

# Faizan Muhammad

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## EXPERIENCE

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### Google

July 2020 – Present

*Software Engineer*

*Mountain View, CA*

- Working on improving and productionizing an RL-trained heuristic for dynamic parallelization of computation
- Developed an Active Learning pipeline for an Anomaly Detection service for fraudulent shopping offers
- Member of the Engineering Residency program that aims to develop the next generation of technology leaders

### Department of Computer Science, Tufts University

Jan 2018 – May 2020

*Research Assistant (with Prof. Jivko Sinapov, Dr. Vasanth Sarathy & Prof. Matthias Scheutz)*

*Medford, MA*

- Pioneered the Novelty Handling capabilities of the Tufts AI agent for the DARPA SAIL-ON challenge [1]
- Achieved top results in independent evaluations and led a team to publish the system architecture [9]
- Developed and published an Augmented Reality interface for Human-Robot Interaction [2][10]
- AR interface won \$100K funding from Verizon 5G EdTech Challenge and is still an active project in the lab

### CTRL Labs (acquired by Facebook)

May 2019 – August 2019

*Software Engineering Intern*

*New York City, NY*

- Interfaced a hexapod robot with a neural interface for neuromuscular teleoperation [3]
- Demoed this experience for the taping of an NPR show episode regarding CTRL Labs [16]
- Devised features for physically contextualized interactions with real-world objects through the neural interface
- Patented these features after prototyping and demonstrating their feasibility

### Center for Engineering Education and Outreach (CEEEO)

Dec 2016 – Aug 2017

*Research Assistant (with Prof. Ethan Danahy)*

*Medford, MA*

- Created a RESTful API for lab-based IoT devices such as a web-controlled lab sign
- Developed computer vision software to digitize classwork and enhance student engagement and collaboration
- Demonstrated the software by creating a robot programming framework that used paper drawings as code [4]

### International Mathematical Olympiad 2016

Sep 2015 – Jul 2016

*Participant*

*HKUST, Hong Kong*

- Selected and trained in Algebra, Number Theory, Combinatorics and Geometry for the Pakistani team
- Learned advanced mathematical problem solving skills and represented the country on an international platform

## EDUCATION

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### Tufts University

Sep 2016 – May 2020

*Bachelor of Science in Computer Science*

*Medford, MA*

**GPA: 3.95 Honors:** Summa Cum Laude, Lieutenant Commander Robert James Manning Prize

**Core Courses:** Data Structures, Algorithms, Computation Theory, Programming Languages, Machine Architecture

**Elective Courses:** Reinforcement Learning, Intro. to Machine Learning, Probabilistic Robotics [5], Autonomous Intelligent Robotics, Computer Vision, Human Robot Interaction, Intro. to Computational Models in Cognitive Science, Ethics for AI

**Other Relevant Courses:** Digital Circuits [6], Discrete Mathematics, Linear Algebra, Calculus (1, 2 and 3), Logic (Philosophy), Probability and Statistics, Cultures in Computing (Anthropology), Neurobiology

**Activities:** President @ Tufts Robotics Club [7][11], Co-Organizer @ URSS [12], Founder @ IDIAS [13], Actor/Director @ Hype Mime Troupe [14], Foilist @ Tufts Fencing Club

## TECHNICAL SKILLS

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**Languages:** C++, Python, Java, Golang, C#, SQL, C, Matlab, VHDL

**Frameworks and Tools:** ROS, Unity, Git, Docker, IntelliJ, Visual Studio

**Libraries:** OpenCV, Tensorflow, Apache Beam, Scikit, Pandas, NumPy, Matplotlib

**Crafting:** Laser Cutting, 3D Printing, Circuitry

## PROJECTS

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- [1] **Novelty Oriented AI Agent for DARPA SAIL-ON** | *Java, C, Python* Tufts CS
- SAIL-ON challenge was created by DARPA to encourage development of AI that can adapt to change
  - Tufts team aims to build a cognitive architecture integrating symbolic approaches (Planning, Logical Reasoning etc.) and neural approaches (Reinforcement Learning, Deep Learning etc.) to participate in this challenge
  - Pioneered development of this architecture, focusing on developing an extensible framework
  - Agent achieved top performance in independent external evaluations against other approaches
  - Led a group of graduate and undergraduate students to publish the system architecture [9]
- [2] **Visualizing a Robot's Perspective in Augmented Reality** | *ROS, Unity, C++, C#, Python* Tufts CS
- Need for a fast, high-bandwidth and accessible medium to convey robot states for Human Robot Interaction
  - Proposed the project for Tufts Summer Scholars and received fellowship and funding to pursue it [15][17]
  - Supports visualizations of robot perception, belief and planning in AR through HoloLens and mobile devices
  - Published the system architecture [10] and won \$100K in further funding from Verizon 5G EdTech Challenge
- [3] **Robot Teleoperation through Neuromuscular Control** | *Golang, Docker, Proprietary Tech.* CTRL Labs
- Humans are capable of very fine control over wrist and hands that can be exploited for next-gen control interfaces
  - Mapped EMG-based readings of muscle activations to a hexapod's appendages for crawling and kicking behaviour
  - Demoed this experience for the taping of an NPR show episode regarding CTRL Labs [16]
- [4] **Programming Robots through Paper Worksheets** | *OpenCV, C++, LabVIEW* CEE0
- Devised a worksheet template format to specify subsections and used Computer Vision to extract them
  - Demonstrated system capabilities by programming LEGO Mindstorms robots through symbolic paper drawings
- [5] **Sound Based Robot Localization** | *Matlab, Machine Learning* Probabilistic Robotics Class
- Indoor navigation for robots in changing physical spaces is difficult due to reduced mapping abilities
  - Some acoustic properties of a room are dependent on room structure and can be used to uniquely identify them
  - Used a Sine Sweep to generate Room Impulse Response (RIR), extract features and train a 90% accurate SVM
- [6] **Clappy Bird** | *VHDL, FPGA, Lattice Radiant* Digital Circuits Class
- Recreated the popular game Flappy Bird in an FPGA using clapping sounds as the means to control the game
  - Developed digital circuits in VHDL and Lattice Radiant to implement the game logic and VGA rendering
  - Game logic and VGA rendering was done completely through clocks, flip-flops, latches and multiplexers
- [7] **Trinity Firefighting Robot Contest** | *ROS, C++, Arduino, Raspberry Pi, Sensors* Tufts Robotics Club
- Yearly international contest held in Trinity College that simulates a fire-emergency in a miniature environment
  - Led the development of the club's first ROS-enabled robot capable of SLAM and point-to-point navigation
  - Won the Olympiad in Senior Individual Category in 2018 and 2019

## PUBLICATIONS

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- [9] **A Novelty-Centric Agent Architecture for Changing Worlds** AAMAS 2021
- Outlines and evaluates the agent architecture developed for the DARPA SAIL-ON challenge [1]  
Accepted for AAMAS 2021 as a full paper to be published after the conference.
- [10] **Creating a Shared Reality with Robots** HRI 2019
- Presents the system architecture for the Augmented Reality Robot Interface [2]  
Citation: *Muhammad, F., Hassan, A., Cleaver, A., Sinapov, J. (2019, March). Creating a shared reality with robots. In 2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI) (pp. 614-615). IEEE.*  
Paper Link: <https://ieeexplore.ieee.org/abstract/document/8673191>  
Demo Link: <https://youtu.be/WjxJnggaNr8>  
Talks given at:
- \* HRI Conference Late-Breaking Report Track, Daegu, South Korea (2018)
  - \* Tufts Summer Scholars Presentation Session (2018)
  - \* Tufts Engineering Advisory Board (2019)
  - \* Tufts Campaign Committee (2019)

## ACTIVITIES

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- [11] **Robotics Club @ Tufts** | *President* 2018 - 2019
- Led development of projects such as fire-fighting robots [7] and the Tufts teams in robotics competitions
  - Improved diversity, accessibility and member retention through reimagination of club roles and support system
  - Encouraged modular and iterative design and development to allow for material reuse and improved performance
- [12] **Undergraduate Research and Scholarship Symposium @ Tufts** | *Co-Organizer* 2019 & 2020
- Held annually to showcase the work of hundreds of student researchers through presentations, panels and posters
  - Managed logistics for marketing, submissions, presentations, documentation and event management
  - Reinvented the conventional symposium into a virtual experience due to the COVID pandemic
- [13] **Interdisciplinary Data Intensive Applications Society @ Tufts** | *Founder* 2019 - 2020
- Provides a platform for collaboration across diverse domains including robotics, environment, sociology and sports
  - Optimized for learning, skill-sharing and community-building by prioritizing the cohort experience for newcomers
  - Organizes hackathons focused on common tools (Colab, Jupyter, Py Libs) and applications (NLP, GIS, Ethics)
- [14] **Hype! Mime Troupe @ Tufts** | *Actor, Writer, Director* 2016 - 2020
- Produced skits for university-wide shows every semester telling human stories in a minimalistic format [18]
  - Collaborated with other performance groups for fundraising and outreach shows

## PRESENTATIONS AND MEDIA

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- [15] **Research and Activism Forum** Tisch College
- Invited as a panelist to talk to the new cohort of Tufts Summer Scholars and other undergraduate researchers about the intersection of research and activism in AI
- Article Link: <https://tischcollege.tufts.edu/news/tufts-students-discuss-research-and-activism>
- [16] **Digital Telekinesis For the Future You?** Future You @ NPR
- Introduces the technology behind CTRL Labs and their neural interface, CTRL Kit. Includes the demo of my neuromuscular teleoperation project there [3]
- Video Link: <https://youtu.be/cdZLg4IORc0>
- [17] **Hands-on Research for Undergraduates** Tufts Now
- Features the Augmented Reality project [3] and my experience with Tufts Summer Scholars
- Article Link: <https://now.tufts.edu/articles/hands-research-undergraduates>
- [18] **Mime Skits Playlist** Hype! Youtube Channel
- Features some of the mime skits I have been involved with as an actor, director or writer [14]
- Playlist Link: [https://www.youtube.com/playlist?list=PL74VX\\_wnv15E9dwS8Zwey6lO\\_8Y6gSIa6s](https://www.youtube.com/playlist?list=PL74VX_wnv15E9dwS8Zwey6lO_8Y6gSIa6s)