Bassel El Mabsout

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EDUCATION

Ph.D. candidate in Computer Science *Boston University* 2018 – MAY 2025

Advisor: Renato Mancuso

Depth exam: *Control Theory and Embedded Systems* PASSED 2022

Committee: [Renato Mancuso ◇ Rich West ◇ Kate Saenko]

Prospectus: *Minimizing the Intent-To-Reality Gap* PASSED 2025

Committee: [Renato Mancuso ◇ Kate Saenko ◇ Sabrina Neuman ◇ Bingzhuo Zhong]

M.S. in Computer Science *Boston University* 2023

Thesis: *Tree Shaping, a solution to the expression problem*

Committee: [Marco Gaboardi ◇ Renato Mancuso]

B.S. in Computer Science *American University of Beirut* 2012 – 2015

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 (AQS) SUBMITTING

We introduce **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 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 the use of schedules by up to 18%

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 stable 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. I contributed to the development of the proposal and led the successful prototype demonstration, coordinating efforts between PhD. students at Boston University, Technical University of Munich, and University of Minho. The project proposes a framework that separates data ownership, processing, and usage concerns, demonstrated through ML workloads. We advanced to the 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.

SELECTED PROJECTS

Control Theory Survey DEPTH EXAM – BU

This survey explores the landscape of safe robot learning, investigating methods that balance high-performance control with rigorous safety constraints. By examining classical control techniques, learning-based approaches, and embedded system design, the research seeks to understand how robotic systems can be developed to prevent hazardous states while maintaining optimal performance.

arxiv: 2501.01432

Stochastic dynamics learning BU/MIT

Achieving safer learned model-based control requires accurate models, given most real-world systems are stochastic, I built Generative Adversarial Networks modeling the distribution of a 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 Nash-ε equilibrium complexity COMPLEXITY THEORY – CS535

We simplify an existing proof of the complexity class specifying the run-time of finding Nash-ε 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

MEDIA

Presentations

Ph.D. Prospectus *"Document"* ◇ *"Slides"* 2025

Presented my thesis proposal on bridging the gap between high-level objectives and real-world performance in robotic systems, focusing on expressive policy specification and robust deployment.

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.

M.S. Thesis Defense *"Slides"* 2023

Presented novel compiler design techniques using Tree Shaping to address the expression problem, demonstrating how it enables more maintainable and extensible language implementations.

Depth Oral Exam *"Slides"* 2022

Presented comprehensive analysis of control methodologies spanning classical control theory to modern learning-based approaches, with emphasis on safety properties and real-world deployment challenges.

BU Systems Seminar *"Slides"* 2022

Presented my PhD journey around efficient reinforcement learning and embedded systems

AI4ALL *"Slides"* 2022

Presented an introduction to robotics and reinforcement learning to high school students, focusing on making complex concepts accessible and inspiring the next generation of researchers.

BU AIR *"bu.edu/hic/centers-initiatives-labs/air"* 2021

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

ICRA *"[2]"* 2021

Presented my paper on regularizing action policies for smooth control

CoG *"[3]"* 2021

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

Honda Research Institute *"honda-ri.de/institute"* 2019

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

News Articles

Haskell Weekly *"Issue 82"* 2017

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

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 a 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 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 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 ◇ ICRA ◇ COG ◇ ROBOT ◇ EMSOFT ◇ DATE ◇ ECRTS ◇ RTSS ◇ TJCA ◇ RTAS

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 the team to a 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 ◇ Portuguese

Languages

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