

# Franck Djeumou

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

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## Research Interests

My research lies broadly at the intersection of learning with prior knowledge, control theory, formal methods, and optimization. Specifically, I investigate how prior knowledge (e.g., laws of Physics, properties empirically validated through engineering experiments) can be incorporated into learning agents to improve the data efficiency and generalization, and how such side information can be used for the formal verification of the agents, particularly in the context of safety-critical applications such as aircraft control and robotics.

## Education

### The University of Texas at Austin

PH.D. IN ELECTRICAL AND COMPUTER ENGINEERING

Austin, Texas, USA

Fall 2018 - Now (Expected in Spring 2023)

- Ph.D. Advisor: Ufuk Topcu
- Member of the Autonomous Systems Group
- Cumulative GPA Over 30 Credits (Ph.D. Major Course Requirements) – 3.967

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

BACHELOR OF SCIENCE AND MASTER OF SCIENCE IN AEROSPACE ENGINEERING

Toulouse, Haute-Garonne, France

September 2014 - June 2018

- Advised by Prof. Jerome Hugues
- Cumulative GPA : 3.8 | Top 4% of the class
- Thesis on "Safety Guarantees for Drones through Set-Based Formal Verification Methods"

### École Polytechnique

MASTER DEGREE IN COMPUTER SCIENCE (COMASIC)

Palaiseau, Essonne, France

September 2016 - September 2017

- Advised by Prof. Eric Goubault and Prof. Sylvie Putot
- Cumulative GPA : 3.7 | Graduated with Honours
- Thesis on "Human-Embedded Autonomous Flight Under Formal Task Specifications"

### Lycée Fénélon

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

Paris 6e, Île-de-France, France

September 2011 - September 2014

- 6th out of 42 students

## Experience

### Cosynus Team at Laboratory LIX of École Polytechnique

RESEARCH INTERN | ADVISOR: ERIC GOUBAULT AND SYLVIE PUTOT

Palaiseau, France

March 2018 - August 2018

- Build the quadrotor testbed for the team based on Crazyflie drones
- Develop a hardware and software in the loop, Gazebo-based swarm simulator for the Crazyflie drones
- Investigate safety of dynamical systems through Taylor-based methods and abstract interpretation
- On-the-fly, lightweight, real-time verification (reach and safety properties) algorithms to be embedded on the Crazyflie drones

### Autonomous System Group (UT Austin)

RESEARCH INTERN | ADVISOR: UFUK TOPCU

Austin, USA

March 2017 - August 2017

- Design and build quadrotors based on the Snapdragon Platform with PX4 as the autopilot. Implementation of a fast trajectory generator for quadrotors based on the minimum snap approach and a new problem modeling
- Human interface with virtual reality and autonomous flight of a quadrotor via eye-tracking.
- Tracking of stochastically moving targets using POMDP (Partially Observable Markov Decision Process) and human input
- Model checking and planning of UAV's autonomous missions with specifications written in linear temporal logic (LTL)

### Liebherr Aerospace and Transportation

MACHINE LEARNING INTERN

Toulouse, France

June 2015 - August 2015

- Implementation in R of supervised learning algorithms to automatically classify aircraft's equipments from a reliability point of view
- Design and implement a human machine interface in Java that interacts with Liebherr's database and provide to a user the classification's result

## Skills

**Languages** French (native), English (fluent), Japanese (beginner)

**Programming** Python, C++, C, JAVA, C#, R, Matlab, HTML5/CSS3

**Tools & Technologies** ROS, Jax, TensorFlow, Unity, Gazebo, PX4 Autopilot, MuJoCo, RTOS, Gurobi, Mosek, Arduino

**Sports** Tennis, Soccer, Running, Biking, Skiing

## PEER-REVIEWED CONFERENCE ARTICLES [9]

- Taylor-Lagrange Neural Ordinary Differential Equations: Toward Fast Training and Evaluation of Neural ODEs  
**Franck Djeumou\***, Cyrus Neary\*, Eric Goubault, Sylvie Putot, Ufuk Topcu  
*Under Review* at *International Joint Conferences on Artificial Intelligence (IJCAI) 2022*  
 URL: <https://arxiv.org/abs/2201.05715> 2022
- Neural Networks with Physics-Informed Architectures and Constraints for Dynamical Systems Modeling  
**Franck Djeumou\***, Cyrus Neary\*, Eric Goubault, Sylvie Putot, Ufuk Topcu  
*Under Review* at *Learning for Dynamics and Control Conference (L4DC) 2022*  
 URL: <https://arxiv.org/abs/2109.06407> 2021
- Learning to Reach, Swim, Walk and Fly in One Trial: Data-Driven Control with Scarce Data and Side Information  
**Franck Djeumou**, Ufuk Topcu  
*Under Review* at *Learning for Dynamics and Control Conference (L4DC) 2022*  
 URL: <https://arxiv.org/abs/2106.10533> 2021
- Task-Guided Inverse Reinforcement Learning Under Partial Information  
**Franck Djeumou**, Murat Cubuktepe, Craig Lennon, Ufuk Topcu  
*Under Review* at *International Conference on Automated Planning and Scheduling (ICAPS) 2022*  
 URL: <https://arxiv.org/abs/2105.14073> 2021
- Blending Controllers via Multi-Objective Bandits  
 Parham Gohari\*, **Franck Djeumou\***, Abraham P Vinod, Ufuk Topcu  
*Under review* at the *2022 American Control Conference (ACC) as an invited paper*  
 URL: <https://arxiv.org/abs/2007.15755> 2021
- Learning-Based, Safety-Constrained Control from Scarce Data via Reciprocal Barriers  
 Christos K Verginis, **Franck Djeumou**, Ufuk Topcu  
*IEEE Conference on Decision and Control*  
 URL: [https://cverginis.github.io/publications/conferences/CDC21\\_safety.pdf](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  
**Franck Djeumou**, Aditya Zutshi, Ufuk Topcu  
*International Conference on Hybrid Systems: Computation and Control (HSCC 2021), Best Demo/Poster Award*  
 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  
*2021 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

## JOURNAL ARTICLES [6]

- Task-Guided IRL on POMDPs at Scale with Information Asymmetry  
**Franck Djeumou**, Christian Ellis, Murat Cubuktepe, Craig Lennon, Ufuk Topcu  
*Under Review* at the special issue *VSI:Risk-Aware Autonomy for consideration at the journal of Artificial Intelligence (2022)*. Elsevier  
 URL: *Processing* 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  
*Conditionally accepted* at *IEEE Transactions on Automatic Control (IEEE TAC) (2021)*. IEEE  
 URL: <https://arxiv.org/abs/2106.15729> 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 (2021)*. IEEE  
 URL: <https://arxiv.org/abs/2105.06526> 2021
- 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  
*Under Review* at *IEEE Transactions on Automatic Control (2021)*. IEEE  
 URL: <https://arxiv.org/abs/2011.05524> 2021
- Policy synthesis for switched linear systems with Markov decision process switching  
 Bo Wu, Murat Cubuktepe, **Franck Djeumou**, Zhe Xu, Ufuk Topcu  
*Accepted* at *IEEE Transactions on Automatic Control (2021)*. IEEE  
 URL: <https://arxiv.org/abs/2009.12733> 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 (2021)*. IEEE  
 URL: <https://ieeexplore.ieee.org/document/9362272> 2021

## Honors & Awards

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2021	<b>Winner</b> , Best Demo/Poster Award at Proceedings of the 24th International Conference on Hybrid Systems: Computation and Control (HSCC 2021)	<i>Nashville, USA</i>
2017	<b>Scholarship</b> , Foundation of Ecole Polytechnique	<i>Palaiseau, France</i>
2017	<b>Scholarship</b> , ISAE-SUPAERO Foundation	<i>Toulouse, France</i>
2016	<b>Scholarship</b> , ISAE-SUPAERO Foundation	<i>Toulouse, France</i>
2015	<b>Scholarship</b> , ISAE-SUPAERO Foundation	<i>Toulouse, France</i>
2014	<b>Scholarship</b> , ISAE-SUPAERO Foundation	<i>Toulouse, France</i>

## Professional Services

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### 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 Transactions on Automatic Control (2021)
- International Conference on Robotics and Automation (2021)
- American Control Conference (2020, 2021)
- IEEE Conference on Decision and Control (2021)
- IFAC symposium system identification (2021)

## Invited Talks

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2021	<b>Incorporating Physics-Based Knowledge into Neural Network Dynamics Models,</b> Galois Inc: Final Briefing for the Assured Autonomy Project	<i>Austin, USA</i>
2021	<b>Learning How to Reach, Swim, Walk and Fly in One Trial,</b> Professor Karen E. Willcox's Research Group	<i>Austin, USA</i>
2021	<b>How to learn to reach, walk, swim and fly in one trial? Well, first, admit that you are not dumb,</b> Lockheed Martin	<i>Austin, USA</i>
2021	<b>How to learn to reach, walk, swim and fly in one trial? Well, first, admit that you are not dumb,</b> Texas Robotics Symposium	<i>Austin, USA</i>
2021	<b>Data-Driven, On-The-Fly Reachability and Control of Unknown Systems,</b> Mini-Symposium on "Learning for Dynamical Systems and Control" at the SIAM Conference on Applications of Dynamical Systems	<i>Portland, USA</i>
2020	<b>Learning On-the-Fly with a Case Study in Hypersonic Flight,</b> Sandia National Laboratories: Autonomy for Hypersonics Virtual Field Day	<i>Austin, USA</i>

## References

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- Prof. Ufuk Topcu, Assistant Professor (Controls, Autonomy and Robotics), The University of Texas at Austin, USA
- Prof. Eric Goubault, Professor (Computer Science), École Polytechnique, France
- Prof. Sylvie Putot, Professor (Computer Science), École Polytechnique, France