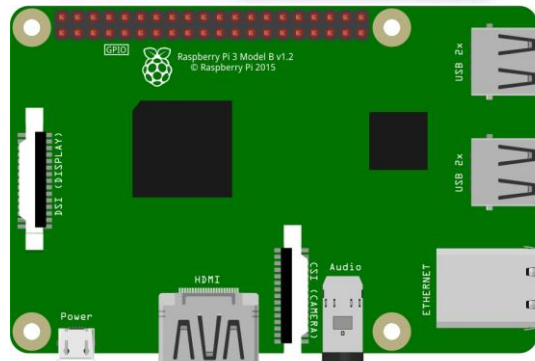
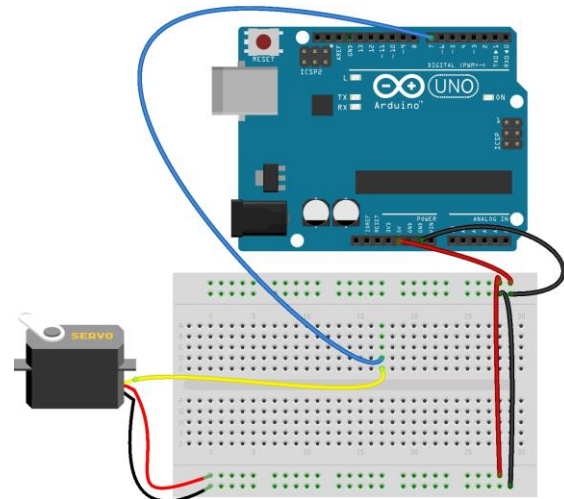
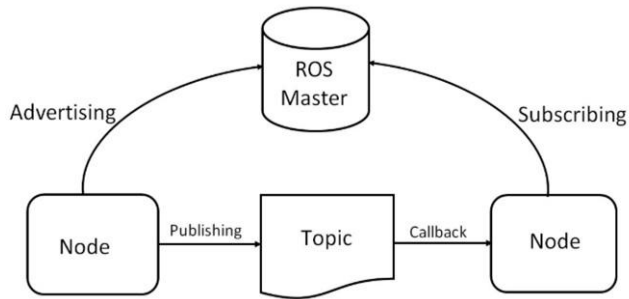


Hands On With ROS

Class 4: Angle Control with ROS



March 26, 2020
Don Wilcher

Class 4: Angle Control with ROS

```
~/ros_ws/src (~/ros_ws-desktop:1321)
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://mrdon-desktop:40015/
ros_core.service 3.14.3

SUMMARY
-----
PARAMETERS
 * /roslaunch: roslaunch
 * /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[roslaunch]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:13311/
setting /run_id to 326d8aa-9470-11ep-975d-ba278b9a75a3
process[rosversion]: started with pid [2033]
started core service [/roscpp]
```

Agenda

- Diving into the ROS Topic
- Servo Motor Control Applications
 - a) Sweep Control
 - b) Knob Control
- Lab Project: Servo Motor Control with ROS

Diving into the ROS Topic

```
* ros@revelio:/jrdon-desktop/1131/
└─$ cd ~; pwd; ls -la; df -h; free -m; top;
Now checking log file disk usage. Usage is -iGB.
started roslaunch server http://jrdon-desktop:40015/
ros_core version: 1.14.3

SUMMARY
=====
PARAMETERS
 * /rostopic: melodic
 * /roscpp_core: 1.14.3
NODES
auto-starting new master
process[master]: started with pid [2000]
RMW_IMPLEMENTATION=rmw_zenoh_cpp /jrdon-desktop/1131/
setting /roscpp_core to 1.14.3
process[roscpp_core]: started with pid [2003]
started core service [/rosout]
```

Definition:

Topic – The publishing and subscribing of a message of a specific name type.

Diving into a ROS Topic...

```
? (roscore)~/roscat-desktop:11317
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is <1GB.
started roslaunch server http://roscat-desktop:48511/
roscat.com version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscat_core: roscatc
 * /roscat_core__name: roscatc
 * /roscat_core__version: 1.14.3

NODES
-----
auto-starting new master
pidof(roscatc): started with pid [2024]
ROS_MASTER_URI=http://roscat-desktop:11311/

setting /run_id to 320d8aa-947b-12e9-975d-b27e0b97583
pidof(roscatc-21): started with pid [2035]
started core service [/roscat]
```

Explanation:

Topics are:

- a) communication defined buses which allow the exchange of messages.
- b) unknown public/subscribe words.
- c) relevant to the subscribing of data of interested nodes.

ROS.(n.d.). *Understanding ros topics*. Retrieved from <http://wiki.ros.org/Topics>

Diving into a ROS Topic...

```
~/roscat@ip:/roscat-desktop:11317
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://roscat-desktop:48511/
ros, core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscat: roscat
 * /roscat__port: 11317

NODES
auto-starting new master
process[roscat]: started with pid [2024]
ROS_MASTER_URI=http://roscat-desktop:11311/

setting /run_id to 32d0ba8-947b-11e9-9758-b278b9a7583
process[roscat-2]: started with pid [2033]
started core service [/roscat]
```

Example:

Turtlesim simulator

Type and run the following commands in different terminal windows after the \$ prompt.

```
roscore
```

```
roslaunch turtlesim turtlesim_node
```

```
roslaunch turtlesim turtle_teleop
```

Diving into a ROS Topics...

```
1 /home/mrdon-desktop:11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is <1GB.
started roslaunch server http://mrdon-desktop:45011/
ros_comm version 1.14.3

SUMMARY
=====

PARAMETERS
* /roscore: melodic
* /rosversion: 1.14.3

NODES

auto-starting new master
process[master]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 32d6d8a-947b-11e9-9758-b278b9a7583
process[roscore-1]: started with pid [2033]
started core service [/roscore]
```

```
roscore http://mrdon-desktop:11311/
File Edit View Search Terminal Help
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://mrdon-desktop:45011/
ros_comm version 1.14.3

SUMMARY
=====

PARAMETERS
* /roscore: melodic
* /rosversion: 1.14.3

NODES

auto-starting new master
process[master]: started with pid [2189]
ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 278d8758-634e-11ea-881e-b827eb9a7583
process[roscore-1]: started with pid [2200]
started core service [/roscore]
```

roscore

Question 1



Name the virtual simulation example used to demonstrate Topics?

Diving into a ROS Topics...

```
~/ros_ws/src/mrdon-desktop11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://mrdon-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roslaunch: melodic
 * /rosworkspace: 1.14.3

NODES
-----
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 320d8aa-947b-11e9-9758-b278b0a7563
process[roscpp-2]: started with pid [2033]
started core service [/roscpp]
```

roslaunch turtlesim turtlesim_node

```
mrdon@mrdon-desktop: ~
File Edit View Search Terminal Help
mrdon@mrdon-desktop:~$ roslaunch turtlesim turtlesim_node
libEGL warning: DRI2: failed to authenticate
[ INFO] [1583899872.105795255]: Starting turtlesim with node name /turtlesim
[ INFO] [1583899872.134961227]: Spawning turtle [turtle1] at x=[5.544445], y=[5.544445], theta=[0.000000]
```

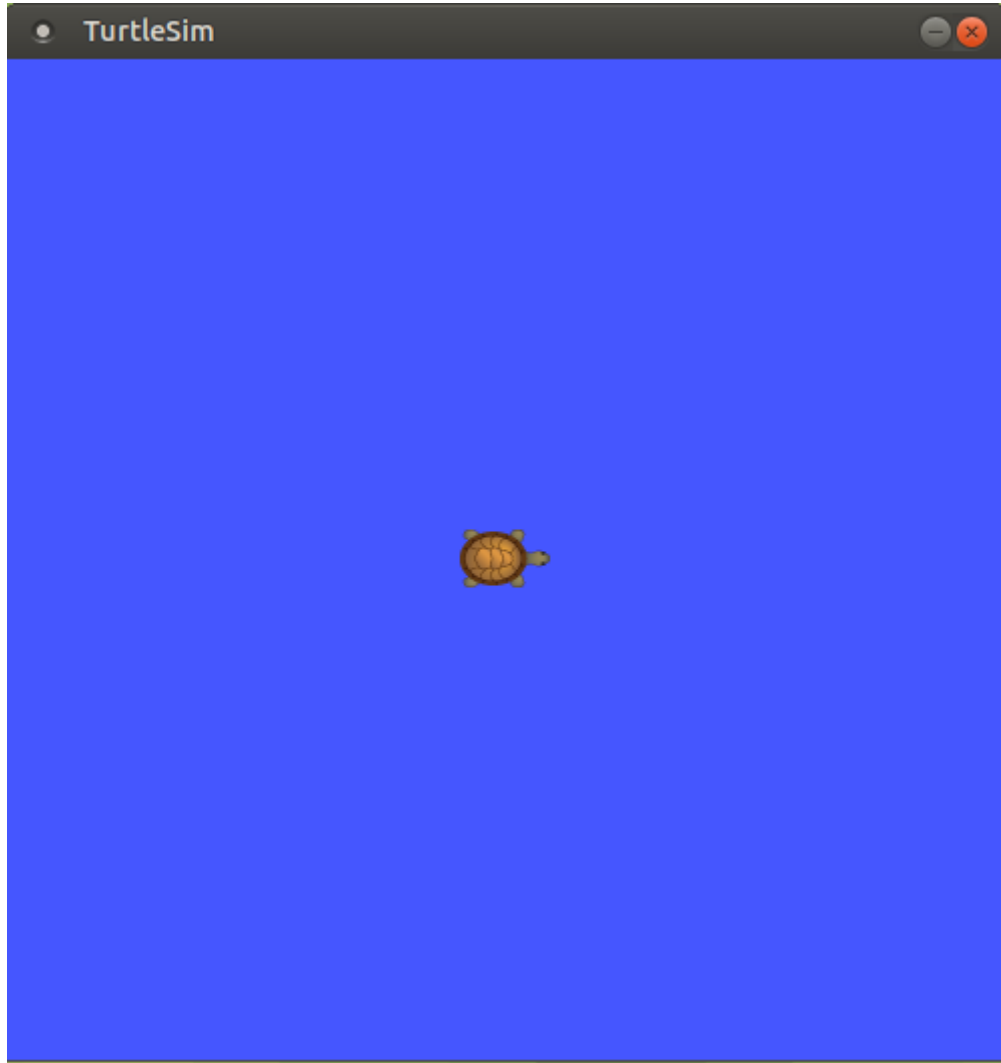

Diving into a ROS Topics...

```
~/ros_ws/src/roscpp_tutorials$ catkin_make
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://nrdon-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp_tutorials: roscpp_tutorials
 * /roscpp_tutorials__ns: /roscpp_tutorials

NODES
  auto-starting new master
  process[roscpp_tutorials]: started with pid [2024]
  ROS_MASTER_URI=http://nrdon-desktop:11311/

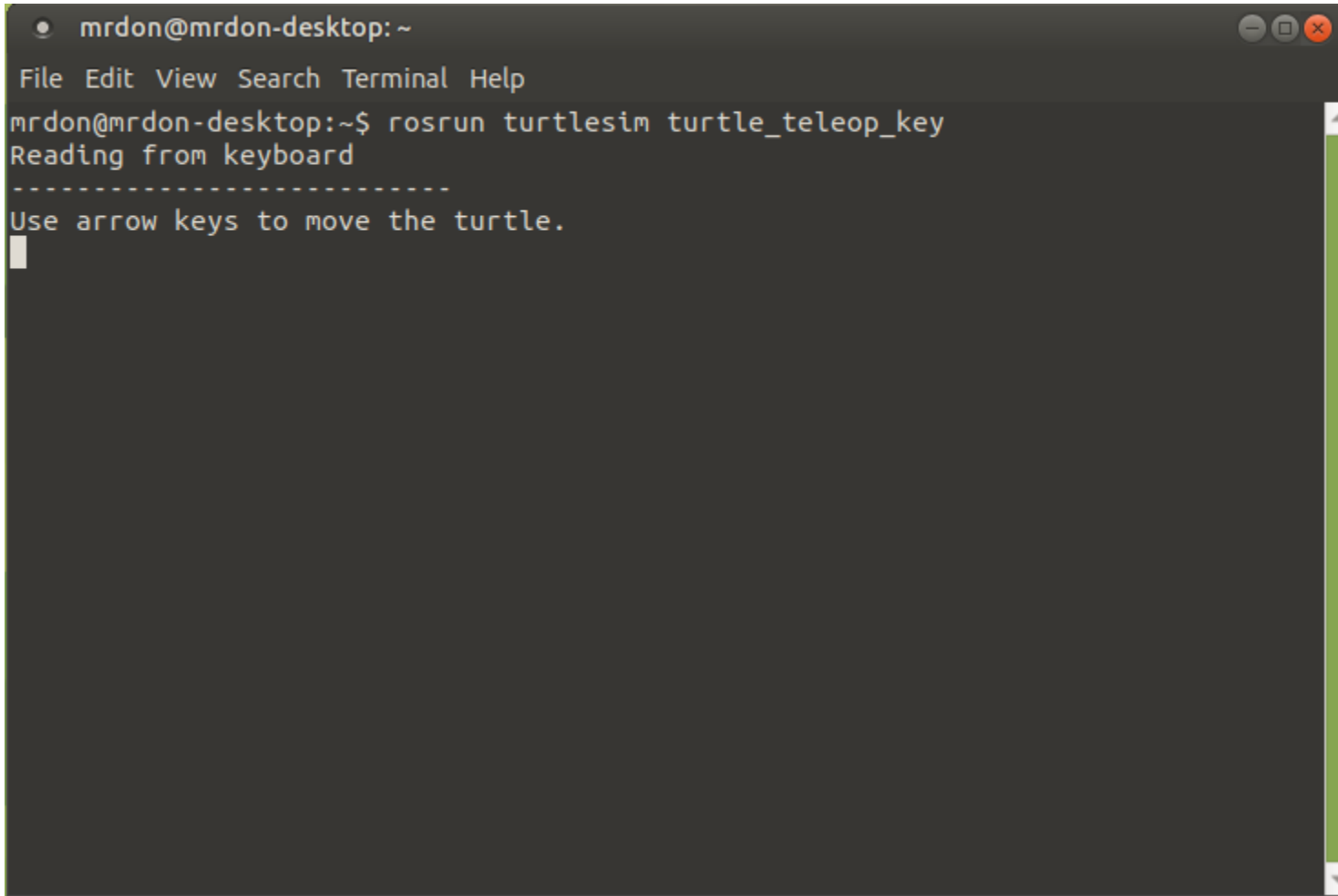
setting /run_id to 320d8ba8-947b-11e5-9758-b278b0a7563
process[roscpp_tutorials]: started with pid [2033]
started core service [/roscpp_tutorials]
```



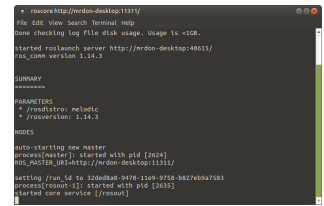
Result of :
roslaunch turtlesim turtlesim_node

Diving into a ROS Topics...

roslaunch turtlesim turtle_teleop_key



```
mrdon@mrdon-desktop: ~  
File Edit View Search Terminal Help  
mrdon@mrdon-desktop:~$ roslaunch turtlesim turtle_teleop_key  
Reading from keyboard  
-----  
Use arrow keys to move the turtle.  
█
```



```
~/roscat@mrdon-desktop:11317  
File Edit View Search Terminal Help  
Done checking log file disk usage. Usage is 1GB.  
started roslaunch server http://mrdon-desktop:4001/  
ros_core version 1.14.3  
  
SUMMARY  
-----  
PARAMETERS  
 * /roslaunch: melodic  
 * /rosversion: 1.14.3  
  
NODES  
-----  
auto-starting new master  
process[roscpp]: started with pid [2024]  
ROS_MASTER_URI=http://mrdon-desktop:11317  
  
setting /run_id to 320d8a8-947b-11e9-9758-ba2780a7563  
process[roscpp-2]: started with pid [2033]  
started core service [/roscpp]
```

Question 2



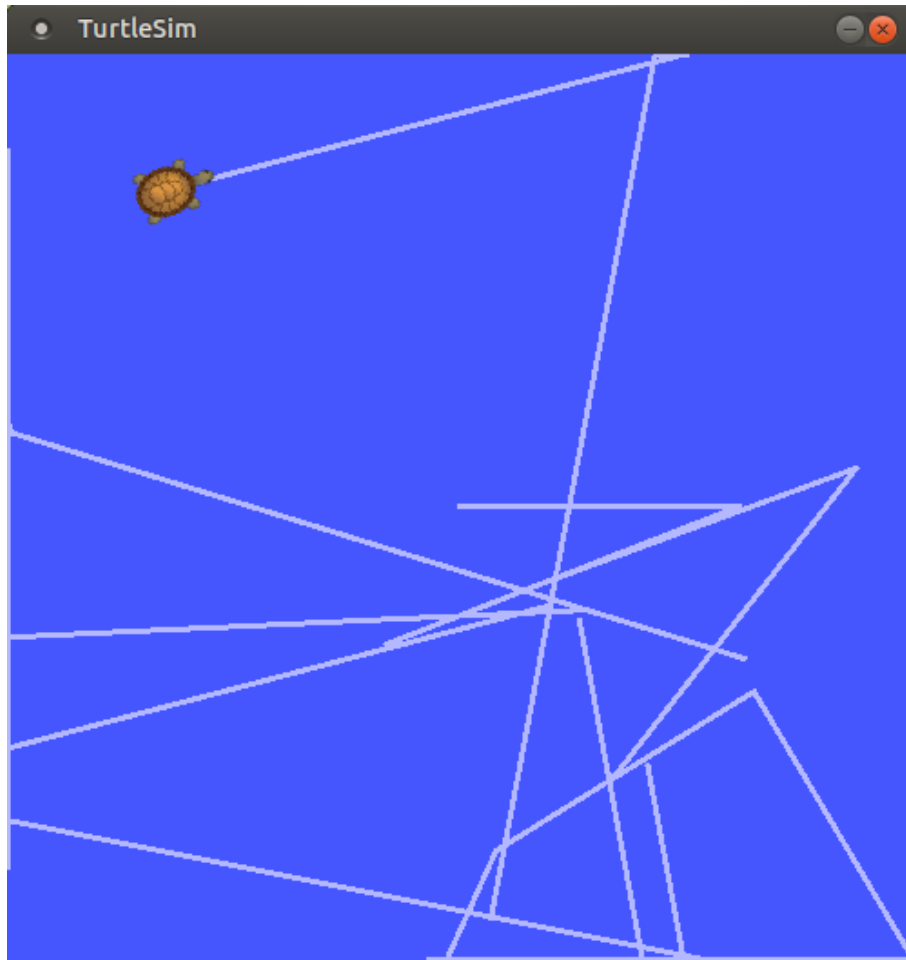
What method is used to move the turtle on the turtlesim window?

Diving into a ROS Topics...

```
~/ros_ws/src/roscpp_tutorials$ catkin_make
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://radeon-desktop-48011/
ros_core version 1.14.3

SUMMARY
=====
PARAMETERS
 * /roscpp_tutorial: melodic
 * /roscpp_tutorial__ns: /
NODES
auto-starting new master
process[roscpp_tutorial]: started with pid [2024]
ROS_MASTER_URI=http://radeon-desktop-11311/

setting /run_id to 320d8a8-947b-11e9-9758-b278b0a7563
process[roscpp_tutorial-1]: started with pid [2033]
started core service [/roscpp]
```



Result of:
`roslaunch turtlesim turtle_teleop_key`

Diving into a ROS Topics...

```
~/roscat@mrdon-desktop:11317
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 1GB.
started roslaunch server http://mrdon-desktop:4001/
ros_comm version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscat: /roscat
 * /roscat: /roscat
 * /roscat: /roscat

NODES
-----
auto-starting new master
process[roscat]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:11317

setting /run_id to 320d8a4-947b-11e5-975e-b278b9a7563
process[roscat-1]: started with pid [2033]
started core service [/roscat]
```

```
mrdon@mrdon-desktop: ~
File Edit View Search Terminal Help

[ WARN ] [1583903708.341542276]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.274624])
[ WARN ] [1583903708.357635088]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.244988])
[ WARN ] [1583903708.373511657]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.215352])
[ WARN ] [1583903708.389180317]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.185716])
[ WARN ] [1583903708.404915173]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.156080])
[ WARN ] [1583903708.421709835]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.126444])
[ WARN ] [1583903708.437723170]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.096808])
[ WARN ] [1583903708.453324333]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.067172])
[ WARN ] [1583903708.469635887]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.037537])
[ WARN ] [1583903708.485219550]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=2.007901])
[ WARN ] [1583903708.500997321]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.978265])
[ WARN ] [1583903708.516893056]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.948629])
[ WARN ] [1583903708.533857556]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.918993])
[ WARN ] [1583903708.549603297]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.889357])
[ WARN ] [1583903708.565467054]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.859721])
[ WARN ] [1583903708.581362894]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.830085])
[ WARN ] [1583903708.597056970]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.800449])
[ WARN ] [1583903708.612792346]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.770813])
[ WARN ] [1583903708.629436492]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.741177])
[ WARN ] [1583903708.645057550]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.711541])
[ WARN ] [1583903708.661054272]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.681906])
[ WARN ] [1583903708.676829855]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.652270])
[ WARN ] [1583903708.693700972]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.622634])
[ WARN ] [1583903708.709474420]: Oh no! I hit the wall! (Clamping from [x=-0.012071, y=1.592998])
```

Result of turtle hitting wall

```
~/ros_ws/src/roscpp_ws$ catkin_make
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://rondon-desktop:4001/
ros_core.service 3.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp_ws: roscpp_ws
 * /roscpp_ws: 3.14.3

NODES
-----
auto-starting new master
process[roscpp_ws]: started with pid [2024]
ROS_MASTER_URI=http://rondon-desktop:11311/

setting /run_id to 320d8a8-947b-11e9-9758-b2780a97583
process[roscpp_ws]: started with pid [2033]
started core service [/roscpp_ws]
```

Diving into a ROS Topics... Conclusion

- The turtlesim simulator illustrates the turtlesim_node and the turtle_teleop_key communications between nodes.
- The turtle_teleop_key is publishing the key strokes based on a topic.
- The turtlesim node subscribes to the same topic as turtle_teleop_key.
- The turtle1/command_velocity is the shared topic between the nodes.

Diving into a ROS Topics...

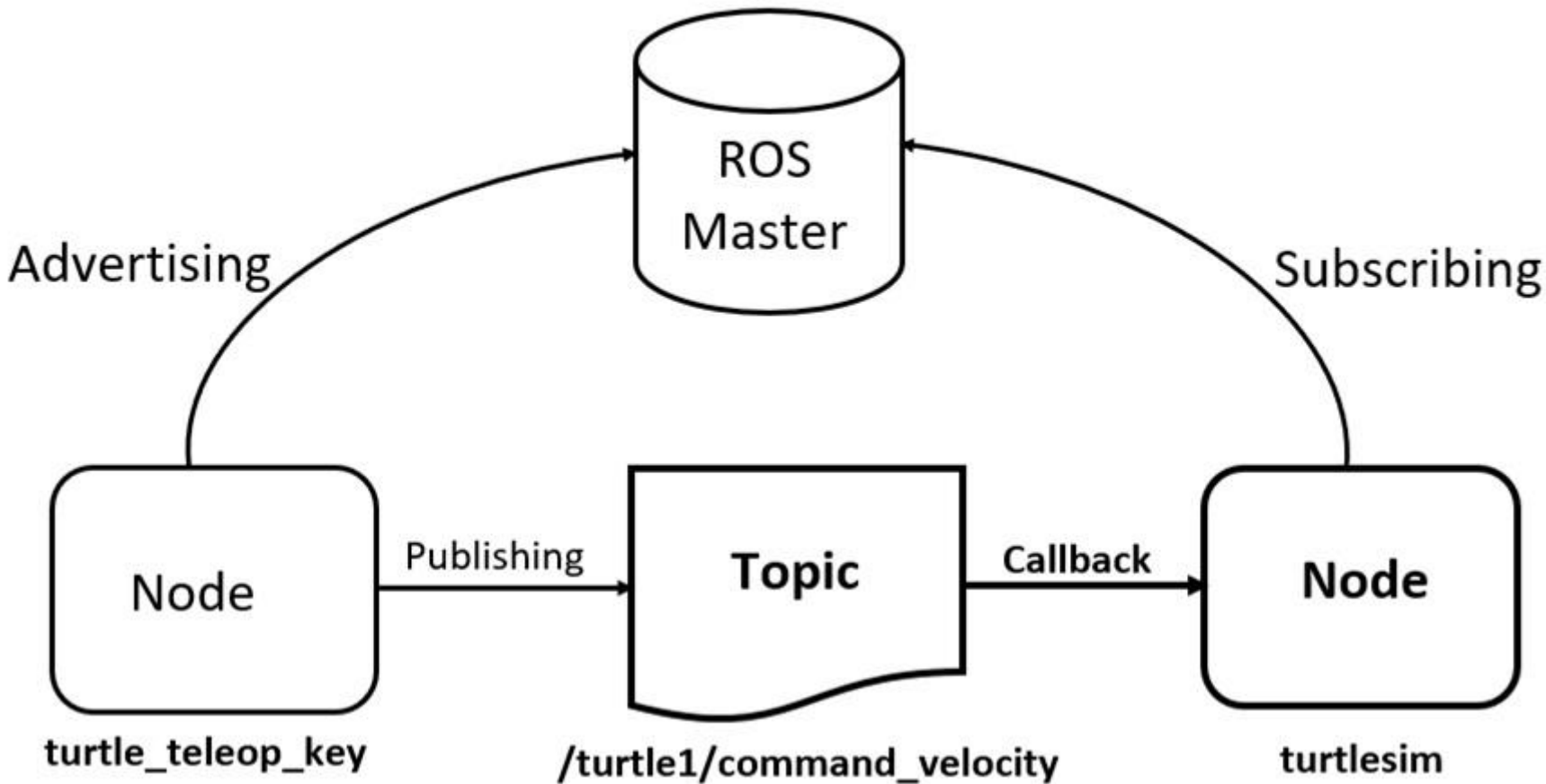
```
~/roscat@/roscat-desktop:1131/
File Edit View Search Terminal Help
Done checking log file disk usage. usage is <1GB.
started roslaunch server http://roscat-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscatros: melodic
 * /roscatros: 1.14.3

NODES
-----
auto-starting new master
process[roscat]: started with pid [2024]
ROS_MASTER_URI=http://roscat-desktop:1131/

setting /run_id to 320d8a8-947b-11e9-9758-ba2780a75e3
process[roscat-1]: started with pid [2033]
started core service [/roscat]
```

Controlling Turtlesim



Model can be displayed using a rostopic dynamic graph command: `$roslaunch rqt_graph rqt_graph`

Presented by:

Question 3



Which command is used to display the rostopic dynamic graph?

- a) `$rosviz rqt_graph rqt_graph`**
- b) `$rosviz rqt_graph rqt_graph`**
- c) `$rosviz rqt_graph`**
- d) None of the above**

Servo Motor Control Application

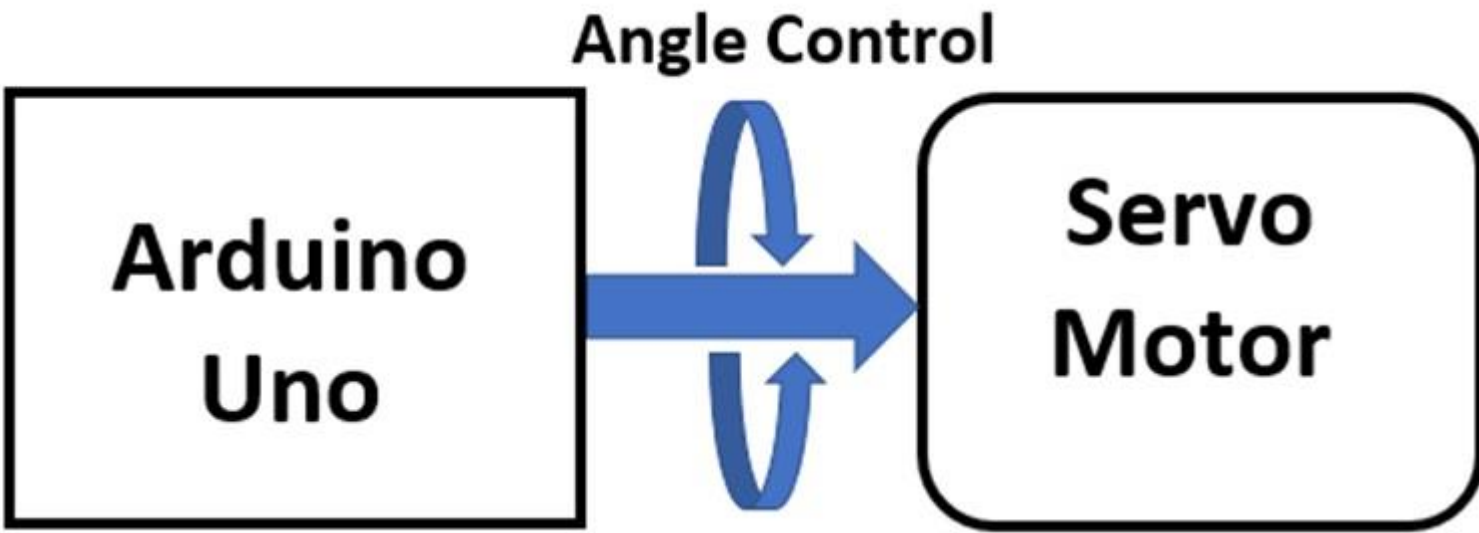
```
~/Documents/arduino-desktop11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 1GB.
started re-launch server http://arduino-desktop48011/
ros_core version 1.14.3

SUMMARY
=====
PARAMETERS
 * /rosdistro: melodic
 * /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[roscore]: started with pid [1024]
ROS_MASTER_URI=http://arduino-desktop11311/

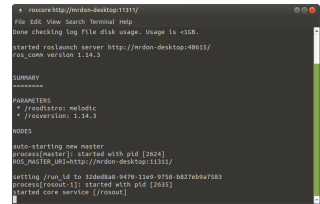
setting /run_id to 320d8a8-9476-11e9-9758-ba2780a7563
process[roscpp]: started with pid [1033]
started core service [/roscpp]
```

Sweep Control Concept



Servo Motor Control Applications...

Sweep Control: Arduino Uno Code



```
void loop() {  
  for (pos = 0; pos <= 180; pos += 1) { // goes from 0 degrees to 180 degrees  
    // in steps of 1 degree  
    myservo.write(pos);           // tell servo to go to position in variable 'pos'  
    delay(15);                   // waits 15ms for the servo to reach the position  
  }  
  for (pos = 180; pos >= 0; pos -= 1) { // goes from 180 degrees to 0 degrees  
    myservo.write(pos);           // tell servo to go to position in variable 'pos'  
    delay(15);                   // waits 15ms for the servo to reach the position  
  }  
}
```

File > Examples > Servo > Sweep

Servo Motor Control Applications...

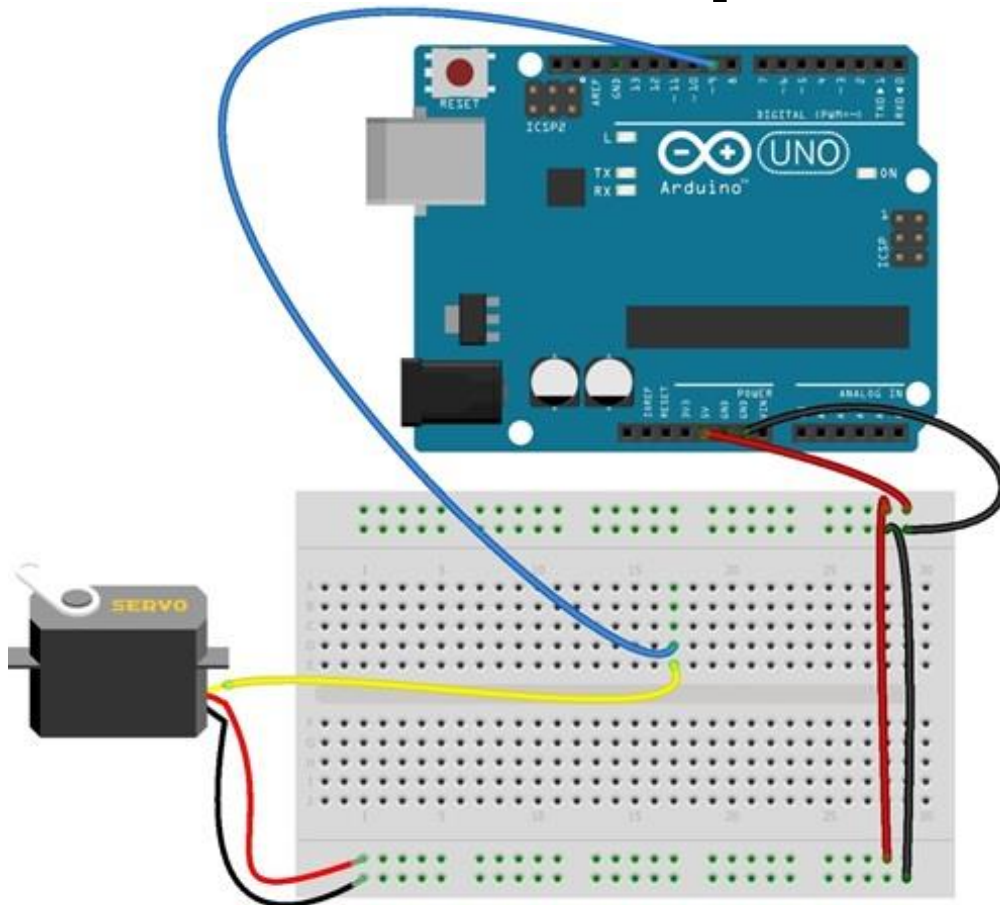
Sweep Control

```
7 /home/13131/rodon-desktop/13131/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://rodon-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /rostopic: melodic
 * /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://rodon-desktop:13131/

setting /run_id to 320d8aa-947b-11e9-9758-ba2780a7563
process[roscpp-1]: started with pid [2033]
started core service [/roscpp]
```



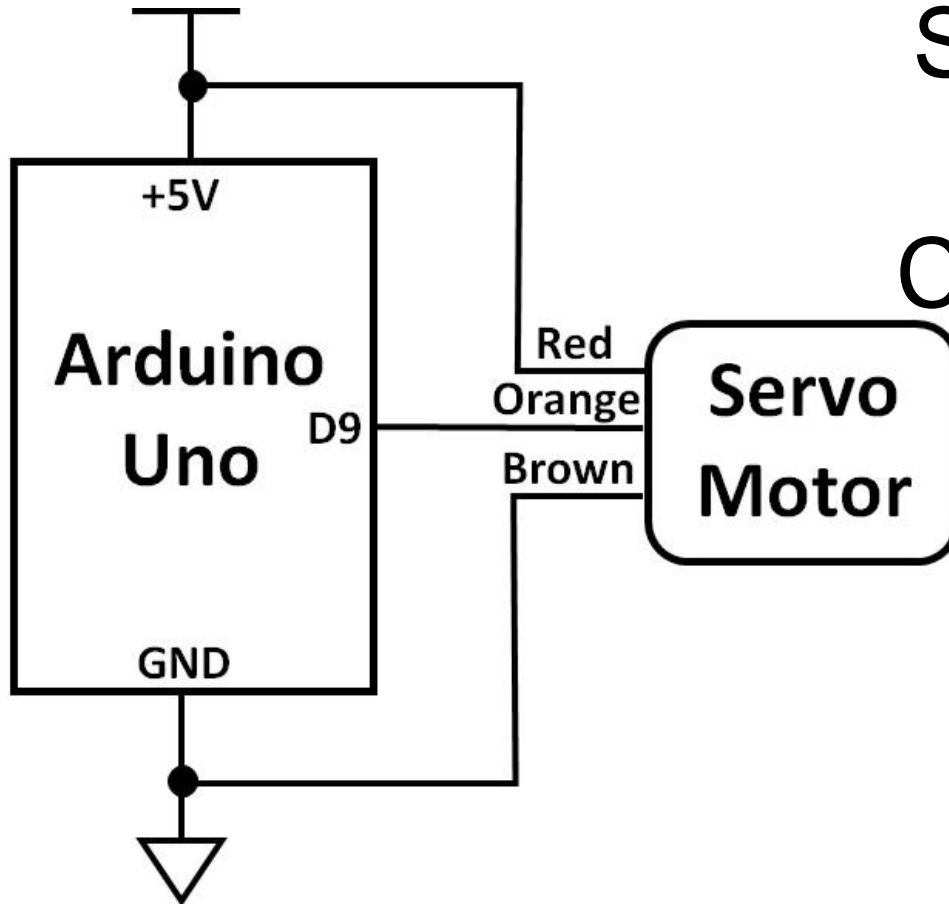
Sweep Control Electrical Wiring Diagram

Servo Motor Control Applications...

Sweep Control

```
roscore http://mimod-desktop:11311/
file_exists: true
some checking log file disk usage, usage is: -1GB.
started ros launch server http://mimod-desktop:40615/
ros_comm version 1.16.3
SUMMARY
=====
SUBSCRIPTS
  * /rosdstra/motoc
  * /rosdstra/1.16.3
=====
INFO: starting new master
process[master]: started with pid [2024]
INFO: setting up ROS
INFO: setting up ROS
setting /run_id to 320d08aa-9470-11e9-9756-b07d09a7593
process[roscpp]: started with pid [2035]
started core service [/roscpp]
```

Sweep Control Electronic Circuit Diagram



Servo Motor Control Applications...

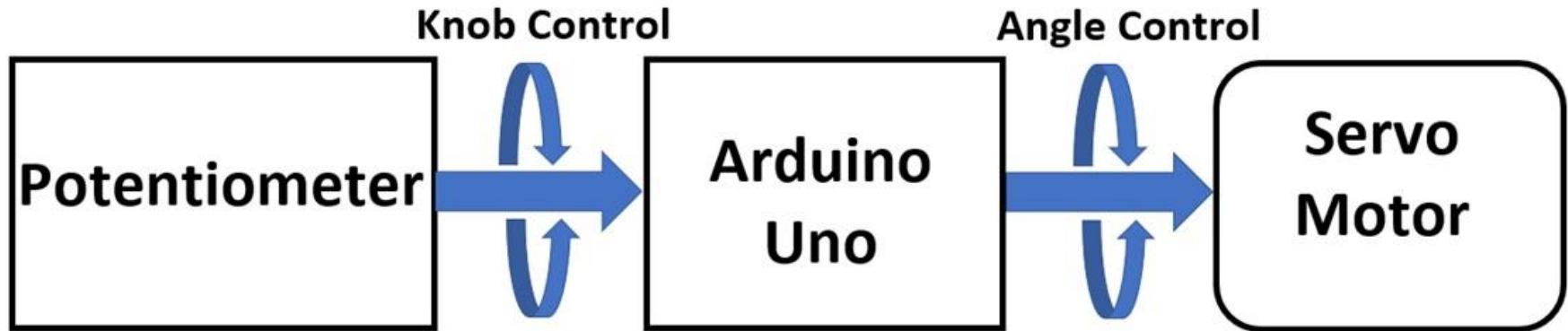
```
~/robohub@/robohub-desktop:11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started re-launch server http://robohub-desktop:40011/
robohub.com version 3.14.3

SUMMARY
-----
PARAMETERS
  /robohub: robohub
  /robohub.com: 3.14.3

NODES
-----
auto-starting new master
process[robohub]: started with pid [2024]
ROS_MASTER_URI=http://robohub-desktop:11311/

setting /run_id to 320d8a8-947b-11e9-9758-b278b0a75e3
process[robohub-2]: started with pid [2033]
started core service [/robohub]
```

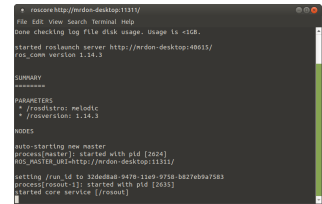
Knob Control Concept



Servo Motor Control Applications...

Knob Control

Arduino Uno Code



```
#include <Servo.h>

Servo myservo; // create servo object to control a servo

int potpin = 0; // analog pin used to connect the potentiometer
int val; // variable to read the value from the analog pin

void setup() {
  myservo.attach(9); // attaches the servo on pin 9 to the servo object
}

void loop() {
  val = analogRead(potpin); // reads the value of the potentiometer (value between 0 and 1023)
  val = map(val, 0, 1023, 0, 180); // scale it to use it with the servo (value between 0 and 180)
  myservo.write(val); // sets the servo position according to the scaled value
  delay(15); // waits for the servo to get there
}
```

File > Examples > Servo > Knob

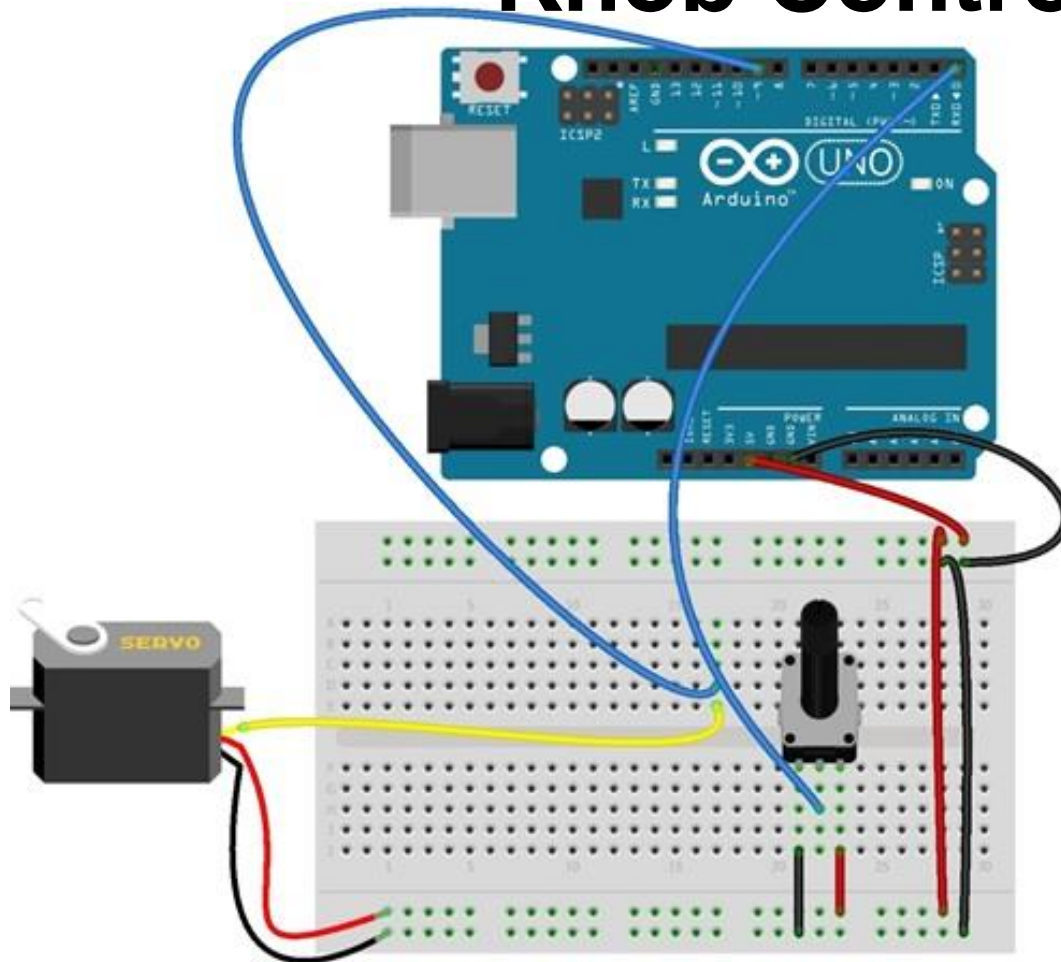
Servo Motor Control Applications... Knob Control

```
7 /home/131p/~/rdoon-desktop/11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started re-launch server http://rdoon-desktop:40011/
rdo.com version 3.14.3

SUMMARY
-----
PARAMETERS
  / /rosdistro: melodic
  / /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://rdoon-desktop:11311/

setting /run_id to 320d8aa-947b-11e9-975a-ba2780a7563
process[roscpp-2]: started with pid [2033]
started core service [/roscpp]
```



Knob Control Electrical Wiring Diagram

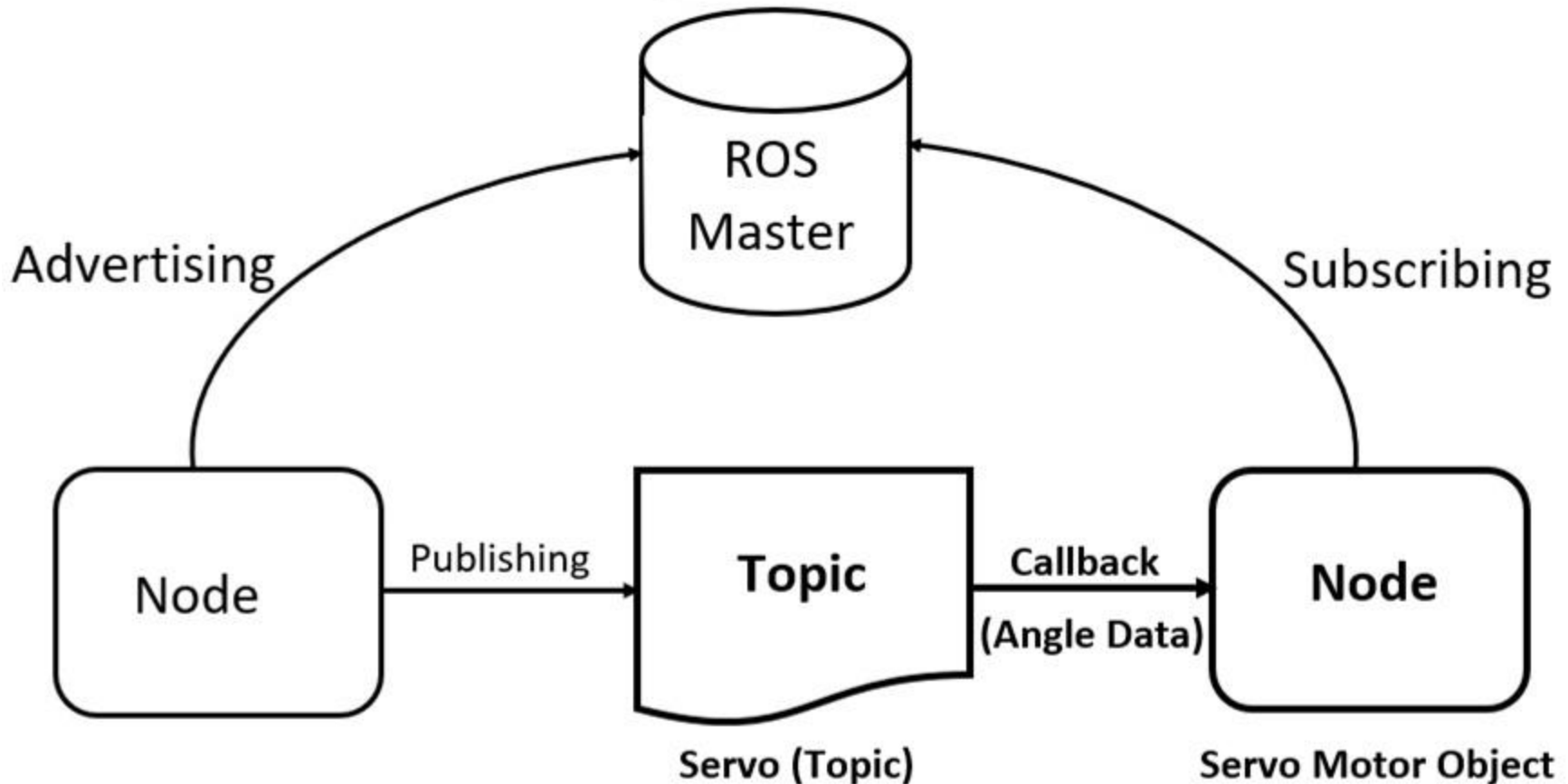
Diving into a ROS Topics...

```
~/roscat@/roscat-desktop:11317/
File Edit View Search Terminal Help
Done checking log file disk usage. usage is <1GB.
started roslaunch server http://roscat-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscat: roscat
 * /roscat_core: 1.14.3

NODES
-----
auto-starting new master
process[roscat]: started with pid [2024]
ROS_MASTER_URI=http://roscat-desktop:11317/
setting /run_id to 320d8a8-947b-11e9-9758-b278b0a7563
process[roscat-2]: started with pid [2033]
started core service [/roscat]
```

Controlling a Servo Motor



Wilcher, D. (2019). *ROS 101: An intro to the robot operating system*. Retrieved from <https://www.designnews.com/gadget-freak/ros-101-intro-robot-operating-system/107053141061075>

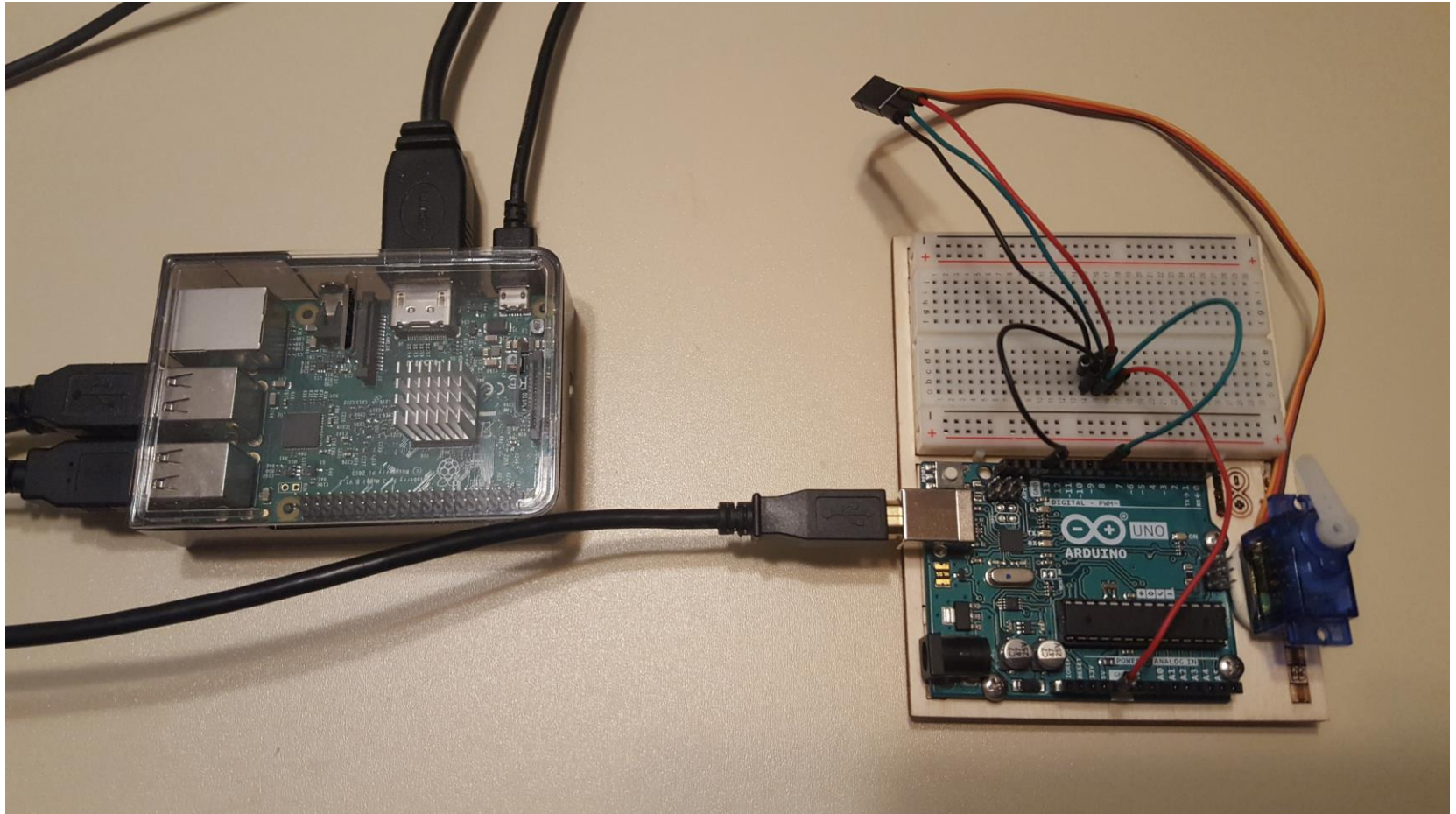
Presented by:

Lab Project: Servo Motor Control with ROS

```
~/ros_ws/src/roscpp/roscpp$ catkin_make
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://mrdon-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /roscpp: roscpp
 * /roscpp__ns: /roscpp
NODES
  auto-starting new master
  process[roscpp]: started with pid [2024]
  ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 320d8aa-947b-11e9-9758-ba2780a7563
process[roscpp-1]: started with pid [2033]
started core service [/roscpp]
```



Lab Project: Servo Motor Control with ROS...

```
? Home http://robo-desktop:11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://robo-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /rostopic: rostopic
 * /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[rostopic]: started with pid [2024]
ROS_MASTER_URI=http://robo-desktop:11311/

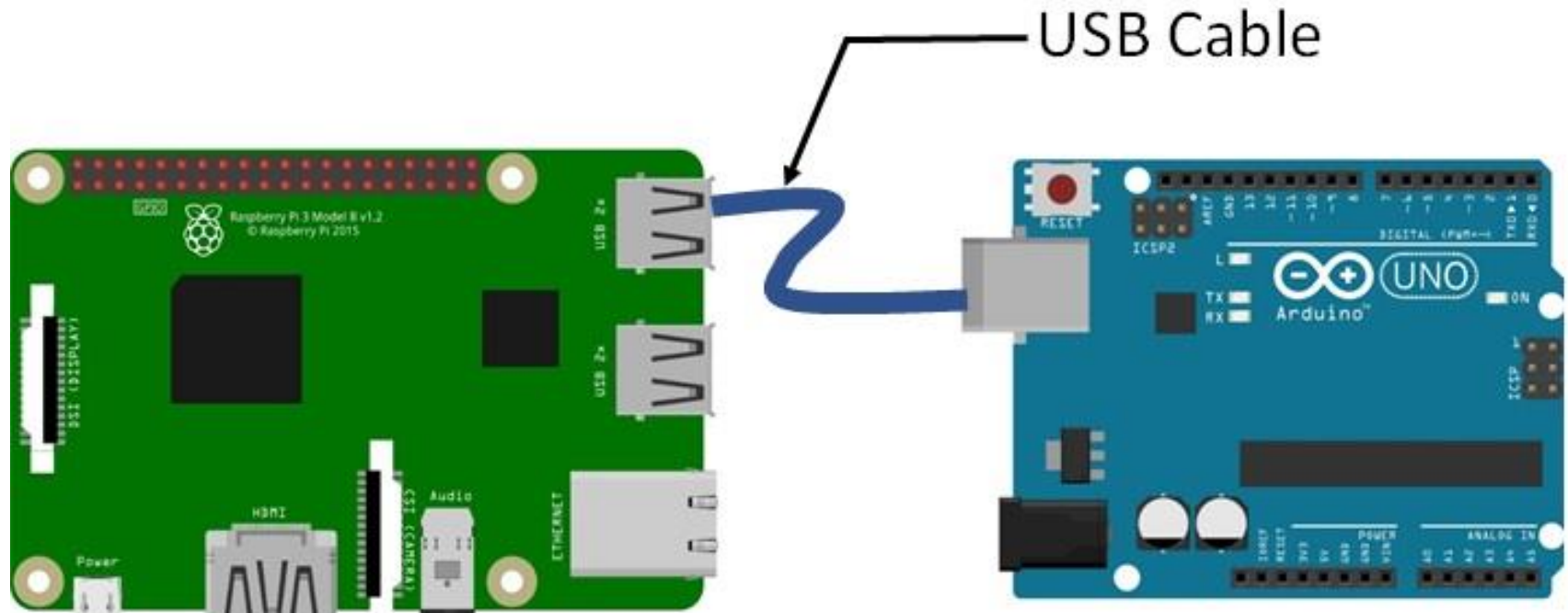
setting /run_id to 32d6d8d-947b-11e5-9758-b278b0a7563
process[rostopic-2]: started with pid [2033]
started core service [/rostopic]
```

Lab Objectives:

- Learn how attach a Raspberry Pi to an Arduino.
- Learn how to communicate with a ROS node.
- Learn how to display the dynamic graph of the servo rostopic.
- Learn how to control a servo motor using the rostopic pub echo command.

How to attach a Raspberry Pi to an Arduino?...

```
* rosrun http://mrdon-desktop:1311/
File Edit View Search Terminal Help
Now checking log file disk usage: usage is <10%.
started roslaunch server http://mrdon-desktop:4051/
ros_core version 1.14.3
-----
SUMMARY
-----
PARAMETERS
 * /rostopic: melodic
   /rosversion: 1.14.3
NODES
auto-starting new master
process[master]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:1311/
setting /run_id to 3260d88-9476-11e9-9750-ba27809a7551
process[roscpp-1]: started with pid [2033]
started core service [/rostop]
```



Serial communication between the Raspberry Pi 3 and Arduino Uno

Servo Motor Control Applications...

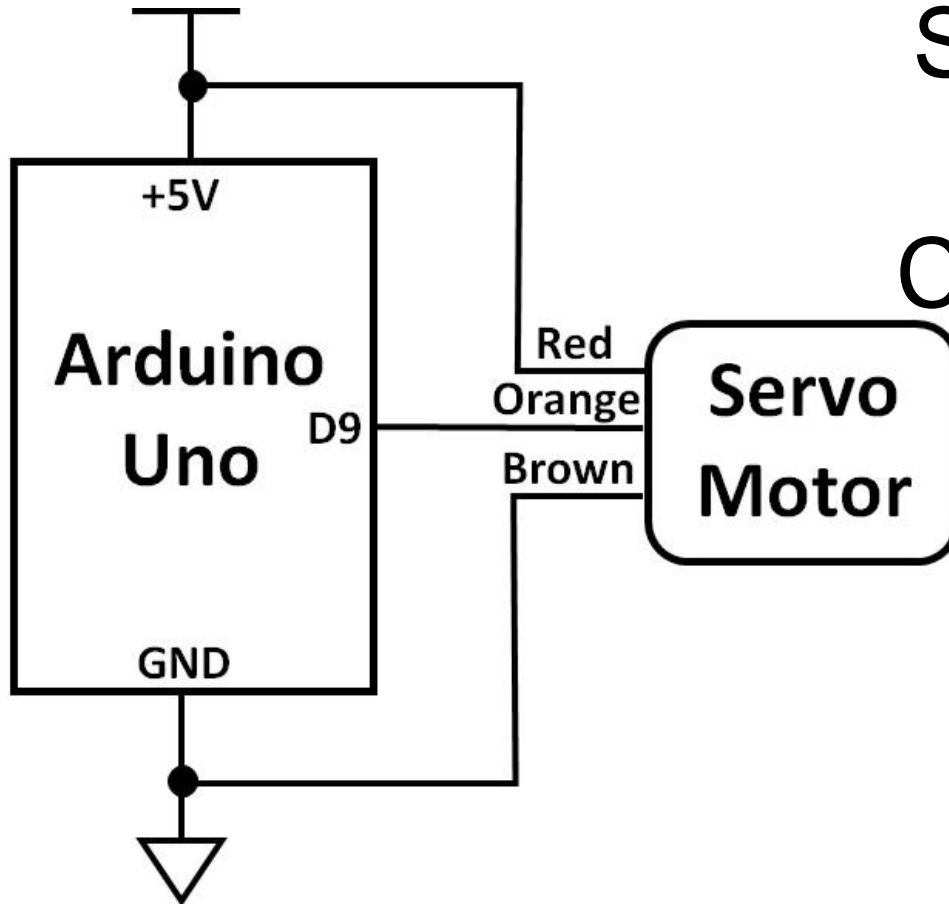
Sweep Control

```
roscore http://mimod-desktop:11311/
file Edit View Search Terminal Help
some checking log file disk usage, usage is -50%
started roslaunch server http://mimod-desktop:40615/
ros_comm version 1.16.3

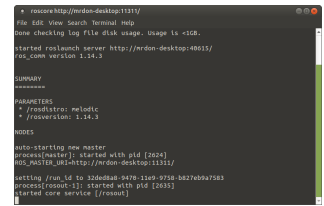
SUMMARY
=====
ROBOTICS
 * /roscpp: melodic
 * /roscpp: melodic
 * /roscpp: melodic
 * /roscpp: melodic

INFO: starting new master
process[master]: started with pid [2042]
ros_mimod: http://mimod-desktop:11311/
setting /run_id to 320d08aa-9470-11e9-9756-b07d09a7593
process[roscpp-1]: started with pid [2035]
started core service [/roscpp]
```

Sweep Control Electronic Circuit Diagram



How to attach a Raspberry Pi to an Arduino?



Open a linux terminal: At the prompt type: `roscore`.

```
roscore http://mrdon-desktop:11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is <1GB.
started roslaunch server http://mrdon-desktop:40615/
ros_comm version 1.14.3

SUMMARY
=====

PARAMETERS
* /roscore: melodic
* /rosversion: 1.14.3

NODES

auto-starting new master
process[master]: started with pid [2624]
ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 32ded8a8-9470-11e9-9758-b827eb9a7583
process[rosout-1]: started with pid [2635]
started core service [/rosout]
```

roscore running in an active window

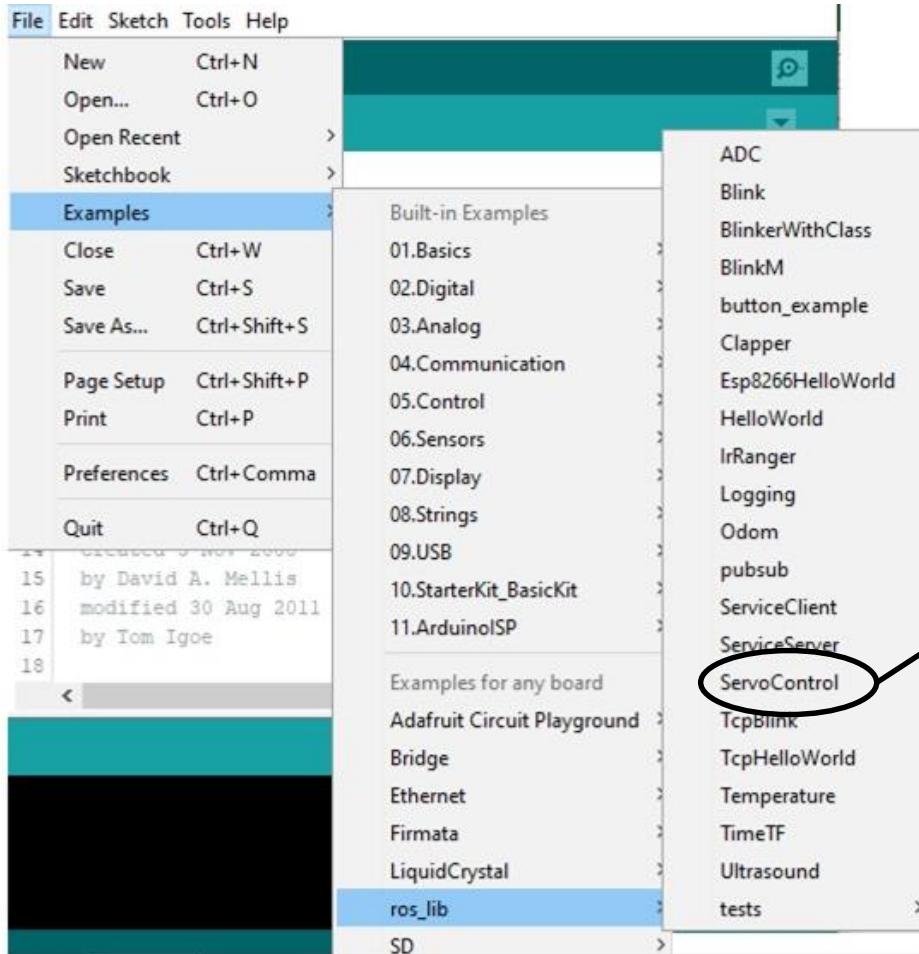


Question 4

Name two control methods to operate a servo motor.

How to attach a Raspberry Pi to an Arduino?...

```
* ros@http://mrdon-desktop:1311/
File Edit View Search Terminal Help
Now checking log file disk usage. Usage is <1GB.
started roslaunch server: http://mrdon-desktop:40051/
ros_core version 1.14.3
-----
SUMMARY
-----
PARAMETERS
 * /rostopic: melodic
 * /rosversion: 1.14.3
NODES
-----
auto-starting new master
process[master]: started with pid [2024]
ROS_MASTER_URI=http://localhost:1311
setting from id to 32000aa1-9476-3109-9750-ba2700a97583
process[rostop-1]: started with pid [2033]
started core service [/rostop]
```



**ros_lib:
Upload the
ServoControl Sketch**

**ros_lib:
The
ServoControl
Sketch
provides the
rostopic for
subscribing!**

How to display a dynamic graph of the servo rostopic?...

```
~/ros_ws/src/mrdon-desktop11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://mrdon-desktop:40511/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /rostopic: melodic
 * /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[master]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 320d8a8-947b-11e9-9758-ba2780a7563
process[roscpp-1]: started with pid [2033]
started core service [/roscpp]
```

```
mrdon@mrdon-desktop: ~
File Edit View Search Terminal Help
mrdon@mrdon-desktop:~$ sudo apt-get install ros-melodic-rqt
[sudo] password for mrdon:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer required:
  apt-clone archdetect-deb cryptsetup-bin dpkg-repack gir1.2-json-1.0
  gir1.2-nm-1.0 gir1.2-nma-1.0 gir1.2-timezonemap-1.0 gir1.2-xkl-1.0
  grub-common libdebian-installer4 libpng12-0 libtimezonemap-data
  libtimezonemap1 os-prober python3-icu python3-pam rdate
Use 'sudo apt autoremove' to remove them.
The following NEW packages will be installed:
  ros-melodic-rqt
0 upgraded, 1 newly installed, 0 to remove and 31 not upgraded.
Need to get 2,232 B of archives.
After this operation, 14.3 kB of additional disk space will be used.
Err:1 http://packages.ros.org/ros/ubuntu bionic/main arm64 ros-melodic-rqt arm64
 0.5.0-0bionic.20190602.130423
 404 Not Found [IP: 2600:3402:200:227::2 80]
E: Failed to fetch http://packages.ros.org/ros/ubuntu/pool/main/r/ros-melodic-rq
t/ros-melodic-rqt_0.5.0-0bionic.20190602.130423_arm64.deb 404 Not Found [IP: 2
600:3402:200:227::2 80]
E: Unable to fetch some archives, maybe run apt-get update or try with --fix-mis
sing?
```

Installing *rqt*

How to display a dynamic graph of the servo rostopic?...

```
~/roscat@mrdon-desktop:~$  
File Edit View Search Terminal Help  
Done checking log file disk usage. Usage is 4GB.  
started roslaunch server http://mrdon-desktop:40011/  
ros_core version 1.14.3  
  
SUMMARY  
-----  
PARAMETERS  
 * /roscat: roscat  
 * /roscat_core: 1.14.3  
  
NODES  
-----  
auto-starting new master  
process[roscat]: started with pid [2024]  
ROS_MASTER_URI=http://mrdon-desktop:11311/  
  
setting /run_id to 320d8a8-947b-11e9-9758-b278b0a7563  
process[roscat-1]: started with pid [2033]  
started core service [/roscat]
```

```
mrdon@mrdon-desktop: ~  
File Edit View Search Terminal Help  
mrdon@mrdon-desktop:~$ rosrn rqt_graph rqt_graph  
libEGL warning: DRI2: failed to authenticate
```

Running *rqt_graph*

How to display a dynamic graph of the servo rostopic?...

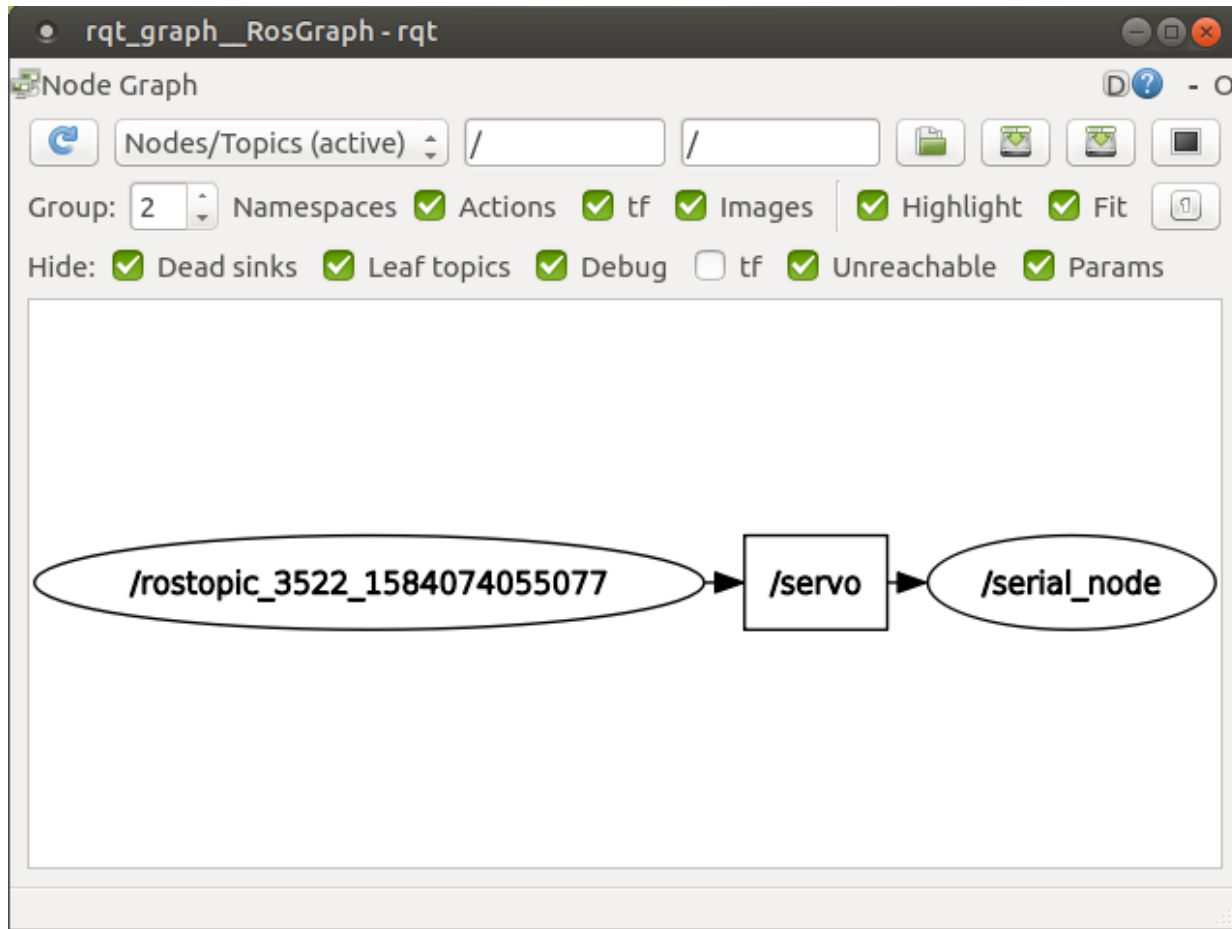
```
~/roscat@/roscat-desktop:11317
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://roscat-desktop:4001/
ros_core version 1.14.3

SUMMARY
=====
PARAMETERS
  /roscat: melodic
  /roscat_core: 1.14.3

NODES
  auto-starting new master
  process[roscat]: started with pid [2024]
  ROS_MASTER_URI=http://roscat-desktop:11317/

setting /run_id to 320d8a8-947b-11e9-9758-b278b9a7563
process[roscat-1]: started with pid [2033]
started core service [/roscat]
```

servo rqt_graph



How to communicate with a ROS node?

```
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://rondon-desktop:4001/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /rostopic: melodic
 * /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[roscpp]: started with pid [2024]
ROS_MASTER_URI=http://rondon-desktop:11311/

setting /run_id to 32d68a8-9476-11e9-9758-b2780b97563
process[roscpp-2]: started with pid [2033]
started core service [/roscpp]
```

To run the roserial client application for communicating with the attached Arduino Uno, open a new window and type the following *ros_lib* command after the prompt.

\$ rosrn roserial_python serial_node.py /dev/*serial port*.

Note: *serial port* is the communication port used on the Arduino Uno to talk to the Raspberry Pi.

For example: ttyACM0 is the Arduino Uno's serial port to communicate with the Raspberry Pi.

How to communicate with a ROS node?...

Open linux terminal: `roslaunch rosseri_python` running

```
mrdon@mrdon-desktop: ~  
File Edit View Search Terminal Help  
mrdon@mrdon-desktop:~$ roslaunch rosseri_python serial_node.py /dev/ttyACM0  
[INFO] [1583114175.513932]: ROS Serial Python Node  
[INFO] [1583114175.547573]: Connecting to /dev/ttyACM0 at 57600 baud  
[INFO] [1583114177.668262]: Requesting topics...  
[INFO] [1583114177.708511]: Note: publish buffer size is 280 bytes  
[INFO] [1583114177.715263]: Setup publisher on pushed [std_msgs/Bool]
```

```
~/ros_ws/src/rosseri_python/rosseri_python  
File Edit View Search Terminal Help  
Done checking log file disk usage. Usage is 1GB.  
started roslaunch server http://mrdon-desktop:4001/  
ros_core version 1.14.3  
  
SUMMARY  
-----  
PARAMETERS  
 * /roslaunch: roslaunch  
 * /rosworkon: 1.14.3  
  
NODES  
-----  
auto-starting new master  
process[roslaunch]: started with pid [2024]  
ROS_MASTER_URI=http://mrdon-desktop:11311/  
  
setting /run_id to 320d8ba1-947b-11e5-9758-b278b0a7563  
process[rosseri_python-1]: started with pid [2033]  
started core service [/roslaunch]
```

How to operate servo motor with rostopic pub?

```
~/roscat@ip:~/roscat-desktop11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is 11GB.
started roslaunch server http://roscat-desktop:40011/
ros_core version: 1.14.3

SUMMARY
-----
PARAMETERS
 * /rostopic: rostopic
 * /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[roscat]: started with pid [2024]
ROS_MASTER_URI=http://roscat-desktop:11311/

setting /run_id to 320d8a8-947b-11e9-9758-ba2780a75e3
process[roscat-1]: started with pid [2033]
started core service [/roscat]
```

To operate the servo motor with rostopic pub, open a new window and type the following *ros_lib* command after the prompt.

`$ rostopic pub servo std_msgs/UInt16 <angle>.`

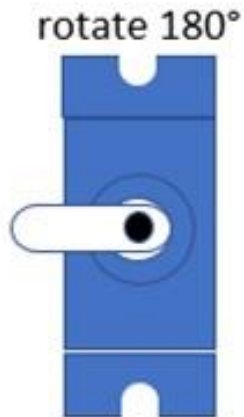
Note.

<angle> is equal to 0 -180.

How to operate a servo motor with rostopic pub?

```
~/roscat$ rostopic pub servo std_msgs/UInt16 180
$rostopic pub servo std_msgs/UInt16 180
$rostopic pub servo std_msgs/UInt16 90
$rostopic pub servo std_msgs/UInt16 0
```

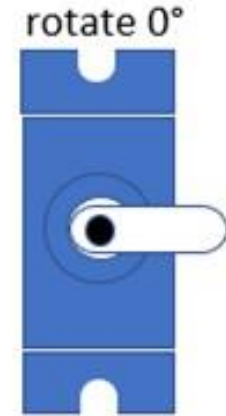
Servo Motor Rotational Control



\$rostopic pub servo std_msgs/UInt16 180



\$rostopic pub servo std_msgs/UInt16 90



\$rostopic pub servo std_msgs/UInt16 0

How to operate servo motor with rostopic pub?

```
~/roscat@mrdon-desktop:11311/
File Edit View Search Terminal Help
Done checking log file disk usage. Usage is <1GB.
started roslaunch server http://mrdon-desktop:40011/
ros_core version 1.14.3

SUMMARY
-----
PARAMETERS
 * /rostopic: rostopic
 * /rosversion: 1.14.3

NODES
-----
auto-starting new master
process[roscat]: started with pid [2024]
ROS_MASTER_URI=http://mrdon-desktop:11311/

setting /run_id to 320d8aa-947b-11e9-9758-ba2780a7563
process[roscd-21]: started with pid [2033]
started core service [/roscat]
```

```
mrdon@mrdon-desktop: ~
File Edit View Search Terminal Help
mrdon@mrdon-desktop:~$ rostopic pub servo std_msgs/UInt16 180
publishing and latching message. Press ctrl-C to terminate
```

Angle = 180



Question 5

What rostopic pub command is used to operate a servo motor?