

INFO 802

Master Advanced Mechatronics

Luc Marechal



Lecture 2

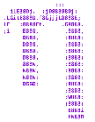
2021

ROS

**Publisher, Subscriber Node
ROS launch**

Script editor in Ubuntu

There are many options to edit script in Ubuntu :



- Nano is a Command Line editor → Not user friendly for Python coding

```
> sudo nano <filename>
```



Gedit is the official default text editor of Ubuntu → A bit basic

```
> sudo gedit <filename>
```



- **Sublime Text3** is a halfway IDE text editor with auto-completion of basic functions → Nice !

```
> sudo subl <filename>
```

IDE for ROS

There is no best IDEs, only the IDE that works best for you !

Eclipse, Net Beans, Qt Creator: popular on Ubuntu (🐱)

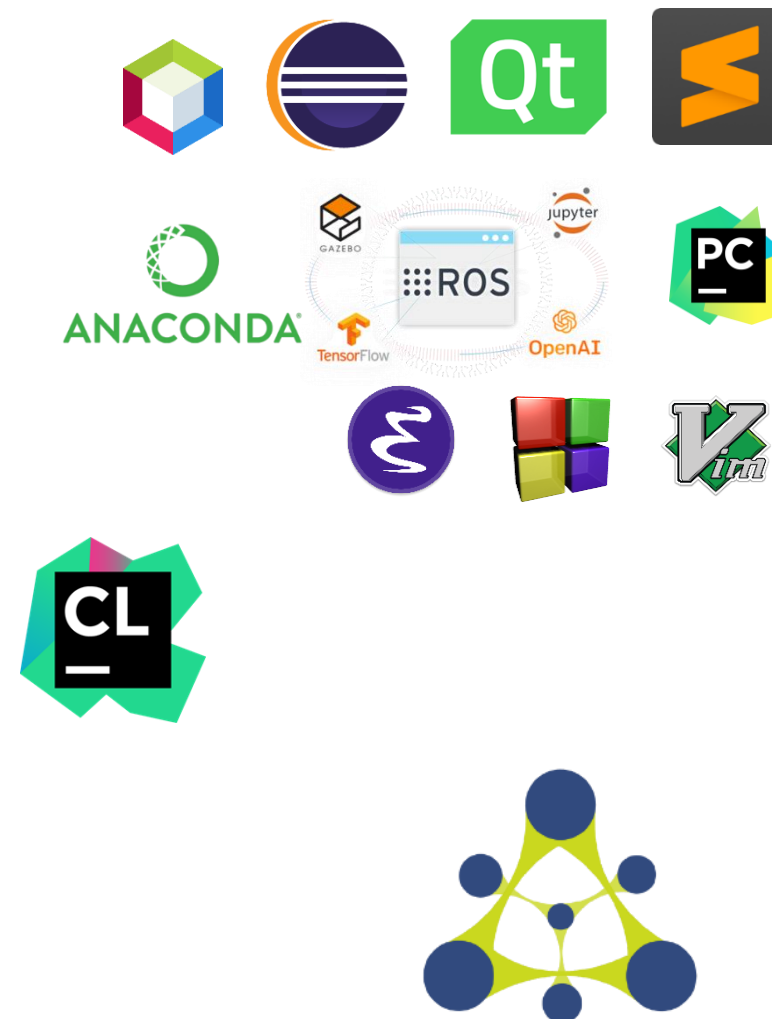
Anaconda: nice interface (🐍)

but the ROS environment has to be set up and can be tedious

ROS Development Studio: only online (🐱 🐍)

Clion: user friendly and easy to setup (🐱 🐍)

RoboWare Studio: IDE especially designed for working with ROS. The installation is quite easy, and automatically detects and loads an ROS environment without additional configurations. It has different out-of-the-box features (🐱 🐍)



Create first node *Hello World (Python)*

with rospy (Python Client Library)

```
#!/usr/bin/env python3
# -*- coding utf-8 -*-

__author__ = "Luc Marechal"
__copyright__ = "The Hello World Project copyright"
__credits__ = "myself"
__license__ = "GPL"
__version__ = "0.0.1"
__maintainer__ = "Luc Marechal"
__email__ = "luc@univ-smb.fr"
__status__ = "Development"

import rospy
rospy.init_node('hello_python')

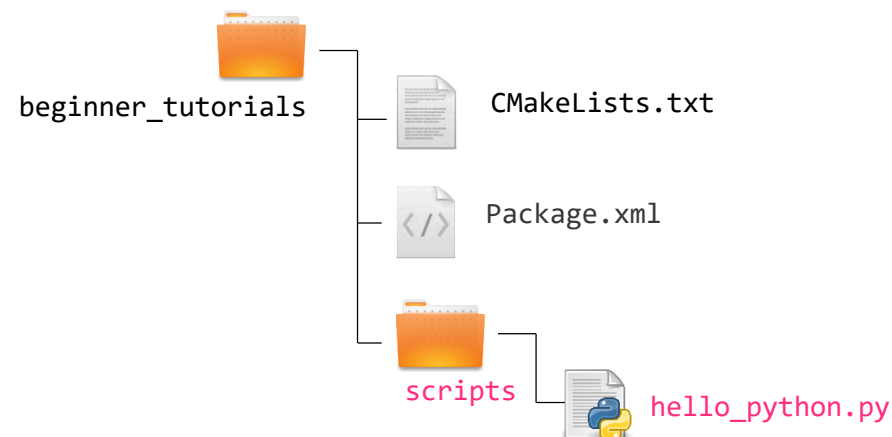
rate = rospy.Rate(10)

while not rospy.is_shutdown():
    print("Hello World")
    rate.sleep()
```

This is the *shebang*. It lets the OS know that this is a Python file, and that it should be passed to the Python interpreter

Create the node

```
> mkdir ~/catkin_ws/src/beginner_tutorials/scripts
> cd ~/catkin_ws/src/beginner_tutorials/scripts
> sudo subl hello_python.py
```



Building first node *Hello World (Python)* with rospy (Python Client Library)

Make the file executable

```
> sudo chmod +x hello_python.py
```

→ Give execution permissions to the file



Build package

```
> cd ~/catkin_ws  
> catkin_make beginner_tutorials
```

Make sure you have sourced your workspace's setup.bash file

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

Run your node

```
> rosrn beginner_tutorials hello_python.py
```

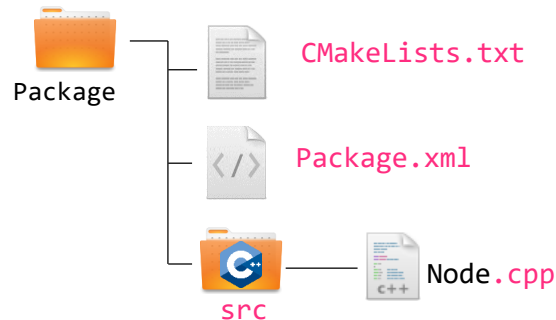
→ Extension needed

http://www2.ece.ohio-state.edu/~zhang/RoboticsClass/docs/ECE5463_ROSTutorialLecture1.pdf

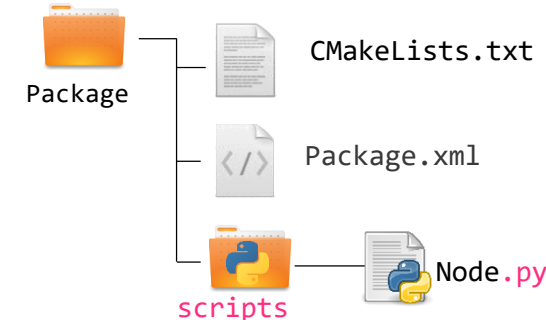
Create Nodes Summary



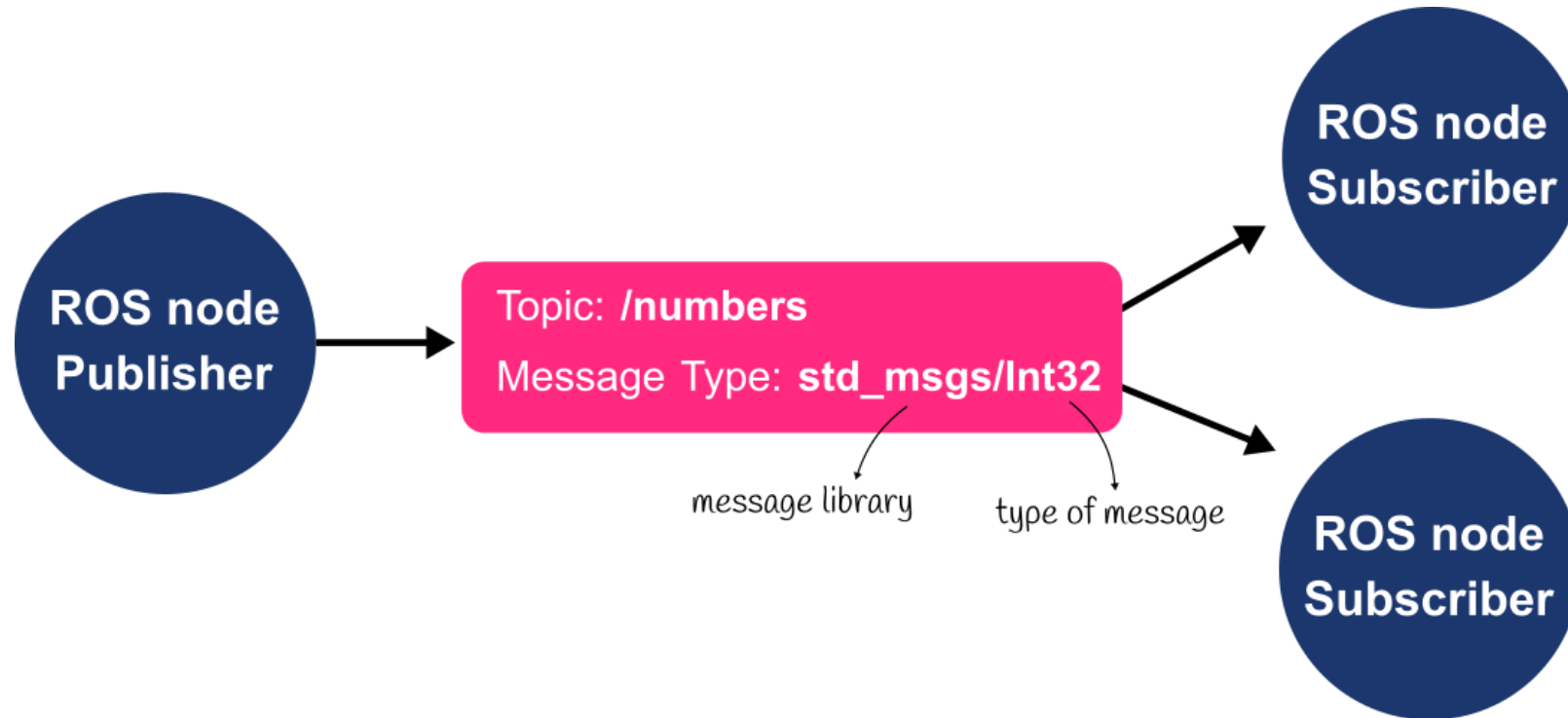
- 1) Create your `*.cpp` file in `/src` folder
- 2) Customize `CMakeLists.txt` and `package.xml` files
- 3) Build the package which contains the node
- 4) Source your workspace
- 5) Run your node



- 1) Create your `*.py` file in `/scripts` folder
- 2) Make the file executable
- 3) Source your workspace
- 4) Run your node with the `.py` extension



Creating a Publisher and a Subscriber Node (Python)



The publisher node publishes a **message** of type *Int32* on the **topic** named *numbers*

The subscriber node subscribes to the topic named *numbers* on which the message is of type *Int32*

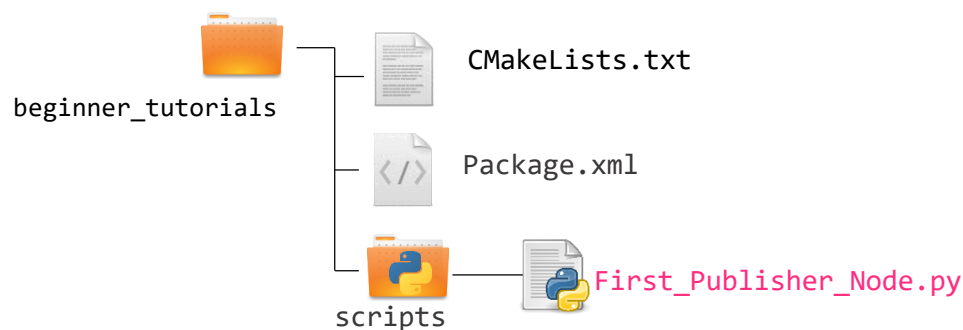
Creating a Publisher and a Subscriber Node (Python)

Writing the **publisher** Node

- This node will publish an integer value on a topic called *numbers*

Edit a .py file in scripts folder

```
> cd ~/catkin_ws/beginner_tutorials/  
> mkdir scripts  
> cd scripts  
> sudo subl First_Publisher_Node.py
```



First_Publisher_Node.py

```
#!/usr/bin/env python3
import rospy
from std_msgs.msg import Int32

def First_Publisher_Node():
    pub = rospy.Publisher('numbers', Int32, queue_size=10)

    rospy.init_node('First_Publisher_Node', anonymous=True)

    rate = rospy.Rate(10) # 10hz

    number_count=0
    while not rospy.is_shutdown():
        rospy.loginfo(number_count)
        pub.publish(number_count)
        rate.sleep()
        number_count += 1

if __name__ == '__main__':
    try:
        First_Publisher_Node()
    except rospy.ROSInterruptException:
        pass
```


Creating a Publisher and a Subscriber Node (Python)

Examining the **publisher** Node

Every Python ROS Node will have this declaration at the top.

You need to import rospy if you are writing a ROS Node.

std_msgs.msg import is so that we can reuse the std_msgs/Int32 message type

The node is publishing to the numbers topic using the message type Int32

The queue_size argument limits the amount of queued messages if any subscriber is not receiving them fast enough.

anonymous = True ensures that your node has a unique name by adding random numbers to the end of NAME.

Helper class to run loop at desired frequency (here 10 Hz)

First_Publisher_Node.py

```
#!/usr/bin/env python3
import rospy
from std_msgs.msg import Int32

def First_Publisher_Node():
    pub = rospy.Publisher('numbers', Int32, queue_size=10)
    rospy.init_node('First_Publisher_Node', anonymous=True)
    rate = rospy.Rate(10) # 10hz

    number_count=0
    while not rospy.is_shutdown():
        #rospy.loginfo(number_count)
        pub.publish(number_count)
        rate.sleep()
        number_count += 1

if __name__ == '__main__':
    try:
        First_Publisher_Node()
    except rospy.ROSInterruptException:
        pass
```

Creating a Publisher and a Subscriber Node (Python)

Examining the **publisher** Node

```
rospy.Publisher(name of the topic, message type, queue size)
```

queue size: this is the size of the outgoing message queue used for **asynchronous** publishing

More info

<http://wiki.ros.org/rospy/Overview/Publishers%20and%20Subscribers>

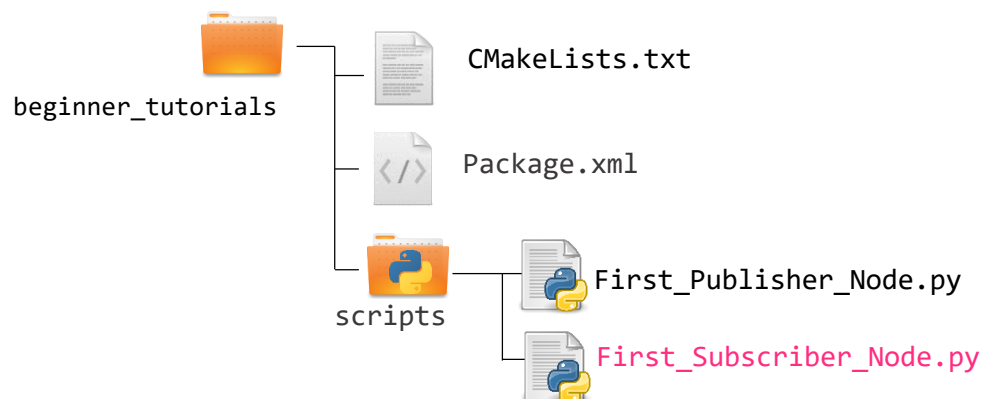
Creating a Publisher and a Subscriber Node (Python)

Writing the **subscriber** Node

- This node will subscribe to an integer value on a topic called *numbers*

Edit a .py file in scripts folder

```
> cd ~/catkin_ws/beginner_tutorials/scripts  
> sudo subl First_Subscriber_Node.py
```



First_Subscriber_Node.py

```
#!/usr/bin/env python3
import rospy
from std_msgs.msg import Int32

def callback(msg):
    rospy.loginfo("I heard %s", msg.data)

def First_Subscriber_Node():
    # In ROS, nodes are uniquely named. If two nodes with the same name are
    # launched, the previous one is kicked off. The anonymous=True flag means that
    # rospy will choose a unique name for our 'listener' node so that multiple
    # listeners can run simultaneously.

    rospy.init_node('First_Subscriber_Node', anonymous=True)

    rospy.Subscriber('numbers', Int32, callback)

    rospy.spin()

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

Creating a Publisher and a Subscriber Node (Python)

Examining the subscriber Node

First_Subscriber_Node.py

`rospy.loginfo`: logs messages to the filesystem

The `anonymous=True` flag tells rospy to generate a unique name for the node so that you can have multiple listener.py nodes run easily

When new messages are received, `callback*` is invoked with the message as the first argument.

`rospy.spin()`: simply keeps the node from exiting until the node has been shutdown

```
#!/usr/bin/env python3
import rospy
from std_msgs.msg import Int32

def callback(msg):
    rospy.loginfo("I heard %s", msg.data)

def First_Subscriber_Node():
    # In ROS, nodes are uniquely named. If two nodes with the same name are launched, the
    # previous one is kicked off. The anonymous=True flag means that rospy will choose a
    # unique name for our 'listener' node so that multiple listeners can run simultaneously.
    rospy.init_node('First_Subscriber_Node', anonymous=True)

    rospy.Subscriber('numbers', Int32, callback)

    rospy.spin()

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

*Callback = function that is passed as an argument to other function

Creating a Publisher and a Subscriber Node (Python)

Examining the **subscriber** Node

```
rospy.Subscriber(name of the topic, message_type, callback_function)
```

The callback function can be seen as a message handler
It contains the message read on the topic as its first argument.
This why in its definition the argument is the message

```
def callback_function(message):
```

Example

If the message is a `std_msgs/Int32`

```
rospy.Subscriber('my_topic', Int32, callback)
```

```
def callback(msg):  
    value_read = msg.data  
    ...
```

structure of Int32 message type

```
luc@USMB:~$ rosmmsg show Int32  
[std_msgs/Int32]:  
int32 data
```

Creating a Publisher and a Subscriber Node (Python)

Building the nodes

Make the node executable (for Python only)

```
> sudo chmod +x First_Subscriber_Node.py  
> sudo chmod +x First_Publisher_Node.py
```

Build package

(we use Cmake as the build system even for Python nodes)

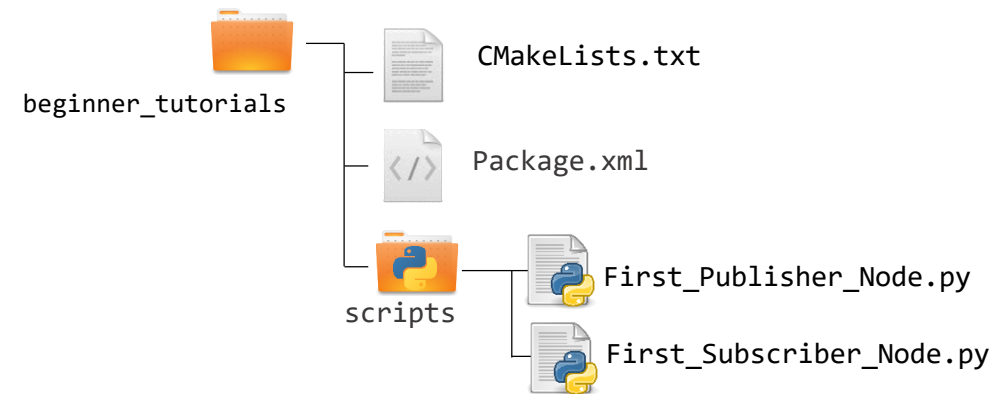
```
> cd ~/catkin_ws  
> catkin_make
```

Make sure you have sourced your workspace's setup.bash file

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

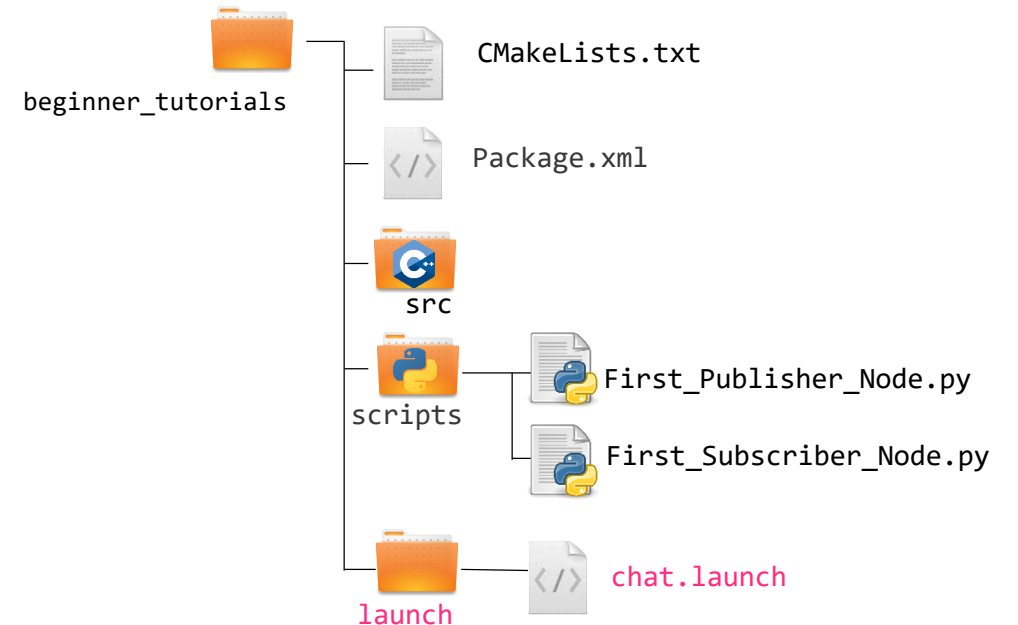
Run your nodes

```
> rosrn beginner_tutorials First_Publisher_Node.py  
> rosrn beginner_tutorials First_Subscriber_Node.py
```



ROS Launch

- *launch* is a tool for launching multiple nodes (as well as setting parameters)
- written in XML but file suffix: **.launch*
- the launch file needs to be located in a folder named “launch” inside the package folder
- If not yet running, launch automatically starts a roscore



Example

The file *chat.launch* is created in order to launch the node :
First_Publisher_Node.py and *First_Subscriber_Node.py*

More info

<http://wiki.ros.org/roslaunch>

ROS Launch

Start a launch file from a package with

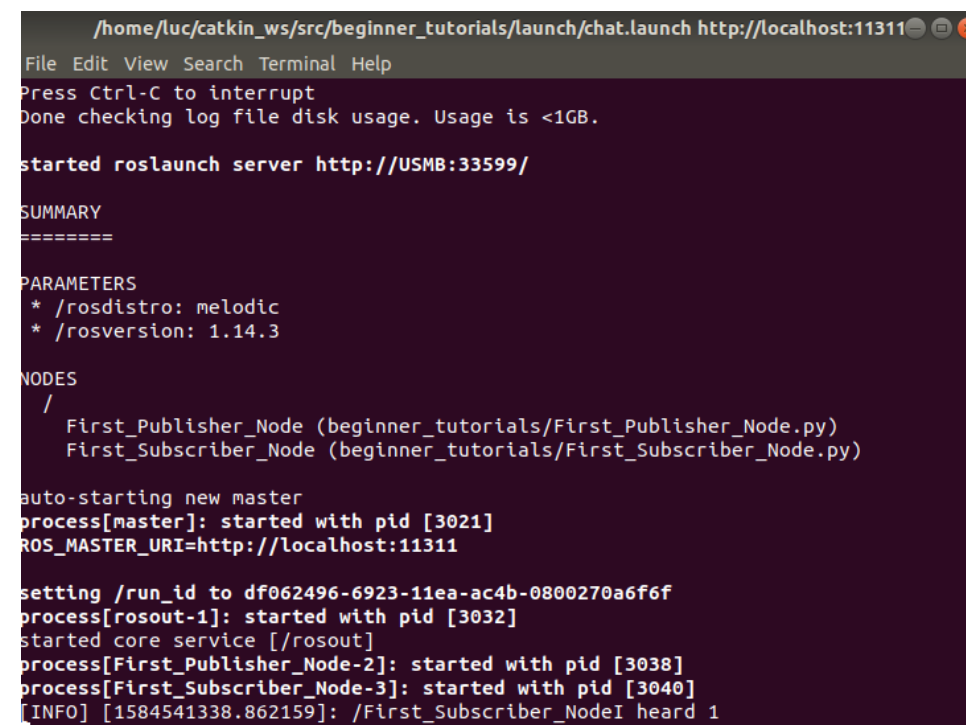
```
> roslaunch [package_name] [file_name.launch]
```

Or browse to the folder and start a launch file with

```
> roslaunch [file_name.launch]
```

Example console output for:

```
> roslaunch beginner_tutorials chat.launch
```



```
/home/luc/catkin_ws/src/beginner_tutorials/launch/chat.launch http://localhost:11311
File Edit View Search Terminal Help
Press Ctrl-C to interrupt
Done checking log file disk usage. Usage is <1GB.

started roslaunch server http://USMB:33599/

SUMMARY
=====

PARAMETERS
* /rostdistro: melodic
* /rosversion: 1.14.3

NODES
/
  First_Publisher_Node (beginner_tutorials/First_Publisher_Node.py)
  First_Subscriber_Node (beginner_tutorials/First_Subscriber_Node.py)

auto-starting new master
process[master]: started with pid [3021]
ROS_MASTER_URI=http://localhost:11311

setting /run_id to df062496-6923-11ea-ac4b-0800270a6f6f
process[rosout-1]: started with pid [3032]
started core service [/rosout]
process[First_Publisher_Node-2]: started with pid [3038]
process[First_Subscriber_Node-3]: started with pid [3040]
[INFO] [1584541338.862159]: /First_Subscriber_NodeI heard 1
```

More info

<http://wiki.ros.org/roslaunch>

ROS Launch

File Structure

chat.Launch

```
<launch>
  <node name="First_Publisher_Node" pkg="beginner_tutorials" type="First_Publisher_Node.py"/>
  <node name="First_Subscriber_Node" pkg="beginner_tutorials" type="First_Subscriber_Node.py" output="screen"/>
</launch>
```

- **launch**: root element of the Launch files. This is an XML document, and every XML document has one
- **node**: each <node> tag specifies a node to be launched
- **name**: name of the node (free to choose)
- **pkg**: package containing the node
- **type**: the executable name (if the executable is a python file, don't forget the **.py** extension)
- **output**: specifies where to output log messages (screen -> consol, log -> log file)
 output="screen" makes the ROS log messages appear on the launch terminal window

ROS Launch

Other example

Turtle.launch

turtlesim_node is NOT a python script

```
<launch>
  <node name="turtlesim_node" pkg="turtlesim" type="turtlesim_node"/>
  <node name="turtlesim_target_node" pkg="beginner_tutorials" type="turtlesim_target_node.py" output="screen"/>
</launch>
```

- **launch**: root element of the Launch files. This is an XML document, and every XML document has one
- **node**: each <node> tag specifies a node to be launched
- **name**: name of the node (free to choose)
- **pkg**: package containing the node
- **type**: the executable name (if the executable is a python file, don't forget the **.py** extension)
- **output**: specifies where to output log messages (screen -> consol, log -> log file)
 output="screen" makes the ROS log messages appear on the launch terminal window

ROS Launch

Arguments

- Create re-usable launch files with `<arg>` tag, which works like a parameter (default optional)

```
<arg name="arg_name" default="default_value"/>
```

- Use arguments in launch file with

```
$(arg arg_name)
```

- When launching, arguments can be set with

```
> roslaunch launch_file.launch arg_name:=value
```

range_world.launch (simplified)

```
<?xml version="1.0"?>
<launch>
  <arg name="use_sim_time" default="true"/>
  <arg name="world" default="gazebo_ros_range"/>
  <arg name="debug" default="false"/>
  <arg name="physics" default="ode"/>

  <group if="$(arg use_sim_time)">
    <param name="/use_sim_time" value="true" />
  </group>

  <include file="$(find gazebo_ros)
                                     /launch/empty_world.launch">
    <arg name="world_name" value="$(find gazebo_plugins)/
                                test/test_worlds/$(arg world).world"/>
    <arg name="debug" value="$(arg debug)"/>
    <arg name="physics" value="$(arg physics)"/>
  </include>
</launch>
```

ROS Launch

Including Other Launch Files

- Include other launch files with `<include>` tag to organize large projects

```
<include file="package_name"/>
```

- Find the system path to other packages with

```
$(find package_name)
```

- Pass arguments to the included file

```
<arg name="arg_name" value="value"/>
```

range_world.launch (simplified)

```
<?xml version="1.0"?>
<launch>
  <arg name="use_sim_time" default="true"/>
  <arg name="world" default="gazebo_ros_range"/>
  <arg name="debug" default="false"/>
  <arg name="physics" default="ode"/>

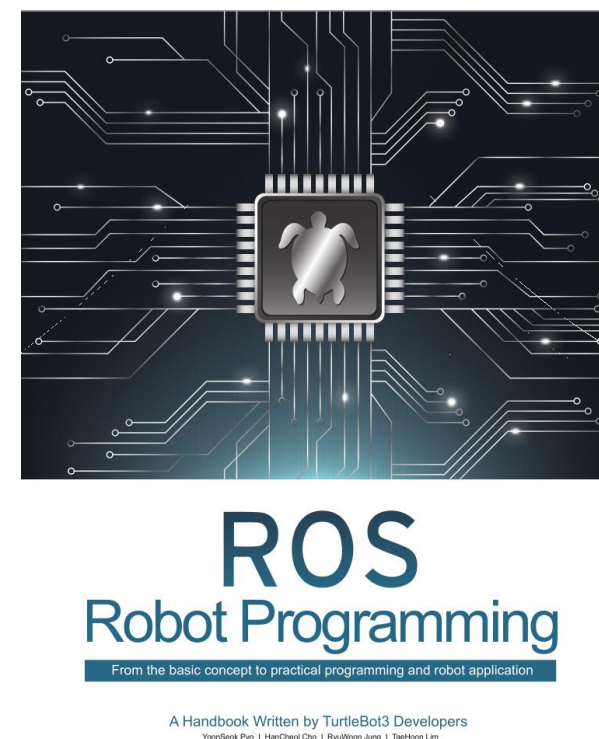
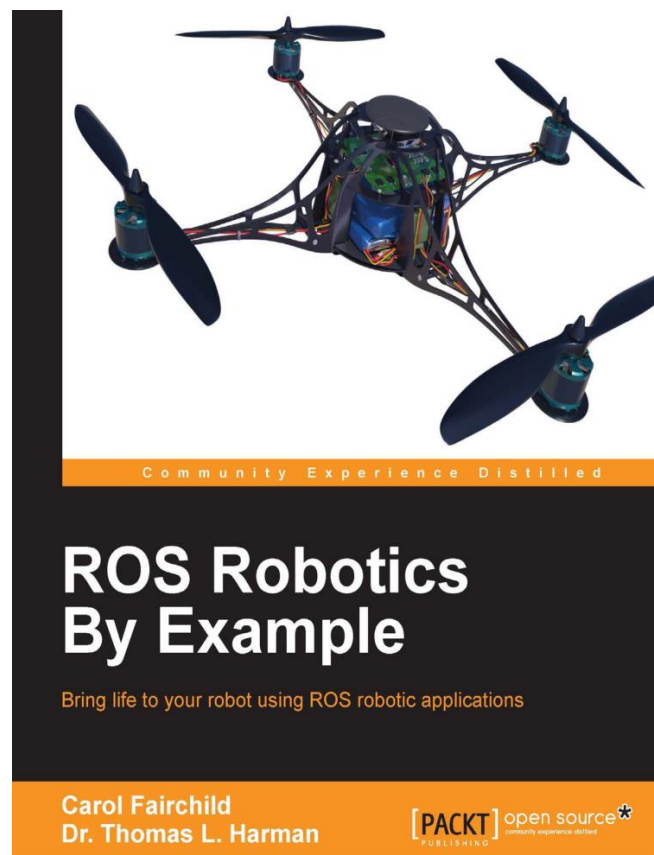
  <group if="$(arg use_sim_time)">
    <param name="/use_sim_time" value="true" />
  </group>

  <include file="$(find gazebo_ros)
                                     /launch/empty_world.launch">
    <arg name="world_name" value="$(find gazebo_plugins)/
                                   test/test_worlds/$(arg world).world"/>
    <arg name="debug" value="$(arg debug)"/>
    <arg name="physics" value="$(arg physics)"/>
  </include>
</launch>
```

Further References

- **ROS Wiki**
 - <http://wiki.ros.org/>
- **Installation**
 - <http://wiki.ros.org/ROS/Installation>
- **Tutorials**
 - <http://wiki.ros.org/ROS/Tutorials>
- **Available packages**
 - <http://www.ros.org/browse/>
- **ROS Cheat Sheet**
 - <https://www.clearpathrobotics.com/ros-robot-operating-system-cheat-sheet/>
 - https://kapeli.com/cheat_sheets/ROS.docset/
- **ROS Best Practices**
 - https://github.com/leggedrobotics/ros_best_practices/wiki
- **ROS Package Template**
 - https://github.com/leggedrobotics/ros_best_practices/tree/master/ros_package_template

Relevant books



Contact Information

Université Savoie Mont Blanc

Polytech' Annecy Chambéry
Chemin de Bellevue
74940 Annecy
France

<https://www.polytech.univ-savoie.fr>

Lecturer

Luc Marechal (luc.marechal@univ-smb.fr)
SYMME Lab (Systems and Materials for Mechatronics)



SYMME