

A decorative header consisting of a series of overlapping, semi-transparent geometric shapes (triangles and polygons) in a color gradient from red on the left to green on the right.

# Supporting Robotic Deliberation: **The Deliberation Working Group and Tools for Behavior Trees**

Christian Henkel, Bosch Research

ROSCon 2023



The programmer may return to being a mathematician. He is supplied with a catalogue of subroutines. No longer does he need to have available formulas or tables of elementary functions. He does not even need to know the particular instruction code used by the computer. He needs only to be able to use the catalogue to supply information to the computer about his problem. The UNIVAC, on the basis of the information supplied by the mathematician,

“The education of a computer” 1952  
Grace Murray Hopper, Remington Rand Corp

1000

stopped - arctan ✓  
 13" sec (032) MP - MC ~~1.982647000~~  
 (033) PRO 2 2.130476415  
 9.037 846 995 condr  
 4.615925059(-2)  
 condr 2.130676415

Relays 6-2 in 033 failed special speed test  
 in relay " " test -

Relay  
 2145  
 Relay 33

1700  
 1525

Relays changed  
 Started Cosine Tap (Sine check)  
 Started Mult + Adder Test.

1545



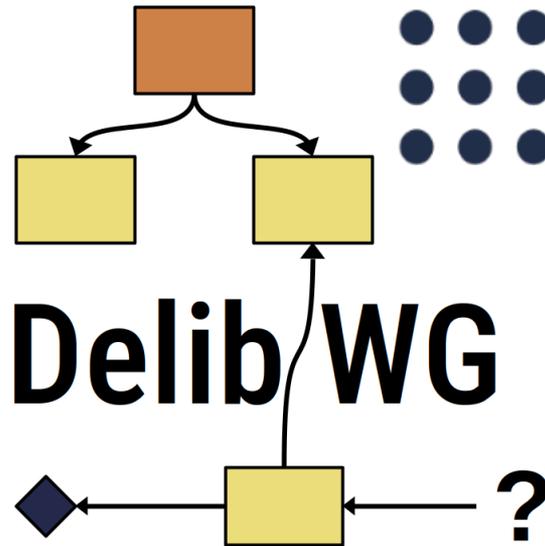
Relay #70 Panel F  
 (moth) in relay.

First actual case of bug being found.

~~1630~~ 1630 arctangent started.  
 1700 closed down.

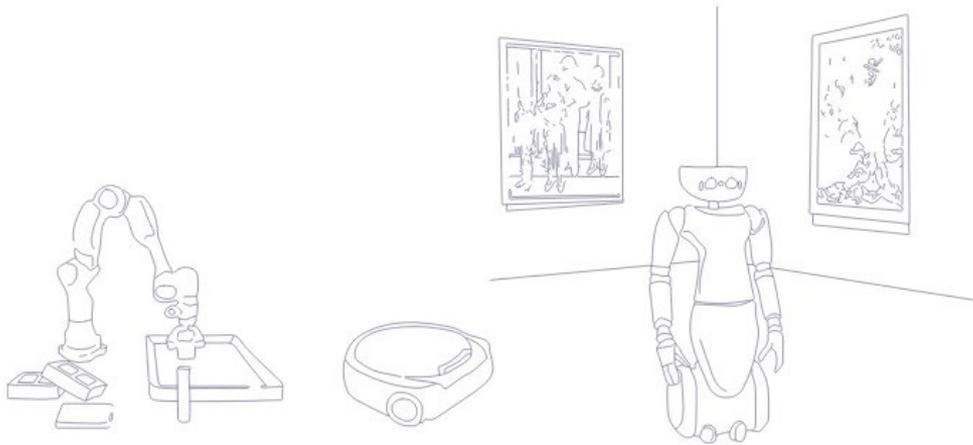
# 1

## Deliberation Working Group



# Deliberation Working Group

## Convince Project

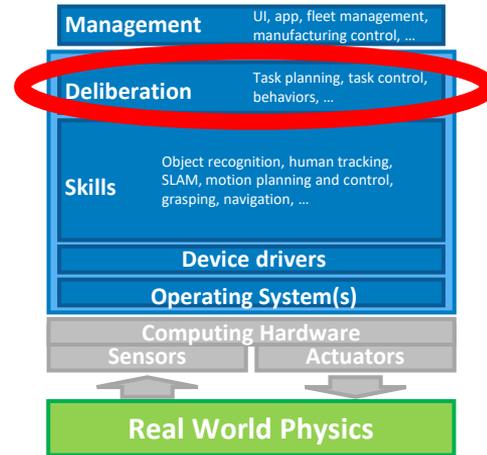


# CONVINCE



Funded by  
the European Union

### Partners



# Deliberation Working Group

## Welcome Page

<https://bit.ly/delibwg>



Networking and knowledge exchange

Discussion of novel and advanced works on top of the state of the art

Streamlining & harmonization of common interfaces

## More information

- To participate: <https://groups.google.com/g/ros-wg-deliberation>
- Recordings: <https://www.youtube.com/playlist?list=PLcSZ3QEfuKf-CKfrcbtUehY4U1brNabnf>

## The ROS Deliberation Working Group

This document contains agenda and protocol of the Deliberation Working Group

### Lead(s)

Christian Henkel

Contact: [Christian.Henkel2@de.bosch.com](mailto:Christian.Henkel2@de.bosch.com)

### Meeting Invitation

If you want to receive an invitation to the working group meetings, please join [ros-wg-deliberation](https://ros-wg-deliberation).

### Working mode

Please add points that you want to discuss to the agenda, and please add points that we discussed during the meeting.

### Access rights

All members of [ros-wg-deliberation](https://ros-wg-deliberation) have rights to suggest changes. If you are attending the meeting regularly and would like to help me moderate the changes, I can give you edit rights. But for security reasons, I don't want to give them to all group members by default.

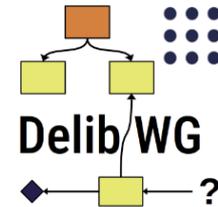
### Recordings

We try to record all meetings. You will find the recordings here: <https://www.youtube.com/playlist?list=PLcSZ3QEfuKf-CKfrcbtUehY4U1brNabnf>

### Index (clickable)

(latest meetings are on the top of the list)

[23-10-02](#)  
[23-08-07](#)  
[23-07-03](#)  
[23-06-05](#)  
[23-04-28](#)





# Working Group

## Our first product: Awesome Deliberation

<https://bit.ly/delibwg>



- Our first Product is a list of robotics deliberation
  - Packages
  - Presentations
  - Publications
- Feel free to contribute:
  - <https://github.com/ros-wg-delib/awesome-ros-deliberation>
- Next steps
  - **Standardization of behavior tree nodes**

**Awesome Robotic Deliberation** 

license **CC0-1.0** build **passing**

A curated list of awesome tools, libraries and resources for deliberation in ROS 2.

Deliberation is the topmost layer in a robotics architecture sometimes also called mission or planning layer. It aims at controlling the robots behavior towards its extended goal or function. This includes pre-programmed state machines, automated symbolic planning as well as behavioral reaction to unforeseen situations happening at runtime.

### Contents

- Packages
- Presentations
- Papers and Book Chapters
- Blog Posts
- Podcasts
- Demos

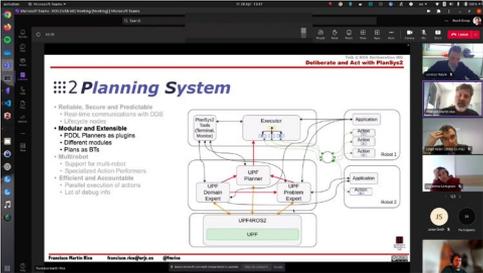
### Packages

- [BehaviorTree.cpp](#) - Implementation of behavior trees in C++.
- [CoSTAR Stack](#) - A collaborative system for task automation and recognition.
- [FlexBE](#) - State machine implementation with web-based GUI.
- [MERLIN2](#) - PDDL Planner.
- [Movelt Studio](#) - ROS 2 based commercial software that uses behavior trees and Movelt / Movelt Task

# Deliberation Working Group

## Some Presentations

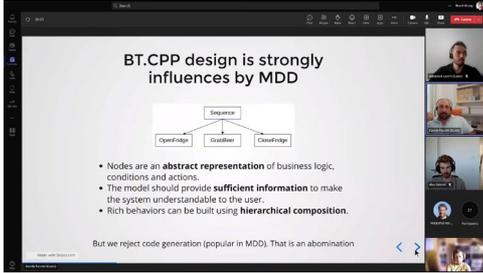
**Deliberate and Act with PlanSys2**, Francisco Martín Rico, Universidad Rey Juan Carlos



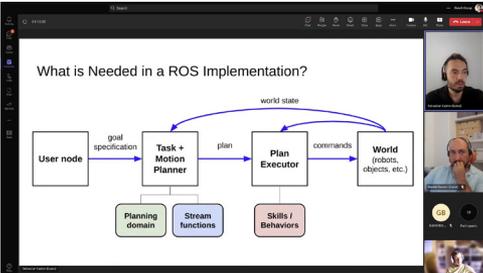
**AIPlan4EU and Planning with Behavior Trees**, Guglielmo Gemignani, Magazino GmbH



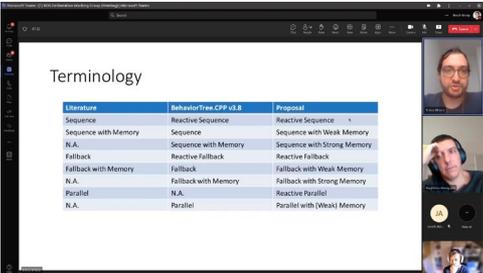
**BehaviorTree.CPP: what makes it different from other implementations**, Davide Faconti



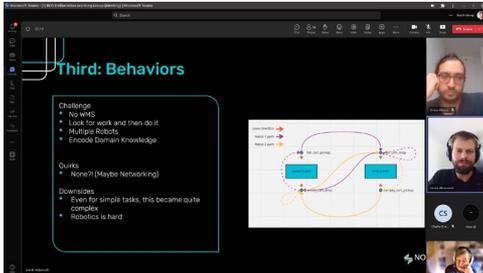
**Integrated Task and Motion Planning with ROS 2 and PDDLStream**, Sebastian Castro



**Different behavior tree formalisms**, Enrico Ghorzi, Università di Genova

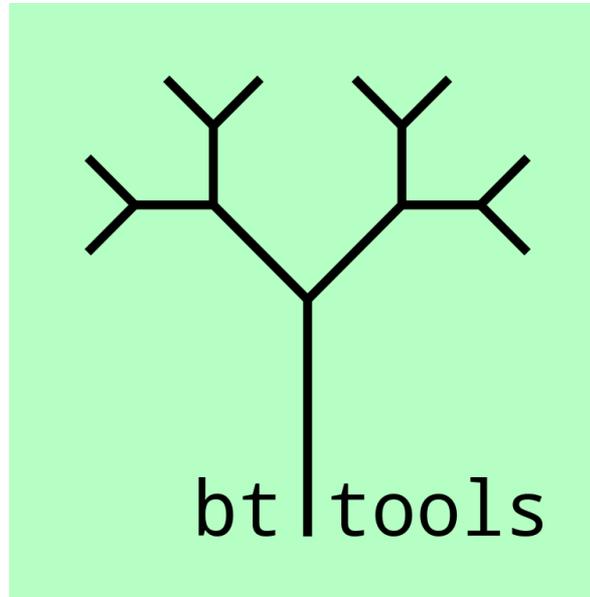


**Deliberation at NODE - Quirks and Features**, Jannik Abbenseth, NODE Robotics



# 2

## Tooling for Behavior Trees



# Tooling for Behavior Trees

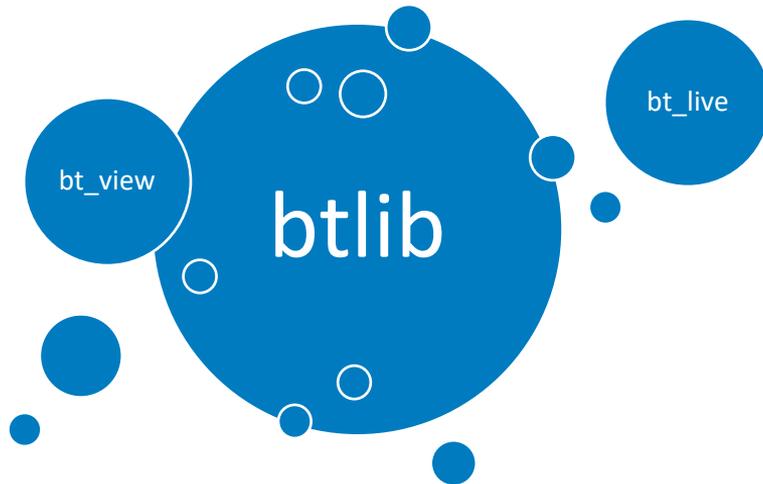
## A toolkit for the Behavior Tree Tender

[https://github.com/boschresearch/bt\\_tools](https://github.com/boschresearch/bt_tools)



### bt\_tools

A *python* library and multiple tools to visualize and analyze behavior trees created with **behaviortree.cpp**



**bt\_tools**

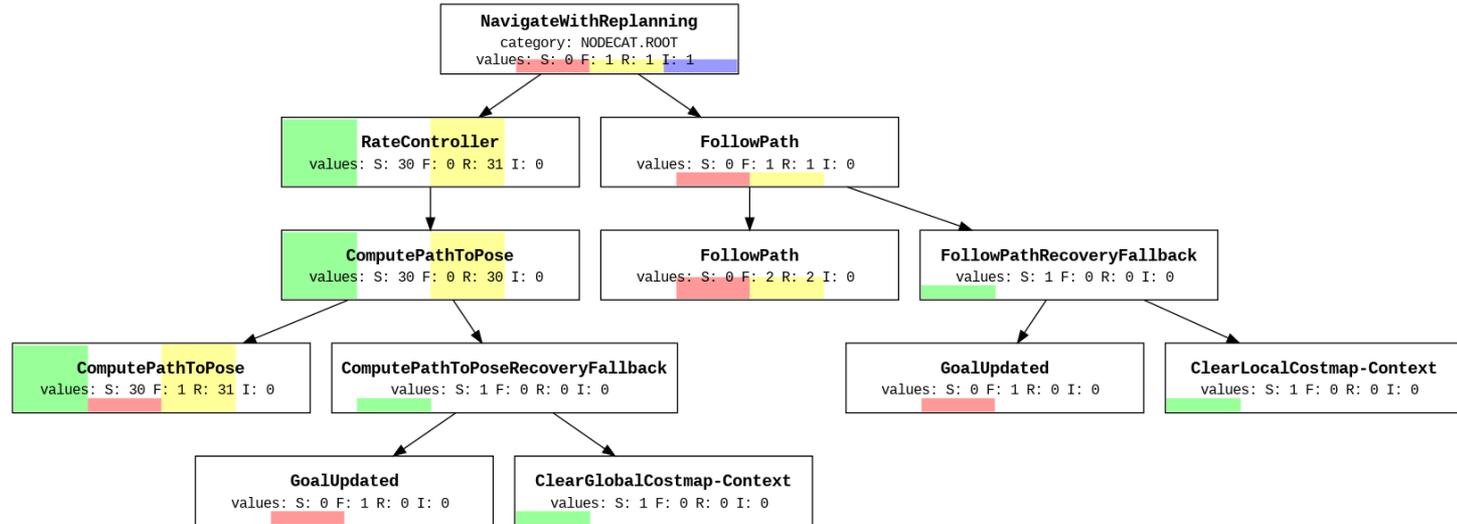
Tools to view behavior trees:

- **btlib**: Library to parse behavior trees.
- **bt\_view**: Tools to visualize behavior tree runs.
- **rqt\_bt\_live**: Tool to view behavior trees in rqt at runtime.

# Tooling for Behavior Trees

## Offline analysis: `bt_view`

[https://github.com/boschresearch/bt\\_tools](https://github.com/boschresearch/bt_tools)

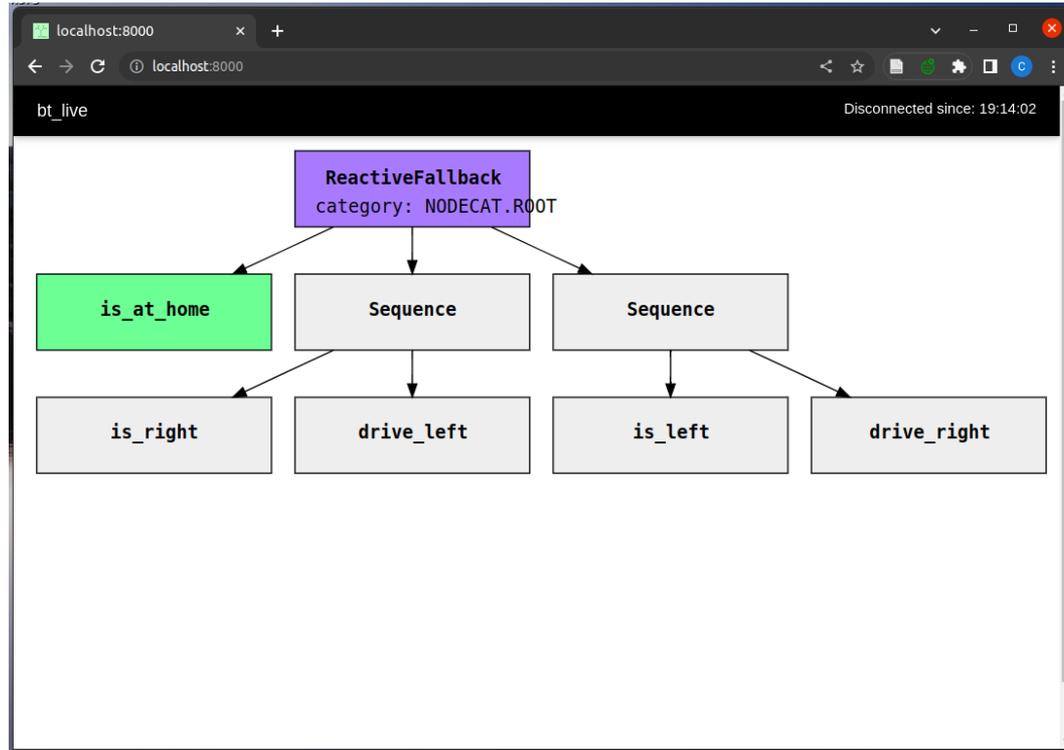


```
ros2 run bt_view bt_view --  
bt_log_fbl_fnames <path_to_fbl_log> --  
coverage-threshold <threshold>
```

# Tooling for Behavior Trees

## Online Visualization: **bt\_live**

[https://github.com/boschresearch/bt\\_tools](https://github.com/boschresearch/bt_tools)



## Deliberation Working Group

- Minutes and general info: <https://bit.ly/delibwg>
- To participate: <https://groups.google.com/g/ros-wg-deliberation>
- Recordings: <https://www.youtube.com/playlist?list=PLcSZ3QEfuKf-CKfrcbtUehY4U1brNabnf>
- Awesome list: <https://github.com/ros-wg-delib/awesome-ros-deliberation>



## BT Tools

- Github: [https://github.com/boschresearch/bt\\_tools](https://github.com/boschresearch/bt_tools)



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