

02. Linux and ROS principles

Lecture

Linux principles



- Only OS supported by ROS
- Security
- Efficiency
- Open-source
- Community support
- User freedom
- Distributions: **Ubuntu**, Linux Mint, Debian, etc.
- Terminal usage more dominant

Suggestion

Install **Terminator** terminal emulator:

```
sudo apt update
sudo apt install terminator
```

Linux commands

See some basic commands below:

- Run as administrator with `sudo`
- Manual of command `man` , e.g. `man cp`
- Package management `apt` , e.g. `apt update` , `apt install`
- Navigation `cd`
- List directory contents `ls`
- Copy file `cp`
- Move file `mv`
- Remove file `rm`
- Make directory `mkdir`
- Remove directory `rmdir`
- Make a file executable `chmod +x <filename>`
- Safe restart: Ctrl + Alt + PrtScr + REISUB
- If not sure, just google the command

ROS principles

ROS file system



ROS package principle

Enough functionality to be useful, but not too much that the package is heavyweight and difficult to use from other software.

ROS package

- Main unit to organize software in ROS
- Buildable and redistributable unit of ROS code
- Consists of:
 - Manifest (package.xml): information about package
 - name
 - version
 - description
 - dependencies
 - etc.
 - CMakeLists.txt: *input for the CMake build system*
 - Anything else
- `roslaunch turtlesim turtlesim_node`

ROS node

- Executable part of ROS:
 - python scripts
 - compiled C++ code
- A process that performs computation
- Inter-node communication:
 - ROS topics (streams)
 - ROS parameter server
 - Remote Procedure Calls (RPC)
 - ROS services
 - ROS actions
- Meant to operate at a fine-grained scale
- Typically, a robot control system consists of many nodes, like:
 - Trajectory planning
 - Localization
 - Read sensory data
 - Process sensory data
 - Motor control
 - User interface
 - etc.

ROS build system---Catkin

- System for building software packages in ROS



ROS workspace

Catkin workspace

A folder where catkin packages are modified, built, and installed.



- Source space:
 - Source code of catkin packages
 - Space where you can extract/checkout/clone source code for the packages you want to build
- Build space
 - CMake is invoked here to build the catkin packages

- CMake and catkin keep intermediate files here
- Devel space:
 - Built target are placed here prior to being installed

Environmental setup file

- setup.bash
- generated during init process of a new workspace
- extends shell environment
- ROS can find any resources that have been installed or built to that location

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

ROS master

```
roscore
```

- Registers:
 - Nodes
 - Topics
 - Services
 - Parameters
- One per system
- `roslaunch` launches ROS master automatically

Gyakorlat



Warning!

At the end of the lesson, everybody must upload their **sources** to **Moodle** as a zip archive!

1: Turtlesim

1. Launch ROS master, `turtlesim_node` and `turtle_teleop_key` node by typing the following commands to separate terminal windows:

Tip

In **Terminator**, `Ctrl-Shift-O`, `Ctrl-Shift-E` divides the terminal window, `Ctrl-Shift-W` closes the current window.

```
roscore
roslaunch turtlesim turtlesim_node
roslaunch turtlesim turtle_teleop_key
```

To stop running

`Ctrl-C`

2. Display the running nodes and topics using this command, in a separate terminal:

```
roslaunch rqt_graph rqt_graph
```

3. Try the following commands to gain more information about the currently running system:

```
roswtf
rospack list
rospack find turtlesim
roslaunch turtlesim turtlesim_node
roslaunch turtlesim turtle_teleop_key
rostopic list
rostopic info /turtle1/cmd_vel
rostopic echo /turtle1/cmd_vel
```

4. Type (or copy) the following command to the terminal:


```
rostopic pub /turtle1/cmd_vel geometry_msgs/Twist -r 1 -- '[2.0, 0.0, 0.0]' '[0.0, 0.0, 1.8]'
```

2: Catkin workspace

1. Install the catkin build tools package:

```
sudo apt update  
sudo apt-get install python3-catkin-tools python3-osrf-pycommon
```

2. Copy the following file to the end of file `~/.bashrc` :

```
source /opt/ros/noetic/setup.bash # replace noetic by whatever your ROS distribution  
is
```

3. Create the workspace:

```
source /opt/ros/noetic/setup.bash  
mkdir -p ~/catkin_ws/src  
cd ~/catkin_ws  
catkin init
```

3: Create a new ROS package

1. Create a new ROS package named `ros_course` , depends packages `std_msgs` ,
`rospy` and `roscpp` :

```
cd ~/catkin_ws/src  
catkin create pkg ros_course --catkin-deps std_msgs rospy roscpp
```

Syntax

```
catkin create pkg <PKG_NAME> --catkin-deps <DEP_1> <DEP_2>
```

2. Open the file `package.xml` and fill the following tags:

```
<description>The beginner_tutorials package</description>

<maintainer email="you@yourdomain.tld">Your Name</maintainer>
```

3. Build the workspace:

```
cd ~/catkin_ws
catkin build
```

Danger

The commands `catkin build` and `catkin make` are not meant to be used within the same workspace!

4. Append the following line to the file `~/bashrc` :

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

4: Implement a Publisher in Python

1. Create folder named `scripts` in the `ros_course` package:

```
cd ~/catkin_ws/src/ros_course
mkdir scripts
cd scripts
```

2. Navigate to the `scripts` folder and create the file `talker.py` , fill it with the following content:

```
import rospy
from std_msgs.msg import String

def talker():
    rospy.init_node('talker', anonymous=True)
    pub = rospy.Publisher('chatter', String, queue_size=10)

    rate = rospy.Rate(10) # 10hz

    while not rospy.is_shutdown():
        hello_str = "hello world %s" % rospy.get_time()
```

```

    print(hello_str)
    pub.publish(hello_str)
    rate.sleep()

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

```

3. Open `CMakeLists.txt` and find the commented out line starting with `catkin_install_python` (it is near line 167). Uncomment and edit as the following:

```

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

```

4. Build the node:

```

cd ~/catkin_ws
catkin build

```

5. Start ROS master and run the node. In separate terminal windows:

```
roscore
```

```
roslaunch ros_course talker.py
```

6. Check the output of the node, in a separate terminal:

```
rostopic echo chatter
```

5: Implement a Subscriber in Python

1. Navigate to the `scripts` folder and create the file `listener.py`:

```

import rospy
from std_msgs.msg import String

def callback(data):

```

```

print(rospy.get_caller_id() + "I heard " + data.data)

def listener():

    # 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('listener', anonymous=True)

    rospy.Subscriber("chatter", String, callback)

    # spin() simply keeps python from exiting until this node is stopped
    rospy.spin()

if __name__ == '__main__':
    listener()

```

2. Modify CMakeLists.txt :

```

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

```

3. Build the workspace:

```

cd ~/catkin_ws
catkin build

```

4. Start ROS master and run the 2 nodes. In separate terminal windows:

```
roscore
```

```
roslaunch ros_course talker.py
```

```
roslaunch ros_course listener.py
```

5. Check the nodes and topic of the system:

```
roslaunch rqt_graph rqt_graph
```

Warning!

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Links

- [ROS Tutorials](#)
- [Curiosity rover simulation](#)