Lab sheet

Mobile Robot Day 1

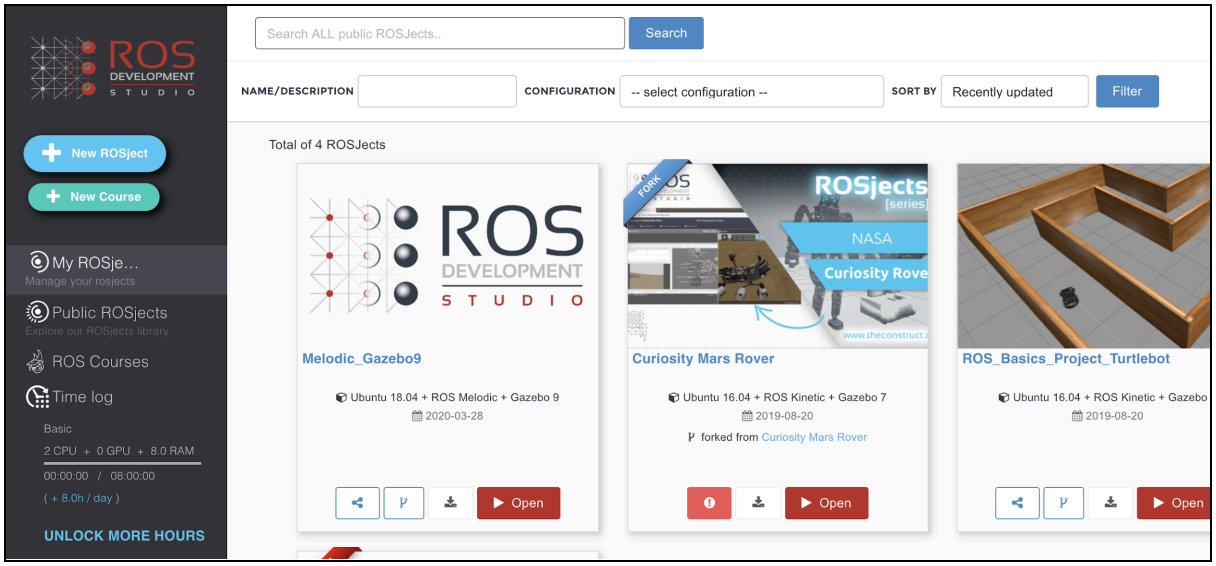
Launch RDS (ROS Development Studio)

Go to http://rosds.online/

Registration

[Video: How to register for the robot development studio]

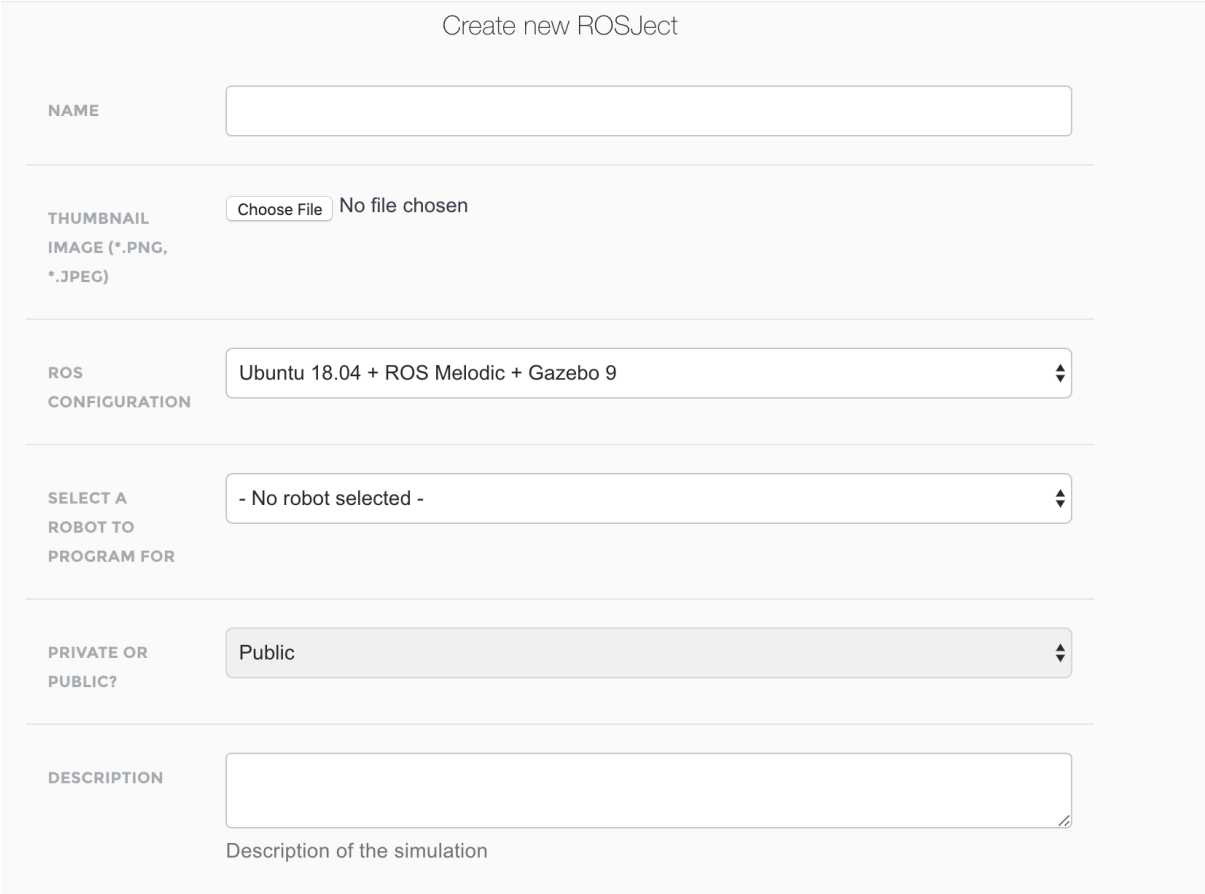
My ROS Workspace



New ROSject

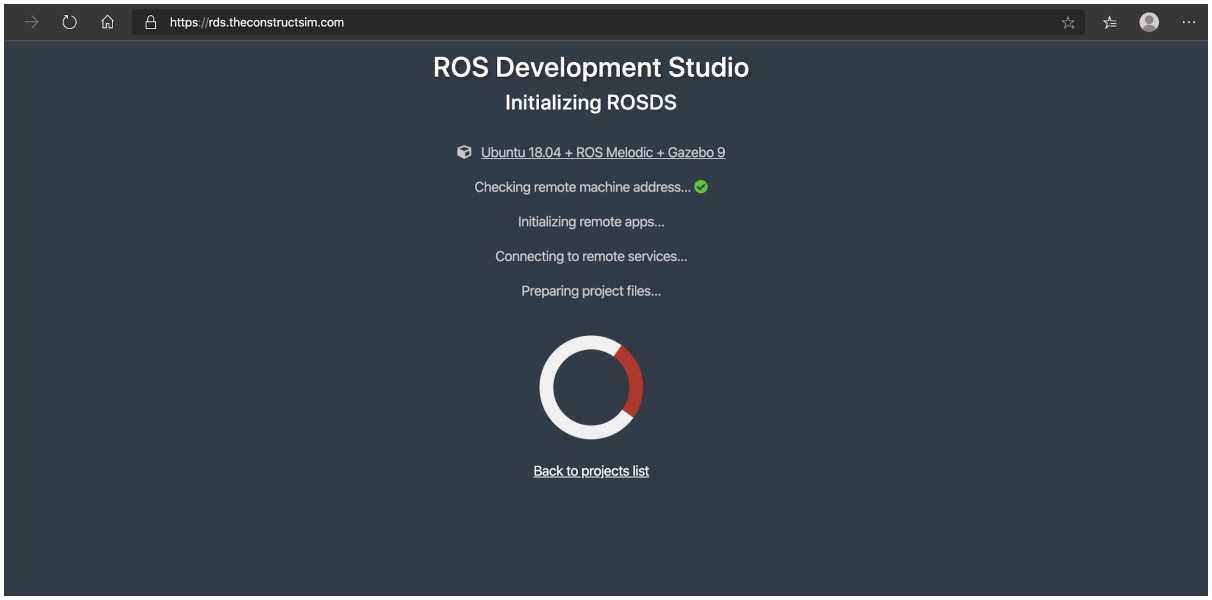
- Name
- ROS Configuration = **Ubuntu 18.04 + Melodic + Gazebo 9**
- No robot selected

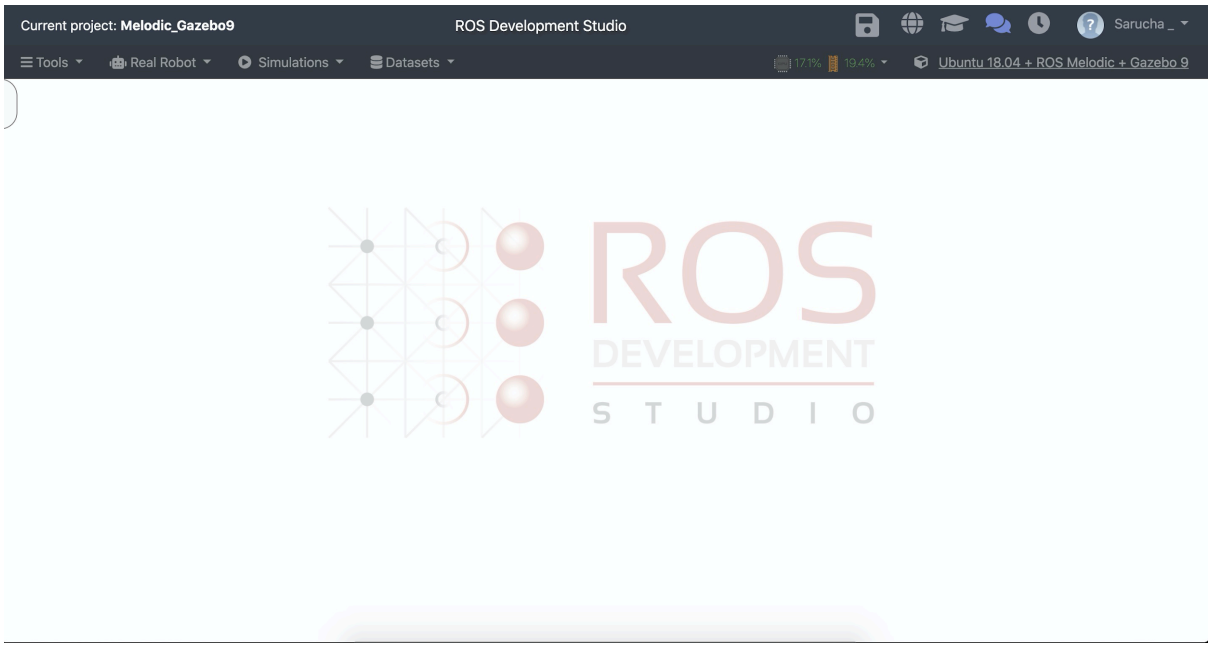
Create new ROSJect



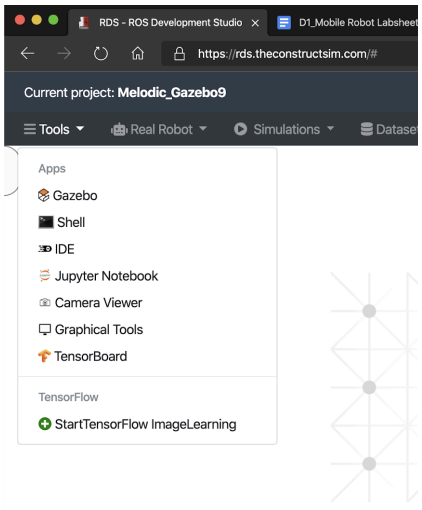
Open project

Wait for 3-5 minutes

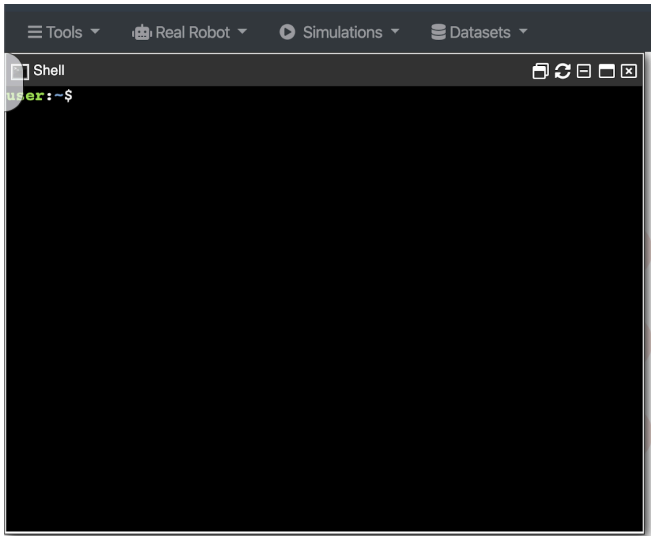




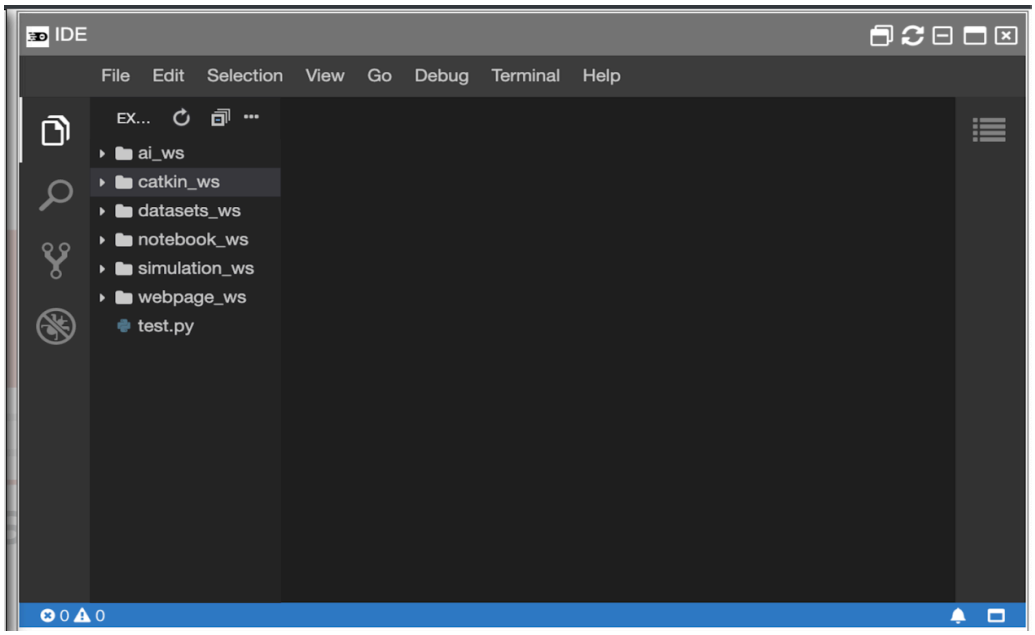
Tools ⟶ Shell



⟶



Tools ⟶ IDE

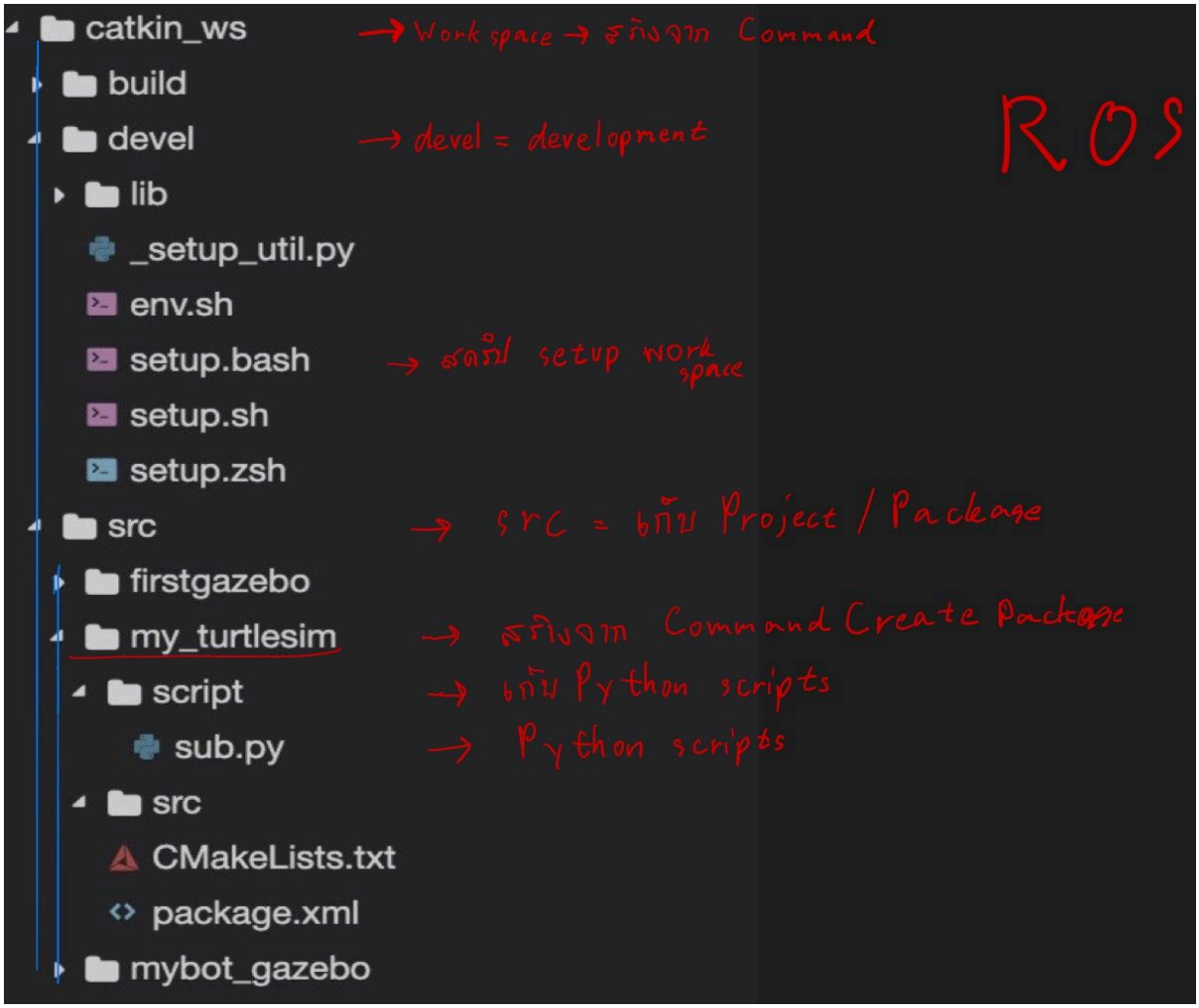


Tools → Graphical tools

Command-line interface

Commands	Description
ls	Directory listing
ls -la	Directory listing and **show hidden files**
cd dir	Change current directory to <dir>
cd	Change current directory to home
pwd	Show current directory
mkdir dir	Create a directory <dir>
mkdir -p dir/dir	Create nested directory
rm file	Delete <file>
rm -r dir	Delete directory <dir>
rm -f file	Force remove <file>
cp file1 file2	Copy file1 to file2
cp file1 directory2	Copy file1 to directory2
mv file1 file2	Rename file1 to file2
mv file1 directory2	Move file1 to directory2
touch file1	Create empty file1
nano file1	Edit file1
gedit file1	Edit file1
cat file1	Read file1
chmod 777 file1	Change permission 777 is read/write from all user See this website for reference https://chmod-calculator.com/
chmod +x file1	Change permission to executable
sudo command	Execute command by Super User

ROS Filesystem



Create workspace

```
source /opt/ros/melodic/setup.bash
mkdir -p ~/catkin_ws/src
cd ~/catkin_ws/
catkin_make
```

After that, you have to import the workspace environment to OS.

```
source devel/setup.bash
```

Auto import workspace into OS Environment

1. Open Shell
2. Type

```
echo "source ~/catkin_ws/devel/setup.bash" >> ~/.bashrc
```

3. Close and reopen all Shell windows

Create a package

The package of ROS must be kept in ~/catkin_ws/src.

```
cd ~/catkin_ws/src
```

std_msgs, rospy, and roscpp are the dependency packages that we need for our package.

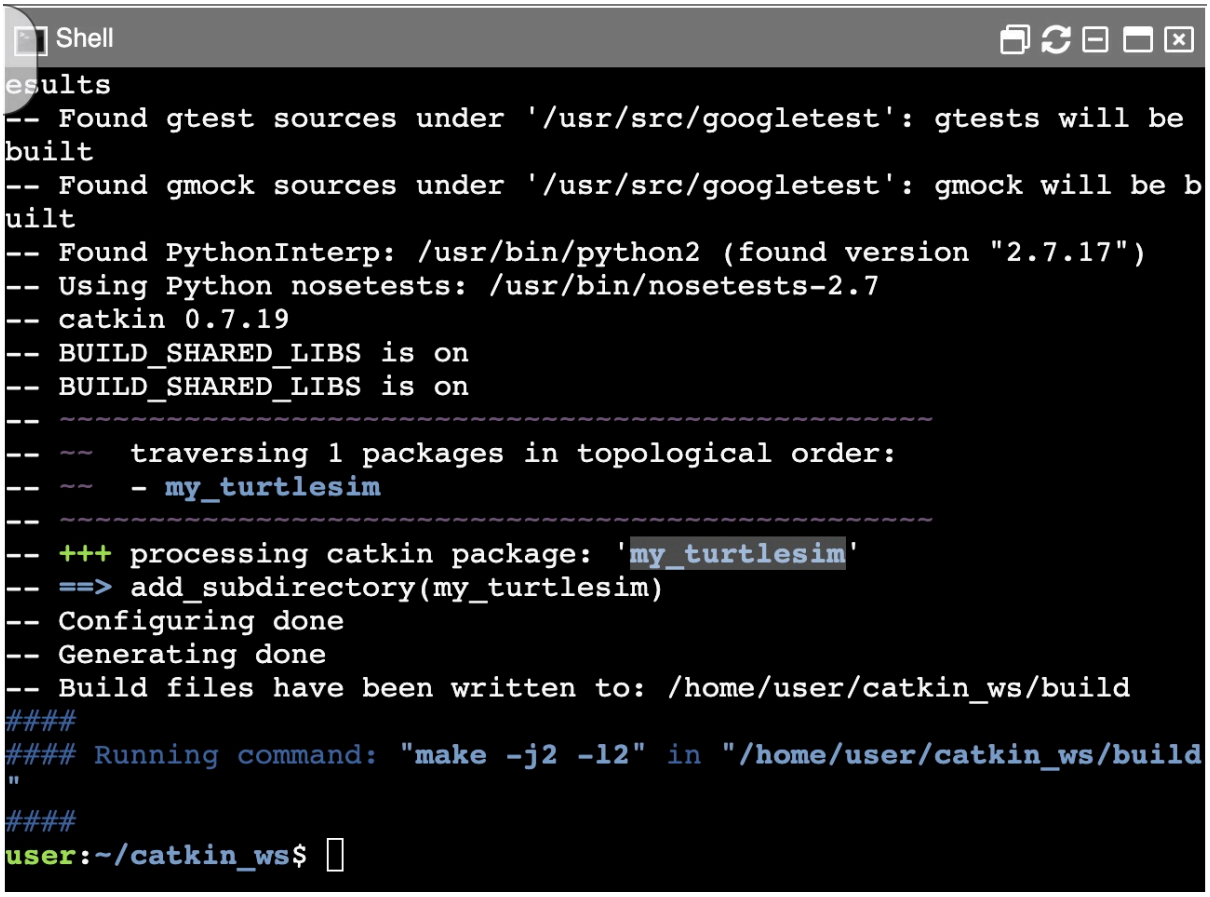
```
catkin_create_pkg my_turtlesim std_msgs rospy roscpp
```

Build workspace

The workspace must be built after it was changed such as a new package and etc.

```
cd ~/catkin_ws
catkin_make
```

Output



Create a python script

Create folder script

```
CMakeLists.txt  include  package.xml  src
user:~/catkin_ws/src/my_turtlesim$ mkdir script
```

New empty python script

```
user:~/catkin_ws/src/my_turtlesim$ cd script/
user:~/catkin_ws/src/my_turtlesim/script$ touch pub.py
```

Change mode to executable

```
user:~/catkin_ws/src/my_turtlesim/script$ chmod +x pub.py
user:~/catkin_ws/src/my_turtlesim/script$
```

File permission

https://chmod-calculator.com/

File permission changing

```
user:~/catkin_ws/src/my_turtlesim/script$ touch pub.py
user:~/catkin_ws/src/my_turtlesim/script$ ls -la
total 8
drwxr-xr-x 2 user user 4096 Jun 12 08:13 .
drwxr-xr-x 5 user user 4096 Jun 12 07:56 ..
-rw-r--r-- 1 user user    0 Jun 12 08:13 pub.py
user:~/catkin_ws/src/my_turtlesim/script$ chmod +x pub.py
user:~/catkin_ws/src/my_turtlesim/script$ ls -la
total 8
drwxr-xr-x 2 user user 4096 Jun 12 08:13 .
drwxr-xr-x 5 user user 4096 Jun 12 07:56 ..
-rwxr-xr-x 1 user user    0 Jun 12 08:13 pub.py
user:~/catkin_ws/src/my_turtlesim/script$
```

Python programming

Python programming language is used to program the robot. In this section, we will learn the basics of Python.

The python script can be created or edited by a graphical text editor.

1.1. Python Indentation

Most of the programming languages like C, C++, Java use braces { } to define a block of code. Python uses indentation.
A code block (body of a function, loop etc.) starts with indentation and ends with the first unindented line. The amount of indentation is up to you, but it must be consistent throughout that block.
Generally four whitespaces are used for indentation and is preferred over tabs. Here is an example.

```
for i in range(1,11):
    print(i)
    if i == 5:
        break
```

The enforcement of indentation in Python makes the code look neat and clean. This results into Python programs that look similar and consistent.

1.2. Python Variables

A variable is a named location used to store data in the memory. It is helpful to think of variables as a container that holds data which can be changed later throughout programming. For example,

```
1. number = 10
```

Here, we have created a named number. We have assigned value 10 to the variable.
You can think variable as a bag to store books in it and those books can be replaced at any time.

```
1.  number = 10
2.  number = 1.1
3.  website = "apple.com"
4.
```

Initially, the value of number was 10. Later it's changed to 1.1.
Note: In Python, we don't assign values to the variables, whereas Python gives the reference of the object (value) to the variable.

1.3. Python Comments

Comments are very important while writing a program. It describes what's going on inside a program so that a person looking at the source code does not have a hard time figuring it out. You might forget the key details of the program you just wrote in a month's time. So taking time to explain these concepts in form of comments is always fruitful.
In Python, we use the hash (#) symbol to start writing a comment.
It extends up to the newline character. Comments are for programmers for better understanding of a program. Python Interpreter ignores comment.

```
#This is a comment
#print out Hello
print('Hello')
```

Multi-line comments
If we have comments that extend multiple lines, one way of doing it is to use hash (#) in the beginning of each line. For example:

```
#This is a long comment
#and it extends
#to multiple lines
```

1.4. Python Output Using print() function

We use the print() function to output data to the standard output device (screen).
We can also output data to a file, but this will be discussed later. An example use is given below.

```
print('This sentence is output to the screen')
# Output: This sentence is output to the screen

a = 5

print('The value of a is', a)
# Output: The value of a is 5
```

1.5. Python if Statement Syntax

Decision making is required when we want to execute a code only if a certain condition is satisfied. The if…elif…else statement is used in Python for decision making.

Syntax of if statement

```
if test expression:
   statement(s)
```

Here, the program evaluates the test expression and will execute statement(s) only if the text expression is True.

If the text expression is False, the statement(s) is not executed.

In Python, the body of the if statement is indicated by the indentation. Body starts with an indentation and the first unindented line marks the end.

Python interprets non-zero values as True. None and 0 are interpreted as False.

Python if Statement Flowchart

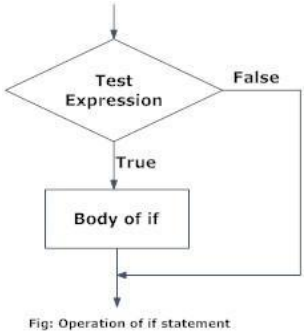


Fig: Operation of if statement

Example of if statement

```
# If the number is positive, we print an appropriate message

num = 3
if num > 0:
   print(num, "is a positive number.")
print("This is always printed.")

num = -1
if num > 0:
   print(num, "is a positive number.")
print("This is also always printed.")
```

Output

```
3 is a positive number
This is always printed
This is also always printed.
```

In the above example, num > 0 is the test expression.
The body of if is executed only if this evaluates to True.
When variable num is equal to 3, test expression is true and body inside body of if is executed.
If variable num is equal to -1, test expression is false and body inside body of if is skipped.
The print() statement falls outside of the if block (unindented). Hence, it is executed regardless of the test expression.

1.6. Python if...else Statement

Syntax of if-else statement

```
if test expression:
   Body of if
else:
```

Body of else

The if..else statement evaluates test expression and will execute body of if only when test condition is True.
If the condition is False, body of else is executed. Indentation is used to separate the blocks.
Python if..else Flowchart

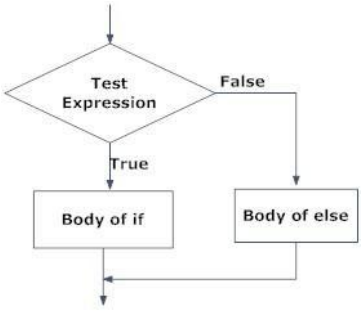


Fig: Operation of if...else statement

Example of if-else statement

```
# Program checks if the number is positive or negative
# And displays an appropriate message

num = 3

# Try these two variations as well.
# num = -5
# num = 0

if num >= 0:
    print("Positive or Zero")
else:
    print("Negative number")
```

Output

```
Positive or Zero
```

In the above example, when num is equal to 3, the test expression is true and body of if is executed and body of else is skipped.

If num is equal to -5, the test expression is false and body of else is executed and body of if is skipped.
If num is equal to 0, the test expression is true and body of if is executed and body of else is skipped.

1.7. Python if...elif...else Statement

Syntax of if-else statement

if test expression:
  Body of if
elif test expression:
  Body of elif
else:
  Body of else

The elif is short for else if. It allows us to check for multiple expressions.
If the condition for if is False, it checks the condition of the next elif block and so on.
If all the conditions are False, body of else is executed.
Only one block among the several if...elif...else blocks is executed according to the condition.
The if block can have only one else block. But it can have multiple elif blocks.

Flowchart of if...elif...else

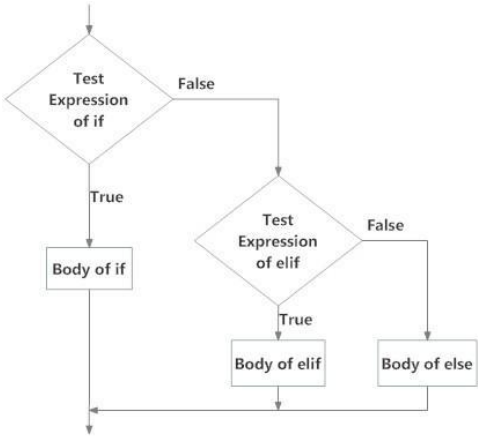


Fig: Operation of if...elif...else statement

Example of if-elif-else statement

In this program,

```
# we check if the number is positive or
# negative or zero and
# display an appropriate message

num = 3.4

# Try these two variations as well:
# num = 0
# num = -4.5

if num > 0:
    print("Positive number")
elif num == 0:
    print("Zero")
else:
    print("Negative number")
```

Output

```
Positive number
```

When variable num is positive, Positive number is printed.
If num is equal to 0, Zero is printed.
If num is negative, Negative number is printed

1.8. Python Nested if statements

We can have a if...elif...else statement inside another if...elif...else statement. This is called nesting in computer programming.

Any number of these statements can be nested inside one another. Indentation is the only way to figure out the level of nesting. This can get confusing, so must be avoided if we can.

Example of nested if statement

```
# In this program, we input a number
# check if the number is positive or
# negative or zero and display
# an appropriate message
# This time we use nested if
num = float(input("Enter a number: "))
if num >= 0:
    if num == 0:
        print("Zero")
    else:
        print("Positive number")
else:
    print("Negative number")
```

Output 1

```
Enter a number: 5
Positive number
```

Output 2

```
Enter a number: -1
Negative number
```

Output 3

```
Enter a number: 0
Zero
```

1.9. Python for loop

In this article, you'll learn to iterate over a sequence of elements using the different variations of for loop.
The for loop in Python is used to iterate over a sequence (list, tuple, string) or other iterable objects. Iterating over a sequence is called traversal.

Syntax of for loop
for val in sequence: Body of for

Here, val is the variable that takes the value of the item inside the sequence on each iteration.
Loop continues until we reach the last item in the sequence. The body of for loop is separated from the rest of the code using indentation.

Flowchart of for Loop

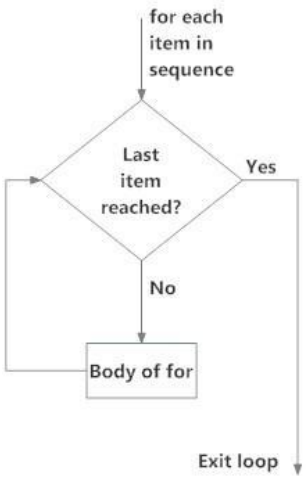


Fig: operation of for loop

1.10. Python while Loop

The while loop in Python is used to iterate over a block of code as long as the test expression (condition) is true.
We generally use this loop when we don't know beforehand, the number of times to iterate.

Syntax of while loop
while test_expression: Body of while

Flowchart of while Loop

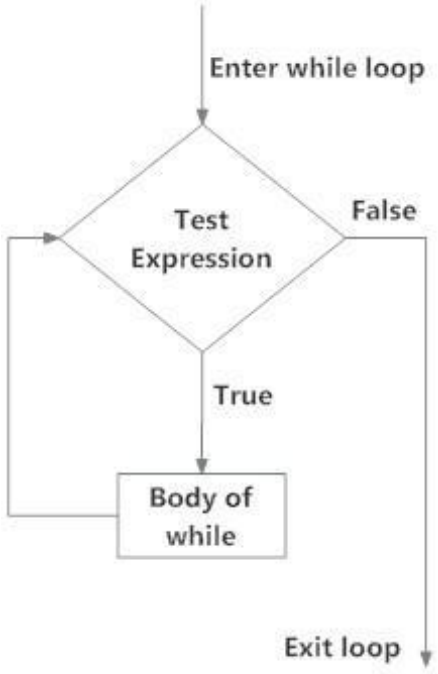
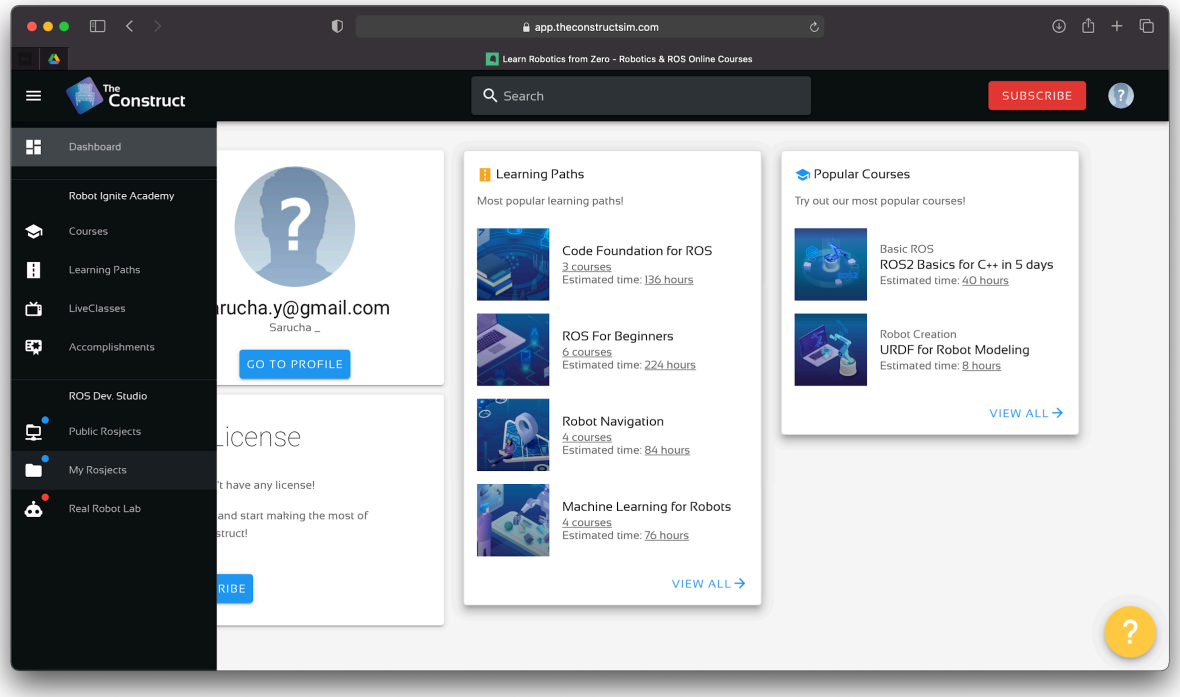
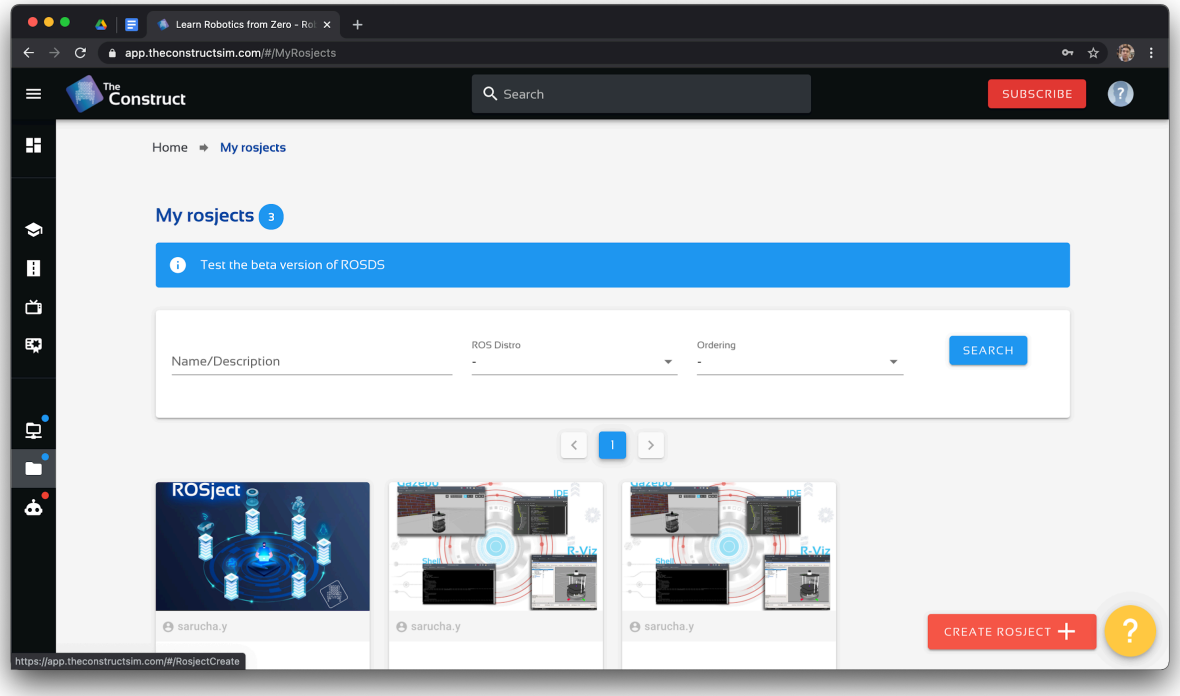


Fig: operation of while loop

APPENDIX: New ROS Development Studio

URL https://app.theconstructsim.com/

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My rosjects
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SEARCH
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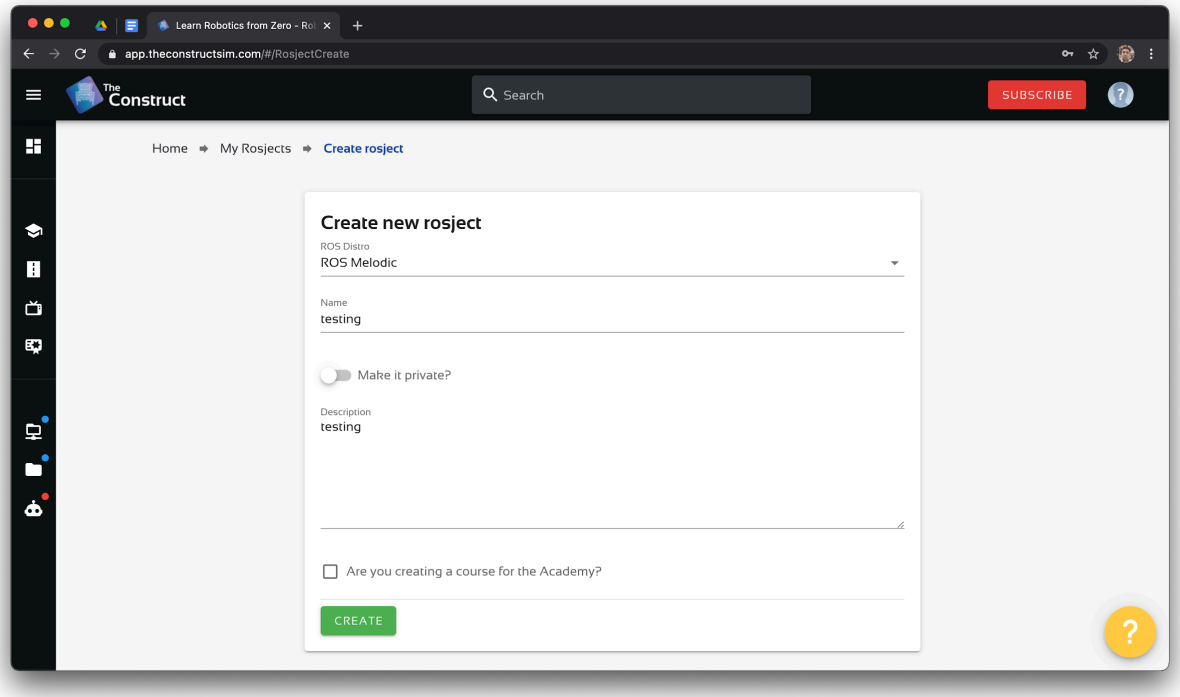
CREATE ROSJECT
https://app.theconstructsim.com/#/RosjectCreate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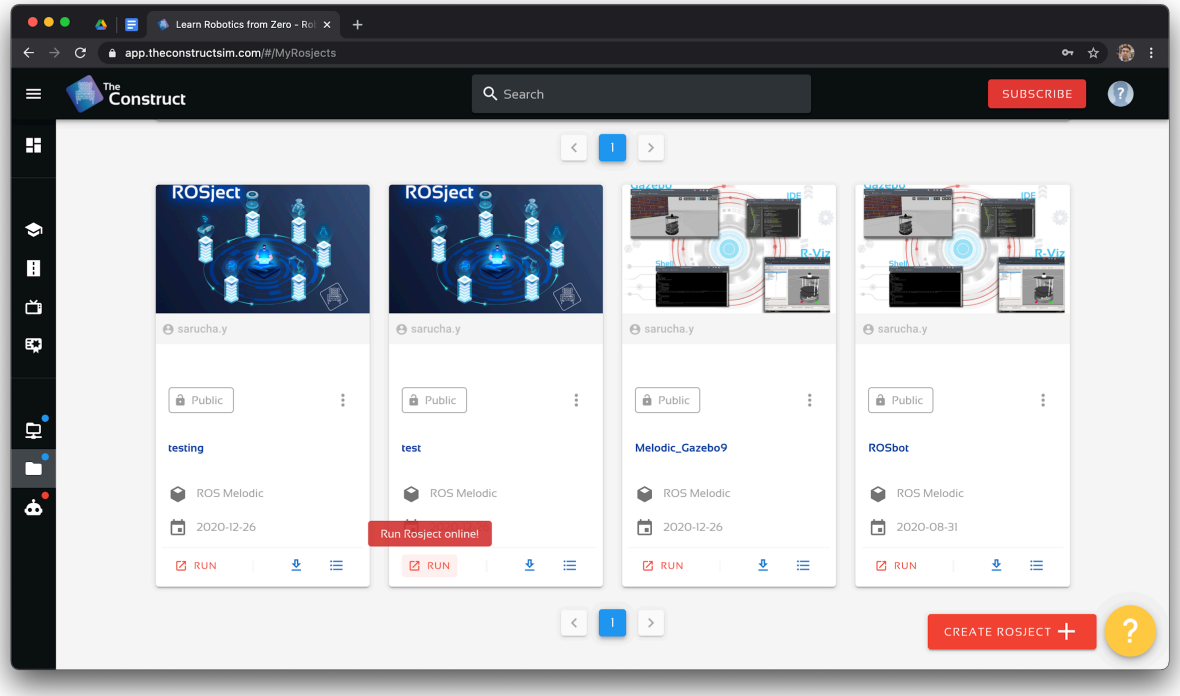
Create rosject
Create new rosject
ROS Distro
ROS Melodic
Name
testing
Make it private?
Description
testing
Are you creating a course for the Academy?
CREATE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ROSject
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testing
ROS Melodic
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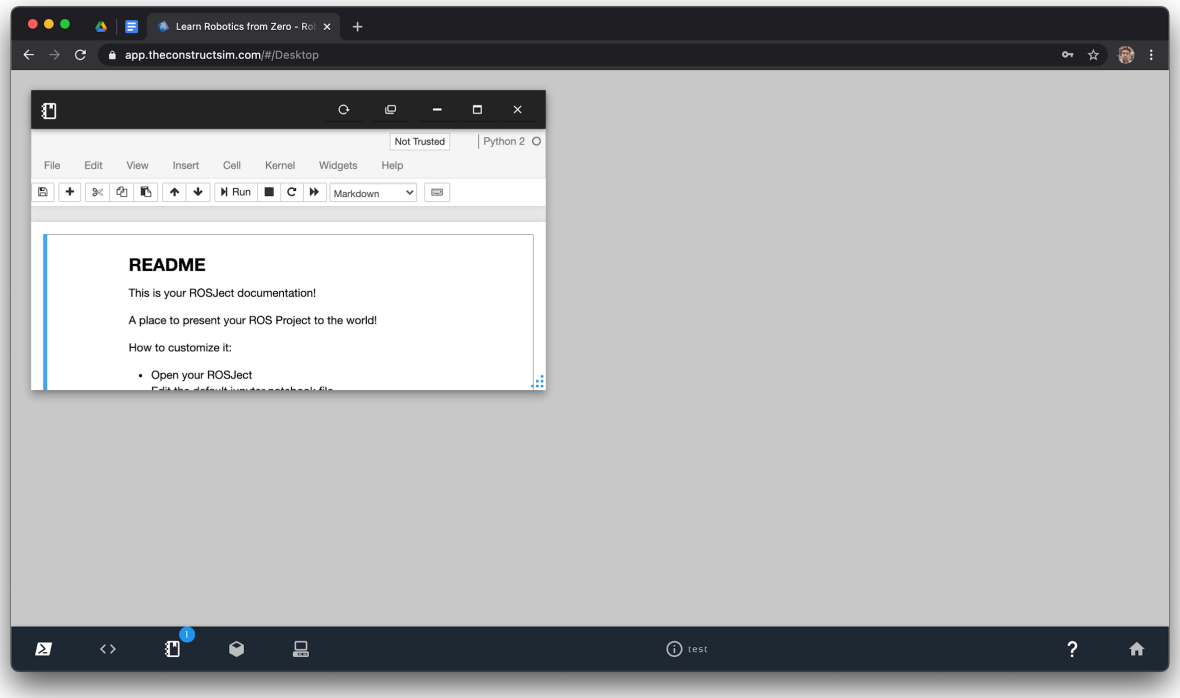
RUN
Run Rosject online!
test
Melodic_Gazebo9
ROSbot
2020-08-31
CREATE ROSJECT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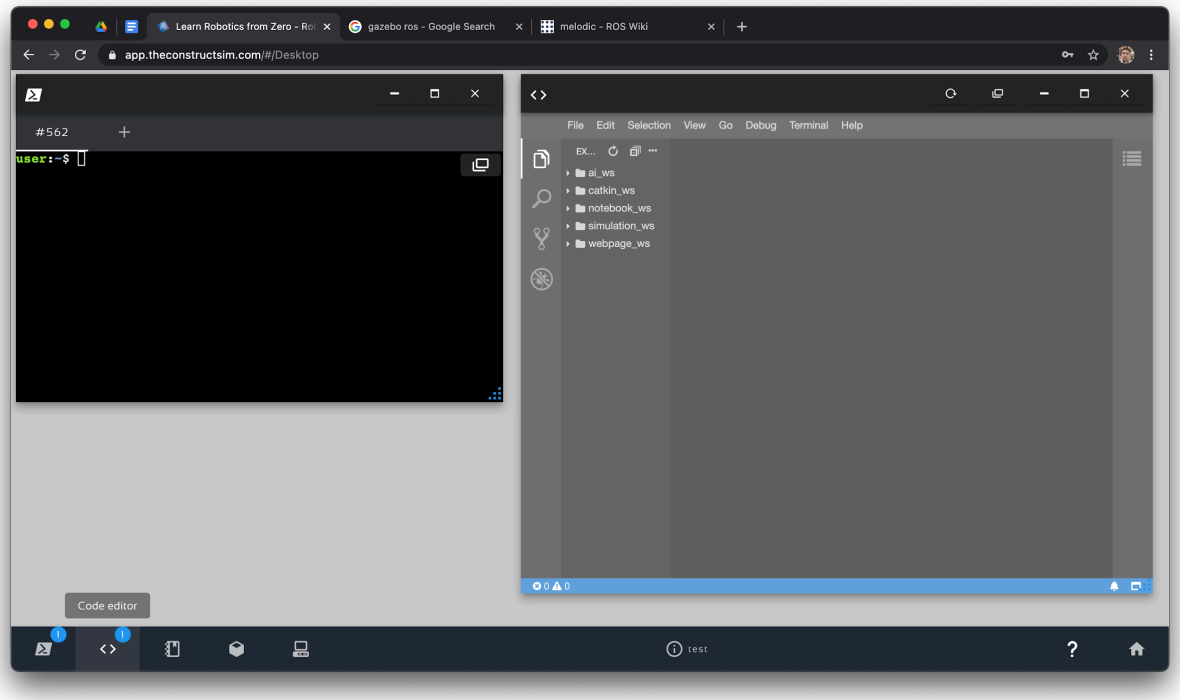
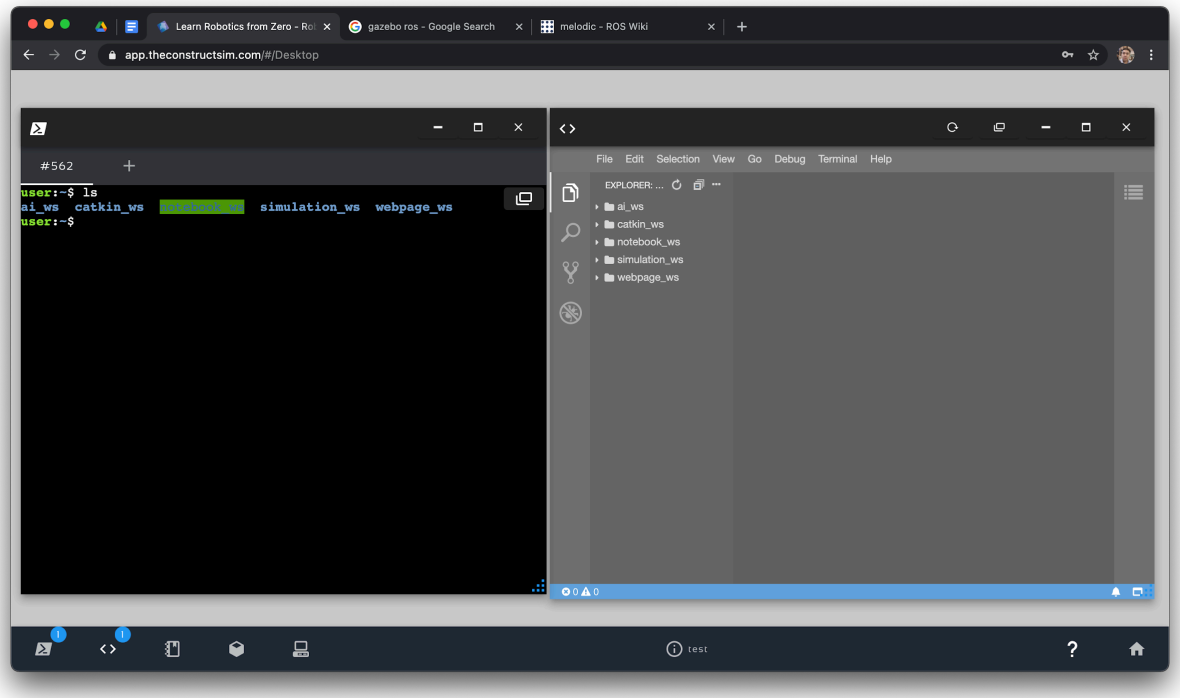
Not Trusted
Python 2
File
Edit
View
Insert
Cell
Kernel
Widgets
Help
Run
Markdown
README
This is your ROSJect documentation!
A place to present your ROS Project to the world!
How to customize it:
Open your ROSJect
test

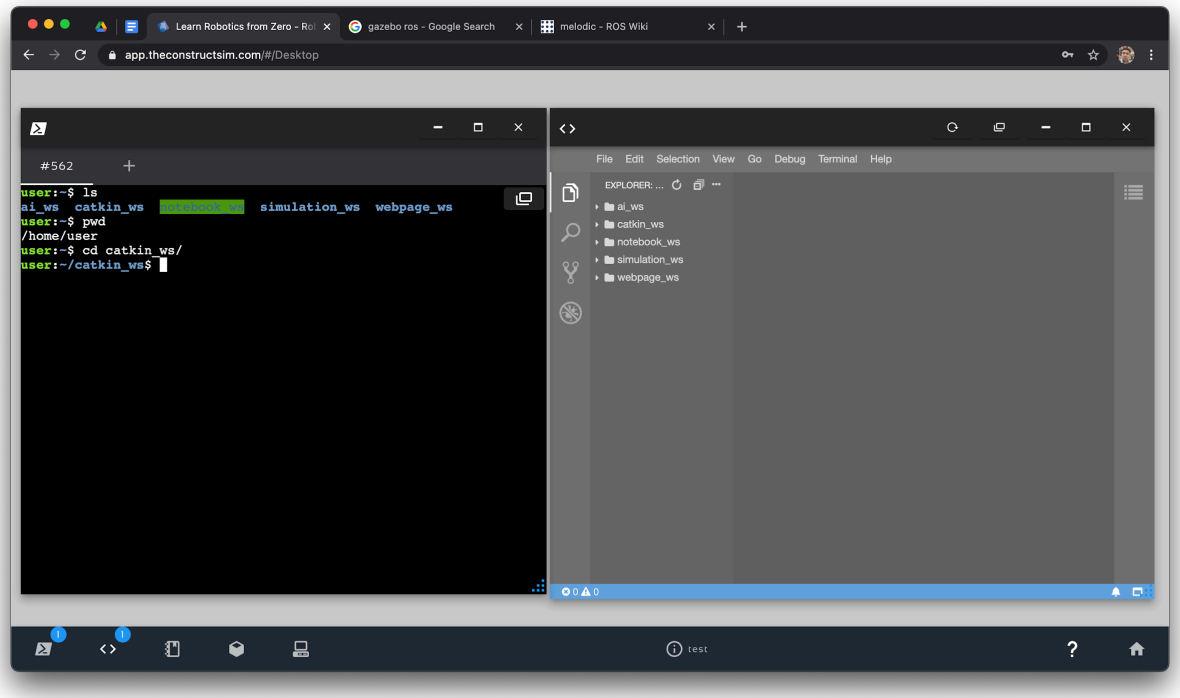
โหลด ROSJect เรียบร้อยแล้วจะได้หน้าต่างนี้ครับ



หลังจากคลิก Web Shell และ Code Editor จะได้ภาพนี้ครับ


Learn Robotics from Zero - Ro
gazebo ros - Google Search
melodic - ROS Wiki
app.theconstructsim.com/#/Desktop
#562
user:~$ ls
ai_ws catkin_ws notebook_ws simulation_ws webpage_ws
user:~$
File Edit Selection View Go Debug Terminal Help
EXPLORER: ...
ai_ws
catkin_ws
notebook_ws
simulation_ws
webpage_ws
test

คอมมาน ls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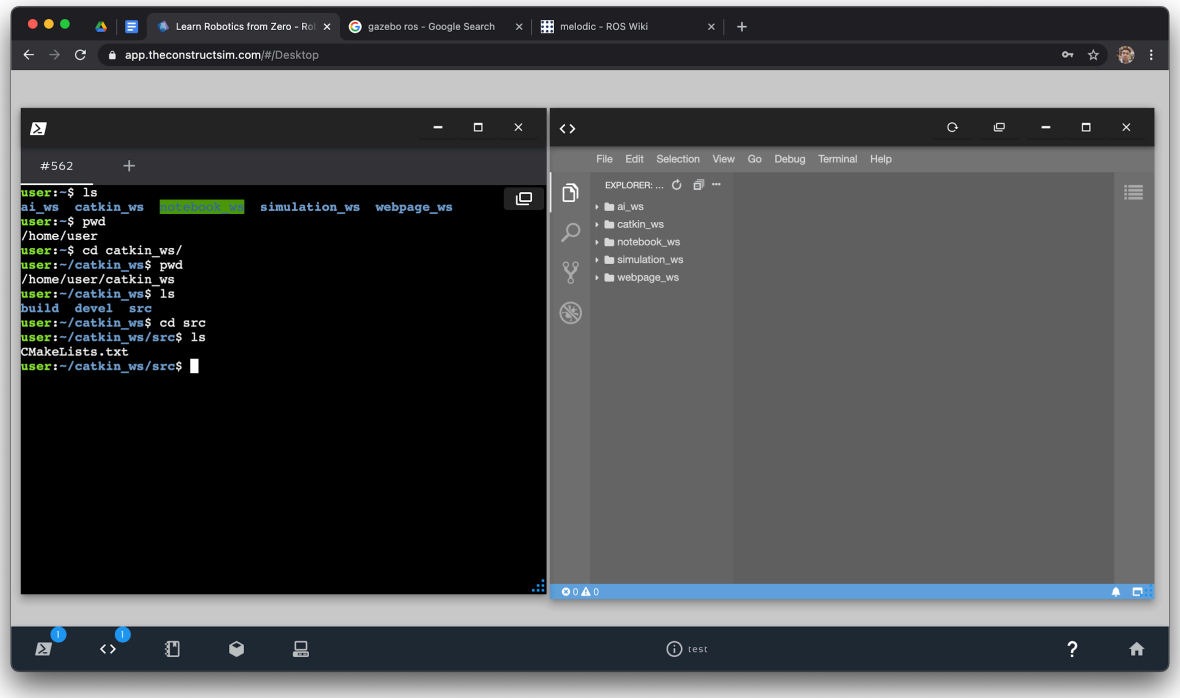
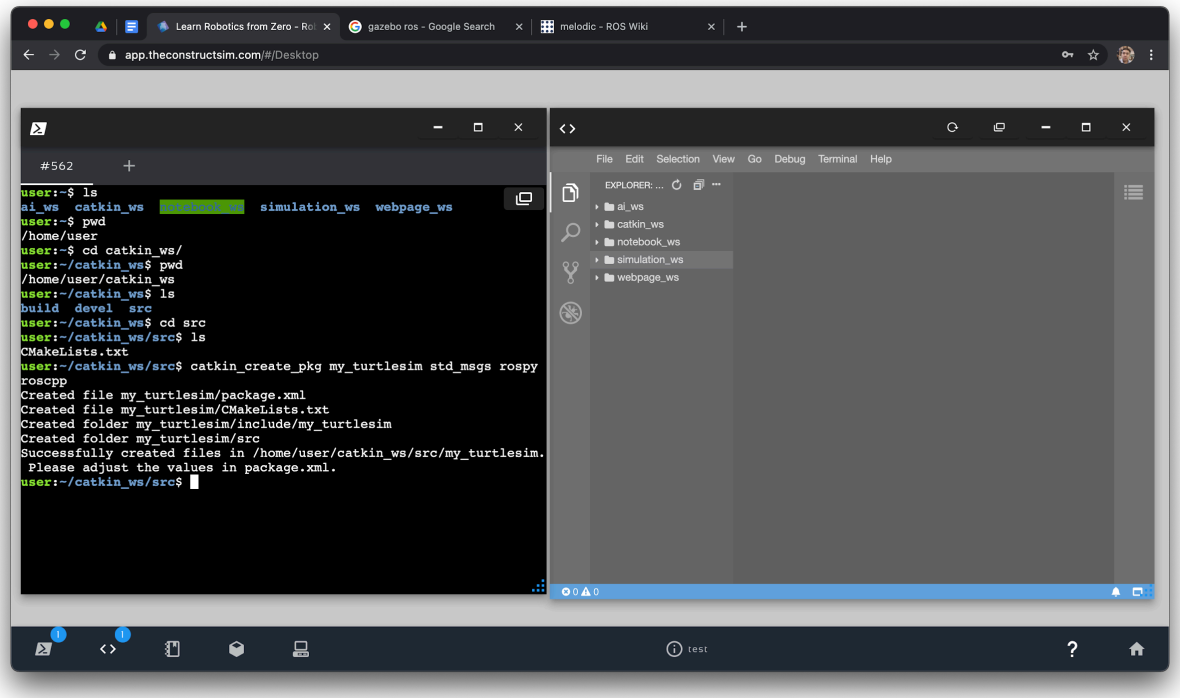
app.theconstructsim.com/#/Desktop
#562
user:~$ ls
ai_ws catkin_ws notebook_ws simulation_ws webpage_ws
user:~$ pwd
/home/user
user:~$ cd catkin_ws/
user:~/catkin_ws$
File Edit Selection View Go Debug Terminal Help
EXPLORER: ...
ai_ws
catkin_ws
notebook_ws
simulation_ws
webpage_ws
test

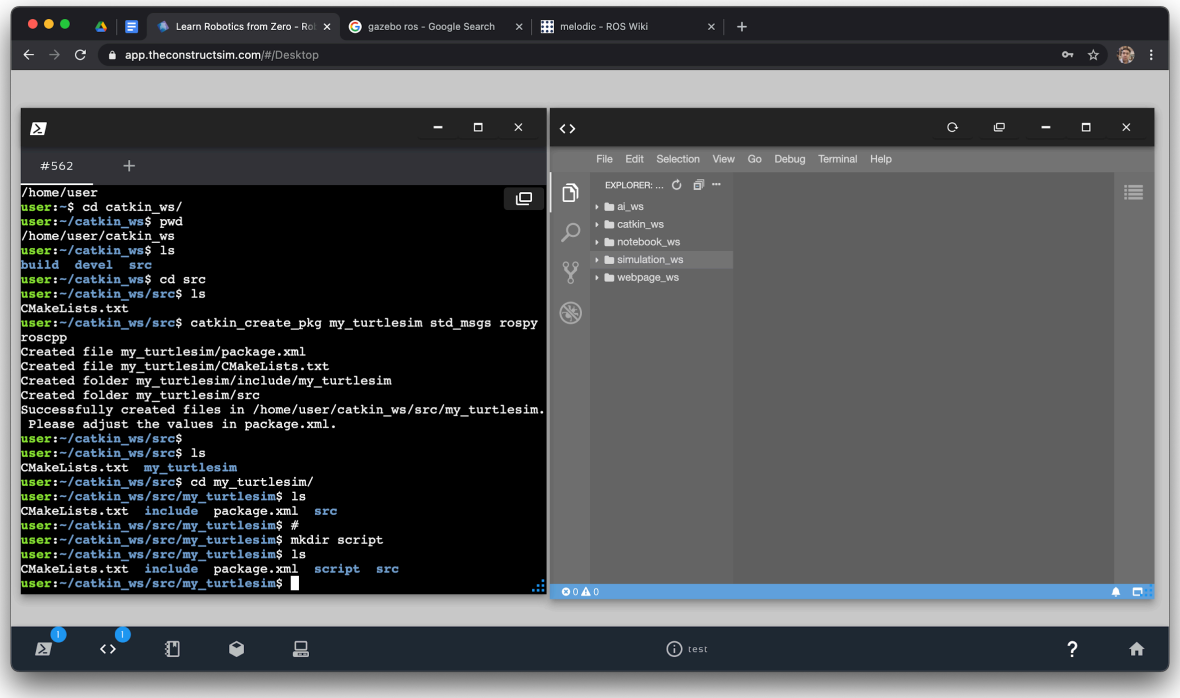
คอมมาน cd



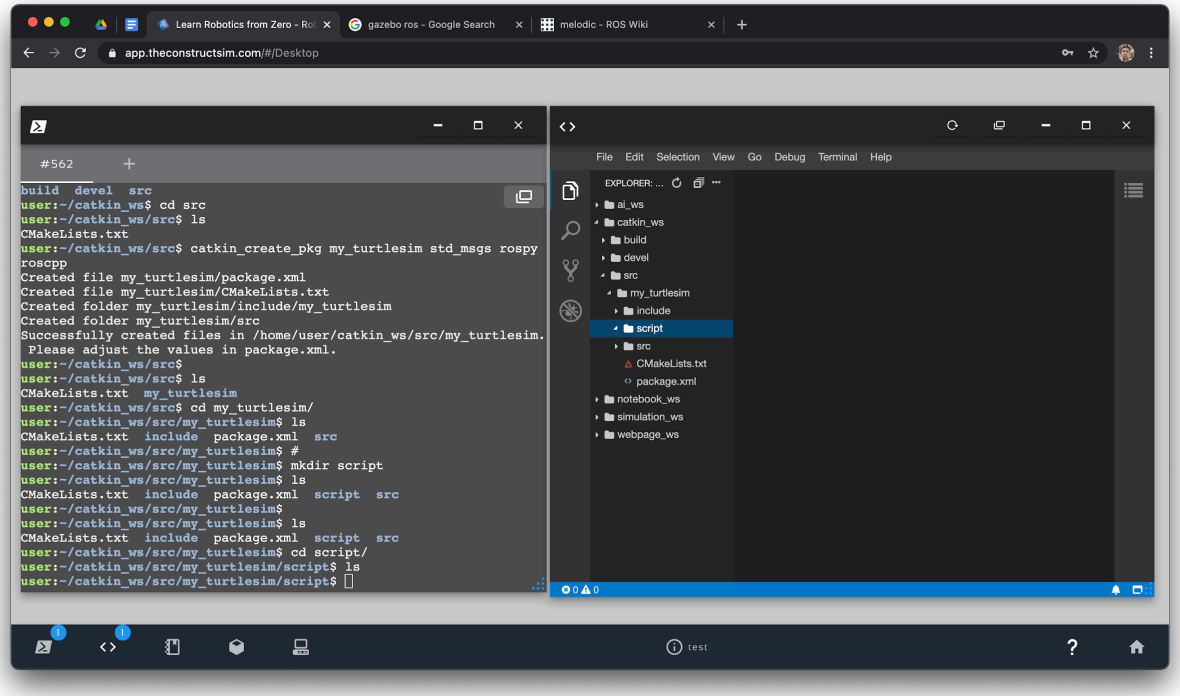
ตำแหน่งปัจจุบันก่อนสร้าง Package



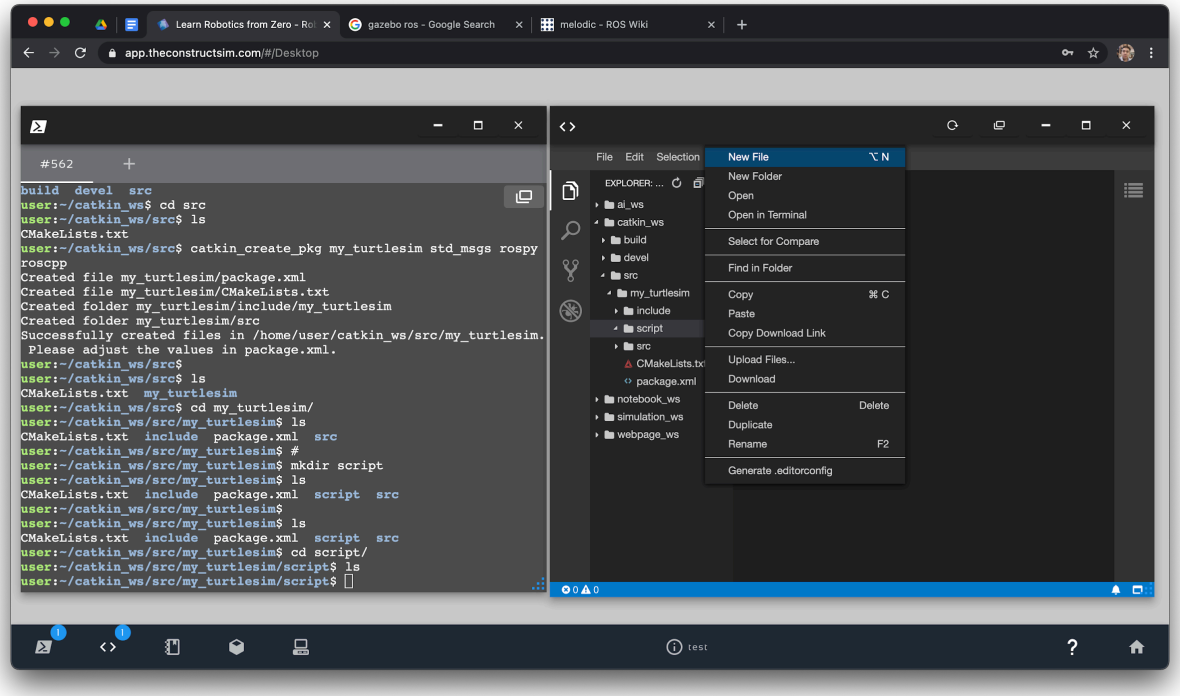
ภาพหลังสร้าง Package ชื่อ my_turtlesim

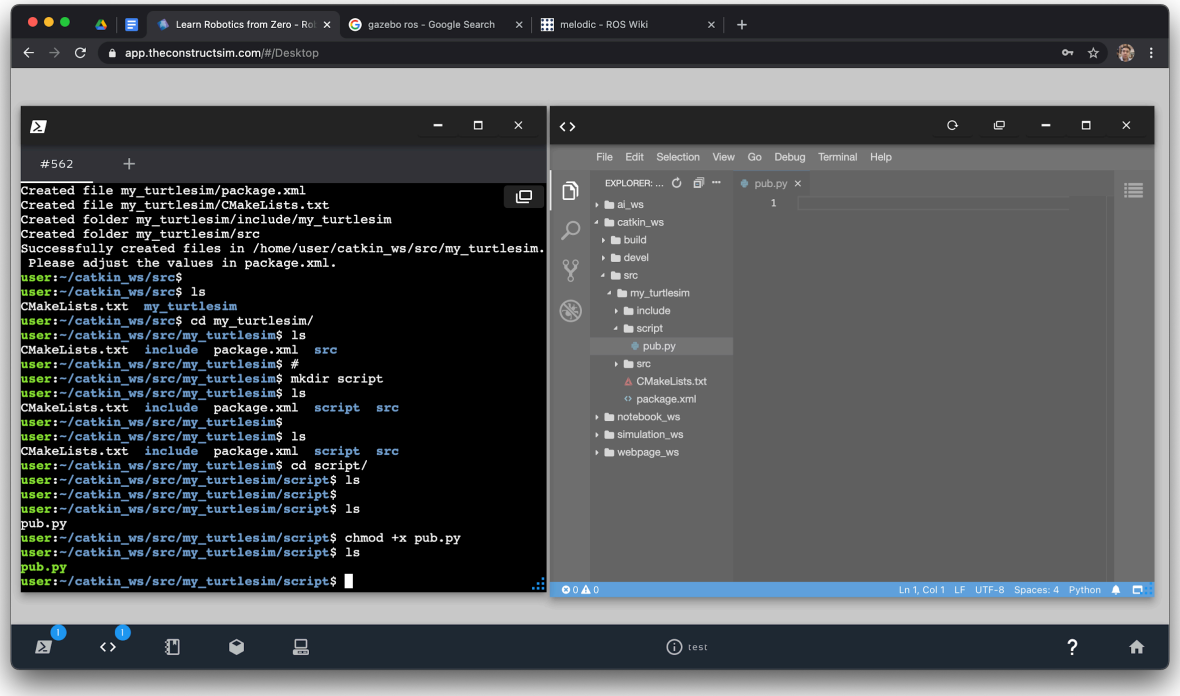


หลังพิมพ์ script



เปิดไฟล์จาก Code Editor


Learn Robotics from Zero - Ro
gazebo ros - Google Search
melodic - ROS Wiki
app.theconstructsim.com/#/Desktop
#562
build devel src
user:~/catkin_ws$ cd src
user:~/catkin_ws/src$ ls
CMakeLists.txt
user:~/catkin_ws/src$ catkin_create_pkg my_turtlesim std_msgs rospy roscpp
Created file my_turtlesim/package.xml
Created file my_turtlesim/CMakeLists.txt
Created folder my_turtlesim/include/my_turtlesim
Created folder my_turtlesim/src
Successfully created files in /home/user/catkin_ws/src/my_turtlesim.
Please adjust the values in package.xml.
user:~/catkin_ws/src$
user:~/catkin_ws/src$ ls
CMakeLists.txt my_turtlesim
user:~/catkin_ws/src$ cd my_turtlesim/
user:~/catkin_ws/src/my_turtlesim$ ls
CMakeLists.txt include package.xml src
user:~/catkin_ws/src/my_turtlesim$ #
user:~/catkin_ws/src/my_turtlesim$ mkdir script
user:~/catkin_ws/src/my_turtlesim$ ls
CMakeLists.txt include package.xml script src
user:~/catkin_ws/src/my_turtlesim$
user:~/catkin_ws/src/my_turtlesim$ ls
CMakeLists.txt include package.xml script src
user:~/catkin_ws/src/my_turtlesim$ cd script/
user:~/catkin_ws/src/my_turtlesim/script$ ls
user:~/catkin_ws/src/my_turtlesim/script$
File Edit Selection
EXPLORER: ...
ai_ws
catkin_ws
build
devel
src
my_turtlesim
include
script
src
CMakeLists.tx
package.xml
notebook_ws
simulation_ws
webpage_ws
New File ⌥N
New Folder
Open
Open in Terminal
Select for Compare
Find in Folder
Copy ⌘C
Paste
Copy Download Link
Upload Files...
Download
Delete Delete
Duplicate
Rename F2
Generate .editorconfig
test


Learn Robotics from Zero - Ro
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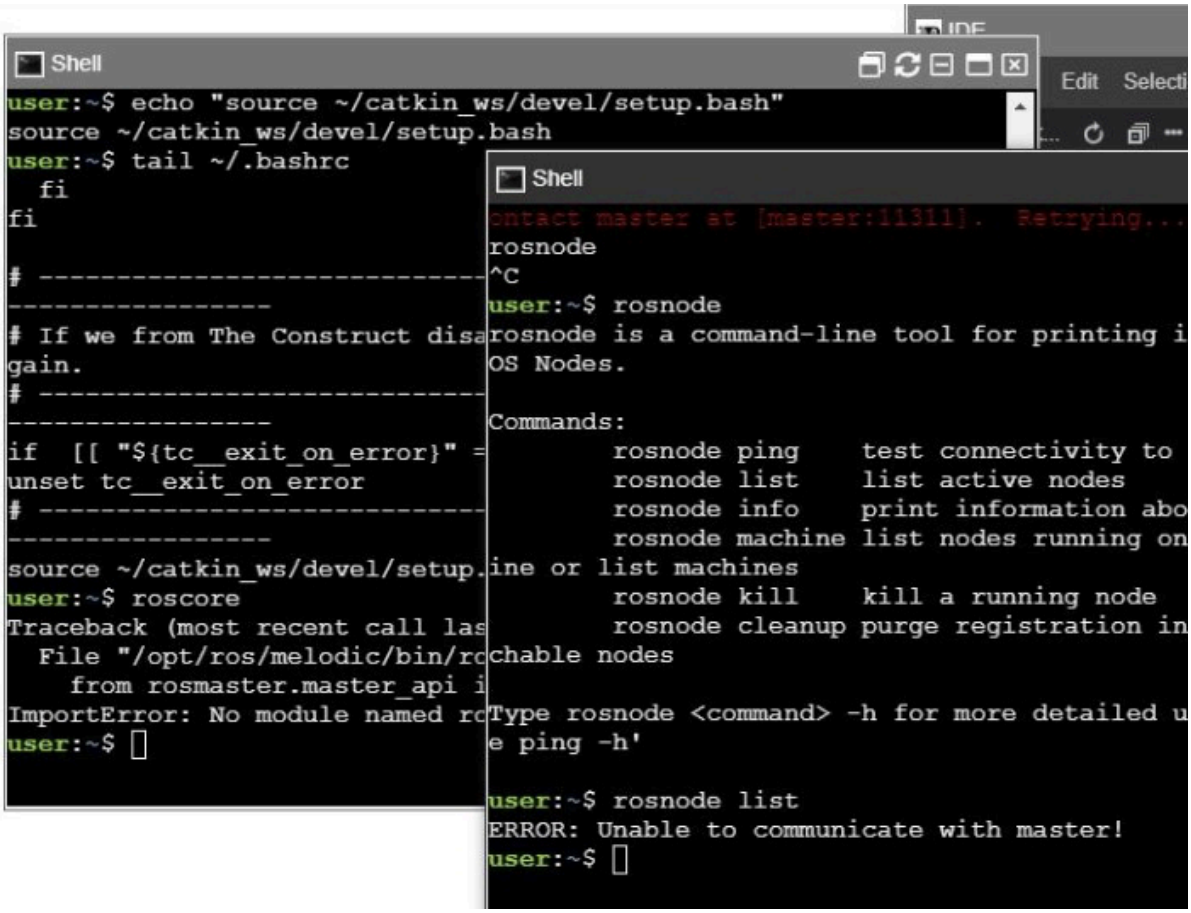
melodic - ROS Wiki
app.theconstructsim.com/#/Desktop
#562
Created file my_turtlesim/package.xml
Created file my_turtlesim/CMakeLists.txt
Created folder my_turtlesim/include/my_turtlesim
Created folder my_turtlesim/src
Successfully created files in /home/user/catkin_ws/src/my_turtlesim.
Please adjust the values in package.xml.
user:~/catkin_ws/src$
user:~/catkin_ws/src$ ls
CMakeLists.txt my_turtlesim
user:~/catkin_ws/src$ cd my_turtlesim/
user:~/catkin_ws/src/my_turtlesim$ ls
CMakeLists.txt include package.xml src
user:~/catkin_ws/src/my_turtlesim$ #
user:~/catkin_ws/src/my_turtlesim$ mkdir script
user:~/catkin_ws/src/my_turtlesim$ ls
CMakeLists.txt include package.xml script src
user:~/catkin_ws/src/my_turtlesim$
user:~/catkin_ws/src/my_turtlesim$ ls
CMakeLists.txt include package.xml script src
user:~/catkin_ws/src/my_turtlesim$ cd script/
user:~/catkin_ws/src/my_turtlesim/script$ ls
user:~/catkin_ws/src/my_turtlesim/script$
user:~/catkin_ws/src/my_turtlesim/script$ ls
pub.py
user:~/catkin_ws/src/my_turtlesim/script$ chmod +x pub.py
user:~/catkin_ws/src/my_turtlesim/script$ ls
pub.py
user:~/catkin_ws/src/my_turtlesim/script$
File Edit Selection View Go Debug Terminal Help
EXPLORER: ...
pub.py
ai_ws
catkin_ws
build
devel
src
my_turtlesim
include
script
pub.py
src
CMakeLists.txt
package.xml
notebook_ws
simulation_ws
webpage_ws
Ln 1, Col 1 LF UTF-8 Spaces: 4 Python
test

Lesson learned



1. ERROR: Unable to communicate with master!

   Solution:
   1. roscore must be running.

2. No module named rosmaster.master_api
   Solution:
   1. Add the workspace to OS Environment variable by

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

3.