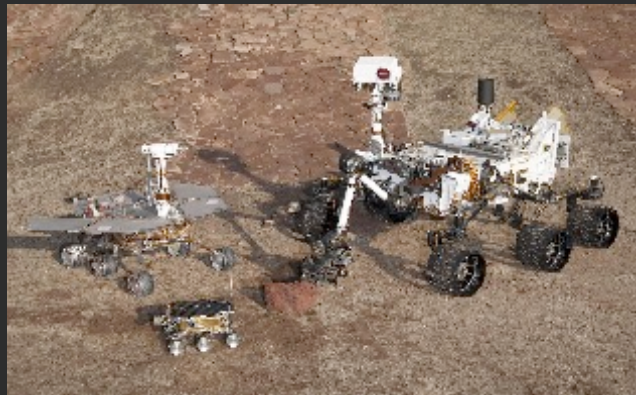




# INTRODUCTION TO ROS WITH NEATO TURTLE

ROSS LUNAN  
JULY 2, 2023



# What is ROS and OS?

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- ROS = Robot Operating System, essentially exclusively uses Ubuntu machines. Others, are available but not to the same support extent. Currently Long-Term Support Versions are now the ROS 2 platform
- OSRF = Open Source Robot Foundation, founded in 2012 in Menlo Park, Ca, (<https://www.osrfoundation.org/about/>). In 2016, OSRF created the for-profit Open Source Robotics Corporation. In Dec/22 Google Intrinsic acquired OSRC. Open Robotics (not-for-profit) holds the ROS, gazebo, and Open-RMF IP , and is their continuing support.  
<https://discourse.ros.org/t/the-osrc-team-is-joining-intrinsic-and-what-it-means-for-the-ros-community/28764>
- Mission: To support the development, distribution, and adoption of open software and hardware for use in robotics research, education, and product development.
- What is ROS: An open-source, meta-operating system for your robot. It provides the services you would expect from an operating system, including hardware abstraction, low-level device control, implementation of commonly-used functionality, message-passing between processes, and package management. It also provides tools and libraries for obtaining, building, writing, and running code across multiple computers.
- Robots: 100's around the world....
- Installations, Tutorials, Blog, Repositories: [www.ros.org](http://www.ros.org) : ROS currently only runs on Unix-based platforms. Software for ROS is primarily tested on Ubuntu. e.g ROS Humble uses Ubuntu 22.04

There be Robots...(a small sample)

<http://robots.ros.org/all>



# Neato Turtle Parts List

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- Single Board Computer (SBC): Raspberry Pi3 or Pi4 2 or 4GB
- Power Raspberry Pi with 10,000 MaH or so Battery Bank
- USB-A to Micro USB 12" cable, USB-A to mini USB (RPi3) or USB-c (RPi4)
- Micro sd Card 16 or 32 GB. Select fast 4K or better
- Neato Robot Vacuum: All models use a similar API from the original 2010 BV 70 & 80 series, newer D-series models D70, D75, D80, D85, and current models D3, D4, D6, D7. Latest D6 & D7 do not.
- Remote Desktop: Ubuntu Machine, such as modest Windows PC (i5) HD reformatted to "Ubuntu ext" or a 2<sup>nd</sup> Partition with ext/Ubuntu 22.04 Desktop
- HDMI Monitor, USB Keyboard & Mouse to configure the Pi. Be aware that RPi4 has USB-C power and micro HDMI connectors
- Optional Teleop: Game Controller, Logitech F710 or Xbox OS4 work great
- Optional Camera: USB Webcam



# Installing ROS 2 on Raspberry Pi (or equivalent)

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- ROBOT SBC: Format Micro SD card with “RaspberryPi Imager” which enables configuring user name, machine name, WiFi. <https://www.raspberrypi.com/software/>
- Remote DESKTOP: Download Ubuntu Ub22.05 Desktop Bootable iso Image to your development Workstation and burn to USB Drive. (e.g. belenaEtcher, Win32DiskImager)
- Boot the Pi, and configure the Ubuntu Parameters, including a 4 GB
  - Update packages & add your desired Apps & Utilities (e.g. synaptic, gedit, etc)
  - Open browser & navigate to ROS 2 Install procedure, selecting Desktop  
<https://docs.ros.org/en/humble/Installation/Ubuntu-Install-Debians.html>
  - Configure the “**Environment Setup**” and “source” from your /Home directory  
`:~/ source /opt/ros/humble/setup.bash`
  - Follow “**Using colcon to build packages**” <https://docs.ros.org/en/humble/Tutorials/Beginner-Client-Libraries/Colcon-Tutorial.html> . Select your preferred workspace, e.g. dev\_ws. Later, after compiling any code, you must “Source “ every Terminal instance from the colcon root, e.g.  
`:~/dev_ws/ source install/setup.bash .`



# Neato Turtle Installation from Github Repository

- **Install Ubuntu 22.04 (Jammy) Desktop and ROS 2 Humble Desktop (with colcon development) on Desktop Workstation and SBC Raspberry Pi**

- **Prerequisites:**

- `sudo apt install build-essential`
- `sudo apt install ros-humble-xacro sudo apt install python3-rosdep2`

Be sure and create a **workspace** and “source” its root directory for your ROS 2 from source builds, on both **Desktop** and **Raspberry Pi Robot**.

- Check ( `$ sudo clone <repo name>`) these following repositories into that **workspace** / source directory as follows:

**Workspace , e.g. ros2\_ws**

- `cd <ws>/src`
- `git clone https://github.com/cpeavy2/botvac_node.git`
- `git clone https://github.com/cpeavy2/neato_robot.git`
- `git clone https://github.com/kobuki-base/cmd_vel_mux.git`
- `git clone https://github.com/kobuki-base/kobuki_velocity_smoother`
- `git clone https://github.com/stonier/ecl_tools`

**Install Navigation 2 on Ubuntu PC workstation (not necessary to have on Pi).**

- `sudo apt install ros-humble-navigation2`
- `sudo apt install ros-humble-nav2-bringup`



By Camp Peavy

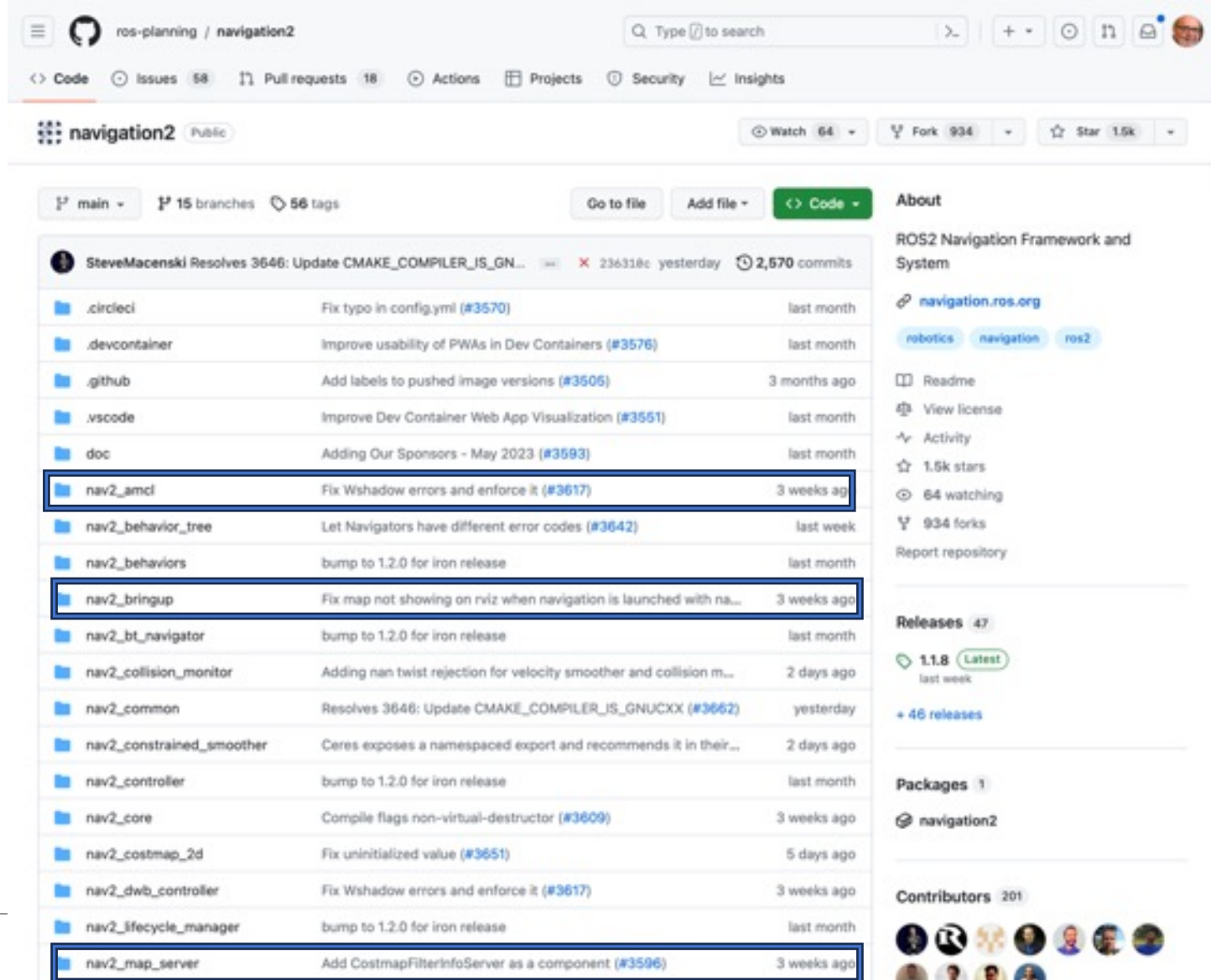
Over-the-shoulder instructions on how to build your own homebrewed robot!

# Navigation 2 Docs, Github, Tutorials

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- NAV 2 <https://navigation.ros.org>
  - Github <https://github.com/ros-planning/navigation2>  
The required packages can be installed from Binary on your Laptop Desktop. e.g.  
:\$ sudo apt install ros-humble-navigation2  
:\$ sudo apt install ros-humble-nav2-bringup
  - Getting Started [https://navigation.ros.org/getting\\_started/index.html](https://navigation.ros.org/getting_started/index.html)  
(Don't necessarily do the Simulation – unless you are curious)
-

# Navigation 2 github.com



ros-planning / navigation2

Type to search

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main 15 branches 56 tags

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About ROS2 Navigation Framework and System

navigation.ros.org

robotics navigation ros2

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Releases 47

1.1.8 Latest last week

+ 46 releases

Packages 1

navigation2

Contributors 201

File/Folder	Description	Commit
.circleci	Fix typo in config.yml (#3570)	last month
.devcontainer	Improve usability of PWAs in Dev Containers (#3576)	last month
.github	Add labels to pushed image versions (#3505)	3 months ago
.vscode	Improve Dev Container Web App Visualization (#3551)	last month
doc	Adding Our Sponsors - May 2023 (#3593)	last month
nav2_amcl	Fix Wshadow errors and enforce it (#3617)	3 weeks ago
nav2_behavior_tree	Let Navigators have different error codes (#3642)	last week
nav2_behaviors	bump to 1.2.0 for iron release	last month
nav2_bringup	Fix map not showing on rviz when navigation is launched with na...	3 weeks ago
nav2_bt_navigator	bump to 1.2.0 for iron release	last month
nav2_collision_monitor	Adding nan twist rejection for velocity smoother and collision m...	2 days ago
nav2_common	Resolves 3646: Update CMAKE_COMPILER_IS_GNUCXX (#3662)	yesterday
nav2_constrained_smoother	Ceres exposes a namespaced export and recommends it in their...	2 days ago
nav2_controller	bump to 1.2.0 for iron release	last month
nav2_core	Compile flags non-virtual-destructor (#3609)	3 weeks ago
nav2_costmap_2d	Fix uninitialized value (#3651)	5 days ago
nav2_dwb_controller	Fix Wshadow errors and enforce it (#3617)	3 weeks ago
nav2_lifecycle_manager	bump to 1.2.0 for iron release	last month
nav2_map_server	Add CostmapFilterInfoServer as a component (#3596)	3 weeks ago



NAV 2

[ros-planning/navigation2](https://github.com/ros-planning/navigation2)



# ROS2 Nodes from Neato Turtle Launch

---

```
/amcl
/behavior_server
/bt_navigator
/bt_navigator_navigate_through_pose
s_rclcpp_node
/bt_navigator_navigate_to_pose_rclcp
p_node
/cmd_vel_mux
/controller_server
/global_costmap/global_costmap
/joy_node
/laser_to_base
/launch_ros_4492
/lifecycle_manager_localization
/lifecycle_manager_navigation
/local_costmap/local_costmap
/map_server
/nav2_container
/neato_node
/planner_server
robot_state_publisher
/rqt_gui_cpp_node_4362
/rviz
/smooth_server
/teleop_twist_joy_node
/transform_listener_impl_aaaaffaa0b40
/transform_listener_impl_aaab0f690d90
/transform_listener_impl_aaab0fd05ea0
/transform_listener_impl_ffff4c00c2e0
/transform_listener_impl_ffff54006170
/transform_listener_impl_ffff600024b0
/v4l2_camera
/velocity_smoother
/waypoint_follower
```

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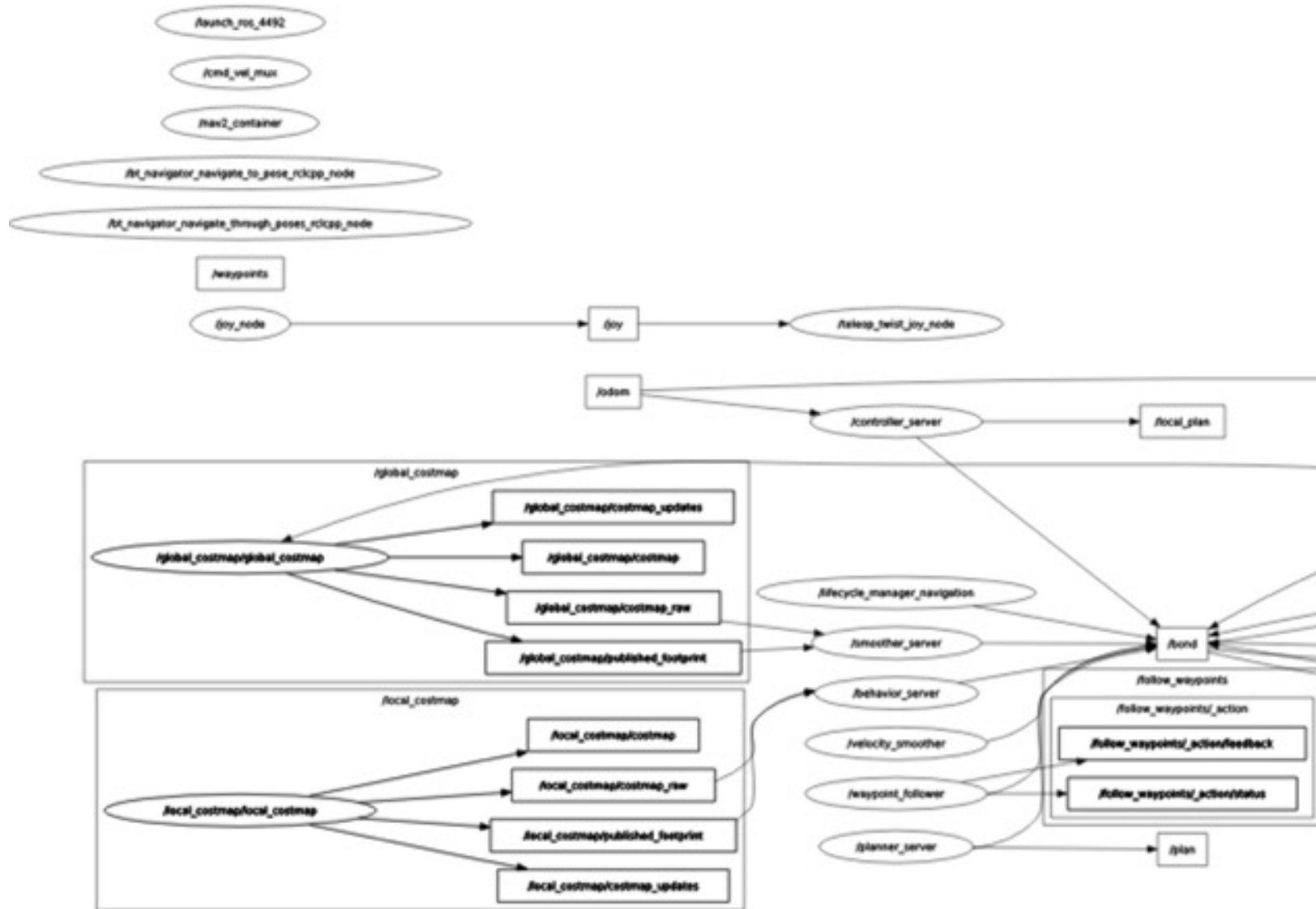
# ROS 2 Topics

---

/active	/global_costmap/costmap	/map
/amcl/transition_event	global_costmap/costmap_raw	/map_server/transition_event
/amcl_pose	/global_costmap/costmap_updates	/map_updates
/behavior_server/transition_event	/global_costmap/footprint	/marker
/behavior_tree_log	/local_costmap/voxel_marked_cloud	/mobile_base/sensors/bumper_pointcloud
/bond	/local_plan	/odom
/bt_navigator/transition_event	/map	/parameter_events
/button	/map_server/transition_event	/particle_cloud
/camera_info	/map_updates	/plan
/clicked_point	/marker	/plan_smoothed
/cmd_vel	/mobile_base/sensors/bumper_pointcloud	/planner_server/transition_event
/cmd_vel_nav	/odom	/preempt_teleop
/cmd_vel_teleop	/parameter_events	/received_global_plan
/controller_server/transition_event	/particle_cloud	/robot_description
/cost_cloud	/plan	/rosout
/diagnostics	/plan_smoothed	/scan
/downsampled_costmap	/planner_server/transition_event	/sensor
/downsampled_costmap_updates	/preempt_teleop	/smoother_server/transition_event
/evaluation	/received_global_plan	/speed_limit
	/robot_description	/tf
	/rosout	/tf_static
	/scan	/transformed_global_plan
	/sensor	/velocity_smoother/transition_event
	/smoother_server/transition_event	/waypoint_follower/transition_event
	/speed_limit	/waypoints

---

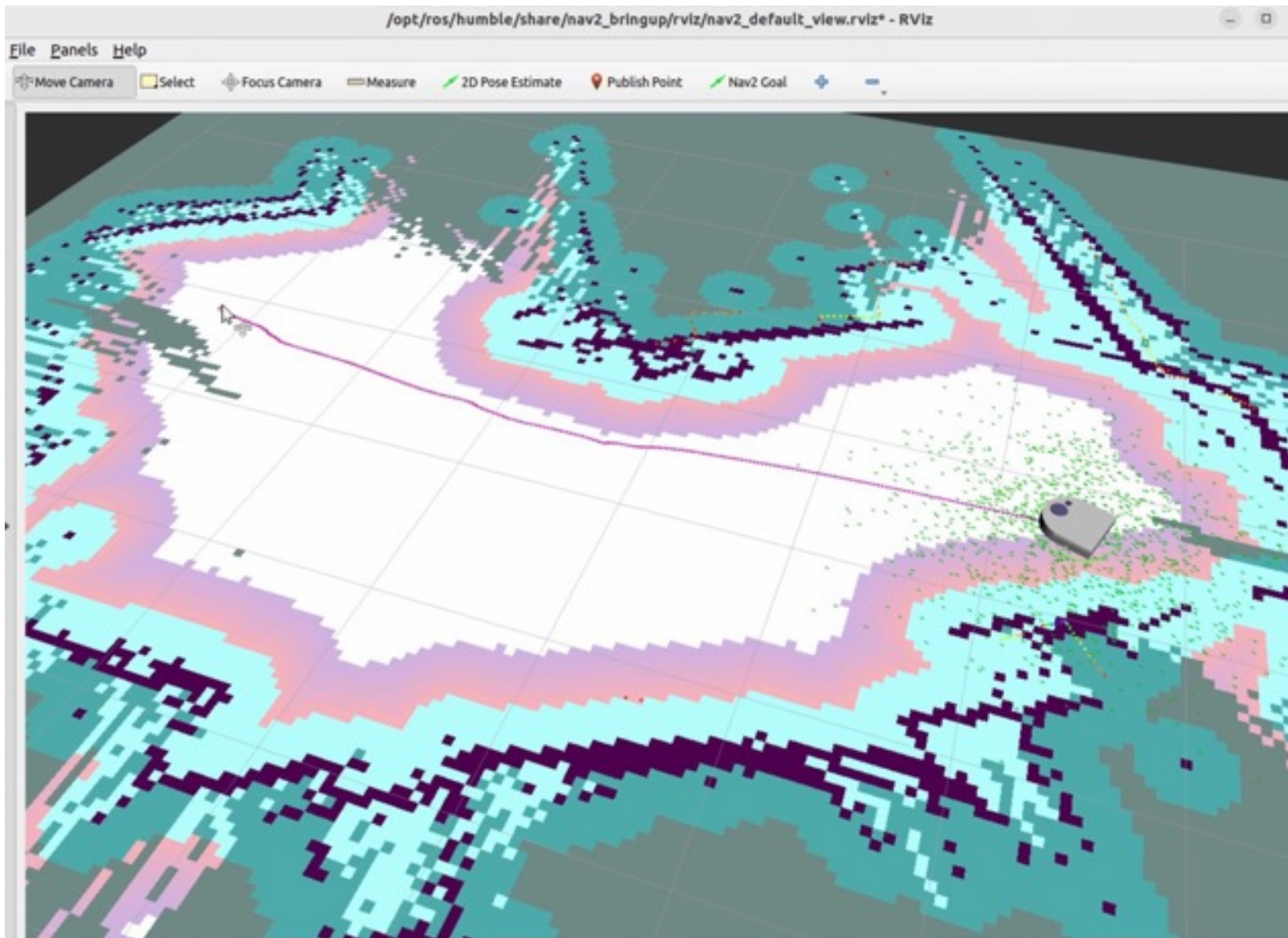
# Neato Turtle ros\_graph (left part)



# Neato Turtle ros\_graph (right part)



# SLAM & Navigation on map with SLAM Toolbox



ROS 2 Rviz Display

Global Map: Outside Perimeter of the Scan data

Costmap: Grid maps where each cell is assigned a specific value of cost. It represents the cost (difficulty) of traversing different areas of the map. The different colors represent known spaces, unknown space, obstacles, and inflation layers.

AMCL Path Plan from Pose Estimate to Nav2 Goal



# ROS References

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- “Home Brewed Robots!, by Camp Peavy .Chapter 6 describes configuring and running a Neato Turtle Robot System. (from Amazon)  
[https://github.com/cpeavy2/botvac\\_node](https://github.com/cpeavy2/botvac_node)
- ROS/Introduction  
<http://wiki.ros.org/ROS/Introduction>
- ROS Users - for general ROS-related discussions  
<https://discourse.ros.org>
- ROS Developers - for ROS core development  
<https://answers.ros.org>
- Neato Turtle (Botvac)S Developers - for ROS core development  
<http://wiki.ros.org/ROS/Introduction>
- Navigation 2  
<https://navigation.ros.org>  
[https://github.com/ros-planning/navigation2/tree/humble/nav2\\_bringup/launch](https://github.com/ros-planning/navigation2/tree/humble/nav2_bringup/launch)