

# AUTONOMOUS TURTLE

## Assignment 2

F1/10 Autonomous Racing – CS 4501/SYS4582 – Spring 2019

Due Wed, 27<sup>rd</sup> February, at 2:00pm, before the lecture

Madhur Behl  
([madhur.behl@virginia.edu](mailto:madhur.behl@virginia.edu))

In this assignment, you will create an ~~self-driving self-swimming~~ autonomous turtle using the ROS turtlesim simulator.

The goal of the assignment is to understand:

- ROS nodes
- ROS topics
- ROS messages
- ROS parameters and services
- ROS launch files

And get familiar with:

- ROS workspace
- The catkin build system
- Creating your own ROS nodes.

# To get started:

- Git pull to obtain the the `autoturtle` ROS package from <https://github.com/linklab-uva/f1tenth-course-labs>
- Link the autoturtle package to the catkin workspace
  - In -s ~/github/f1tenth-course-labs/autoturtle/ ~/catkin\_ws/src/
  - Run catkin\_make in the catkin\_ws folder. Source your environment.
- The node `turtlesim_move.py` has been provided for reference.
- Make sure you are able to run the provided node successfully before attempting the remaining assignment:

`roslaunch autoturtle turtlesim_move.py`

[should move the turtle towards the x direction until it hits the wall]



## Problem 1: Turtle Swim School

[20 points]

## Problem 1a: swim\_school.py

1. Using the `turtlesim_move.py` as reference, create a new ROS node called `swim_school.py`
2. Modify the code to demo the following:

**[1a demo:]** Upon running the command `roslaunch autoturtle swim_school.py`

- User can input a linear (x) velocity
- User can input an angular (z) velocity
- The turtle then swims in a figure 8 shape, using the velocity and angular rate specified by the user.

## Problem 1b

[20 points]

### random\_swim\_school.py

1. Create a new ROS node `random_swim_school.py`

#### [1b demo:]

Upon running the command `roslaunch autoturtle random_swim_school.py`

- A random figure 8 is drawn in the ocean:
  - Turtle moves with a random linear velocity and a random angular velocity which is chosen every time the node is run.
  - The figure 8 is drawn at a random position during each run. Its fine if the figure 8 hits the tsim boundary.
- The center position (x,y) of the random figure 8 is displayed on the terminal.

[30 points]

## Problem 1c: `back_to_square_one.py`

1. Using the `turtlesim_move.py` as reference, create a new ROS node called `back_to_square_one.py`
2. Modify the code to demo the following:

**1b demo:** Upon running the command

`roslaunch autoturtle back_to_square_one.py`

- User inputs the length of the side of the square (number between 1 and 5, any number including floating points is allowed.)
- **The ocean turns red**
- A square is drawn with the length of the side of the square equal to the user input.
  - Note the square must be drawn as the turtle swims...do not use teleport absolute to draw the square.
- The bottom left corner of the square is always at  $(x,y) = (1,1)$ , theta could be anything you want.





Problem 2: Swim to goal



[30 points]

## Problem 2: `swim_to_goal.py`

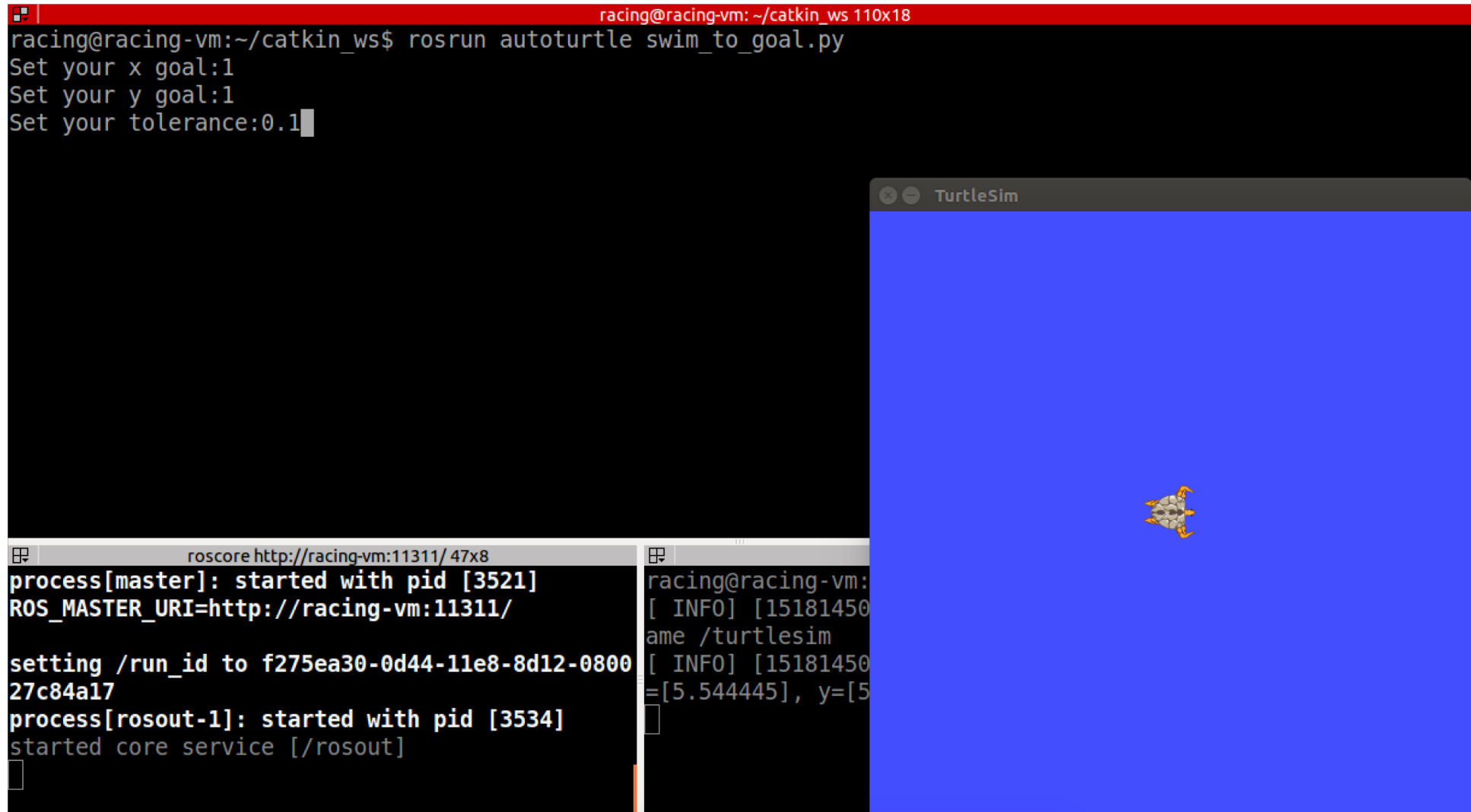
1. Create a new ROS node called `swim_to_goal.py`

### Demo the following:

- User inputs the x coordinate for the goal: (e.g. 1)
- User inputs the y coordinate for the goal: (e.g. 1)
- User inputs a 'tolerance' value (defined in subsequent slides): (e.g. 0.1)
- The turtle swims (not teleports) to the goal with a velocity and angular rate, proportional to the distance between the current position and the goal.
- Display and explain the rqt\_graph for this system

# Problem 2: What should node execution look like ?

User enters x, y, goal, and a tolerance value.



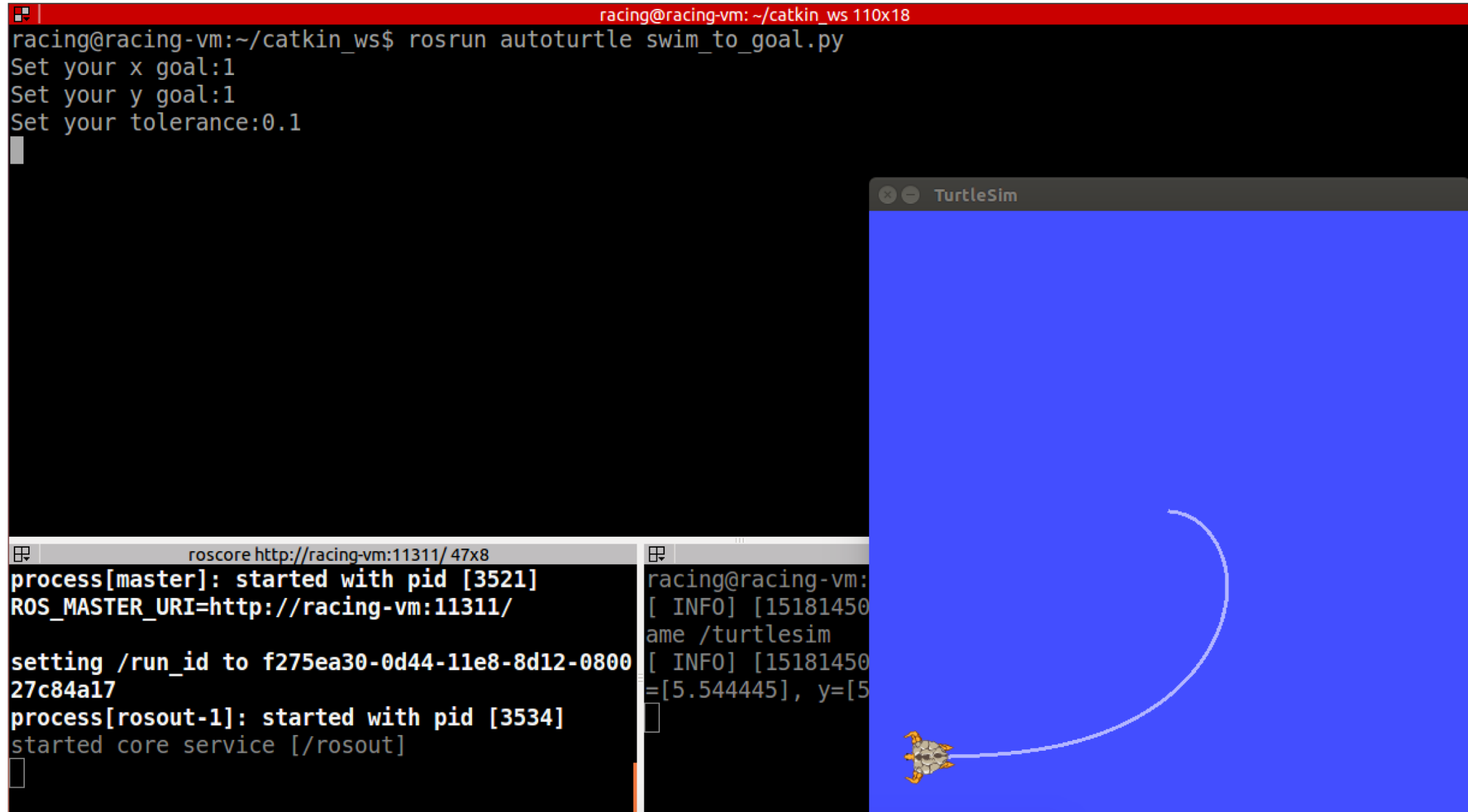
The screenshot displays a ROS environment with two main windows. The top window is a terminal titled 'racing@racing-vm: ~/catkin\_ws 110x18'. It shows the command 'roslaunch autoturtle swim\_to\_goal.py' being executed. The terminal prompts the user to 'Set your x goal:1', 'Set your y goal:1', and 'Set your tolerance:0.1'. The bottom window is a 'TurtleSim' window, which is a blue square representing a 2D environment. A small turtle icon is visible in the center of the blue area. The bottom-left corner of the screenshot shows a 'roscore' window with the following output: 'process[roscout-1]: started with pid [3534]', 'started core service [/roscout]', and 'process[roscout-1]: started with pid [3521]'. The bottom-right corner shows a terminal window with the following output: 'racing@racing-vm: [ INFO ] [15181450] name /turtlesim', '[ INFO ] [15181450] x=[5.544445], y=[5.544445]', and '[ INFO ] [15181450]'. The bottom-right corner also shows a terminal window with the following output: 'racing@racing-vm: [ INFO ] [15181450] name /turtlesim', '[ INFO ] [15181450] x=[5.544445], y=[5.544445]', and '[ INFO ] [15181450]'.

```
racing@racing-vm: ~/catkin_ws 110x18
racing@racing-vm:~/catkin_ws$ roslaunch autoturtle swim_to_goal.py
Set your x goal:1
Set your y goal:1
Set your tolerance:0.1

roscore http://racing-vm:11311/ 47x8
process[roscout-1]: started with pid [3534]
started core service [/roscout]

racing@racing-vm: [ INFO ] [15181450] name /turtlesim
[ INFO ] [15181450] x=[5.544445], y=[5.544445]
```

## Problem 2: What should the output look like ?



The screenshot displays a ROS environment with three windows. The top window is a terminal titled 'racing@racing-vm: ~/catkin\_ws 110x18'. It shows the command 'roslaunch autoturtle swim\_to\_goal.py' being executed, followed by prompts for 'Set your x goal:1', 'Set your y goal:1', and 'Set your tolerance:0.1'. The bottom-left window is a terminal titled 'roscore http://racing-vm:11311/ 47x8', showing ROS master startup logs including 'process[roscout-1]: started with pid [3534]' and 'started core service [/roscout]'. The bottom-right window is a 'TurtleSim' window with a blue background. It features a small turtle icon at the bottom left and a white curved line representing its trajectory, starting from the bottom left and curving upwards and to the right.

```
racing@racing-vm: ~/catkin_ws 110x18
racing@racing-vm:~/catkin_ws$ roslaunch autoturtle swim_to_goal.py
Set your x goal:1
Set your y goal:1
Set your tolerance:0.1

roscore http://racing-vm:11311/ 47x8
process[roscout-1]: started with pid [3534]
started core service [/roscout]

racing@racing-vm:
[ INFO] [15181450
ame /turtlesim
[ INFO] [15181450
=[5.544445], y=[5
```

## Problem 2: swim\_to\_goal.py - Hints

What does proportional velocity and angular command mean ?

### Proportional speed and turning:

Velocity  $x = 1.5 * (\text{Euclidean distance between position at any time and the goal})$

Angular  $z = 4 * (\text{atan2 (Euclidean distance between position at any time and the goal)})$

The 1.5 and 4 are constants but the velocity and angular rate will change as the turtle moves towards the goal, since the distance between the position of the turtle and the goal is always decreasing. **You should use 1.5 and 4 as the constants in your code.**

**Tolerance** is a constant which dictates how close does the turtle need to be to the (x,y) goal before it is considered that it has reached the goal.

The tolerance is needed since the pose messages that turtlesim echoes is usually a floating point value.

A good value for the tolerance is between 0.1 and 1.

A useful command in python to use for dealing with pose data is:

**round(number[, ndigits])**

Useful declarations for this problem are:

```
import rospy  
from geometry_msgs.msg import Twist  
from turtlesim.msg import Pose  
from math import pow, atan2, sqrt
```

You will demo your code in the lab, but in addition to that you need to submit all your code by the assignment deadline.

## What do I have to submit ?

- All the ROS nodes you create should be inside the `/autoturtle/scripts` directory. (The same as the `turtlesim_move.py` script).
- Compress the entire `/autoturtle` folder.
- **Rename the compressed file to `<your_computing_ID>.zip` and submit on Collab.**
  - **Only submit a single zip file.**
- Ensure, the code you are submitting does not throw any errors during a `catkin_make`.

- We will un-compress your submitted folder inside the src folder of our catkin workspace and run catkin\_make.
- We will then test your code with the following commands:
  - `roslaunch autoturtle swim_school.py`
  - `roslaunch autoturtle random_swim_school.py`
  - `roslaunch autoturtle back_to_square_one.py`
  - `roslaunch autoturtle swim_to_goal.py`



# Extra Credit >> Upto 40 points

There are 4 problems:

For each problem, you can earn 10 points for Extra Credit, if you can create and use a launch file to demonstrate that problem (i.e. you create the appropriate node, but use a launch file for each problem to launch the relevant nodes for that problem).