Quick ROS Intro

CS189 Spring 2019

What is ROS?

- “Robot Operating System”
- Provides a way to communicate with robots
- Allows us to write several programs which work together
- Multilingual support (Can write programs in: C++,Python,LISP, Java, JavaScript, MATLAB, Ruby, Haskell, R, Julia,...)

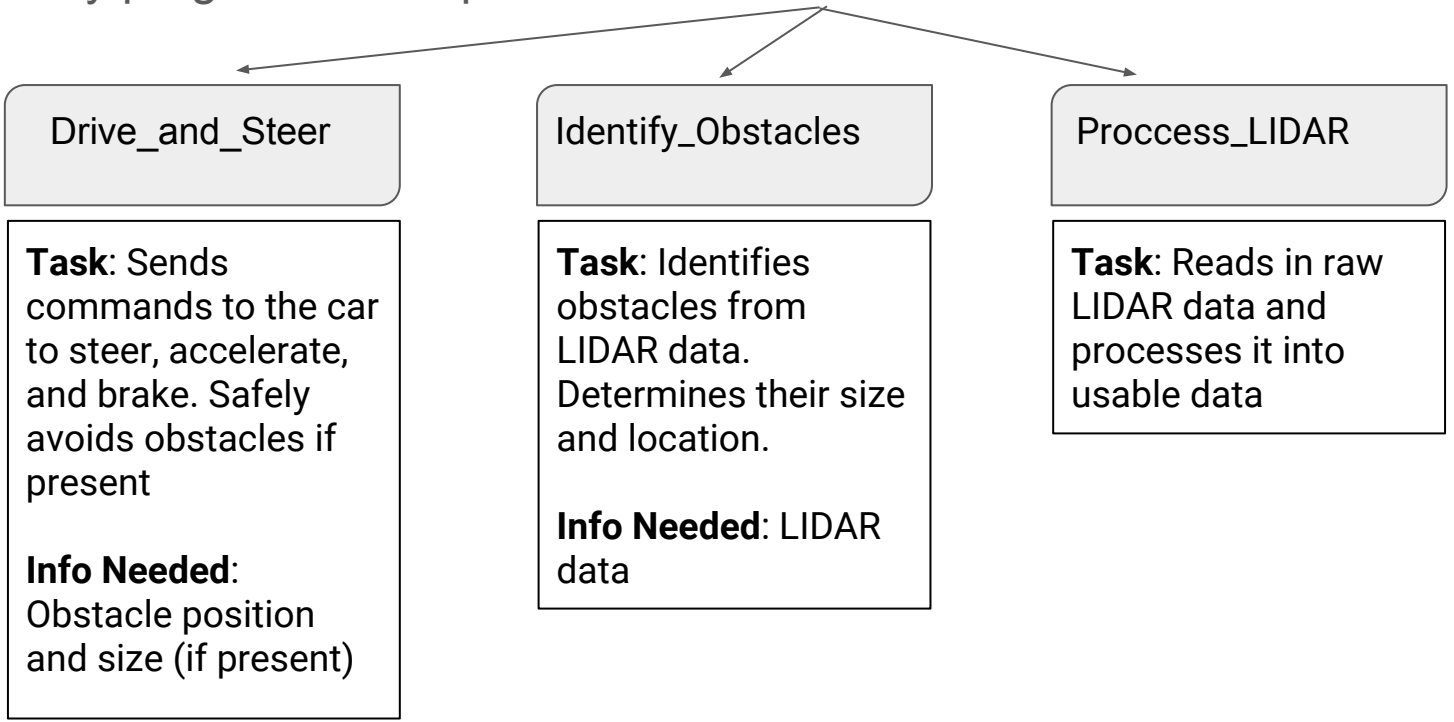
An Example Problem: Self-Driving Car as a Robot!

- What kind of things do we want our cars to be able to do on our commute?
  - Turn on and back out of the garage
  - Wait for us to get into the car
  - Plan a route to follow
  - Adapt route for traffic changes
  - Avoid potholes, roadkill, or bad drivers
  - Place a phone call
  - Play music
  - Go refuel/recharge when needed

- If each is a program, do they need to be constantly running?
- What kind of sensors and signals would we take in?

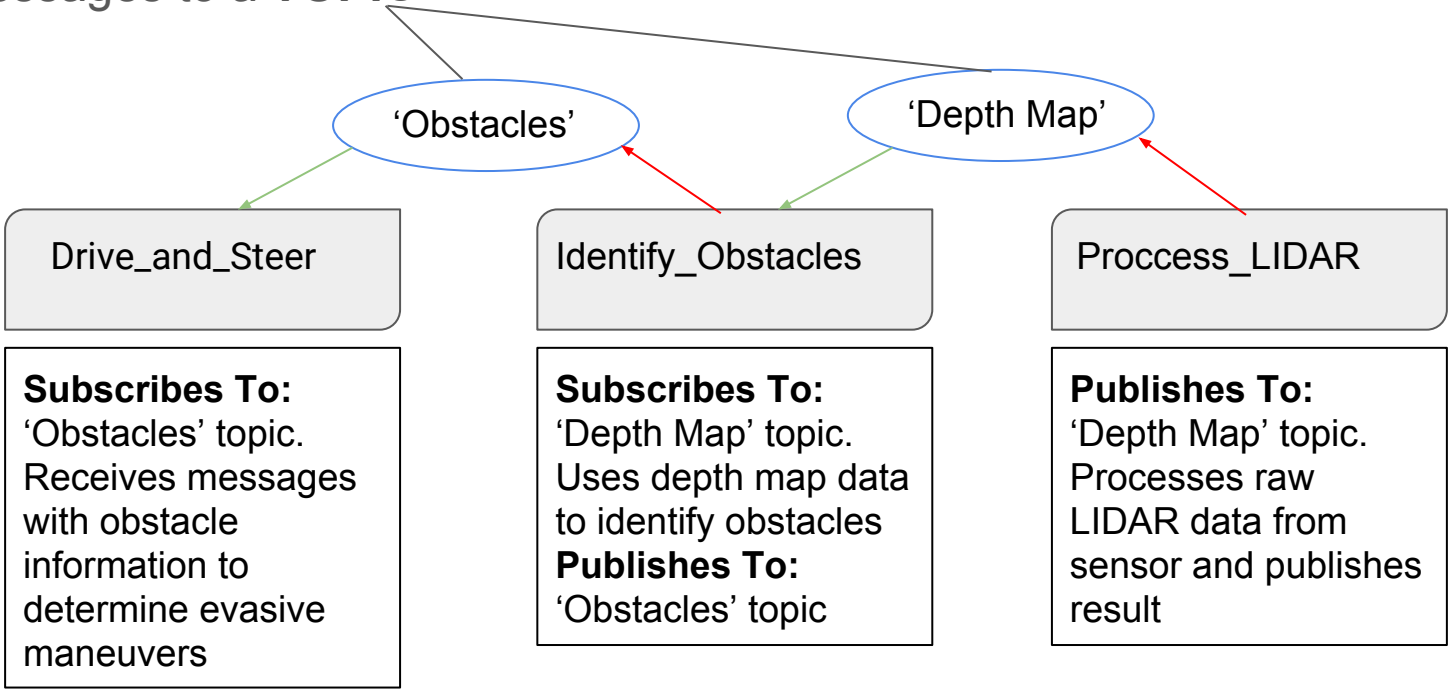
ROS Architecture

- Many programs with specific tasks: **NODES**



How do Nodes communicate?

- **NODES** communicate by **Publishing**(sending) and **Subscribing**(receiving) messages to a **TOPIC**



More on Publisher/Subscriber

- When a publisher sends a message to a topic, it does not care which node is subscribed to it

- Likewise, a subscriber will not care which node published to the topic

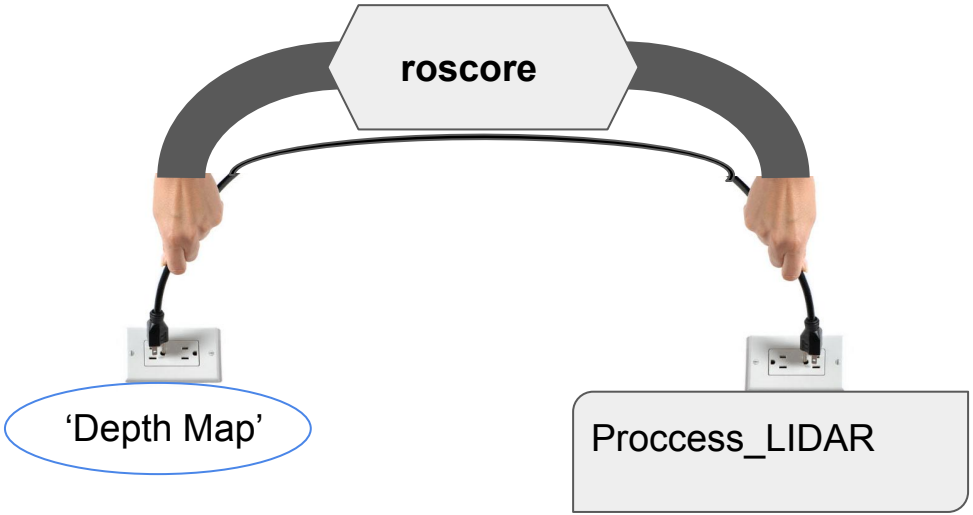
- It is possible to have multiple publishers or subscribers to a single topic
  - When could we require multiple subscribers to the same topic?
  - What about multiple publishers?

Publisher Queues

- By default, a publisher in rospy is **synchronous;** After a message is published, the publisher is blocked from sending another message until:
  - The message has been sent to the topic
  - The topic has sent the message to each of the current subscribers
    - Can you think of why this may not be good?
- It is recommended that we use **asynchronous** publishing, which is defined by queue_size.
- For asynchronous, the publisher is still blocked while it is sending the message to the topic, but can publish another message once it is sent
  - A queue of messages can be kept; once it overflows, oldest messages are removed
  - The subscribers can receive the messages from the topic at their own rate
- Choosing a good queue_size (None = synchronous, Zero = infinite,1 = Most Recent)

What is ‘roscore’?

- Invisible master that manages communication between nodes
- When a node is started up, it connects to roscore to let it know where it will publish and subscribe to
- roscore only sets up peer-to-peer connections between nodes



“So, what will I actually be using….”

- Here are some commands we will use in this class:
  - **roscore**
    - Starts roscore, which is required for nodes to communicate
  - **rosrun**
    - Starts a node running
  - **roslaunch**
    - Starts a collection of specified nodes; if roscore isn’t running, it will start up roscore
  - **Crtl + C**
    - Stops a program while it is running

Starting and stopping our nodes

- We will be writing our nodes using Python with help of 'rospy'
- Initializing a node
  - rospy.init_node("my_node_name")
- Shutdown sequence
  - rospy.on_shutdown(self.shutdown)
    - When the program is shut down, it will run the function described in shutdown
    - For our robot, this may include telling it to stop moving
- Defining a Publisher
  - pub = rospy.Publisher('topic_name',std_msgs.msg.String, queue_size = 10)
    - pub can now publish to the topic 'topic_name' messages of type String,only keeping 10 most recent messages if they aren't being received as fast as they are published
    - pub.publish("Hello World") #Publishes the message using publisher we defined
- Defining a Subscriber
  - rospy.Subscriber('topic_name',std_sg.msg.String, process_topic)
    - When a message is published to 'topic name', the information will be processed using the function we define as process_topic

Example Code from Lab 1 (Today):

```
cmd_vel_pub = rospy.Publisher('cmd_vel',Twist,queue_size=1)

move = Twist()

move.linear.x = 0.5 #drive straight ahead at 0.5 m/s

rate = rospy.Rate(10) #iterate at 10 Hz

while not rospy.is_shutdown():

        cmd_vel_pub.publish(move)

        rate.sleep()
```

IF THE PUBLISHER SENDS COMMANDS TOO SLOWLY, THE TURTLEBOT WILL SHUT DOWN AND STOP LISTENING!

```
bump_sub = rospy.Subscriber('bumper',BumperEvent,bump_callback)

rate = rospy.Rate(10) #iterate at 10 hz

def bump_callback(data):
        bump = False
        if data.state == BumperEvent.PRESSED:
                bump = True
while not rospy.is_shutdown():
        if bump:
                Move.linear.x = 0 #stop
        rate.sleep()
```

- Any additional questions:
  - Check Canvas for links to documentation resources
  - Ask your peers
  - Ask a question on Piazza
  - Ask your TFs!

Have fun using the Turtlebots and treat them well!