

Machine Vision for Autonomous Mode

2024 Kickoff

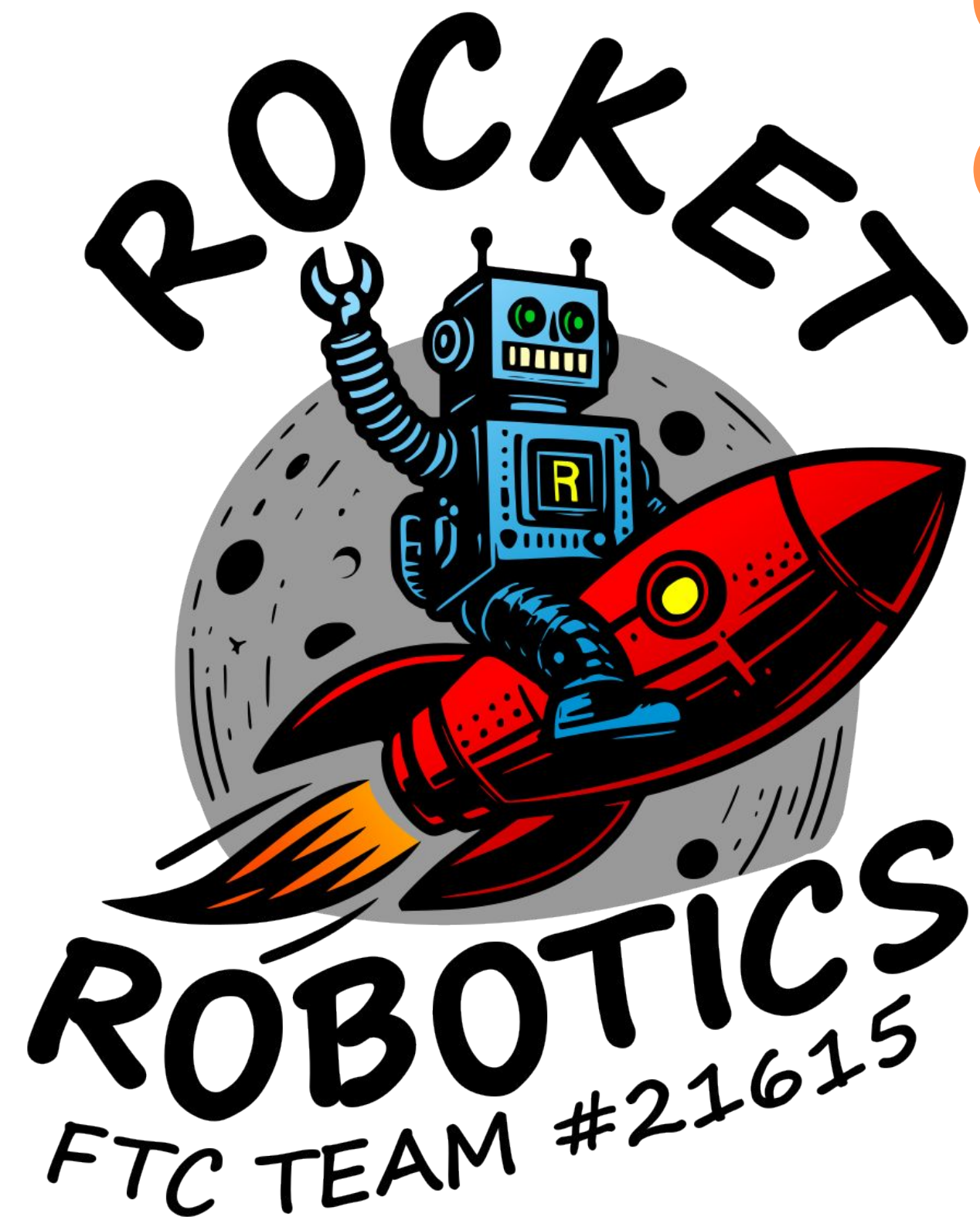


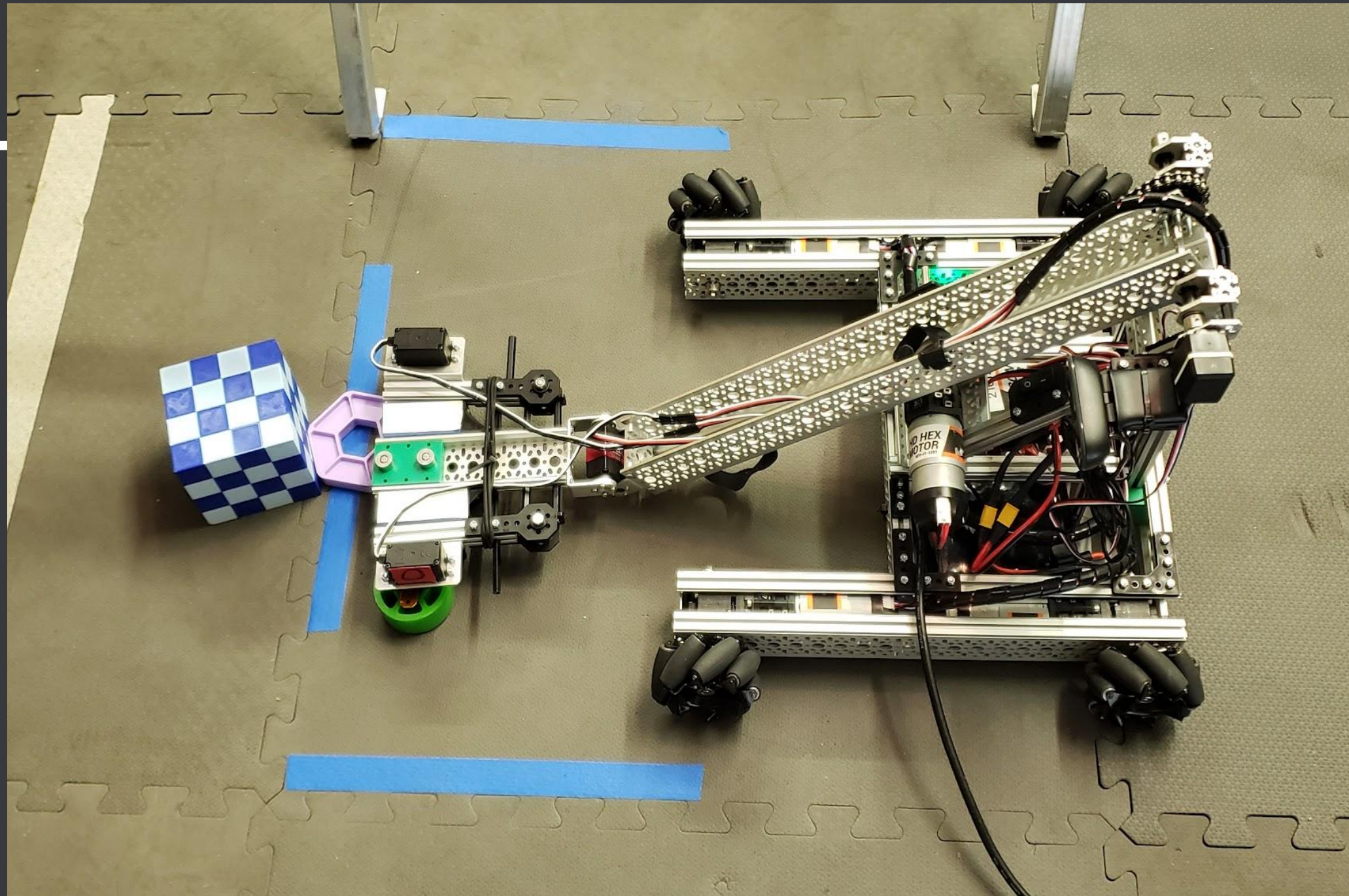
Hi!

I'm Julien Vanier

Coach of Rocket Robotics

3rd year FTC team from East Middle School





Example from 2023



Example from 2023

Types of Machine Vision



TensorFlow
w

- Good to detect objects from a known set (like blue or red prop)
- Needs training

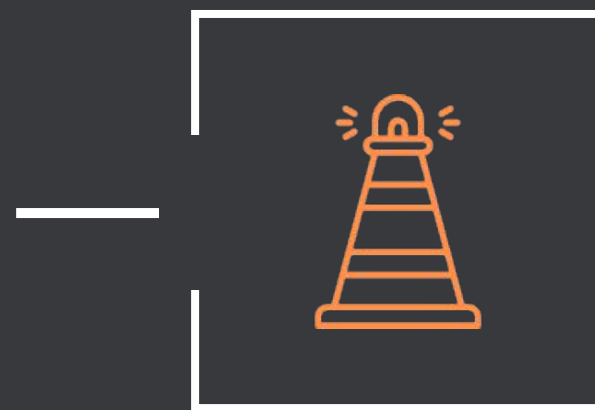


April
Tags

- Built-in support (no training)
- Give distance and orientation from camera to tag

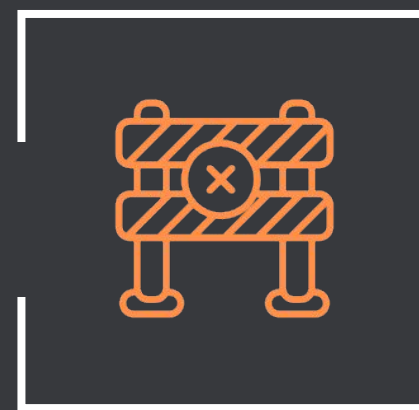


TensorFlow Object Detection



Create Object(s)

Pick what objects you want to detect.



Train Model

Record videos, label them and train the model.

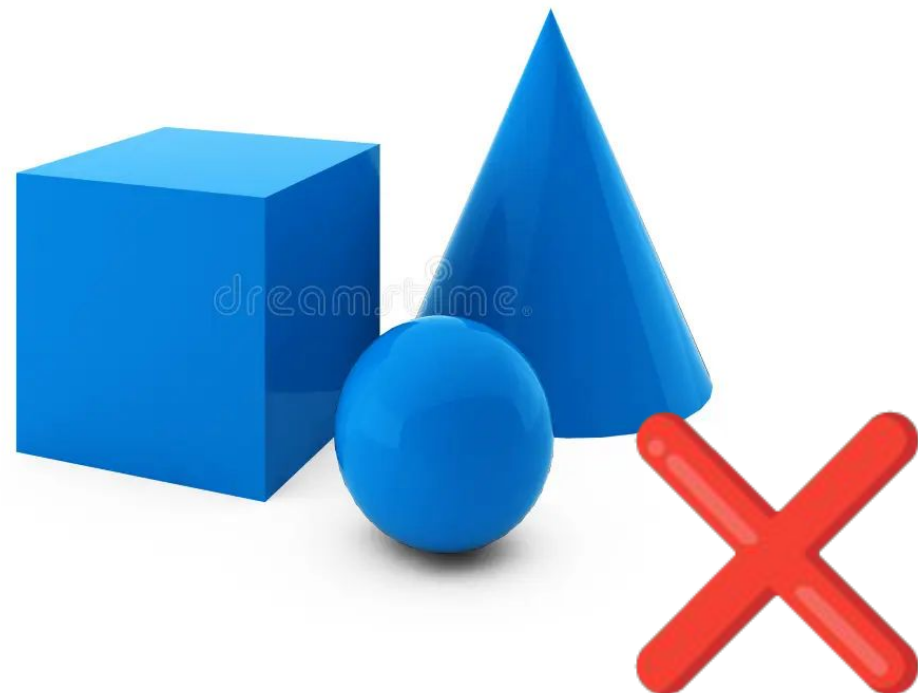


Use Model

Navigate the robot based on what it sees.



TF Objects



Good with patterns and features.

Bad with geometric shapes.

Stand out from the background.

Training a TF Model



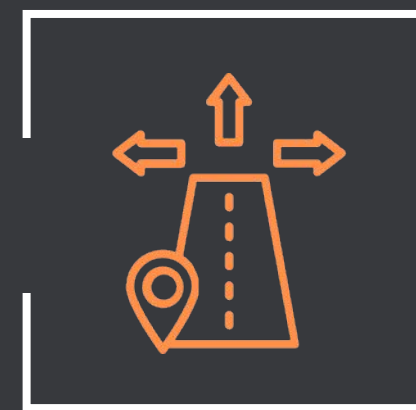
Record videos

Use robot webcam to record objects.



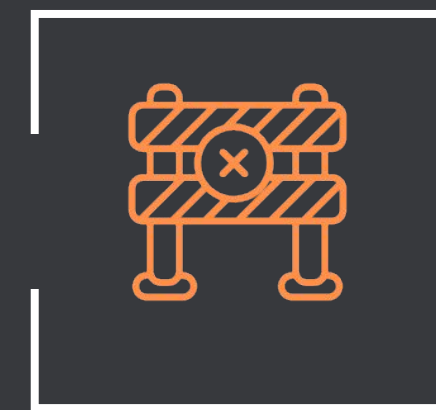
Upload videos

Use FTC ML website.



Label objects

Draw a rectangle around your object(s) in each frame.



Train model

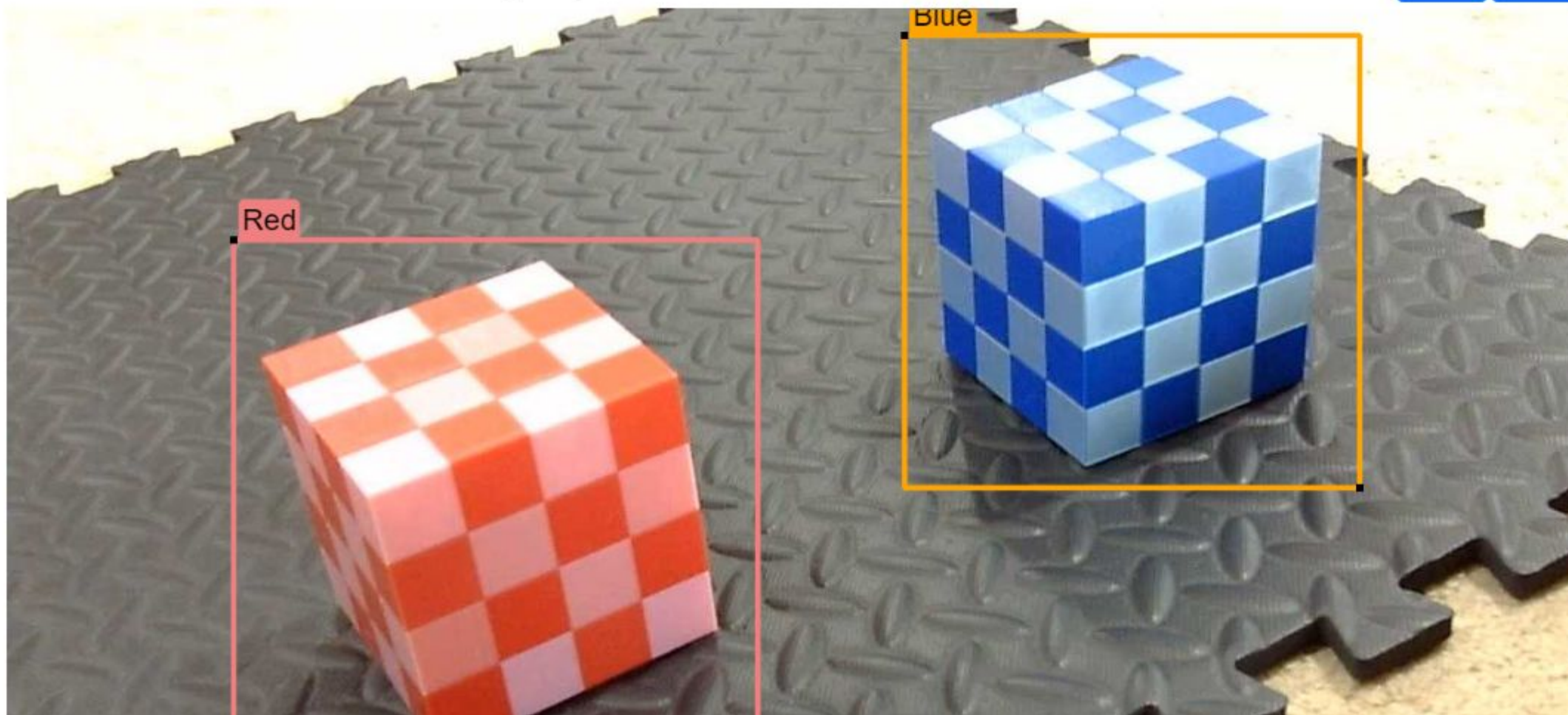
This takes time.
Output is a .tflite file.

Labeling Objects

Video: red and blue team prop



255 Frames 

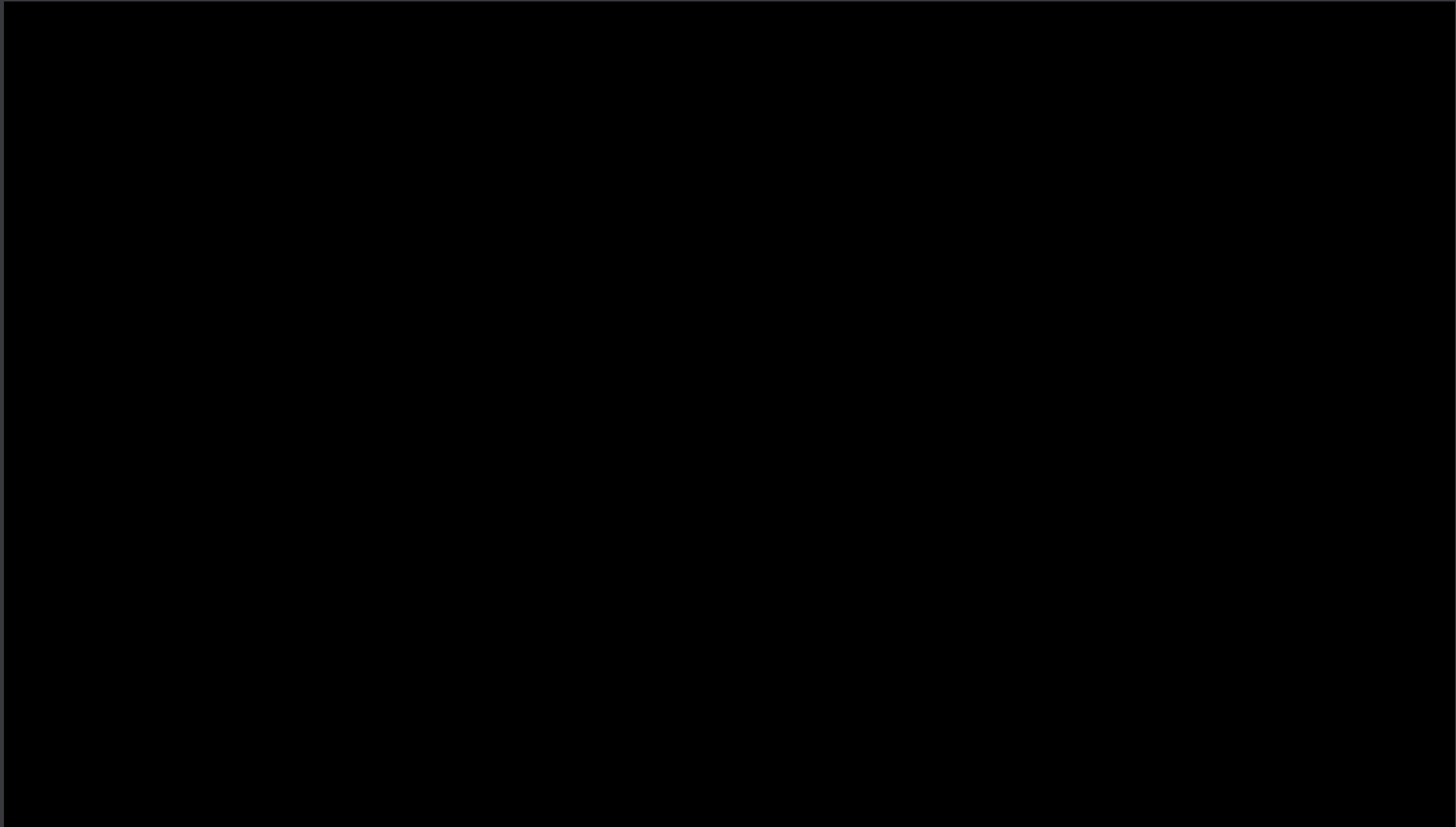


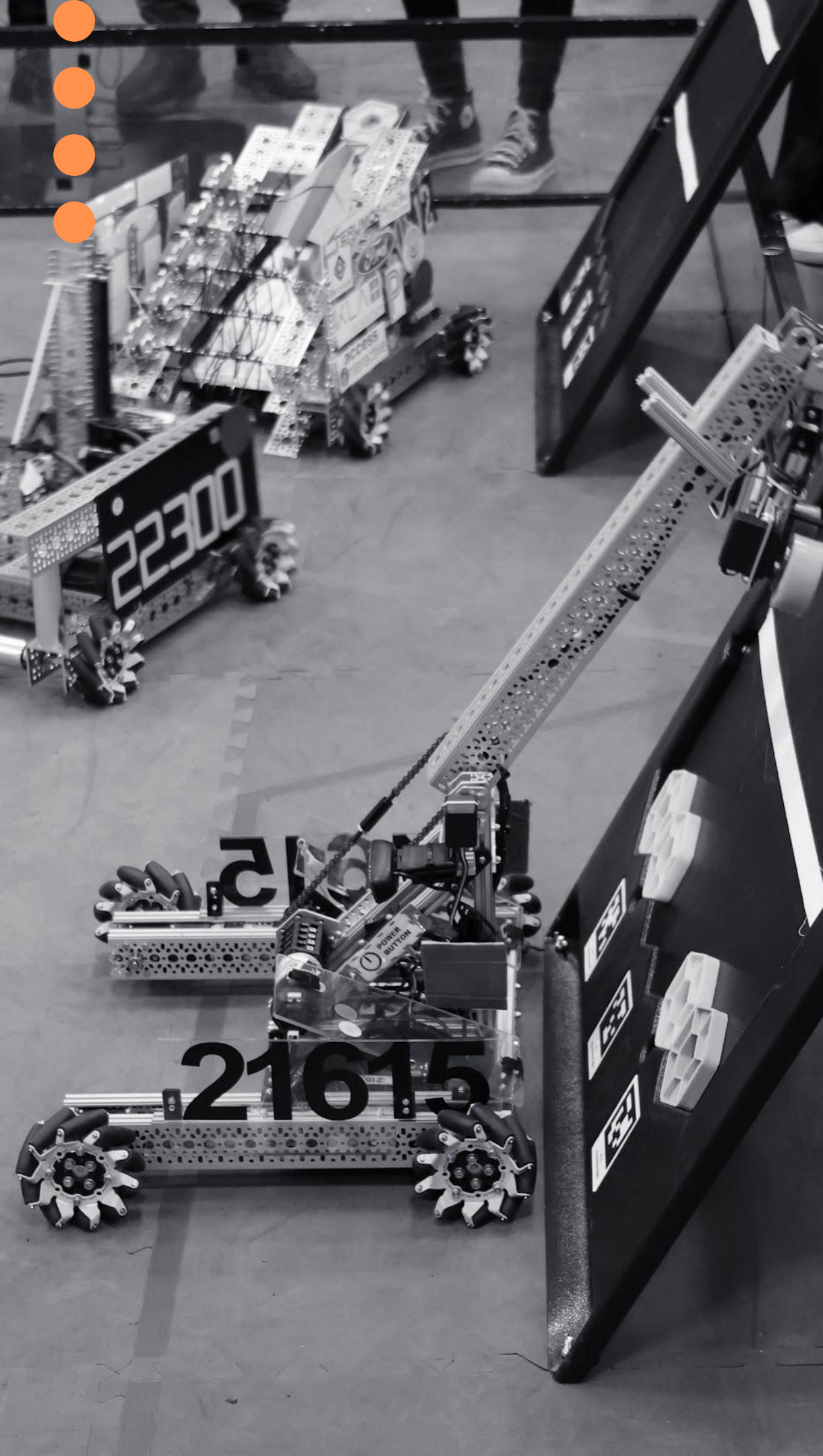
X1	Y1	X2	Y2	Label	
184	187	609	629	Red	
728	21	1097	388	Blue	

Draw boxes around objects in each frame of the video.



Training Video





Tricks and Pitfalls

★ Include entire object in box.

★ Ignore blurry frames.

Use different backgrounds and lighting.

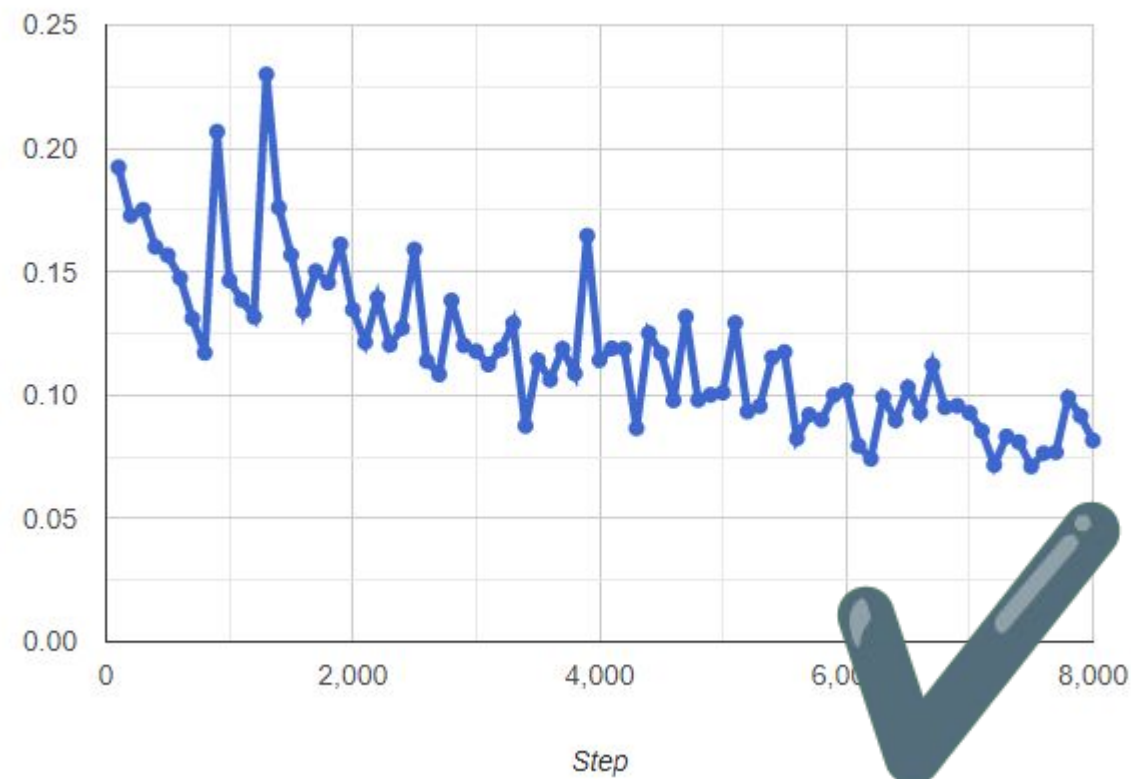
Take videos of different angles.

Use same object name in all videos.

Use low frame rate for videos.

How Long to Train?

Loss/classification_loss



Loss/classification_loss



Train each frame 100 times.

1 step = 32 frames

Graphs should go down and stabilize.

Using a TF Model

Start with a
program template



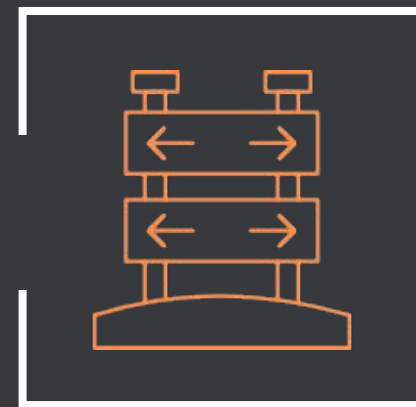
Setup model

In init, use .tflite file
uploaded to Control Hub



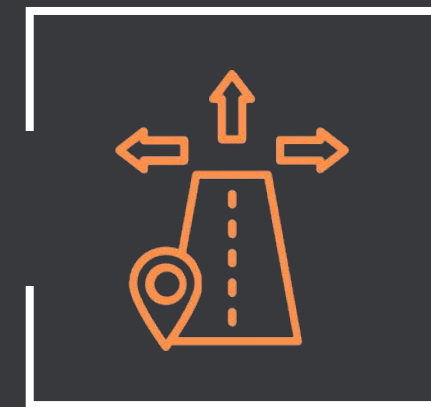
Detect objects

Built-in TF block fills in a
list with all detected
objects.



Iterate

detections
Go through each
detection and do
something with the
information.



Navigate

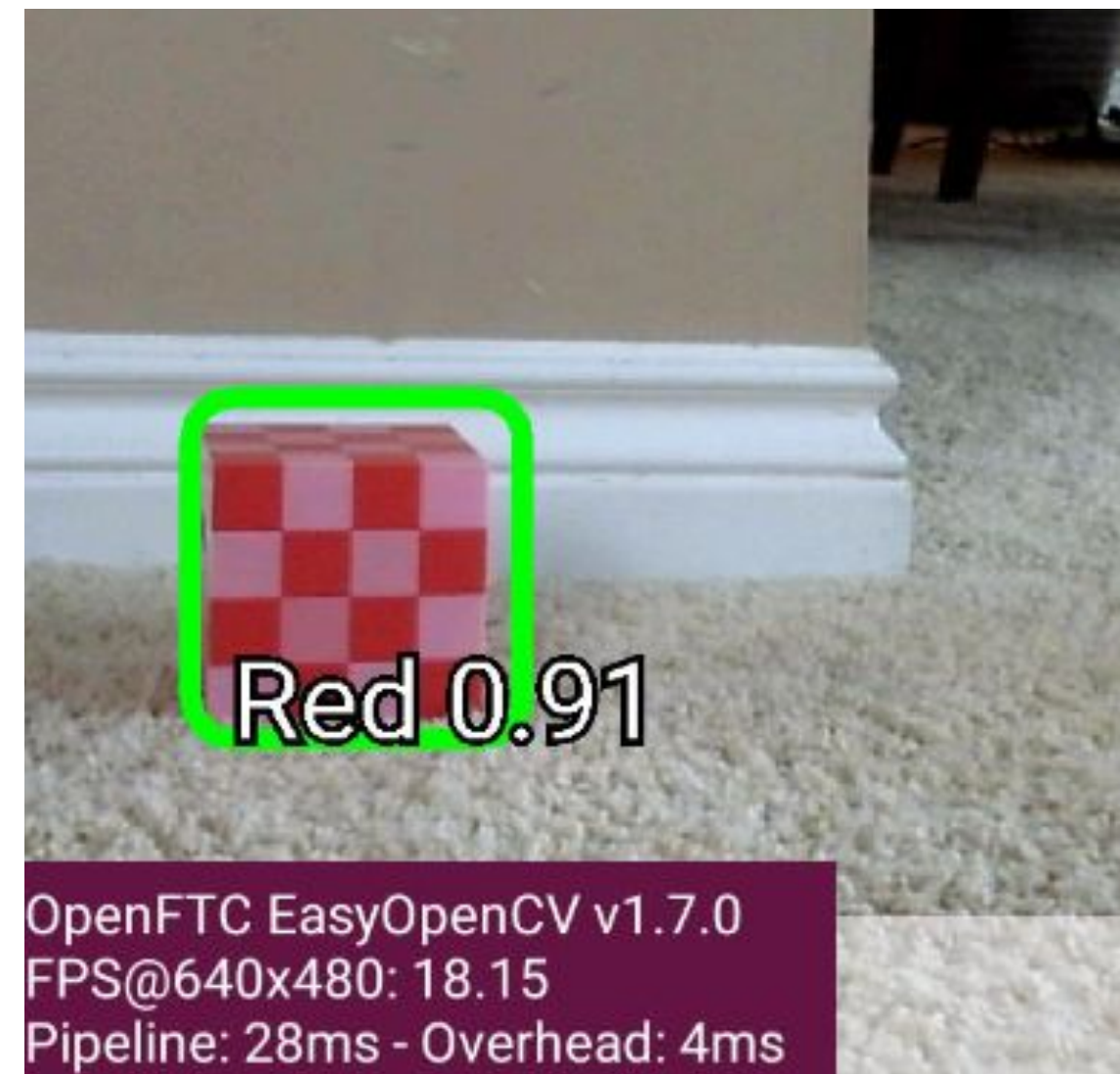
Wait for start, then move
based on the location of
the object.

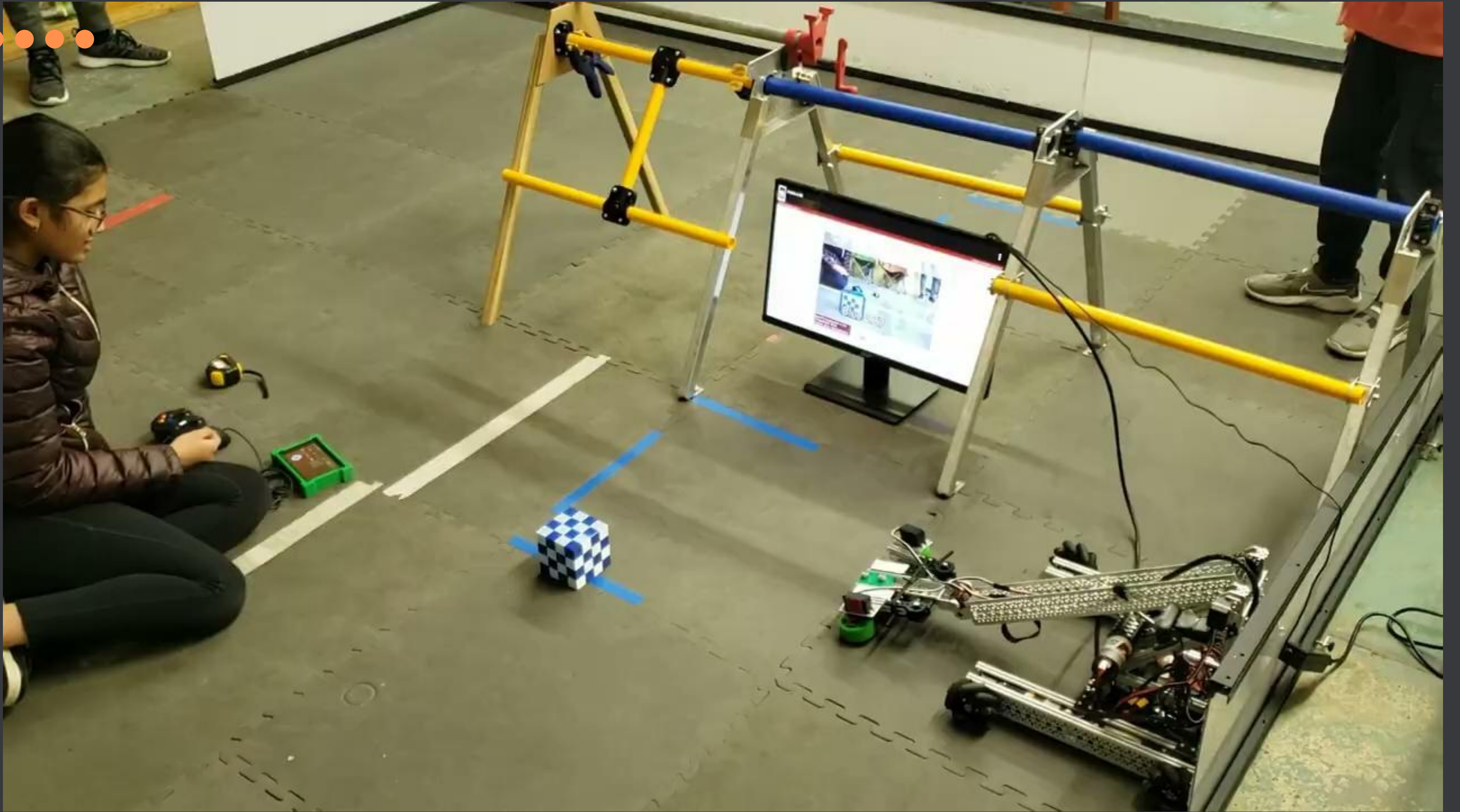
What You Get From TF



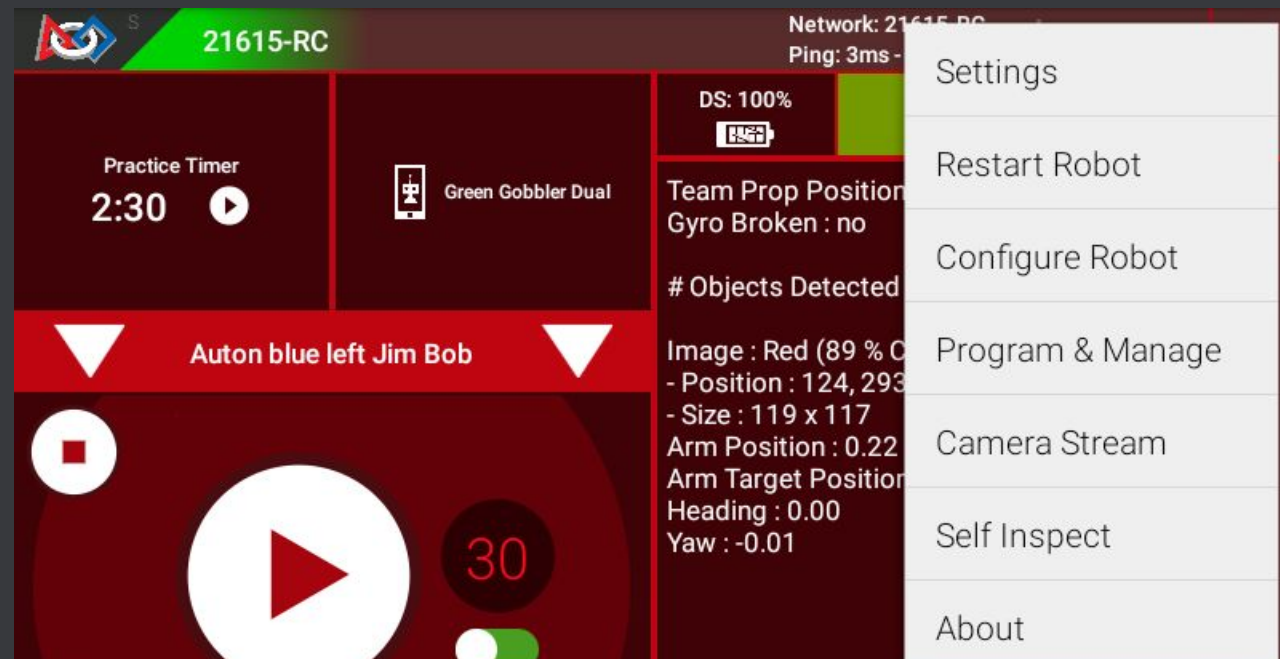
For each object detected

- Object name
- Position from top/left of camera
- Size in camera pixels
- Confidence in percent

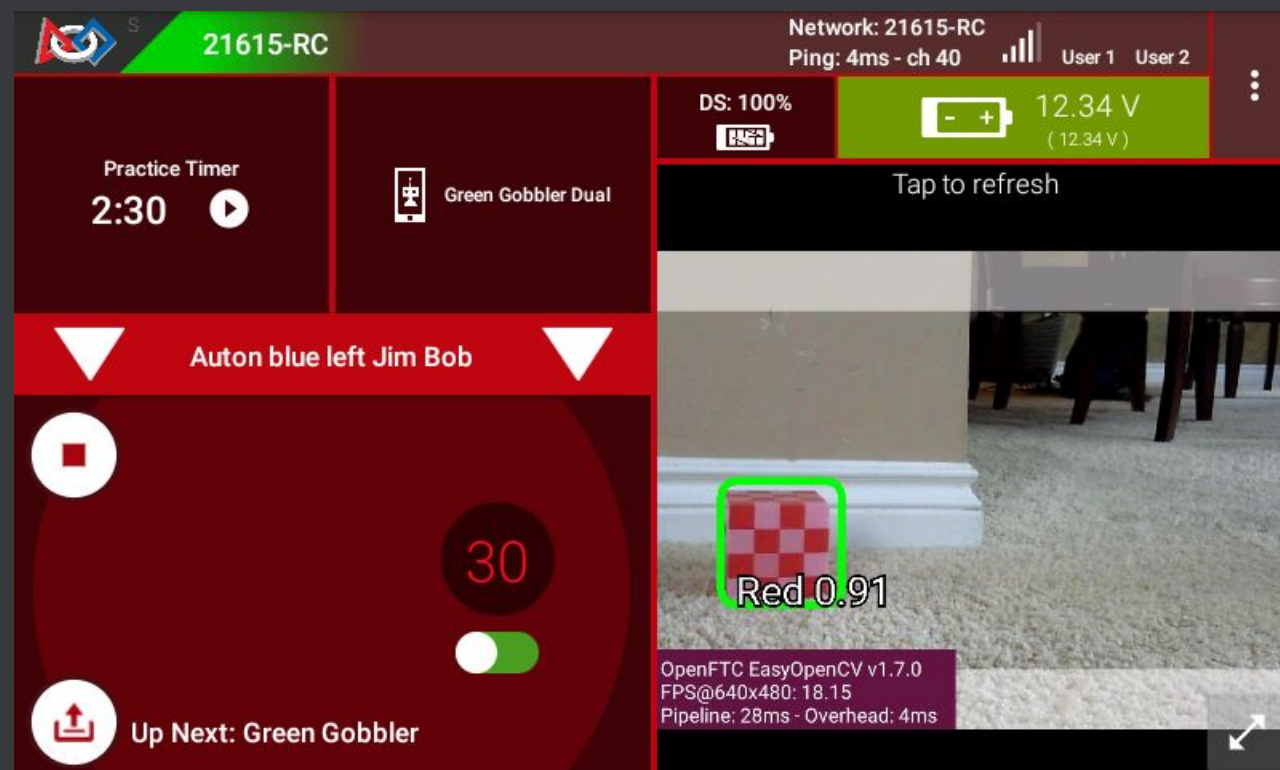




Match Prep



Align the camera using the
Camera Stream preview during
Init.



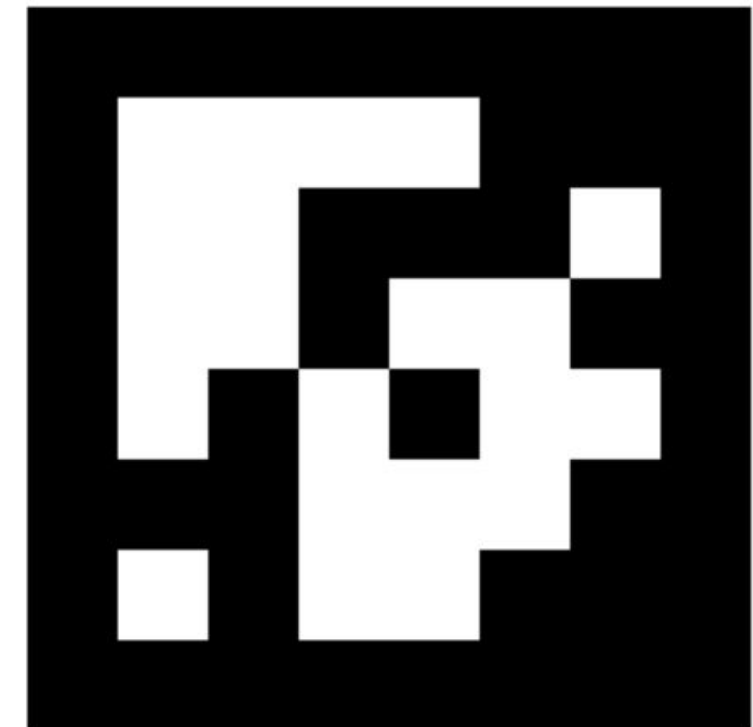
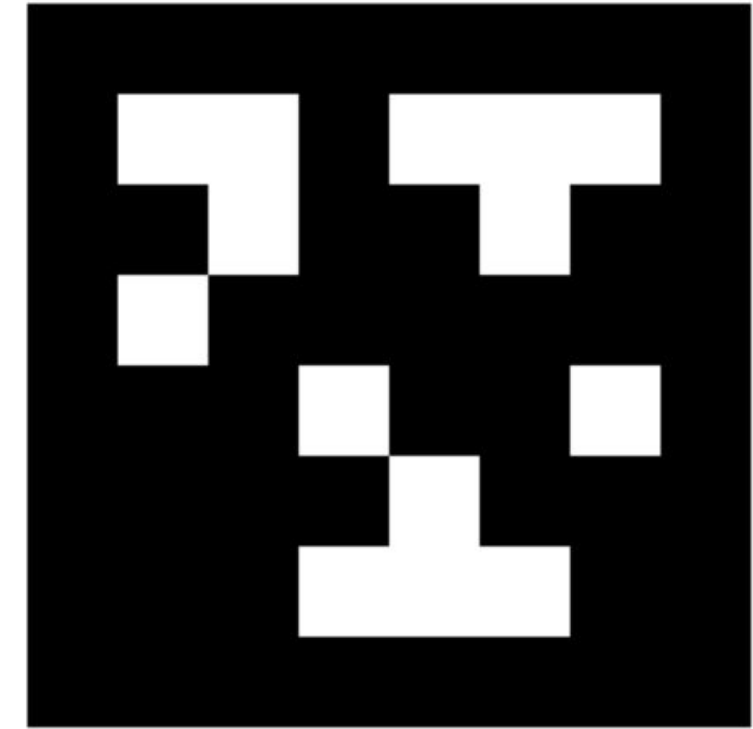
Make sure it's seeing the objects
before giving 👍 to match
judges.



April Tags

2D barcode of a known size that can be detected reliably and quickly.

Reports distance in real world units, not in camera pixels!

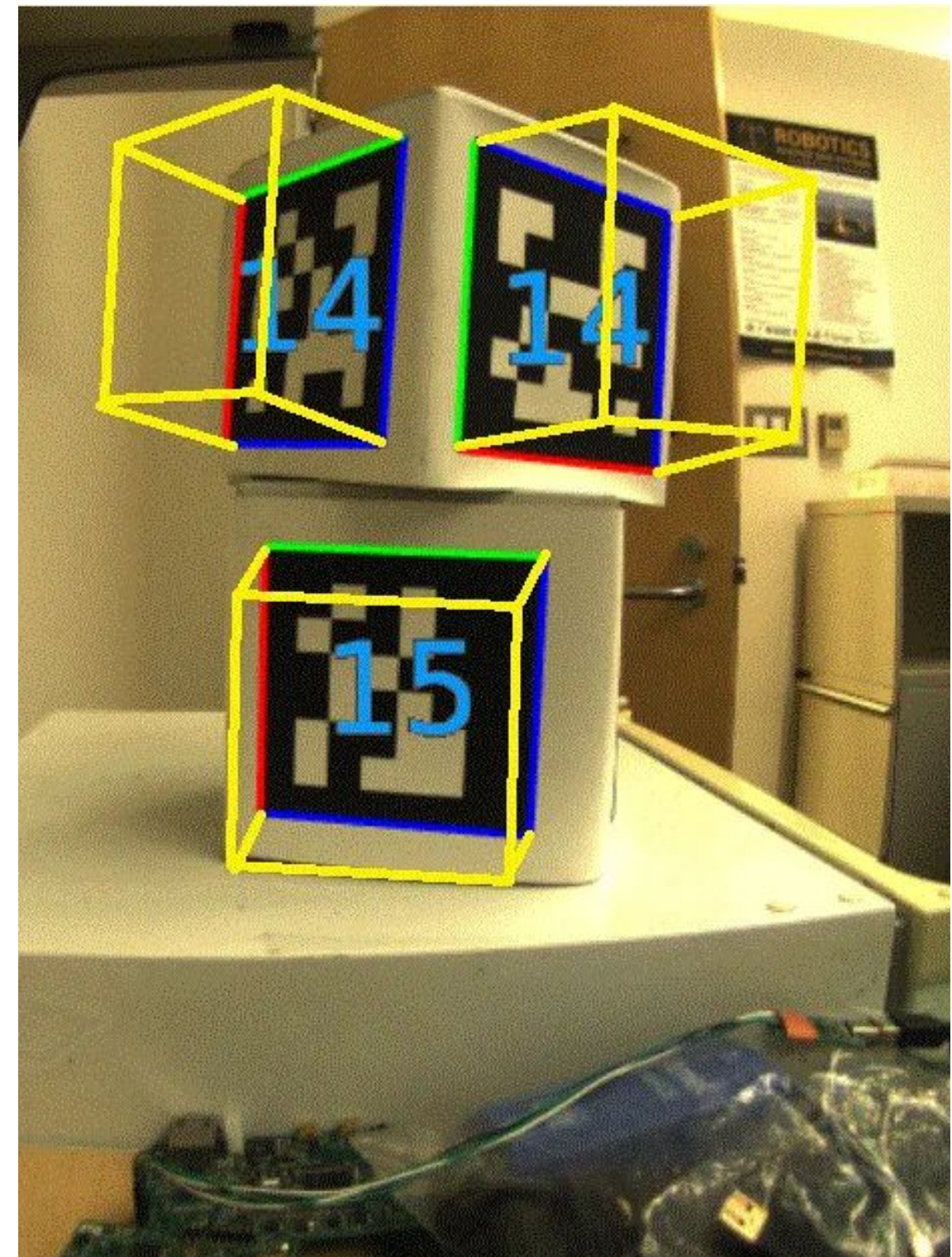


What You Get From April Tags



For each tag detected

- Tag number and name
- XYZ position vs camera
- Orientation of tag (yaw, pitch, roll)
- Range (distance from camera)
- Bearing (horizontal angle from camera)
- Elevation (vertical angle from camera)



Using April Tags



Navigate to a Tag

Continuously detect tags and drive to a target position and orientation relative to the tag.

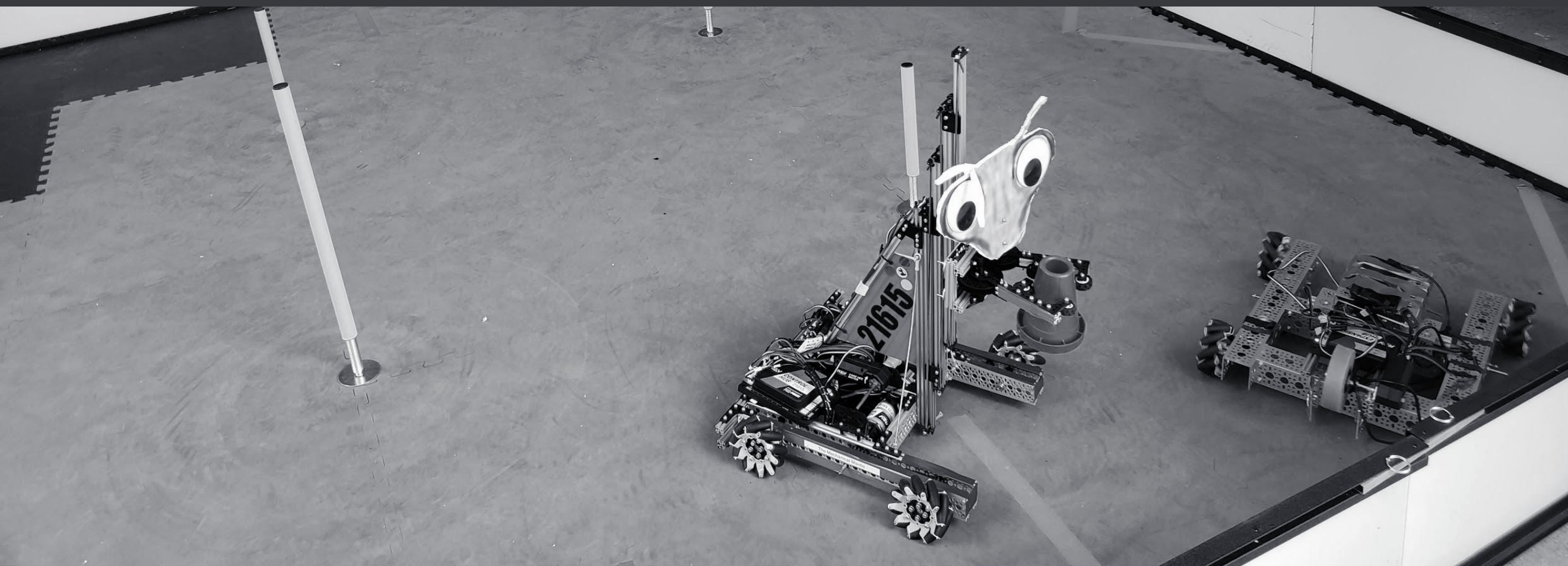
Distinguish Between Game Element

If a game has several elements with identical shape but different purpose.

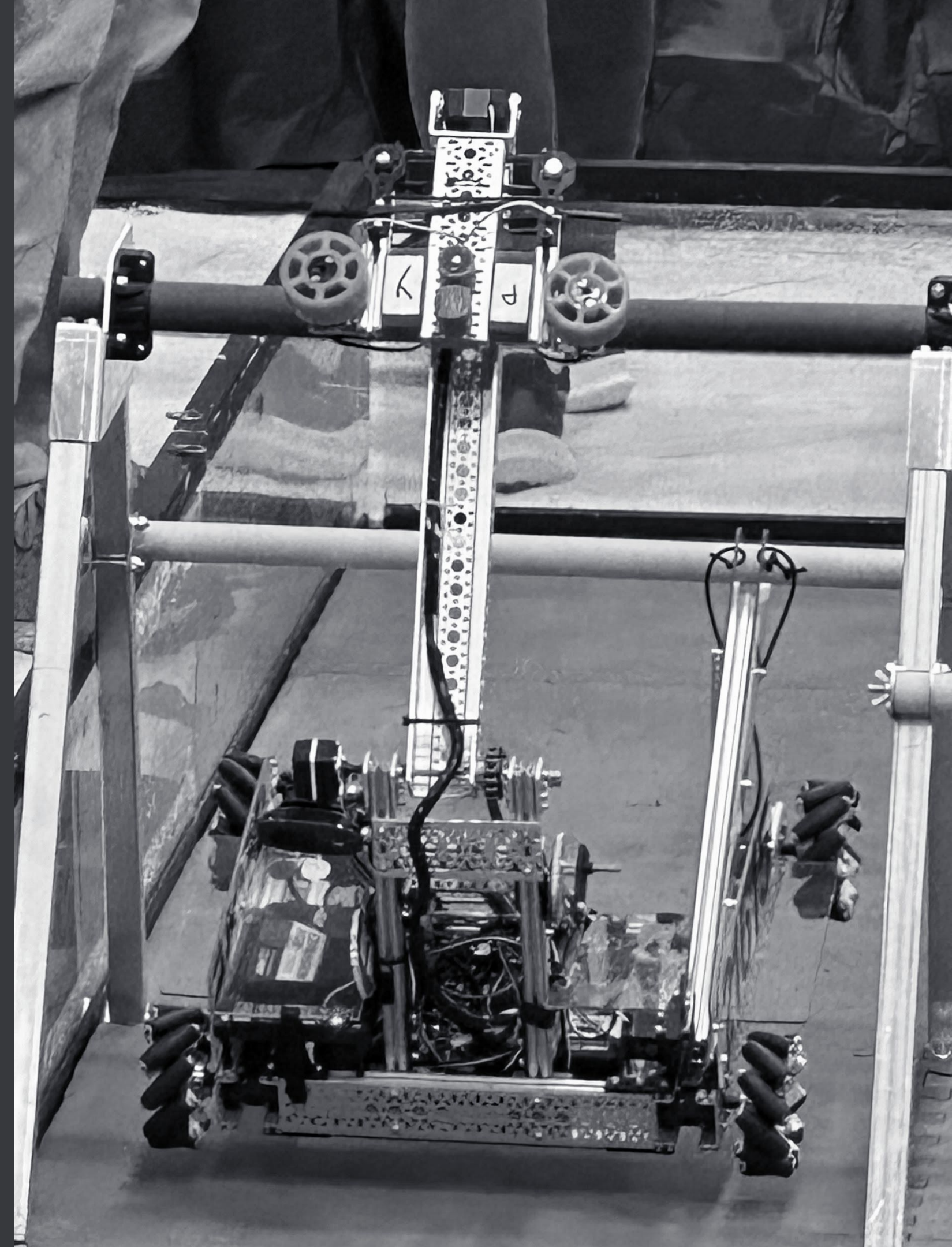


Live Demo!

Using scrapy



Good luck!



Credits

Slides Carnival

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Pexels for the photos

Happy designing!

