FF1RR NAU Course

Setting up Linux and ROS

You need to have a Linux machine with ROS installed to follow this course. Having Linux (Ubuntu) installed natively on your computer is strongly encouraged, but if you use a different operating system, there are two ways to set up Linux and ROS on your computer.

1. You can set up a virtual machine (emulation of a computer) on your own computer, then install Linux and ROS on the virtual machine (VM). We provide a premade VM image with Linux and ROS already installed to make it easier for you to start.
2. A more performant option is to use Docker to set up a container on your computer to run Linux and ROS. You will need to learn a bit about terminal / command-line in order to use Docker. And to access the graphical user interface of Linux, you will need to connect to its virtual desktop via your web browser or a virtual desktop program.

The next two sections will detail the two methods of setting Linux and ROS on your computer.

Install Linux and ROS with Virtual Machine

VM Software

- VMWare Player (Windows, free) or VMWare Fusion (Mac, paid)
- Parallel Desktop (Mac, paid)r
- Virtual Box (free for both Windows and Mac)

We recommend you to have at least 20GB of available disk space on your computer to run the virtual machine.

Problems with Virtual Box on Mac OS

If you use Virtual Box (VBox) on Mac OS with a Retina Display (high resolution display), you may have problems with VBox becoming extremely slow. There are several ways you can try to resolve the issues:

1. If you have a non-retina monitor, you can use it as a secondary monitor and move VBox windows to this monitor rather than on the retina monitor.
2. You can enable Remote Desktop on Ubuntu (on the VM) and use a Remote Desktop program on Mac OS (such as Screen Sharing or MS Remote Desktop) to access the VM.

Refer to this discussion thread for some workarounds. If you face these problems, we can try to help you during your lab session.

Software versions

Ubuntu

We recommend that you install Ubuntu version 16.04, although it is not the latest version. All the code and labs for this course were tested on this version of Ubuntu. Newer Ubuntu versions may work fine though. On newer Ubuntu versions, you need to install different versions of ROS and its dependencies, so you need to do a little bit of extra work (not much). In case you know how to adapt the provided code with your system, feel free to use what you prefer.

ROS

We recommend ROS Kinetic (which in turn requires Ubuntu 16.04), because all our code and labs were tested on this version of ROS. If you use a different version of Ubuntu, you may need to install a different version of ROS, which may or may not cause issues with the code and labs.

Installation

First, you need to install a VM program of your choice (VMWare, Parallel, or Virtual Box). Then you will need to install Ubuntu and ROS on a new VM in the program. To facilitate this step and save you time and effort, you can use a VM image with Ubuntu and ROS already installed, made by ETHZ. Follow the steps below to obtain and install the VM image.

1. Download the ZIP file "Ubuntu 16 and ROS Kinetic" (~ 6.5 GB) from polybox, extract it to a folder.
2. Create a virtual machine with the premade image:
    a. If your VM program can open or import VMX files, open / import the file `Ubuntu_ROS_Course.vmx` in the downloaded folder.

   b. If your VM program does not support VMX files, create a new virtual machine in the program and allocate at least 2 Gb of memory (RAM) to the VM. Do not create a new disk image for the VM (you may need to choose an Advanced Setup option to be able to do this). Instead, choose the option to import or use an existing disk image, then select the file `ROS_Course_18-cl2.vmdk` in the downloaded folder.
3. Start the virtual machine. If everything is set up properly, you will see Ubuntu starting up and you will be able to log in and start using Ubuntu and ROS. If you use Virtual Box on Mac OS and the VM is very slow, read the section Problems with Virtual Box on Mac OS for some possible solutions.
4. Follow this tutorial to test the new virtual machine:

https://ethz.ch/content/dam/ethz/special-interest/mavt/robotics-n-intelligent-systems/rsl-dam/ROS2019/CoursePreparation.pdf

Install Linux and ROS with Docker

An alternative to using virtual machines to run Ubuntu and ROS is to use Docker containers. This section will describe how to set up Docker and run and use Ubuntu and ROS with Docker.

Install and learn the basics of Docker

Install Docker on your computer from the appropriate link: for Mac OS, for Windows. You may need to register for a Docker Hub account (free). Having a Docker Hub account is useful because later you may need to obtain pre-made Docker images from Docker Hub.

Once you have installed Docker on your computer, read and follow the Docker beginners' tutorial at https://docker-curriculum.com/ until section "Terminology." Make sure that you practice all the examples in the tutorial.

Depending on the specifications of your computer, you may want to increase the number of CPUs and the amount of RAM for Docker (go to Preferences… or Settings… of your Docker program to change the settings).

Run and use Ubuntu and ROS on Docker

The official Docker image for F1/10, including a car simulator, is `f110penn/f110sim` at https://hub.docker.com/r/f110penn/f110sim.

- First, pull (i.e., download and install) the image to your computer by running the following command in a terminal: `docker pull f110penn/f110sim`
- To run / start Ubuntu + ROS from the image, run the following command in a terminal: `docker run -it --rm -p 6080:80 f110penn/f110sim`

    - Open your web browser and go to http://127.0.0.1:6080/.
    - After you've connected to the Ubuntu in Docker on your web browser, you will see the remote desktop of Ubuntu inside your web browser. Your interaction with the Docker container will be through the remote desktop in your web browser.
    - To test the car simulator, click the button at the bottom left of the screen, go to System Tools --> LXTerminal, and run in the terminal the commands:
        - Change directory to the main folder: `cd /home/catkin_ws`
        - Set up the environment: `source devel/setup.bash`
        - Launch simulation: `roslaunch f110_simulator simulator.launch`
        - To drive the simulated car: in the terminal, press “k” to switch the control to the keyboard, then use “ASDW” to drive, Space to stop, “k” to regain control after a collision.
        - To exit: close the GUI window, then in the terminal, press Ctrl-C to quit.
- If you want to use a dedicated remote desktop program (VNC) instead of your web browser, start the container with the following command: `docker run -it --rm -p 6080:80 -p 5900:5900 f110penn/f110sim`. Use your favorite VNC program to log onto 127.0.0.1:5900.
    - Sometimes, an error may happen that the port 5900 is already used. In that case, change the command to `docker run -it --rm -p 6080:80 -p 5901:5900 f110penn/f110sim` and use your VNC program to log onto 127.0.0.1:5901.
- Once you are done with using Ubuntu and ROS, you can shutdown the container with the following steps:
    - first, log out of the remote desktop if you are still using it.
    - then, in a terminal of your operating system (not inside the remote desktop), run `docker container ls` and find the name of the Ubuntu+ROS container. Then stop the container (if it’s not running) by the command `docker stop <name of the container>`. If after a while the container does not stop, you can “kill” it by running `docker kill <name of the container>`.
    - Once stopped, the container should be automatically removed. To check whether it’s been removed or not, run the command `docker container ls -a` and see if its name is still listed. If not yet removed, you can remove it with the command `docker container rm <name of the container>`.