SPANDAN MADAN

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EDUCATION

Harvard University Oct 2024 (Expected)
***Ph.D.**, Computer Science* *Cambridge, USA*
***Dissertation:** Out-of-Distribution Generalization in Biological and Artificial Intelligence*

Harvard University 2018
***M.E.**, Computational Scineces and Engineering* *Cambridge, USA*
***Dissertation:** Computer Vision for Graphic Designs and Data Visualizations*

IIT Delhi 2016
***B.Tech. and M.Tech.**, Biochemical Engineering and Biotechnology* *New Delhi, India*
***Dissertation:** Ensemble machine learning methods for targeted genome editigin.*

SELECTED AWARDS AND FELLOWSHIPS

John I. Yellott Award 2024
Awarded annually to two students attending the Vision Sciences Society (VSS) conference.

Outstanding Reviewer, CVPR 2022
Awarded to top 5% of reviewers based on editor feedback.

Winston Chen Family Fellow 2021
Awarded by Harvard University on recommendation of the Computer Science Department.

Certificate of Distinction in Teaching (Harvard GSAS) 2021
Awarded by the Derek Bok Center for Teaching at Harvard University.

Harvard SEAS Fellow 2019
Awarded by the School of Engineering and Applied Sciences for master's thesis research.

Snap Research Scholar 2018
One of ten master's students across the US funded by Snap Inc.

Harvard SEAS Fellow 2017
Awarded by the School of Engineering and Applied Sciences for master's thesis research.

Honorable Mention Paper Award, UIST 2017
Awarded for our paper modeling visual importance using computer vision models at UIST.

MHRD Fellow 2015
Scholarship awarded by the Government of India for master's thesis research.

Viterbi India Scholar 2012
One of thirteen Indian students selected for the Viterbi India Program at University of Southern California, USA.

ACADEMIC RESEARCH EXPERIENCE

Doctoral Researcher 2019 – 2024
Harvard University *Cambridge, MA*

- **Out-of-Distribution Generalization in AI:** Improving generalization capabilities of AI models across real-world transformations in 3D viewpoints, scene lighting, and object materials, among others. [1, 2, 3, 4, 5, 6]
- **Machine Learning Theory:** Identifying representations that enable better generalization under distribution shifts. [1, 2]
- **Computational Neuroscience:** Investigating generalization in-vivo through Electro-physiological recordings of Macaque Brains. [7]
- **Psychophysics:** Benchmarking how well human vision generalizes under transformations like scene context, gravity, and relative size. [8, 9]

Research Contractor 2018 – 2019
Massachusetts Institute of Technology *Cambridge, MA*

- **Computer Graphics:** Designed and implemented a procedural graphics pipeline to create photorealistic cities using city-engine and physically based rendering with path tracing. Used this pipeline to generate a large scale dataset with fine-grained control over scene parameters including object viewpoints, light source distribution and intensity, and scene layout, among others [10].
- **Generalization in AI:** Investigated generalization behaviour of visual recognition models using above mentioned dataset, leading to a publication [1].

Master's Thesis Research 2016 – 2018
Harvard University *Cambridge, MA*

- **Computer Vision:** Designed algorithms for automated parsing and understanding of graphic designs and infographics. [11, 12].
- **Modeling human vision:** Implemented computer vision models to predict high-level visual cognitive attributes including visual importance [13], eye movements [14], and memorability [15].

Master's Thesis Research 2014 – 2015
University of Pennsylvania, IIT Delhi *Philadelphia, PA*

- **Machine Learning for Genomics:** Conceptualized and implemented an algorithm for designing targeted molecular scissors (zinc proteins) for cleaving DNA at desired target locations [16].
- Using a mixture of synthetic and experimental data generated using molecular docking simulations, trained an ensemble of neural networks to predict DNA-Protein interactions [17].

INDUSTRY RESEARCH EXPERIENCE

Adobe Research Summer 2019
Investigating if generative AI models understand out-of-distribution. *Seattle, WA*

- Implemented a procedural graphics pipeline to create photorealistic cities under changing lighting.
- Investigated lighting variations generated by Generative AI models (GANs) trained on a dataset of controlled, parametric lighting variations.

Microsoft Research Summer 2018
Building ChatBots with a Persona. *Redmond, WA*

- Developed an algorithm for non-parametric reservoir sampling. Given a stream of data, our algorithm samples points which match a seed distribution (based on the MMD criterion).
- Designed a framework to create conversational agents for Microsoft XBox which build their own dataset by sampling relevant lines from the internet using above mentioned sampling algorithm.

RESEARCH AND TEACHING INTERESTS

Out-of-Distribution Generalization in Machine Learning
Artificial Intelligence
Machine Learning for Natural Sciences
Biological and Computer Vision
Computational models of the Visual Cortex
Computational Neuroscience

REVIEWING EXPERIENCE

Conferences: NeurIPS, ICML, ICLR, IJCAI, AAAI, CVPR, ECCV, ICCV, UIST, VSS, VIS.
Journals: Neural Networks, Pattern Recognition Letters.

SELECTED INVITED TALKS

Vision Sciences Society Annual Meeting	May 2024
Center for Brain Sciences, Harvard	May 2024
Brains, Minds, Machines Summer Program, MBL	Aug 2023
Biological and Artificial Intelligence (Neuro 240), Harvard	Feb 2023
Scene Grammar Lab, Goethe University Frankfurt	Jan 2023
Graphics Seminar, UMass Boston	Nov 2022
Vision Sciences Lab, Harvard University	Apr 2022
Biological and Artificial Intelligence (Neuro 240), Harvard	Mar 2022
Museum of Science, Boston	Jan 2022
Museum of Science, Boston	Dec 2021
Workshop on Generalization, ICLR	Jul 2021
Sinha Lab for Developmental Research, MIT	May 2021
Poggio Lab, MIT	Mar 2021
Vision and Graphics Seminar, MIT	Feb 2021
Science in the News, Harvard University	Apr 2018
Harvard Business School	Oct 2017
MIT Blueprints	Mar 2017
Berkeley Vision Seminar, UC Berkeley	Dec 2017

REFERENCES

Hanspeter Pfister — Harvard University
pfister@seas.harvard.edu — *An Wang Professor of Computer Science*

Gabriel Kreiman — Harvard University
gabriel.kreiman@tch.harvard.edu — *Professor of Opthalmology*

Fredo Durand — MIT
fredo@mit.edu — *Amar Bose Professor of Computing*

Zoya Bylinskii — Adobe Research
zoya.gavr@gmail.com — *Senior Research Scientist*

MENTORING

Master's: Serena Bono (Now: Ph.D. student, MIT Media Lab), Ravi Srinivasan (Now: Ph.D. student, UC Berkeley)
Undergraduate: Arshika Lalan (Now: Master's, CMU), Yash Gupta (Now: Master's University of Pennsylvania), Mao Yaseuda (Now: PhD, Syracuse University), Helen Ho (Now: Google).

OPEN SOURCE PROJECTS/TUTORIALS

HINGLISH: Android app with over 50,000 downloads on google play store
Me Bot: A framework to quickly launch chat bots (~600 stars on Github).
Tutorial: End to end implementation of a machine learning pipeline (~4700 stars on Github).
Tutorial: Pytorch tutorial on fine tuning for classification
Tutorial: Commonly used Pytorch tasks
Lecture Series: Learning to Speak Python—a series of online lectures teaching Python.

PUBLICATIONS

[1] **Spandan Madan**, Timothy Henry, Jamell Dozier, Helen Ho, Nishchal Bhandari, Tomotake Sasaki, Frédo Durand, Hanspeter Pfister, and Xavier Boix. When and how convolutional neural networks generalize to out-of-distribution category–viewpoint combinations. *Nature Machine Intelligence*, 4(2):146–153, Feb 2022. [AI, Theory].

[2] **Spandan Madan**, Tomotake Sasaki, Hanspeter Pfister, Tzu-Mao Li, and Xavier Boix. Adversarial examples within the training distribution: A widespread challenge, 2023. [AI, Theory].

[3] **Spandan Madan**, Tomotake Sasaki, Hanspeter Pfister, Tzu-Mao Li, and Xavier Boix. ShapeNet with camera and lighting variations. *Harvard Dataverse*, 2023. [AI, Theory].

[4] **Spandan Madan**, You Li, Mengmi Zhang, Hanspeter Pfister, and Gabriel Kreiman. Improving generalization by mimicking the human visual diet, 2024. [AI, Psycophysics].

[5] Serena Bono, **Spandan Madan**, Ishaan Grover, Mao Yasueda, Cynthia Breazeal, Hanspeter Pfister, and Gabriel Kreiman. Look around! unexpected gains from training on environments in the vicinity of the target. *arXiv preprint arXiv:2401.15856*, 2024. [AI].

[6] Akira Sakai, Taro Sunagawa, **Spandan Madan**, Kanata Suzuki, Takashi Katoh, Hiromichi Kobashi, Hanspeter Pfister, Pawan Sinha, Xavier Boix, and Tomotake Sasaki. Three approaches to facilitate invariant neurons and generalization to out-of-distribution orientations and illuminations. *Neural Networks*, 155:119–143, 2022. [AI].

[7] **Spandan Madan**, Mingran Cao, Will Xiao, Hanspeter Pfister, and Gabriel Kreiman. Out-of-distribution generalization behavior of dnn-based encoding models for the visual cortex. *Journal of Vision*, 2024. [Neuroscience].

[8] Philipp Bomatter, Mengmi Zhang, Dimitar Karev, **Spandan Madan**, Claire Tseng, and Gabriel Kreiman. When pigs fly: Contextual reasoning in synthetic and natural scenes. In *Proceedings of the IEEE/CVF International Conference on Computer Vision (ICCV)*, pages 255–264, October 2021. [AI, Psychophysics].

[9] Mengmi Zhang, Giorgia Dellaferrera, Ankur Sikarwar, Marcelo Armendariz, Noga Mudrik, Prachi Agrawal, **Spandan Madan**, Andrei Barbu, Haochen Yang, Tanishq Kumar, et al. Human or machine? turing tests for vision and language. *arXiv preprint arXiv:2211.13087*, 2022. [Psychophysics].

[10] **Spandan Madan**, Timothy Henry, Jamell Dozier, Helen Ho, Nishchal Bhandari, Tomotake Sasaki, Fredo Durand, Hanspeter Pfister, and Xavier Boix. Biased-Cars Dataset. *Harvard Dataverse*, 2021. [AI, Theory].

[11] **Spandan Madan**, Zoya Bylinskii, Matthew Tancik, Adrià Recasens, Kimberli Zhong, Sami Alsheikh, Hanspeter Pfister, Aude Oliva, and Fredo Durand. Synthetically trained icon proposals for parsing and summarizing infographics. *arXiv preprint arXiv:1807.10441*, 2018. [Computer Vision].

[12] **Spandan Madan**, Zoya Bylinskii, Carolina Nobre, Matthew Tancik, Adria Recasens, Kimberli Zhong, Sami Alsheikh, Aude Oliva, Fredo Durand, and Hanspeter Pfister. Parsing and summarizing infographics with synthetically trained icon detection. In *2021 IEEE 14th Pacific Visualization Symposium (PacificVis)*, pages 31–40. IEEE, 2021. [Computer Vision].

[13] Zoya Bylinskii, Nam Wook Kim, Peter O'Donovan, Sami Alsheikh, **Spandan Madan**, Hanspeter Pfister, Fredo Durand, Bryan Russell, and Aaron Hertzmann. Learning visual importance for graphic designs and data visualizations. In *Proceedings of the 30th Annual ACM symposium on user interface software and technology*, pages 57–69, 2017. [Human Vision].

[14] Zoya Bylinskii, Anelise Newman, Matthew Tancik, **Spandan Madan**, Fredo Durand, and Aude Oliva. Zoommaps: Using zoom to capture areas of interest on images. *Journal of Vision*, 19(10):149–149, 2019. [Human Vision].

[15] Anelise Newman, Zoya Bylinskii, Steve Haroz, **Spandan Madan**, Frédo Durand, and Aude Oliva. Effects of title wording on memory of trends in line graphs. *Journal of Vision*, 18(10):837–837, 2018. [Human Vision].

[16] Shayoni Dutta, **Spandan Madan**, and Durai Sundar. Exploiting the recognition code for elucidating the mechanism of zinc finger protein-dna interactions. *BMC genomics*, 17(13):109–125, 2016. [Genomics].

[17] Shayoni Dutta, **Spandan Madan**, Harsh Parikh, and Durai Sundar. An ensemble micro neural network approach for elucidating interactions between zinc finger proteins and their target dna. *BMC Genomics*, 17(13):97–107, 2016. [Genomics].