

Franck Djeumou

GRADUATE RESEARCH ASSISTANT · AUTONOMOUS SYSTEMS GROUP · THE UNIVERSITY OF TEXAS AT AUSTIN

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Research Interests

My research aims to build autonomous or artificial intelligence-based systems that can learn how to operate in the real world while respecting underlying data, computational, safety, perception, and known physics-based limitations. To this end, I develop theoretical, computationally efficient, and practical methods by drawing from and contributing to diverse fields such as machine learning, optimization, (deep) reinforcement learning, dynamical systems modeling, formal methods, and optimal control theory.

Education

The University of Texas at Austin

PH.D. IN ELECTRICAL AND COMPUTER ENGINEERING

Austin, USA

September 2018 - July 2023

- Ph.D. Advisor: Ufuk Topcu
- Thesis on "Learning for autonomy in the wild: Theory, algorithms, and practice"

ISAE-SUPAERO (Institut Supérieur de l'Aéronautique et de l'Espace)

BACHELOR OF SCIENCE AND MASTER OF SCIENCE IN AEROSPACE ENGINEERING

Toulouse, France

September 2014 - June 2018

- Advised by Prof. Jerome Hugues
- Thesis on "Safety Guarantees for Drones through Set-Based Formal Verification Methods"

École Polytechnique

MASTER DEGREE IN COMPUTER SCIENCE (COMASIC)

Palaiseau, France

September 2016 - September 2017

- Advised by Prof. Eric Goubault and Prof. Sylvie Putot
- Thesis on "Human-Embedded Autonomous Flight Under Formal Task Specifications"
- This master degree was obtained as a collaboration between ISAE-SUPAERO and École Polytechnique

Lycée Fénelon

CLASS PREPARATORY (EQUIVALENT TO JUNIOR UNDERGRADUATE LEVEL) IN MATHEMATICS, PHYSICS, AND COMPUTER SCIENCE

Paris, France

September 2011 - June 2014

- Graduated with honours

Experience

Autonomous Systems Group

GRADUATE RESEARCH ASSISTANT | ADVISOR: UFUK TOPCU

Austin, USA

September 2018 - Present

- Published 11 conference papers (with 1 currently under review) and 6 journal papers (with 1 currently under review)
- Collaborated with researchers from various international academic institutions, national research laboratories and companies, and presented research outcomes at more than 10 invited talks

Toyota Research Institute (TRI)

RESEARCH SCIENTIST INTERN - EXTREME VEHICLE DYNAMICS CONTROL | MANAGER: JONATHAN GOH

Los Altos, USA

May 2022 - August 2022

- Proposed a data-efficient, deep learning approach that was used on a highly-customized Toyota Supra vehicle to achieve autonomous drifting. Such drifting skills may improve drivers' safety in highly dynamic situations such as road accidents
- The approach enables autonomous drifting by merging a novel physics-informed deep neural network model of the road-vehicle interaction and a well-designed nonlinear model predictive control problem
- Extensive experiments at a race track showed that scarce amounts of driving data – less than three minutes – were sufficient to achieve high-performance autonomous drifting

Cosynus Team at Laboratory LIX of École Polytechnique

RESEARCH INTERN | ADVISORS: ERIC GOUBAULT AND SYLVIE PUTOT

Palaiseau, France

March 2018 - August 2018

- Designed and Built the quadrotor testbed for the research team based on Crazyflie drones
- Implemented a hardware and software in the loop, Gazebo-based swarm simulator for the Crazyflie drones
- The code for the simulator is publicly available at [wuwushrek/sim_cf](https://github.com/wuwushrek/sim_cf) and has over 20 stars and 20 forks on GitHub
- Investigated on-the-fly, lightweight, and real-time verification (reach and safety properties) algorithms to be embedded on Crazyflie drones

Autonomous Systems Group (UT Austin)

RESEARCH INTERN | ADVISOR: UFUK TOPCU

Austin, USA

March 2017 - August 2017

- Designed and built quadrotors based on the Snapdragon Platform and PX4 as the autopilot. Implemented a fast trajectory generator for quadrotors based on the minimum snap approach via a new problem modeling
- Investigated human interface with virtual reality and autonomous flight of a quadrotor via eye-tracking ([youtube.com/watch?v=AfosHcUJR9M](https://www.youtube.com/watch?v=AfosHcUJR9M))
- Investigated the problem of tracking moving targets using POMDPs (Partially Observable Markov Decision Process) and human inputs
- Designed model checking and planning algorithms for UAVs autonomous missions with specifications expressed in temporal logic

- Implementation in R of supervised learning algorithms to automatically classify aircraft's equipment from a reliability point of view
- Designed and implemented an application in Java that interacts with Liebherr's database to provide classification results to an expert

Skills

Languages	French (native), English (fluent), Japanese (beginner)
Programming	Python, C++, C, Java, R, Matlab, HTML5/CSS3 <i>My GitHub stats</i> estimate more than 100k lines of code
Tools & Technologies	ROS, JAX, TensorFlow, Unity, Gazebo, PX4 Autopilot, Crazyflie, MuJoCo, RTOS, CVXPY, Gurobi, Mosek, Arduino

Publications

* indicates equal contribution

JOURNAL ARTICLES [6]

Task-Guided IRL in POMDPs that Scales

Franck Djeumou, Christian Ellis, Murat Cubuktepe, Craig Lennon, Ufuk Topcu

Journal of Artificial Intelligence: Special issue VSI:Risk-Aware Autonomy

URL: <https://doi.org/10.1016/j.artint.2023.103856>

2022

On-The-Fly Control of Unknown Systems: From Side Information to Performance Guarantees through Reachability

Franck Djeumou, Abraham P Vinod, Eric Goubault, Sylvie Putot, Ufuk Topcu

IEEE Transactions on Automatic Control (IEEE TAC)

URL: <https://ieeexplore.ieee.org/document/9930630>

2022

Probabilistic Control of Heterogeneous Swarms Subject to Graph Temporal Logic Specifications: A Decentralized and Scalable Approach

Franck Djeumou, Zhe Xu, Murat Cubuktepe, Ufuk Topcu

IEEE Transactions on Automatic Control (IEEE TAC)

URL: <https://ieeexplore.ieee.org/document/9779942>

2021

Safety-Constrained Learning and Control using Scarce Data and Reciprocal Barriers

Christos K Verginis, **Franck Djeumou**, Ufuk Topcu

Under Review at IEEE Transactions on Automatic Control (IEEE TAC)

URL: <https://arxiv.org/abs/2105.06526>

2021

Policy Synthesis for Switched Linear Systems with Markov Decision Process Switching

Bo Wu, Murat Cubuktepe, **Franck Djeumou**, Zhe Xu, Ufuk Topcu

IEEE Transactions on Automatic Control (IEEE TAC)

URL: <https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9691772>

2021

Online Synthesis for Runtime Enforcement of Safety in Multi-Agent Systems

Dhananjay Raju, Sudarshanan Bharadwaj, **Franck Djeumou**, Ufuk Topcu

IEEE Transactions on Control of Network Systems (IEEE TCNS)

URL: <https://ieeexplore.ieee.org/document/9362272>

2021

PEER-REVIEWED CONFERENCE ARTICLES [11]

Physics-Informed Kernel Embeddings: Integrating Prior System Knowledge with Data-Driven Control

Adam J. Thorpe*, Cyrus Neary*, **Franck Djeumou***, Meeko M. K. Oishi, Ufuk Topcu

Learning for Dynamics and Control Conference (L4DC)

URL: <https://arxiv.org/abs/2301.03565>

2023

Autonomous Drifting with 3 Minutes of Data via Learned Tire Models

Franck Djeumou, Jonathan Goh, Ufuk Topcu, Avinash Balachandran

Accepted at IEEE International Conference on Robotics and Automation (ICRA), 2023

URL: [Processing](#)

2023

Taylor-Lagrange Neural Ordinary Differential Equations: Toward Fast Training and Evaluation of Neural ODEs

Franck Djeumou*, Cyrus Neary*, Eric Goubault, Sylvie Putot, Ufuk Topcu

International Joint Conferences on Artificial Intelligence (IJCAI)

URL: <https://www.ijcai.org/proceedings/2022/0405.pdf>

2022

Neural Networks with Physics-Informed Architectures and Constraints for Dynamical Systems Modeling

Franck Djeumou*, Cyrus Neary*, Eric Goubault, Sylvie Putot, Ufuk Topcu

Learning for Dynamics and Control Conference (L4DC)

URL: <https://proceedings.mlr.press/v168/djeumou22a/djeumou22a.pdf>

2022

Learning to Reach, Swim, Walk and Fly in One Trial: Data-Driven Control with Scarce Data and Side Information

Franck Djeumou, Ufuk Topcu

Learning for Dynamics and Control Conference (L4DC)

URL: <https://proceedings.mlr.press/v168/djeumou22b/djeumou22b.pdf>

2022

Task-Guided Inverse Reinforcement Learning Under Partial Information

Franck Djeumou, Murat Cubuktepe, Craig Lennon, Ufuk Topcu

International Conference on Automated Planning and Scheduling (ICAPS)

URL: <https://ojs.aaai.org/index.php/ICAPS/article/view/19785>

2022

- Blending Controllers via Multi-Objective Bandits
Parham Gohari*, **Franck Djeumou***, Abraham P Vinod, Ufuk Topcu
American Control Conference (ACC)
URL: <https://ieeexplore.ieee.org/document/9867486> 2022
- Learning-Based, Safety-Constrained Control from Scarce Data via Reciprocal Barriers
Christos K Verginis, **Franck Djeumou**, Ufuk Topcu
IEEE Conference on Decision and Control (CDC)
URL: https://cverginis.github.io/publications/conferences/CDC21_safety.pdf 2021
- On-the-fly, Data-driven Reachability Analysis and Control of Unknown Systems: An F-16 Aircraft Case Study (**Best Demo/Poster Award**)
Franck Djeumou, Aditya Zutshi, Ufuk Topcu
International Conference on Hybrid Systems: Computation and Control (HSCC)
URL: <https://dl.acm.org/doi/abs/10.1145/3447928.3457355> 2021
- On-The-Fly Control of Unknown Smooth Systems from Limited Data
Franck Djeumou, Abraham P. Vinod, Éric Goubault, Sylvie Putot, Ufuk Topcu
American Control Conference (ACC)
URL: <https://ieeexplore.ieee.org/document/9483367> 2021
- Probabilistic Swarm Guidance Subject to Graph Temporal Logic Specifications
Franck Djeumou, Zhe Xu, Ufuk Topcu
Robotics: Science and Systems (RSS)
URL: <http://www.roboticsproceedings.org/rss16/p058.pdf> 2020

Honors & Awards

- 2022 **Rising Star**, Selected to participate at the 2022 Rising Stars in Aerospace (RSIA) Symposium hosted by the University of Colorado Boulder and sponsored by CU-Boulder, MIT AeroAstro, Stanford, and Penn State. *Boulder, USA*
- 2022 **Rising Star**, Selected to participate at the Cyber-Physical Systems (CPS) Rising Stars Workshop 2022 hosted by the University of Virginia Link Lab *Virginia, USA*
- 2022 **Scholarship**, Category 'Award Winners, Invited Speakers and Sponsors' at the 32nd International Conference on Automated Planning and Scheduling (ICAPS) *Virtual, Singapore*
- 2021 **Winner**, Best Demo/Poster Award at Proceedings of the 24th International Conference on Hybrid Systems: Computation and Control (HSCC 2021) *Nashville, USA*
- 2017 **Scholarship**, Foundation of Ecole Polytechnique *Palaiseau, France*
- 2014-2018 **Scholarship**, ISAE-SUPAERO Foundation *Toulouse, France*

Selected Talks

- 2022 **Autonomous Drifting with 3 Minutes of Driving Data**, *Texas, USA*
Texas Robotics Symposium
- 2022 **Neural Networks with Physics-Informed Architectures and Constraints for Dynamical Systems Modeling**, *Atlanta, USA*
SIAM Conference on Uncertainty Quantification (UQ22)
- 2021 **Incorporating Physics-Based Knowledge into Neural Network Dynamics Models**, *Austin, USA*
Galois Inc: Final Briefing for the Assured Autonomy Project
- 2021 **How to learn to reach, walk, swim and fly in one trial? Well, first, admit that you are not dumb**, *Austin, USA*
Lockheed Martin
- 2021 **How to learn to reach, walk, swim and fly in one trial? Well, first, admit that you are not dumb**, *Austin, USA*
Texas Robotics Symposium
- 2021 **Data-Driven, On-The-Fly Reachability and Control of Unknown Systems**, *Portland, USA*
Mini-Symposium on "Leaning for Dynamical Systems and Control" at the SIAM Conference on Applications of Dynamical Systems
- 2020 **Learning On-the-Fly with a Case Study in Hypersonic Flight**, *Austin, USA*
Sandia National Laboratories: Autonomy for Hypersonics Virtual Field Day

Professional Services

WORKSHOPS ORGANIZED

- Workshop on Safe and Reliable Robot Autonomy under Uncertainty** *Philadelphia, USA*
INTERNATIONAL CONFERENCE ON ROBOTICS AND AUTOMATION (ICRA) *May 2022*
Co-organizer

REVIEWER

I was a reviewer at the following journals and conferences.

- IEEE Open Journal of Control Systems (OJ-CSYS) (2022)
- International Conference on Robotics and Automation (2022)
- American Control Conference (2020, 2021)
- IEEE Conference on Decision and Control (2021)
- IFAC symposium system identification (2021)