

# Pulkit Khandelwal

COMPUTER VISION · DEEP LEARNING · SHAPE ANALYSIS · MEDICAL IMAGING

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## Education

### University of Pennsylvania

Philadelphia, United States

PHD IN MEDICAL IMAGE ANALYSIS

Aug 2019 - Present

- Courses: Network Neuroscience, Theoretical Neuroscience, Systems Neuroscience, Advanced Image Applications
- Social, Affective and Cognitive Neuroscience, Advanced Linear Algebra and Optimization, Differential Geometry

### McGill University

Montreal, Canada

MASTER'S IN COMPUTER SCIENCE

Sep 2016 - Aug 2019

- Courses: Computer Vision, Statistical Computer Vision, Advanced Medical Imaging, Deep Learning
- Natural Language Processing, Reinforcement Learning, Applied Machine Learning

### Vellore Institute of Technology

Vellore, India

BACHELOR'S IN TECHNOLOGY IN ELECTRONICS AND COMMUNICATION ENGINEERING

July 2012 - May 2016

- Courses: Data Structures and Algorithms, Digital Image Processing, Digital Signal Processing
- Probability Theory and Random Process, Statistics, Calculus and Differential Equations, Information Theory and Coding

## Industrial Research Experience

### Google

Mountain View, United States

RESEARCH INTERN

September 2022 - Present

- Developing deep learning-based methods for personalized health recommendations

### Amazon

Palo Alto, United States

APPLIED SCIENTIST INTERN

May 2022 - Aug 2022

- Developed state-of-the-art transformers-based image retrieval model for fashion images.
- Boosted the evaluation metrics by 8 % for Fashion 200K dataset.

### Imagia Cybernetics

Montreal, Canada

COMPUTER VISION INTERN

May 2018 - Aug 2018

- Domain adaptation and Meta-learning based domain generalization for colonoscopy and brain tumor datasets

### Planet Labs

San Francisco, United States

MACHINE LEARNING INTERN

Aug 2017 - Dec 2017

- Developed image segmentation APIs and GIS libraries to query Open Street Maps data

## Academic Research Experience

### Penn Image Computing and Science Laboratory (PICSL), University of Pennsylvania

Philadelphia, United States

PHD STUDENT | SUPERVISOR: PAUL YUSHKEVICH

Aug 2019 - Present

- Few-shot Meta-learning based domain generalization for CT vertebrae segmentation
- Image synthesis, domain disentanglement, self-supervised learning for *ex vivo* 7T MRI cortical segmentation and registration
- Multi-atlas segmentation of human skull for craniofacial surgery in 3D Ultrashort Echo Time MRI
- Longitudinal network analysis of brain network measurements for early stage detection in Alzheimer's disease

### Shape Analysis Group, McGill University

Montreal, Canada

GRADUATE RESEARCH ASSISTANT | SUPERVISORS: KALEEM SIDDIQI AND LOUIS COLLINS

Oct 2016 - Aug 2019

- Spine segmentation in computed tomography images using geometric flows and shape priors [Link MSc. thesis]
- Methods: Flux based Level-sets with shape priors, coherence and edge enhanced anisotropic diffusion filtering

### Centre for Advanced Imaging, University of Queensland

Brisbane, Australia

SUMMER RESEARCH SCHOLAR | SUPERVISOR - STEFFEN BOLLMANN

Dec 2015 - Mar 2016

- Evaluated reliability and reproducibility of probabilistic and atlas based segmentation for Hippocampal subfields
- Performance evaluation of FreeSurfer and ASHS on 7T brain MRI volumes

- Evaluation of Reproducibility and Accuracy in Semi-automated Interactive Image Segmentation Algorithms
- Focused on HCI and developed a web app to enhance usability research and analysis

## Publications: Journals and Conferences

- **Pulkit Khandelwal**, and Paul A. Yushkevich. *Domain Generalizer: A Few-shot Meta Learning Framework for Domain Generalization in Medical Imaging*. Domain Adpatation and Representation Transfer Workshop, International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI) 2020 [Link Conference Proceedings]
- **Pulkit Khandelwal**, et al. *Brain mapping using deep learning of ultra high resolution T2w 7 Tesla post-mortem ex vivo MRI across neurodegenerative diseases reveals associations with underlying neuropathology*. [Under Review]
- **Pulkit Khandelwal**, et al. *Three-dimensional image translation-based diffeomorphic image registration using contrastive learning and generative adversarial networks: application to 7 Tesla ex vivo and 3 Tesla in vivo human brain hemispheres*. [In preparation]
- **Pulkit Khandelwal**, D. Louis Collins, Kaleem Siddiqi. *Spine and Individual Vertebrae Segmentation in Computed Tomography Images using Geometric Flows and Shape Priors*. Frontiers in Computer Science Journal 2021 [Link Journal]
- Zimmerman, Carrie E.<sup>\*\*\*</sup>, **Pulkit Khandelwal**<sup>\*\*\*</sup>, et al. *Automatic Segmentation of Bone Selective MR Images for Visualization and Craniometry of the Cranial Vault*. Academic Radiology (2021). [Link Journal]  
<sup>\*\*\*</sup>Joint first authors
- Mark E., Christopher, Mingfang, Stephen R., **Pulkit Khandelwal**. *Benchmarking Human Performance in Semiautomated Image Segmentation*. Interacting with Computers Oxford University 2020 [Link Journal]
- Ahmed H. Aly, **Pulkit Khandelwal**, et al. *Fully Automated 3D Segmentation and Diffeomorphic Medial Modeling of the Left Ventricle Mitral Valve Complex in Ischemic Mitral Regurgitation* [Medical Image Analysis Journal]
- Long Xie, Laura E.M. Wisse, Jiancong Wang, Sadhana Ravikumar, **Pulkit Khandelwal**, Trevor Glenn, Anica Luther, Sydney Lim, David A. Wolk, and Paul A. Yushkevich. *Deep Label Fusion: A Generalizable Hybrid Multi-Atlas and Deep Convolutional Neural Network for Medical Image Segmentation* [Under Review at Medical Image Analysis Journal]

## Publications: Abstracts and Posters

- **Pulkit Khandelwal**, et al. *Deep learning pipeline for cortical gray matter segmentation and thickness analysis in Ultra High Resolution T2w 7 Tesla Ex vivo MRI across neurodegenerative diseases reveals associations with underlying neuropathology*. Alzheimer's Association International Conference (AAIC) 2022
- **Pulkit Khandelwal**, et al. *Deep Learning for Ultra High Resolution T2-weighted 7 Tesla Ex vivo Magnetic Resonance Imaging Reveals Differential Subcortical Atrophy across Neurodegenerative Diseases*. Alzheimer's Association International Conference (AAIC) 2022
- Mohammad Taghvaei, Philip Cook, **Pulkit Khandelwal**, et al. *Mechanisms of Cognitive Decline due to White Matter Lesions in Cognitively Intact Older Adults*. Alzheimer's Association International Conference (AAIC) 2022
- **Pulkit Khandelwal**, et al. *Gray Matter Segmentation in Ultra High Resolution 7 Tesla ex vivo T2w MRI of Human Brain Hemispheres*. Organization for human brain mapping (OHBM) 2022
- **Pulkit Khandelwal**, et al. *Image to image translation for cortical segmentation in 7 Tesla T2w ex vivo human brain MRI*. Organization for human brain mapping (OHBM) 2022
- **Pulkit Khandelwal**, et al. *Longitudinal Network Connectivity Measurements in Medial Temporal Lobe Sub-regions Discriminate Preclinical Alzheimer's Disease Patients from Amyloid- $\beta$  Negative Controls*. Alzheimer's Association International Conference (AAIC) 2020 [Link]

- Villavisanis Dillan, **Pulkit Khandelwal**, et al. *Craniofacial Soft Tissue Anthropomorphic Database: MRI-Based Diffeomorphic Algorithmic Approach*. The International Society of Craniofacial Surgery 2021
- Zachary D. Zapatero, **Pulkit Khandelwal**, et al. *Generation of a Craniofacial Soft Tissue Anthropomorphic Database: Pilot Study*. Plastic Surgery The Meeting 2021
- **Pulkit Khandelwal**, C. E. Zimmerman, et al. *Automated Segmentation of the Human Cranial Vault with Bone-Selective MRI as an alternative to radiative CT for Craniofacial Imaging*. European Society for Magnetic Resonance in Medicine and Biology (ESMRMB) 2020 [**Lightning Talk Poster**]
- Carrie E Zimmerman, **Pulkit Khandelwal**, et al. *Bone-Selective MRI As a Nonradiative Alternative to CT for Cranial Vault Imaging: Concordance and Implementation of an Automated Segmentation Pipeline for Timely Image Processing*. Plastic Surgery the Meeting 2020 [**Poster**]
- **Pulkit Khandelwal**, Carrie E. Zimmerman, et al. *Automated Segmentation of Human Skull to plan Craniofacial Surgery using dual-Radiofrequency dual-Echo, 3D Ultrashort Echo Time MRI sequence*. International Society of Magnetic Resonance in Medicine (ISMRM), Paris, France 2020 [**Poster**]
- **P. Khandelwal**, M. Barth, S. Bollmann. *Performance evaluation for automated segmentation of Hippocampus Subfields: Preliminary Results using FreeSurfer and ASHS*. European Society for Magnetic Resonance in Medicine and Biology (ESMRMB), Vienna, Austria, September 2016 [Link](#) [**Lightning Talk Poster**]

## Teaching

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- University of Pennsylvania:
  - Machine Learning [CIS 520]: Fall 2019
  - Biomedical Image Analysis [CIS/BE 537]: Fall 2020, Fall 2021
  - Machine Learning [PHY 359]: Spring 2021
- McGill University:
  - Introduction to Computer Vision [COMP 558]: Fall 2018
  - Practical Machine Learning [YCBS 258]: Summer 2019
  - Introduction to Software Systems [COMP 206]: Fall 2016, Winter 2017, Winter 2018 and Winter 2019
  - Introduction to Computer Systems [COMP 273]: Winter 2019

## Reviewer Duties and Services

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- Medical Image Analysis
- Medical Image Computing and Computer Assisted Intervention Society (MICCAI) 2020, 2021, 2022
- Medical Imaging with Deep Learning (MIDL) 2022
- Domain Adaptation and Representation Transfer (DART) Workshop at MICCAI 2021 (Program committee)
- Medical Imaging meets NeurIPS 2021 (Program committee)
- NeurIPS workshop on Machine Learning and the Physical Sciences 2021
- Organization of Human Brain Mapping (OHBM) 2020, 2021
- Journal of Applied Clinical Medical Physics
- International Journal of Computer Assisted Radiology and Surgery
- Technical book reviewer: Packt Publishing **Applied Supervised Learning with R** [[Link to textbook](#)]

## Software

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- Reinforcement Learning Jupyter Notebooks (>1000 stars) [GitHub Link](#)
- Few-shot Meta Learning Framework for Domain Generalization in Medical Imaging [GitHub Link](#)
- Python Interface for Open Street Maps Queries [GitHub Link](#)
- PyTorch ecosystem: Kornia [Link](#)
- Level-set segmentation demos and code [Link](#)

## Honors & Awards

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2019-	<b>School of Engineering and Applied Science</b> , Graduate Fellowship (\$80,000 per year)	<i>Philadelphia, USA</i>
2016-19	<b>NSERC CREATE-MIA</b> , Graduate Fellowship (\$41,000)	<i>Montreal, Canada</i>
2016-17	<b>Mitacs Globalink Graduate Fellowship</b> , Graduate Fellowship (\$15,000)	<i>Montreal, Canada</i>
2015	<b>University of Queensland Summer Research Program</b> , Internship Scholarship (\$3,000)	<i>Brisbane, Australia</i>
2015	<b>Mitacs Globalink Research Internship</b> , Internship Scholarship (\$7,500)	<i>Saskatoon, Canada</i>

## Talks

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- Organization for Human Brain Mapping (OHBM) and Alzheimer's Association International Conference (AAIC) (June/July 2022) [[Link](#)]
- Center for Biomedical Image Computing and Analytics Seminar, University of Pennsylvania, March 2022
- Bioengineering Graduate Group Research Symposium, University of Pennsylvania 2021
- Medical Image Computing and Computer Assisted Interventions (MICCAI) 2020 [[Link](#)]
- Alzheimer's Association International Conference (AAIC) 2020 [[Link](#)]
- The European Society for Magnetic Resonance in Medicine and Biology 2020 [[Link](#)]
- Lightning talk for Product Engineering team, Planet Labs, San Francisco 2017 [[Link](#)]

## **Skills**

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- Languages: Python • C • C++ • R • Bash
- Libraries: scikit-learn • vlfeat • PIL • OpenCV • nltk • geoPandas • PyTorch • Keras
- Tools and Packages: Matlab • Mathematica • git • ITK • VTK • FreeSurfer • ASHS • Slicer

## **Media**

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- Podcast guest at **Abstract: The Future of Science**. Listen [here](#)