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,
1000

stopped - action

13" oc (032) MP - MC

(033) PRO

2.130476415

2.130476415

Relays 0-2 in 033 failed special speed test

Relays changed

In Relay

Relays checked

1700

Started Cosine Tape (Sine check)

1525

Started Multi Adder Test.

1545

First actual case of bug being found.

Relay #70 Panel F

(moth) in relay.

1630

Antifog started.

1700

closed down.
Deliberation Working Group
Deliberation Working Group

Convince Project

Partners

Convince Project

Real World Physics

Funded by the European Union

Management
- UI, app, fleet management, manufacturing control, ...

Deliberation
- Task planning, task control, behaviors, ...

Skills
- Object recognition, human tracking, SLAM, motion planning and control, grasping, navigation, ...

Device drivers

Operating System(s)

Computing Hardware
- Sensors
- Actuators

© Robert Bosch GmbH 2023. All rights reserved, also regarding any disposal, exploitation, reproduction, editing, distribution, as well as in the event of applications for industrial property rights.
Deliberation Working Group

Welcome Page

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=PLcSZ3QEfKf-CKrCbtUehY4U1brNabnf

Deliberation Working Group

Technologies Word Cloud

- behavior trees
- planning and acting
- task and motion planning
- cognitive architectures
- moveit task constructor
- plansys2
- smacc
- hfsm
- scene graphs
- formal semantics
- petri net plans
- bdi agents
- knowrob
- bdi
- state machines
- multi-agent systems
- linear temporal logic
- pddl
- pddlstream
- state machines
- mape-k
- prolog
- jason
- hgn
- flexbe
- classical planning
- planning
- merlin 2
- petri net
- symbolic ai
- acinos
- ontologies

Our first product: Awesome Deliberation

- 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
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 Ghiorzi, Università di Genova

Deliberation at NODE - Quirks and Features, Jannik Abbenseth, NODE Robotics
Tooling for Behavior Trees
**Tooling for Behavior Trees**

* A toolkit for the Behavior Tree Tender

**bt_tools**

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

![Diagram of bt_tools and btlib](https://github.com/boschresearch/bt_tools)

- **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.
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
Deliberation Working Group

- To participate: [https://groups.google.com/g/ros-wg-deliberation](https://groups.google.com/g/ros-wg-deliberation)
- Recordings: [https://www.youtube.com/playlist?list=PLcSZ3QEfukf-CKfrcbtUehY4U1brNabnf](https://www.youtube.com/playlist?list=PLcSZ3QEfukf-CKfrcbtUehY4U1brNabnf)
- Awesome list: [https://github.com/ros-wg-delib/awesome-ros-deliberation](https://github.com/ros-wg-delib/awesome-ros-deliberation)

BT Tools

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

Christian Henkel

christian.henkel2@de.bosch.com | github.com/ct2034