Pulkit Khandelwal

Computer Vision · Deep Learning · Shape Analysis · Medical Imaging

(+1) 267-601-6629 | pulks@seas.upenn.edu | pulkit-khandelwal.github.io/ | Pulkit-Khandelwal | pulkit-khandelwal-42849284 | pulkittweet

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

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

Imaging, Media and Graphics Laboratory, University of Saskatchewan — *Saskatoon, Canada*

Mitacs Globalink Research Intern | Supervisor - Mark Eramian — *June 2015 - Aug 2015*

- Evaluation of Reproducibility and Accuracy in Semi-automated Interactive Image Segmentation Algorithms
- Markov Random Fields and graph cuts based methods for Image Segmentation
- Focused on HCI and developed a web app to enhance usability research and analysis

Industrial Research Experience

Imagia Cybernetics — *Montreal, Canada*

Computer Vision Intern | Supervisor - Florian Soudan — *May 2018 - Aug 2018*

- Domain Adaptation via Adversarial Training to classify Polyp type in Colonoscopy data
- Meta-learning based Domain Generalization across multiple modalities for Brain Tumor Segmentation
- Interpretability of Deep Networks for medical imaging

Planet Labs — *San Francisco, United States*

Intern | Supervisor - Katherine Scott — *Aug 2017 - Dec 2017*

- Created Segmentation APIs for in-house Computer Vision, Machine Learning and GIS library
- Developed an open-source tool to query Open Street Maps data
- Developed deep semantic segmentation modules for building segmentation in Planet Satellite Imagery

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**, Shokufeh Sadhagiani, Sadhana Ravikumar et al. *Gray Matter Segmentation in Ultra High Resolution 7 Tesla ex vivo MRI of human brain hemispheres.* [**Under Review**] [**arXiv Link**]

- **Pulkit Khandelwal**, Shokufeh Sadhagiani, Sadhana Ravikumar 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.***, **Pulkit Khandelwal***, Long Xie, Hyunyeol Lee, Hee Kwon Song, Paul A. Yushkevich, Arastoo Vossough, Scott P. Bartlett, and Felix W. Wehrli. *Automatic Segmentation of Bone Selective MR Images for Visualization and Craniometry of the Cranial Vault. Academic Radiology (2021).* [**Link Journal**] ***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**, Abdullah H. Aly, Takayuki Kawashima, Kazuki Mori, Yoshiaki Saito, Judy Hung, Joseph H. Gorman III, Alison M. Pouch, Robert C. Gorman, and Paul A. Yushkevich. *Fully Automated 3D Segmentation and Diffeomorphic Medial Modeling of the Left Ventricle Mitral Valve Complex in Ischemic Mitral Regurgitation* [**Under Review at 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**, Long Xie, Danielle S. Bassett, Robin de Flores, David A. Wolk, Paul A. Yushkevich, and Sandhitsu R. Das. *Longitudinal Network Connectivity Measurements in Medial Temporal Lobe Subregions Discriminate Preclinical Alzheimer's Disease Patients from Amyloid-β Negative Controls.* Alzheimer's Association International Conference (AAIC) 2020 [**Link**]

- Villavisanis Dillan, **Pulkit Khandelwal**, Zachary Zapatero, Connor Wagner, Blum Jessica D., Cheung Liana, Yushkevich Paul, Bartlett Scott. *Craniofacial Soft Tissue Anthropomorphic Database: MRI-Based Diffeomorphic Algorithmic Approach.* The International Society of Craniofacial Surgery 2021

- Zachary D. Zapatero, **Pulkit Khandelwal**, Connor S. Wagner, Mychajlo S. Kosyk, Christopher L. Kalmar, Paul A. Yushkevich, Bartlett P. Scott. *Generation of a Craniofacial Soft Tissue Anthropomorphic Database: Pilot Study.* Plastic Surgery The Meeting 2021

- **Pulkit Khandelwal**, C. E. Zimmerman, L. Xie, H. Lee, H. K. Song, S. P. Bartlett, P. A. Yushkevich, F. W. Wehrli. *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**, Rosaline S Zhang, Long Xie, Hyunyeol Lee, Jesse A. Taylor, Jordan W Swanson, Paul Yushkevich, Felix W Wehrli, Scott Paul P Bartlett. *Bone-Selective MRI As a Non-radiative 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, Long Xie, Hyunyeol Lee, Cheng-Chieh Cheng, Scott P. Bartlett, Paul Yushkevich, Felix W. Wehrli. *Automated Segmentation of Human Skull to plan Craniofacial Surgery using dual-Radiofrequency dual-Echo, 3D Ultrashort Echo Time MRI sequence.* International Society of Mag-

netic 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

- 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
  - Deep Learning [CIS 522]: Spring 2022
- 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

- Organization of Human Brain Mapping (OHBM) 2020, 2021
- Medical Image Computing and Computer Assisted Intervention Society (MICCAI) 2020, 2021
- 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
- International Journal of Computer Assisted Radiology and Surgery
- Technical book reviewer: Packt Publishing **Applied Supervised Learning with R** **[Link to textbook]**

Software

- Reinforcement Learning Jupyter Notebooks (**>1000 stars**) **GitHub Link**
- Domain Generalizer: A 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

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

Talks

- 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

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

Media

- Podcast guest at **Abstract: The Future of Science**. Listen **here**