Anirudh Choudhary

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INTERESTS	Weakly-supervised Learning, Multimodal Learning, Biomedical Data Analysis

EDUCATION	**University of Illinois Urbana-Champaign**, Champaign, USA	*Aug'20 - present*
	Ph.D., Electrical Engineering (GPA: 3.91/4.00)	
	Georgia Institute of Technology, Atlanta, USA	*Aug'18 - present*
	M.S.(Thesis), Computational Science and Engineering (GPA: 3.81/4.00)	
	Thesis : Robust Causal Inference for Observational Health Data Analysis	
	Indian Institute of Management Calcutta, Kolkata, India	*Jun'11 - Apr'13*
	Masters in Business Administration	
	Indian Institute of Technology Kharagpur, Kharagpur, India	*Jul'05 - May'10*
	B.Tech & M.Tech (Honors), Electrical Engineering	

PREPRINTS/ ARTICLES (*EQUAL CONTRIBUTION)

A. Choudhary, S. Nassir, Y. Miranda, A. Hughes, X. Li, N. Zhang, D. DiCaudo, A. Mangold, R. Iyer "Sparse Multimodal Analysis of Whole Slide Image and Transcriptomics for Metastasis Prediction in Cutaneous Skin Cancer" (in preparation)

A. Choudhary, A. Hwang, J. Kechter, K. Saboo, B. Bordeaux, P. Bhullar, N. Comfere, D. DiCaudo, S. Nelson, E. Johnson, L. Swanson, D. Murphree, A. Mangold, R. Iyer "RACR-MIL: Weakly Supervised Skin Cancer Grading using Rank-Aware Contextual Reasoning on Whole Slide Images." (arXiv preprint)

W. Shi*, H. Wu*, **A. Choudhary**, M. Wang, "Clinical Decision Making under Uncertainty: A Bootstrapped Counterfactual Inference Approach", BMC Medical Informatics and Decision Making (in submission)

A. Choudhary, L. Tong, Y. Zhu, M. Wang, "Advancing medical imaging informatics by deep learning-based domain adaptation", IMIA Yearbook of Medical Informatics (2020)

PUBLICATIONS (*EQUAL CONTRIBUTION)

A. Choudhary, S. Nassir, Y. Miranda, N. Comfere, D. DiCaudo, S. Nelson, E. Johnson, L. Swanson, D. Murphree, A. Mangold, and R. Iyer. "RACR-MIL: Weakly Supervised Skin Cancer Grading Using Rank-Aware Contextual Reasoning on Whole Slide Images.", SID Annual Meeting 2024 (Poster)

A. Choudhary, B. Boudreaux, P. Bhullar, S. Nelson, A. Mangold, and R. Iyer. "Risk stratification of squamous cell carcinoma using weakly supervised multitask learning of whole slide images.", Journal of Investigative Dermatology 2022 (Poster)

K. Saboo, **A. Choudhary**, Y. Cao, G. Worrell, D. Jones, R. Iyer, "Reinforcement learning based disease progression model for Alzheimer's disease", NeurIPS 2021

F. Heemeyer*, **A. Choudhary***, J. P. Desai, "Pose-aware C-arm Calibration & Distortion Correction for Guidewire Tracking & Image Reconstruction", International Symposium on Medical Robotics 2020

A. Choudhary, H. Wu, L. Tong, M. Wang, "Learning to Evaluate Color Similarity for Histopathology Images using Triplet Networks", ACM Conference on Bioinformatics, Computational Biology, & Health Informatics, 2019 (Long Oral, Invited for JBHI Special Issue)

M. Krishnan, **A. Choudhary** et al., "Texture based segmentation of epithelial layer from oral histological images", Micron Journal *(Elsevier)*, 2011

M. Krishnan, P. Shah, **A. Choudhary** et al., "Textural characterization of histopathological images for oral sub-mucous fibrosis detection", Tissue Cell Journal *(Elsevier)*, 2011

F.P. Ferrarese, N. Moretto, D. Botturi, **A. Choudhary**, G.A. Zamboni, "A new image processing filter for the automatic extraction of organs' internal structures: Application to liver tumors", ECR 2009 (Poster)

A. Choudhary et al., "An entropy based multi-thresholding method for semi-automatic segmentation of liver tumors", MICCAI Workshop, 2008 (Oral)

RESEARCH EXPERIENCE

DEPEND Group, UIUC; *Graduate Researcher*   *Fall 2020 - present*
- **Weakly-supervised cancer diagnosis** (*Mentors: Prof. Ravishankar Iyer, Dr. Aaron Mangold*): Developed weakly-supervised multiple instance learning approach for grading and staging squamous cell cancer. Proposed a novel ML framework leveraging self-supervised pretraining, semantic graph network, grade-based rank ordering and multitask learning, achieving 80% concordance with pathologists.
- **Tumor metastasis prediction** (*Mentors: Prof. Ravishankar Iyer, Dr. Aaron Mangold*): Multimodal learning integrating imaging and genomic data to predict patient metastasis achieving 2% improvement in

accuracy. Analyzed the relationship between gene molecular functionality and image cellular morphology using multivariate correlation analysis.

- **Alzheimer's disease progression** (*Mentor: Prof. Ravishankar Iyer*): Modeled long-term cognition decline during Alzheimer's disease using ODE-based simulator and on-policy reinforcement learning, outperforming existing RNN-based approaches.

BioMIB Lab, Georgia Tech; *Graduate Researcher*   *Spring 2019 - Spring 2020*

- **RL-based clinical policy learning** (*Mentor: Prof. May Wang*): Implemented bootstrapping and adversarial learning-based frameworks to tackle model uncertainty and meta-learning-based reinforcement learning to enable improved generalization during offline policy learning on EHR data
- **Self-supervised learning for image retrieval** (*Mentor: Prof. May Wang*): Developed triplet network-based representation learning approach for image retrieval and perceptual similarity evaluation of pathology images. Studied optimal transport-based generative models for stain color transfer

Medical Robotics and Automation Lab, Georgia Tech; *Graduate Researcher*   *Fall 2019*

- Developed camera-based pose-estimation method for X-ray arm using Siamese tracking and Superpoint network for keypoint-based homography estimation; Working on tissue segmentation in CT images

Centre for Spatial Planning, Georgia Tech; *Research Assistant*   *Fall 2018 - Spring 2019*

- Formulated multi-year highway infrastructure optimization framework with network reliability constraints
- Implemented parallel Genetic Algorithm in OpenCL and simulated traffic routing using SUMO package

B.Tech & M.Tech Thesis, IIT Kharagpur   *Fall 2008 - Spring 2010*

- Cancer detection in oral pathology images using spatial & wavelet based texture features (91% accuracy)

Biomedical Image Analysis Lab, University of Pennsylvania; *Research Intern*   *Summer 2009*

- Cerebellum segmentation in MRI images using 3D Gabor features based Demons registration & SVM

Altair Robotics Laboratory, University of Verona, Italy; *Research Intern*   *Summer 2008*

- Liver tumor segmentation using cross-entropy minimization-based thresholding for abdominal CT scans (75% ROI overlap); Work incorporated into Mirosurge robotic platform (4th in MICCAI's grand challenge)

COURSES	Computer Vision, Graphical Models, Deep Learning, Machine Learning, ML with Limited Supervision, Artificial Intelligence, Pattern Recognition, Random Processes, Trustworthy Machine Learning, Computational Inference, Reinforcement Learning, CSE Algorithms, Numerical Linear Algebra, Modeling & Simulation

PROFESSIONAL EXPERIENCE

Mastercard Advisors, India; *Senior Analyst, Advanced Analytics*   *Sep'17 – Jul'18*

- Developed ML models for customer persona & shopping behaviour analysis using 100TB transaction data; Worked on hierarchical clustering, latent class analysis, graph clustering & dimension reduction methods

Loyalty Partner(AmEx subsidiary), India; *Manager, Customer Analytics*   *Jun'16 — Aug'17*

- Led a team of 3 for spend analytics & customer acquisition modelling for India's leading grocery retailer
- Designed campaign propensity models using logistic regression/CHAID leading to 10x uplift in response

EXL Analytics, India; *Manager, Decision Analytics*   *Jun'13 - Jun'16*

- Led a team of 10 consultants for pricing & supply chain analytics for leading US insurer operating T-Mobile's device trade-in program; Developed GLM and ARIMAX-based models for market price and trade-in volume forecasting (95% MAPE); Optimized trade-in prices to achieve 30% incremental profits

Sabre Corporation, India; *Associate Software Developer*   *Jul'10 – May'11*

- Full-stack developer responsible for optimization & enhancement of Travelocity.com's checkout module

ACADEMIC ACHIEVEMENTS

Teachers Ranked as Excellent, ECE 598 Dependable AI Systems, UIUC (2021)

NSF Travel Grant & Graduate Student Travel Award(Georgia Tech) - ACM BCB Conference (2019)

Runners-up : Procter & Gamble's marketing strategy case-study competition, IIM Calcutta (2013)

High performance award (top 5 in Q1'11 at Sabre India); Best technology award at Hack Day (2011)

Masters Research Scholarship and Indian Oil Scholarship at IIT Kharagpur (2009)

Research Assistantships during internships at Univ. of Verona (2008) & Univ. of Pennsylvania (2009)

Best Outgoing Technology Award, IIT Kharagpur (2010)

Winner - National level product design competition at Entrepreneurship Summit, IIT Kharagpur (2010)

All India Rank 68 in IIT Prelims Examination & 507 in All India Engineering Entrance Examination
State Rank 5 in Regional Mathematical Olympiad (2002)
Mamraj Agarwal Scholarship in Std 10$^{\text{th}}$; CBSE Merit Certificate in Mathematics (top 0.01% - Std 12$^{\text{th}}$)
Qualified for final round of KVPY & cleared state level of National Talent Search Examination (2001)

PROGRAMMING   C, C++, Python, PySpark, R, MATLAB, SQL, PyTorch, Tensorflow