



Programming for Robotics

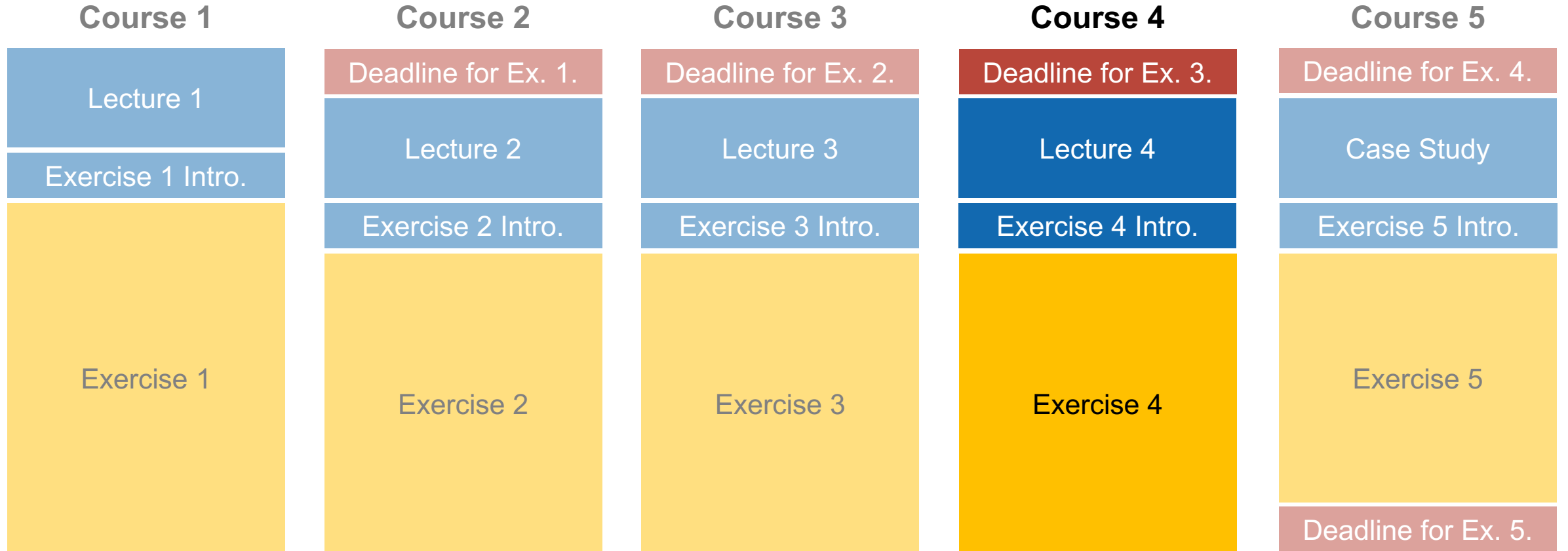
Introduction to ROS

Course 4

Péter Fankhauser, Dominic Jud, Martin Wermelinger
Prof. Dr. Marco Hutter



Course Structure



Overview Course 4

- ROS services
- ROS actions (actionlib)
- ROS time
- ROS bags

ROS Services

- Request/response communication between nodes is realized with *services*
 - The *service server* advertises the service
 - The *service client* accesses this service
- Similar in structure to messages, services are defined in **.srv* files

List available services with

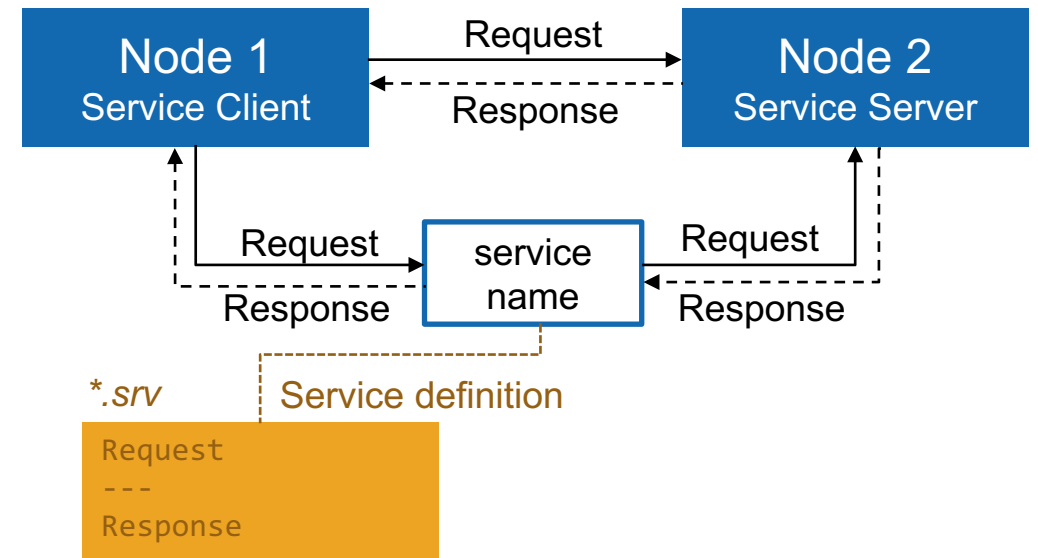
```
> rosservice list
```

Show the type of a service

```
> rosservice type /service_name
```

Call a service with the request contents

```
> rosservice call /service_name args
```



More info

<http://wiki.ros.org/Services>

ROS Services

Examples

std_srvs/Trigger.srv

```
---  
bool success  
string message
```

Request

Response

nav_msgs/GetPlan.srv

```
geometry_msgs/PoseStamped start  
geometry_msgs/PoseStamped goal  
float32 tolerance  
---  
nav_msgs/Path plan
```

ROS Service Example

Starting a *roscore* and a *add_two_ints_server* node

In console nr. 1:

Start a *roscore* with

```
> roscore
```

In console nr. 2:

Run a service demo node with

```
> rosruncpp_tutorials add_two_ints_server
```

```
PARAMETERS
* /roscpp_tutorials: indigo
* /roscpp_tutorials: 1.11.20

NODES

auto-starting new master
process[master]: started with pid [6708]
ROS_MASTER_URI=http://ubuntu:11311/

setting /run_id to 6c1852aa-e961-11e6-8543-000c297bd368
process[roscpp_tutorials-1]: started with pid [6721]
started core service [/roscpp_tutorials]
```

```
student@ubuntu:~$ rosruncpp_tutorials add_two_ints_server
```

ROS Service Example

Console Nr. 3 – Analyze and call service

See the available services with

```
> rosservice list
```

```
student@ubuntu:~$ rosservice list
/add_two_ints
/add_two_ints_server/get_loggers
/add_two_ints_server/set_logger_level
/rosout/get_loggers
/rosout/set_logger_level
```

See the type of the service with

```
> rosservice type /add_two_ints
```

```
student@ubuntu:~$ rosservice type /add_two_ints
roscpp_tutorials/TwoInts
```

Show the service definition with

```
> rossrv show roscpp_tutorials/TwoInts
```

```
student@ubuntu:~$ rossrv show roscpp_tutorials/TwoInts
int64 a
int64 b
---
int64 sum
```

Call the service (use Tab for auto-complete)

```
> rosservice call /add_two_ints "a: 10
b: 5"
```

```
student@ubuntu:~$ rosservice call /add_two_ints "a: 10
b: 5"
sum: 15
```

ROS C++ Client Library (*roscpp*)

Service Server

- Create a service server with


```
ros::ServiceServer service =
  nodeHandle.advertiseService(service_name,
                              callback_function);
```
- When a service request is received, callback function is called with the request as argument
- Fill in the response to the response argument
- Return to function with true to indicate that it has been executed properly

add_two_ints_server.cpp

```
#include <ros/ros.h>
#include <roscpp_tutorials/TwoInts.h>

bool add(roscpp_tutorials::TwoInts::Request &request,
         roscpp_tutorials::TwoInts::Response &response)
{
  response.sum = request.a + request.b;
  ROS_INFO("request: x=%ld, y=%ld", (long int)request.a,
           (long int)request.b);
  ROS_INFO(" sending back response: [%ld]",
           (long int)response.sum);
  return true;
}

int main(int argc, char **argv)
{
  ros::init(argc, argv, "add_two_ints_server");
  ros::NodeHandle nh;
  ros::ServiceServer service =
    nh.advertiseService("add_two_ints", add);
  ros::spin();
  return 0;
}
```

More info

<http://wiki.ros.org/roscpp/Overview/Services>

ROS C++ Client Library (*roscpp*)

Service Client

- Create a service client with

```
ros::ServiceClient client =
  nodeHandle.serviceClient<service_type>
    (service_name);
```

- Create service request contents
`service.request`

- Call service with

```
client.call(service);
```

- Response is stored in `service.response`

More info

<http://wiki.ros.org/roscpp/Overview/Services>

add_two_ints_client.cpp

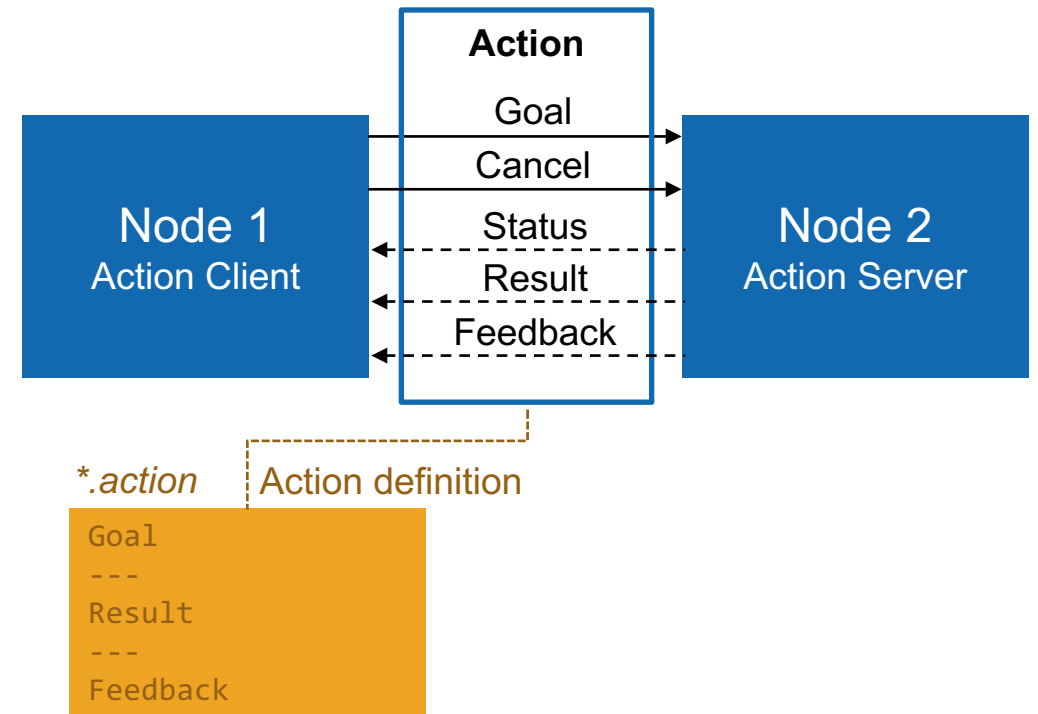
```
#include <ros/ros.h>
#include <roscpp_tutorials/TwoInts.h>
#include <cstdlib>

int main(int argc, char **argv) {
  ros::init(argc, argv, "add_two_ints_client");
  if (argc != 3) {
    ROS_INFO("usage: add_two_ints_client X Y");
    return 1;
  }

  ros::NodeHandle nh;
  ros::ServiceClient client =
    nh.serviceClient<roscpp_tutorials::TwoInts>("add_two_ints");
  roscpp_tutorials::TwoInts service;
  service.request.a = atoi(argv[1]);
  service.request.b = atoi(argv[2]);
  if (client.call(service)) {
    ROS_INFO("Sum: %ld", (long int)service.response.sum);
  } else {
    ROS_ERROR("Failed to call service add_two_ints");
    return 1;
  }
  return 0;
}
```

ROS Actions (actionlib)

- Similar to service calls, but provide possibility to
 - Cancel the task (preempt)
 - Receive feedback on the progress
- Best way to implement interfaces to time-extended, goal-oriented behaviors
- Similar in structure to services, action are defined in **.action* files
- Internally, actions are implemented with a set of topics



More info

<http://wiki.ros.org/actionlib>

<http://wiki.ros.org/actionlib/DetailedDescription>

ROS Actions (actionlib)

Averaging.action

```
int32 samples
---
float32 mean
float32 std_dev
---
int32 sample
float32 data
float32 mean
float32 std_dev
```

Goal

Result

Feedback

FollowPath.action

```
navigation_msgs/Path path
---
bool success
---
float32 remaining_distance
float32 initial_distance
```

ROS Parameters, Dynamic Reconfigure, Topics, Services, and Actions Comparison

	Parameters	Dynamic Reconfigure	Topics	Services	Actions
Description	Global constant parameters	Local, changeable parameters	Continuous data streams	Blocking call for processing a request	Non-blocking, preemptable goal oriented tasks
Application	Constant settings	Tuning parameters	One-way continuous data flow	Short triggers or calculations	Task executions and robot actions
Examples	Topic names, camera settings, calibration data, robot setup	Controller parameters	Sensor data, robot state	Trigger change, request state, compute quantity	Navigation, grasping, motion execution

ROS Time

- Normally, ROS uses the PC's system clock as time source (*wall time*)
- For simulations or playback of logged data, it is convenient to work with a simulated time (pause, slow-down etc.)
- To work with a simulated clock:
 - Set the `/use_sim_time` parameter


```
> roseth param set use_sim_time true
```
 - Publish the time on the topic `/clock` from
 - Gazebo (enabled by default)
 - ROS bag (use option `--clock`)

- To take advantage of the simulated time, you should always use the ROS Time APIs:

- **ros::Time**

```
ros::Time begin = ros::Time::now();
double secs = begin.toSec();
```

- **ros::Duration**

```
ros::Duration duration(0.5); // 0.5s
```

- **ros::Rate**

```
ros::Rate rate(10); // 10Hz
```

- If wall time is required, use `ros::WallTime`, `ros::WallDuration`, and `ros::WallRate`

More info

<http://wiki.ros.org/Clock>

<http://wiki.ros.org/roscpp/Overview/Time>

ROS Bags

- A *bag* is a format for storing message data
- Binary format with file extension *.bag
- Suited for logging and recording datasets for later visualization and analysis

Record all topics in a bag

```
> rosbag record --all
```

Record given topics

```
> rosbag record topic_1 topic_2 topic_3
```

Stop recording with Ctrl + C

Bags are saved with start date and time as file name in the current folder (e.g. 2017-02-07-01-27-13.bag)

Show information about a bag

```
> rosbag info bag_name.bag
```

Read a bag and publish its contents

```
> rosbag play bag_name.bag
```

Playback options can be defined e.g.

```
> rosbag play --rate=0.5 bag_name.bag
```

<code>--rate=factor</code>	Publish rate factor
<code>--clock</code>	Publish the clock time (set param use_sim_time to true)
<code>--loop</code>	Loop playback etc.

More info

<http://wiki.ros.org/rosbag/Commandline>

Further References

- **ROS Wiki**
 - <http://wiki.ros.org/>
- **Installation**
 - <http://wiki.ros.org/ROS/Installation>
- **Tutorials**
 - <http://wiki.ros.org/ROS/Tutorials>
- **Available packages**
 - <http://www.ros.org/browse/>
- **ROS Cheat Sheet**
 - https://github.com/ros/cheatsheet/releases/download/0.0.1/ROSCheatsheet_catkin.pdf
- **ROS Best Practices**
 - https://github.com/ethz-asl/ros_best_practices/wiki
- **ROS Package Template**
 - https://github.com/ethz-asl/ros_best_practices/tree/master/ros_package_template

Contact Information

ETH Zurich

Robotic Systems Lab
Prof. Dr. Marco Hutter
LEE J 225
Leonhardstrasse 21
8092 Zurich
Switzerland

<http://www.rsl.ethz.ch>

Lecturers

Péter Fankhauser (pfankhauser@ethz.ch)
Dominic Jud
Martin Wermelinger

Course website:

<http://www.rsl.ethz.ch/education-students/lectures/ros.html>