Bassel El Mabsout

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EDUCATION

Ph.D. candidate in Computer Science **2018 – May 2025**

Boston University
Advisor: Dr. Renato Mancuso

M.S. in Computer Science **2022**

Boston University
Thesis Committee: Dr. Marco Gaboardi, Dr. Renato Mancuso

B.S. in Computer Science **2012 – 2015**

American University of Beirut

RESEARCH INTERESTS

My research focuses on enabling roboticists to **faithfully** translate high-level objectives into **robust** learned behaviors, particularly for *resource-constrained* robotic systems. By combining programming languages and machine learning techniques, I develop methods to synthesize controllers that perform **reliably** in real-world environments. My work emphasizes principled *adaptation* and *sim-to-real* transfer approaches to ensure learned controllers maintain their intended behavior when deployed.

My topics of interest include:

Reinforcement Learning ◇ Embedded Systems ◇ Type Theory ◇ Metaheuristics ◇ Control Systems

PUBLICATIONS

[1] **Mabsout B.*** ◇ Mysore S.* ◇ Saenko K. ◇ Mancuso R. **(#citations: 23) 2021**
How to train your quadrotor: A framework for consistently smooth and responsive flight control via reinforcement learning
ACM Trans. Cyber-Phys. Syst., 5(4): 10.1145/3466618 ◇ **website:** cpslab.bu.edu/projects/httyq

[2] **Mabsout B.*** ◇ Mysore S.* ◇ Saenko K. ◇ Mancuso R. **(#citations: 83) 2021**
Regularizing Action Policies for Smooth Control with Reinforcement Learning
ICRA: 10.1109/ICRA48506.2021.9561138 ◇ **website:** cpslab.bu.edu/projects/caps/

[3] Mysore S. ◇ **Mabsout B.** ◇ Mancuso R. ◇ Saenko K. **(#citations: 12) 2021**
Honey. I Shrunk The Actor: A Case Study on Preserving Performance with Smaller Actors in Actor-Critic Reinforcement Learning
IEEE CoG: 10.1109/CoG52621.2021.9619008

[4] **Mabsout B.** **2023**
Tree Shaping, a solution to the expression problem showcased via a compiler for a programming language named Puler
Masters Thesis, Boston University: hdl.handle.net/2144/49330 ◇ **github:** bmabsout/puler

* Authors contributed equally

ONGOING RESEARCH

Anchored Learning for On-the-Fly Adaptation **Submitted**

A novel strategy for enhancing the robustness of reinforcement learning agents in crossing the sim-to-real gap. Our method maximizes multiple Q-values across domains, ensuring high performance in both simulation and reality, achieving a near-50% reduction in power consumption while maintaining controllable, stable flight

arXiv: 2301.06987 ◇ **github:** bmabsout/AnchoredActorCritic

Expressive Reinforcement Learning via Algebraic Q-Value Scalarization **Submitting**

We introduce Algebraic Q-value Scalarization (AQS), a novel domain-specific language for specifying policy behavior. AQS generalizes linear utilities by employing the power-mean as a logical operator over normalized Q-values. By specifying how different policy objectives interact, users can intuitively design policy losses

github: bmabsout/AQS

Scrap Your Schedules with PopDescent **Submitted**

A novel population-based hyperparameter optimization method which adaptively controls hyperparameter selection via a normalized fitness function. The method combines the exploration benefits of evolutionary algorithms with the exploitation of gradient descent, outperforming existing methods by up to 18% in test loss

arXiv: 2310.14671

Adaptive Lyapunov-based controller learning **Ongoing**

We construct learned controllers using quickly converging learned bounded Lyapunov functions for maintaining stability under multiple complex dynamical systems at the same time. This technique is then used to take advantage of learned dynamics as well as idealized models, improving the probability of stabile and high-performance control when deployed in the real world

github: bmabsout/SystemDescent

Risk-aware path planning using 2D-Gaussian mixtures **Ongoing**

In order to maximize the safety and performance of autonomous vehicles, we propose a risk-aware path planning framework that uses 2D-Gaussian mixtures. We propose an efficient method for computing the risk of trajectories allowing for real-time sampling and optimization on computationally constrained F1tenth vehicles

github: bmabsout/gaussian_racer_jax

PROPOSAL WRITING

GenZero Proposal *PIs: Benjamin Lubin, Marco Caccamo, Sandro Pinto, Renato Mancuso* **2024**

Selected proposal and ***Best Presentation Award*** winner at the GenZero Workshop. Contributed to proposal development and led the successful prototype demonstration, coordinating efforts between Boston University, Technical University of Munich, and University of Minho teams. The project focuses on novel computation frameworks that separate data ownership, processing, and usage concerns, demonstrated through ML workloads. We advanced to final phase following the competitive selection process.

BU Technology Development Ignition Award *PI: Renato Mancuso* **2024**

Accepted Letter of Interest for a proposed plug-and-play solution for confidential computing. Allowing secure application execution on traditional server hardware without requiring costly upgrades, and maintaining security even when the server is compromised.

Efficient Control for Small-Scale Limbed Robots *PIs: Renato Mancuso, Sabrina Neuman* **2024**

NSF-medium proposal focused on three research thrusts: improving neural network control for under-instrumented limbed robots, exploring HW/SW architectures for energy-efficient control, and designing efficient learned runtime adaptation techniques on constrained platforms. Aims to enable a new class of cost- and power-efficient robots

Solar-Powered UAV for Sustainable Agriculture *PIs: Renato Mancuso, Marco Caccamo* **2023**

NSF-medium Research proposal on eco-friendly UAV design for agriculture through solar power and energy-efficient computing. We propose a novel architecture that enables sustainable long-endurance missions by designing neural networks that maximize power-efficent control and formal safety bounds.

Certified Survivability *PIs: Renato Mancuso, Chuchu Fan* **2022**

Joint proposal with MIT focused on developing certifiably safe and robust neural network-based controllers for robots that can adapt to substantial system damages while maintaining provable safety guarantees. The project builds on my work on neural network-based control and transfer learning.

MEDIA

Presentations

WASP **"wasp-sweden.org"** **2023**

Presented my research to the Wallenberg AI, Autonomous Systems and Software Program group on increasing controller robustness and reducing power consumption on complex robots

Galois Inc. **"Achieving Robustness in Learned Control"** **2023**

Presented work on combining formal verification with reinforcement learning for control, exploring the challenges of defining and proving specifications for learned controllers while maintaining performance and robustness.

BU AIR **"bu.edu/hic/centers-initiatives-labs/air"** **2022**

Presented findings on reward design [1] and minimizing actuation [2] for real world RL-based control

BU Systems Seminar **2022**

Presented my PhD journey around efficient reinforcement learning and embedded systems

Honda Research Institute **"honda-ri.de/institute"** **2021**

Presented work on privacy-preserving ridesharing using secure multi-party computation (MPC), focusing on optimization constraints for pooling users with similar preferences, and presented methodology for n-dimensional similarity matching using the Hilbert space-filling curve

ICRA **2021**

Presented my paper on regularizing action policies for smooth control [2]

CoG **2021**

Presented work on minimizing actor sizes for real-time control in actor-critic RL [3]

News Articles

Haskell Weekly "Issue 82" 2017

BU Hub Innovation Center "Simplifying Machine Learning for Drone Flight Control" 2021

SELECTED PROJECTS

Stochastic dynamics learning **BU/MIT**

Achieving safer learned model-based control requires accurate models, given most real-world systems are stochastic, we built Generative Adversarial Networks which modeling the distribution of the system's trajectories
github: bmabsout/swirls ◇ **github:** bmabsout/SystemDescent

Honda Ridesharing **SAIL**

In collaboration with BU's SAIL and Honda, we worked on privacy preserving (using MPC) preferential ride-sharing. My responsibilities included defining optimization constraints so users with similar preferences get pooled together

Seizure Prediction **Machine learning – CS542**

A Kaggle competition project which accurately predicted seizure activity in epileptic patients. Utilizing machine learning techniques, we achieved the highest score with a significant margin (AUC score of 0.92), our model was tested by the competition's organizers and was found to be the best performing model.
preprint: tinyurl.com/seizure-prediction

Simplifying the complexity of computing a Nash-ε equilibrium **Complexity Theory – CS535**

This term paper simplifies an existing proof of the complexity class specifying the run-time of finding approximate Nash equilibria
preprint: tinyurl.com/nash-complexity

Haskell Blog **Personal Blog**

I created a programming languages focused blog exploring geometry, automatic differentiation, and dependently typed vector construction. The blog garnered interest and was featured on Haskell Weekly
blog: bmabsout.com/blog

WORK EXPERIENCE

Founder *Scanman* **2020 – Present**

Developed a full-stack inventory management system combining React Native barcode scanning and real-time web dashboard for inventory tracking. System acquired by Meathouse for supply chain management.

Cofounder/CTO *Zahera* **2018 – 2022**

Led development of an app-based photo printing service reaching over 15,000 installations. Managed product design, technology stack, and 3 developers
instagram: @zahera_me

Researcher *American University of Beirut* **2016 – 2018**

Developed *neural-swarm*, a collection of experimental optimization algorithms for learning decentralized swarm control systems using neural networks, implemented in Haskell
github: neural-swarm

Software Developer *CCC* **2015 – 2017**

Core team member of C3D, a leading 3D construction project control application designed for energy projects. I performed optimizations that improved performance by 2000%, refactored main architectural components of the huge codebase increasing maintainabilility and type-safety, and implemented bug fixes in Java. I also contributed to JFoenix
website: cctintl.com/solutions/c3d-project-control.html

Mentorship

F1Tenth Racing Team *Boston University* **2024**

Mentored a team of 11 students (Koneshka Bandyopadhyay, Muhammad Aseef Imran, Shahnawaz Fakir, Georgina Focia, Ruihang Liu, Hyunjin Jung, Jiawei Sun, Patrick Kuzdzal, Yann Arif, Jiyayi Shen) in developing an autonomous racing platform. Led the development of simulation environments, classic control algorithms, computer vision systems, and hardware integration. The team successfully competed and won second place in an official F1Tenth competition. We developed novel approaches to autonomous racing including obstacle avoidance and path planning algorithms, as well as Guassian-mixture-based control methods, and explored Gaussian-splatting based localization.

Unified Local-Cloud Decision-Making via Reinforcement Learning *Boston University* **2023**

Mentored Kathakoli Sengupta and Sandesh Bharadwaj in developing UniLCD, a hybrid inference framework for local-cloud collaboration in mobile robotics. Guided the implementation of the complete control pipeline in CARLA simulator and guided the design of the reward structure for the reinforcement learning system following [1] , contributing to a 35% performance improvement over baselines. Their work was accepted at ECCV 2024.
paper: UniLCD ◇ **Kathakoli (web):** diasengupta.github.io ◇ **Sandesh (linkedin):** bharadwaj97

RISE Program *Boston University* **2022**

Mentored Abhinav Pomalapally in gradient-based optimization research, this work led to the population-based optimization paper. Provided recommendation letter leading to his admission to UC Berkeley. Led weekly reading groups on advanced topics in control theory and optimization.
linkedin: apomalapally

Kilachand Honors College Keystone Project *Boston University* **2024**

Advised Rithvik Doshi on embedded systems localization project. Implemented pedestrian detection system using ESP32 Bluetooth modules and integrated RTK-GPS for precise positioning. This project was part of the explorations that evolved into building SafeSteps, a startup focused on pedestrian safety.
website: doshir.dev/about

BU Spark *Boston University* **2023**

Supervised team of 5 students in building a 3d printed quadrotor which uses a jetson for onboard processing for research purposes. The quadrotor succesfully completed flight tests.

Zahera *Software Engineering Lead* **2021**

Mentored Shadi Shahin, Marwa Karaki, and Pierre Kamel in building an application with heavy image processing components. Guiding them on modern development practices, code quality, and system architecture. I Led technical training sessions and provided guidance on best practices in software development.

Scanman *Founder* **2022**

Mentored two developers in development on live real-time data processing, database design, and program architecture. Provided guidance on algorithm implementations, code optimization, and full-stack development.

ACADEMIC SERVICES

Peer Review Venues

ICLR ◇ ROBOT ◇ EMSOFT ◇ COG ◇ DATE ◇ ECRTS ◇ RTSS ◇ TJCA

Teaching Experience

Teaching Fellow - CS 350 Distributed Systems *Boston University* **2024**

Supported Prof. John Liagouris in teaching distributed systems concepts. Designed and implemented a Raft-based distributed locking homework assignment, including testing infrastructure. Held regular office hours to assist students with distributed systems challenges.

Teaching Fellow - CS 454/654 Embedded Systems *Boston University* **2023**

Led weekly lab sections for 24 students using the AmazingBall platform. Designed a PyBullet simulation environment to teach filtering and PID control fundamentals. Created and supervised four successfully completed projects: (1) embedded system identification and simulation enhancement, (2) real-time vision processing for state estimation, (3) higher-level control using reinforcement learning, and (4) low-latency communication system for remote control. Projects emphasized practical embedded systems challenges including real-time constraints and hardware-software integration.

Teaching Fellow - CS 506 Data Science *Boston University* **2018**

Assisted Prof. Andrei Lapets by delivering secondary lectures in core data science topics including feature space design, clustering algorithms, classification methods (decision trees, SVM, kNN), regression techniques, neural networks. Supervised industry-partnered projects such as fraud detection for Painting with Data, aviation safety analysis for ACAS, and a project for the City of Boston.

HONORS

Best Demonstration Award *GenZero Workshop - UAE* **2024**

Awarded for outstanding presentation and demonstration of novel computation frameworks for data ownership and processing.

Second Place *F1Tenth Autonomous Racing Competition - Boston University* **2024**

Led team to second place finish, developing innovative approaches to autonomous racing including obstacle avoidance and Gaussian-based control methods.

Fourth Place *ACM LCPC* **2014**

Achieved fourth place in the ACM Languages and Compilers for Parallel Computing competition.

First Place *AUB Science, Mathematics and Technology Fair* **2011**

Won first place in the Annual Science, Mathematics and Technology fair.

Model United Nations *MUN* **2010**

Participated in the Model United Nations conference.

TECHNICAL SKILLS

Programming Languages

IMPERATIVE	C ◇ C++ ◇ Go ◇ Java
FUNCTIONAL	Haskell ◇ F# ◇ Clojure
SCRIPTING	Python ◇ Bash ◇ Fish
THEOREM PROVERS	Rocq ◇ Lean ◇ ATS
WEB	JavaScript ◇ TypeScript ◇ Elm
BUILD SYSTEMS	Nix ◇ Make
GRAPHICS	GLSL ◇ WGSL
MARKUP	LaTeX ◇ Typst ◇ HTML ◇ CSS ◇ XML ◇ Markdown

Frameworks & Libraries

ML	TensorFlow ◇ PyTorch ◇ JAX ◇ Keras ◇ NumPy ◇ SciPy
ROBOTICS	Stable Baselines ◇ Spinning Up ◇ PyBullet ◇ Gurobi
DATABASES	PostgreSQL ◇ Firebase ◇ Pandas
CROSS-PLATFORM	React Native
HASKELL	Megaparsec ◇ Recursion-Schemes ◇ Polysemy ◇ ImplicitCAD

Tools

DEVELOPMENT	Git ◇ Nix ◇ GNU Utils ◇ Make ◇ Docker
SOFTWARE	AutoCAD ◇ GIMP ◇ Photoshop ◇ Jupyter Notebook
HARDWARE	Soldering ◇ Electrical Tools ◇ Development Boards

PERSONAL INFORMATION

Nationalities

Lebanese and Portuguese

Languages

English (Fluent), Arabic (Native), French (Intermediate)