Introduction to Cognitive Robotics

Module 10: Using Turtlesim with CRAM
Lecture 7: Automatically choosing a process module for a motion

www.cognitiverobotics.net

The CRAM Beginner Tutorials

Based on CRAM tutorials
http://cram-system.org/tutorials

Automatically Choosing a Process Module for a Motion

Based on Automatically Choosing a Process Module for a Motion
http://cram-system.org/tutorials/beginner/assigning_actions_2

Automatically Choosing a Process Module for a Motion

In previous example, we called a process module explicitly using `cram-process-modules:pm-execute` providing it with appropriate designators

Sometimes it is useful to reason about what process module to use to handle a given designator ...

Automatically Choosing a Process Module for a Motion

Setting up fact groups to select a process module

We will put this in a new file `selecting-process-modules.lisp`

Automatically Choosing a Process Module for a Motion

As before, when developing new code, we need to

- (Update the dependencies in package.xml)
- Update the dependencies in cram-my-beginner-tutorial.asd
- (Update the dependencies in package.lisp)
- Add the new code to selecting-process-modules.lisp
- Test the code
  - Run the ROS master
  - Run the Lisp REPL, loading the new program, creating a ROS node
  - Run turtlesim
  - Run turtlesim_teleop
  - Call the new functions

We don't need to do this as there are no new packages being used

We need to do this because we are going to put the new code in a separate file

We don't need to do this as there are no new packages being used

We will place the new code is a separate Lisp file

Automatically Choosing a Process Module for a Motion

Update the ASDF dependencies

Make sure you are in the cram_my_beginner_tutorial sub-directory

```
~$ cd ~/workspace/ros/src/cram_my_beginner_tutorial
~/workspace/ros/src/cram_my_beginner_tutorial$
```

Automatically Choosing a Process Module for a Motion

Update the ASDF dependencies

Edit cram-my-beginner-tutorial.asd

```
~/workspace/ros/src/cram_my_beginner_tutorial$ emacs cram-my-beginner-tutorial.asd
```

Automatically Choosing a Process Module for a Motion

Update the ASDF dependencies

```
(defsystem cram-my-beginner-tutorial
   :depends-on (roslisp cram-language
                turtlesim-msg turtlesim-srv
                cl-transforms geometry_msgs-msg
                cram-designators cram-prolog
                cram-process-modules cram-language-designator-support
                cram-executive)
   :components
   ((:module "src"
             :components
             ((:file "package")
              (:file "control-turtlesim" :depends-on ("package"))
              (:file "simple-plans" :depends-on ("package" "control-turtlesim"))
              (:file "motion-designators" :depends-on ("package"))
              (:file "process-modules" :depends-on ("package"
                                                    "control-turtlesim"
                                                    "simple-plans"
                                                    "motion-designators"))
              (:file "selecting-process-modules" :depends-on ("package"
                                                              "motion-designators"
                                                              "process-modules"))))))
```

Add this line

Add these lines

Automatically Choosing a Process Module for a Motion

Create a new Lisp file for the process modules code

Make sure you are in the cram_my_beginner_tutorial/src sub-directory

```
~$ cd ~/workspace/ros/src/cram_my_beginner_tutorial/src
~/workspace/ros/src/cram_my_beginner_tutorial/src$
```

Automatically Choosing a Process Module for a Motion

Create a new Lisp file for the process modules code

Edit selecting-process-modules.lisp

```
~/workspace/ros/src/cram_my_beginner_tutorial/src$ emacs selecting-process-modules.lisp
```

Automatically Choosing a Process Module for a Motion

Create a new Lisp file for the process modules code

Edit selecting-process-modules.lisp

Copy and paste the code from the following slide

```
(in-package :tut)

(def-fact-group available-turtle-process-modules (available-process-module
                                                  matching-process-module)
  (<- (available-process-module turtlesim-navigation))
  (<- (available-process-module turtlesim-pen-control))

  (<- (matching-process-module ?desig turtlesim-navigation)
    (desig-prop ?desig (:type :driving)))
  (<- (matching-process-module ?desig turtlesim-navigation)
    (desig-prop ?desig (:type :moving)))
  (<- (matching-process-module ?desig turtlesim-pen-control)
    (desig-prop ?desig (:type :setting-pen))))

(defun perform-some-motion (motion-desig)
  (top-level
    (with-process-modules-running (turtlesim-navigation turtlesim-pen-control)
      (cram-executive:perform motion-desig))))
```

```
(in-package :tut)

(def-fact-group available-turtle-process-modules (available-process-module
                                                  matching-process-module)
  (<- (available-process-module turtlesim-navigation))
  (<- (available-process-module turtlesim-pen-control))

  (<- (matching-process-module ?desig turtlesim-navigation)
    (desig-prop ?desig (:type :driving)))
  (<- (matching-process-module ?desig turtlesim-navigation)
    (desig-prop ?desig (:type :moving)))
  (<- (matching-process-module ?desig turtlesim-pen-control)
    (desig-prop ?desig (:type :setting-pen))))

(defun perform-some-motion (motion-desig)
  (top-level
    (with-process-modules-running (turtlesim-navigation turtlesim-pen-control)
      (cram-executive:perform motion-desig))))
```

This fact group extends `cram-process-modules:matching-process-module` and `cram-process-modules:available-process-module`

There are two process modules available for automatically matching them to designators

Use `turtlesim-navigation` with `(:type :driving)`

Use `turtlesim-navigation` with `(:type :moving)`

Use `turtlesim-pen-control` with `(:type :setting-pen)`

We use `perform` with a motion designator instead of calling `pm-execute` with a process module *and* an motion designator ... allow the system to decide what process module to use

Automatically Choosing a Process Module for a Motion

Now, let's experiment with this code

First, we need to make sure a ROS master is running

If you have not already done it, open a terminal and enter

```
~$ roscore
```

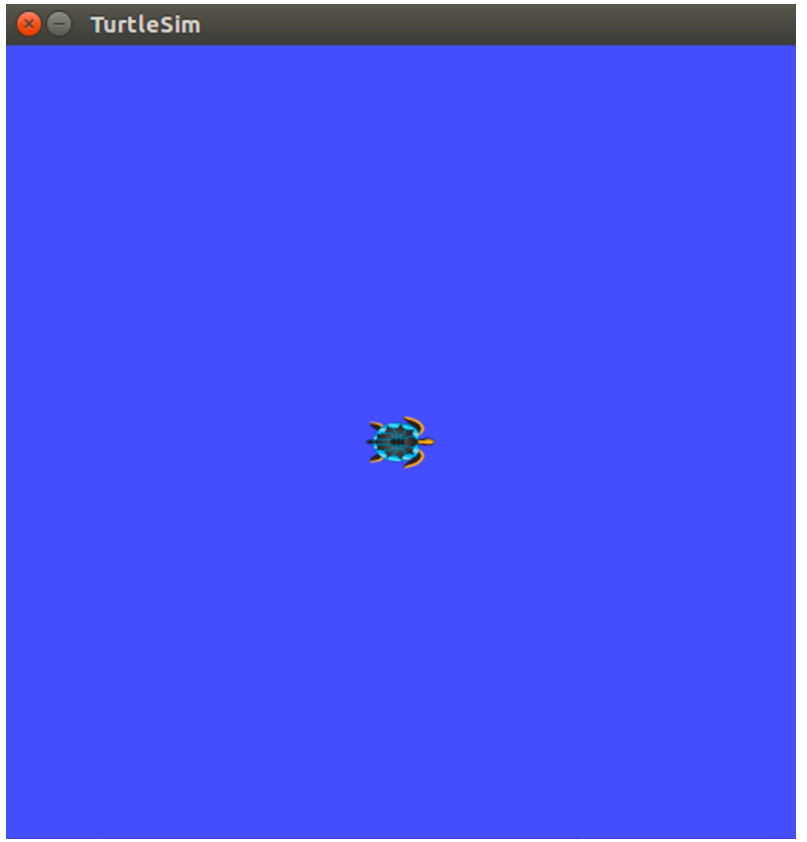
Automatically Choosing a Process Module for a Motion

Now, start turtlesim

Open a new terminal and enter

```
~$ rosrun turtlesim turtlesim_node
```

This is what you should see



Automatically Choosing a Process Module for a Motion

Launch the Lisp REPL

If you have not already done it, open a terminal and enter

```
~/workspace/ros$ roslisp_repl
```

Load the system

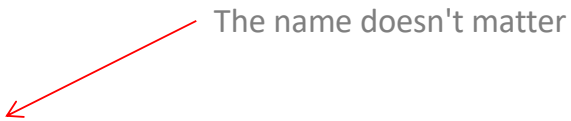
```
CL-USER> (ros-load:load-system "cram_my_beginner_tutorial" :cram-my-beginner-tutorial)
```

Switch to the package

```
CL-USER> (in-package :tut)
TUT>
```

Automatically Choosing a Process Module for a Motion

Start a ROS node




```
TUT> (start-ros-node "turtle1")
[(ROSLISP TOP) INFO] 1292688669.674: Node name is turtle1
[(ROSLISP TOP) INFO] 1292688669.687: Namespace is /
[(ROSLISP TOP) INFO] 1292688669.688: Params are NIL
[(ROSLISP TOP) INFO] 1292688669.689: Remappings are:
[(ROSLISP TOP) INFO] 1292688669.691: master URI is 127.0.0.1:11311
[(ROSLISP TOP) INFO] 1292688670.875: Node startup complete
```

Automatically Choosing a Process Module for a Motion

Call the function we wrote to perform the initialization

```
TUT> (init-ros-turtle "turtle1")
```

Use turtle1 ... remember, this forms the prefix on the topic names
This is the name of the first turtle that turtlesim spawns

Automatically Choosing a Process Module for a Motion

First, let's make a couple of designators for testing

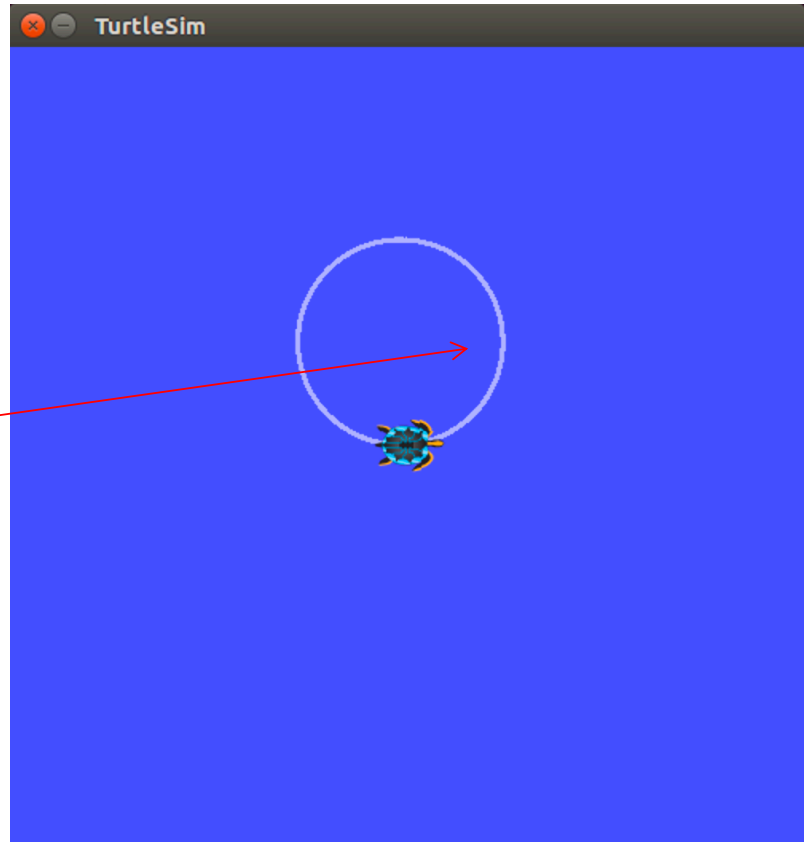
```
TUT> (defparameter *fast-circle* (desig:a motion (type driving) (speed 10) (angle 7)))
*FAST-CIRCLE*
TUT> (defparameter *goal* (desig:a motion (type moving) (goal (1 9 0))))
*GOAL*
TUT> (defparameter *pen-off* (desig:a motion (type setting-pen) (off 1)))
*PEN-OFF*
```

Automatically Choosing a Process Module for a Motion

Now, let's perform some motions

TUT> (perform-some-motion *fast-circle*)

The turtle drives in a circular path



Automatically Choosing a Process Module for a Motion

Now, let's perform some motions

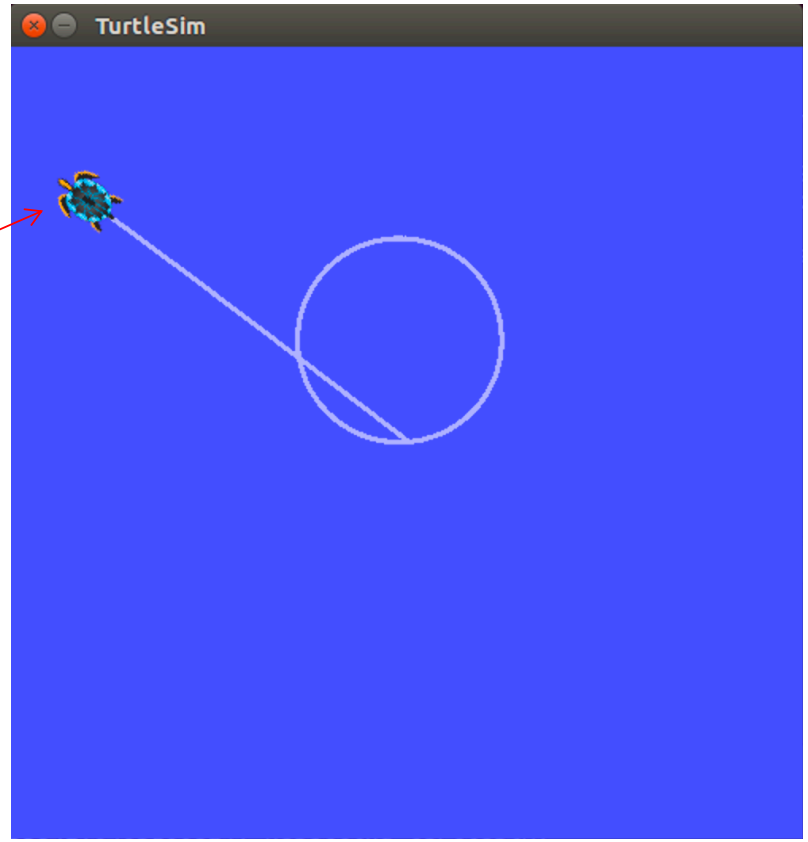
```
TUT> (perform-some-motion *fast-circle*)
[(TURTLE-PROCESS-MODULES) INFO] 1501142699.638: TurtleSim navigation invoked with motion designator `#<MOTION-DESIGNATOR ((TYPE
                                                 DRIVING)
                                                (SPEED
                                                 10)
                                                (ANGLE
                                                 7)) {1009D756C3}>'.
```

Automatically Choosing a Process Module for a Motion

Now, let's perform some motions

TUT> (perform-some-motion *goal*)

The turtle drives to the goal



Automatically Choosing a Process Module for a Motion

Now, let's perform some motions

```
TUT> (perform-some-motion *goal*)
[(TURTLE-PROCESS-MODULES) INFO] 1501142702.867: TurtleSim navigation invoked with motion designator `#<MOTION-DESIGNATOR ((TYPE
                                                 MOVING)
                                                (GOAL
                                                 (1 9
                                                  0))) {10068602D3}>'.
T
```

Automatically Choosing a Process Module for a Motion

Now, lets turn the pen off and do the same thing again

- If the turtlesim environment gets a bit messy,
  you can clear the background by entering the following from a terminal

  ~/workspace/ros/src/cram_my_beginner_tutorial/src$ rosservice call /clear

- Or you can reset it completely by entering the following from a terminal
  (this creates a new turtle in the default pose)

  ~/workspace/ros/src/cram_my_beginner_tutorial/src$ rosservice call /reset

Let's do this so that the turtle is repositioned back at the centre

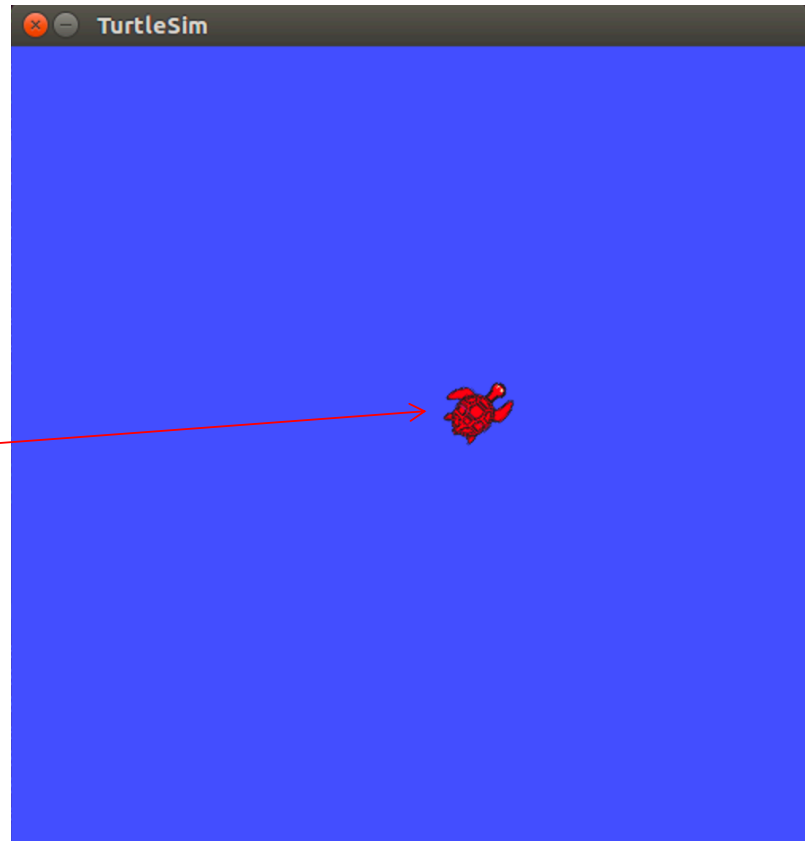
Automatically Choosing a Process Module for a Motion

Now, let's perform some motions

TUT> (perform-some-motion *pen-off*)

TUT> (perform-some-motion *fast-circle*)

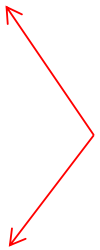
The turtle drives in a circular path (really!)



Automatically Choosing a Process Module for a Motion

Now, lets turn the pen off and do the same thing again

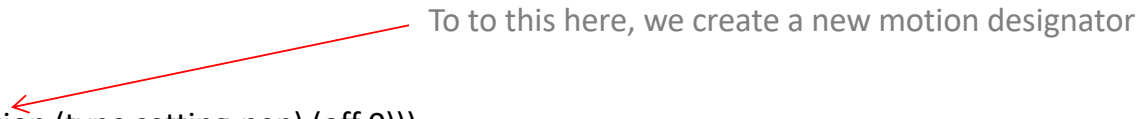
```
TUT> (perform-some-motion *pen-off*)
[(TURTLE-PROCESS-MODULES) INFO] 1504786623.566: TurtleSim pen control invoked with motion designator `#<MOTION-DESIGNATOR ((TYPE
                                 SETTING-PEN)
                                (OFF
                                 1)) {1002BB26A3}>'.
[TURTLESIM-SRV:SETPEN-RESPONSE]
TUT> (perform-some-motion *fast-circle*)
[(TURTLE-PROCESS-MODULES) INFO] 1504786630.845: TurtleSim navigation invoked with motion designator `#<MOTION-DESIGNATOR ((TYPE
                                 DRIVING)
                                (SPEED
                                 10)
                                (ANGLE
                                 7)) {1002BB2CD3}>'.
```



These execute in parallel now

Automatically Choosing a Process Module for a Motion

Turn the pen back on




```
TUT> (perform-some-motion (desig:a motion (type setting-pen) (off 0)))
[(TURTLE-PROCESS-MODULES) INFO] 1504786654.744: TurtleSim pen control invoked with motion designator `#<MOTION-DESIGNATOR ((TYPE
                                                 SETTING-PEN)
                                                (OFF
                                                 0)) {1002D6D763}>'.
[TURTLESIM-SRV:SETPEN-RESPONSE]
```

CRAM Beginner Tutorials

Create a CRAM Package	http://cram-system.org/tutorials/beginner/package_for_turtlesim
Controlling turtlesim from CRAM	http://cram-system.org/tutorials/beginner/controlling_turtlesim_2
Implementing simple plans to move a turtle	http://cram-system.org/tutorials/beginner/simple_plans
Using Prolog for reasoning	http://cram-system.org/tutorials/beginner/cram_prolog
Creating motion designators for the TurtleSim	http://cram-system.org/tutorials/beginner/motion_designators
Creating process modules	http://cram-system.org/tutorials/beginner/process_modules_2
Automatically choosing a process module for a motion	http://cram-system.org/tutorials/beginner/assigning_actions_2

Background Reading

G. Kazhoyan, Lecture notes: Robot Programming with Lisp 7. Coordinate Transformations, TF, ActionLib, slides 5-8.
`https://ai.uni-bremen.de/_media/teaching/7_more_ros.pdf`

`http://wiki.ros.org/tf/Overview/Transformations`

T. Rittweiler, CRAM – Design and Implementation of a Reactive Plan Language, Bachelor Thesis, Technical University of Munich, 2010.
`https://common-lisp.net/~trittweiler/bachelor-thesis.pdf`