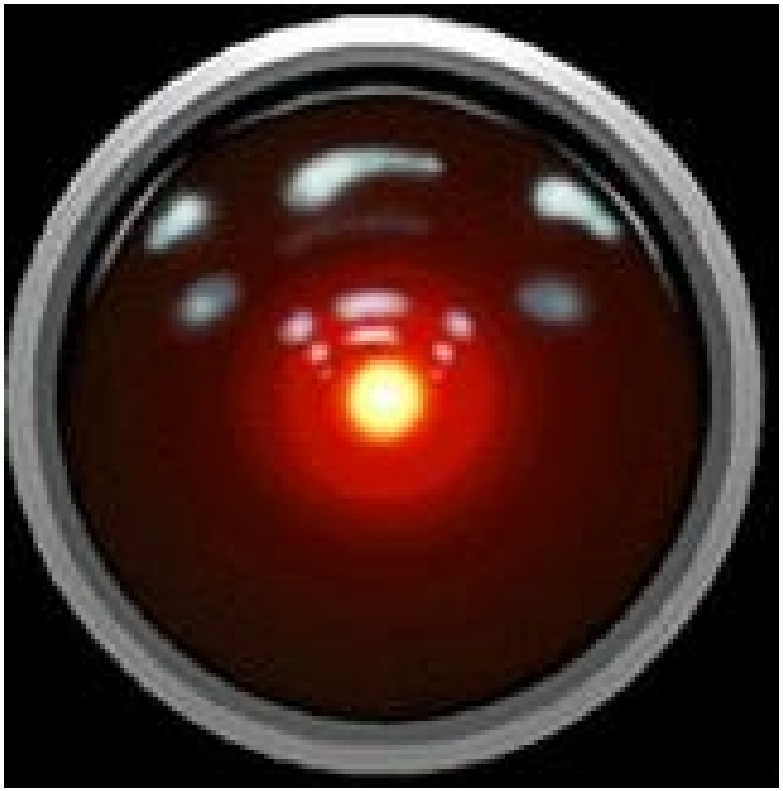
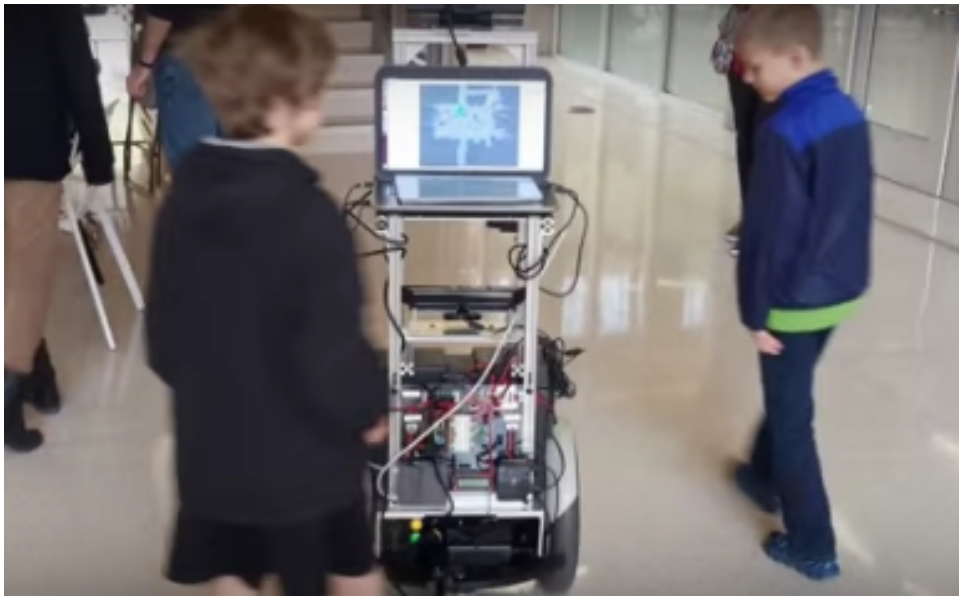


CS 378: Autonomous Intelligent Robotics

Instructor: Jivko Sinapov

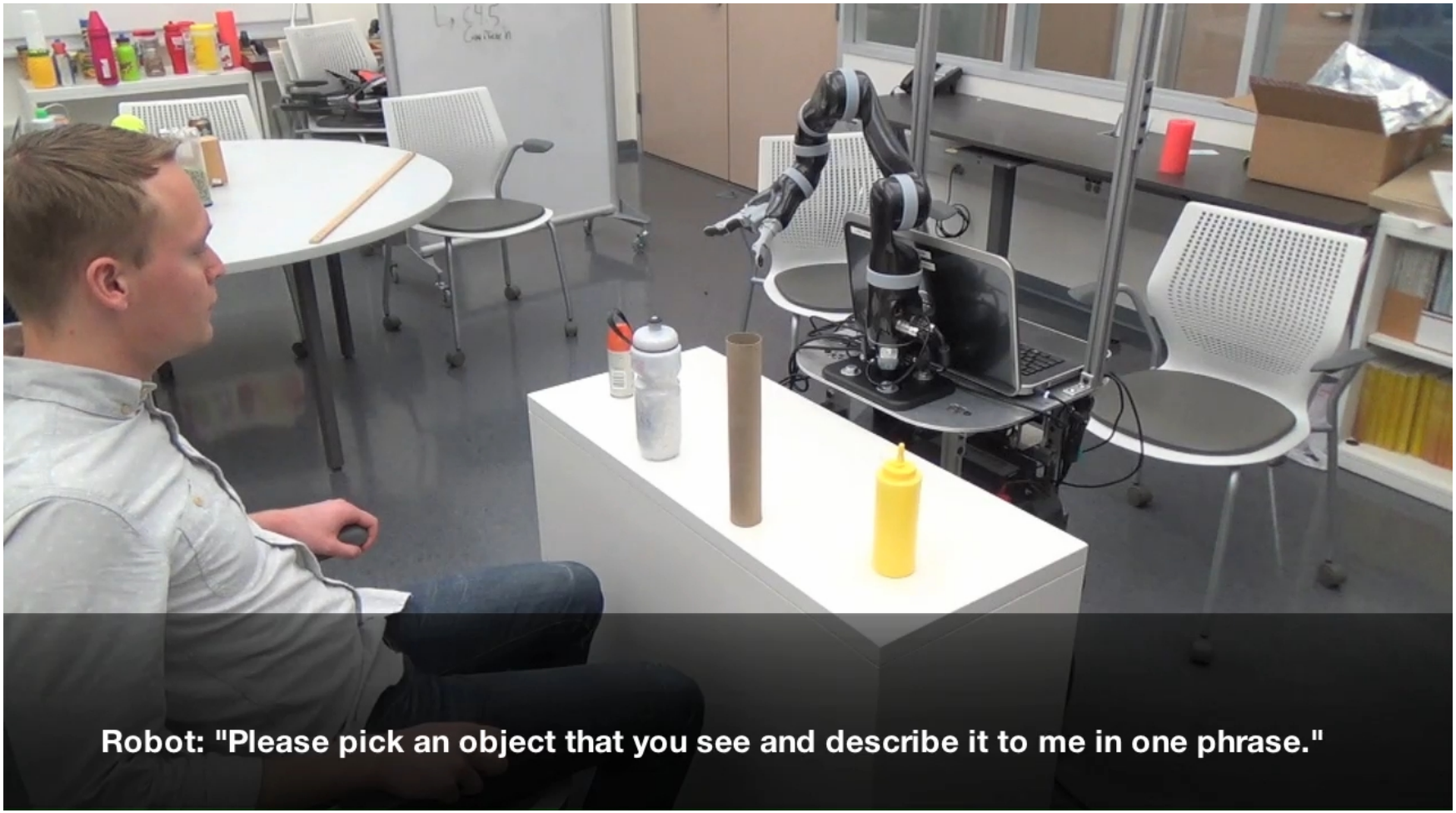
http://www.cs.utexas.edu/~jsinapov/teaching/cs378/

About the Robots...

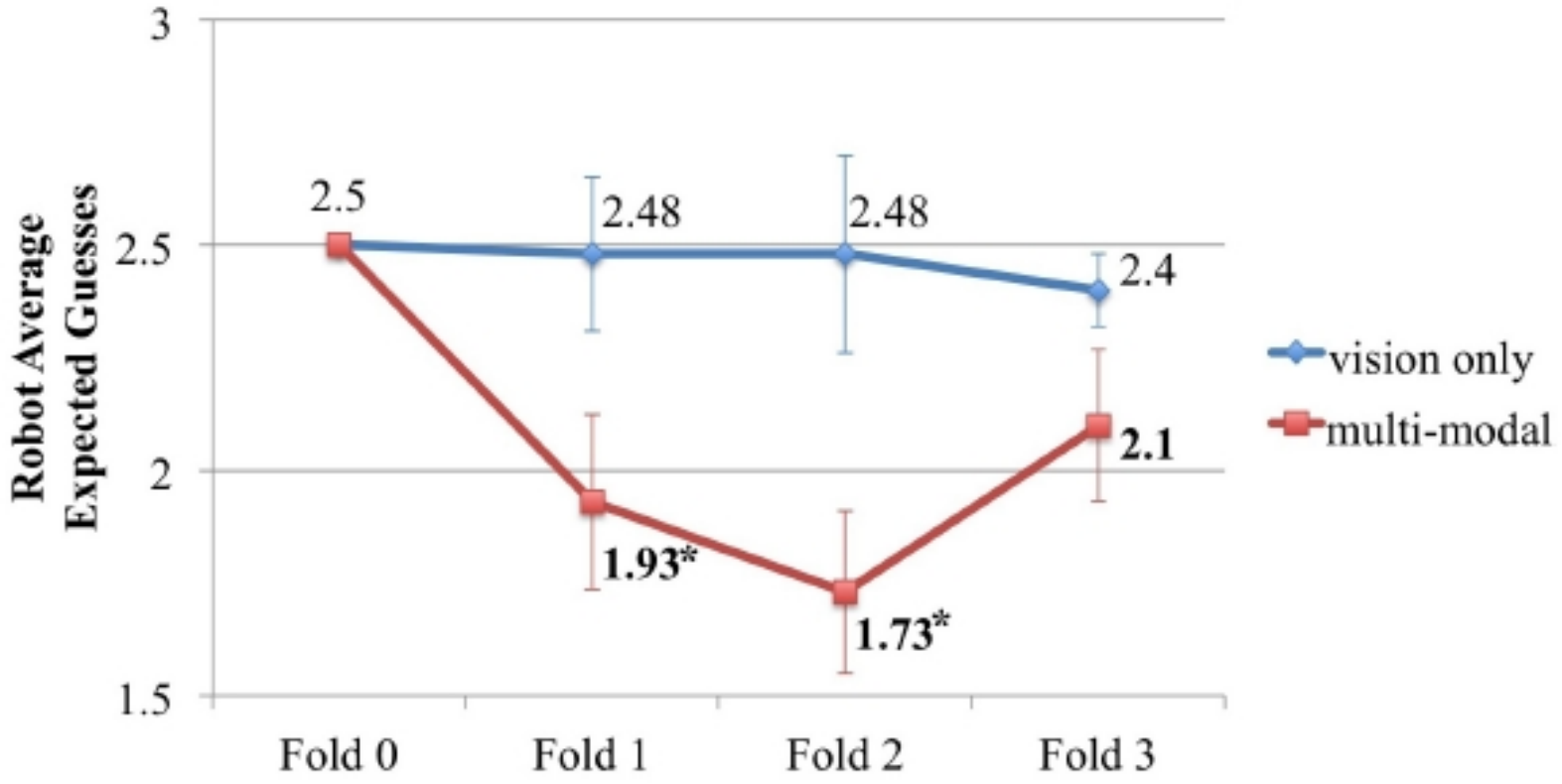


Announcements

Remember this?



Results


Robot Average Expected Guesses
3
2.5
2
1.5
2.5
2.48
2.48
2.4
1.93*
1.73*
2.1
Fold 0
Fold 1
Fold 2
Fold 3
vision only
multi-modal

Announcements

Installing our code base

- Github page:
  - https://github.com/utexas-bwi/bwi
- In addition, install bwi_experimental repository in catkin_ws/src :
  - https://github.com/utexas-bwi/bwi_experimental

Getting your project code up on github

GitHub guide:

https://guides.github.com/activities/hello-world/

Readings for next week

As before, your pick.

Robotics and AI Conferences

- IEEE International Conference on Robotics and Automation (ICRA)
- IEEE International Conference on Intelligent Robots (IROS)
- IEEE International Conference on Development and Learning (ICDL)
- Robotics Science and Systems (RSS)

Robotics and AI Conferences (con't)

- ACM / IEEE International Conference on Human-Robot Interaction (HRI)
- International Conference on Social Robotics (ICSR)
- AAAI Conference on Artificial Intelligence (AAAI)
- International Joint Conference on Artificial Intelligence (IJCAI)

Robotics Journals

- IEEE Transactions on Robotics (TRO)
- IEEE Transactions on Autonomous Mental Development (TAMD)
- International Journal of Robotics Research (IJRR)
- Robotics and Autonomous System (RAS)

Today

- Recording data from the robot
- Controlling the robot from code
  - Issuing goal positions and orientation
  - Logical Navigation (e.g., “go to office 3.432”)
- Important topics relevant to your projects:
  - costmaps, planned trajectories, visual input and detected humans

Recording data using the *rosbag* tool

To record:

rosbag record <topic 1> <topic 2> … <topic n>

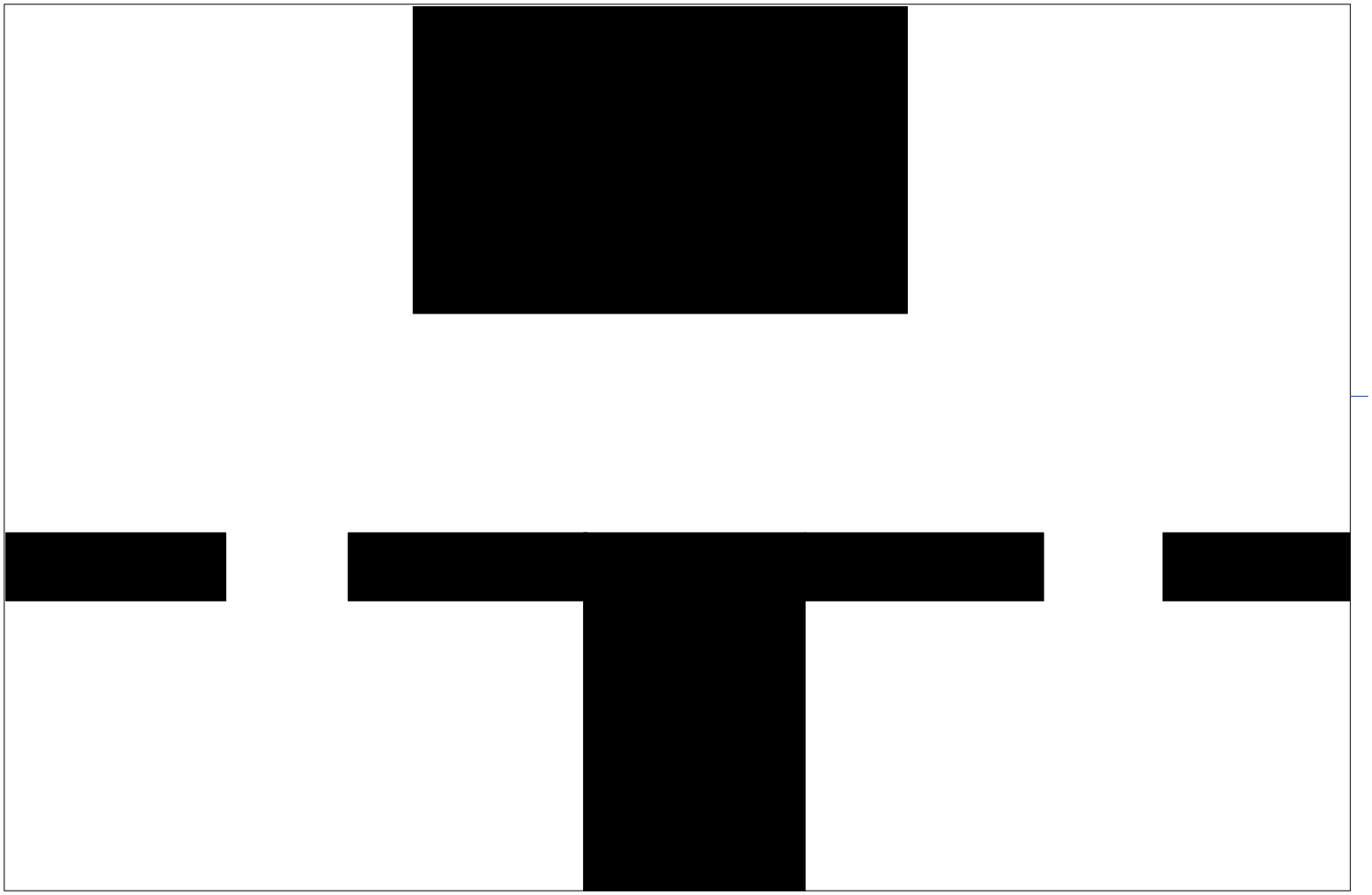
To play:

rosbag play <bag file>

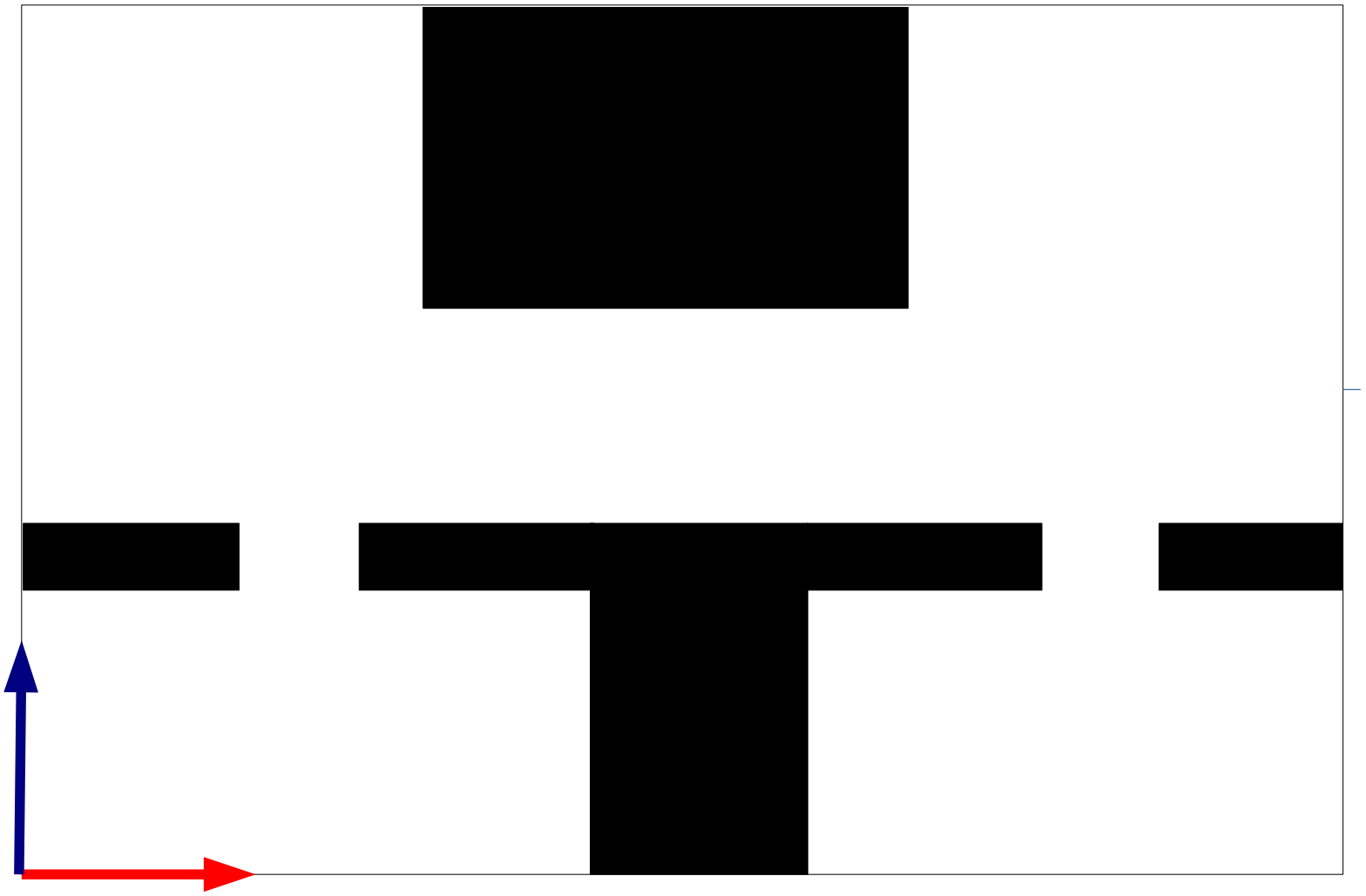
rosbag play -l <bag file>

Frames of Reference in ROS

Frames of Reference

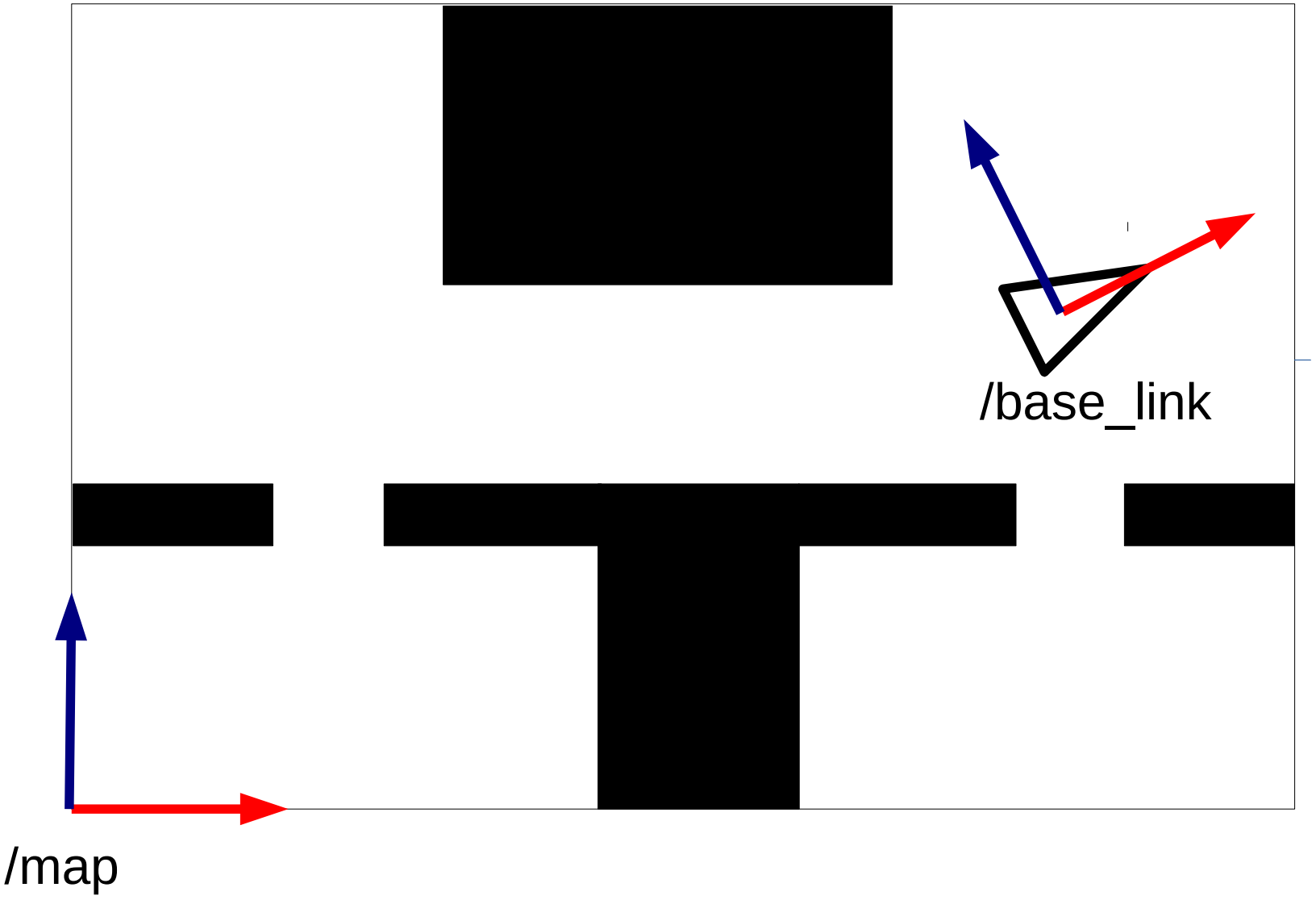


Frames of Reference

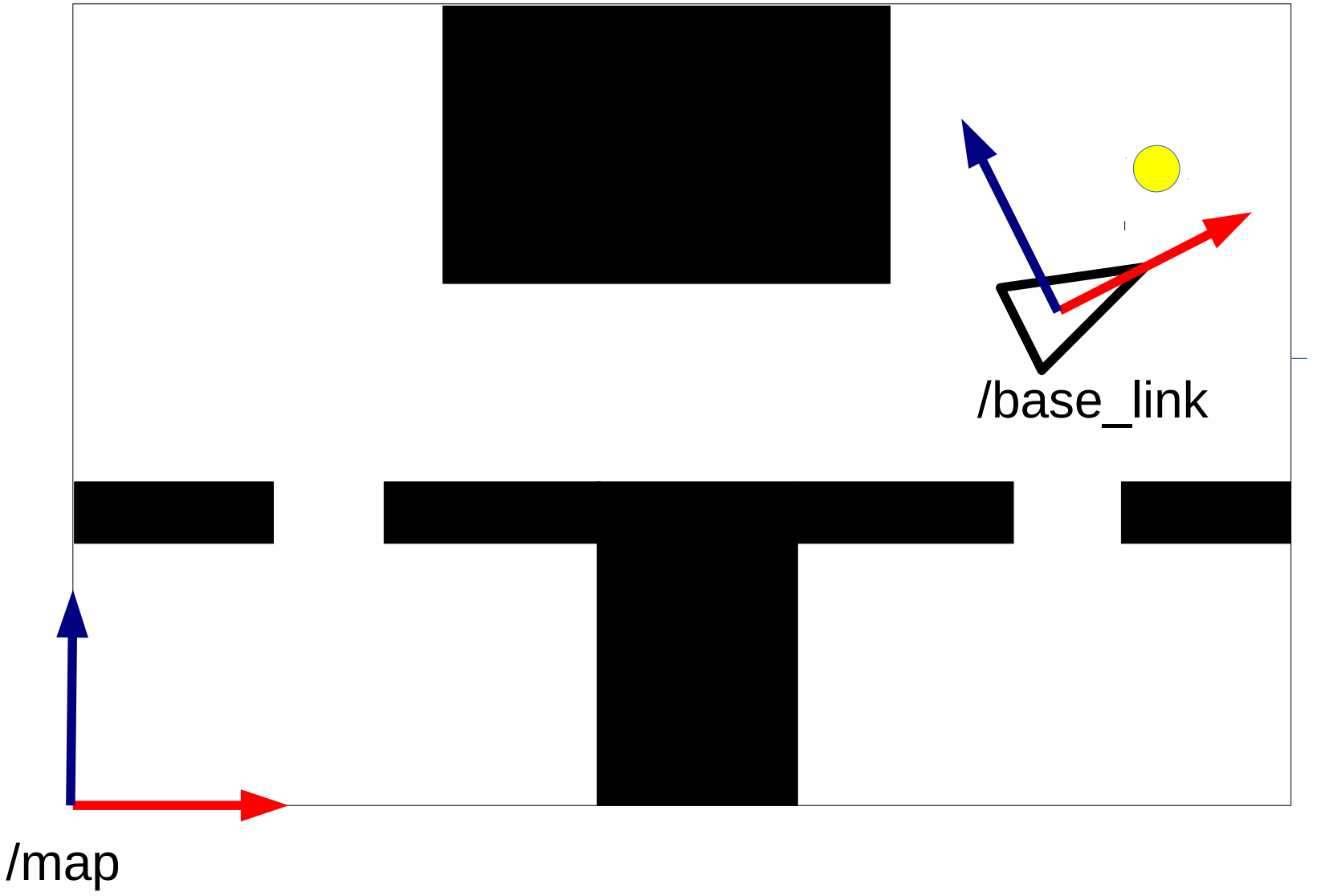


/map

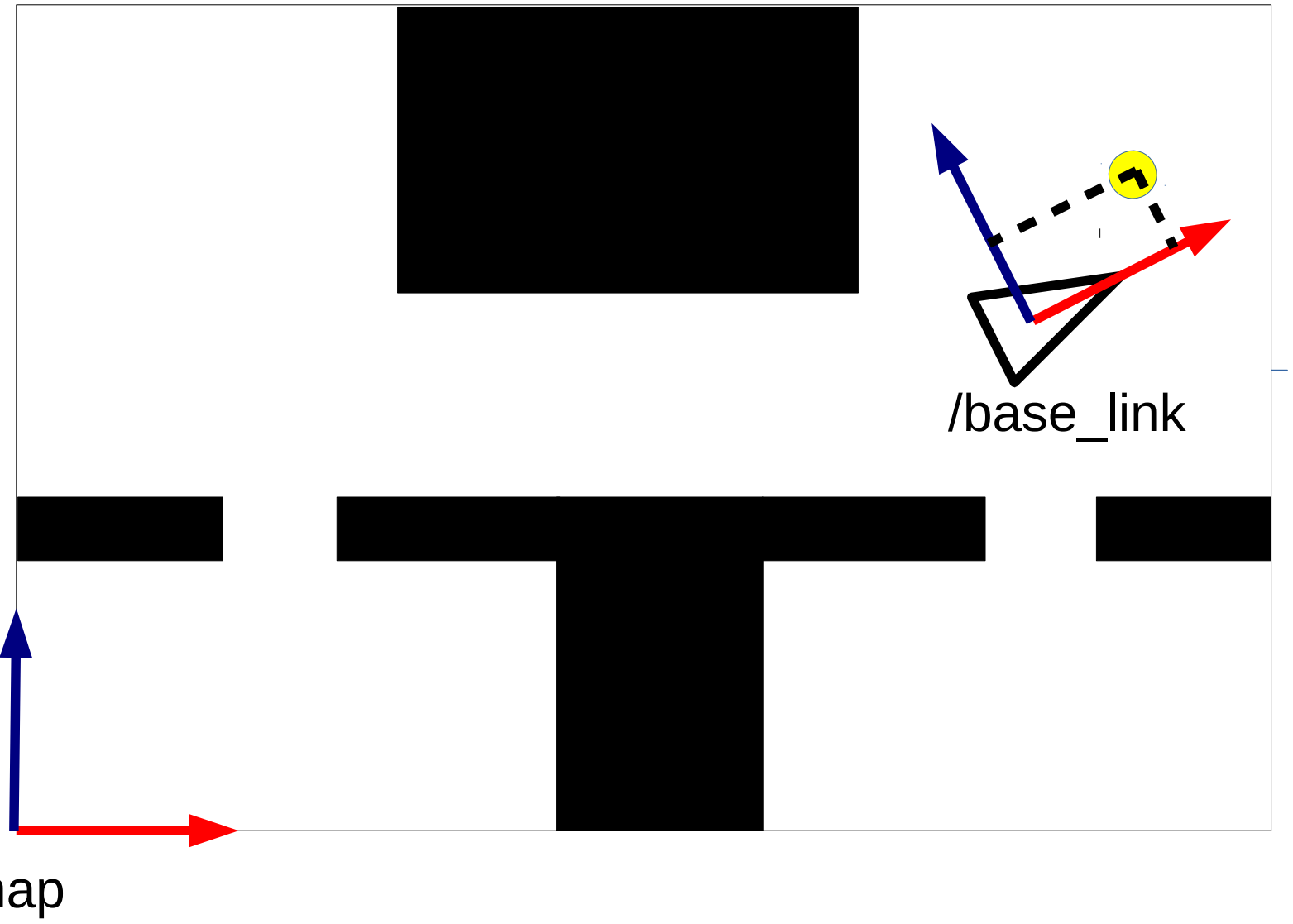
Frames of Reference



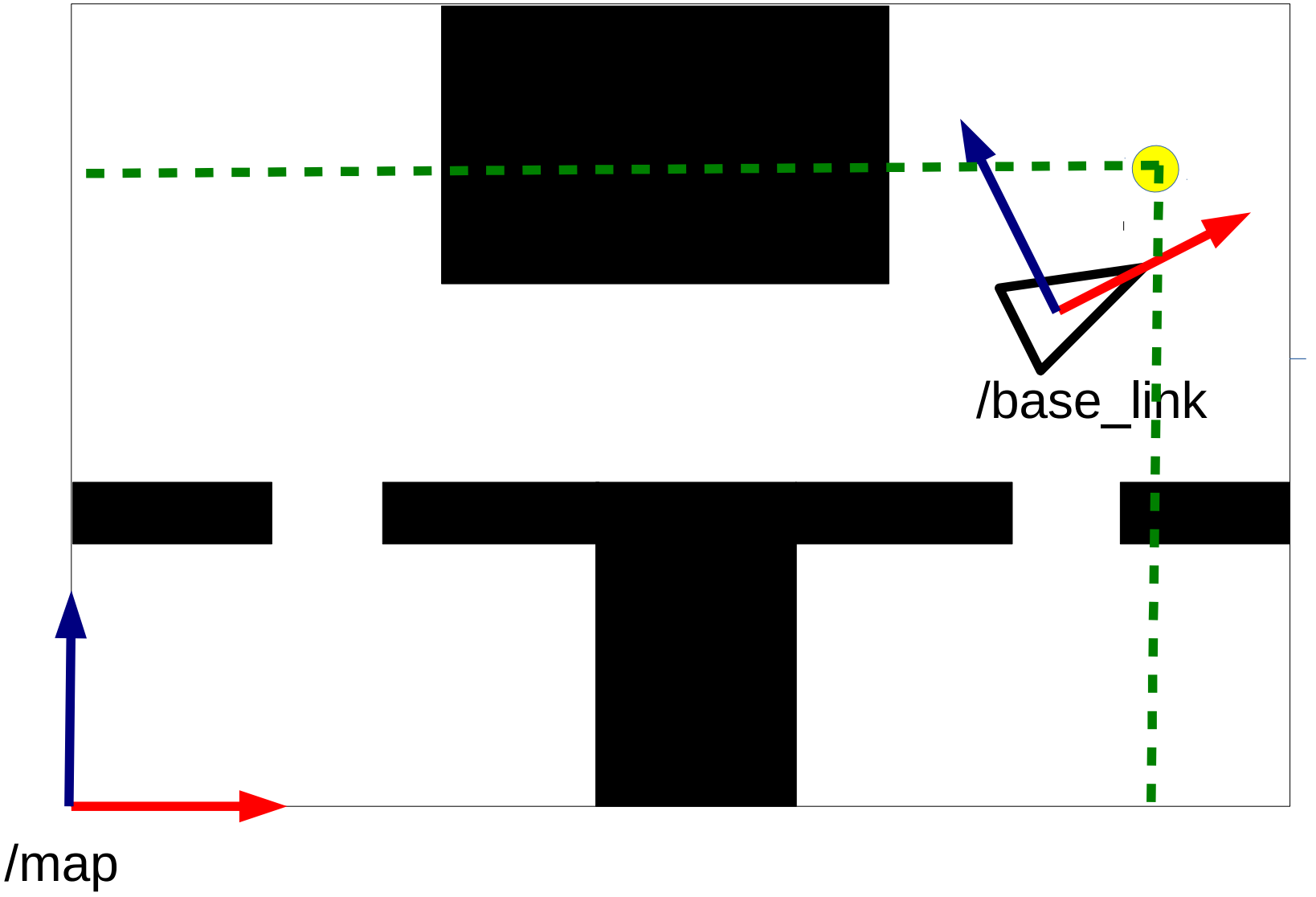
Frames of Reference



Frames of Reference



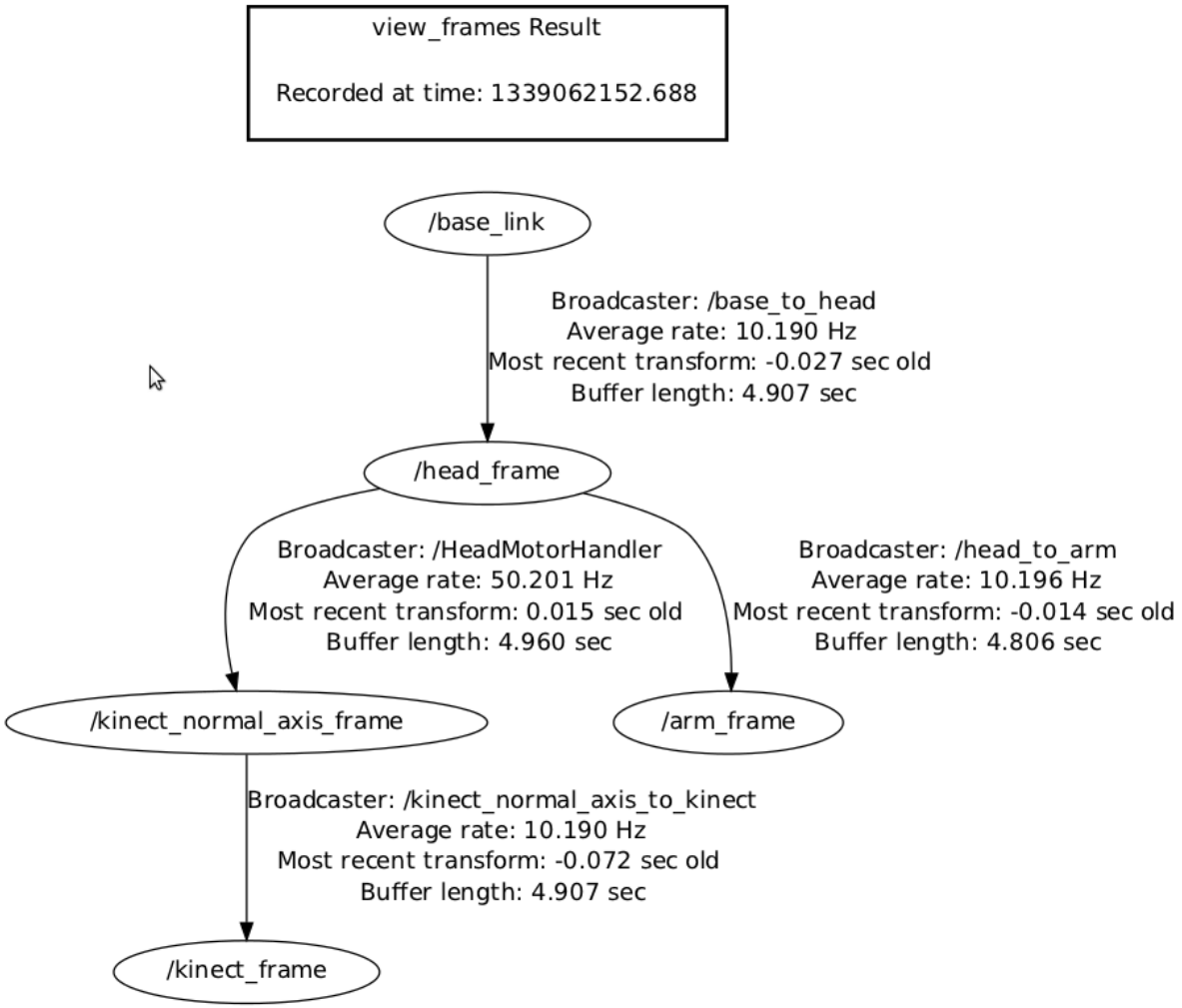
Frames of Reference



Frames of Reference in ROS

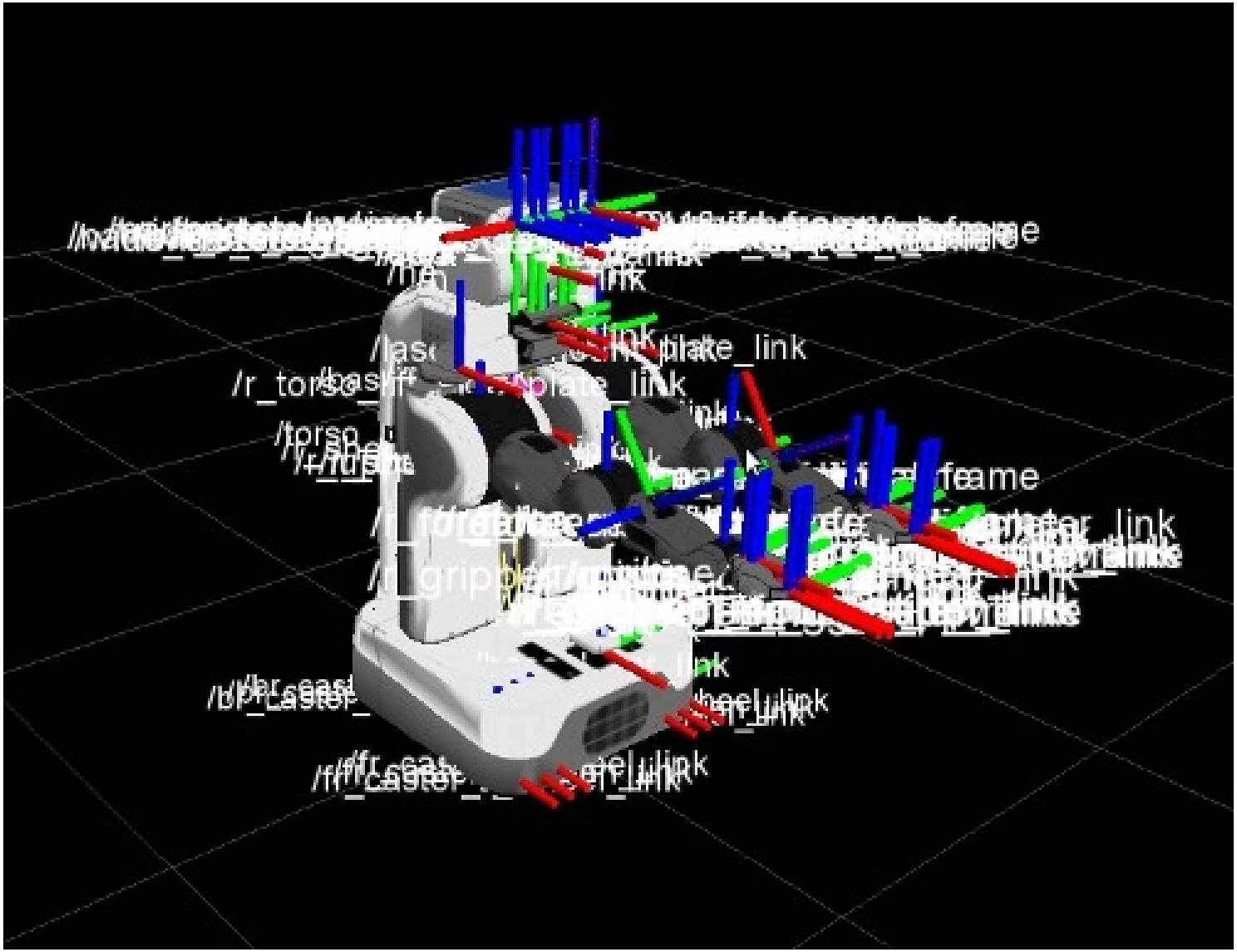
- The relationships between different frames of references are represented using a tree of transformations (each frame of reference has a parent and 1 or more children)
- The tree is published on the /tf topic
- Whenever you log data from the robot, always include the /tf topic

An example /tf tree

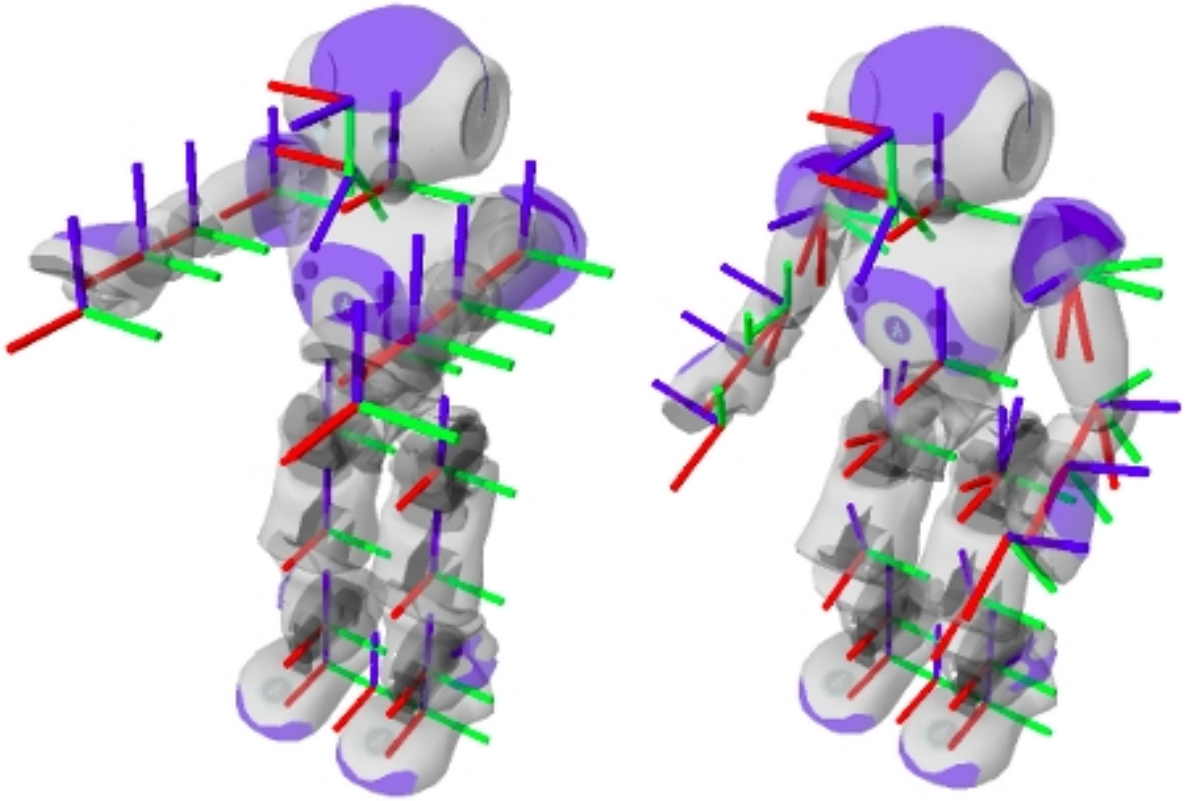


[http://answers.ros.org/upfiles/13390630204578006.png]

Visualizing the /tf tree in rviz



Visualizing the /tf tree in rviz



[http://library.isr.ist.utl.pt/docs/roswiki/attachments/nao_description/nao_tf.png]

Frames of Reference in ROS

- Messages that contain geometric or spatial information, visual data, etc. will generally have a frame of reference stored in the message's header's frame_id

Going from one frame of reference to another...

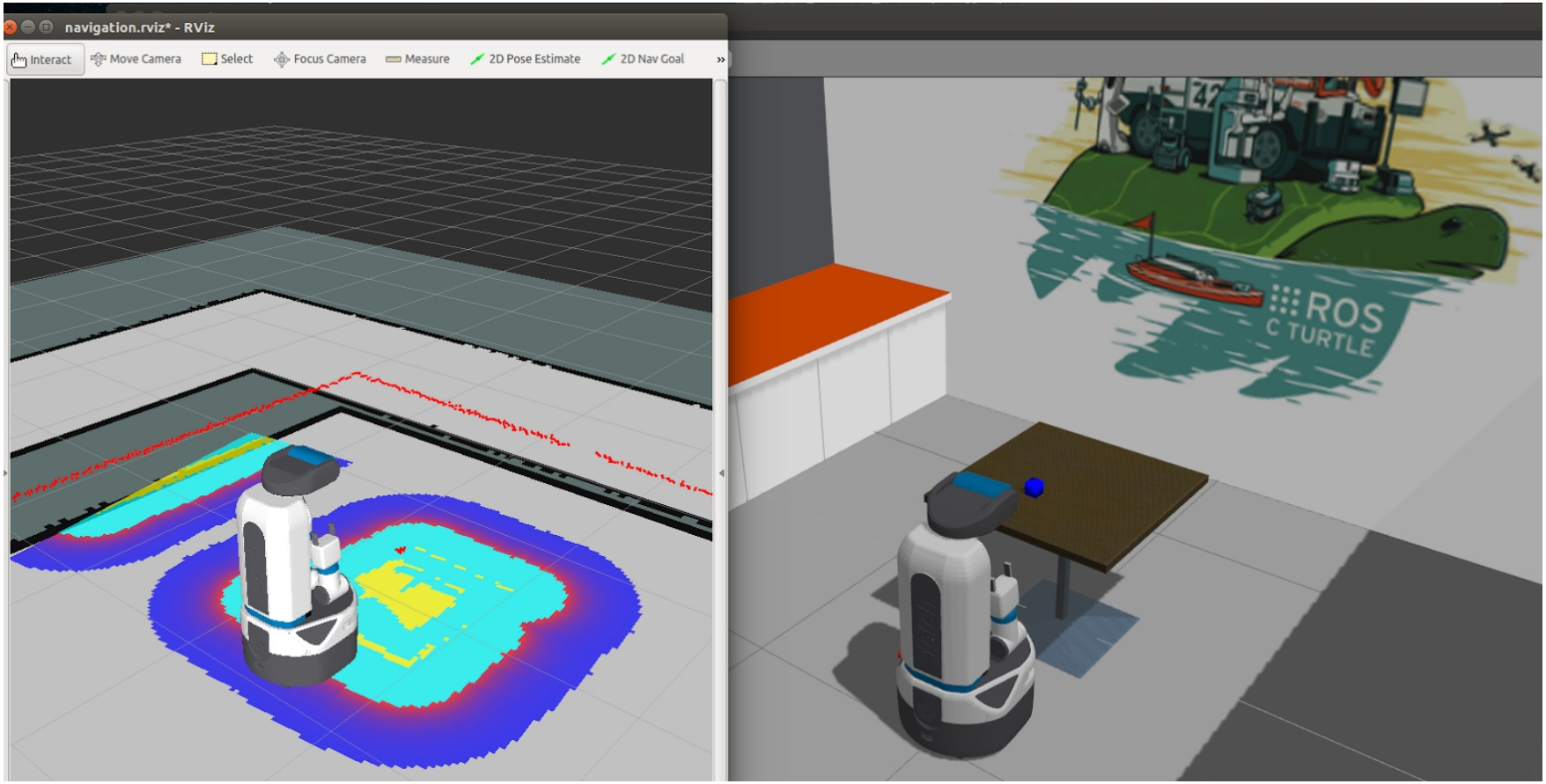
- Code example

ROS tutorials on tf

Issuing position and orientation goals to the robot

- Example in simulation

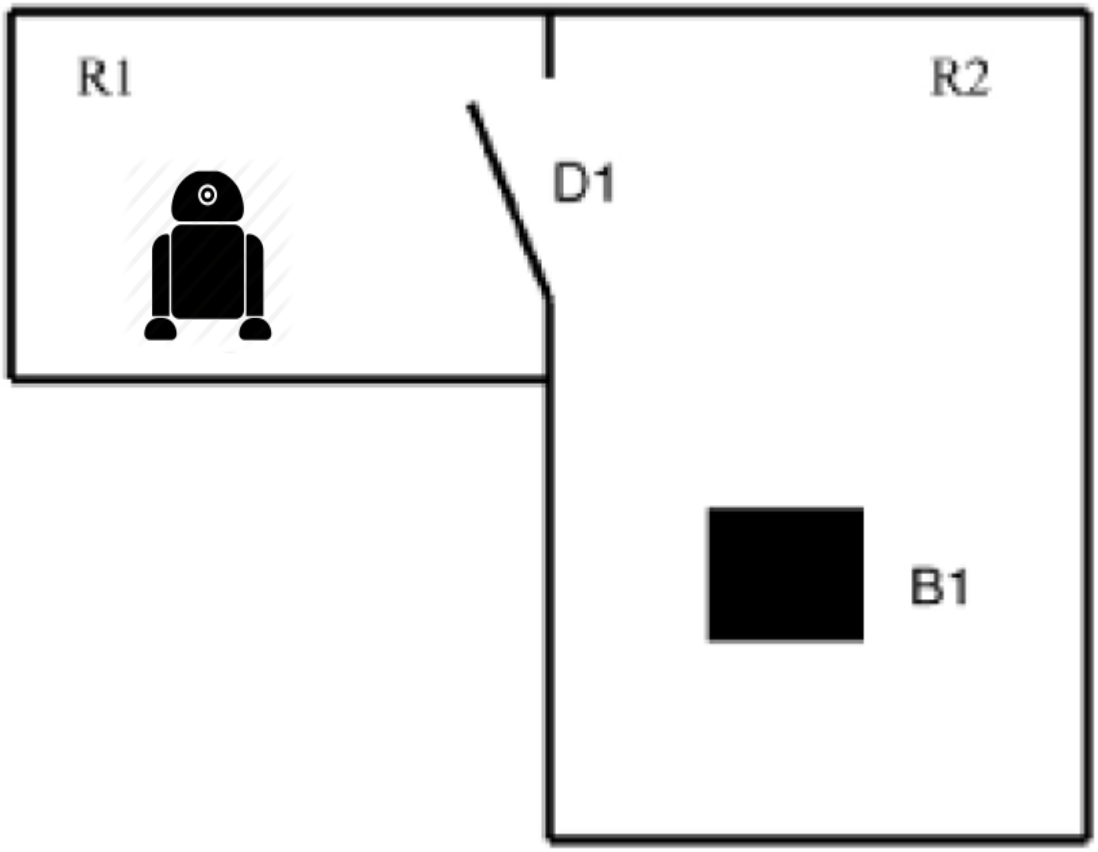
The Costmap


navigation.rviz* - RViz
Interact
Move Camera
Select
Focus Camera
Measure
2D Pose Estimate
2D Nav Goal
ROS
C TURTLE

Local vs. Global Costmap

Logical Navigation

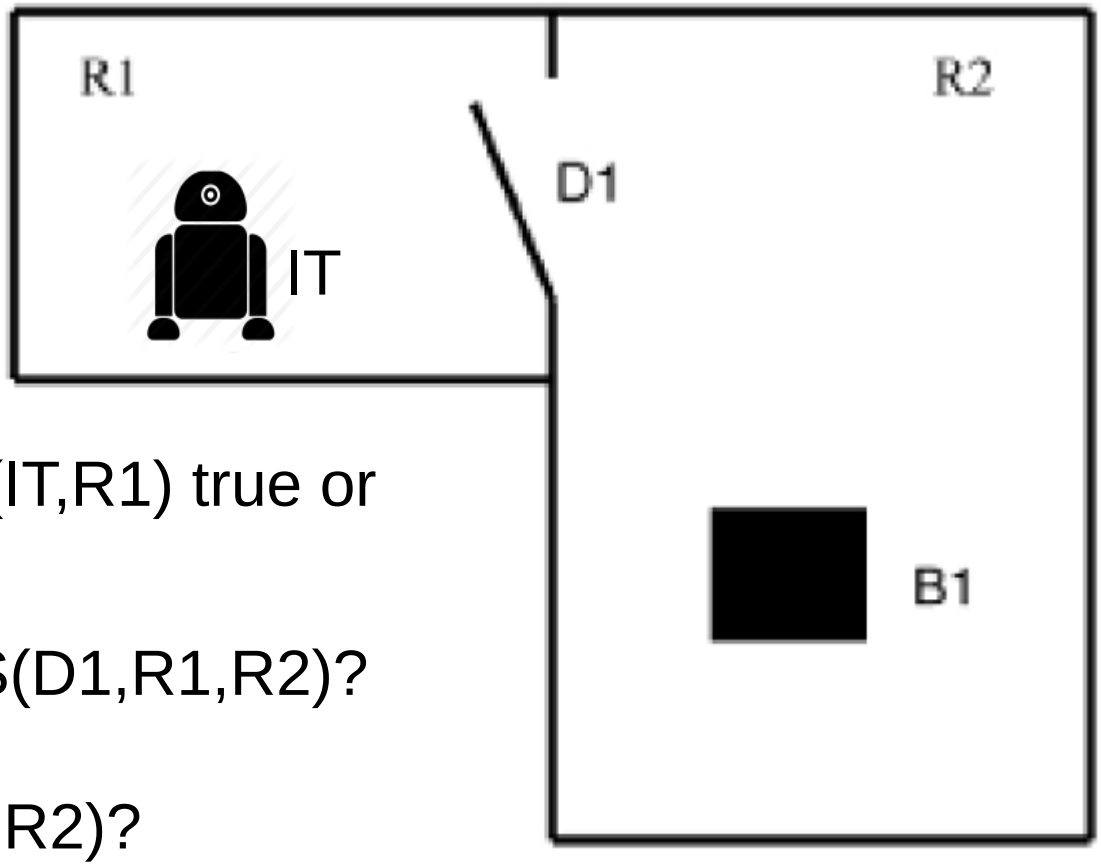
Logical Navigation



Logical Navigation

`INROOM(x, r)`	where x is an object of type `movable_object`, `r` is type `room`
`NEXTTO(x, t)`	where x is a `movable_object`, `t` is type `door` or `movable_object`
`STATUS(d, s)`	where `d` is type `door`, `s` is an enumerated type: `OPEN` or `CLOSED`
`CONNECTS(d, rx, ry)`	where `d` is type `door`, `rx, ry` are the `room`

Logical Navigation

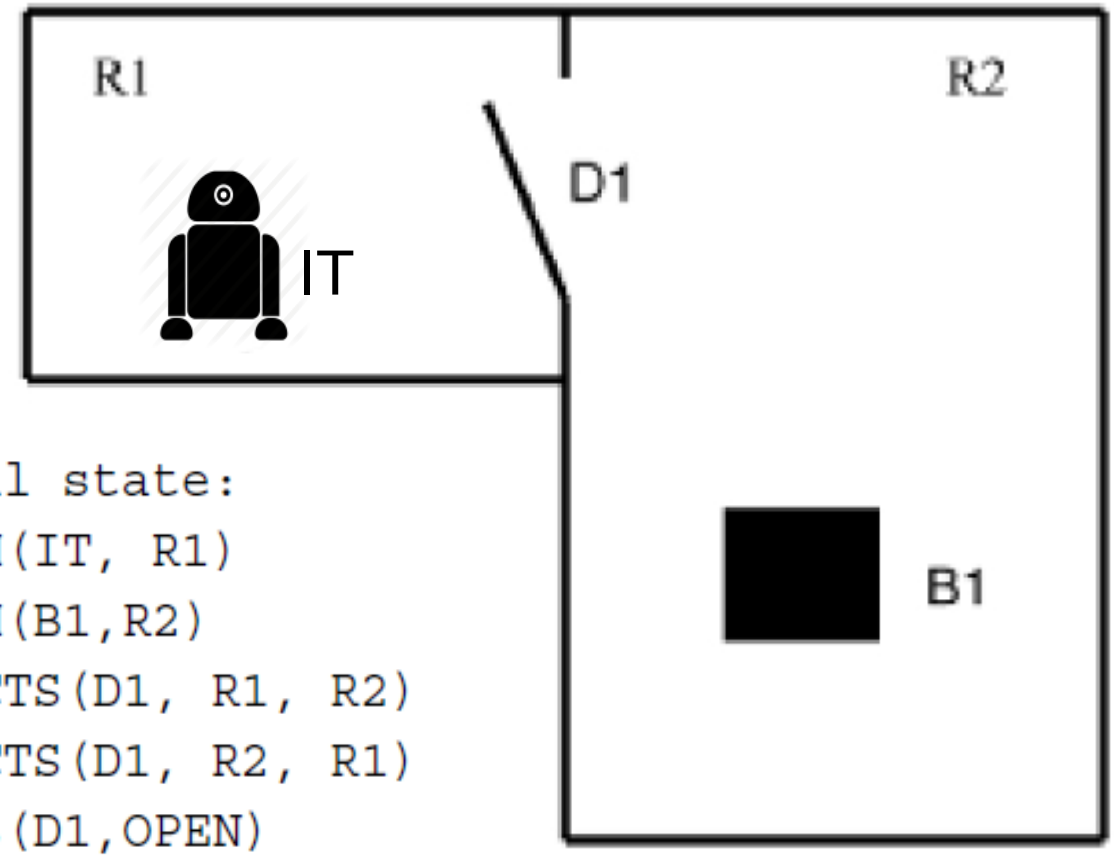


Is INROOM(IT,R1) true or false?

CONNECTS(D1,R1,R2)?

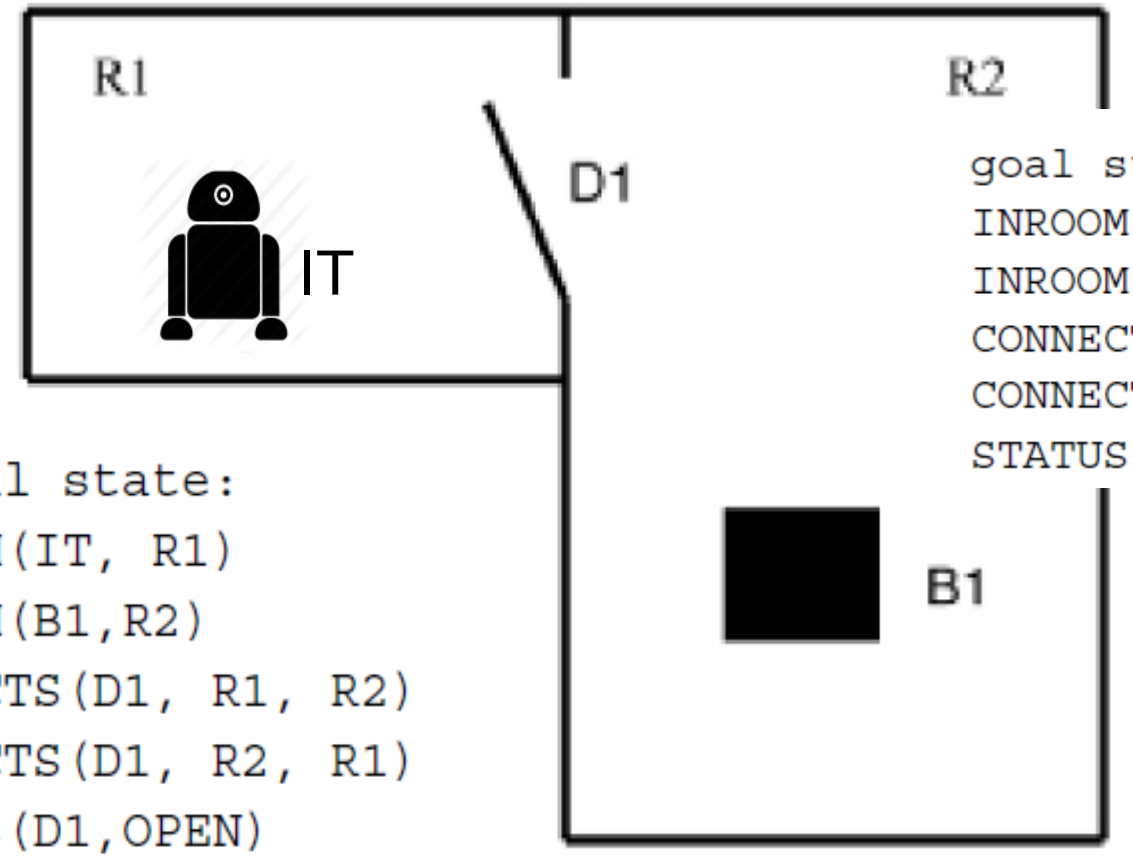
INROOM(IT,R2)?

Logical Navigation




```
initial state:
INROOM(IT, R1)
INROOM(B1,R2)
CONNECTS(D1, R1, R2)
CONNECTS(D1, R2, R1)
STATUS(D1,OPEN)
```

Logical Navigation



initial state:
INROOM(IT, R1)
INROOM(B1,R2)
CONNECTS(D1, R1, R2)
CONNECTS(D1, R2, R1)
STATUS(D1,OPEN)

goal state:
INROOM(IT,R2)
INROOM(B1,R2)
CONNECTS(D1, R1, R2)
CONNECTS(D1, R2, R1)
STATUS(D1,OPEN)

The “difference” table

operator	preconditions	add-list	delete-list
OP1: GOTODOOR(IT,dx)	INROOM(IT,rk) CONNECT(dx,rk,rm)	NEXTTO(IT,dx)	
OP2: GOTHRUDOOR(IT,dx)	CONNECT(dx,rk,rm) NEXTTO(IT,dx) STATUS(dx, OPEN) INROOM(IT,rk)	INROOM(IT,rm)	INROOM(IT,rk)

Logical Difference

goal state:
INROOM(IT,R2)
INROOM(B1,R2)
CONNECTS(D1, R1, R2)
CONNECTS(D1, R2, R1)
STATUS(D1,OPEN)

—

initial state:
INROOM(IT, R1)
INROOM(B1,R2)
CONNECTS(D1, R1, R2)
CONNECTS(D1, R2, R1)
STATUS(D1,OPEN)

=

$\neg$INROOM(IT, R2)

or

INROOM(IT, R2)=FALSE

Logical Navigation

- Example in simulation

Logical Navigation

To start on real robot:

- roslaunch bwi_launch segbot_v2.launch
- Localize the robot using the rviz GUI
- roslaunch bwi_kr_execution bwi_kr_execution.launch

THE END