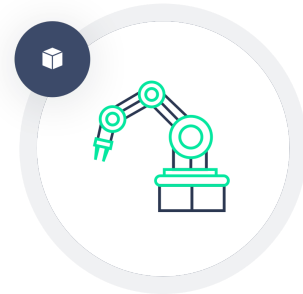
# MoveIt's Planner Zoo



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2. STOMP
3. Realtime's High-frequency planner
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5. Descartes Cartesian Planner
6. TrajOpt + Bullet
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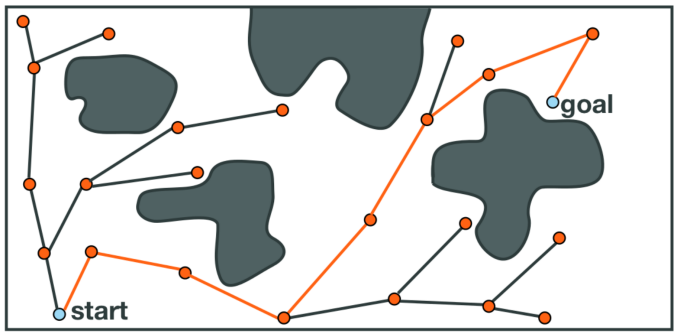
# Open Motion Planning Library (OMPL)

Sampling-based motion planners:

- Single-query: RRTConnect, RRT, KPIECE, ... ...
- Multi-query: PRM, LazyPRM, ...
- Optimizing: RRTstar, PRMstar, Bitstar, ...




Unrealized potential:

- Multi-query planner support (PRM variants, SPARS)
- Experience-based planners (persisting planner data)
- Custom optimization objectives
- Control-based planners

# OMPL - AnytimePathShortening

**Problem:** Single-query planners can compute unpredictable results

**Approach:** Run multiple single-query planners and combine paths

- Repeatedly run (different) single-query planners
- Attempt to shortcut and hybridize solutions

MoveIt: https://github.com/ros-planning/moveit/pull/1686 (WIP)

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# OMPL - CostConvergenceTerminationCondition

**Problem:** Optimizing planners use up full planning time

**Approach:** Terminate planner if solutions don't improve

- Poll costs of each new solution
- Terminate if best cost converges to a threshold relative to the running average cost

MoveIt: https://github.com/ros-planning/moveit/pull/1557 (WIP)
OMPL: https://github.com/ompl/ompl/119

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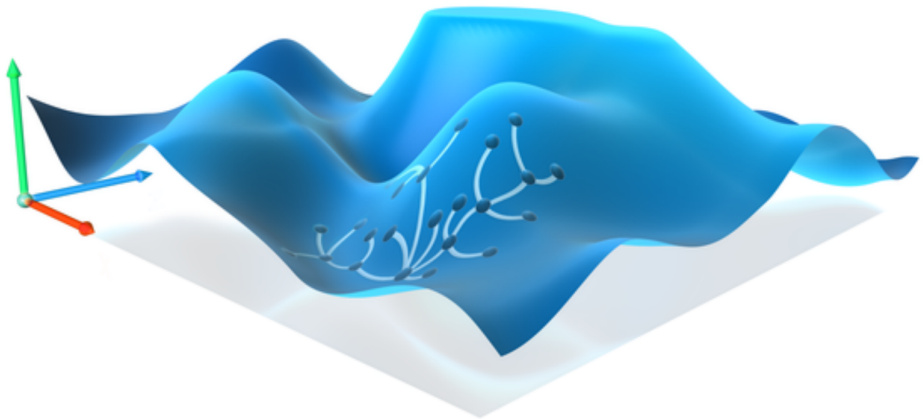
# Constraint planning - Manifold Approximation

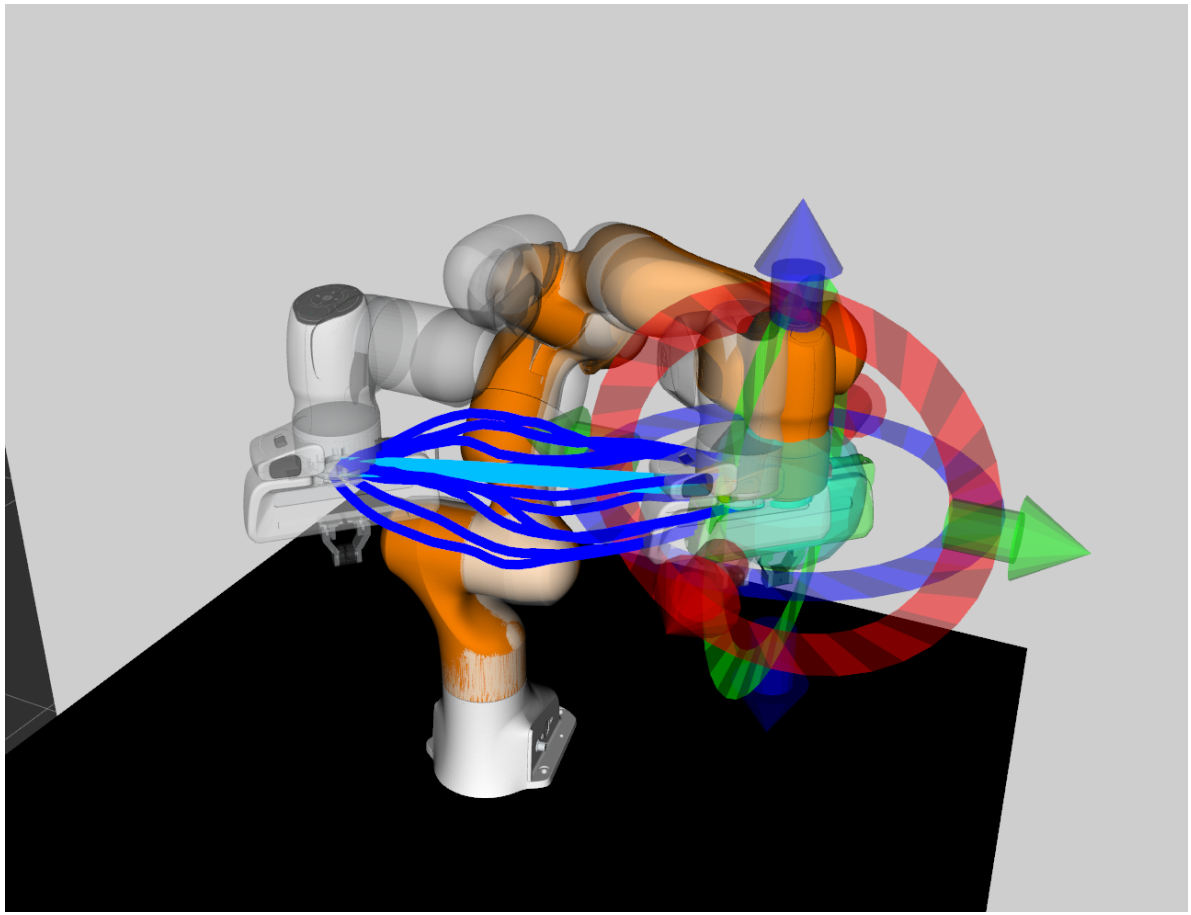
**Pre-generate approximate state space for constraint manifold**



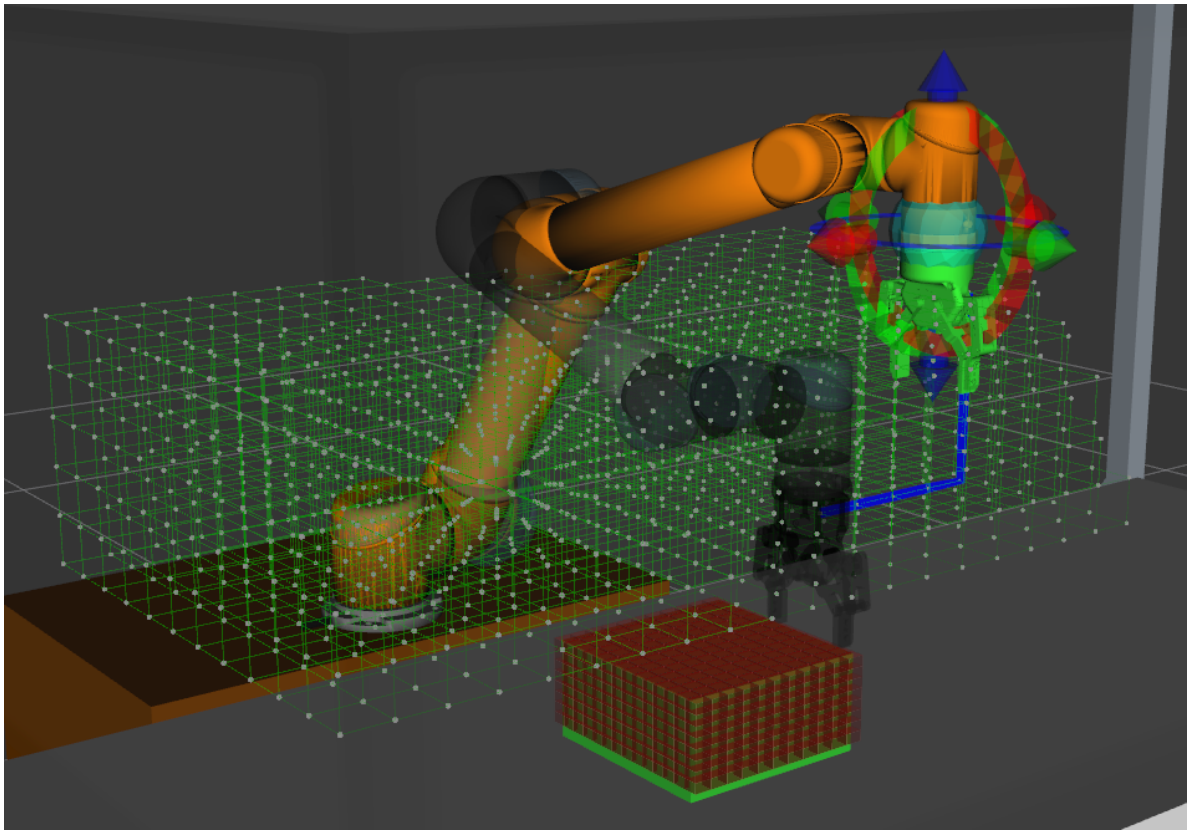
1. Generate state space database using moveit_generate_state_database
2. Load database to move_group/constraint_approximations_path
3. Reference constraint ID for planning

https://ros-planning.github.io/moveit_tutorials/doc/planning_with_approximated_constraint_manifolds/planning_with_approximated_constraint_manifolds_tutorial.html

## Stochastic Trajectory Optimization for Motion Planning (STOMP)



# Realtime Robotics' RapidPlan - rtr_moveit



realtime robotics

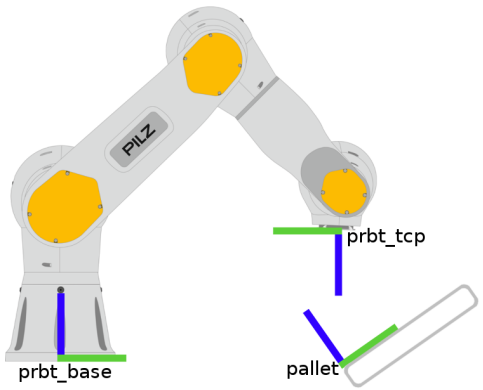
- Implemented by PickNik for Realtime Robotics (Q1 2019)
- Parallel collision checking using dedicated hardware chip

Repository: https://github.com/RealtimeRobotics/rtr_moveit

# Pilz Industrial Motion - pilz_industrial_motion

- ROSin FTP implemented by Pilz GmbH & Co. KG
- Completed in February 2019
- Convenient API for industrial Cartesian trajectories in MoveIt
- Supports blending sequential motion commands

PILZ
THE SPIRIT OF SAFETY

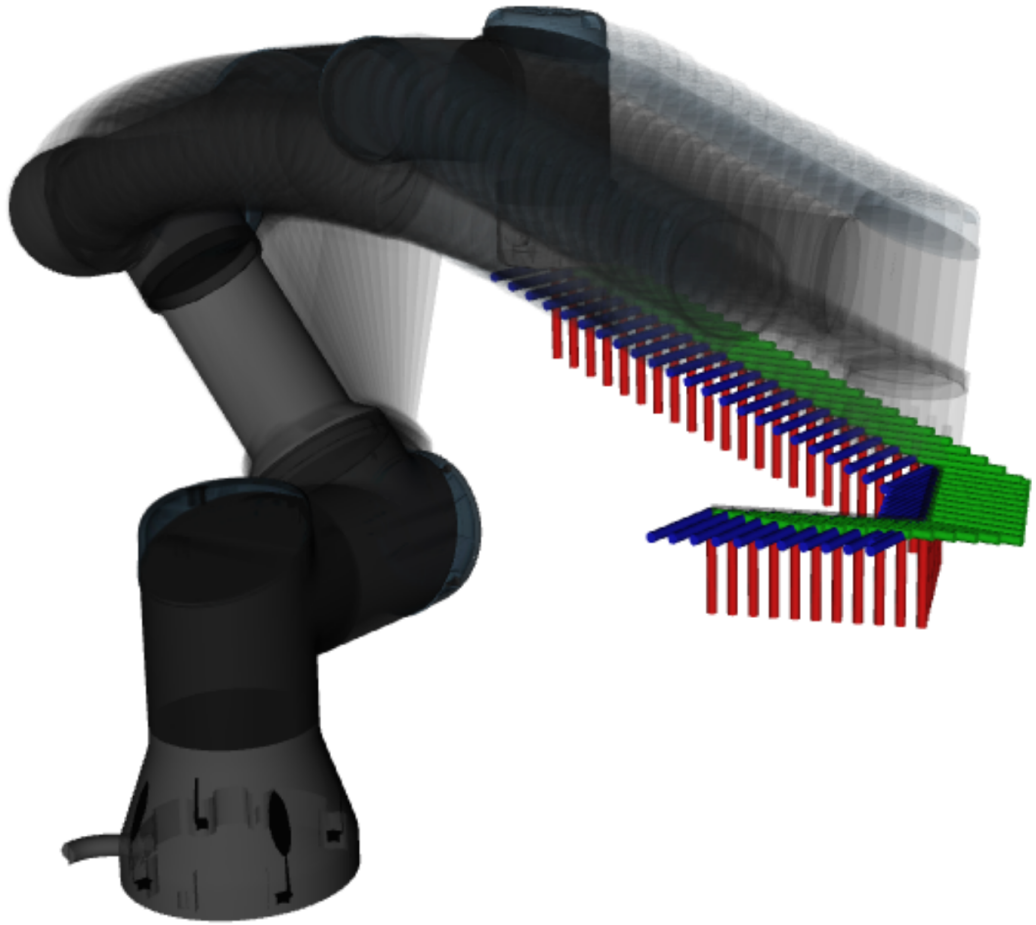



ROSin

Repository: https://github.com/PilzDE/pilz_industrial_motion

# Descartes Cartesian Planner

## New Capability by PickNik and Carbon Robotics (April 2019)



Repository: https://github.com/PickNikRobotics/descartes_capability

# TrajOpt

**2 GSoC projects 2019 (TrajOpt + Bullet)**

Current state of TrajOpt

- Planner Plugin implemented
- Simple joint-space goals are working
- Removed dependencies to Tesseract

Advantages:

- More deterministic
- Supports sparse constraints natively
- Supports free-space and Cartesian space
- Utilizes continuous collision checking
- Directly optimizes velocity, acceleration, jerk

TrajOpt: https://github.com/ros-planning/moveit/pull/1626 (WIP)

# Bullet

Features:

- Unified robot and world in single environment
- Support for continuous collision checks

| **Collision Environment** | Bullet Unified | Bullet | FCL |
|---|---|---|---|
| Robot self check, no col | 270,000 | 15,000 | 110,000 |
| World 100 meshes, no col | 38,000 | 2,000 | 35,000 |
| World 100 meshes, 4 col | 8,600 | 1,600 | 800 |

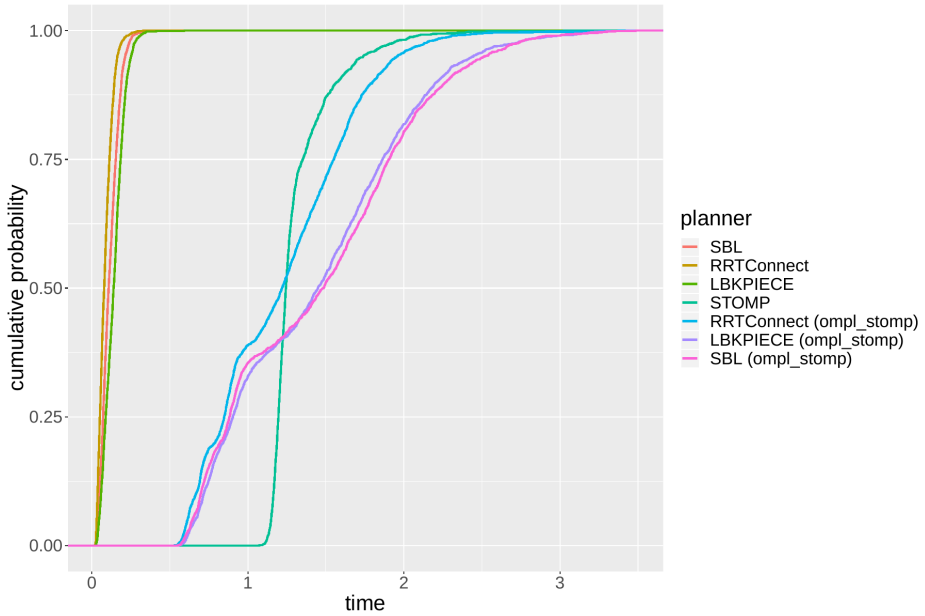
(Collision checks per second)

Bullet: https://github.com/ros-planning/moveit/pull/1572 (WIP)

# Planner Benchmarks (Upgraded)

New Features:

- Support for full planning pipelines (instead of planner only)
- Comparison of planners for all results (not only per experiment)
- Added metric for repeatability based on Fréchet distance
- Generate experiments from combinations of predefined targets




See: https://github.com/ros-planning/moveit/pull/1510
https://github.com/ros-planning/moveit/pull/1531
https://github.com/ros-planning/moveit/pull/1548

**Questions, Ideas, Wishes?**