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`

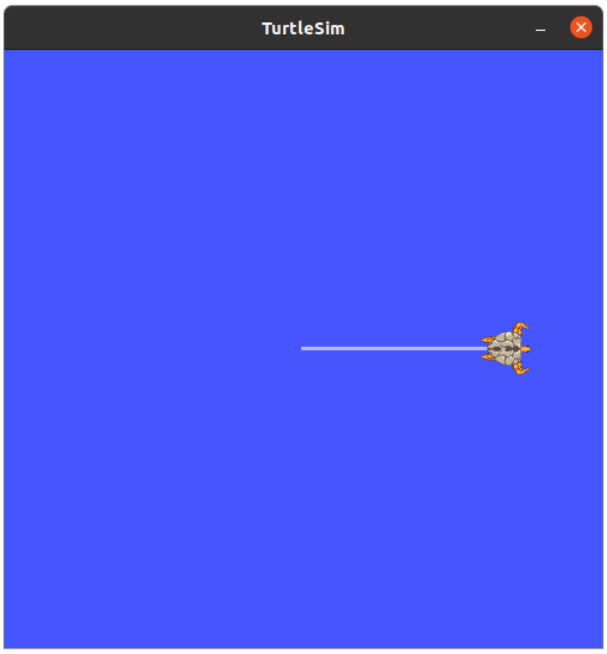
Python syntax

```python
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.")
            else:
                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 `geometry_msgs/msg/Twist` 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 `go_straight` 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:

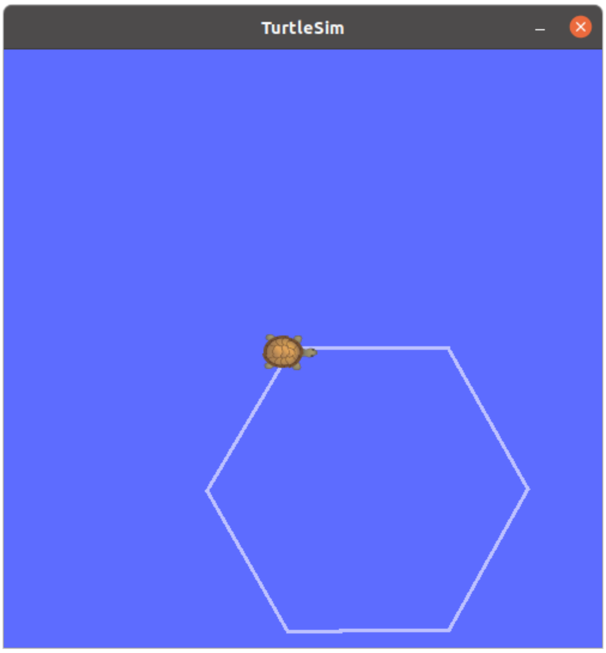
   ```
   # Create and publish msg
   vel_msg = Twist()
   if distance > 0:
       vel_msg.linear.x = speed
   else:
       vel_msg.linear.x = -speed
   vel_msg.linear.y = 0.0
   vel_msg.linear.z = 0.0
   vel_msg.angular.x = 0.0
   ```

```
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 = ...

# Publish first msg and note time when to stop
self.twist_pub.publish(vel_msg)
# self.get_logger().info('Turtle started.')
when = 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
```

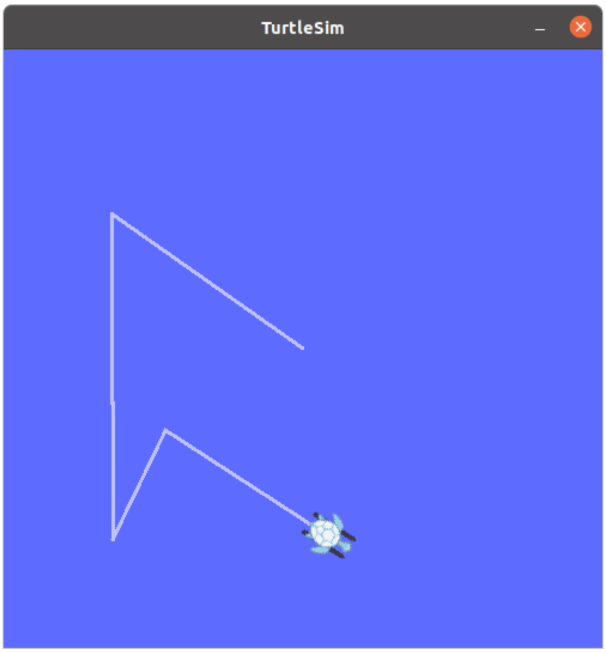
2. Let's implement the straight movement method of drawing a square with a turtle and using the methods that perform the turn.

```
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`:

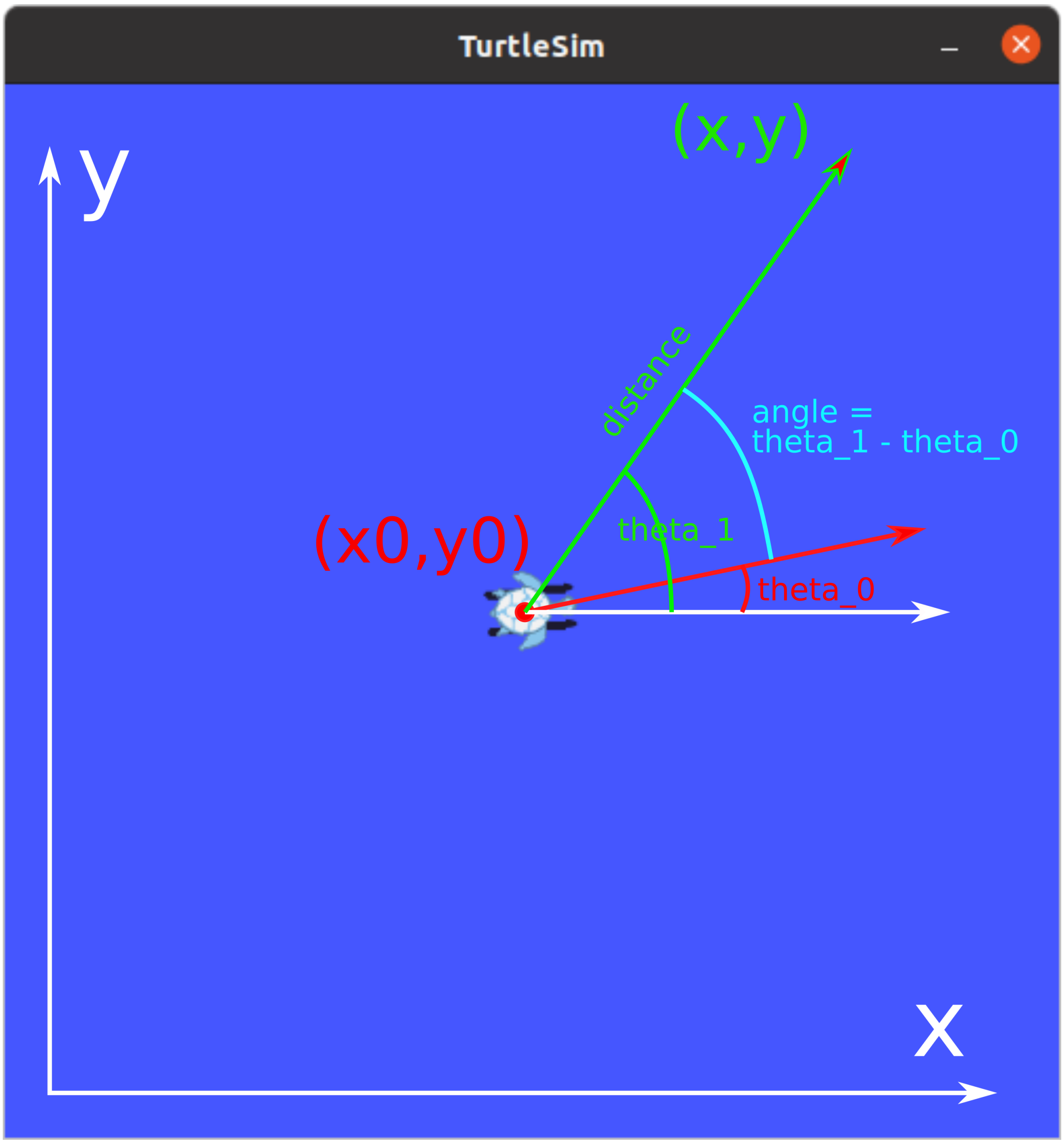
```
ros2 run rqt_gui rqt_gui
```

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
```

3. 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(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