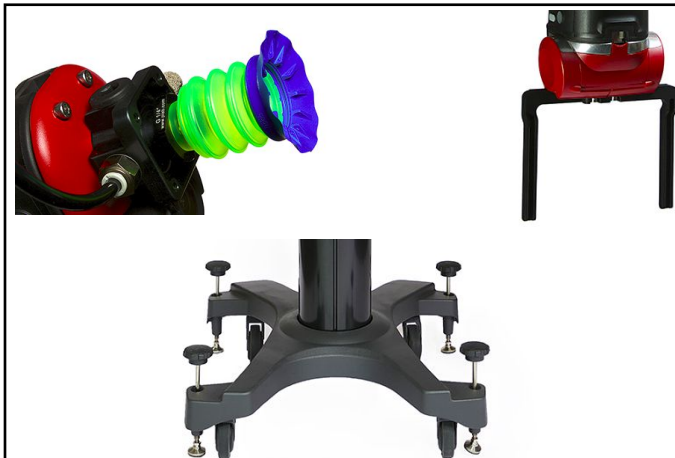
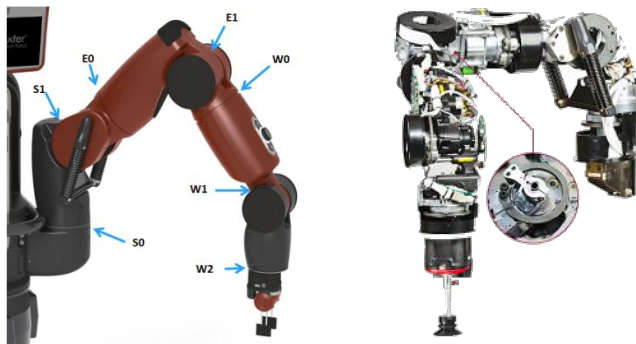
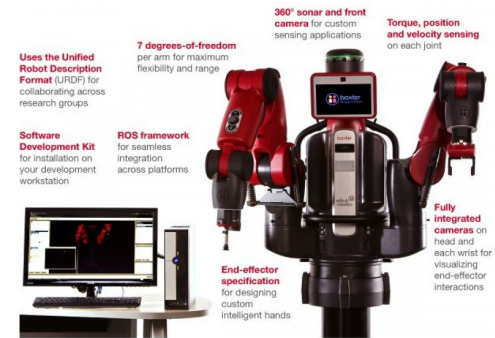


Programación del robot Baxter

Clase 12
Ing. Alexander López



BY THE NUMBERS

Baxter is cheaper and more quickly deployed than are traditional robots. In a decade, it might be able to tackle tens of millions of manufacturing and service jobs.

How much it costs

BAXTER:

\$22,000, all in

TYPICAL INDUSTRIAL ROBOT:

\$100,000

plus another

\$200,000

or more in programming costs

How long it takes to get running

BAXTER:

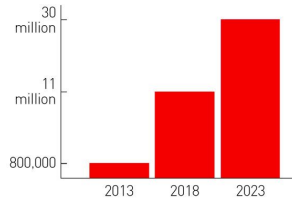
1 hour

to unpack and set up, plus five minutes to train on the first job

TYPICAL INDUSTRIAL ROBOT:

Months

How many jobs Baxter could potentially replace in the U.S.



A ROBOT'S EMOTIONS

Brooks didn't set out to build a humanoid robot, but he found that giving Baxter a face was the most intuitive way to communicate information.



NEUTRAL

Ready for training



ASLEEP

On standby



CONCENTRATING

Learning a task



FOCUSED

Working away without a problem



SURPRISED

A human has approached



CONFUSED

Having trouble finding an object or otherwise completing a task



SAD

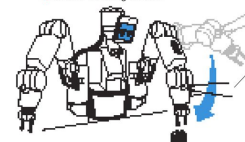
Given up trying to complete a task; there's a problem



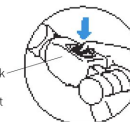
HOW TO TRAIN A ROBOT, IN SEVEN EASY STEPS

Baxter can be trained by anyone, simply by guiding one or both of its arms and following menu prompts on the monitor that serves as Baxter's "head." Screen selections are made by using a sort of mouse built into Baxter's arm. Here's how to train Baxter to pick up widgets and stuff them into boxes:

1. Select training mode.



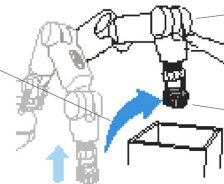
2. Grab one of Baxter's arms and swing its "hand" over the widget, and click to indicate that this is the object to be grabbed.



3. A camera in Baxter's hand will center on the widget and display the image on the screen; confirm with a click that this is the right sort of object.

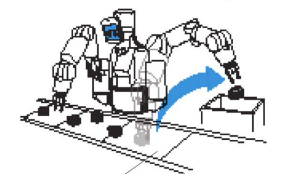


4. Baxter will grab the object. Swing the arm over the four corners of the box, and click to indicate that this is the destination for the widget.



5. Click to confirm that Baxter is to insert the widget into the box.

6. Baxter will put the object into the box, using sensors to guide the widget in. Click to confirm that this is the entire task.



7. Run the conveyor. As long as widgets appear in roughly the same area, Baxter will identify, grab, and box them. Its facial expressions will indicate if it is struggling or working smoothly.



Crear workspace

```
alex@alex-X555LA: ~/baxter_ws
alex@alex-X555LA:~$ mkdir -p baxter_ws/src
alex@alex-X555LA:~$ ls
baxter_ws  Documents  examples.desktop  Pictures  Templates
Desktop    Downloads  Music             Public    Videos
alex@alex-X555LA:~$ cd baxter_ws/
alex@alex-X555LA:~/baxter_ws$ catkin_make
Base path: /home/alex/baxter_ws
Source space: /home/alex/baxter_ws/src
Build space: /home/alex/baxter_ws/build
Devel space: /home/alex/baxter_ws/devel
Install space: /home/alex/baxter_ws/install
Creating symlink /home/alex/baxter_ws/src/CMakeLists.txt pointing to "/opt/ros/indigo/share/catkin/cmake/toplevel.cmake"
####
-- Running command "cmake /home/alex/baxter_ws/src -DCMAKE_INSTALL_PREFIX=/home/alex/baxter_ws/install -c un
tx Makefiles" in "/home/alex/baxter_ws/build"
####
-- The C compiler identification is GNU 4.8.4
-- The CXX compiler identification is GNU 4.8.4
-- Check for working C compiler: /usr/bin/cc
-- Check for working C compiler: /usr/bin/cc -- works
-- Detecting C compiler ABI info
-- Detecting C compiler ABI info - done
```

Especificar la configuración del WS

```
alex@alex-X555LA:~$ sudo gedit .bashrc
[sudo] password for alex:
(gedit) .bashrc(-) - gedit
File Edit View Search Tools Documents Help
p.D by
by
(gedit) .bashrc X
# Please see:
# You may want to put all your additions into a separate file like
# ~/.bash_aliases, instead of adding them here directly.
# See /usr/share/doc/bash-doc/examples in the bash-doc package.

if [ -f ~/.bash_aliases ]; then
    . ~/.bash_aliases
fi

# enable programmable completion features (you don't need to enable
# this, if it's already enabled in /etc/bash.bashrc and /etc/profile
# sources /etc/bash.bashrc).
if ! shopt -oq posix; then
    if [ -f /usr/share/bash-completion/bash_completion ]; then
        . /usr/share/bash-completion/bash_completion
    elif [ -f /etc/bash_completion ]; then
        . /etc/bash_completion
    fi
fi

source /opt/ros/indigo/setup.bash
source /home/alex/baxter_ws/devel/setup.bash

Plain Text - Tab Width: 8 - Ln 114, Col 3 JNS
```

Instalar las dependencias

```
alex@alex-X555LA:~$ sudo apt-get install git-core python-argparse python-wstool
python-vstools python-roscpp ros-indigo-control-msgs ros-indigo-joy-stick-driver

alex@alex-X555LA:~$
git-core set to manually installed.
libpython2.7-stdeb is already the newest version.
libpython2.7-stdeb set to manually installed.
python-roscpp is already the newest version.
python-roscpp set to manually installed.
python-vstools is already the newest version.
python-vstools set to manually installed.
python-wstool is already the newest version.
python-wstool set to manually installed.
ros-indigo-control-msgs is already the newest version.
ros-indigo-control-msgs set to manually installed.
The following extra packages will be installed:
  evenu-tools evtest joystick libicudtl1 libevent1 libspnav-dev libspnav0
  libusb-dev python-bluez python-cvdl ros-indigo-joy ros-indigo-ps3joy
  ros-indigo-spacenav-node ros-indigo-wlnote spacenavd
The following NEW packages will be installed:
  evenu-tools evtest joystick libicudtl1 libevent1 libspnav-dev libspnav0
  libusb-dev python-bluez python-cvdl ros-indigo-joy
  ros-indigo-joy-stick-drivers ros-indigo-ps3joy ros-indigo-spacenav-node
  ros-indigo-wlnote spacenavd
0 upgraded, 16 newly installed, 0 to remove and 0 not upgraded.
Need to get 493 kB of archives.
After this operation, 2.896 kB of additional disk space will be used.
Do you want to continue? [Y/n] Y
```

Descargar e instalar los paquetes

```
alex@alex-X555LA: ~/baxter_ws/src
alex@alex-X555LA:~$ cd baxter_ws/src/
alex@alex-X555LA:~/baxter_ws/src$ wstool init .
Writing /home/alex/baxter_ws/src/.rosinstall
update complete.
alex@alex-X555LA:~/baxter_ws/src$ wstool merge https://raw.githubusercontent.com/
/bethinkRobotics/baxter/master/baxter_sdk.rosinstall
Performing actions:
  Add new elements:
    baxter, baxter_common, baxter_examples, baxter_interface, baxter_tools
Config changed, maybe you need run wstool update to update SCM entries.
Overwriting /home/alex/baxter_ws/src/.rosinstall
update complete.
alex@alex-X555LA:~/baxter_ws/src$ wstool update
```

Compilando los paquetes

```
alex@alex-X555LA:~/baxter_ws
alex@alex-X555LA:~$ cd baxter_ws/
alex@alex-X555LA:~/baxter_ws$ catkin_make
```

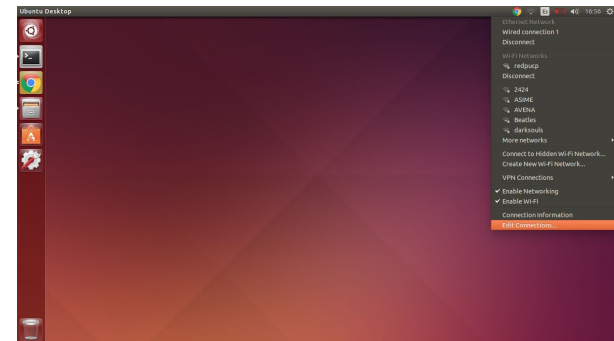
```
alex@alex-X555LA:~/baxter_ws
-- traversing 9 packages in topological order:
--   - baxter_common (metapackage)
--   - baxter_description
--   - baxter_sdk (metapackage)
--   - rethink_ee_description
--   - baxter_maintenance_msgs
--   - baxter_core_msgs
--   - baxter_interface
--   - baxter_tools
--   - baxter_examples
-- processing catkin metapackage: 'baxter_common'
--> add_subdirectory(baxter_common/baxter_common)
-- processing catkin package: 'baxter_description'
--> add_subdirectory(baxter_common/baxter_description)
-- processing catkin metapackage: 'baxter_sdk'
--> add_subdirectory(baxter/baxter_sdk)
-- processing catkin package: 'rethink_ee_description'
--> add_subdirectory(baxter_common/rethink_ee_description)
-- processing catkin package: 'baxter_maintenance_msgs'
--> add_subdirectory(baxter_common/baxter_maintenance_msgs)
-- Using these message generators: gencpp;genlisp;genpy
-- baxter_maintenance_msgs: 7 messages, 0 services
```

Instalar en el sistema

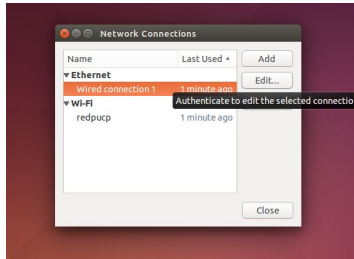
```
alex@alex-X555LA:~/baxter_ws
-- traversing 9 packages in topological order:
--   - baxter_common (metapackage)
--   - baxter_description
--   - baxter_sdk (metapackage)
--   - rethink_ee_description
--   - baxter_maintenance_msgs
--   - baxter_core_msgs
--   - baxter_interface
--   - baxter_tools
--   - baxter_examples
-- processing catkin metapackage: 'baxter_common'
--> add_subdirectory(baxter_common/baxter_common)
-- processing catkin package: 'baxter_description'
--> add_subdirectory(baxter_common/baxter_description)
-- processing catkin metapackage: 'baxter_sdk'
--> add_subdirectory(baxter/baxter_sdk)
-- processing catkin package: 'rethink_ee_description'
--> add_subdirectory(baxter_common/rethink_ee_description)
-- processing catkin package: 'baxter_maintenance_msgs'
--> add_subdirectory(baxter_common/baxter_maintenance_msgs)
-- Using these message generators: gencpp;genlisp;genpy
-- baxter_maintenance_msgs: 7 messages, 0 services

alex@alex-X555LA:~/baxter_ws
alex@alex-X555LA:~/baxter_ws$ catkin_make install
```

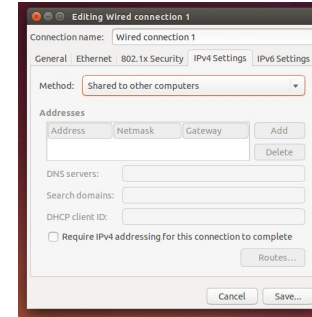
Estableciendo la conexión



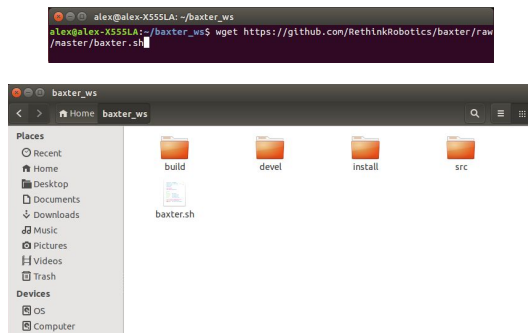
Estableciendo la conexión



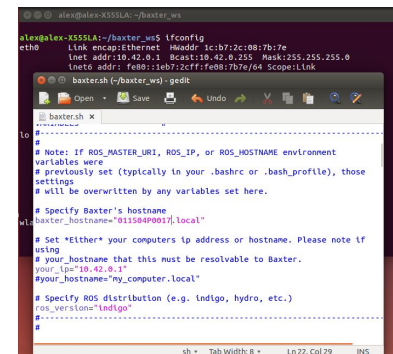
Estableciendo la conexión



Estableciendo la conexión



Estableciendo la conexión



Lista de tópicos

```
alex@alex-X555LA: ~/baxter_ws
alex@alex-X555LA:~/baxter_ws$ chmod u+x ./baxter.sh
alex@alex-X555LA:~/baxter_ws$ ./baxter.sh
[baxter - http://011504P0017.local:11311] alex@alex-X555LA:~/baxter_ws$

alex@alex-X555LA:~/baxter_ws
[baxter - http://011504P0017.local:11311] alex@alex-X555LA:~/baxter_ws$
rostopic list
/ExternalTools/left/PositionKinematicsNode/FKServer/reply
/ExternalTools/left/PositionKinematicsNode/FKServer/request
/ExternalTools/left/PositionKinematicsNode/IKServer/reply
/ExternalTools/left/PositionKinematicsNode/IKServer/request
/ExternalTools/right/PositionKinematicsNode/FKServer/reply
/ExternalTools/right/PositionKinematicsNode/FKServer/request
/ExternalTools/right/PositionKinematicsNode/IKServer/reply
/ExternalTools/right/PositionKinematicsNode/IKServer/request
/cameras/right_hand_camera/camera_info
/cameras/right_hand_camera/camera_info_std
/cameras/right_hand_camera/image
/collision/left/collision_detection
/collision/left/debug
/collision/right/collision_detection
/collision/right/debug
/diagnostics
/diagnostics_agg
/diagnostics_toplevel_state
/hdraw
/robot/accelerometer/left_accelerometer/state
/robot/accelerometer/right_accelerometer/state
/robot/accelerometer_names
/robot/accelerometer_states
```

Nodos listos en el robot

```
alex@alex-X555LA:~/baxter_ws
[baxter - http://011504P0017.local:11311] alex@alex-X555LA:~/baxter_ws$ rosrn b
baxter_tools enable_robot.py -e
[INFO] [WallTime: 1489014435.981243] Robot Enabled
[baxter - http://011504P0017.local:11311] alex@alex-X555LA:~/baxter_ws$ rosrn b
baxter_tools tuck_arms.py -t
[INFO] [WallTime: 1489014448.287345] Tucking arms
[INFO] [WallTime: 1489014448.457075] Moving head to neutral position
[INFO] [WallTime: 1489014448.457366] Tucking: one or more arms not Tucked;
[INFO] [WallTime: 1489014448.457586] Moving to neutral start position with coll
sion on.
[INFO] [WallTime: 1489014452.642450] Tucking: Tucking with collision avoidance d
ff.
[INFO] [WallTime: 1489014459.003018] Robot Disabled
[INFO] [WallTime: 1489014459.003777] Finished tuck
[baxter - http://011504P0017.local:11311] alex@alex-X555LA:~/baxter_ws$ rosrn b
baxter_tools tuck_arms.py -u
[INFO] [WallTime: 1489014463.853370] Untucking arms
[INFO] [WallTime: 1489014464.007953] Moving head to neutral position
[INFO] [WallTime: 1489014464.008264] Untucking: One or more arms Tucked; Disabl
ng Collision Avoidance and untucking.
[INFO] [WallTime: 1489014471.347023] Finished tuck
[baxter - http://011504P0017.local:11311] alex@alex-X555LA:~/baxter_ws$
```

Nodos creados para la clase

```
alex@alex-X555LA:~/baxter_ws/src
alex@alex-X555LA:~/baxter_ws/src$ cd baxter_ws/src/
alex@alex-X555LA:~/baxter_ws/src$ catkin_create_pkg my_nodes rospmsg sensor_msgs g
eometry_msgs
Created file my_nodes/CMakeLists.txt
Created file my_nodes/package.xml
Created folder my_nodes/src
Successfully created files in /home/alex/baxter_ws/src/my_nodes. Please adjust t
he values in package.xml.
alex@alex-X555LA:~/baxter_ws/src$
```

```
alex@alex-X555LA:~/baxter_ws
[baxter - http://011504P0017.local:11311] alex@alex-X555LA:~/baxter_ws$ rosrn m
y_nodes hello_baxter.py
{"right_e0": 0.6638301859574128, "right_w1": 1.02086042143377429, "right_w2": 0.49470880409304
59, "right_e0": 1.1462671437473755, "right_e1": 1.9477721054173041}
{"right_e0": 0.0, "right_s1": 0.0, "right_w": 0.0, "right_w1": 0.0, "right_w2":
0.0, "right_e0": 0.0, "right_e1": 0.0}
[baxter - http://011504P0017.local:11311] alex@alex-X555LA:~/baxter_ws$
```

¡Gracias!

¡La única pregunta tonta es la que no se
hace!