Vatsal Agarwal

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Education

University of Maryland, College Park **Sep. 2022 – May 2027 (Expected)**
Ph.D. Computer Science College Park, MD
Dean's Fellowship Overall GPA: 4.0

University of Maryland, College Park **Sep. 2018 – May 2022**
Bachelor of Science in Computer Science College Park, MD
Gemstone Honors College, Departmental CS Honors (Presidential Scholarship) Overall GPA: 3.96

Graduate Experience

Perception and Intelligence Lab **Sept 2022 – Present**
Graduate Research Assistant — Dr. Abhinav Shrivastava *University of Maryland*

- **Current Research**: My research focuses on improving the efficiency and performance of attention mechanisms across a variety of computer vision tasks. Currently, I am interested in augmenting deep neural networks with explicit memory to improve model accuracy and generalizability.
- Developed algorithm to utilize superpixels in Vision Transformers. Used SLIC to generate superpixels and experimented with integration in different ViT architectures.

PAII Inc **June 2022 – Nov 2022**
Graduate Research Intern — Dr. Youbao Tang and Dr. Mei Han *Remote (San Francisco, CA)*

- Developed deep learning model for precise human shape and pose estimation from a single image using Transformers
- Devised method to recover human mesh via a coarse-to-fine approach that is able to maintain performance with up to 2x reduction in parameters and 10x reduction in FLOPs.

Undergraduate Experience

MIT CSAIL **June 2021 – Oct 2021**
Undergraduate Research Intern — Dr. Antonio Torralba *Remote (Cambridge, MA)*

- Developed methods for Sim2Real task, by translating synthetic indoor scenes from **VirtualHome** environment to realistic images using text as an intermediary.
- Built automated pipeline using VirtualHome API to create image-text dataset. Used API-generated segmentation maps to filter out objects and obtain object relations. Wrote templates to ensure diverse caption generation.

Perception and Intelligence Lab **March 2021 – May 2022**
Undergraduate Research Assistant — Dr. Abhinav Shrivastava *College Park, Maryland*

- Investigated adversarial attacks and defenses in context of frequency domain and experimented with attention methods to discover most important frequencies.
- Devised method to enhance multi-scale interactions by using high-level features to select important information from lower-level features. Integrated module to PvT architecture and demonstrated strong improvement in performance.

National Institutes of Health Clinical Center **June 2019 – Nov 2021**
Deep Learning Research Intern — Dr. Youbao Tang and Dr. Ronald Summers *Bethesda, Maryland*

- Developed a weakly-supervised attention-based co-segmentation model adapted from **arXiv:1810.06859** and applied it for the task of lesion segmentation using the **DeepLesion** dataset.
- Experimented with different channel/spatial attention mechanisms and post-processing strategies to improve model performance. Incorporated mechanisms to aggregate multi-scale features and obtain high-resolution features.
- Designed novel attention methods to improve co-segmentation models.

Gemstone Honors College **Jan 2019 – May 2022**
Student Researcher — Dr. Anil Deane *College Park, Maryland*

- Worked as part of team of 13 students to apply deep learning methods to understand psychiatric illnesses using MRI scans. Leading development of models to discriminate between healthy and mentally-ill patients.
- Built supervised/unsupervised models to identify imaging biomarkers corresponding with mental illnesses.

Speer Lab **Jan 2019 – Oct 2021**
Research Intern — Dr. Colenso Speer *College Park, Maryland*

- Created a UI for more streamlined STORM imaging analysis using PyQt5. Cleaned existing analysis codebase for increased modularity and ported several MATLAB codes to Python for more cohesive pipeline.

Technical Skills

Programming Languages: Python, Java, SQL, C, SAS, Ruby, OCaml, Visual Basic
Tools: Pytorch, Keras, Scikit-Learn, Pandas, NumPy, SciPy, Matplotlib, Plotly, OpenCV, PyQt5
Frameworks: Git, AWS Sagemaker, Google Cloud, Anaconda, Jupyter, Docker
Relevant Coursework: Algorithms, Applied Statistics, Advanced Visual Recognition, Computational Linguistics, Data Science, Deep Learning, Machine Learning, Linear Algebra, Multivariate Calculus, Probability Theory, Statistics

Projects

Deformable 1D Convolutions | *Python, Pytorch* **October 2020**

- Adapted **Efficient Channel Attention** mechanism and modified it by experimenting with shuffling operation and deformable convolution to more effectively capture global interactions.

Animating Pokemon with Donkey-Net | *Python, Pytorch* **April 2020**

- Modified **Monkey-Net** model for dual reconstruction of moving key-points using cycle-consistency loss and created custom dataset using affine similarity and frame re-sampling. Experimented with attention mechanisms and multi-scale perceptual losses to improve performance.

Publications

- **Do text-free diffusion models learn discriminative visual representations?**
  Soumik Mukhopadhyay, Matthew Gwilliam, **Vatsal Agarwal**, Yosuke Yamaguchi, Namitha Padmanabhan, Archana Swaminathan, Tianyi Zhou, Abhinav Shrivastava
  Under Review
- **Diffusion Models Beat GANs on Image Classification**
  S. Mukhopadhyay, M. Gwilliam, **V. Agarwal**, N, Padmanabhan, A. Swaminathan, S. Hegde, T. Zhou, A. Shrivastava
- **A Frequency Perspective of Adversarial Robustness**
  S. R. Maiya, M. Ehrlich, **V. Agarwal**, S. Lin, A. Shrivastava
  BMVC 2023
- **Volumetric super-resolution imaging by serial ultrasectioning and STORM in neural tissue**
  T. Vatan, J. A. Minehart, C. Zhang, **V. Agarwal**, J. Yang, C M. Speer
  Star Protocols, 2021
- **Weakly Supervised Lesion Co-Segmentation on CT Scans**
  V. Agarwal, Y. Tang, J. Xiao, R. Summers
  IEEE International Symposium on Biomedical Imaging (**ISBI**), 2020
- **Weakly-Supervised Lesion Segmentation on CT Scans using Co-Segmentation**
  V. Agarwal, Y. Tang, J. Xiao, R. Summers
  SPIE Medical Imaging, 2020

Awards

CRA Undergraduate Research Award | *Honorable Mention* **December 2021**

Northrop Grumman Cyber-Security Challenge | *Python, Raspberry Pi* **March 2019**

- Developed Python application for keyboard dynamics classification using self-organizing maps for anomaly detection and classifying users based on keystroke dynamics.
- Won **third place** award as part of three-person team against undergraduate teams for choice of problem and efficacy of model.

Northrop Grumman Image Recognition Challenge | *Python, Raspberry Pi* **November 2018**

- Developed Python application using YOLOV2 algorithm to detect emergency vehicles. Utilized Keras and Tensorflow for data augmentation and design of convolutional neural network for object detection.
- Won **first place** award as part of a three-person team against undergraduate teams for model accuracy and speed