# Mustafa Shaikh

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Machine learning practitioner focusing on object tracking with experience in computer vision, deep learning and classical ML. I have 5 years of industry experience in data science working closely with business stakeholders. I can dive deep into the details, and I have also lead projects end to end, from identifying a problem and designing a solution, to implementation and delivery.

## EDUCATION

**M.S. Electrical and Computer Engineering**                                   San Diego, CA | 2022 - 2024
UNIVERSITY OF CALIFORNIA, SAN DIEGO
 Specialization: Robotics and Intelligent Systems

**B.A.Sc. Engineering Science**                                                        Toronto, ON | 2013 - 2017
UNIVERSITY OF TORONTO

## WORK EXPERIENCE

**RESEARCH ENGINEER** | SALK INSTITUTE FOR BIOLOGICAL STUDIES                San Diego, CA | 2024 -

Key Skills: Multi-object tracking, deep learning, transformers, ResNet, rotary embeddings, segmentation, Kalman filters, optical flow, Hungarian matching, pose estimation, camera distortion, video encoding, ffmpeg, parallel video loading

Summary: Implement a transformer based multiple object tracking system for microscopy and animal video data, enabling the study of animal and organelle motion with regards to neurodegenerative diseases

- Performed **ablations** and experiments, including with state of the art models, to identify areas for improving model performance as: **boost position signal** vs. visual for microscopy; **pretrain** on large public cell datasets vs. curated in-house data; **classical post-processing** methods lead to >10% improved performance
- Acquired and processed **public cell tracking** datasets **40x larger** than in-house dataset; trained on multiple GPUs to **improve key metrics** ID switches and tracking accuracy by **>40%** vs. previous, and **>8%** vs. state of the art
- Implemented features to boost position signal, learning capacity and usability including: **rotary embeddings**, mixed dataset training, customizable feature extractor factory
- **Created** and **implemented** robust **global tracking accuracy** metric to address gaps in multi-object tracking metrics for downstream biological analysis; this metric helped us address a key failure mode of the model
- Created **value proposition** for our method, selected **tracking** and **biological metrics** to compare to existing methods

**GRADUATE RESEARCH ASSISTANT** | EXISTENTIAL ROBOTICS LAB, UC SAN DIEGO San Diego, CA | 2023 - 2024

Key Skills: Model predictive control, control barrier functions (CBF), casADi, CVX, JAX, automatic differentiation, QP, Extended Kalman Filter, RRT*, collision avoidance, ROS, Jackal robot, LiDAR, depth camera, HectorSLAM

Summary: Determine the optimal trajectory (online) for an autonomous robot with limited field-of-view to keep a target within view while avoiding collisions with obstacles

Publication: *"Control Strategies for Pursuit-Evasion Under Occlusion Using Visibility and Safety Barrier Functions"* accepted at ICRA 2025. Arxiv: https://arxiv.org/abs/2411.01321

- **Implemented** a **model predictive controller** with control barrier (CBF) constraints to compute the optimal trajectory of the 'seeking' robot in order to keep a target within the field of view
- Implemented features to improve the **stability, and reliability** of the controller: **smoothing** to reduce changes in direction; **adaptive tuning** of CBF to improve collision avoidance; **slack** to improve feasibility of solution
- Demonstrated **>95% tracking** in **real world experiments** with Jackal wheeled robot in a cluttered environment
- Operated lightweight controller at 50Hz onboard the robot; fused sensor data from 3D LiDAR and RGB camera for SLAM and target detection using Python ROS nodes
- Implemented **Extended Kalman Filter** to estimate target's position and velocity using camera detections

**DATA SCIENTIST, SR. DATA SCIENTIST** | WALMART CANADA                    Toronto, ON | 2019 – 2022

**Key Skills:** Natural Language Processing - Spacy, Named Entity Recognition, BERT, human-in-the-loop systems, AutoML, ARIMA, Prophet, xgboost, PySpark, SQL, MLOps, Python, Pandas, Numpy, Keras, Google Cloud Platform, Airflow

**Project lead - Automated Attribute Assignment** (2021 - 2022). **Goal:** Extract product features from item descriptions to populate missing data for products on walmart.ca to improve search quality

- Developed **named entity recognition pipeline** (Spacy, BERT) to learn **context-aware** features from product descriptions; led to **>$1MM CAD revenue increase** annually by populating features for over 500,000 items
- Recognized need for **high quality custom annotated data**; pitched and integrated a **human-in-the-loop** annotation tool (Prodigy); setup **active labelling** loop with **least confident predictions** annotated
- **Coordinated Jr. Data Scientist**, and guided the implementation of an **asynchronous orchestration layer**
- Worked closely with business stakeholders to guide problem framing, roadmap, execution and production support

**Other Projects** (2019 - 2021)

- Developed and deployed **hierarchical model factory** (xgboost) to categorize 3rd party vendor items on walmart.ca; increased **categorization rate from 90% to 97%** which increased product views for previously 'unfindable' items
- Lead developer for data-driven, rules based online **grocery substitutions recommendation** engine; **300bps improvement in customer satisfaction**
- Created and maintained **fulfillment centre forecast** (ARIMA, Prophet, AutoML) to optimize labour; **>90% accuracy** up from 75% previously, **>$1MM annual labour savings** by achieving high accuracy during holiday period
- Designed and implemented **randomized control test** to test optimal email voucher strategy for grocery customers; **saved $100,000 in marketing spend** for a single 3-month campaign

**SR. DATA ANALYST** | SHOPPERS DRUG MART                    Toronto, ON | 2017 – 2019

**Key Skills:** Data engineering, systems engineering, performance metrics, worfklow improvements

- Developed **ETL pipeline** and a large SQL application that **transforms event triggers** into key pharmacy **workflow metrics** such as customer wait times, rework rates and labour heatmaps, to enable store performance reporting
- Used metrics to create business cases and guided rollout of **$1MM CAD in workflow improvements**

## PROJECTS

**DEEP LEARNING AND SOFTWARE** ⬈                    UC SAN DIEGO, 2023 – 2024

**Key Skills:** PointNet, instrinsics, odometry, depth images, SIFT, point cloud registration, PyTorch, C++, RAII, smart pointers, design patterns, templates, variants, STL

- **PointNet-based neural network** in PyTorch to solve the **point cloud registration** problem, and achieved performance close to **Iterative Closest Point** (ICP) method on basic trajectories in Eden dataset
- (C++) **String library** with underlying buffer manager. **Achieved 25% lower memory usage than C++ std::string** for common string operations: append, replace, insert, erase, search
- (C++) Graph-based **in-memory JSON datastore** with query capability
- (C++) **Compressing archive tool** with add, extract, retrieve capability

## SKILLS

C++, Python, SQL, Numpy, Pandas, PyTorch, Keras, CVX, JAX, OpenCV, Open3D, GCP, PySpark, Hadoop, Airflow