



Hochschule
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ROS Nodes, Topics, and Messages

Foundation Course

September 4, 2019

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1. Recap

2. ROS nodes in Python

- 2.1 A simple ROS node in Python
- 2.2 Writing a publisher node in Python
- 2.3 How to use ROS messages
- 2.4 Writing a subscriber node in Python
- 2.5 General notes

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Recap

Summary of yesterday's session

- ROS is a collection of libraries and tools that helps you when you develop software for robots.
- ROS provides several ways to transfer data between nodes:
 1. ROS topics and messages (**publish/subscribe**).
 2. ROS services (**request/reply**).
 3. ROS actions (**request/reply**).
 4. Parameter server.

Recap

Summary of yesterday's session

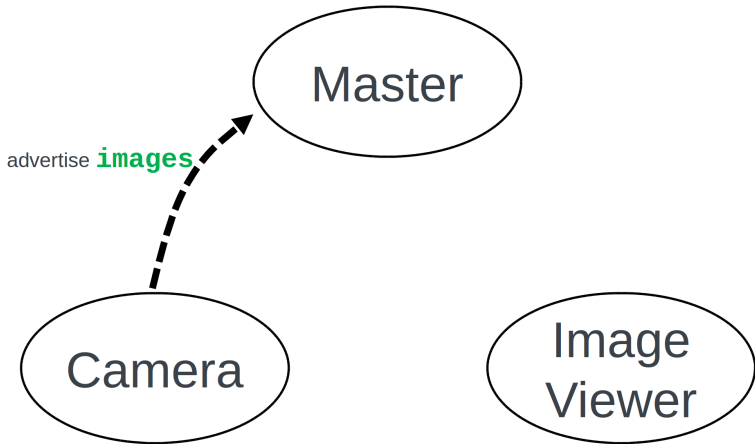
- We will focus today on ROS topics and messages..

```
graph TD; Master([Master]); Camera([Camera]); ImageViewer([Image Viewer]);
```

Master

Camera

Image
Viewer







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A simple ROS node

../scripts/00_simple_node.py

```
#!/usr/bin/env python

import rospy
from time import sleep

rospy.init_node("print_text")

while True:
    print "Hello world!"
    sleep(1)
```

A simple ROS node

../scripts/01_simple_node.py

```
#!/usr/bin/env python
```

```
import rospy
```

```
rospy.init_node("print_text")  
rate = rospy.Rate(1)
```

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

Writing a publisher node in Python

../scripts/02_simple_publisher.py

```
rospy.init_node('node name')
```

- nodes name must be unique. If you want to make sure the name of the node is unique:

```
rospy.init_node('node name', anonymous= True)
```

- node name will look like this:
/print_text_19637_1567065017476

Three ways to run a node

ROS Nodes

There are 3 ways to run a node:

1. Like you normally do (not recommended). Example (in case of python node):

```
python <file name>
```

2. using rosrun command:

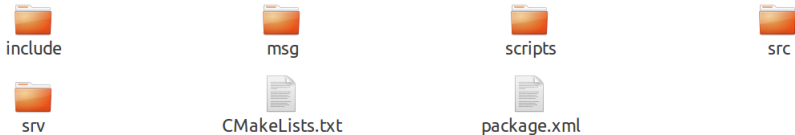
```
rosrun <package name> <node name>
```

3. Using launch files. (we'll see it later)

Let's create a package first!

ROS Nodes

- ROS commands find your files (python scripts, cpp files, launch files, message definitions) if they are located in a package inside the workspace.
- Normally, a package looks like this:



Let's create a package first!

ROS Nodes

- go to the README and do the steps for **creating a package**.

ROS commands

ROS Nodes

- Navigate to a ROS package directly:

```
roscd <package name>
```

- run a node without navigating to it's directory:

```
roslaunch <package name> <executable>
```

Let's create a package first!

ROS Nodes

- go to the README and do the steps for **running a node**.

More ROS commands

ROS Nodes, Topics, and Messages

- List all the running nodes:

```
rostopic list
```

- Get more info. about a certain node:

```
rostopic info <node name>
```

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Writing a publisher node in Python

ROS Nodes, Topics, and Messages

- Let's extend our previous node and make it publish a String ROS message.

Writing a publisher node in Python

../scripts/02_simple_publisher.py

```
#!/usr/bin/env python

import rospy

from std_msgs.msg import String

rospy.init_node('talker')

pub = rospy.Publisher('myFirstTopic', String, queue_size=10)

rate = rospy.Rate(1)

my_message = String()
my_message.data = "Hello there! How are you?"

while not rospy.is_shutdown():
    pub.publish(my_message)
    rate.sleep()
```

Writing a publisher node in Python

../scripts/02_simple_publisher.py

```
rospy.Publisher(name, data_class, queue_size)
```

- `name`: Name of the topic to publish on.
- `data_class`: The type of message. It is a ROS message class.
- `queue_size`: The size of the outgoing message queue.

Writing a publisher node in Python

../scripts/02_simple_publisher.py

```
rospy.Publisher(  
    name,  
    data_class,  
    subscriber_listener=None,  
    tcp_nodelay=False,  
    latch=False,  
    headers=None,  
    queue_size=None  
)
```


Writing a publisher node in Python

Things to note..

- ROS messages are implemented as classes.
- To publish a message you also need to define a **Publisher** class.
- Most of ROS concepts and functionalities are implemented as classes. This is why understanding OOP helps you understand ROS better.

Writing a publisher node in Python

ROS Nodes, Topics, and Messages

- Go to the README file and do the instructions of section:
some of ROS commands.

More ROS commands

ROS Nodes, Topics, and Messages

- Get the current list of topics:

```
rostopic list
```

- Print published messages:

```
rostopic echo <topic name>
```

More ROS commands

ROS Nodes, Topics, and Messages

- Publish a message from terminal:

```
rostopic pub <topic name> <msg type> <msg>
```

- Get message type of a topic:

```
rostopic type <topic name>
```

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How to use ROS messages

ROS Nodes, Topics, and Messages

- ROS messages are just classes with attributes you can fill.
- ROS messages are defined in separate files and have to be placed in a package. (will be covered today).
- The following command can be used to see the class attributes, or the description, of a ROS message:

```
rosmmsg show <package/msg>
```

How to use ROS messages

Example

```
rosmmsg show std_msgs/String
```

The output is:

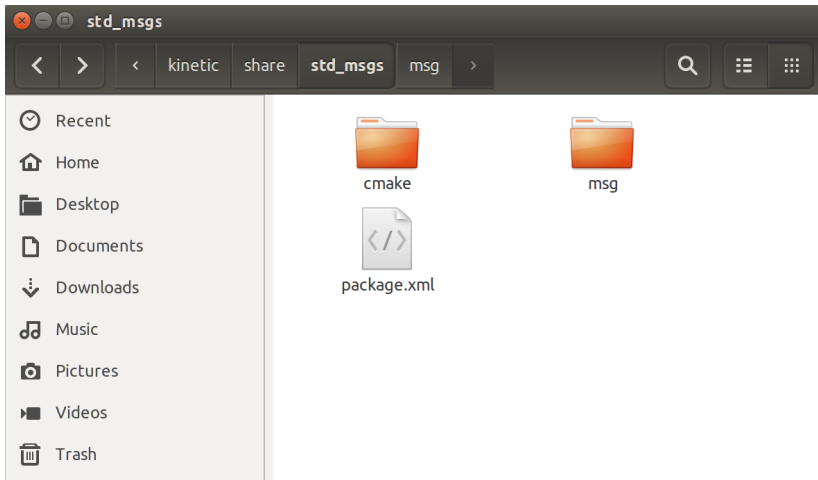
```
string data
```

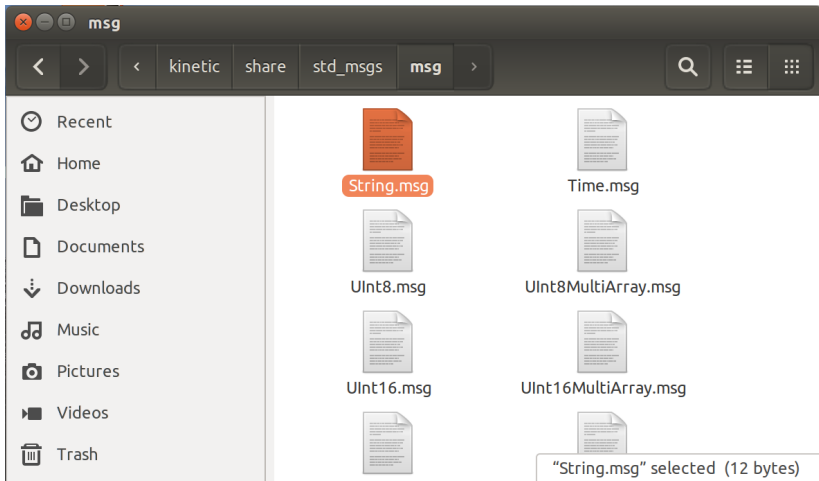
- It means ROS **String** message is a class with an attribute named **data** of type string (Python string).

How to use ROS messages

Importing a ROS message

- `String` message is located in the `std_msgs` package.





Note: this is not the file that is imported in our script though! this file is not even Python nor C++. We will see later what this file is.

How to use ROS messages

Importing a ROS message

Python

```
from std_msgs.msg import String
```

C++

```
#include "std_msgs/String.h"
```

Exercise 1

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Writing a subscriber node in Python

../scripts/03_simple_subscriber.py

```
#!/usr/bin/env python

import rospy
from std_msgs.msg import String

def my_callback_function(msg):
    print msg

rospy.init_node('listener')
rate = rospy.Rate(100)
sub = rospy.Subscriber('myFirstTopic', String,
                       callback=my_callback_function)

while not rospy.is_shutdown():
    pass
```

Writing a subscriber node in Python

../scripts/04_simple_subscriber.py

```
#!/usr/bin/env python
```

```
import rospy
from std_msgs.msg import String
```

```
def my_callback_function(msg):
    print msg
```

```
rospy.init_node('listener')
rate = rospy.Rate(100)
```

```
rospy.Subscriber('myFirstTopic', String, callback=my_callback_function)
```

```
rospy.spin()
```

Writing a subscriber node in Python

Subscriber class

- go to the README, and let's do section:
Simple subscriber

Writing a subscriber node in Python

Subscriber class

```
rospy.Subscriber(  
    name,  
    data_class,  
    callback=None,  
    callback_args=None,  
    queue_size=None,  
    buff_size=65536,  
    tcp_nodelay=False  
)
```

Writing a subscriber node in Python

Subscriber class

- go to the README, and let's do section:
Simple subscriber

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General notes

more on ROS nodes

- You can define multiple publishers and subscribers in a node.
- You can call `init_node` function once only!
- To make your code look neat, you can wrap ROS stuff in a class and hide them!

Let's see an example with multiple publishers/subscribers and let's define them in a class...

Let's see script
05_node_example.py

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Parameter Server

- A network-shared dictionary accessible to all nodes.
- All nodes can access and modify those values.
- Parameter server is a part of ROS Master.

Parameter Server

Command line tools

- The `rosparam` command can do the following:
 - Get a list of parameter names currently held by the master.

```
rosparam list
```

- Set/change the value of a parameter:

```
rosparam set <parameter name>
```

- Get/fetch the value of a parameter:

```
rosparam get <parameter name>
```

Parameter Server

rospy interface to the parameter server

- A node can fetch/retrieve a parameter as follows:

```
rospy.get_param(param_name)
```

- It can optionally define a default value in case the parameter is not set in the parameter server:

```
rospy.get_param(param_name, default=value)
```

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- In ROS, packages are compiled and built using Catkin.
- The build process is not only to compile C++ nodes, it's also used to generate source files (ex. Python and C++ files that define ROS messages as classes which you can import/include).
- Today, we will look at ROS message generation, and how to define custom ROS messages.

- Catkin is not a compiler. It is a tool that handles the compilation process from source files to executables. It invokes system's compiler (ex. g++) and handles your package dependencies.
- to do that, Catkin needs information on what to compile, where to find, etc...

A ROS package

- The `CMakeList.txt` file is what tells Catkin these things.
- `package.xml` file is where you add information about the package (author, maintainer, dependencies, etc..).



- These files are auto-generated by `catkin_create_pkg` command.

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Package Manifest

package.xml file

- Go to the package we have created earlier
(`my_first_package`) and open the `package.xml` file there.

Package Manifest

package.xml file

- It's an XML file that consists of tags you need to fill.
- It defines properties of the package which include:
 - Name of the package: `<name>`.
 - Version number: `<version>`.
 - Description: `<description>`.
 - Package maintainer: `<maintainer>`.
 - License: `<license>`.
 - Package URL: `<url>`.
 - Author of package `<author>`.

Package Manifest

package.xml file

- It also defines package dependencies:
 - Build Dependencies: `<build_depend>`.
 - Build Export Dependencies: `<build_export_depend>`.
 - Execution Dependencies: `<exec_depend>`.
 - Test Dependencies: `<test_depend>`.
 - Build Tool Dependencies: `<buildtool_depend>`. (catkin)
 - Documentation Tool Dependencies: `<doc_depend>`
 - All of the above: `<depend>`.

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CMakeLists.txt

- The second file is (`CMakeLists.txt`). This defines how to build the package, what to compile, etc..
- Go to the package we have created earlier (`my_first_package`) and open the(`CMakeLists.txt`).

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rospy reference

- rospy full documentation (all the classes, all the functions ..etc):

`http://docs.ros.org/kinetic/api/rospy/html/`