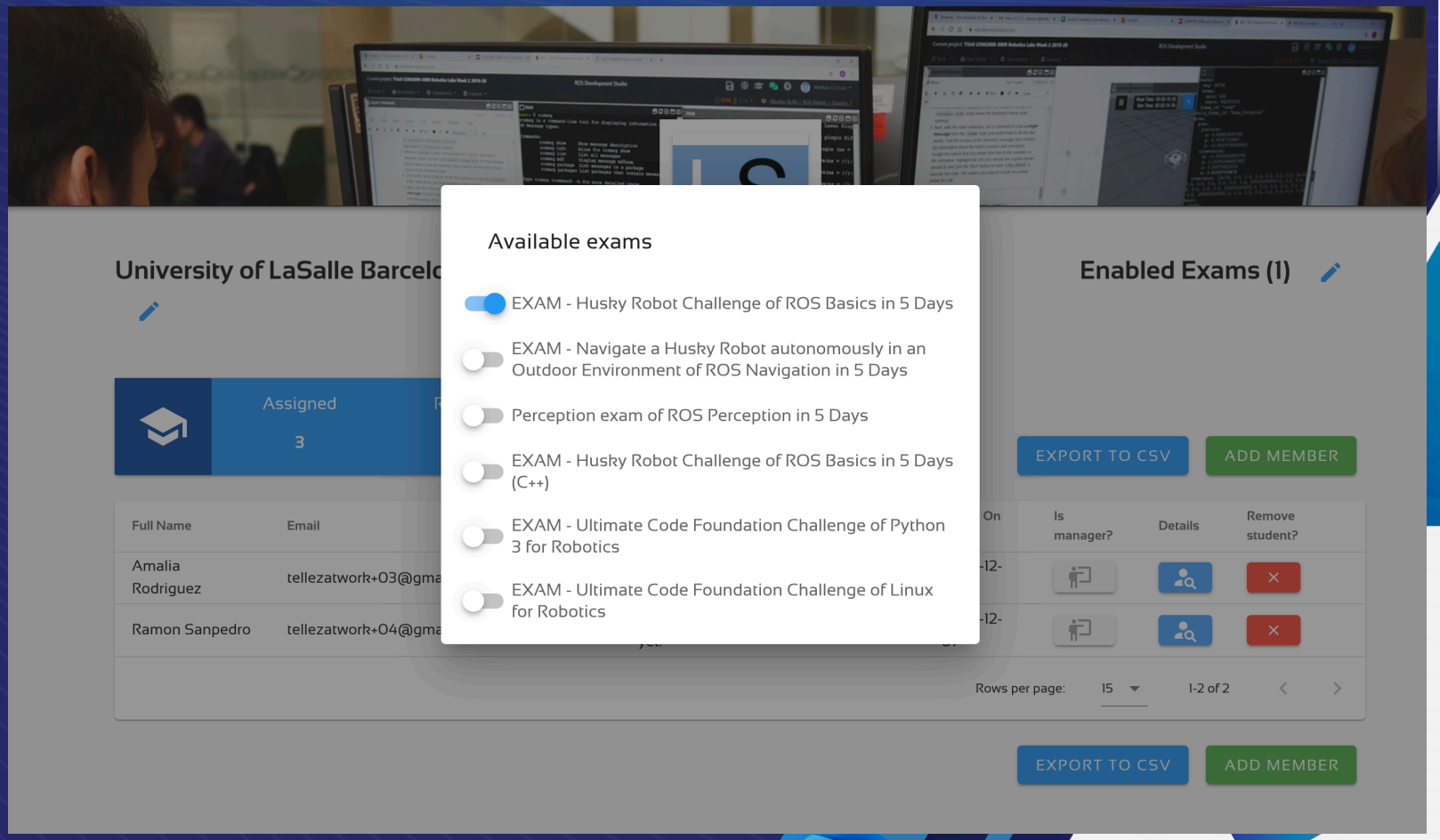
Off-Hours support for your students

- Forum answered by our team of ROS/Robotics experts.
- Answers within 24h on week days



Self-Corrected Exams Provided

- Exams already created
- Self-corrected
- Random exam to students to prevent copying (in preparation)



Students’ progress control panel

Assigned	Remaining	Total
52	10	62

EXPORT TO CSV ADD MEMBER

Full Name	Email	Total Hours	Exams Taken	Certificates	Added On	Is manager?	Details	Remove student?
Leeor Nehardea	lneharde@ucsd.edu	22.57 hours	None taken yet.	- None earned yet -	2020-07-30			
Haoru Xue	hxue@ucsd.edu	1.02 hours	None taken yet.	- None earned yet -	2020-07-31			
Jan Tengdyantono	jtengdya@ucsd.edu	59.83 hours	None taken yet.	- None earned yet -	2020-08-05			
Nathan Perkins	nperkins487@gmail.com	42.89 hours	None taken yet.	- None earned yet -	2020-08-05			
Lavita Zuo	x5zuo@ucsd.edu	22.67 hours	None taken yet.	- None earned yet -	2020-08-05			
Ryan Dunn	ryan.dunn729@gmail.com	18.59 hours	None taken yet.	- None earned yet -	2020-08-05			
Drew Britten	drewbritt10@gmail.com	15.29 hours	None taken yet.	- None earned yet -	2020-08-13			
Songyu Lu	sol009@ucsd.edu	46.71 hours	None taken yet.	- None earned yet -	2020-09-01			
Joshua Orozco	jorozco@ucsd.edu	3.45 hours	None taken yet.	- None earned yet -	2020-10-02			
Owen Cruise	ocruise@ucsd.edu	3.53 hours	None taken yet.	- None earned yet -	2020-10-07			
Ethan Lerner	elerner@ucsd.edu	0.57 hours	None taken yet.	- None earned yet -	2020-10-07			
Benjamin Crawford	bcrawfor@ucsd.edu	0.18 hours	None taken yet.	- None earned yet -	2020-10-07			
Udai Kandah	ukandah@ucsd.edu	2.45 hours	None taken yet.	- None earned yet -	2020-10-07			
Dominic Nightingale	djnighti@ucsd.edu	16.20 hours	None taken yet.	- None earned yet -	2020-10-07			

Students’ progress control panel

Ramon Sanpedro
tellezatwork+04@gmail.com

Added on	Last activity	Total learning hours	Exams taken | Score	Certificates
2020-12-07	December 07, 2020, 19:08	0.06 hours	None taken yet.	- None earned yet -

Lesson	Started on	Time spent
URDF Introduction	December 07, 2020, 19:05	0:02:04
Building the Visual Robot Model with URDF	December 07, 2020, 19:07	0:00:46
Using URDF for Gazebo	December 07, 2020, 19:08	0:00:49

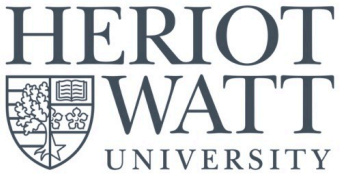
Rows per page: 15 1-3 of 3

Advantages of Paid solution

1. Get all the material done ready to teach
2. No need to install anything
3. Get exams and corrections of them
4. Include LinkedIn certificates
5. We provide support to your students
6. Follow student’s progress
7. Real robot lab ready

- Enjoy yourself teaching instead of wasting your time with the preparation

Some Universities Using Our Solution



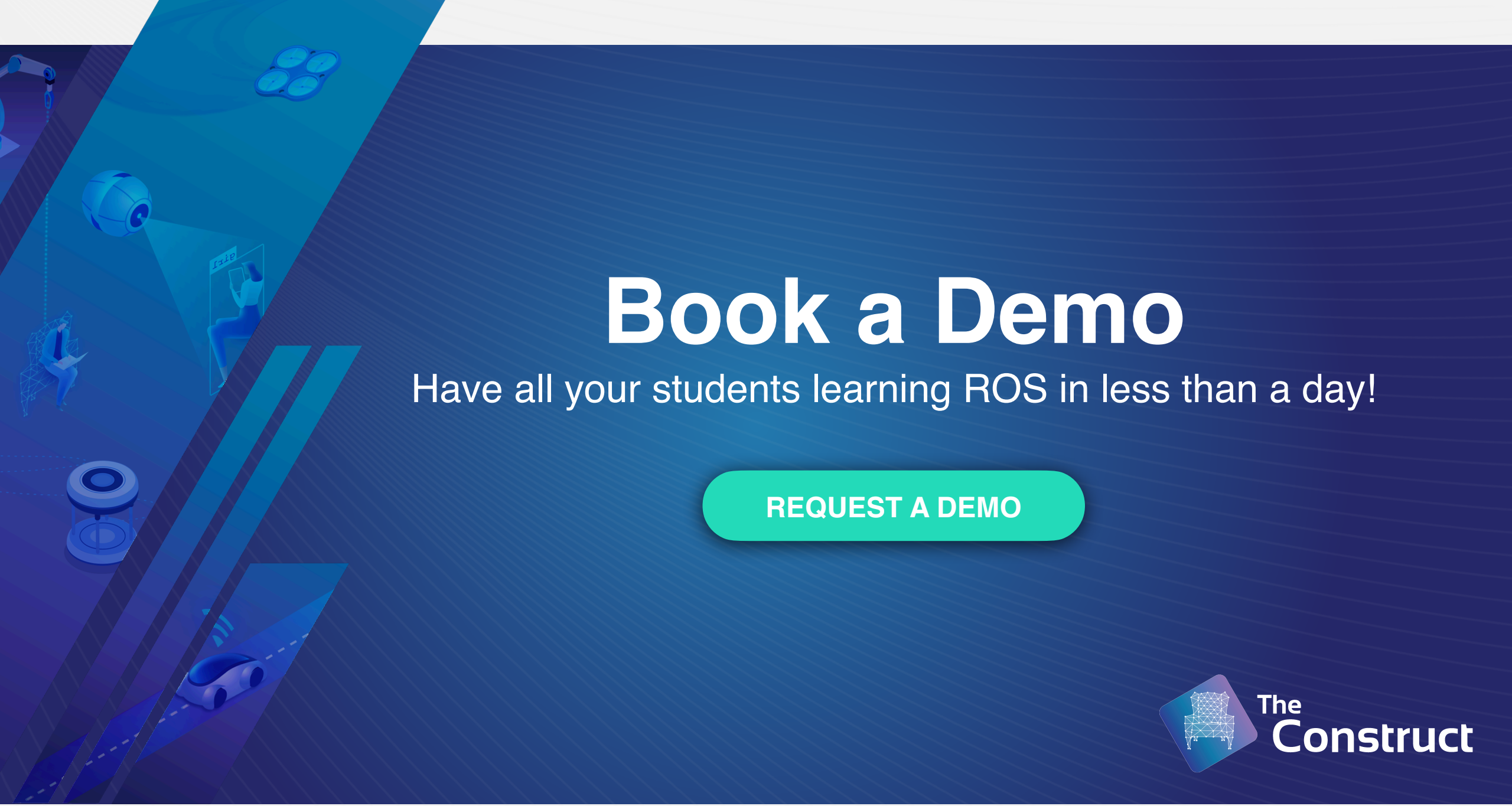
“With The Construct, our students can jump right into ROS without all the hardware and software setup problem. And the best: they can do this from everywhere”

Steffen Pfiffner

Lecturer at University of Weingarten

The Construct

Now let’s do an example of a Zoom class!


Book a Demo
Have all your students learning ROS in less than a day!
REQUEST A DEMO
The Construct

The Construct