

# Balagopal Unnikrishnan

[www.balagopal.me](http://www.balagopal.me) | [+1-437-991-1394](tel:+14379911394) | [balu@cs.toronto.edu](mailto:balu@cs.toronto.edu) | [github.com/theidentity](https://github.com/theidentity)

## — Educational Qualifications —

- Ph.D. in Computer Science - University of Toronto - CGPA: 4/4** 09/21 - 09/25 (Anticipated)
- Co-advised by Dr. Michael Brudno & Dr. Chris McIntosh - supported by Vector Institute, University Health Network (UHN) & SickKids Hospital
- Masters in Knowledge Engg. / Intelligent Systems - National Univ. of Singapore (NUS) - CGPA: 4.16/5** 2019
- Advised by Dr. Michael Chua & supported by the Agency for Sc., Technology & Research (A\*STAR), Singapore - specializing in computational intelligence focusing on building diagnostic tools for radiology and ophthalmology
- Bachelor in Computer Sc. and Engg. - Univ. of Kerala / College of Engg. Trivandrum (CET) - CGPA: 8.49 / 10** 2017

## — Professional / Research Experience —

- Ph.D. Student / Graduate Researcher - University of Toronto** 2021 - Present
- Diffusion for bias mitigation** – Developed a bias mitigation algorithm that debiased classifiers while training on 95% biased data. Achieved similar performance (~within 1% AUC) to models trained on 0% biased data.
  - Papilledema detection from ultrasound videos** – Built and deployed a semi-supervised GUI pipeline for clinical annotation. Utilized deep learning models to detect disease regions (.90 AUC) and localize them (< 2% normalized MSE) and studied the impact of bias due to acquisition devices.
  - Bias Detection and Generalization** – Co-developed an algorithm to study AI model generalization without external data. Showed an average of 21% performance overestimation across 13 medical datasets and correctly predicted external accuracies (<4% error) without external data estimates.
- AI Research Engineer - Institute for Infocomm Research (I2R / A\*STAR), Singapore** 2019 - 21
- Algorithm development/translation** – Developed semi-supervised and self-supervised algorithms for 2D/3D medical imaging data – resulting publication being runner-up for the best paper award at MICCAI.
  - Performed IP development and translation work for semi-supervised guided medical image annotation.
- Research Intern - Institute for Infocomm Research (I2R / A\*STAR), Singapore** 2018 - 19
- Co-developed and trained patch-based **semi-supervised GANs** and transfer-learning-based methods for **abnormality/anomaly detection** in diabetic retinopathy and retinopathy of prematurity (ROP) detection
  - Developed 2D and 3D segmentation pipelines for MRI data
- Systems Engineer C1 - TATA Digital Enterprises, India** 2017
- Differential/special hire as part of the Digital Enterprise program - worked on vision / NLP tasks
- Research Intern: Robotics and Cognitive Division - TATA Digital Enterprises, India** 2017
- Developed proof-of-concept for boosted edge detection methods for image processing
  - Developed NLP-based knowledge engine for integration into communication system

## — Selected Publications —

[\*A full list of 16 articles is available on Google Scholar | Citations: 337, h-index: 6\*](#)

- “Shortcut Learning in Medical AI Hinders Generalization: Method for Estimating AI Model Generalization without External Data” - Ly, C, O\*., **Unnikrishnan, B\*** et. al. (2024). \*equal contribution [**Nature Digital Medicine**]
- “Semi-supervised classification of radiology images with NoTeacher: A teacher that is not mean” - **Unnikrishnan, B.**, Nguyen, C., et. al. (2021). [**MICCAI + Extended version in Medical Image Analysis**]
- “Self-path: Self-supervision for classification of pathology images with limited annotations” - Koohbanani, N. A., **Unnikrishnan, B.**, et. al. (2021) [**IEEE Transactions on Medical Imaging**]
- “Semi-supervised and Unsupervised Methods for Heart Sounds Classification in Restricted Data Environments” **Unnikrishnan, B.**, Singh, P. R., Yang, X., & Chua, M. C. H. (2020). [Arxiv Preprint – Project]
- “Towards practical unsupervised anomaly detection on retinal images” - Ouardini, K., Yang, H., **Unnikrishnan, B.**, et.al. (2019). MICCAI Workshop - Domain Adaptation and Representation Transfer, [**DART / MICCAI**].
- “Semi-supervised deep learning for abnormality classification in retinal images” - Lecouat, B., Chang, K., Foo, C. S., **Unnikrishnan, B.**, et. al.(2018). Machine Learning for Health (ML4H) Workshop at NeurIPS [**ML4H / NeurIPS**]

## — Skills —

- AI Research & Engineering** – Capable of **quick AI prototyping** with platforms such as **PyTorch & TensorFlow**
- Web development & Prototyping** – Have built web-based research prototypes with **Flask & MongoDB** with and **HTML, CSS, JS** – have also deployed solutions using **AWS & Google AutoML**
- Experience in creating **IP, publications**, and technologies for companies and **productizing** them - domain expertise in **vision, radiology, and medical data**.
- Data Science (Pandas, R, SPSS Modeller, JMP, and Scikit-learn) | **Computer Vision** (OpenCV, Scikit-Image, Fiji) | **Audio Processing**(Librosa, SciPy) | **Natural Language Processing** (NLTK, TextBlob, Pattern)

## — Research Projects —

- Understanding and mitigating shortcut learning and data bias in healthcare data** 2021-Present
- Studied **performance deterioration** in models from lab to field in mobile health applications. Developed a novel method to identify data outliers and estimate performance on the field.
  - Improved **semi-supervised algorithm performance** on radiology data (.91 to .96 AUC) by developing a new multi-view loss function that promotes the learning of non-spurious features. Additionally achieved 97% of fully supervised performance with 100x fewer labels
  - Co-developed an algorithm to study **AI model generalization without external data**. Showed an average of 21% performance overestimation across 13 medical datasets and correctly predicted external accuracies (<4% error) without external data estimates.
- Debiasing models using generative AI** 2021-Present
- Developed a bias mitigation algorithm that debiased classifiers while training on 95% biased data. Achieved similar performance (~within 1% AUC) to models trained on 0% biased data.
  - Achieved SOTA performance and a 7% margin to the closest competing method.
- Papilledema detection from ultrasound videos** 2023-Present
- Built and deployed a semi-supervised GUI pipeline for clinical annotation. Utilized deep learning models to detect disease regions (.90 AUC) and localize them (< 2% normalized MSE) and studied the impact of bias due to acquisition devices.
- AI-assisted models for pneumothorax detection** 2021 – Present
- Curated a **200k large X-ray dataset** with public and private data and created a scalable pipeline for pneumothorax detection to improve scan-to-intervention response times – the resulting model is deployed at UHN
  - Identified critical data bias and confounder issues, which bottlenecked model generalization and created a proof of concept tool for clinical usage.
- Ask-Me-Right Radiology Annotation Platform** 2021
- Built, deployed, and tested a platform to source annotations for X-rays. Used HCI design principles and multi-arm bandits to reframe annotation tasks resulting in a **2x reduction in annotation time** and improved annotator accuracy.
- Semi-Supervised Learning for Radiology Images** 2020-21
- Developed NoTeacher, a novel semi-supervised method for reduction in annotation burden in radiology data
  - Achieved 90% performance of fully supervised models with just 5% of labels for X-ray and CT data
  - Published works in MICCAI 2020 and IEEE Transactions in Medical Imaging (TMI) and was the runner up for the **MICCAI Best Paper Award 2021**.
  - Translated into IP – “A Semi-Supervised Process to Guide Annotation for Image Classification Tasks” and has been *licensed to a private company for revenue*
- Self Supervision and Domain Transfer for Pathology Data** 2020
- Developed self-supervision tasks that use multi-resolution and semantic features in histopathology images.
  - Achieved state-of-the-art performance with limited annotation on whole slide images.
  - Accepted into IEEE Transactions on Medical Imaging (TMI)
- Anomaly Detection in qPCR Curves for CoVID Detection** 2020
- Used machine learning techniques to flag anomalies in automated qPCR testing for CoVID - detecting late amplification and fluorescence drift cases.
  - Developed an automated tool to enable faster inferences and error reduction in clinicians.
- Deep Learning for Tuberculosis Detection** 2019
- Built a proof of concept tuberculosis detection model and studied the effect of transfer learning and architecture for limited data settings.
  - Created a web application that provides interpretable results using class activation maps (CAMs)
- Heart Sounds Classification in Restricted Data Environments** 2018
- Built a system to detect abnormal heart murmurs from audio data and 2D Mel spectrogram images.
  - Used additional hand-engineered features and 1D convolutions to improve model accuracy with 4x lesser parameters
- Karyogram Classification for Cancer Detection** 2017
- Used machine learning and computer vision techniques for karyogram generation.
  - Improved cytogeneticist workflow using graphs and convolutions for chromosome tagging and pairing.
  - **Received Best Engineering Project Award**

## — Certifications —

AI Product Manager Nanodegree - Udacity	2020
AI for Medicine Specialization - Deeplearning.ai / Coursera	2020
Deep Learning Specialization - Deeplearning.ai / Coursera	2017
Machine Learning Specialization - Deeplearning.ai / Coursera	2016
Introduction to the IoT and Embedded Systems - University of California Irvine (UCI) / Coursera	2016

## — Achievements / Awards / Volunteer Positions —

Schwartz Reisman Institute (SRI) Graduate Fellowship	2024
Reviewer: Nature Scientific Reports	2024 – Present
Mentor: Graduate Application Assistance Program (GAAP)	2022 – Present
Reviewer: IEEE Transactions in Medical Imaging (TMI)	2022 – Present
University Of Toronto Fellowship, Faculty Of Arts And Science	2023
Vector Research Grant	2022, 2023
Executive Council Member: Computer Science Graduate Students' Benevolent Society (CSGSBS)	2022 – 2023
Chairperson: Singapore Computer Society (SCS) Chapter - NUS ISS	2018 – 2019
Ministry of Education Grant for International Students	2019
Richard E Merwin Scholar - IEEE Computer Society	2017
Youth Excellence Award for Most Promising Engineer - Kerala	2017
Section Student Representative - IEEE Kerala Section	2016 – 2017
Chairperson: IEEE Computer Society CET Chapter	2016 – 2017
Co-Organizer: NASA Space Apps Challenge	2016
Represented the state in the Asia-Pacific Student Young Professional Congress in Colombo, Sri Lanka	2016

## — Teaching Experience —

Lecture & Tutorial TA: CSC 111: Foundations of Computer Science II	2024
Lecture TA: CSC 110: Foundation of Computer Science I	2023
Lecture TA: CSC 108: Introduction to Computer Programming	2022
Lecture TA: CSC 2431: Artificial Intelligence in Medicine	2022
<ul style="list-style-type: none"><li>Coordinated students and mentors for two Ukrainian Universities (NaUKMA, UCU) and Ph.D. students at UofT for a unique international course where students developed AI algorithms for medicine/health.</li><li>Created and deployed a responsive <a href="#">website</a> to disseminate project details, teams, and study materials.</li></ul>	
Marking TA: CSC 420: Introduction to Image Understanding	2021

## — Selected Talks & Workshops —

AI in Healthcare [ <a href="#">Slides</a> ]	2021
<ul style="list-style-type: none"><li>Gave a talk discussing AI in Healthcare use cases for computer science professionals in Singapore.</li></ul>	
Research Workshop - [ <a href="#">Outcome slides from students</a> ]	2021
<ul style="list-style-type: none"><li>Led a workshop for undergraduate students where they learned to review scientific papers.</li><li>Moderated the literature discussion on deep residual learning for image recognition.</li></ul>	
Introduction to Artificial Intelligence & Machine Learning - [ <a href="#">Slides</a> ]	2021
<ul style="list-style-type: none"><li>Showed learning paradigms and AI/ML applications in various fields such as healthcare, finance, etc.</li><li>Discussed with students in MuLearn (a learning community) ways to learn, upskill, and complete live projects</li></ul>	
Lecture on Logistic Regression - [ <a href="#">Slides</a> ]	2020
<ul style="list-style-type: none"><li>Introduced the concept of logistic regression for students in <a href="#">MuLearn</a> community.</li><li>Also showcases the math behind the back-propagation and differentiation involved in the technique</li></ul>	

## — Misc / Hobbies —

### Scuba Diving

- PADI-certified scuba diver trained in dive planning, underwater emergency responses, and safety protocols – capable of undertaking dives of up to 60 feet.

### Reading

- Reads 24+ books a year with topics covering science, philosophy, religion, and poetry.
- [Reading List on GoodReads](#)