Ashwin Ramachandran

B.Tech in Computer Science at IIT Bombay

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Education

Indian Institute of Technology Bombay, Mumbai, India   *Nov 2020 – Mar 2024 (expected)*
Bachelor of Technology in Computer Science and Engineering with Honours   CPI - **9.44/10**

Scholastic Achievements

- Secured an **All India Rank 56** in **Joint Entrance Exam - Advanced** among 1,50,000+ candidates.   *(2020)*
- Achieved an **All India Rank 262** in **Joint Entrance Exam - Mains** among 9,00,000+ candidates   *(2020)*
- Awarded the prestigious **KVPY** Fellowship with an **All India Rank 239** in the **SA** stream   *(2018)*
- Secured an **All India Rank 320** in the **KVPY** Fellowship examination in the **SX** stream   *(2019)*
- Selected for the **National Talent Search Examination Fellowship** by NCERT, Govt. of India   *(2017)*
- Placed as the **State Topper** at the **National Standard Examination in Astronomy**   *(2019)*
- Among the **National Top 1%** of 50,000 candidates at the **National Standard Examination in Physics**   *(2019)*
- quadehye scholarship

Publications

1. Title: **Video-based in-vehicle action recognition for continuous health monitoring**   [paper, poster]
   Authors: **Ashwin Ramachandran**, Kartik Gokhale, Maike Kripps, Thomas Deserno
   Conference: SPIE Medical Imaging 2023: Imaging Informatics for Healthcare, Research, and Applications
   TLDR: We enhance driver action recognition by introducing a novel feature engineering approach that accounts for the order of frames in videos, a key aspect overlooked by the current state-of-the-art models.

Submitted

1. Title: **Investigating Independent Data Processing for Custom Data Querying**   [paper]
   Authors: **Ashwin Ramachandran**
   Conference: ACL ARR 2023
   TLDR: The paper explores methods for independent data processing with Large Language Models, addressing context window limitations and revealing LLM behavior insights, especially regarding entity relationship.

Internships

Automated C++ Function Migration with Advanced Compiler Theory   *Summer 2023*
Google | Software Engineering Intern   *Bangalore, India*

- Spearheaded the automation of C++ function migration, **surpassing all manual execution expectations**.
- Applied advanced **compiler theory** concepts to streamline and accelerate the migration process, resulting in efficiency improvements that **saved 1700 software engineering hours**.
- Created a **versatile grammar** with ANTLR, enabling an efficient lexer and parser to **handle diverse C++ functions**, ensuring accurate AST representation for reliable migration.

Research Experience

In-context Retrieval Augmented Generation   *Autumn 2023 - Ongoing*
Guide: Prof. Sunita Sarawagi, Prof. Soumen Chakroborti | Bachelor's Thesis Project   *IIT Bombay*

- Conducted experiments to harness the independence of contexts within the Retrieval Augmented Generation (RAG) model, enabling efficient processing of multiple contexts and preserving hidden states for subsequent use. This approach eliminated the need for sequential processing and provided insights into how the model maintains relationships between entities in various contexts.[paper]
- Developing an approach to provide the model with access to an extensive context datastore, enabling multi-hop retrievals at every generation step, with a specific focus on encoding and querying from tables within a closed system, free from external influence.

Interpretable Subgraph Matching for Graph Retrieval with Early Interaction · *Autumn 2023 - Ongoing*

Guide: Prof. Abir de, Prof. Soumen Chakroborti | Bachelor's Thesis Project · *IIT Bombay*

- Developing an innovative interpretable neural edge alignment model for identifying relevant subgraphs in corpus graphs through isomorphic matching with query graphs.
- Achieved training efficiency by utilizing binary relevance labels for graph pairs, eliminating the need for fine-grained ground truth data on node or edge alignments.
- Leveraging early interaction within Graph Neural Networks (GNN) to advance graph analysis and retrieval methods, showcasing the practical application of interpretable neural networks in information retrieval tasks.

Diverse Question Generation from Product Descriptions · *Winter 2022*

Guide: Prof. Sunita Sarawagi | R&D Project · *IIT Bombay*

- Implemented various training strategies to **generate diverse, non-comprehension type questions from product descriptions** across seven Amazon product categories, emphasizing relevance **beyond simple factual retrieval**.
- Leveraged a template-based approach as the core strategy, which involved generating product-specific details or question types relevant to each product category. This approach provided a structured foundation for tailored question generation, ensuring questions were contextually appropriate and diverse.

Video-based in-vehicle action recognition · *Summer 2022*

Guide: Prof. Thomas Deserno | Research Intern · *PLRI, Technische Universitat Braunschweig*

- Analysed performance of State of the Art models in **video-based action recognition** on the Drive&Act dataset
- Identified the models's **permutation invariance** in the temporal and spatial dimension and proposed a feature engineering module that uses **human pose estimates** to incorporate **ordering of frames** and **spatial layout**.
- Showed proof of concept by increasing the accuracy of **six** badly performing action classes to **80** percent

Plagiarism Detection using Deep Learning · *Summer 2021*

Guide: Prof. Prabhu Ramachandran | Research Intern · *Summer Undergraduate Research Program, IIT Bombay*

- Studied working of **Abstract Syntax Tree Neural Networks** used in the task of **Source Code classification**.
- Built a **Syntax Tree Parser** to generate Syntactical tokens from Java code corpus using **Javalang** library.
- Designed a **two way classification model** consisting of a bidirectional multilayered **Gated Recurrent Unit (GRU)** network using the **PyTorch** library and integrated the **Syntax Tree Parser**
- Trained the model on a dataset of 100 plagiarised codes using **Stanford Moss's Algorithm** as a benchmark.

Hackathons

SnapEnPlay · *Summer 2021*

*Abracadabra Hacks | **Best Use of Google Cloud (Among 256 teams)** | Demo* · *Major League Hacking*

- Created a web application that converts images of **hand-made doodles to playable games** using **Unity** through **WebGL** & **NodeJS** and implemented smooth conversion of image data to the **in-browser game world**
- Implemented image processing in **OpenCV** and allowed for **shadowy and low-resolution** images
- Used **Google Firebase** to make the custom maps shareable among users and deployed the app on **Heroku**

COVIDQueue · *May 2021*

Hackon 2.0 | Demo · *HackerEarth*

- Developed a crowd management and **social distancing solution** for retail and grocery stores within a **48-hour** deadline
- Implemented a real-time queue management system using **Firebase**, optimizing customer flow and reducing wait times.
- Created a user-friendly interface that allowed customers to join virtual queues with a **unique store code**
- Addressed the challenges of the pandemic by **minimizing time spent in crowded lines, contributing to public health, and providing a solution for a safe shopping experience**.

CoronaWars · *Apr 2021*

*Game-Dev Hackathon | **Winners*** · *Web & Coding Club, IIT Bombay*

- Created a **Unity-based first-person** action game focusing on the COVID-19 pandemic.
- Executed intricate pandemic simulation logic, including character spawning, infection mechanics, and vaccine distribution
- Translated real-world pandemic scenarios into engaging gameplay, showcasing creativity and adaptability in game design.

Technical Projects

Blockchain Simulator
Guide: Prof. Vinay Ribeiro | Blockchains, Cryptocurrencies and Smart Contracts

Spring 2023
Course Project

- Implemented a peer-to-peer cryptocurrency network simulation following the **Bitcoin** protocols.
- Simulated selfish and stubborn mining attacks, analyzing the effects of hash power and network connectivity.
- Developed a decentralized payment application on top of Ethereum in Solidity, utilizing smart contracts

Compiler for C-like Language
Guide: Prof. Amitabha Sanyal | Implementation of Programming Languages

Spring 2023
Course Project

- Developed a Flex scanner to accurately identify language tokens, integrating a Bison script to enforce thorough syntax checks using a robust lexical analysis tool.
- Enhanced the compiler's overall performance by integrating essential components such as type verification, semantic checks, overload resolution, and the generation of Abstract Syntax Trees.
- Created a Symbol Table based on stack offsets, proficiently generated Assembly code, and rigorously verified the compiler against a standard compiler to ensure the precision and dependability of the generated code.

Digital Mess App
Developer's Community Project | HomePage

Apr 2022 - May 2023
IIT Bombay

- Developed an application for streamlining meal card management, featuring support for all card types, offline functionality, QR code integration, including features for opt-out subscriptions and rebate management.
- Enhanced the platform with a statistics dashboard, providing insights into meal usage for 9 hostels and 6,500+ students.
- Played a pivotal role in optimizing operations, saving over 3,000 hours in meal card management, and facilitating the service of 500,000+ meals in the initial five months, greatly improving efficiency for students and staff.

Visual Perception of Self Driving Cars
Seasons of Code Project | Github Page

Summer 2021
Web & coding club, IIT Bombay

- Implemented an **Object Detection** model based on **Faster RCNN** to identify traffic lights, traffic signs and vehicles and used the data to guide vehicles on the **Carla Simulation** software
- Modified **NVIDIA's PilotNet** architecture to have **two regression heads** to output both throttle and steering commands to obtain good results on **multi-lane roads** on the **Carla Simulation** software
- Identified the need for **semantic segmentation** to give more perception to the surroundings of the vehicle and used the **Mask RCNN** model to get improved results for the task of **vehicular guidance**

RISC 16 Bit Processor in VHDL
Guide: Prof Virendra Singh | Digital Logic Design & Computer Architecture

Spring 2022
Course Project

- Created an efficient **finite state machine** implementing a CPU based on 16 bit instructions and 8 registers
- Experimented with **non-pipelined** & **6-stage pipelined** architectures to study optimization of execution time
- Implemented & tested the adequate **RISC Instruction Set Architecture** in **Quartus** Prime using VHDL
- Created a **Python-based Assembler** for translating assembly into machine code for execution using VHDL

Technical Skills

Languages: Python, Java, C, HTML/CSS, JavaScript, SQL
Developer Tools: VS Code, Eclipse, Google Cloud Platform, Android Studio
Technologies/Frameworks: Linux, Jenkins, GitHub, JUnit, WordPress

Leadership Positions

Department Academic Mentor
Computer Science & Engineering Department

Jun 2022 - Jun 2023
IIT Bombay

- Mentoring **6** sophomores of CSE department to assist them in navigating department specific curriculum
- Working in a supportive, facilitative and developmental role for the student community in general as a mentor

Mentor, Seasons of Code
Web & Coding club

Summer 2022
IIT Bombay

- Mentored **15** students through the CNN-lytical course, designed for an in-depth study of Computer Vision models
- Guided the mentees to build a **video-based American Sign Language to Text** conversion model

Teaching Assistant

- **Artificial Intelligence & Machine Learning** | Prof. Preeti Jyoti — *IIT Bombay, Aug 2023 - Nov 2023*
- **Calculus - II (MA 111)** | Prof. Niranjan Balachandran, Prof. Preeti Raman — *IIT Bombay, Jan 2023 - Apr 2023*
- **Calculus - I (MA 109)** | Prof. Sanjoy Pusti, Prof. Madhusudan Manjunath — *IIT Bombay, Aug 2022 - Nov 2022*

Responsible for conducting doubt sessions, preparing problem sets, programming labs and grading examinations

Project Lead *April 2022 - May 2023*
Developer's Community *IIT Bombay*
- Lead a team of 21 student developers as part of one of the biggest institute **Developers' Community** in India, responsible for ideating, developing and deploying countless out of the box applications for the institute
- Built a module for the collection & verification of student's achievements in institute organized events for the **InstiApp**, used by 5,000+ students for regular updates regarding institute events
- Built the backend API endpoints for the Institute's **Digital Mess App** using **Flask** and the **MongoDB** database

Software Subsystem Member *Aug 2021 - Apr 2022*
Mars Rover Team *IIT Bombay*
- Official member of IIT Bombay's Mars Rover Team, representing the institute at Rover Building challenges
- Made improvements to the **Mean-Shift Segmentation algorithm** for **Rock Detection** and worked on **Image Enhancement** and **Data Compression** techniques for **IRDC** 2021
- Working on tasks of **AR tag** detection and **Crater** detection using **OpenCV** for **URC** 2021

Other Projects

Peer-to-Peer Network using Socket Programming *Spring 2022*
Guide: Prof. Kameswari Chebrolu | Computer Networks *Course Project*
- Designed a **P2P network** for search and retrieval of files till depth 2 in client networks using a catch-up mechanism
- Implemented **breadth-first** approach for search and employed **MD5 hashing** to judge correctness of retrieved files
- Built **Python & Bash** scripts to automate testing of system on different client connection graphs

Image to Image Translation *Autumn 2021*
Guide: Prof. Biplab Banerjee | Machine Learning for Remote Sensing *Course Project*
- Implemented a **Conditional Generative Adversarial Network** for translation of images to different forms
- Used the **CycleGAN** model in diverse domains like changing **artistic styles, seasons** or **animal type** in images
- Worked on the **Pix2Pix** model for conversion of **aerial images to maps** with great usage in **Geospatial Imaging**

Sudoku Solver App *Summer 2021*
Self Project | Github Page *IIT Bombay*
- Built an Android app in **Java** capable of solving Sudoku puzzles from captured images using a **heuristic algorithm** that uses strategies like **Hidden pairs**, **SwordFish** and **Naked Pairs** for candidate elimination
- Implemented **contour detection** and **perspective transformation** algorithms in **OpenCV** to separate out the main puzzle from the rest of the image and segment it for recognising digits
- Trained a **Neural Network** on the **MNIST dataset** for recognizing numbers which reached a **96.4% accuracy**
- Implemented **Online Learning Method** to continually improve the model with new data presented by the user

Extracurriculars

- Completed the **ACM** IITB trust lab winter school on topics in **Digital Trust** *(2023)*
- Placed **5th** overall among the students at IIT Bombay at the IITB Trust Lab **Capture The Flag** contest. *(2023)*
- Among the top three teams at the interhostel **Coding GC** at IIT Bombay *(2022)*
- Pitched a **Business Model Canvas** to implement the **National Education Policy 2020's** vocational training proposal for the **EnB Buzz** competition conducted by the **Entrepreneurship cell** of IIT Bombay *(2021)*
- Designed a drone to collect crowd density statistics at surrounding shops to help maintain social distancing during the pandemic at the **Magic Box challenge** conducted by the **Tinkerer's Laboratory, IIT Bombay** *(2021)*
- Completed a year long **National Cadet Corps (NCC)** programme at IIT Bombay *(2020)*
- Among the **Top 30% teams** at the **Kanpur-Mathura** regional finals for **ICPC** *(2020)*