Lecture 4

2025

INFO 703
Master Advanced Mechatronics

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ROS

Robot control
Turtlesim

Course 4 : Robot control

Objectives

- Know which topics are at stake in a node
- Know what type of message is at stake and what is the source package
- Know how to use Twist, Pose, Odometry messages
- Write a publisher function
- Write a subscriber function and understand its callback

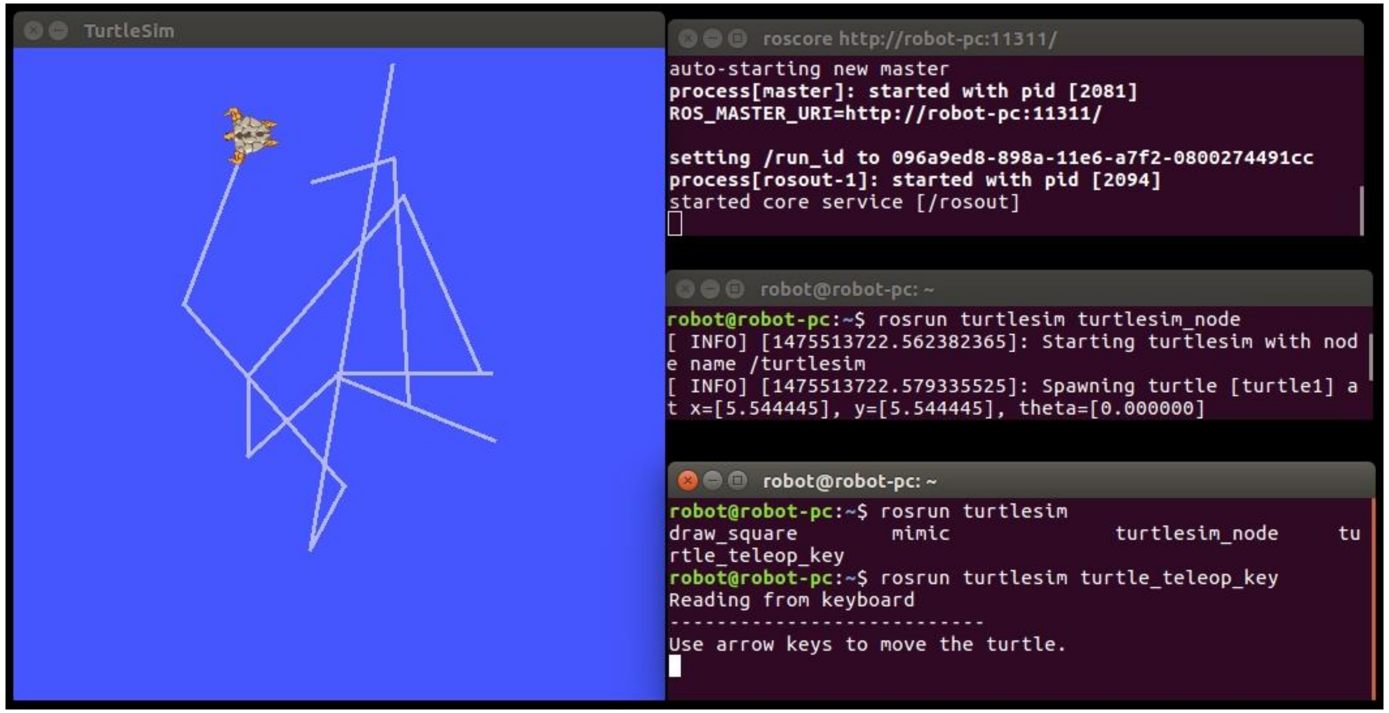
Turtlesim

Recall: Open a terminal for each command

```
> roscore
```

```
> rosrun turtlesim turtlesim_node
```

```
> rosrun turtlesim turtle_teleop_key
```



```
auto-starting new master
process[master]: started with pid [2081]
ROS_MASTER_URI=http://robot-pc:11311/

setting /run_id to 096a9ed8-898a-11e6-a7f2-0800274491cc
process[rosout-1]: started with pid [2094]
started core service [/rosout]
```

```
robot@robot-pc:~$ rosrun turtlesim turtlesim_node
[ INFO] [1475513722.562382365]: Starting turtlesim with nod
e name /turtlesim
[ INFO] [1475513722.579335525]: Spawning turtle [turtle1] a
t x=[5.544445], y=[5.544445], theta=[0.000000]
```

```
robot@robot-pc:~$ rosrun turtlesim
draw_square         mimic               turtlesim_node      tu
rtle_teleop_key
robot@robot-pc:~$ rosrun turtlesim turtle_teleop_key
Reading from keyboard
---------------------------
Use arrow keys to move the turtle.
```

Turtlesim

- Questions to answer:

Which topic is the velocity command published to?

Which topic is the position information available from?

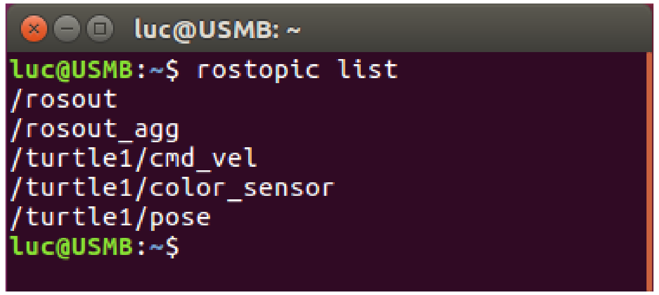
What kind of messages are used?

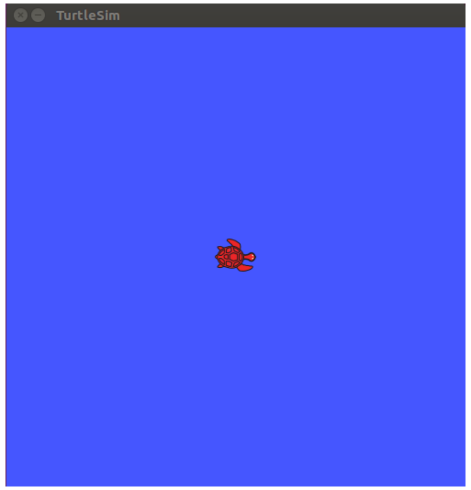
Which message packages are they from?

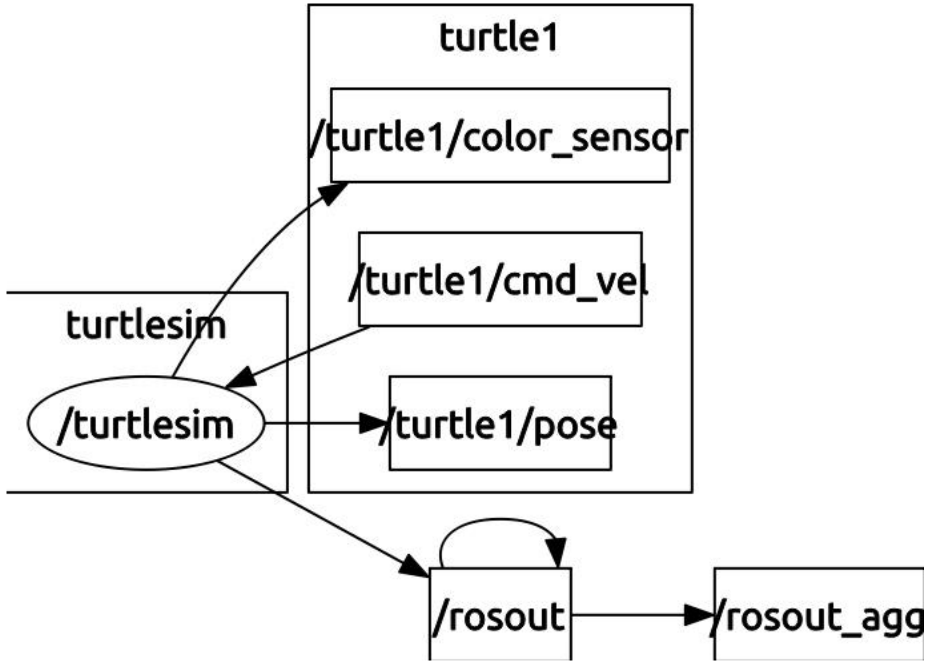
```
> rosrun turtlesim turtlesim_node
> rostopic list
> rostopic type [topic]
> rosnode info turtlesim_node
```

Visualize node and topic

```
> rqt_graph
```


```
luc@USMB:~$ rostopic list
/rosout
/rosout_agg
/turtle1/cmd_vel
/turtle1/color_sensor
/turtle1/pose
luc@USMB:~$
```





Turtlesim

Twist

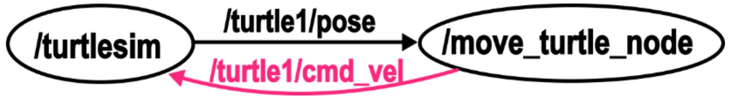
- To make a turtle move in ROS we need to publish:

  `Twist` messages to the topic *`/turtle1/cmd_vel`*

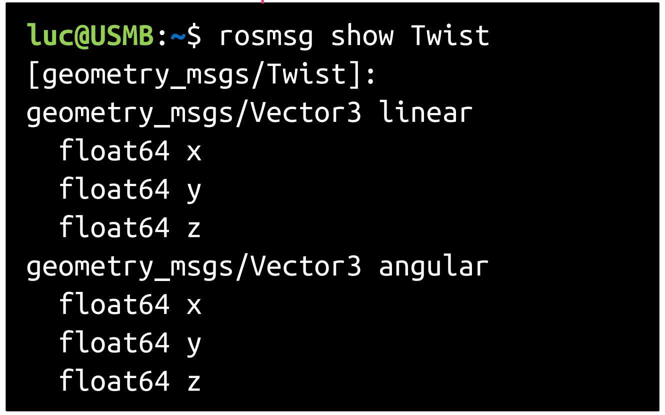
- This message has:
  - a linear component for the (x,y,z) velocities,
  - an angular component for the angular rate about the (x,y,z) axes

- Twist is part of *`geometry_msgs`* message package

  (don't forget to add *`import geometry_msgs.msg`* in your code header)



```
> rostopic type /turtle1/cmd_vel
> rosmsg show Twist
```



```
luc@USMB:~$ rosmsg show Twist
[geometry_msgs/Twist]:
geometry_msgs/Vector3 linear
  float64 x
  float64 y
  float64 z
geometry_msgs/Vector3 angular
  float64 x
  float64 y
  float64 z
```

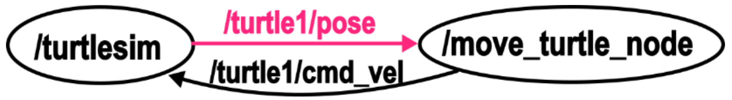
Example of use

create a *Twist* object
set the linear velocity along x
set the angular rate about z

```
vel = Twist()
vel.linear.x = 1.0
vel.angular.z = 0.4
```

Turtlesim

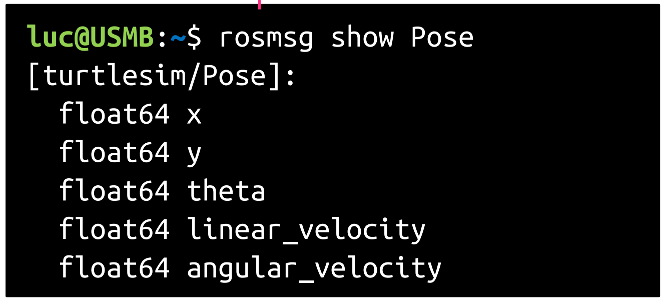
Pose



- To get a turtle position and orientation in ROS we need to subscribe:

  to the topic `/turtle1/Pose` and read `Pose` message

```
> rostopic type /turtle1/Pose
> rosmsg show Pose
```



```
luc@USMB:~$ rosmsg show Pose
[turtlesim/Pose]:
  float64 x
  float64 y
  float64 theta
  float64 linear_velocity
  float64 angular_velocity
```

- This message has:
  - a linear component for the (x,y) 2D coordinates,
  - an angular component theta about the z axes

- Pose is among others part of *`turtlesim`* message package
  (don't forget to add *`import turtlesim.msg`* in your code header)

Example of use

create a *Pose* object
get the x position of turtle
get the y position of turtle

```
pose = Pose()
robot_x = pose.x
robot_y = pose.y
```

Turtlesim

Twist / Pose

Test moving the turtle
(command from the Terminal)

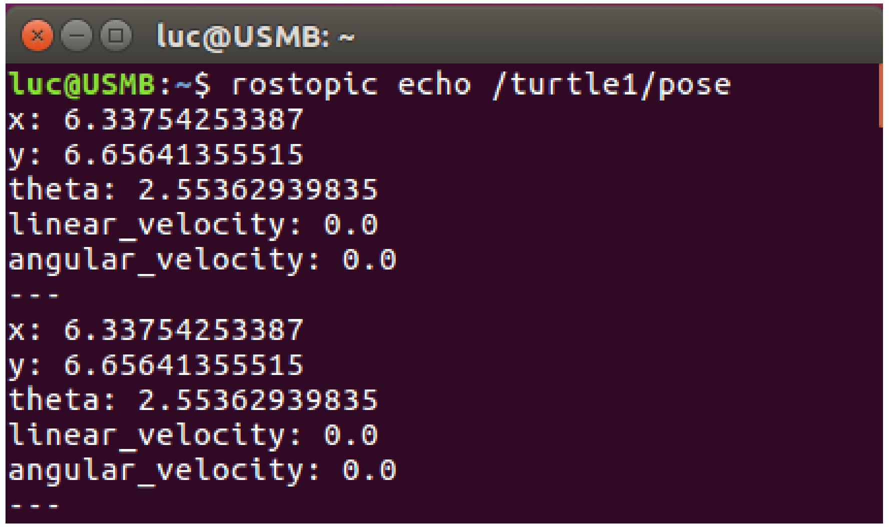
linear.x linear.y linear.z angular.x angular.y angular.z

```
> rostopic pub -1 /turtle1/cmd_vel geometry_msgs/Twist -- '[2.0, 0.0, 0.0]' '[0.0, 0.0, 1.8]'
```

topic message

Test printing out the turtle position
(command from the Terminal)

```
> rostopic echo /turtle1/pose
```



```
luc@USMB:~$ rostopic echo /turtle1/pose
x: 6.33754253387
y: 6.65641355515
theta: 2.55362939835
linear_velocity: 0.0
angular_velocity: 0.0
---
x: 6.33754253387
y: 6.65641355515
theta: 2.55362939835
linear_velocity: 0.0
angular_velocity: 0.0
---
```

move_turtle_linear_node (Python)

Writing the Node

Create package

```
> cd ~/catkin_ws/src/
> catkin_create_pkg turtlesim_tutorials rospy std_msgs
```

Edit script

```
> cd ~/catkin_ws/src/turtlesim_tutorials
> mkdir scripts
> sudo code move_turtle_linear_node.py
```

Make script executable

```
> cd ~/catkin_ws/src/turtlesim_tutorials/scripts
> sudo chmod +x move_turtle_linear_node.py
```

Make package and source environment

```
> cd ~/catkin_ws
> catkin_make
> source ~/catkin_ws/devel/setup.bash
```

move_turtle_linear_node.py

```
#! /usr/bin/env python3

import rospy
XXXXXXXXXXXX  # import Twist message

def move_turtle():
   # Initialize node
    XXXXXXXXXXXX

    # Create a publisher to "talk" to Turtlesim
    pub = XXXXXXXXXXXX

    # Create a Twist message and add linear x values
    vel = Twist()
    vel.linear.x = 1.0  # Move along the x axis only

    # Save current time and set publish rate at 10 Hz
    tStart = rospy.Time.now()
    rate = rospy.Rate(10)

    # For the next 6 seconds publish vel move commands to Turtlesim
    while rospy.Time.now() < tStart + rospy.Duration.from_sec(6):
        XXXXXXXXXXXX # publish velocity command to Turtlesim
        rate.sleep()

if __name__ == '__main__':
    move_turtle()
```

https://https://raw.githubusercontent.com/LucMarechal/USMB_INFO802_ROS_Lectures/master/turtlesim_tutorials/move_turtle_linear_node.py

move_turtle_linear_node (Python)

Writing the Node

Create package

```
> cd ~/catkin_ws/src/
> catkin_create_pkg turtlesim_tutorials rospy
```

Edit script

```
> cd ~/catkin_ws/src/turtlesim_tutorials
> mkdir scripts
> sudo code move_turtle_linear_node.py
```

Make script executable

```
> cd ~/catkin_ws/src/turtlesim_tutorials/scripts
> sudo chmod +x move_turtle_linear_node.py
```

Make package and source environment

```
> cd ~/catkin_ws
> catkin_make
> source ~/catkin_ws/devel/setup.bash
```

move_turtle_linear_node.py

```python
#! /usr/bin/env python3

import rospy
from geometry_msgs.msg import Twist  # import Twist message

def move_turtle():
    # Initialize node
    rospy.init_node('move_turtle_linear_node', anonymous=False)

    # Create a publisher to "talk" to Turtlesim
    pub = rospy.Publisher('turtle1/cmd_vel', Twist, queue_size=1)

    # Create a Twist message and add linear x values
    vel = Twist() # Creates a Twist object
    vel.linear.x = 1.0  # Move along the x axis only

    # Save current time and set publish rate at 10 Hz
    tStart = rospy.Time.now()
    rate = rospy.Rate(10)

    # For the next 6 seconds publish vel move commands to Turtlesim
    while rospy.Time.now() < tStart + rospy.Duration.from_sec(6):
        pub.publish(vel) # publish velocity command to Turtlesim
        rate.sleep()

if __name__ == '__main__':
    move_turtle()
```

https://https://raw.githubusercontent.com/LucMarechal/USMB_INFO802_ROS_Lectures/master/turtlesim_tutorials/move_turtle_linear_node.py

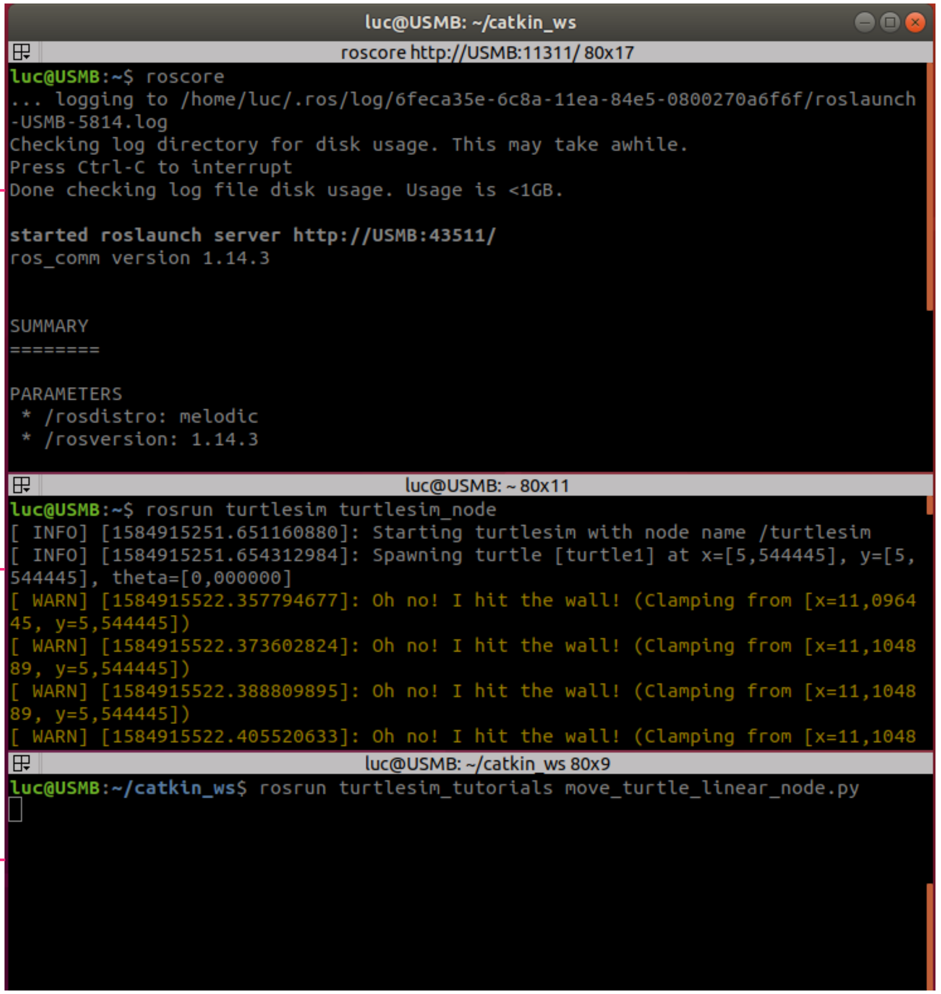
move_turtle_linear_node (Python)

Run the Node

`start roscore`

`run the turtlesim_node`

`run your node !`

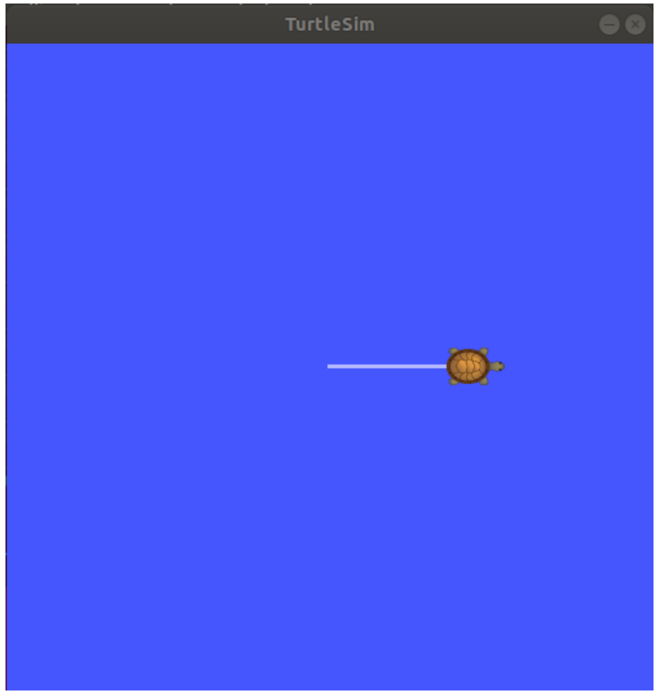


```
luc@USMB: ~/catkin_ws
roscore http://USMB:11311/ 80x17
luc@USMB:~$ roscore
... logging to /home/luc/.ros/log/6feca35e-6c8a-11ea-84e5-0800270a6f6f/roslaunch
-USMB-5814.log
Checking log directory for disk usage. This may take awhile.
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://USMB:43511/
ros_comm version 1.14.3


SUMMARY
========

PARAMETERS
 * /rosdistro: melodic
 * /rosversion: 1.14.3
```

```
luc@USMB: ~ 80x11
luc@USMB:~$ rosrun turtlesim turtlesim_node
[ INFO] [1584915251.651160880]: Starting turtlesim with node name /turtlesim
[ INFO] [1584915251.654312984]: Spawning turtle [turtle1] at x=[5,544445], y=[5,
544445], theta=[0,000000]
[ WARN] [1584915522.357794677]: Oh no! I hit the wall! (Clamping from [x=11,0964
45, y=5,544445])
[ WARN] [1584915522.373602824]: Oh no! I hit the wall! (Clamping from [x=11,1048
89, y=5,544445])
[ WARN] [1584915522.388809895]: Oh no! I hit the wall! (Clamping from [x=11,1048
89, y=5,544445])
[ WARN] [1584915522.405520633]: Oh no! I hit the wall! (Clamping from [x=11,1048
```

```
luc@USMB: ~/catkin_ws 80x9
luc@USMB:~/catkin_ws$ rosrun turtlesim_tutorials move_turtle_linear_node.py
```

move_turtle_linear_node.py



https://https://raw.githubusercontent.com/LucMarechal/USMB_INFO802_ROS_Lectures/master/turtlesim_tutorials/move_turtle_linear_node.py

move_turtle_command_node (Python)

Adding command line arguments

move_turtle_command_node.py

```python
#! /usr/bin/env python3

import rospy
from geometry_msgs.msg import Twist

# Handling command line arguments
import sys # Python sys module to get the command-line arguments
           # inside our code

def move_turtle_command(lin_vel, ang_vel):
    rospy.init_node('move_turtle_command', anonymous=False)

    pub = rospy.Publisher('/turtle1/cmd_vel', Twist, queue_size=10)
    rate = rospy.Rate(10) # 10hz

    vel = Twist()  # creates a Twist object

    while not rospy.is_shutdown():

       # Adding linear and angular velocity to the message
       vel.linear.x = lin_vel
       vel.linear.y = 0
       vel.linear.z = 0

       vel.angular.x = 0
       vel.angular.y = 0
       vel.angular.z = ang_vel
```

Display information in the Console

```python
        rospy.loginfo("Linear Vel = %f: Angular Vel =%f",lin_vel,ang_vel)

        #Publishing Twist message
        pub.publish(vel)

        rate.sleep()


if __name__ == '__main__':
    #Providing linear and angular velocity through command line
    move_turtle_command(float(sys.argv[1]),float(sys.argv[2]))
```

Run the node

```
> rosrun turtlesim_tutorials move_turtle_command_node.py 0.5 0.2
```

arguments
linear.x angular.z

https://raw.githubusercontent.com/LucMarechal/USMB_INFO802_ROS_Lectures/master/turtlesim_tutorials/move_turtle_command_node.py

move_turtle_printout_node (Python)

Adding the turtle position print out

move_turtle_printout_node.py

```python
#! /usr/bin/env python3

import rospy
XXXXXXXXXXXX  # import Twist message
XXXXXXXXXXXX  # import Pose message

import sys

# callback for topic /turtle1/Pose
def pose_callback(XXXXX):
    XXXXXXXXXX # printout in the console the pose of turtle1

def move_turtle_printout(lin_vel,ang_vel):
    rospy.init_node('move_turtle_printout', anonymous=False)

    pub = rospy.Publisher('/turtle1/cmd_vel', Twist, queue_size=10)

    # Creating new subscriber. Topic name: /turtle1/pose
    #                          Callback name: pose_callback
    XXXXXXXXXXXXXXXXXXX

    rate = rospy.Rate(10) # 10hz

    vel = Twist()
```

```python
    while not rospy.is_shutdown():
        vel.linear.x = lin_vel
        vel.linear.y = 0
        vel.linear.z = 0

        vel.angular.x = 0
        vel.angular.y = 0
        vel.angular.z = ang_vel

        rospy.loginfo("Linear Vel = %f: Angular Vel
=%f",lin_vel,ang_vel)

        pub.publish(vel)

        rate.sleep()

if __name__ == '__main__':
    # Providing linear and angular velocity through command line
    move_turtle_printout(float(sys.argv[1]),float(sys.argv[2]))
```

https://raw.githubusercontent.com/LucMarechal/USMB_INFO802_ROS_Lectures/master/turtlesim_tutorials/move_turtle_printout_node.py

move_turtle_printout_node (Python)

Adding the turtle position print out

move_turtle_printout_node.py

```python
#! /usr/bin/env python3

import rospy
from geometry_msgs.msg import Twist    # import Twist message
from turtlesim.msg import Pose         # import Pose message

import sys

# callback for topic /turtle1/Pose
def pose_callback(pose):
    rospy.loginfo("Robot X = %f : Y=%f : Z=%f\n",pose.x,pose.y,pose.theta)

def move_turtle_printout(lin_vel,ang_vel):
    rospy.init_node('move_turtle_printout', anonymous=False)

    pub = rospy.Publisher('/turtle1/cmd_vel', Twist, queue_size=10)

    # Creating new subscriber. Topic name: /turtle1/pose
    #                          Callback name: pose_callback
    rospy.Subscriber('/turtle1/pose', Pose, pose_callback)

    rate = rospy.Rate(10) # 10hz

    vel = Twist()
```

```python
    while not rospy.is_shutdown():
        vel.linear.x = lin_vel
        vel.linear.y = 0
        vel.linear.z = 0

        vel.angular.x = 0
        vel.angular.y = 0
        vel.angular.z = ang_vel

        rospy.loginfo("Linear Vel = %f: Angular Vel 
=%f",lin_vel,ang_vel)

        pub.publish(vel)

        rate.sleep()

if __name__ == '__main__':
 # Providing linear and angular velocity through command line
    move_turtle_printout(float(sys.argv[1]),float(sys.argv[2]))
```

https://raw.githubusercontent.com/LucMarechal/USMB_INFO802_ROS_Lectures/master/turtlesim_tutorials/move_turtle_printout_node.py

move_turtle_feedback_node (Python)

Adding the position feedback

move_turtle_feedback_node.py

```python
#! /usr/bin/env python3

import rospy
from geometry_msgs.msg import Twist
from turtlesim.msg import Pose

import sys

robot_x = 0

# callback for topic /turtle1/Pose
def pose_callback(pose):
    global robot_x
    rospy.loginfo("Robot X = %f\n", pose.x)
    robot_x = pose.x

def move_turtle(lin_vel,ang_vel,distance):

    global robot_x

    rospy.init_node('move_turtle', anonymous=False)
    pub = rospy.Publisher('/turtle1/cmd_vel', Twist, queue_size=10)
    rospy.Subscriber('/turtle1/pose',Pose, pose_callback)
    rate = rospy.Rate(10) # 10hz
    vel = Twist()
```

```python
    while not rospy.is_shutdown():

        vel.linear.x = lin_vel
        vel.linear.y = 0
        vel.linear.z = 0
        vel.angular.x = 0
        vel.angular.y = 0
        vel.angular.z = ang_vel

# Checking the robot distance is greater than the commanded distance
# If it is greater, stop the node
        if(robot_x >= distance):
            rospy.loginfo("Robot Reached destination")
            rospy.logwarn("Stopping robot")

            break

        pub.publish(vel)
        rate.sleep()

if __name__ == '__main__':
    #Providing linear and angular velocity through command line
    move_turtle(float(sys.argv[1]),float(sys.argv[2]),
float(sys.argv[3]))
```

https://raw.githubusercontent.com/LucMarechal/USMB_INFO802_ROS_Lectures/master/turtlesim_tutorials/move_turtle_feedback_node.py