Daniel Felipe **Ordoñez Apraez**

ELLIS Ph.D Student in Bioengineering and Robotics - M.Sc. Artificial Intelligence

Contact

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Profile

Third year ELLIS Ph.D. student exploring the applications of group theory in robot modeling, control and design. My research strives to enhance robotic functionality through mathematically driven innovation. I have a specialized focus on the exploitation of structural/morphological symmetry groups in robot locomotion and manipulation.
Born in: 1995.

Interests

Geometric Deep Learning
Group theory · Control theory
Legged Locomotion
Dynamical Systems theory

Languages

Spanish	Mother Tongue
English	C1 (TOEFL)
German	Intermediate - B2
Italian	Intermediate

Programming

Python · C++ · Matlab · LaTeX

Software

Pinocchio · Drake · Crocoddyl
ROS · ESCNN · OMPL · Torch

References

Dr. Massimiliano Pontil
Italian Institute of Technology
Massimiliano.Pontil@iit.it

Dr. Mario Martin
Universitat Politècnica de Catalunya
mmartin@cs.upc.edu

Dr. Claudio Semini
Italian Institute of Technology
claudio.semini@iit.it

Education

Oct 2022 – Present
Genova Italy
Edinburgh UK

Italian Institute of Technology (IIT) – University of Genova
European Laboratory for Learning and Intelligent Systems (ELLIS)
Ph.D. in Bioengineering and Robotics
My research project focuses on leveraging morphological symmetries in data-driven and modeling, control and estimation of robotic systems.
For **data-driven** methods, leveraging these symmetry priors leads to enhanced sample efficiency and generalization. For **model-based** methods, exploiting these symmetry priors lead to improved numerical complexity.
Supervisors: • Dr. Massimiliano Pontil (CSML) • Dr. Claudio Semini (DLS).
Period abroad at Dr. Carlos Mastalli's RoMi lab from Herriot-Watt University.

2019–2021
Barcelona
Spain

Universitat Politècnica de Catalunya – Barcelona Tech
M.Sc. in Artificial Intelligence
Thesis: Learning to run naturally: guiding policies with the spring-loaded inverted pendulum. An approach to learning realistic locomotion policies by exploiting sagittal reflectional symmetry and the passive dynamics priors.

2013–2018
Bogota
Colombia

Universidad Nacional de Colombia
B.Sc. in Mechatronics Engineering - Major in robotics
Five year bachelor's program.
Exchange Semester: Technical University of Munich

Experience

2021–2022
2019–2021
Barcelona
Spain

Institut de Robòtica i Informàtica Industrial (IRI-CSIC)
Assistant Researcher
Student Researcher
Research Projects: • Learning realistic legged locomotion by imitating low order template passive models.
• Learning human hand synergies of motion with Variational Autoencoders

2018–2019
2017–2018
Cologne
Germany

INVITE GmbH Research Center (TU Dortmund & Bayer AG)
Junior Research Assistant
Robotics Intern
Research project: Manipulation of plastic bags using a two-arm robot with 3D vision and force feedback. (see presentation video)
• EP-Patent: *Autonomous Drum and Inliner Handling*

Selected publications full list here

- **Morphological Symmetries in Robotics**. **Ordoñez-Apraez, D.**, Turrisi, G., Kostic, V., Martin, M., Agudo, A., Moreno-Noguer, F., Pontil, M., Semini, C., & Mastalli, C. International Journal of Robotics Research. IJRR-2025
- **Dynamics Harmonic Analysis of Robotic Systems: Application in Data-Driven Koopman Modeling**. **Ordoñez-Apraez, D.**, Kostic, V., Turrisi, G., Novelli, P., Mastalli, C., Semini, C., & Pontil, M. Learning for Dynamics & Control Conference. PMLR 2024
- **Leveraging Symmetry in RL-based Legged Locomotion Control**. Su, Z., Huang, X., **Ordoñez-Apraez, D.**, Li, Y., Li, Z., Liao, Q., ... & Sreenath, K. IEEE International Conference on Intelligent Robots and Systems. IROS-2024
- **On discrete symmetries of robotics systems: A group-theoretic and data-driven analysis**. **Ordoñez-Apraez, D.**, Agudo, A., Moreno, F., & Martin, M. Robotics Science and Systems RSS-2023
- **An Adaptable Approach to Learn Realistic Legged Locomotion without Examples**. **Ordoñez-Apraez, D.**, Agudo, A., Moreno, F., & Martin, M. International Conference on Robotics and Automation ICRA-2022
- [Patent] **Autonomous Drum and Inliner Handling**. INVITE GmbH., Bayer A.G. Published European and US patent EP4112238A1/US2023009062A1.

Open-Source Projects

- **MorphoSymm**: Repository with tools for exploiting morphological/structural symmetry groups in robotics. Including:
  - A library of symmetric robotic systems and the relevant group representations needed for transforming state/action spaces and proprioceptive/exteroceptive measurements.
  - Tools for the construction of equivariant/invariant neural networks based on ESCNN.
  - [In development] Tools for exploiting harmonic analysis of structural groups for modeling/control.
- **Gym-Quadruped**: Mujoco quadruped gym environment for testing model-based controllers and collecting datasets of locomotion used by IIT's Dynamics Legged System's laboratory.
- **SLIP Control**: Repository with tools for optimal control of the Spring-Loaded Inverted Pendulum (SLIP). A low order template model used for capturing the dynamics of legged locomotion. Including:
  - An model predictive control based on the differential flatness of the actuated SLIP model.
  - Tools for multi step/hops planning.
- **ROS driver for Robotiq 2F-85/140 Grippers**: ROS packages enabling the control, visualization and simulation of the Robotiq 2 Fingers Adaptive Grippers model version C3.

Teaching and Invited Lectures

Feb 2023 Bogotá Colombia	**Modern techniques of machine learning and control to robotics** Seminar - Universidad Nacional de Colombia Lecture: On the role of symmetries in machine learning and control of robotic systems
Jan-Feb 2022 Barcelona Spain	**Scene reconstruction and structure from Motion** Laboratory series of 3D-Vision course - Universitat Autònoma de Barcelona Main Lecturer: Prof. Dr. Gloria Haro
Dec 2021 Barcelona Spain	**Introduction to AI for speech–language pathology students** Bachelor in Speech–language pathology - Universitat Autònoma de Barcelona Higher cognitive functions seminar series. Main Lecturer: Prof. Paula Resina
Mar–Dec 2016 Bogotá Colombia	**Engineering faculty tutor** Universidad Nacional de Colombia Courses tutored: - Data structures and algorithms - Numerical methods - Control theory - Object-oriented programming - Basic programming

Presentations

Oct 2024 Paris France	**Morphological symmetries in analytical and data-driven modelling and control.** Inria's Willow research group seminar series. Inria, Ecole normale supérieure de Paris, CNRS. Invited seminar lecture (Slides)
July 2024 Paris France	**Dynamics Harmonic Analysis of Robotic Systems: Application in Data-Driven Koopman Modelling** Workshop at RSS 2024: Geometric and Algebraic Structure in Robot Learning. Workshop presentation (Slides)
Oct 2023 Berkley US	**Symmetries in robot modeling and control** Hybrid Robotics Laboratory seminar series. University of California, Berkeley Invited seminar lecture (Slides)
July 2023 Daegu Korea	**Morphological symmetries in robot learning** Workshop on Symmetries in Robot Learning (RSS-2023) Workshop presentation: youtu.be/E2l16T0biu4
May 2023 London UK	**[Spotlight] Morphological symmetries in robot learning** Worshop Effective Representations, Abstractions, and Priors for Robot Learning (ICRA-2023) Workshop presentation: youtu.be/vxTKCbNNU8M
Dec 2021 Barcelona Spain	**An Adaptable Approach to Learn Realistic Legged Locomotion without Examples** Poster at Deep Learning Barcelona Symposium

Awards

2022 Admitted to the European Laboratory for Learning Systems (ELLIS) doctoral program.
2020 Awarded COLFUTURO's scholarship/loan for master studies
2019 Top 1% score on the Colombian *saber-pro* national exam, which evaluates all students near graduation of a higher education's degree.
2019 Admitted to COLFUTURO's recruitment of talent program.
2015 Universidad Nacional de Colombia tuition exception.