# 03. Python principles, ROS Publisher, ROS Subscriber

## Lecture

# Python principles



- Interpreted, high-level programming language
- Name tribute to the comedy group *Monty Python*
- Powerful, still easy to learn, easy to use
- Readability
- Whitespace indentation



- Dynamically-typed
- Garbage colector and reference counting
- Object oriented programming
- Used in: AI, web applications, scientific computing, and many other areas

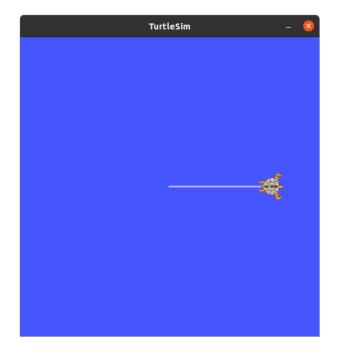
• python3

## Python syntax

```
import numpy as np
import math
class A:
  def __init__(self, name):
     self.name = name
  def do_something(self):
     # will do something
     print(self.name + " is doing something.")
  def count_to(self, n):
     # count to n, tell if the number is odd or even
     for i in range(n):
       if i % 2 == 0:
         print(i + ", it's even.")
          print(i + ", it's odd.")
if \__name\_\_ == "\__main\_\_":
  a = A("John")
  a.do_something()
  a.count_to(10)
```

# **Practice**

- 1: Move the turtle in a straight line
  - 1. Let's write a ROS node that moves the turtle forward along a straight line for a given distance. Let's open a terminal. Let's create ~/ros2\_ws/src/ros2\_course/ros2\_course the turtlesim controller.py file in our directory:



```
cd ros2_ws/src/ros2_course/ros2_course
touch turtlesim_controller.py
```

2. Add a new entry point in the setup.py file:

```
'turtlesim_controller = ros2_course.turtlesim_controller:main',
```

3. Copy the skeleton of the program into turtlesim controller.py:

```
import math
import rclpy
from rclpy.node import Node

class TurtlesimController(Node):

    def __init__(self):
        super().__init__('turtlesim_controller')

    def go_straight(self, speed, distance):
        # Implement straght motion here

def main(args=None):
    rclpy.init(args=args)
    tc = TurtlesimController()

# Destroy the node explicitly
```

```
# (optional - otherwise it will be done automatically
# when the garbage collector destroys the node object)
tc.destroy_node()
rclpy.shutdown()

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

4. Let's start a turtlesim\_node and then examine the topic, with which we can control. In two separate terminal windows:

```
ros2 run turtlesim turtlesim_node

ros2 topic list
ros2 topic info /turtle1/cmd_vel
ros2 interface show geometry_msgs/msg/Twist

Or use rqt_gui:
ros2 run rqt_gui rqt_gui
```

5. Import the message type <code>geometry\_msgs/msg/Twist</code> and create the publisher in turtlesim controller.py:

```
from geometry_msgs.msg import Twist
#...
# In the constructor:
self.twist_pub = self.create_publisher(Twist, '/turtle1/cmd_vel', 10)
```

6. We implement the <code>go\_straight</code> method. Let's calculate how long it takes, so that the turtle covers the given distance at the given speed. Publish a message with which we set the speed, then wait for the calculated time, after that send another message to reset the speed. A little help for using the API:

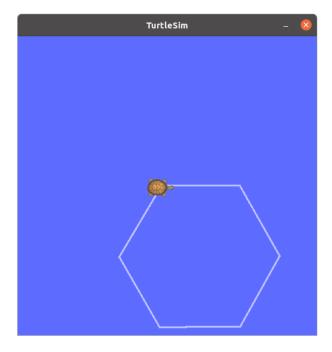
```
# Create and publish msg
vel_msg = Twist()
if distance > 0:
    vel_msg.linear.x = speed
else:
    vel_msg.linear.x = -speed
vel_msg.linear.y = 0.0
vel_msg.linear.z = 0.0
vel_msg.angular.x = 0.0
```

```
vel_msg.angular.y = 0.0
vel msg.angular.z = 0.0
# Set loop rate
loop_rate = self.create_rate(100, self.get_clock()) # Hz
# Calculate time
\# T = \dots
# Publish first msg and note time when to stop
self.twist_pub.publish(vel_msg)
# self.get_logger().info('Turtle started.')
when = \underline{self.get\_clock}().now() + rclpy.time.Duration(seconds{=}T)
# Publish msg while the calculated time is up
while (some condition...) and rclpy.ok():
  self.twist_pub.publish(vel_msg)
  # self.get logger().info('On its way...')
  rclpy.spin_once(self) # loop rate
# turtle arrived, set velocity to 0
vel_msg.linear.x = 0.0
self.twist_pub.publish(vel_msg)
# self.get logger().info('Arrived to destination.')
```

#### 7. Build and run the node:

```
cd ros2_ws
colcon build --symlink-install
ros2 run ros2_course turtlesim_controller
```

## 2: Draw shapes



1. Let's implement the method for turning with a given angle a in turtlesim\_controller.py , similar to straight motion.

```
def turn(self, omega, angle):
    # Implement rotation here
```

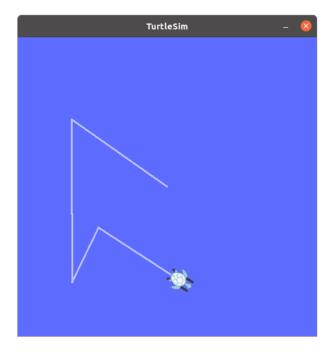
2. Let's implement the straight movement method of drawing a square with a turtle and using the methods that perform the turn.

```
def draw_square(self, speed, omega, a):
```

3. Let's implement the method of drawing any regular shape with a turtle using the methods that perform straight movement and turning.

```
def draw_poly(self, speed, omega, N, a):
```

#### 3: Go to function



1. Let's examine the topic on which turtlesim\_node publishes its current position.

```
ros2 topic list
ros2 topic info /turtle1/pose
ros2 interface show turtlesim/msg/Pose

Or use rqt_gui:
ros2 run rqt_gui rqt_gui
```

2. Let's define a subscriber for the topic and write the callback function.

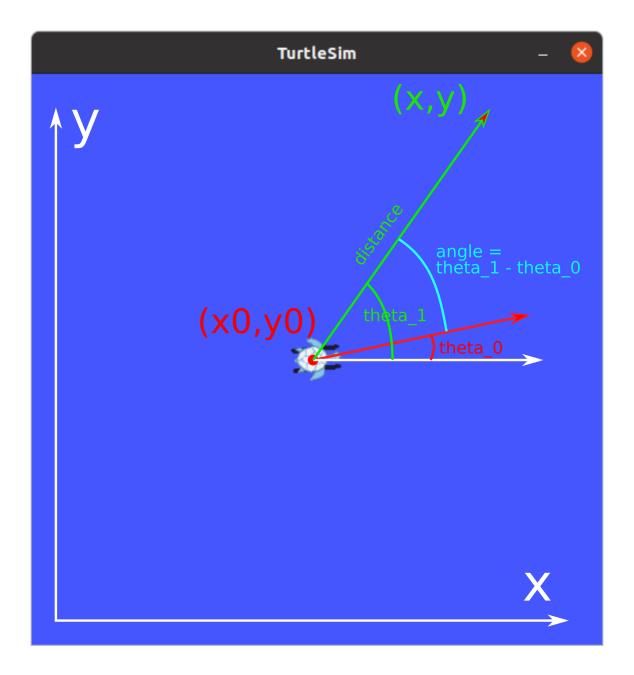
```
# Imports
from turtlesim.msg import Pose

# Constructor
self.pose = None
self.subscription = self.create_subscription(
    Pose,
    '/turtle1/pose',
    self.cb_pose,
    10)

# New method for TurtlesimController
def cb_pose(self, msg):
    self.pose = msg
```

1. We implement the go\_to method. Let's test it, call it from main.

```
# ...
# Go to method
  def go_to(self, speed, omega, x, y):
     # Wait for position to be received
     loop rate = self.create rate(100, self.get clock()) # Hz
     while self.pose is None and rclpy.ok():
       self.get_logger().info('Waiting for pose...')
       rclpy.spin\_once(\underline{self})
     # Stuff with atan2
# Main
def main(args=None):
  rclpy.init(args=args)
  tc = TurtlesimController()
  tc.go_to(1.0, 20.0, 2, 8)
  tc.go to(1.0, 20.0, 2, 2)
  tc.go_to(1.0, 20.0, 3, 4)
  tc.go_to(1.0, 20.0, 6, 2)
  # Destroy the node explicitly
  # (optional - otherwise it will be done automatically
  # when the garbage collector destroys the node object)
  tc.destroy node()
  rclpy.shutdown()
```



Extra: Advanced go to

Write a go to function that uses a proportional controller.

# Useful links

- For loops in python
- Some python functions
- Turtlesim help

• atan2