

# Carlos Quintero-Peña

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Houston, TX USA

## Education

### Rice University

*Ph.D in Computer Science*

Towards safe motion planning under sensing uncertainty for high DoF robots

Houston, TX

*Aug. 2019 - May 2024*

*(expected)*

### Universidad de los Andes

*M.Sc in Electronic and Computer Engineering - GPA: 4.44/5.0*

Embeddings, connectivity and minimum spanning trees in dimensionality reduction

Bogotá, Colombia

*Aug. 2009 - Dec. 2010*

### Universidad de los Andes

*B.S in Electronic Engineering - GPA 4.16/5.0*

Hardware/software implementation of Adaboost

Bogotá, Colombia

*Jan. 2004 - May 2009*

## Experience

### Graduate Student

*Kavraki Lab, Rice University*

**Aug. 2019 - Present**

*Houston, TX*

Working towards safe motion planning for high degree-of-freedom robots in unstructured environments through the use of optimization and learning-based models.

- **Stochastic Implicit Neural Representations for Motion Planning under Sensing Uncertainty:** Sensor uncertainty quantification is posed as a variational inference problem. The uncertainty information is used in a novel chance-constrained hierarchical planner that can be solved efficiently to global optimality using convex optimization.
- **Optimal Grasps and Placements for Task and Motion Planning in Clutter:** Formulation of an optimization-based grounding layer capable of improving the scalability of task and motion planners by jointly optimizing for grasps and object locations in tabletop manipulation problems.
- **MotionBenchMaker:** Open source tool to generate datasets for benchmarking realistic robot manipulation problems.
- **Human-Guided Motion Planning in Partially Observable Environments:** Human preferences are learned by using a Bayesian reward learning approach to learn safe motions. Proposed a method based on sampling-based motion planners and a novel guided trajectory optimization formulation that make learning tractable and efficient.
- **Robust Motion Planning under Sensing Uncertainty:** Formulation of safe motion planning as a trajectory optimization problem where safety is enforced as a positive signed distance between noisy objects and the robot geometry and solved using sequential quadratic optimization and robust optimization.
- Teaching assistant for the course **Algorithmic Robotics** (Fall 2020, Fall 2022).

### Instructor

*Dept. of Elect. Engineering, Universidad de los Andes*

**Jan. 2018 - Jul. 2019**

*Bogotá, Colombia*

- Taught undergraduate level courses: **Robotics** (Spring 2019), **Analog Electronics** (Spring 2018, Spring 2019), **Intr. to EE.** (Fall 2018), **Digital Systems** (Spring 2018, Fall 2018), **Electronics Workshop** (Fall 2018).
- Advised 3 undergraduate student graduation projects.

- Led a 4-month specialized consultancy and assessment project on the analysis of an intelligent debit system using machine learning for Bancolombia.
- Co-founder of the inter-institutional initiative SinfonIA for working on developing artificial intelligence methods for service robots.
- Advised undergraduate group SinfonIA for the participation on the RoboCupHome social standard platform league in Sydney Australia for RoboCup 2019.

#### **Instructor**

**Jan. 2013 - Dec. 2017**

*Dept. of Elect. Engineering, Universidad Santo Tomás*

*Bogotá, Colombia*

- Taught undergraduate level courses: **Operating Systems** (Spring 2014, Fall 2014, Spring 2015, Fall 2015, Spring 2016, Fall 2016, Spring 2017, Fall 2017), **Digital Systems** (Fall 2017), **Circuits** (Fall 2016).
- Taught graduate level courses: **Artificial Intelligence** (Fall 2016), **Optimization** (Spring 2017).
- Advised 10 undergraduate student graduation projects.
- Member of the STOX's team for the development of artificial intelligence methods for mobile robots. Participated in the Small Size League of RoboCup from 2014-2018. In charge of leading the development of robot soccer coordination based on optimization and machine learning. Led the writing of the team's technical description papers for qualification material in 2014, 2015, 2016, 2017, 2018

#### **R&D Engineer**

**Oct. 2011 - Jul. 2012**

*Accellogic LLC*

*Sunrise, FL*

- Conducted research on topics of interest to the company for accelerating numerical software through algorithmic design and specialized hardware.
- Involved in the design, development, benchmark, testing and documentation of the company's algorithm-based products and prototypes.
- Involved in the preparation of government funding opportunities (SBIR) and patents.
- Proposed and implemented direct and iterative algorithms for the solution of large scale linear systems, eigenvalue problems and general matrix computations.

#### **Research and Teaching Assistant**

**Aug. 2009 - Jun. 2011**

*Dept. of Elect. Engineering, Universidad de los Andes*

*Bogotá, Colombia*

- **Online Pairwise Ranking Based on Graph Edge-Connectivity:** Novel ranking algorithm for pairwise object preferences that uses graph edge-connectivity.
- **Embeddings, connectivity and minimum spanning trees in dimensionality reduction:** Conducted research on manifold learning techniques based on graphs. Proposed methods for manifold learning using stochastic minimum spanning trees and local principal component analysis.
- Teaching assistant for the courses **Digital Systems** (Fall 2009, Spring 2010, Fall 2010) and **Optimization** (Fall 2010).

### **Publications**

#### **Preprints under review**

- **Quintero-Peña, C.,** Thomason, W., Kingston, Z., Kyrillidis, A., and Kavraki, L.E. Stochastic Implicit Neural Signed Distance Functions for Safe Motion Planning under Sensing Uncertainty. Under review <https://arxiv.org/pdf/2309.16862.pdf>.

#### **Peer-reviewed articles**

- **Quintero-Peña, C.**, Kingston, Z., Pan, T., Shome, R., Kyrillidis, A., and Kavraki, L.E. Optimal Grasps and Placements for Task and Motion Planning in Clutter. IEEE ICRA 2023. doi: 10.1109/ICRA48891.2023.10161455
- **Quintero-Peña, C.**, Qian, P., Fontenot, N., Chen, H.-M. , Hamlin, S., Kavraki, L. and Unhelkar, V. Robotic Tutors for Nurse Training: Opportunities for HRI Researchers, in 2023 31st IEEE International Conference on Robot and Human Interactive Communication (RO-MAN), 2023. doi:10.1109/RO-MAN57019.2023.10309573
- **Quintero-Peña, C.**, Chamzas, C., Sun, Z., Unhelkar, V. and Kavraki, L.E. Human-Guided Motion Planning in Partially Observable Environments. IEEE ICRA 2022. doi: 10.1109/ICRA46639.2022.9811893
- Chamzas, C., **Quintero-Peña, C.**, Kingston, Z., Orthey, A., Rakita, D., Gleicher M., Toussaint, M. and Kavraki, L.E. MOTION BENCH MAKER: A Tool to Generate and Benchmark Motion Planning Datasets. IEEE Robotics and Automation Letters, November 2021. doi:10.1109/LRA.2021.3133603
- **Quintero-Peña, C.**, Kyrillidis, A. and Kavraki, L.E. Robust Optimization-based Motion Planning for high-DOF Robots under Sensing Uncertainty. IEEE ICRA 2021. doi:10.1109/ICRA48506.2021.9560917
- Chamzas, C., Kingston, Z., **Quintero-Peña C.**, Shrivastava, A., and Kavraki, L.E. Learning Sampling Distributions Using Local 3D Workspace Decompositions for Motion Planning in High Dimensions, IEEE ICRA 2021. doi: 10.1109/ICRA48506.2021.9561104 Top-4 finalist for best paper in Cognitive Robotics
- **Quintero, C.**, Uribe, R., Calderón, J., Lozano, F. Online pairwise ranking based on graph edge connectivity. In Innovations in Bio-inspired Computing and Applications, 2015. doi:https://doi.org/10.1007/978-3-319-28031-8\_44
- **Quintero, C.**, Rodríguez, S., Pérez, A., López, J., Rojas, E., Calderón, J. Learning soccer drills for the small size league of RoboCup. In Lecture Notes on Artificial Intelligence, Springer 2015. doi:https://doi.org/10.1007/978-3-319-18615-3\_32
- **Quintero, C.**, Lozano, F. Locally linear minimum spanning trees for manifold learning. In 12th International Conference on Machine Learning and Applications ICMLA 2013. doi: 10.1109/ICMLA.2013.12

## Awards, Grants & Honors

IEEE RAS ICRA 2023 Studen Travel Grant . . . . .	2023
IEEE RAS ICRA 2022 Studen Travel Grant . . . . .	2022
Nominated, Best Paper in Cognitive Robotics, IEEE RAS ICRA 2021 . . . . .	2021
Fulbright Scholarship . . . . .	2019
IEEE EVIC 2008 Student Travel Grant . . . . .	2008

## Professional Service

- Organizer of Evaluating Motion Planning Performance Workshop, IROS 2022
- Reviewer for ICRA 2024, 2023, 2022, 2021, IROS 2023, 2021, ROMAN 2023, Humanoids 2023, Robotics and Automation Letters (RA-L).
- Associate Editor for IEEE Colombian Caribbean Conference - C3, *Robotics and Automation Systems* track, 2023.

## Invited Presentations and Lectures

- Interviewed in special report on advances in artificial intelligence prepared by Telemundo Houston (in spanish) in November 2023: Part 1, Part 2, Part 3 and Part 4
- Invited to co-teach the summer course Robot Learning at Universidad de los Andes, summer 2023.
- Invited to teach a workshop on *Motion Planning Algorithms for High-DoF Robots: Data Generation and Benchmarking* for CCAC 2023.
- Invited to give a talk at Sistemas Robóticos Autónomos y Aplicaciones on Dec. 2020.

## Skills

- **Programming:** C/C++, Python, MATLAB, Julia, R
- **Robotics software:** ROS, Gazebo, DART, VRep, MoveIt, PyBullet.
- **Optimization/ML software:** PyTorch, Gurobi, Ipopt, Pyomo, CVXPY.
- **Languages:** Spanish (native), English (fluent).