ROS

ROBOTICS CLUB

SCIENCE AND TECHNOLOGY COUNCIL
IIT KANPUR

Contents

- What is ROS?
- Why ROS?
- Some applications
- ROS from the Terminal
- Launch files

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What is ROS?

ROS is an open-source, meta-operating system for your robot. It is a medium of communication between the hardware and software of the robot.

Why ROS?

- ROS is an open source environment, it has brought all of robotics under one roof.
- It saves us the trouble of writing standard pieces of code like path planning and localization algorithms as it makes them available in user-editable packages.
- It makes working with sensors, their data and its integration much simpler through messages and topics.

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Why ROS?

- Standard ROS programmable robots are available with working simulations.
  For example, Turtlebot 3, Pioneer 3dx.
- It provides us with robust simulation environment called Gazebo and many other functionalities like Rviz, some of which we will discuss later.

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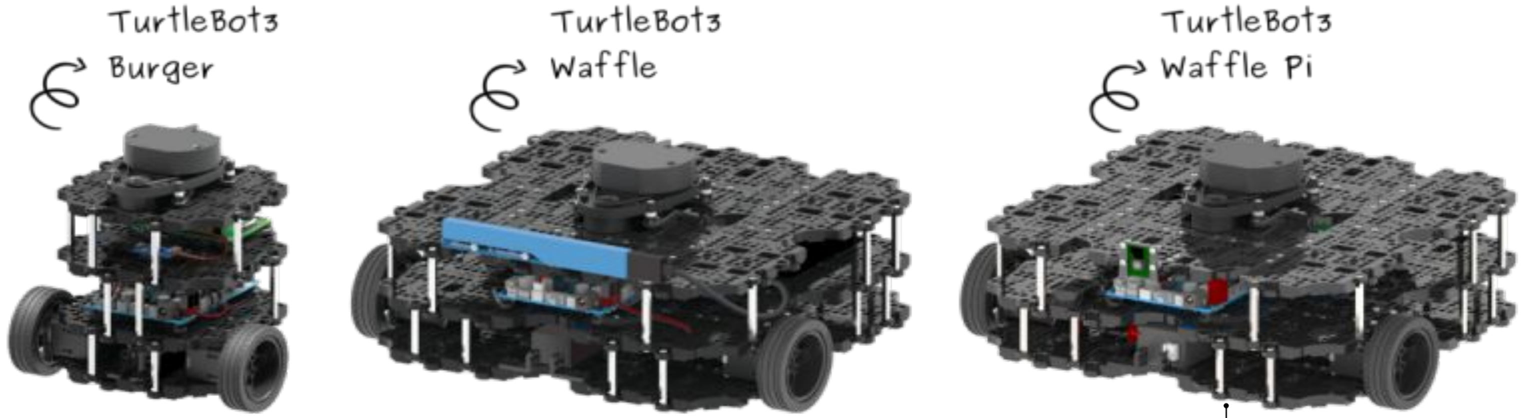
Turtlebot

TURTLEBOT3



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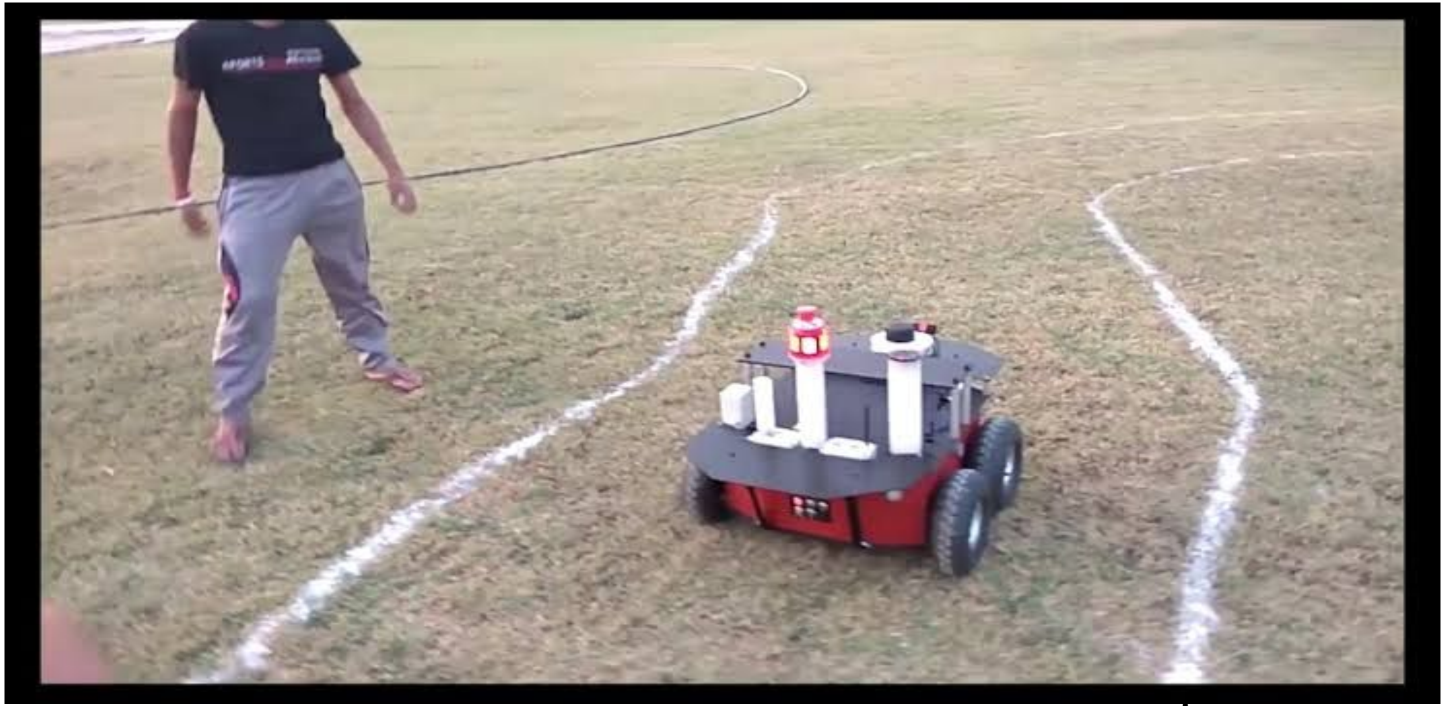
Pioneer 3dx (Team IGVC)



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Gazebo

Gazebo is simulation environment that works hand in hand with ROS.

- It allows to import custom CAD models.
- It allows to define the physics and dynamics of our environment.
- It allows us to test our code on a real world like environment.

Turtlebot modeled in Gazebo

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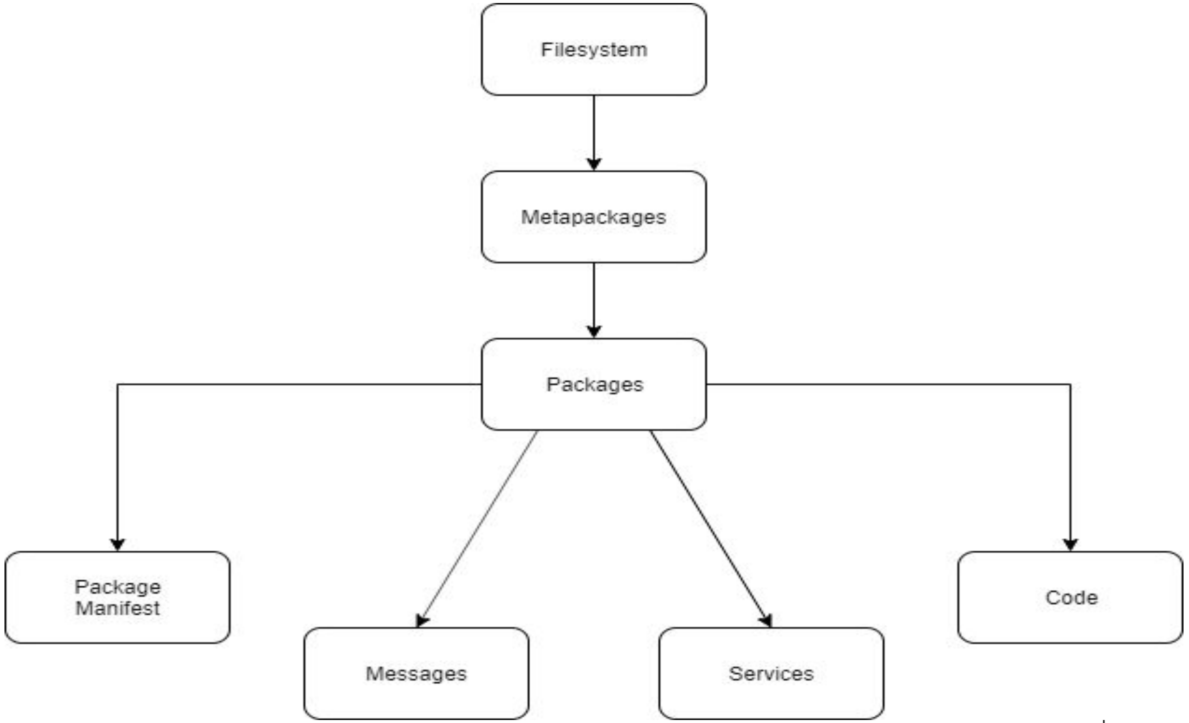
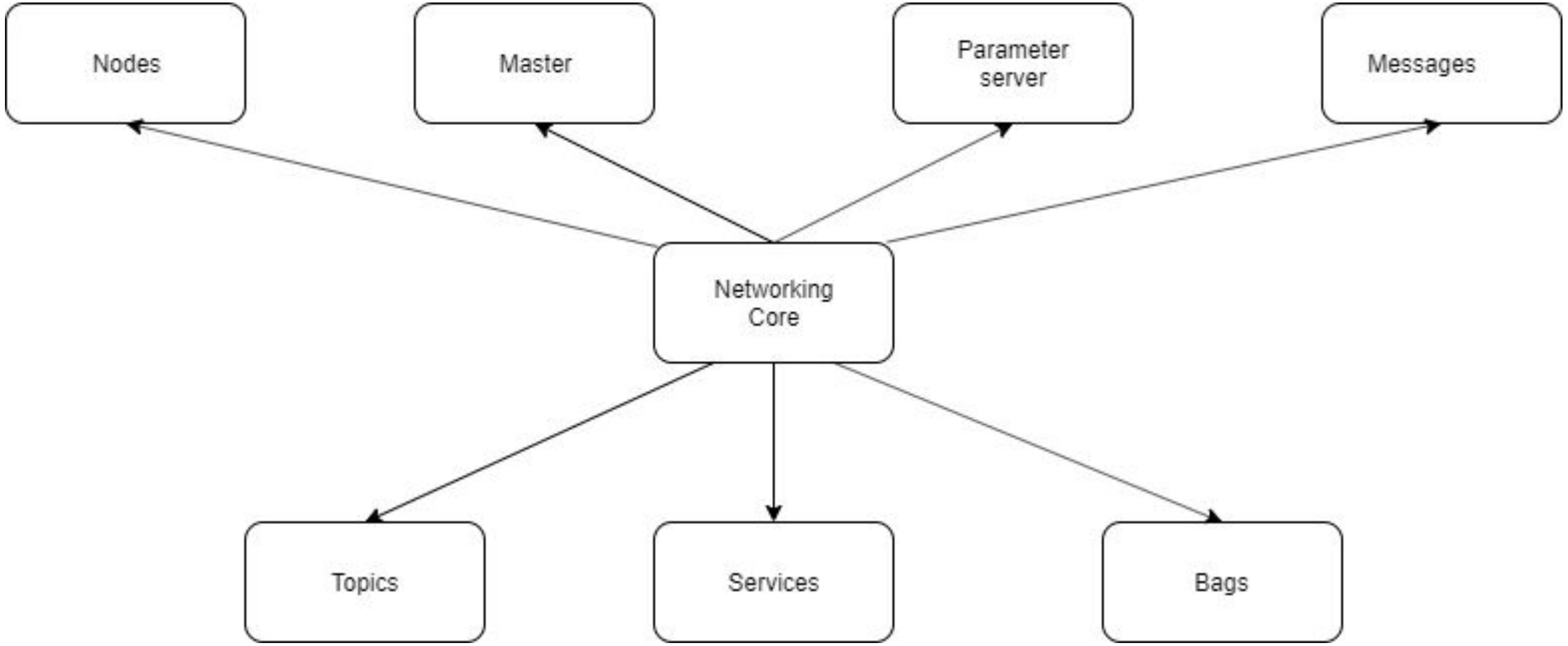
Understanding the ROS filesystem



Understanding the ROS Network



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Understanding the ROS Network

- Nodes are processes where computations happen, many nodes connected to the ROS network can interact with each other.
- Master sets up communication between nodes, messages and services. It registers the names of for components of our system.
- Parameter server stores our parameters.
- Messages are used by nodes to communicate with each other.

Understanding the ROS Network

- Topics : Messages are routed to the ROS network and hence other nodes on particular topics.
- Services are used to request or get an answer from a node.
- Bags are a format to save and play back ROS message data.

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Catkin

- Catkin is a build system used with ROS
- Build system - Automatically creates executables from your code
- Runs using g++, Python and CMake - more on this later
- Needs properly structured workspaces to function

Catkin Workspaces

Every catkin workspace has five main folders:

- **build** - this is where catkin works to make the executables
- **devel** - everything needed to develop the executable is kept here
- **src** - all the source code goes here - this is where you will work
- **logs** - to store error logs
- **install** - for testing the built executables - (out of scope for us)

Never edit any files in the build and devel folders.

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Creating Catkin Workspaces

- Can convert any directory to a catkin workspace by:

```
catkin init
```

- Provided there is an src subfolder - rest directories automatically made
- To check the status of a catkin workspace, use:

```
catkin config
```

- To build a ROS package using catkin,

```
catkin build [package_name]
```

- To clean your workspace i.e delete build and devel use

```
catkin clean
```

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Git - A Brief Introduction

- git is a version control system
- It allows you to keep track of each version of your code.
- GitHub is a website that maintains your code using git
- GitHub is the hub of open-source development
- ROS is also open-source - so you can find a lot of ROS packages on GitHub
- Downloading a Git repository is termed cloning

Install git: sudo apt-get install git
To clone a repository: git clone [repository_url]

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Bash Cheatsheet

- cd [DIR_PATH]
- ls [DIR_PATH]
- mkdir [DIR_NAME]
- touch [FILE_NAME]
- pwd
- ~
- ..
- .
- /

- export [VAR_NAME]=[VALUE]
- source [SCRIPT_NAME]
- rm [FILE_PATH]
- rmdir [DIR_PATH]
- mv [SRC_PATH] [DST_PATH]
- cp [SRC_PATH] [DST_PATH]

Time for a tutorial!

- First let's create a catkin workspace in the home directory(~)

```
mkdir -p ~/tutorial_ws/src
cd ~/tutorial_ws
catkin init
```

- Now, let's clone a repository **into the src folder**

```
cd ~/tutorial_ws/src
git clone https://github.com/ashwin2802/ROS-WC19
```

- Next let's build the package

```
catkin build turtlesim
```

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Few Things to note

- catkin will automatically search for the package in all subdirectories of the src folder
  - We had turtlesim at src/ROS-WC19/turtlesim

- You cannot have two packages of the same name.
  - catkin searches by package name, this will confuse it

- You can execute catkin build from any subdirectory of the workspace
  - As long as the package you want to build is inside the src folder

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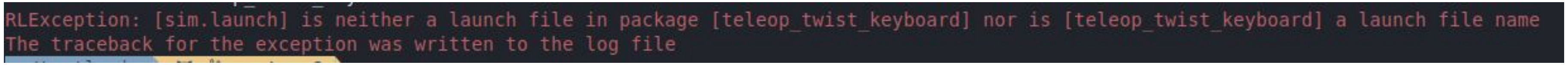
A Very Important Command

source [WS_PATH]/devel/setup.bash

- Basically tells the system about the executables you just built
- If you miss this, you will get errors like these:



```
RLException: [sim.launch] is neither a launch file in package [teleop_twist_keyboard] nor is [teleop_twist_keyboard] a launch file name
The traceback for the exception was written to the log file
```

- Has to be done every time you open a new terminal
- **Hax:** Put the command in your **~/.bashrc** file
  - All commands in the ~/.bashrc file are run when a new terminal is created

Tutorial 1

In three separate terminals:

Starts up ROS

```
roscore
```

```
rosrun turtlesim turtlesim_node
```

```
rosrun turtlesim turtle_teleop_key
```

Starts up ROS nodes

General Syntax: ros[cmd] [package_name] [file_name]

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ROS Terminal Commands

- rosnode: list, info, kill, ping
- rostopic: list, info, type, find, echo, pub, hz
- rosservice: list, info, type, find, call
- rosparam: list, get, set
- rosmsg: show
- rossrv: show

When in doubt, press TAB

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Some more ROS commands

Here's a cheat sheet for important commands you will regularly use.

- roscd : used for switching between various ROS package directories.
- rospack find [package_name] : gives exact path to a ROS package.
- rosls : allows you to ls directly in a ROS package.
- rosed : allows you to edit any file in any ROS package.
- roscore : starts up ros
- rosrun : to run a node.

Don't forget to press TAB

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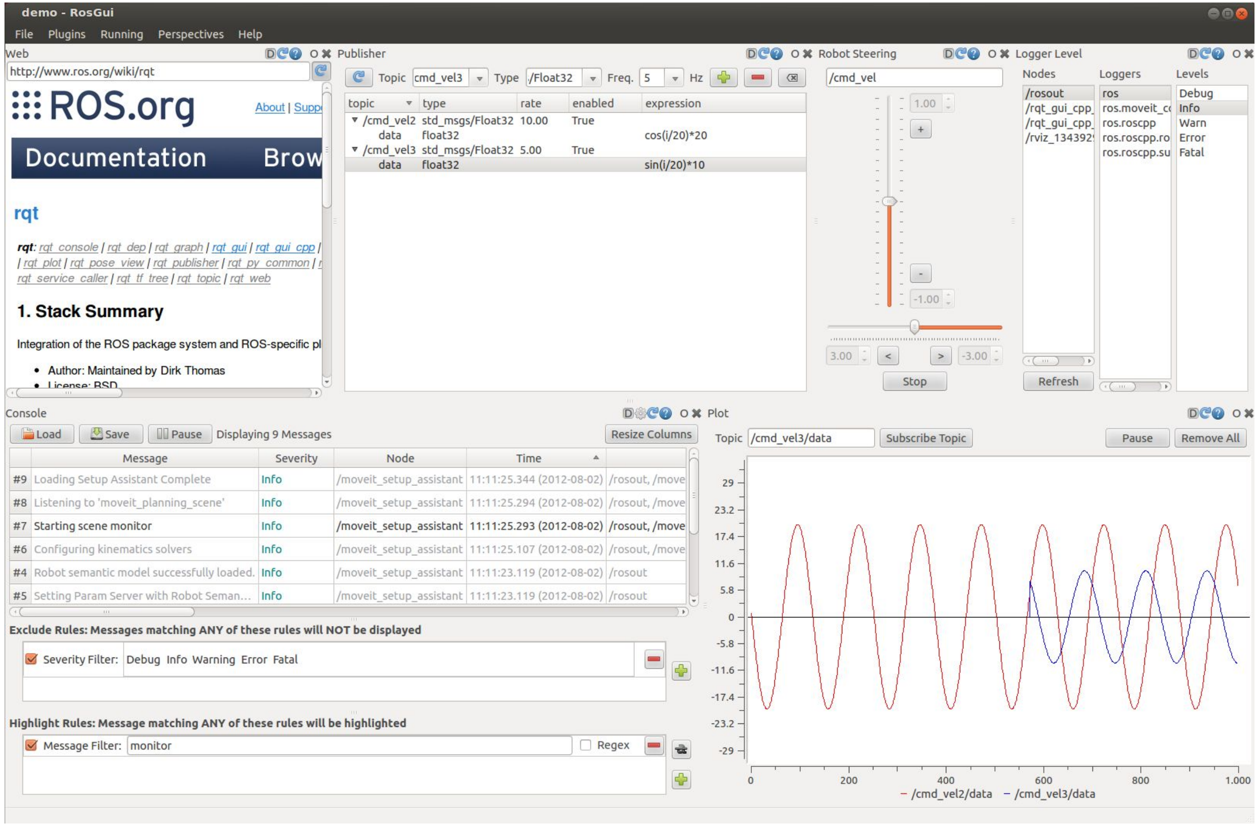
RQt



demo - RosGui

File Plugins Running Perspectives Help

Web

http://www.ros.org/wiki/rqt

ROS.org About | Supp

Documentation Brow

rqt

rqt: rqt_console | rqt_dep | rqt_graph | rqt_gui | rqt_gui_cpp | | rqt_plot | rqt_pose_view | rqt_publisher | rqt_py_common | rqt_service_caller | rqt_tf_tree | rqt_topic | rqt_web

1. Stack Summary

Integration of the ROS package system and ROS-specific pl

- Author: Maintained by Dirk Thomas
- License: BSD

Publisher

Topic: cmd_vel3 Type: /Float32 Freq.: 5 Hz

topic	type	rate	enabled	expression
▼ /cmd_vel2	std_msgs/Float32	10.00	True	
data	float32			cos(i/20)*20
▼ /cmd_vel3	std_msgs/Float32	5.00	True	
data	float32			sin(i/20)*10

Robot Steering

/cmd_vel

1.00 + - -1.00

3.00 < > -3.00

Stop

Logger Level

Nodes	Loggers	Levels
/rosout	ros	Debug
/rqt_gui_cpp_	ros.moveit_c	Info
/rqt_gui_cpp_	ros.roscpp	Warn
/rviz_134392	ros.roscpp.ro	Error
	ros.roscpp.su	Fatal

Refresh

Console

Load Save Pause Displaying 9 Messages Resize Columns

	Message	Severity	Node	Time	
#9	Loading Setup Assistant Complete	Info	/moveit_setup_assistant	11:11:25.344 (2012-08-02)	/rosout, /move
#8	Listening to 'moveit_planning_scene'	Info	/moveit_setup_assistant	11:11:25.294 (2012-08-02)	/rosout, /move
#7	Starting scene monitor	Info	/moveit_setup_assistant	11:11:25.293 (2012-08-02)	/rosout, /move
#6	Configuring kinematics solvers	Info	/moveit_setup_assistant	11:11:25.107 (2012-08-02)	/rosout, /move
#4	Robot semantic model successfully loaded.	Info	/moveit_setup_assistant	11:11:23.119 (2012-08-02)	/rosout
#5	Setting Param Server with Robot Seman…	Info	/moveit_setup_assistant	11:11:23.119 (2012-08-02)	/rosout

Exclude Rules: Messages matching ANY of these rules will NOT be displayed

☑ Severity Filter: Debug Info Warning Error Fatal

Highlight Rules: Message matching ANY of these rules will be highlighted

☑ Message Filter: monitor ☐ Regex

Plot

Topic /cmd_vel3/data Subscribe Topic Pause Remove All

- GUI for ROS
- Has many useful plugins
- We will look at some of them

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RQt Plugins

General Syntax: rosrun rqt_[plugin_name] rqt_[plugin_name]

- rqt_graph: Shows you the whole ROS network
  - **most useful** for debugging errors
- rqt_plot: used to plot data published on topics
- rqt_top: shows amount of resources used by each ROS node
- rqt_image_view: used to view images published on topics
- rqt_publisher: used to publish messages to topics
- rqt_service_caller: used to call services
- rqt_gui: can display multiple plugins

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Launch files

- Used to launch multiple nodes in one single go
- No need to launch roscore too - it does it automatically
  - No need to open multiple terminals
  - But also - all the nodes will write messages to same terminal
- All launch files go in **launch** directory - inside your package
- Launch files must end in **.launch**
- Written in XML (e**X**tensible **M**arkup **L**anguage)
  - Just like HTML - tags, nesting, attributes etc.

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Writing a launch file

```
cd turtlesim
mkdir launch
cd launch
```

- Create the launch directory in the turtlesim package
- Create a launch file **main.launch** and open it
- First line: `<?xml version="1.0" encoding="UTF-8"?>` specifies that file is in XML
- Second line: `<launch>` specifies that file is a launch file
- Last line: `</launch>` ends the launch tag
- Add node using:

```
<node pkg="[PACKAGE_NAME]" type="[EXECUTABLE_NAME]" name="[NODE_NAME]" output="screen"/>
```

Notice / at the end - This is a more compact form
Can be used since there are no tags to be nested inside node **yet**

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Sample launch file

```
<?xml version="1.0" encoding="UTF-8"?>
<launch>
   <include file="$(find mavros)/launch/px4.launch" />
   <node pkg="inter_iit_uav_fleet" type="planner" name="planner" output="screen"/>
   <node pkg="inter_iit_uav_fleet" type="router" name="router"/>
   <node pkg="inter_iit_uav_fleet" type="detector" name="detector">
       <remap from="image" to="camera/image_raw"/>
   </node>
</launch>
```

Two new tags here

Had to close with </node> here

include tag: used to include other launch files in current launch file

remap tag: used to change name of topics just before launch

- will be useful in debugging - fixing wrong connections

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Rosbags

- Used to store message data from topics
- We can store a bag and then play it later on any other system
- Very useful for in-depth analysis in case of any failures
- To record a bag,

```
rosbag record -o [BAG_NAME] [TOPIC_NAME1] [TOPIC_NAME2] [...]
```

- To play a rosbag

This will play the bag on loop till you stop it using **Ctrl+C**

```
rosbag play [BAG_NAME].bag --loop
```

- When you play a bag, no nodes are created, only the messages are published

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- Remember, ROS will give you a tough time at the start but the documentation will be a life saver, learn to navigate it well and also learn to not get intimidated by it.
- You do not need to memorize much in ROS, feel free to use the documentation whenever you get stuck. This is something we still do to this day!
- Watching someone do it is way different than doing it yourself. So do try your best at the assignments.

Contact us if you have any problem/suggestion:

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