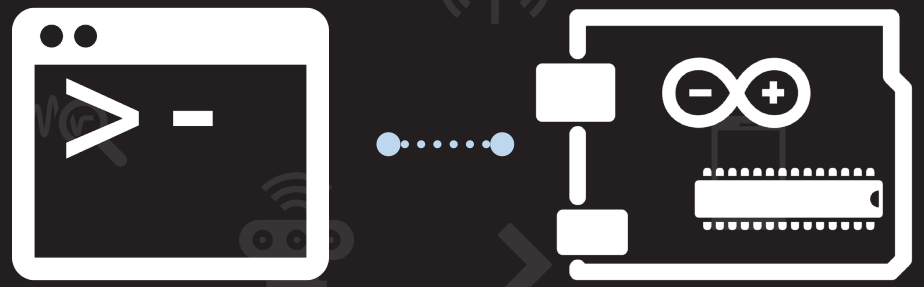
ROS – Arduino

workshop

Objective

- Nodes and topics
- ROS node: rosserial
- Arduino IDE: ROS Serial library



- Understanding rosserial
- Code simple pub/sub program

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

Node and Topics

Nodes

Executable codes that does things. Each node have its own job(s)

Node and Topics

Topic

Usually represented by an arrow or oval. Each topic has a unique message type and is being to communicate between nodes.

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Node and Topics

Wood chopper

pile of woods

Factory

wooden boards

Student

Every node only accepts a specific type of message. If the topic's message is wrong, the node cannot understand

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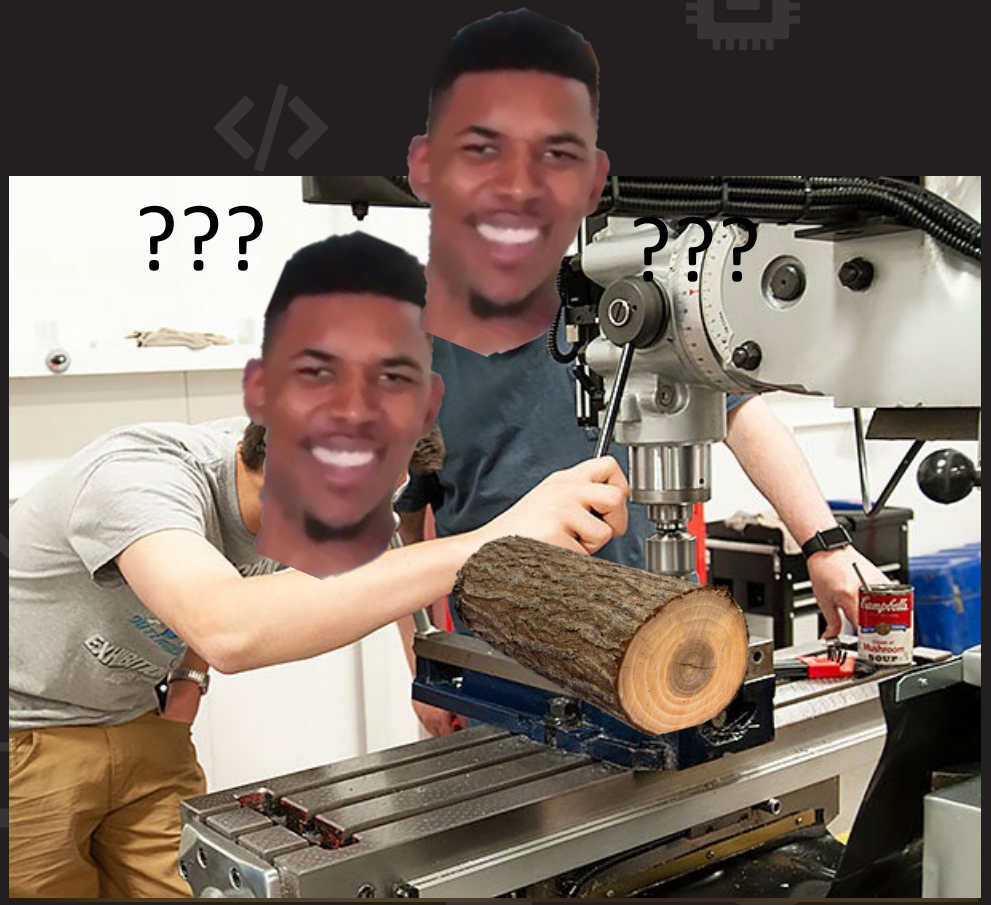
Node and Topics



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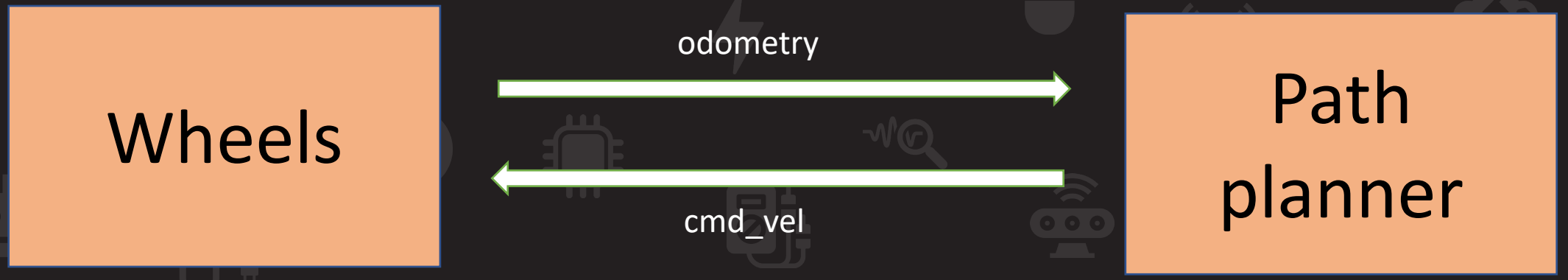
Node and Topics

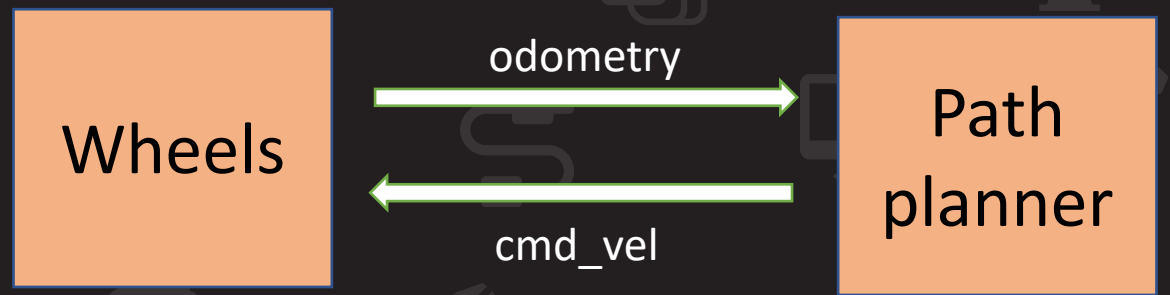



```
odometry – position of the robot
cmd_vel – speed of the motor
```

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

Publisher and Subscriber

- Nodes can *publish* and *subscribe* to a topic
- “Wheels”(node) publish to “odometry”(topic) and subscribe to “cmd_vel”(topic)



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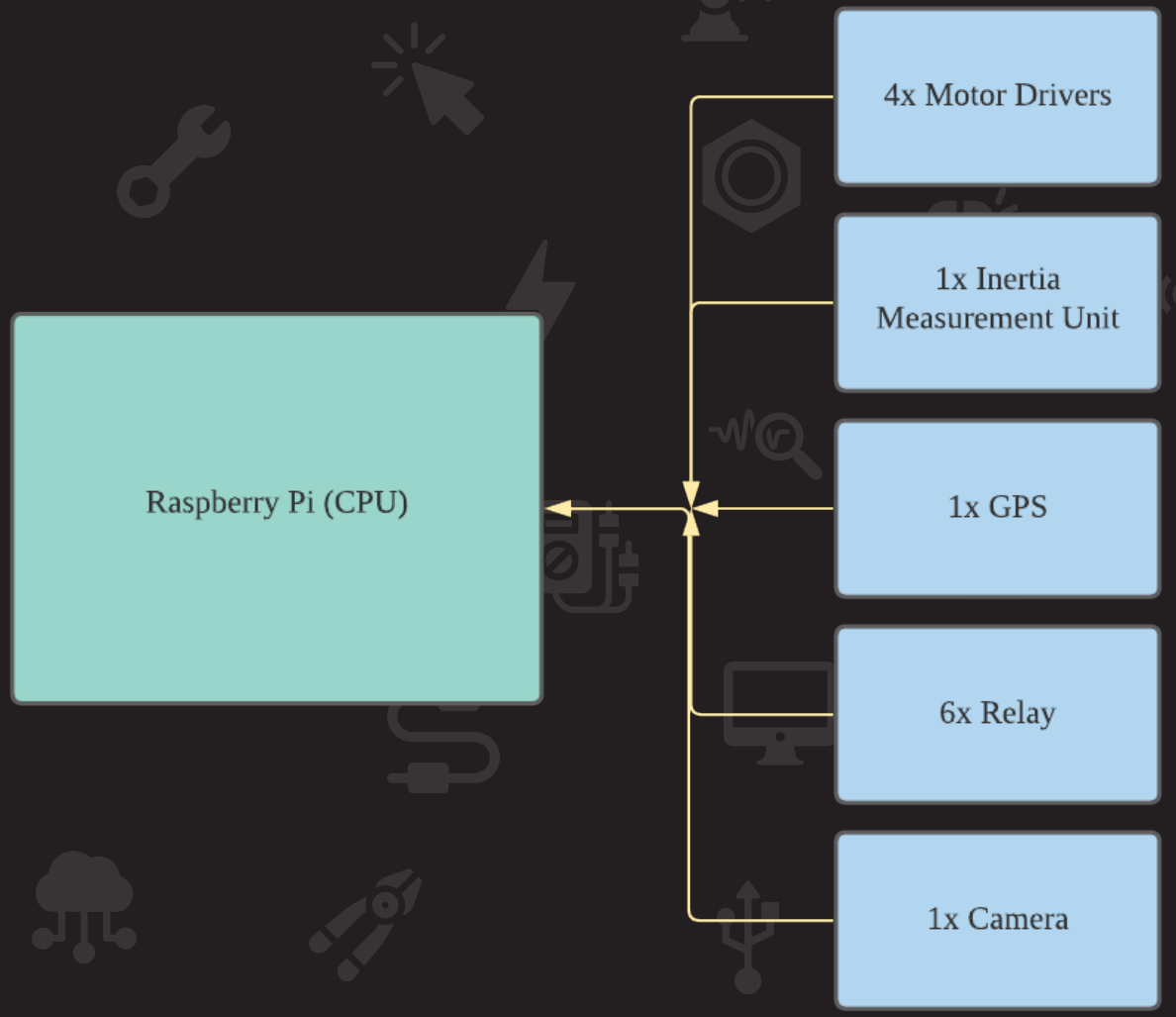
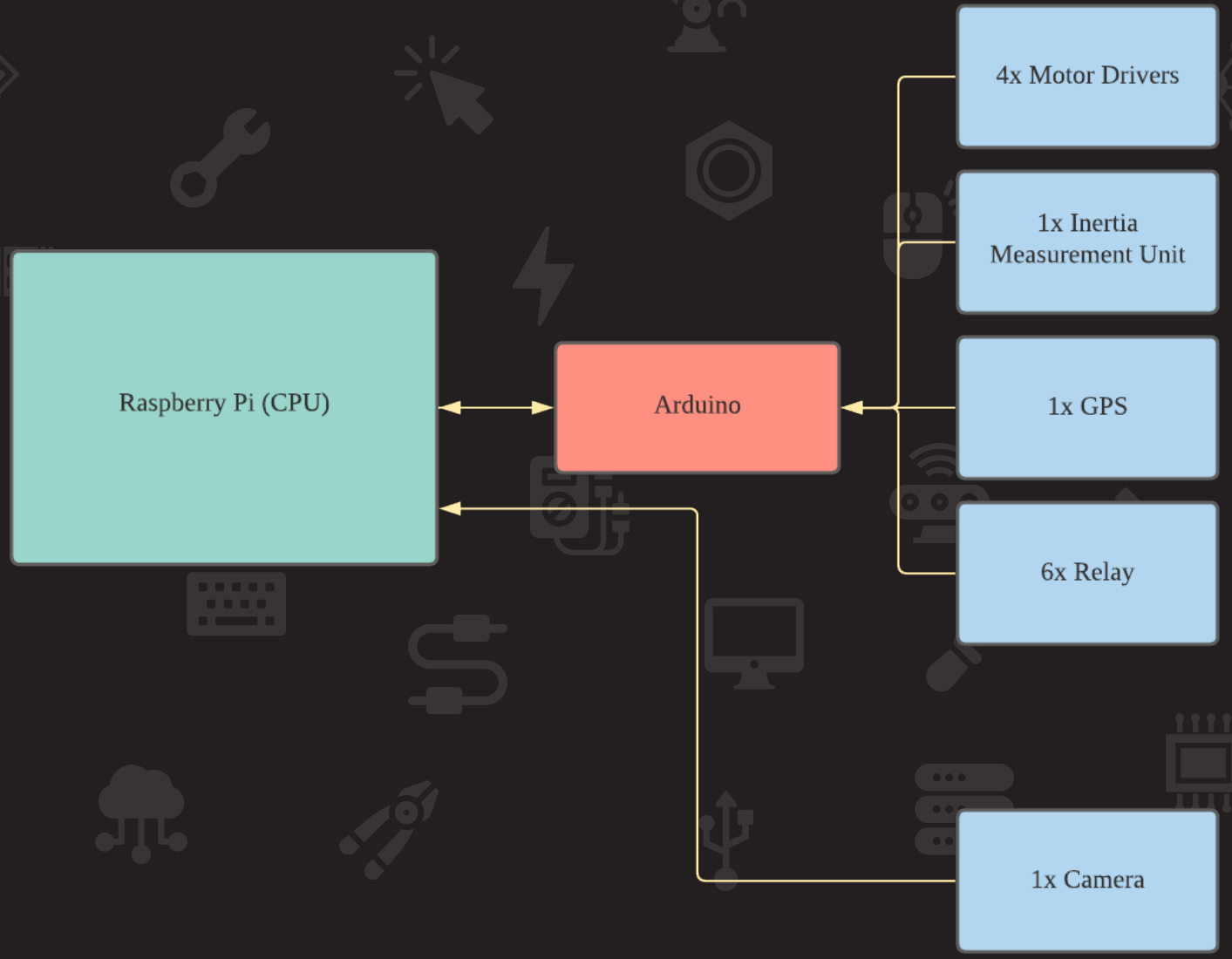
Parcel Delivery Robot

Sensor & Actuators Architecture



SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

Sensor & Actuators Architecture



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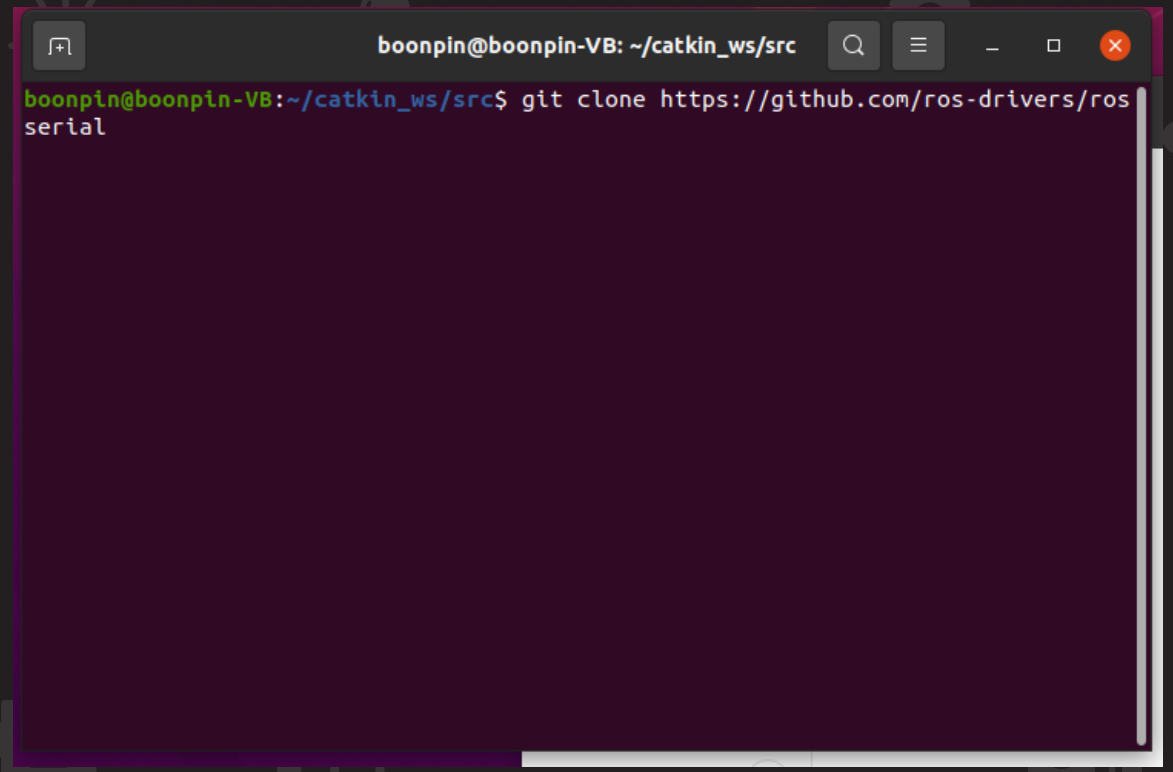
Motivation

- Unloading processing burden from CPU
- Most CPU only supports 3.3V hardware application whereas most hardware are 5V
- More hardware libraries available in Arduino

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



Install rosserial

```
cd catkin_ws/src
git clone https://github.com/ros-drivers/rosserial
cd ..
catkin_make
```

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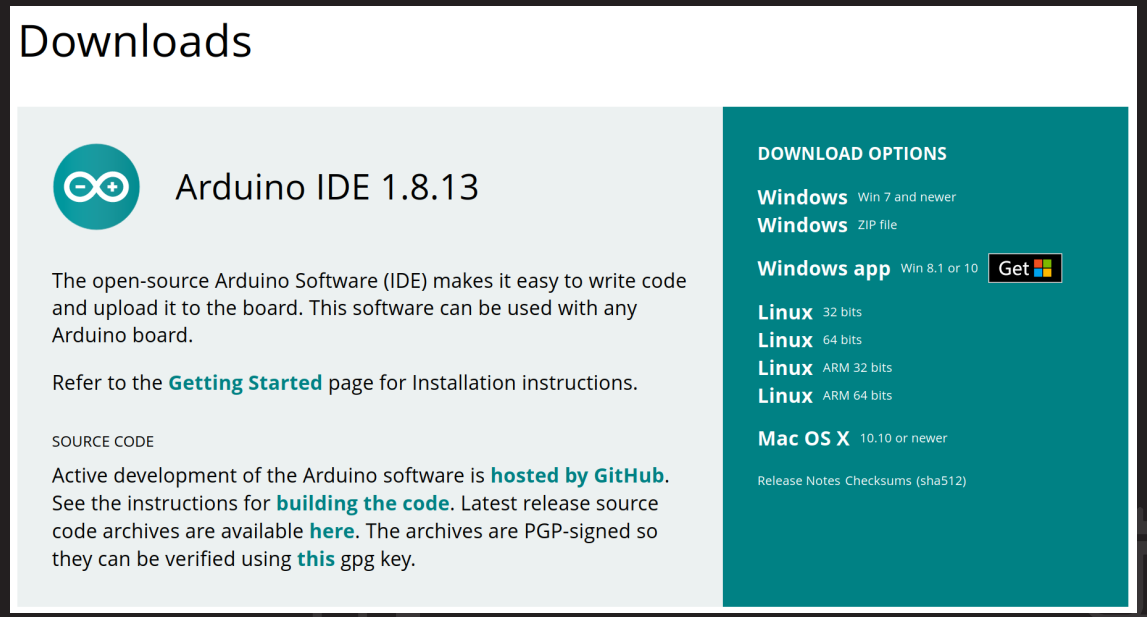
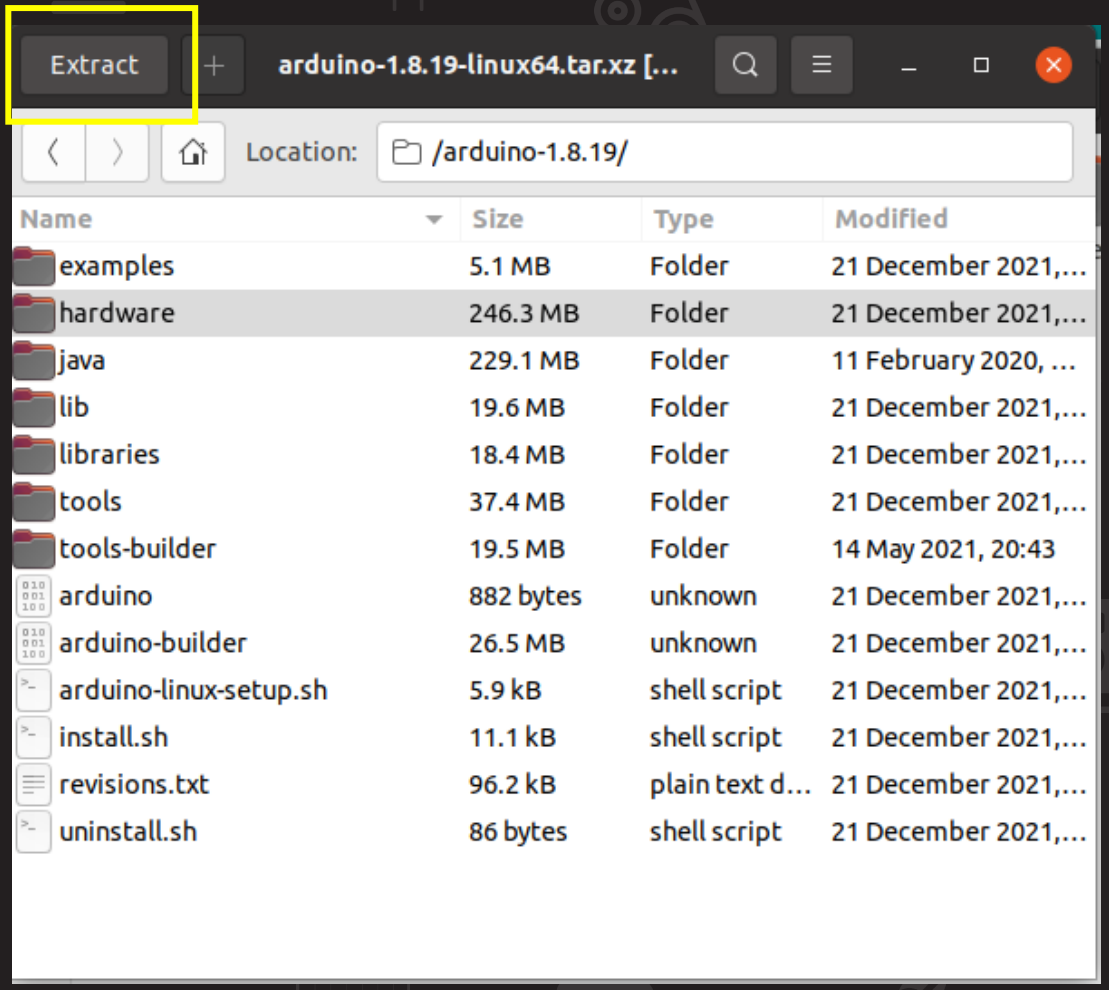
Install Arduino IDE



https://www.arduino.cc/en/software/

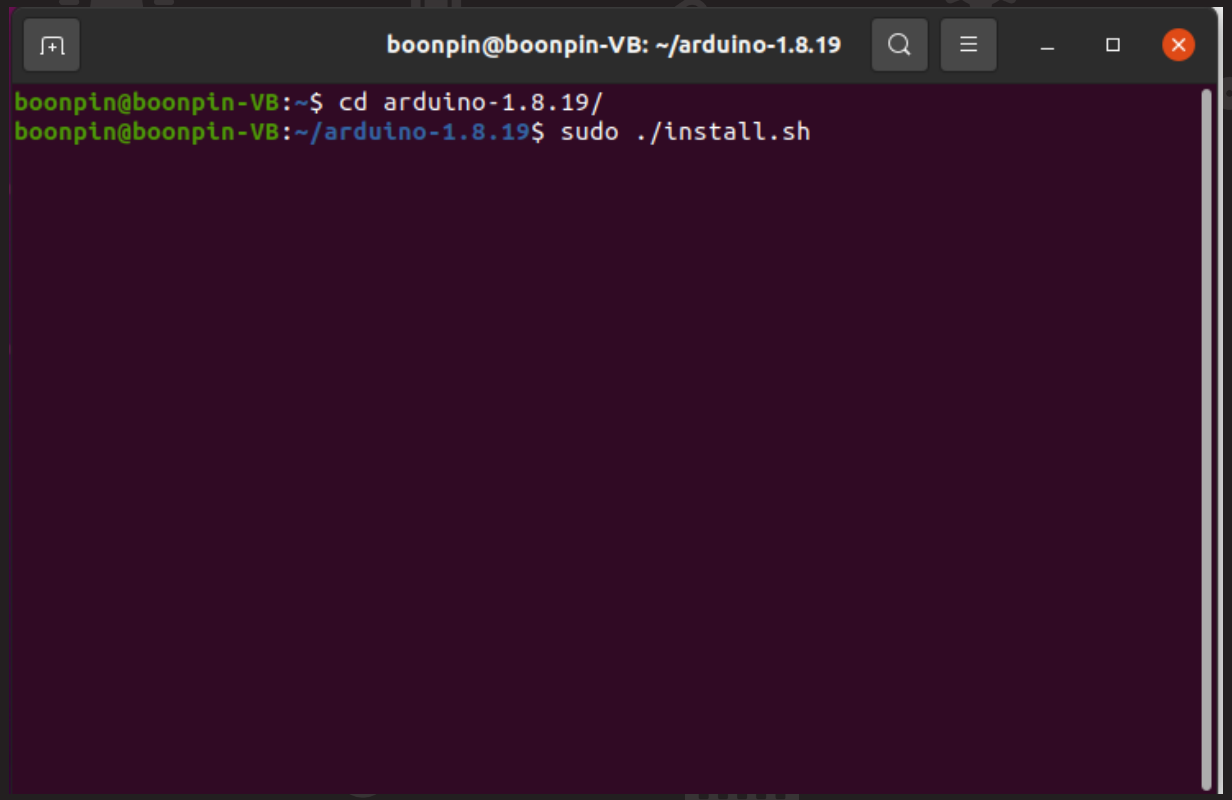
SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



Extract the file

".tar.xz" is a compressed file so we must extract it to "Home"

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

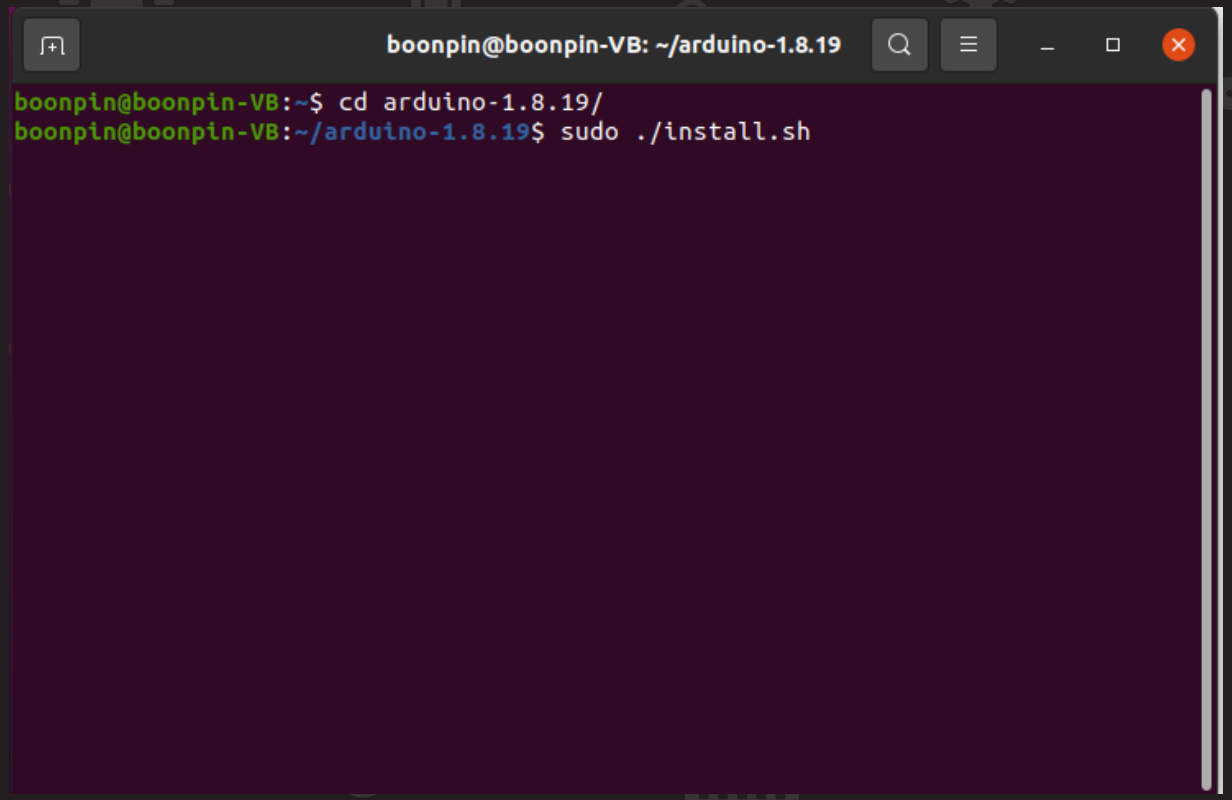


Install Arduino

Navigate to the Arduino file and run “install.sh”

```
cd arduino-1.8.19/
sudo ./install.sh
```

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



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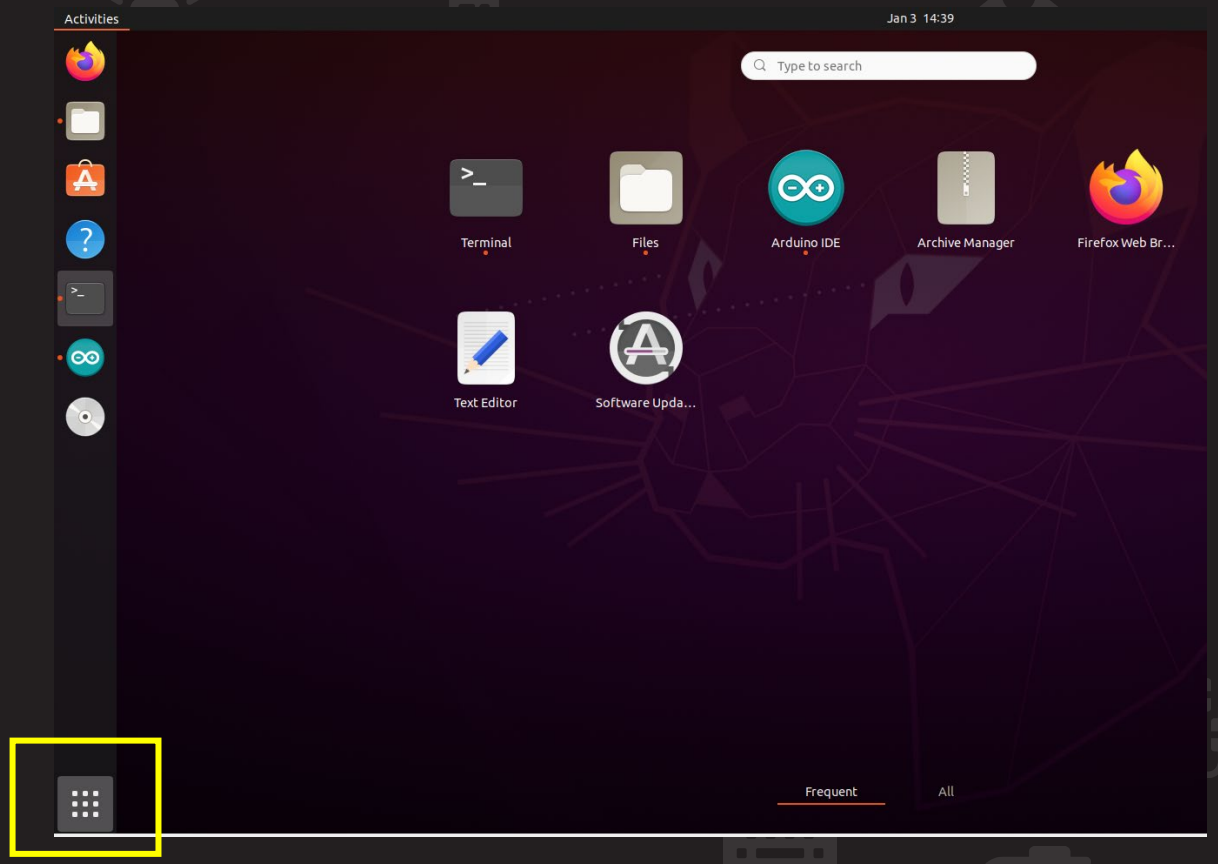
SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

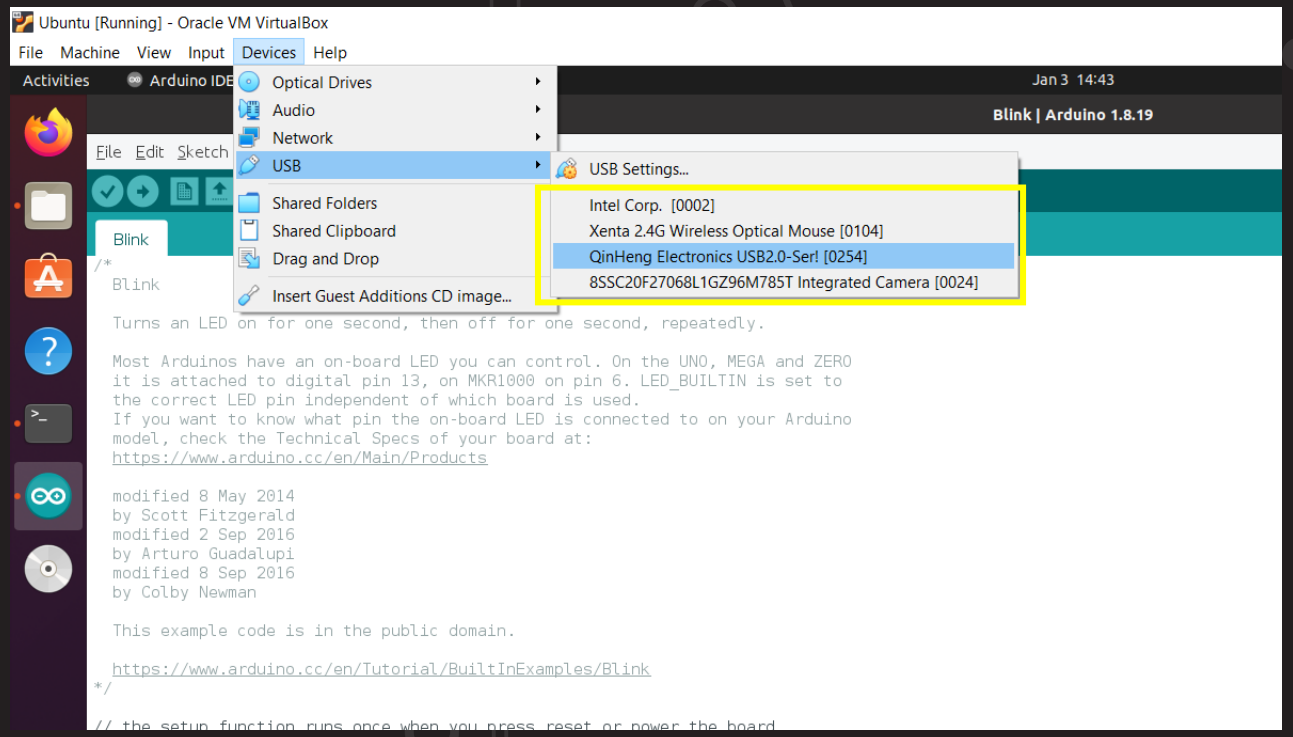


Launch Arduino

Click the icon at the bottom-left corner and search for “Arduino”

```
cd arduino-1.8.19/
sudo ./install.sh
```

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

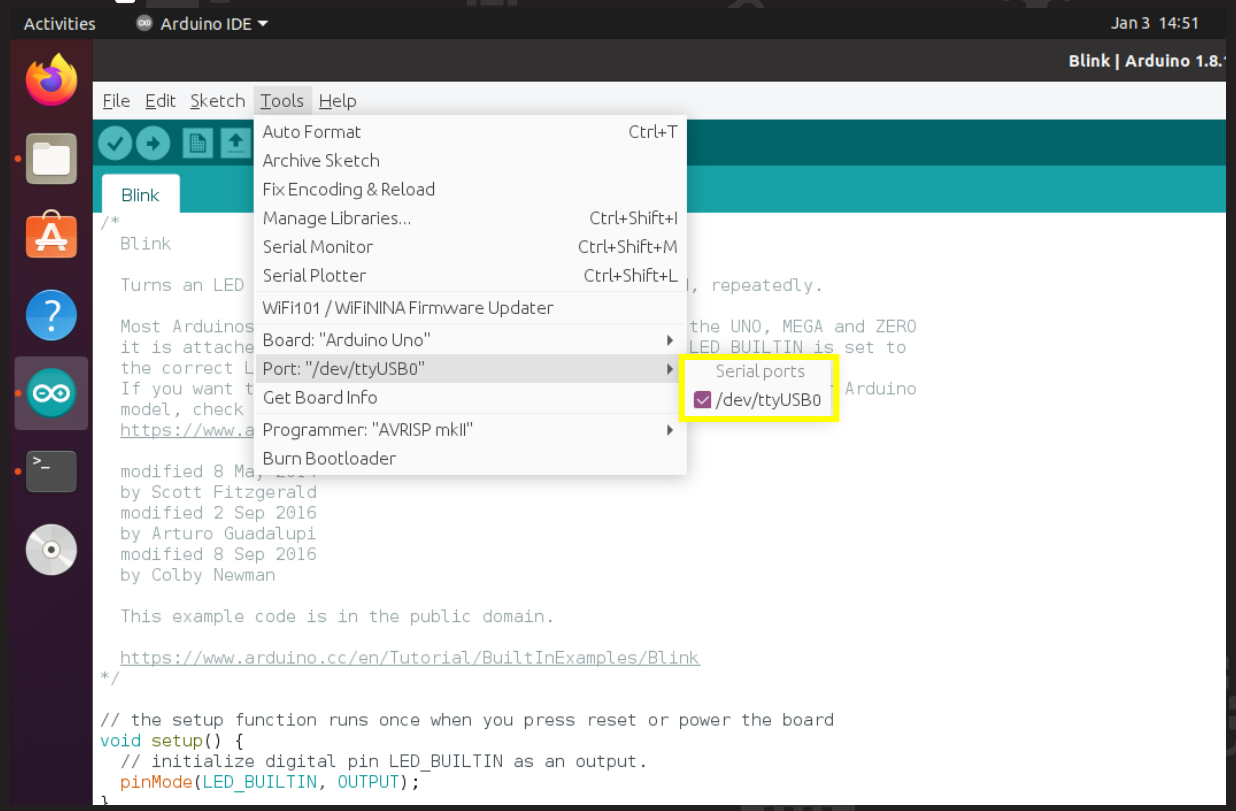


USB port

Plug in the Arduino

Select Devices >> USB >> <USB_port>

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

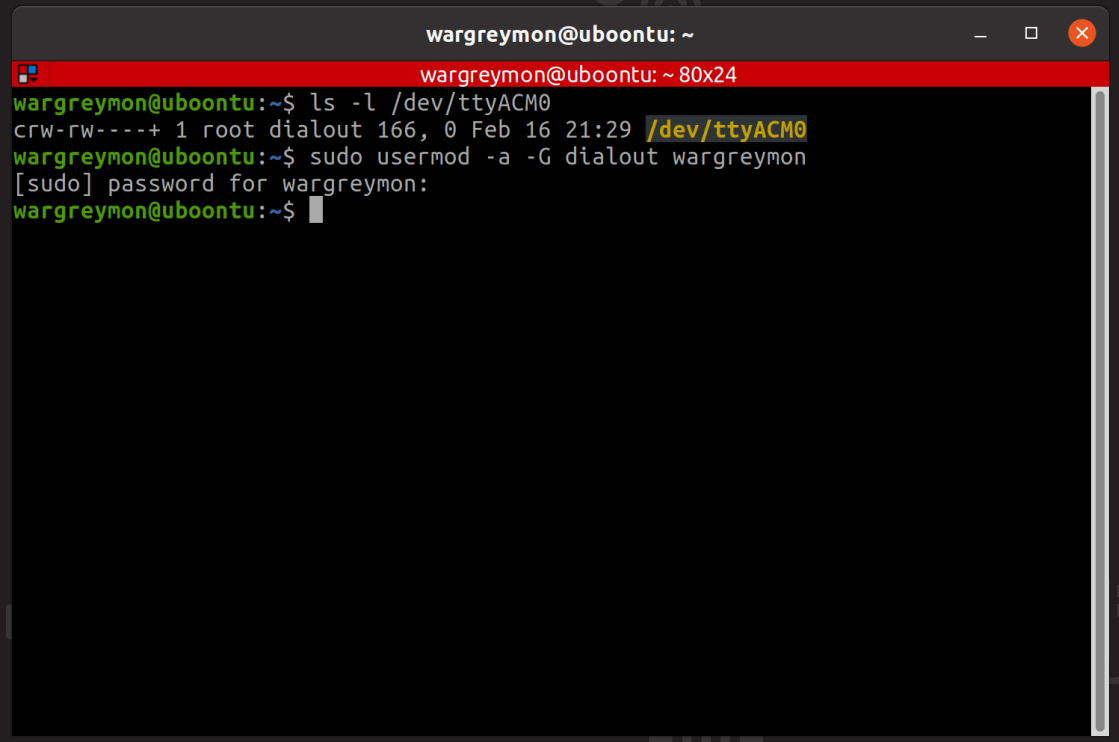


USB port

Go to Tools >> Port

Find out what is the port name for the Arduino and remember it

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

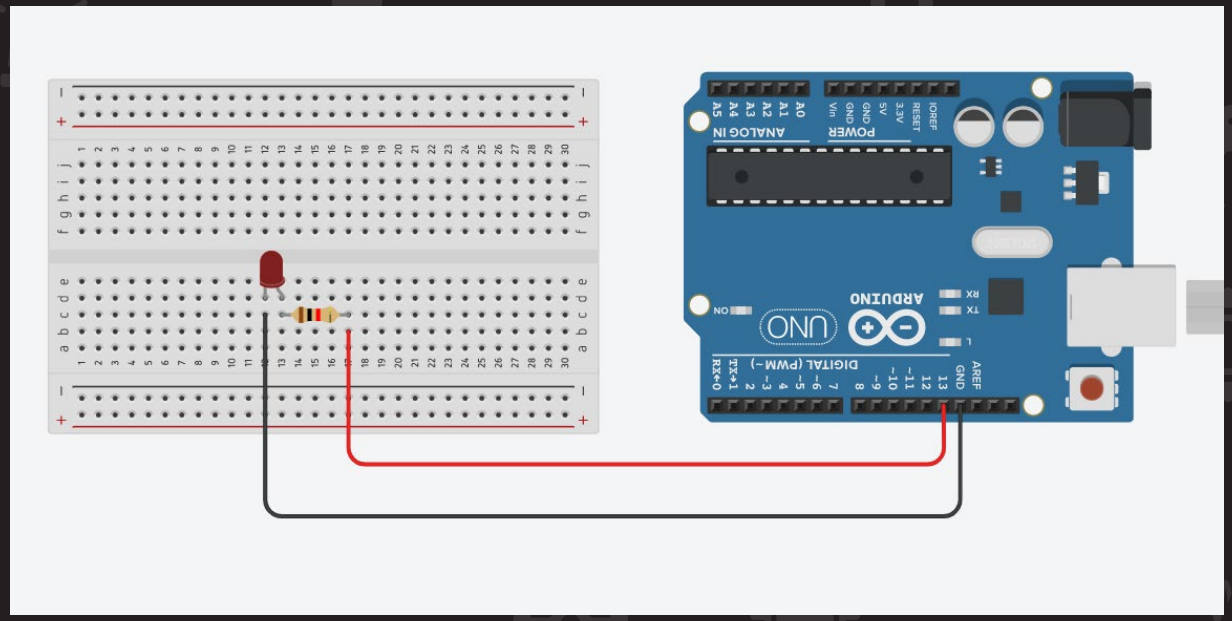


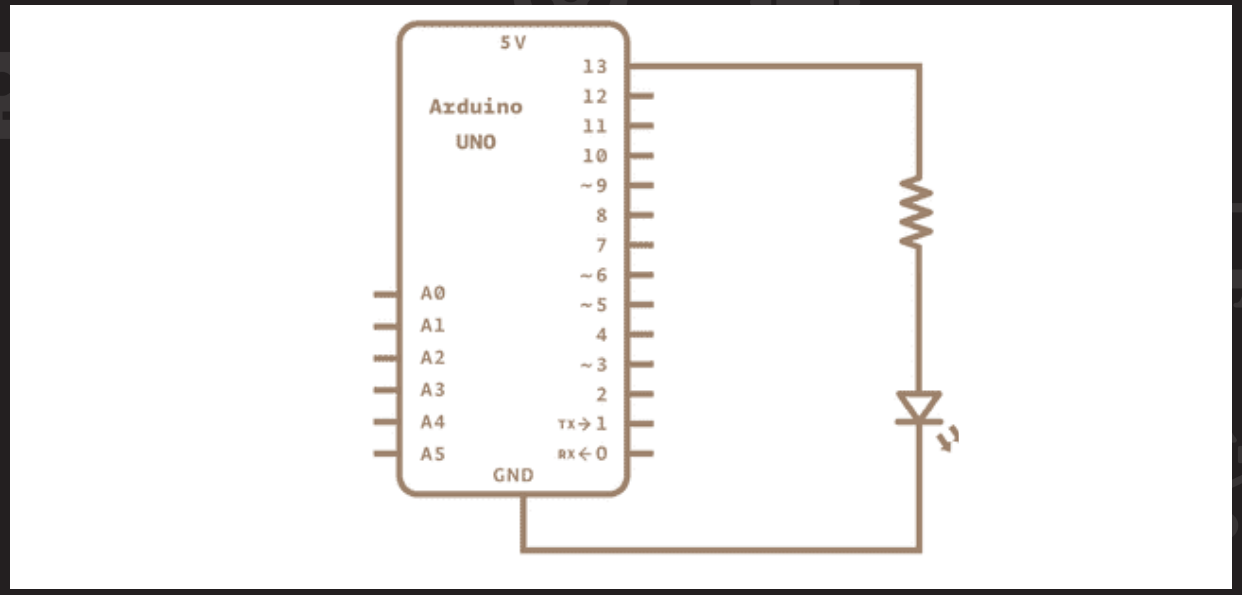
Add user to dialout

reboot to take effect

```
ls -l /dev/tty<USB_port> (e.g /dev/ttyUSB0)
sudo usermod -a -G dialout <user>
```

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



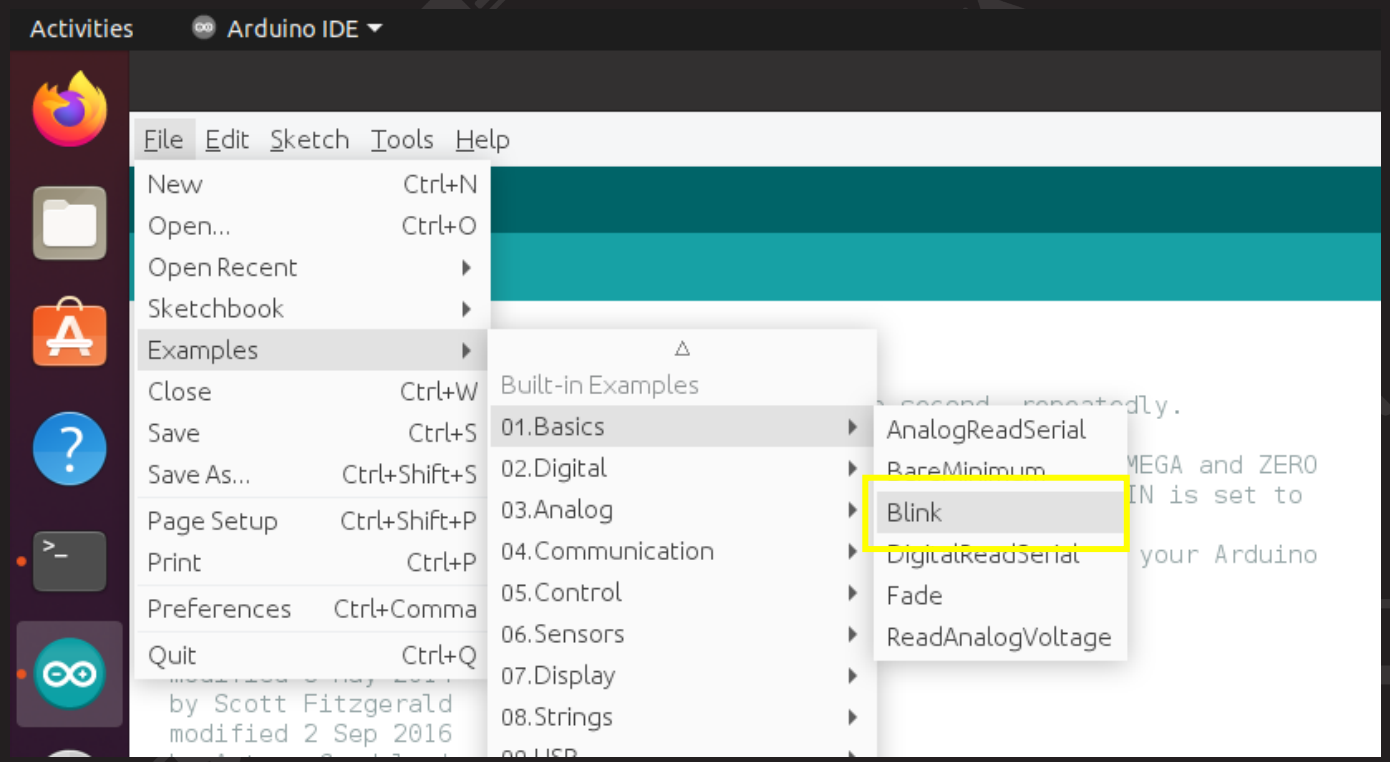


Breadboarding LED

Materials:

1x Breadboard
1x Arduino (pin 13)
1x LEDs
1x Resistor

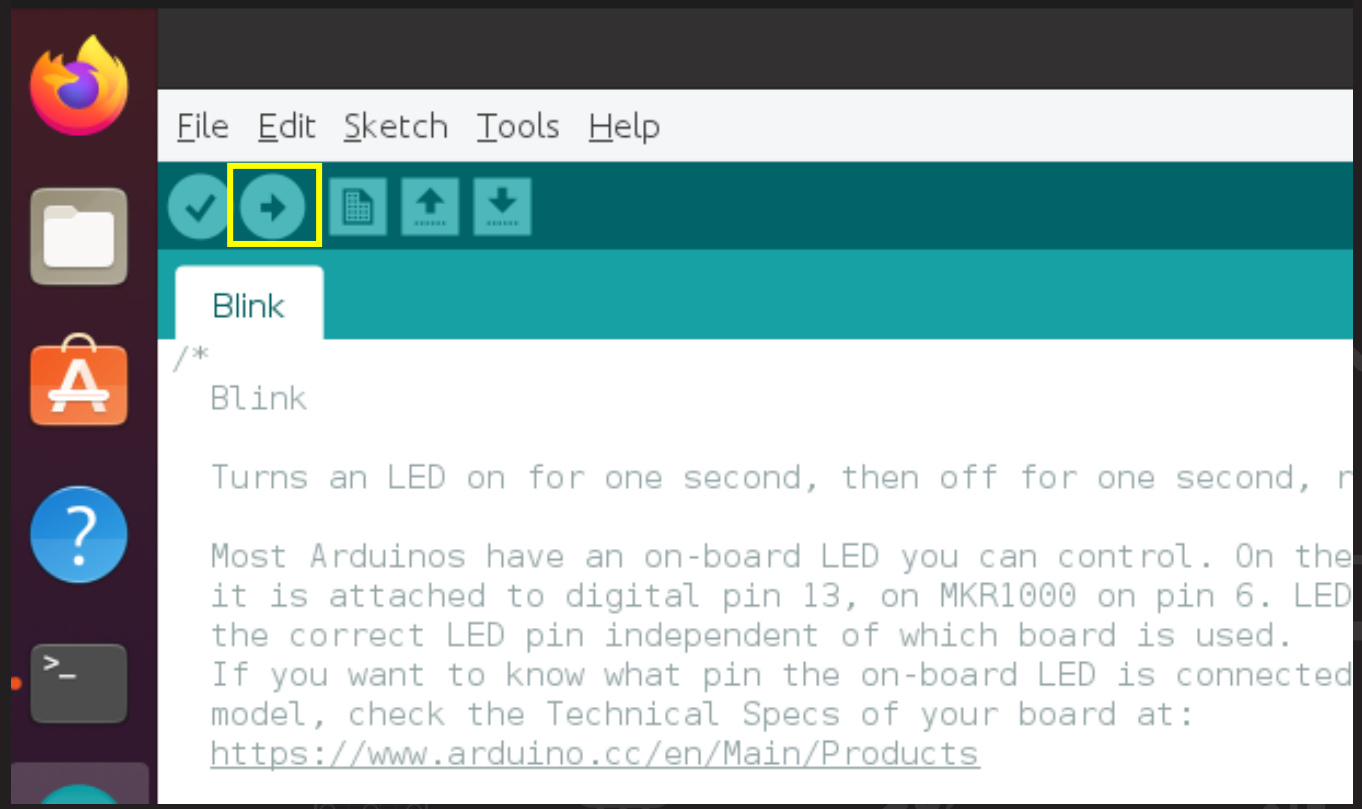
SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



Blinking Code

Open a sample blinking program by going to Examples >> Basics >> Blink

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



Upload

Upload the code by clicking the icon at the top-left corner

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

Troubleshooting tips:

1. Unplug and plug back in the Arduino
2. Check that you have selected the USB port under Devices >> USB in VirtualBox
3. Check that you have selected the USB port under Tools >> Port in the Arduino software
4. Open terminal and type

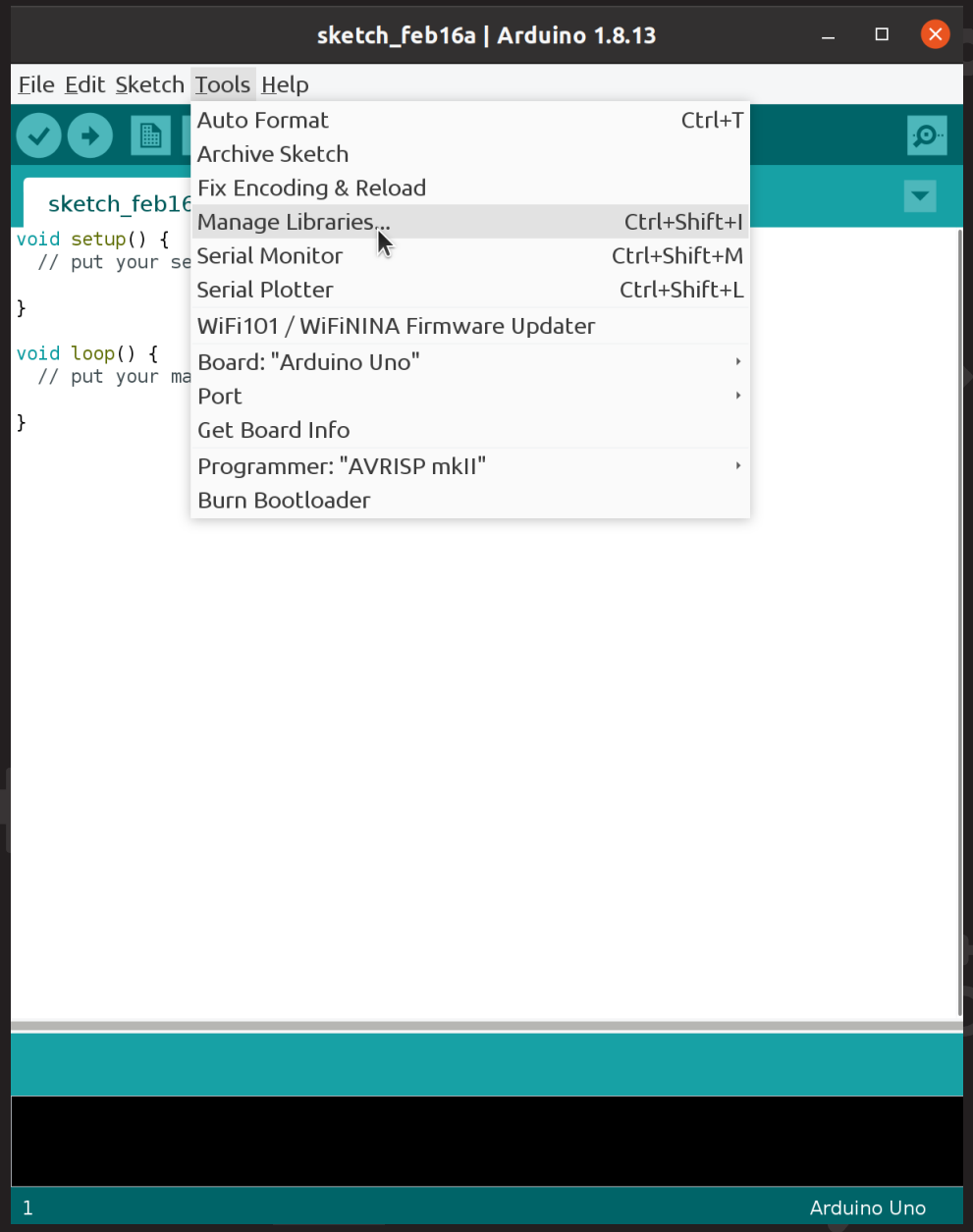
    sudo chmod 777 /dev/ttyUSB0

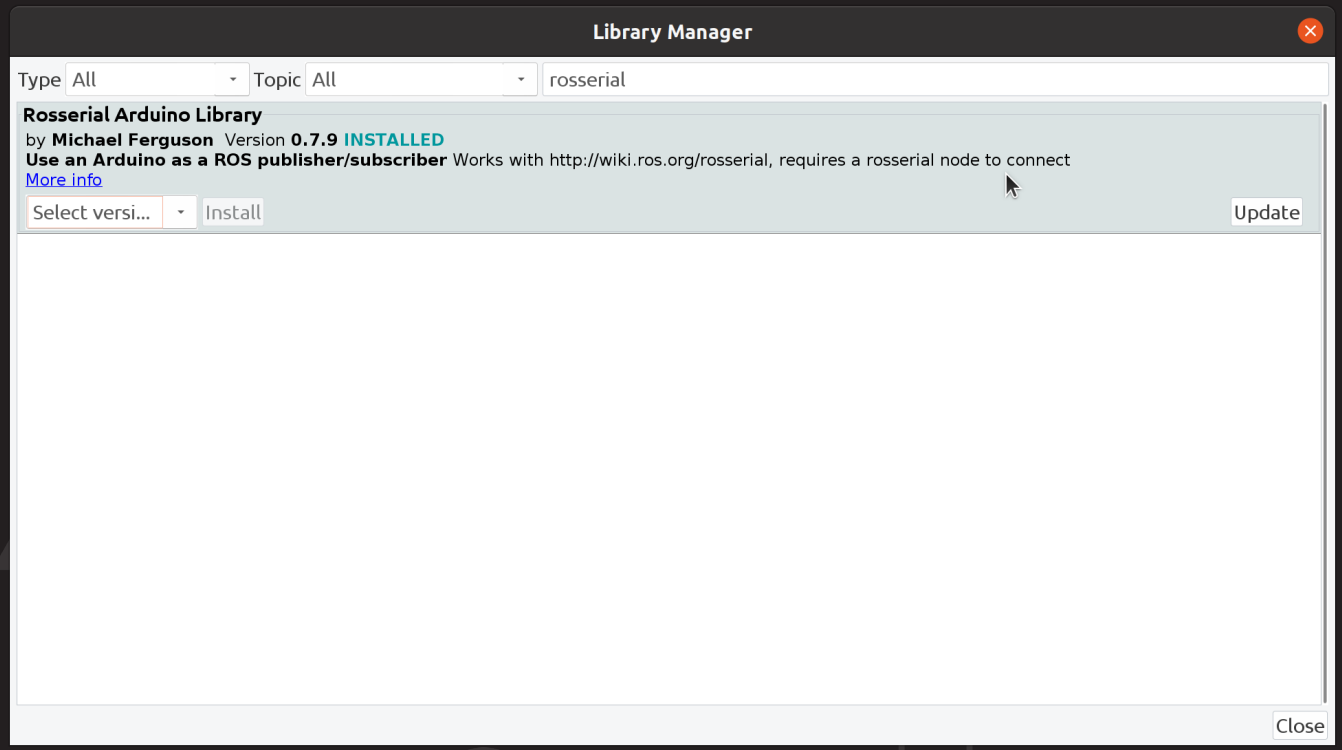
SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

Activity 1: Fast blinky LED

- A quick recap of Arduino coding
- Open a new sketch
- Program the LED to blink at an interval of 0.3 second
- 5 minutes

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS





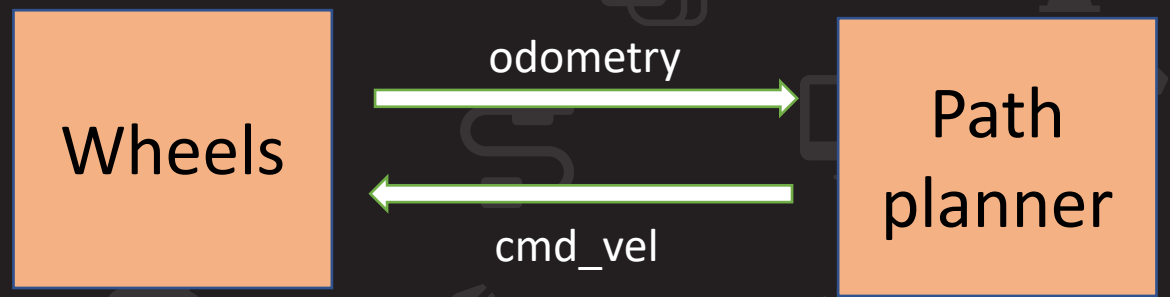
Install Rosserial Arduino Library Version 0.7.9

1. Go to Tools >> Manage Libraries
2. Search “rosserial”
3. Download version 0.7.9
4. Restart Arduino

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

Recap: Publisher and Subscriber

- Nodes can *publish* and *subscribe* to a topic
- “Wheels”(node) publish to “odometry”(topic) and subscribe to “cmd_vel”(topic)

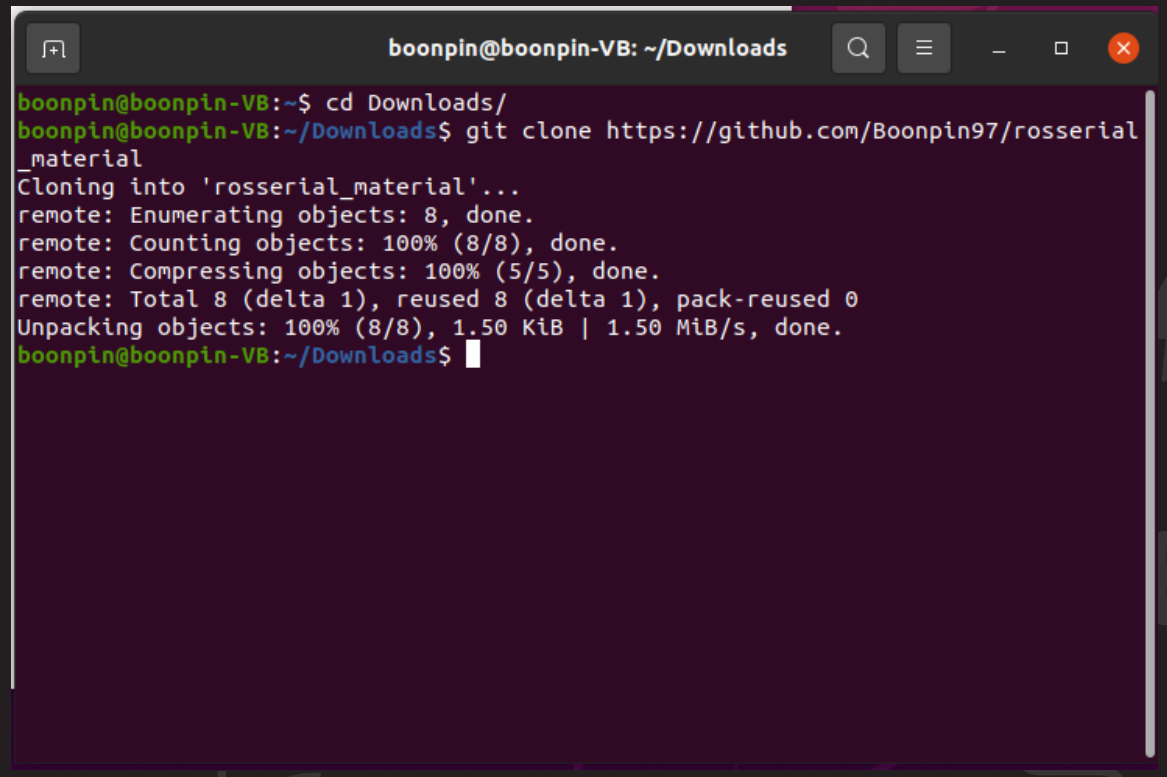


SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

LED Subscriber

- Serial_node(node) – Arduino node
- /toggle_LED(topic) – topic message to control LED

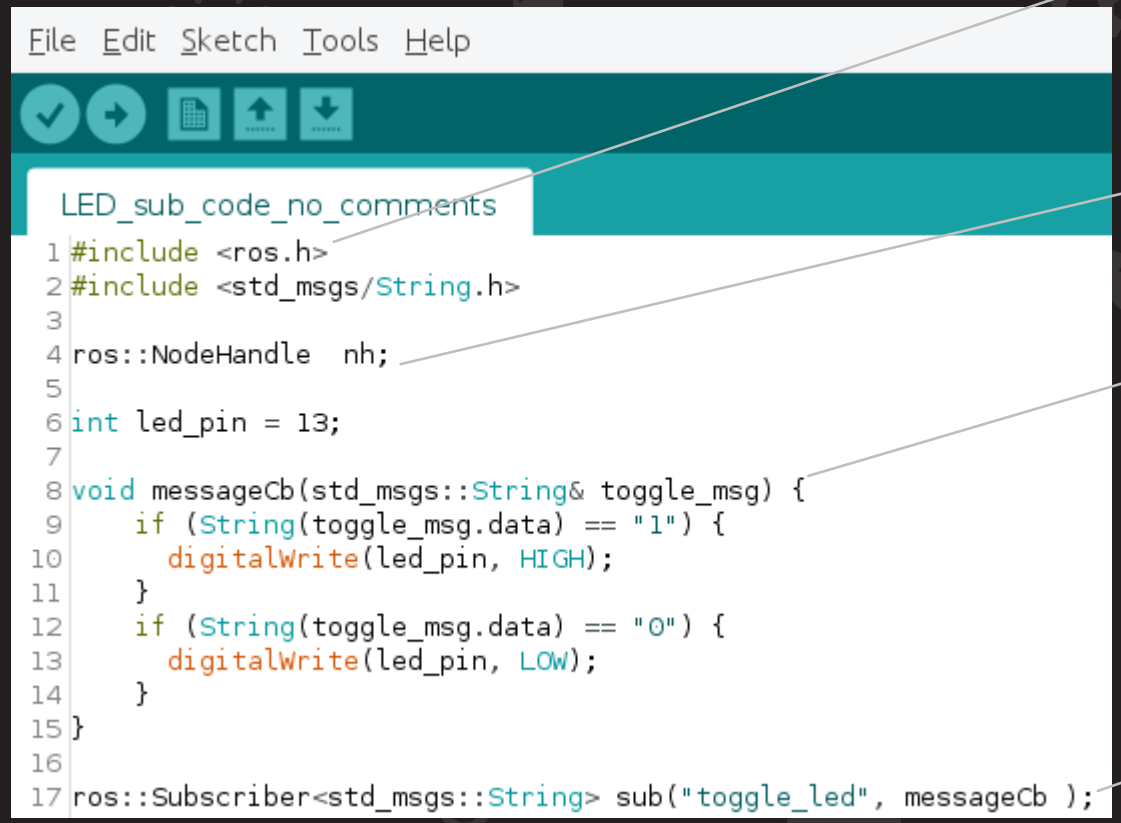
SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



Git clone sample code

```
cd Downloads/
git clone https://github.com/sutd-robotics/ros-ws-2022.git
```

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS




```
#include <ros.h>
```

- include the rosserial library

```
ros::NodeHandle nh;
```

- create a handler for this Arduino node

```
void messageCb(std_msgs::String& toggle_msg)
```

- message is stored in toggle_msg.data
- if toggle_msg.data is 1, turn on LED
- if toggle_msg.data is 0, turn off LED

```
ros::Subscriber<std_msgs::String>
sub("toggle_led", messageCb);
```

- create a subscriber object call sub
- subscribe to "/toggle_led" topic
- "/toggle_led" is message type of std_msgs::String
- once message received, it will run callback function messageCb

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

```
18
19 void setup() {
20   // put your setup code here, to run once:
21   pinMode(led_pin, OUTPUT);
22   nh.initNode();
23   nh.subscribe(sub);
24 }
25
26 void loop() {
27   // put your main code here, to run repeatedly:
28   nh.spinOnce();
29   delay(1);
30 }
```

`nh.initNode();`

- initialise node

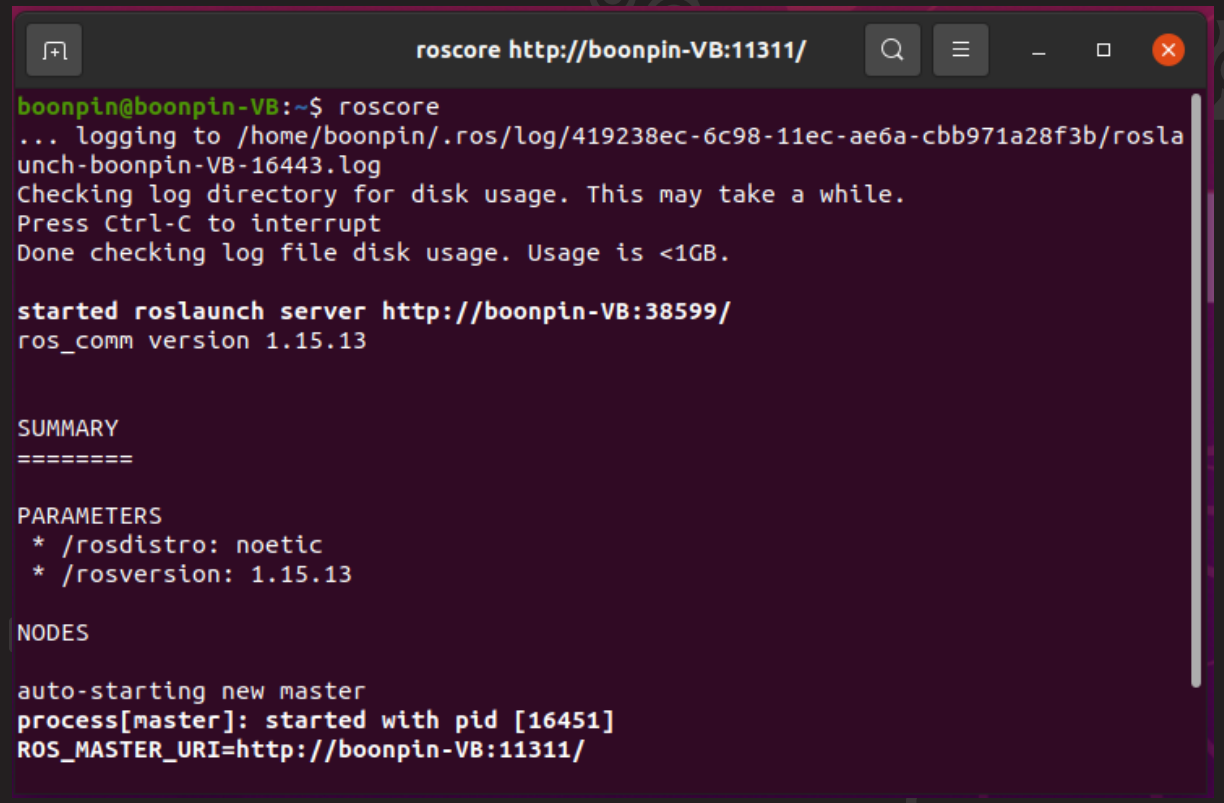
`nh.subscribe(sub)`

- set sub as the node's subscriber

`nh.spinOnce()`

- check for updates in the rostopic

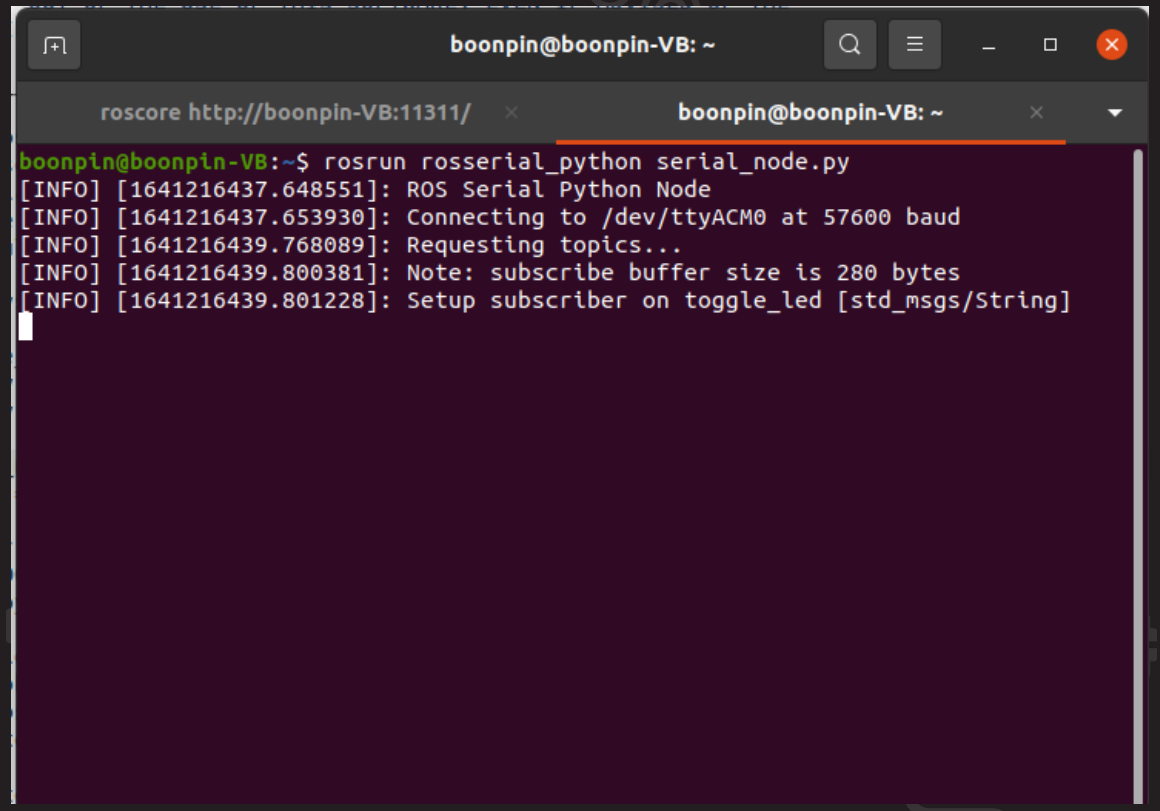
SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



Start roscore

Open a terminal and start roscore

```
roscore
```

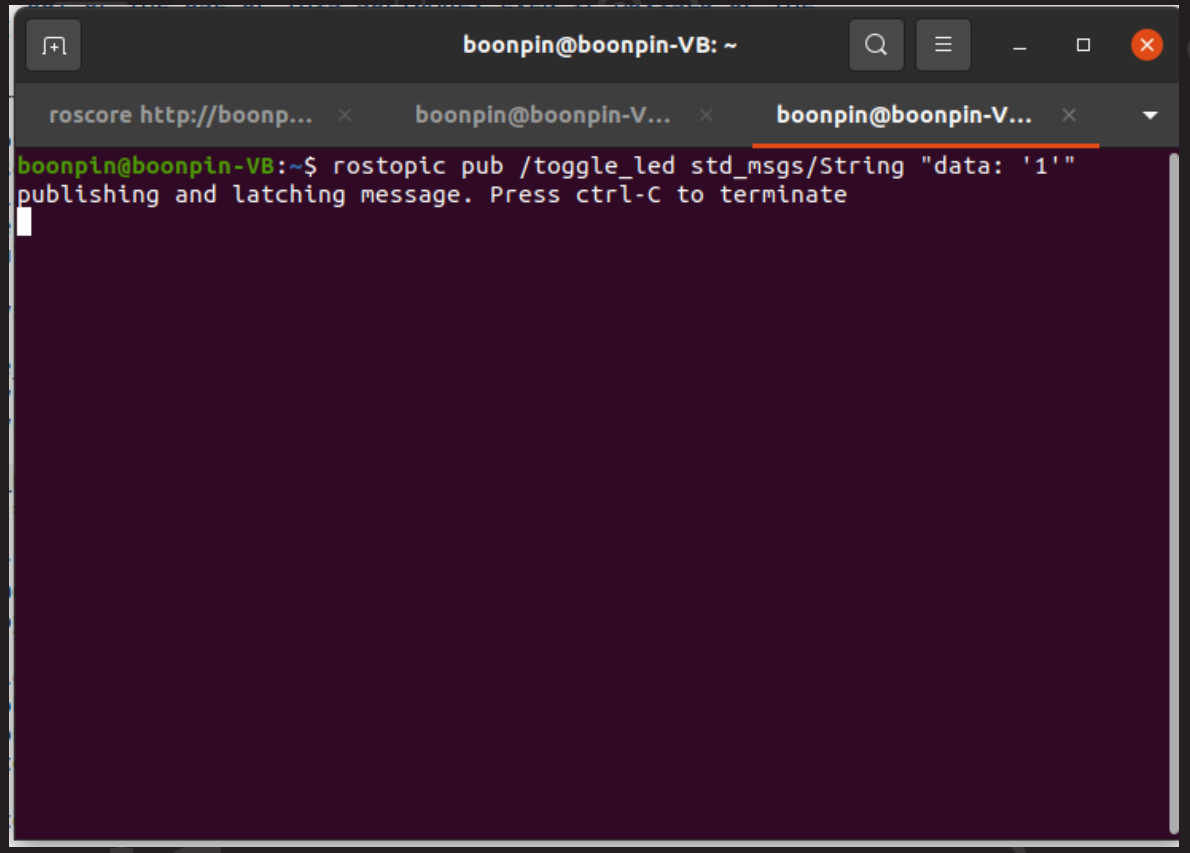


Start rosserial

Open a new terminal and run rosserial

```
rosrun rosserial_python serial_node.py /dev/ttyUSB0 (your Arduino USB port)
```

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



Publish “/toggle_led”

Publish 0 and 1 to “/toggle_led to control the LED”

1. Open a new terminal
2. Publish 1 to turn on LED, 0 to turn off

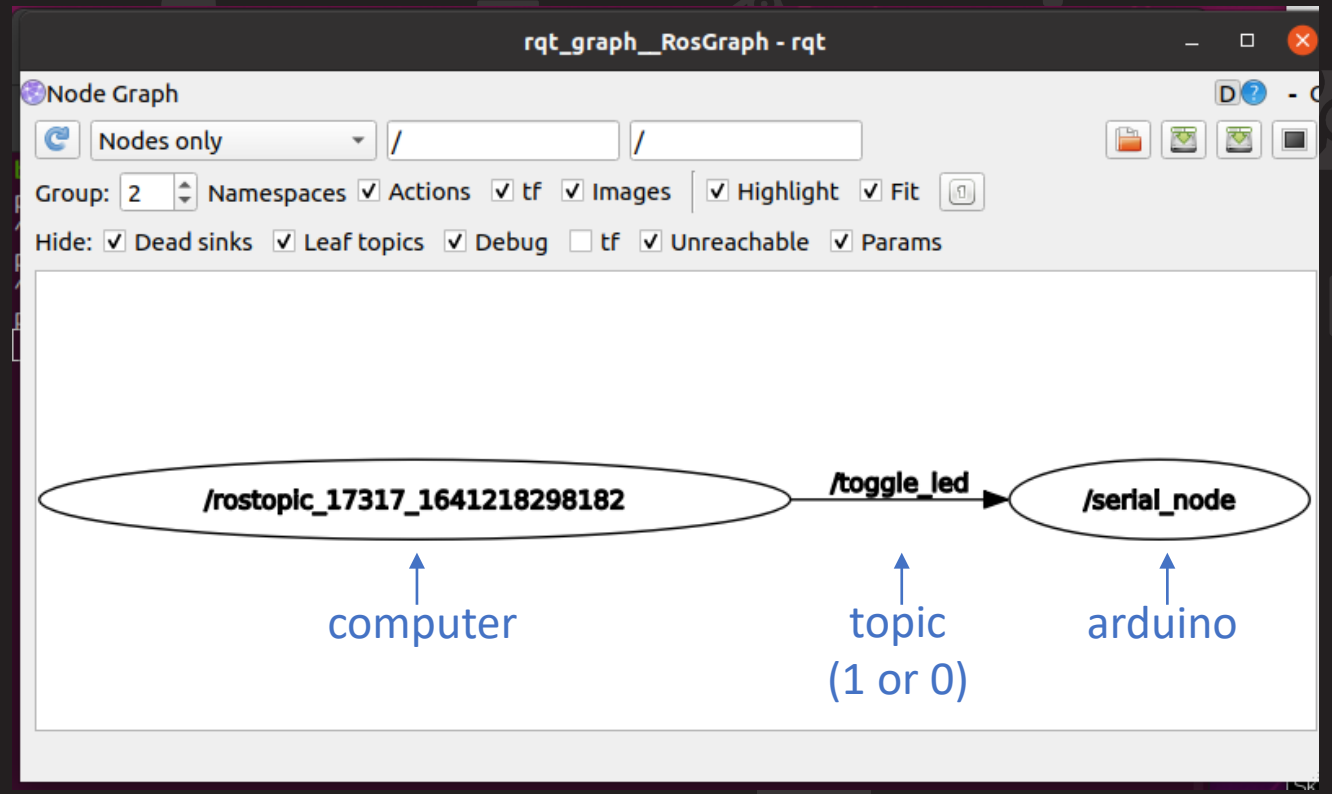
```
rostopic pub /toggle_led std_msgs/String "data: '1’”
```

Topic’s name

Topic’s message type

Message

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



rqt graph

open rqt graph to understand what nodes and topics are there and how they are communicating with each other

```
rqt_graph
```

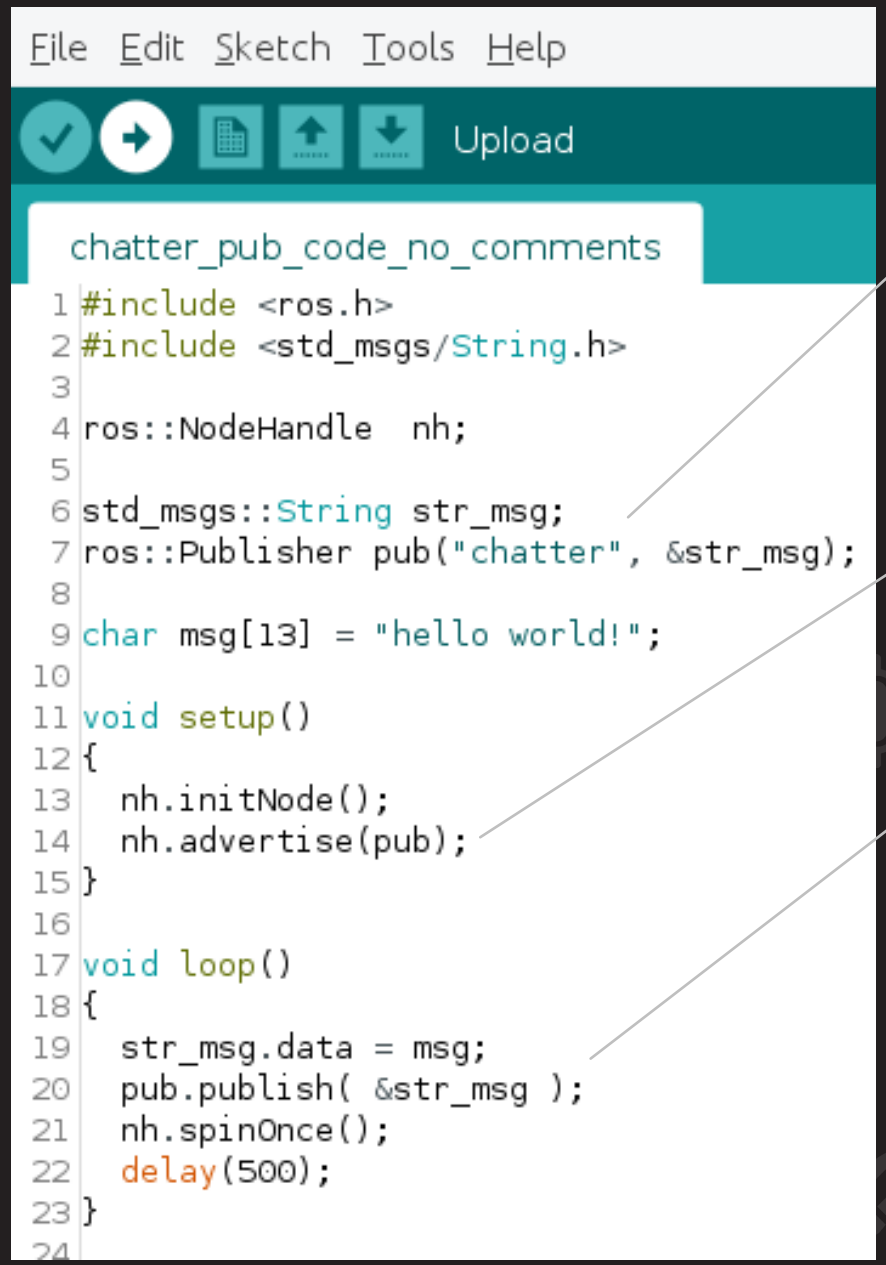
SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

Break Time~

Please be back in 5mins

Chatter Publisher

- Serial_node(node) – Arduino node
- /chatter(topic) – topic message Arduino publishes




```
ros::Publisher pub("chatter",&str_msg);
```

- create a publisher object call pub
- publish a rostopic named "chatter" with the value of &str_msg

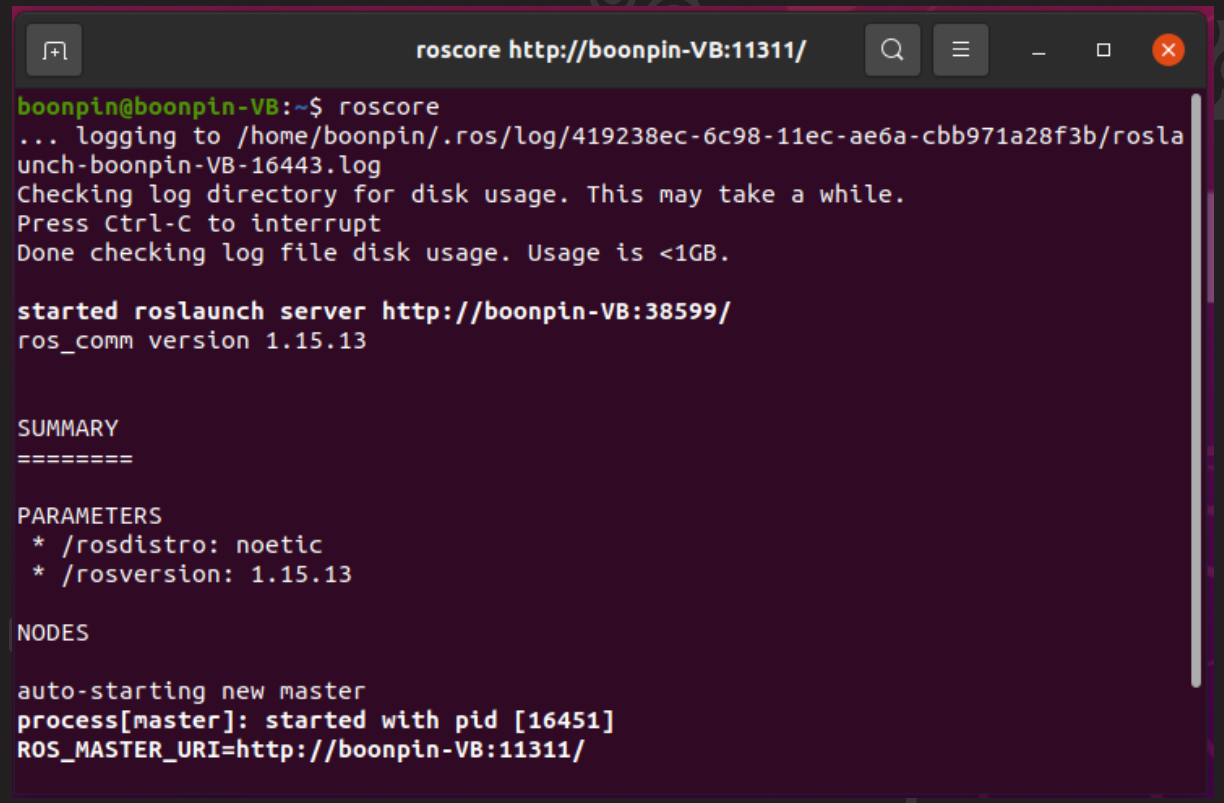
```
nh.advertise(pub);
```

- set pub as the node's publisher

```
pub.publish(&str_msg);
```

- publish pub with the message being &str_msg

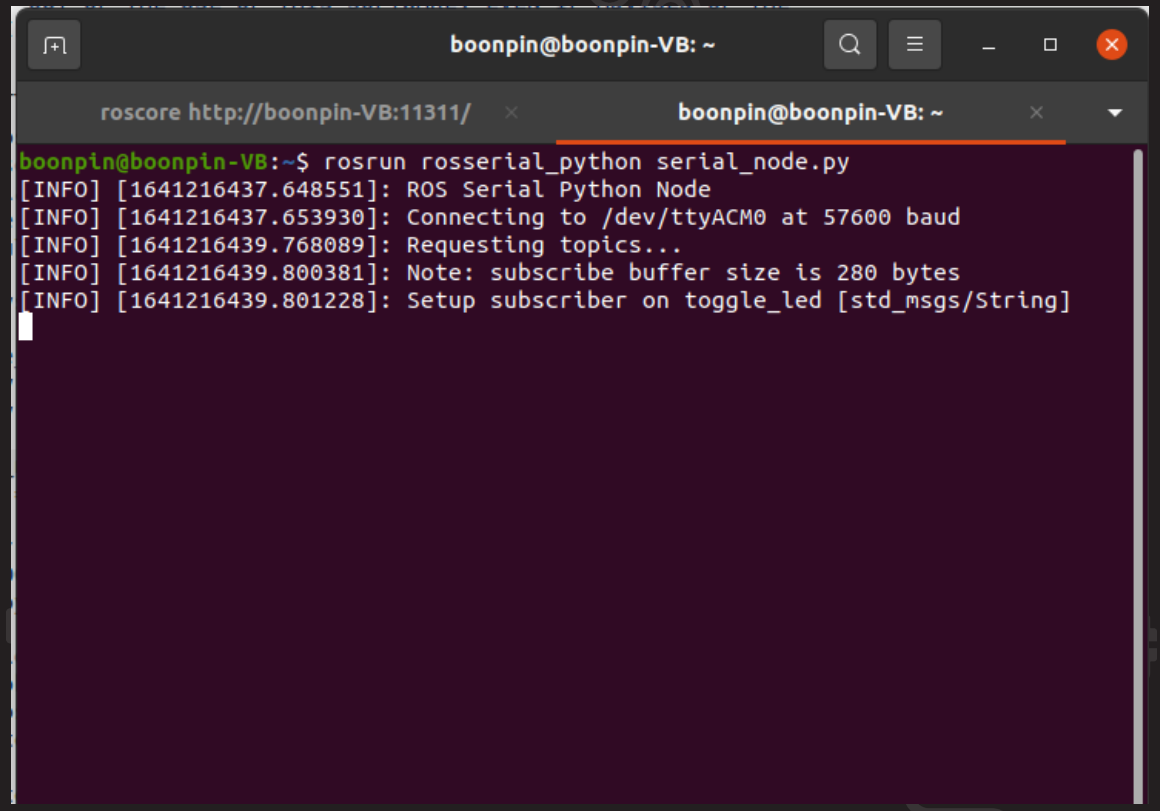
SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



Start roscore

Open a terminal and start roscore

```
roscore
```

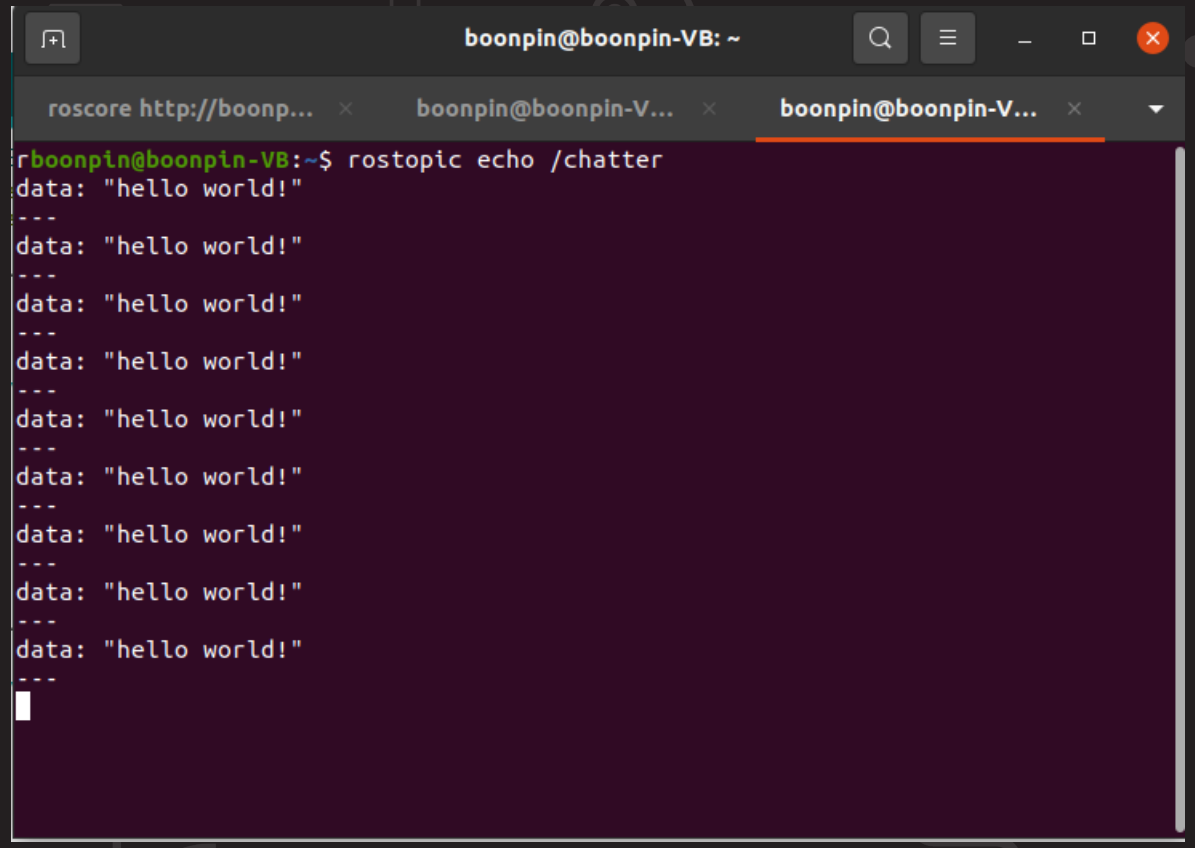


Start rosserial

Open a new terminal and run rosserial

```
rosrun rosserial_python serial_node.py /dev/ttyUSB0
```

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



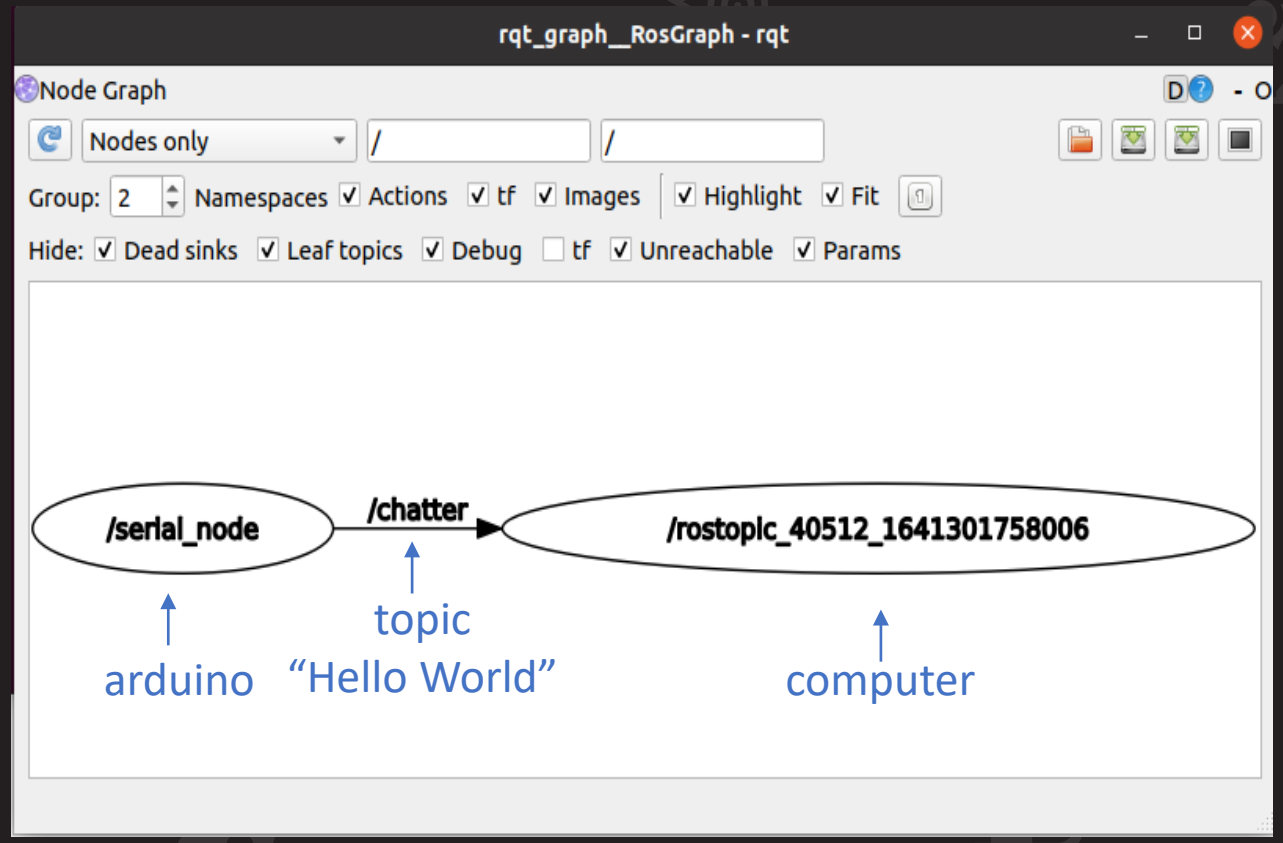
Echo topic “/chatter”

See what the rostopic “/chatter” is showing

```
rostopic echo /chatter
```

Topic’s name

SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS



rqt graph

open rqt graph to understand what nodes and topics are there and how they are communicating with each other

```
rqt_graph
```

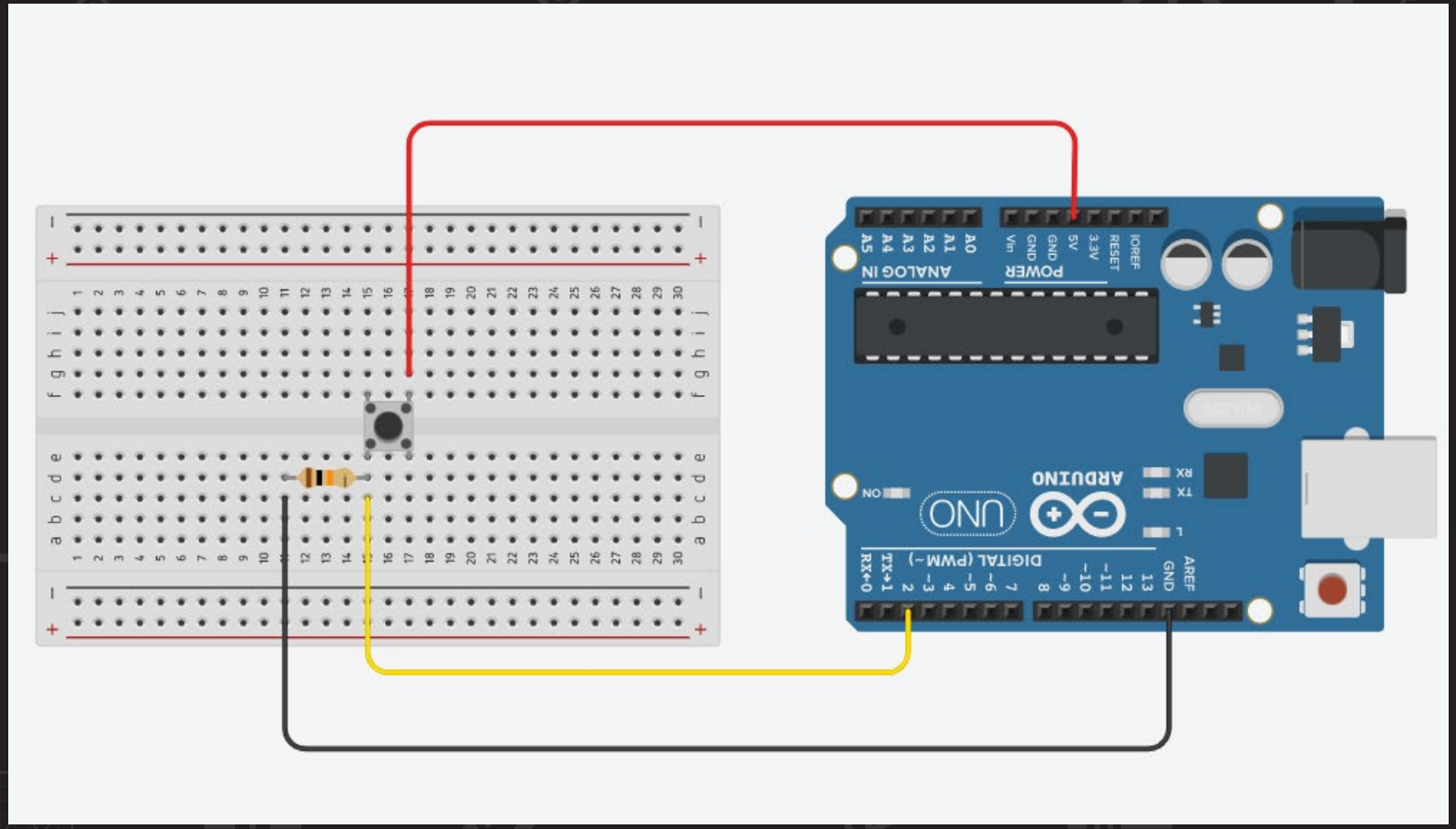
SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

Activity 2: Button Publisher

- Create a press button circuit
- Publish a topic of string type called “button_status”
- Topic message should be “pressed” or “not pressed”
- 30 minutes

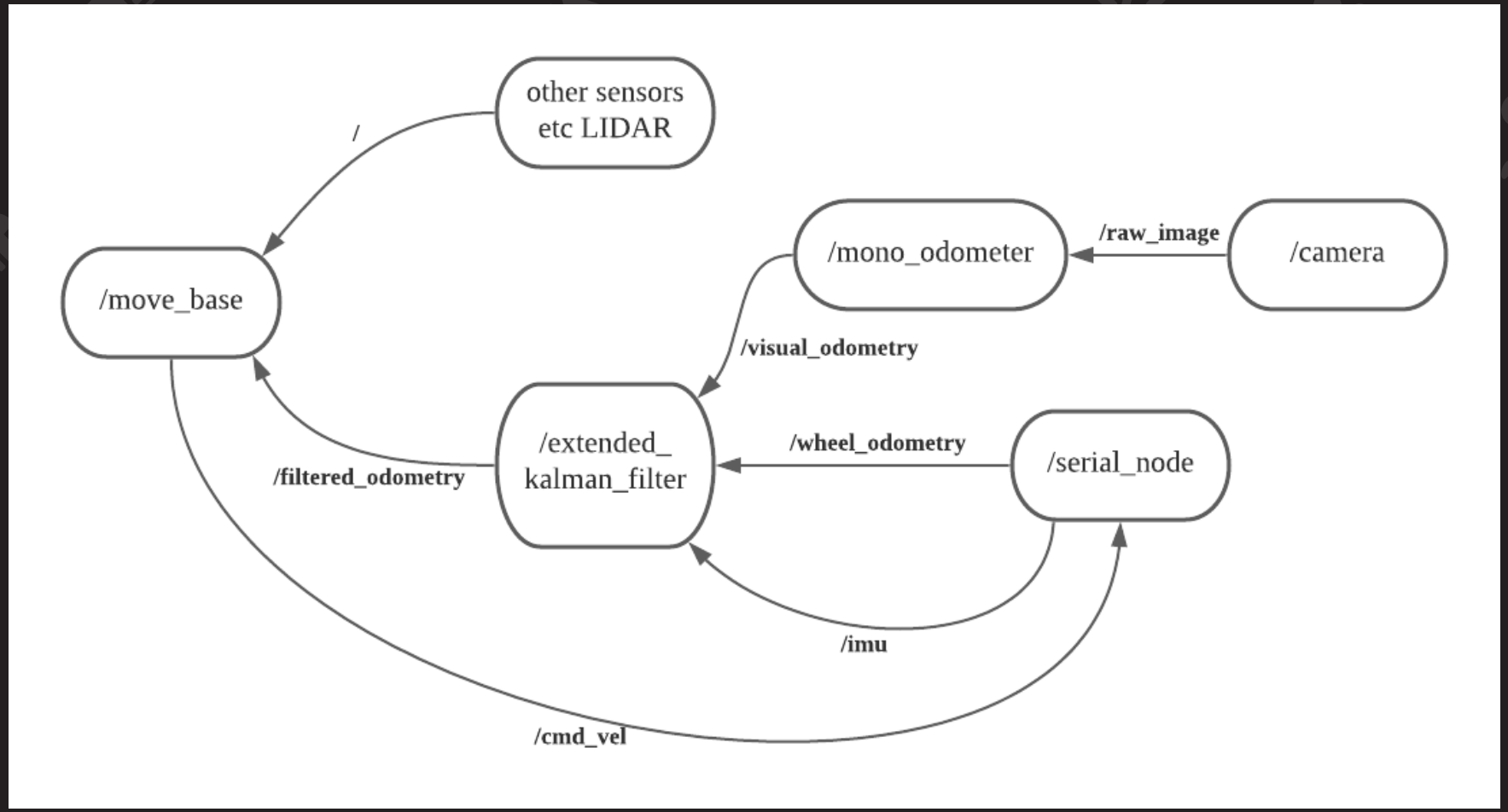
SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

Activity 2: Button Publisher



SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS

Simplified rqt_graph



SUTD ORGANIZATION OF AUTONOMOUS ROBOTICS