

Testing with rotest and GTest

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Table of contents

- 1 Why Automated Testing
- 2 Unit Tests
- 3 Example
- 4 GTest
- 5 rotest
- 6 Next Time

Some Examples

- Gripper Integration of the Last Meeting
 - Interface changed
 - Hardware configuration changed
 - Developer was away
 - A lot of guessing

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- Gripper Integration of the Last Meeting
 - Interface changed
 - Hardware configuration changed
 - Developer was away
 - A lot of guessing
- Ariane 5
 - 370 million US\$ damage
 - Overflow of inertial system led to deactivation
 - Direct usage of Ariane 4 software
 - Lack of exception handling in Ariane 4 code
 - No test of Ariane 4 code within Ariane 5

Regressions

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Violation of a specific part of the expected behaviour of a piece of Software after a code change.

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Solution

Automatically test software on each code change and report results.

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Benefits

- Eases integration
- Finds bugs during development
- Documents API
- Checks refactoring

Unit Test: Examples

Unit to Test

```
1 int Factorial(int n); // Returns the factorial of n
```

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GTest Primer Example

```
1 // Tests factorial of 0.
2 TEST(FactorialTest, HandlesZeroInput) {
3     EXPECT_EQ(1, Factorial(0));
4 }
5
6 // Tests factorial of positive numbers.
7 TEST(FactorialTest, HandlesPositiveInput) {
8     EXPECT_EQ(1, Factorial(1));
9     EXPECT_EQ(2, Factorial(2));
10    EXPECT_EQ(6, Factorial(3));
11    EXPECT_EQ(40320, Factorial(8));
12 }
```

Example Setup

GitHub Project

<http://github.com/steup/Ros-Test-Example>

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git clone https://github.com/steup/Ros-Test-Example.git
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Compile Command

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cd Ros-Test-Example && catkin_make
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Create Documentation

```
cd src/cars && Doxygen common/Doxyfile
```

Accessing Documentation

Webbrowser on `src/cars/doc/html/index.html`

Run the Simulation

Setup Workspace

```
. devel/setup.bash
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Basic Simulation

A simple car simulation using *RVIZ* to show the current state. The cars are remotely controlled using individual nodes. The simulation node handles new cars, state updates and collision checking. The simulation's speed can be set using the `frameRate` parameter.

Run Simulation

```
roslaunch cars run.launch
```

Adding Cars

Adding Cars

Each car has its own unique identifier. The first car is always "BEG_IN_001". The car's id can be set using the `numberPlate` parameter.

Add Car

```
roslaunch cars car.launch numberPlate:=<something unique>
```

Unit Tests

Running Unit Tests

Unit tests are integrated within `catkin` using the `CMakeLists.txt`.

Run Unit Tests

```
catkin_make run_tests
```

Result of Unit Tests

Unit tests report their result in the console after the tests are finished. Additionally, a XML-file containing the results can be found in the build-folder of the workspace. In this case:

`build/test_results/cars/gtest_cars_test.xml`

rotests

Running rotest-Tests

`rotest`-Tests are integrated using `roslaunch`'s XML notion. They are executed using `rotest`. They spawn their own `roscore` on a different port to avoid interfering with an existing instance.

Run Simulation Test

```
rotest cars simHz.test
```

Run Car Test

```
rotest cars carHz.test
```

Result of rotest-Tests

`rotest`-Tests report their result in the console after the tests are finished. However, this is only a brief overview. The full result is an XML-file in the user's `.ros`-folder, in this case:

`.ros/test_results/cars/...`

Writing GTest Tests

Test Environments

The **GTest** Framework needs the declared tests to be executed in a program using the following functions :

InitGoogleTest(...) : This function parses testing relevant command parameters and sets up the environment

RUN_ALL_TESTS() : This function runs all specified tests, outputs the results and returns 0 on success

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Defining Tests

A test is always associated to a test suite and has a unique name. There exist two specifications:

`TEST(Suite, test)` : Declares an isolated test named `test` associated to the test suite `suite`.

`TEST_F(Suite, test)` : Declares a test `test` using a Fixture named after the test suite `suite`.

ASSERT vs. EXPECT

Basic Test Operations

The following test operations are automatically recognized and evaluated by GTest:

`ASSERT_TRUE()` : If passed parameter evaluates to false stops execution of the test and fails it

`EXPECT_TRUE()` : If passed parameter evaluates to false continues with the test, but test fails anyway

...`_EQ()` : Test for equality of items (typically using `==`)

...`_NE()` : Test for inequality of items (typically using `!=`)

...`_LT()` : Test for if first item is less then second item (typically using `<=`)

...`_STREQ()` : Test for equality of two C string ((const) char*)

...`_STRCASEEQ()` : Test for equality of two C string ignoring case ((const) char*)

Fixtures

Definition

A Fixture is class used as an environment template for test execution. It provides a repeatedly created similar environment for each test, isolating the individual test.

Advanced Tests

Advanced Test Operations

The general test operation cannot grasp all language constructs that are test-worthy. One very important example is exception handling. Fortunately, the advanced test operations of *GTest* already contain appropriate operations:

- `..._THROW(statement, exception_type)` : fails if the statement does not throw an exception of type `exception_type`
- `..._NO_THROW(statement)` : fails if the statement throws exception

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Many More

There exist many more specialized test operations in *GTest* to be presented in this talk. Have a look yourself, when you feel the need to!

catkin Integration

CMakeList.txt

Typically, there will be one *GTest* program per packet. This program needs to be registered with Catkin through the `CMakeList.txt` using `catkin_add_gtest`. The signature of the statement is similar to `add_executable`. However, if libraries need to be linked to the test program additional work needs to be done. As a template the following CMake snippet may be used:

```
1  ## Add gtest based cpp test target and link libraries
2  catkin_add_gtest(${PROJECT_NAME}-test src/Test.cpp)
3  if(TARGET ${PROJECT_NAME}-test)
4      target_link_libraries(${PROJECT_NAME}-test
5                          ${catkin_LIBRARIES}
6                          ${PROJECT_NAME})
7  endif()
```

Writing a rostest-Test

rostest roslaunch XML-Files

rostest uses the roslaunch XML description. The tag `<test>` is especially reserved for rostest and is ignored by roslaunch. `<test>` is similar to a node accepting `<param>` and being grouped in a namespace. The code executed by such a node needs to be a set of test suites implemented using GTest. It may be integrated in your CMakeLists.txt using `add_rostest_gtest(name, testFile, GTestSource)`.

```
1 if(CATKIN_ENABLE_TESTING)
2   find_package( rostest REQUIRED )
3   add_rostest_gtest( ${PROJECT_NAME}_test_<name>
4                     launch/<name>.test src/Test_something.cpp )
5   target_link_libraries( ${PROJECT_NAME}_test_<name>
6                         ${catkin_LIBRARIES} ${PROJECT_NAME} )
7 endif()
```

```
1 <launch>
2   <test test-name="<project>_test_<name>"
3       pkg="<project>" type="<project>_test_<name>" />
4 </launch>
```

HzTest

Pre-defined Publish Rate Test

rostopic already provides a pre-build test. The so-called `hztest` tests publish frequency of nodes. It is very configurable using different parameters like:

`topic` : Topic to listen to (namespace aware)

`hz` : target frequency of the publisher

`hzerror` : allowed difference between measured frequency and
hz value

`test_duration` : how long the test should run

HzTest Example

```
1 <launch>
2   <include file="$(find cars)/launch/sim.launch">
3     <arg name="frameRate" value="0.1"/>
4   </include>
5   <test test-name="hztest_test" pkg="roctest" type="hztest"
6     name="simHz" >
7     <param name="topic" value="roads" />
8     <param name="hz" value="10" />
9     <param name="hzerror" value="1" />
10    <param name="test_duration" value="5.0" />
11  </test>
12 </launch>
```

Next Time

- Testing interfaces
- Mocking interfaces using [GMock](#)
- Using [selftest](#) to test on run time
- Using [git](#) to find regressions