03. Python principles, ROS Publisher, ROS Subscriber

Theory

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.")
            else:
                print(i + ", it's odd.")



if __name__ == "__main__":
    a = A("John")
    a.do_something()
    a.count_to(10)
```

Practice

1: Hello, World!

1. Navigate to the `~/catkin_ws/src/ros_course/scripts/` folder and create the file `hello.py`:

   ```
   cd catkin_ws/src/ros_course/scripts
   touch hello.py
   ```

2. Type or copy this line into the file `hello.py`:

   ```
   print("Hello, World!")
   ```

> **Tip**
>
> **In gedit:** Fix whitespace handling in gedit: Preferences -> Editor -> Insert spaces instead of tabs.

3. To run the file, `cd` to the `scripts` directory and type:

```
python3 hello.py
```

!!! tip In the case of issues with permissions, type the following to grant the file permission to execute:

```
chmod +x hello.py
```

1. Modify the script to replace the word "World" with a command line argument:

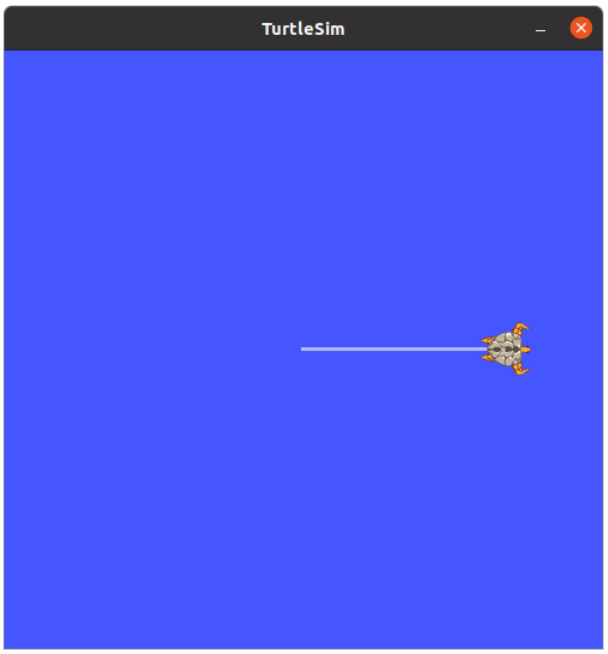
```
import sys

msg = sys.argv[1]
print("Hello," , msg, "!")
```

2. Run the file:

```
python3 hello.py John
```

2: Moving the turtle straight

1. Write a ROS node which communicates with the `turtlesim_node` and moves the turtle straight forward until it reaches the given distance. Open a terminal and create the file `turtlesim_controller.py` in the folder `~/catkin_ws/src/ros_course/scripts:




```
cd catkin_ws/src/ros_course/scripts
touch turtlesim_controller.py
```

2. Add `turtlesim_controller.py` to `CMakeLists.txt`:

```
catkin_install_python(PROGRAMS
   scripts/talker.py
   scripts/listener.py
   scripts/turtlesim_controller.py
   DESTINATION ${CATKIN_PACKAGE_BIN_DESTINATION}
)
```

3. Copy the skeleton of the program into `turtlesim_controller.py`:

```
import rospy
import math

class TurtlesimController:
   def __init__(self):
      # Call init node only once
      rospy.init_node('turtlesim_controller', anonymous=True)
      # Define publisher here



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

```
if __name__ == '__main__':
    # Init
    tc = TurtlesimController()
    # Send turtle on a straight line
    tc.go_straight(1, 4, True)
```

4. Launch a `turtlesim_node`, then find the topic we can use to control its movement. In three separate terminal windows:

```
roscore
```

```
rosrun turtlesim turtlesim_node
```

```
rostopic list
rostopic info /turtle1/cmd_vel
rosmsg show geometry_msgs/Twist
```

5. Import the message type `geometry_msgs/Twist` and create the publisher handle object for the topic named `turtlesim_controller.py`:

```
from geometry_msgs.msg import Twist

#...

self.twist_pub = rospy.Publisher('/turtle1/cmd_vel', Twist, queue_size=10)
```

6. Implement the `go_straight` method. Calculate how much time it takes for the turtle to move to the given distance with the given velocity. Publish and repeat a message to set the velocity, and when the calculated time is up, send another message to set the velocity to 0. A little help on the usage of the API:

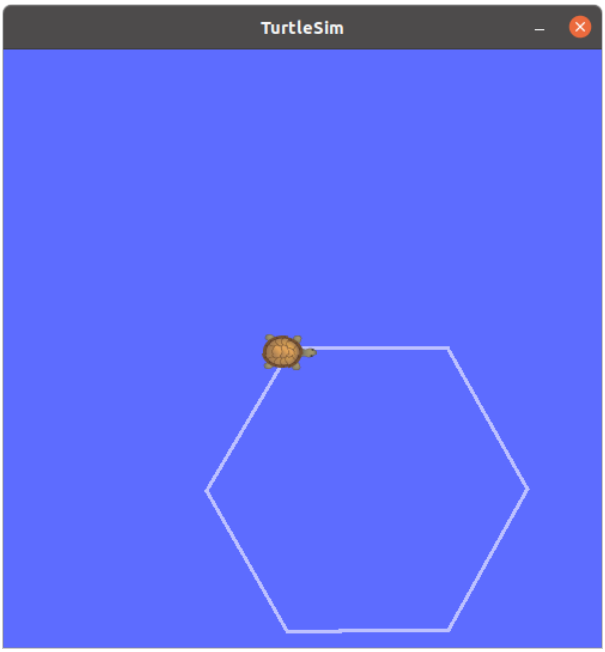
```
# Create and publish msg
vel_msg = Twist()
if forward:
    vel_msg.linear.x = speed
else:
    vel_msg.linear.x = -speed
vel_msg.linear.y = 0
vel_msg.linear.z = 0
vel_msg.angular.x = 0
vel_msg.angular.y = 0
vel_msg.angular.z = 0

# Set loop rate
rate = rospy.Rate(100) # Hz
```

```
# Publish first msg and note time
self.twist_pub.publish(vel_msg)
t0 = rospy.Time.now().to_sec()

# Publish msg while the calculated time is up
while (some condition...) and not(rospy.is_shutdown()):
    self.twist_pub.publish(vel_msg)
    # ...and stuff
    rate.sleep()    # loop rate


# Set velocity to 0
vel_msg.linear.x = 0
self.twist_pub.publish(vel_msg)
```

7. Launch the node:

```
rosrun ros_course turtlesim_controller.py
```

3: Drawing polygons



1. Implement a method to turn the turtle with a given angle in `turtlesim_controller.py` in a similar way to the straight movement. `Omega` refers to the angular velocity.

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

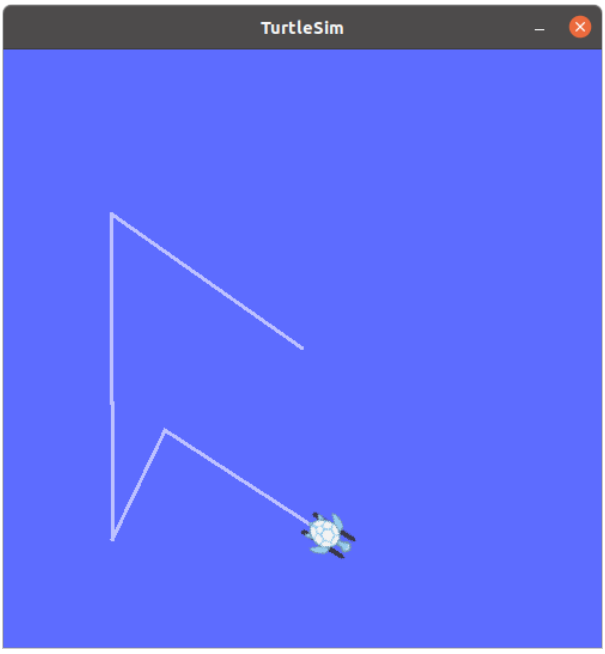
2. Implement a method that draws a square with the turtle. Use the methods `go_straight` and `turn`.

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

3. Implement a method to draw arbitrary regular polygons.

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

4: Go to method



1. Search for the topic turtlesim which publsihes the pose (position and orientation) of the turtle into:

```
rostopic list
rostopic info /turtle1/pose
rosmsg show turtlesim/Pose
```

2. Create a subscriber for the topic and write the callback function:

```
# Imports
from turtlesim.msg import Pose

    # Constructor
    self.pose_subscriber = rospy.Subscriber('/turtle1/pose', Pose, self.cb_pose)

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

3. Implement the method `go_to`. Test it by calling from the main.

```
    # ...

    # Go to method
    def go_to(self, speed, omega, x, y):
        # Stuff

    # Main
    if __name__ == '__main__':
        # Init
        tc = TurtlesimController()
        # 1 sec sleep so subscriber can get msgs
        rospy.sleep(1)
        tc.go_to(1, 2, 2, 8)
    tc.go_to(1, 2, 2, 2)
    tc.go_to(1, 2, 3, 4)
    tc.go_to(1, 2, 6, 2)
```

Bonus exercise: Advanced go to

Write a more accurate go to method using proportional controller.

Useful links

- For loops in python
- Some python functions
- Turtlesim documentation
- atan2