FENIL DOSHI

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RESEARCH INTERESTS

I am broadly interested in how the human mind transforms visual sensory input into causal and meaningful high-level representations. I am also interested in exploring the inductive biases and computational principles underlying the large-scale organization of the ventral visual cortex. In my research, I combine computational models of vision (deep neural networks) and behavioral psychophysics, to probe how emergent properties of a hierarchical visual processor both support and limit complex cognition.

EDUCATION

SRM Institute of Science and Technology, Chennai, India *2014 - 2018*
B.Tech in Computer Science and Engineering (GPA: 8.65/10.0)

RESEARCH EXPERIENCE

Harvard University, Dept. of Psychology *Nov 2018 - Present*
Research Assistant (Fellow), Vision Sciences Lab
Faculty Advisor: Prof. George A. Alvarez & Prof. Talia Konkle
Focus:
1. Explored if the large-scale brain topography reflects a smoothly mapped object-selective cortex by optimizing the intermediate representations of a deep neural network using self-organizing principles. The trained maps showed an emergent large-scale organization by animacy and size.
2. Trained generative models (variational autoencoders) to discover causal representations that can explain seemingly high-level human judgements pertaining to the stability of randomly arranged block towers. Used psychophysical analyses to compare internal representations of unsupervised and supervised models with human behavior.
3. Used gradient-based methods to synthesize stimuli to maximize primate and human neural responses in the intermediate layers of the visual cortex. The resulting stimuli and the corresponding visual representations were used to build and test models of capacity limits in human visual working memory.

Harvard Medical School (BWH) *Jan 2018 - July 2018*
Research Intern, Shafiee Lab
Faculty Advisor: Prof. Hadi Shafiee
Focus:
Trained convolutional neural networks to identify and qualitatively analyze the structural morphology of cells. Optimized the models to deal with class imbalance using class-sensitive training and sampling.

IIIT-Delhi, Dept. of Computer Science *June 2017 - Aug 2017*
Summer Research Intern
Faculty Advisor: Prof. Saket Anand
Focus:
Lane detection on urban roads using semantic segmentation in autonomous vehicles.

UW-Madison *Sept 2016 - Dec 2016*
Undergraduate Researcher, Computational Materials Group
Faculty Advisor: Prof. Dane Morgan
Focus:
Used bayesian models and neural networks to predict changes in the mechanical properties of steel components due to alloy configurations.

PUBLICATIONS

Conference Proceedings

1. **Doshi, F.**, Konkle, T.(2021). Organizational motifs of cortical responses to objects emerge in topographic projections of deep neural networks. Talk presented at *Vision Sciences Society, 2021.*
2. **Doshi, F.**, Pailian, H., Alvarez, G.A.(2020). Using Deep Convolutional Neural Networks to Examine the Role of Representational Similarity in Visual Working Memory. In *Vision Science Society, 2020.*
3. Conwell, C., **Doshi, F.**, Alvarez, G.A.(2019). Shared Representations of Stability in Humans, Supervised, & Unsupervised Neural Networks. In *Shared Visual Representations in Human and Machine Intelligence (SVRHM) workshop at NeurIPS 2019.*
4. Conwell, C., **Doshi, F.**, Alvarez, G.A.(2019). Human-Like Judgments of Stability Emerge from Purely Perceptual Features: Evidence from Supervised and Unsupervised Deep Neural Networks. In *Proceedings of the 3rd Conference on Cognitive Computational Neuroscience (CCN), 2019.*
5. Thirumalaraju, P., Bormann, CL., Kanakasabapathy, M., **Doshi, F.**, Souter, I., Dimitriadis, I., Shafiee, H.(2018).Automated sperm morpshology testing using artificial intelligence. In *Fertility and sterility. 2018 Sep 1;110(4):e432.*
6. Chatterjee, S., Archana, V., Suresh, K., Saha, R., Gupta, R., **Doshi, F.(2017)**.Detection of non-technical losses using advanced metering infrastructure and deep recurrent neural networks. In *IEEE International Conference on Environment and Electrical Engineering.*

Manuscripts

1. **Doshi, F.**, Konkle, T. Organizational motifs of cortical responses to objects emerge in topographic projections of deep neural networks. (Paper in Prep)
2. Conwell, C., **Doshi, F.**, Alvarez, G.A.. Human-Like Judgments of Stability Emerge from Purely Perceptual Features in Unsupervised and Supervised Models. (Paper in Prep)
3. Kanakasabapathy, M., Thirumalaraju, P., Kandula, H., **Doshi, F.**, Sivakumar, A., Kartik, D., Gupta, R., Pooniwala, R., Branda, J., Tsibris, A., Kuritzkes, D., Petrozza, J., Bormann, C., Shafiee H. (2021). Adaptive adversarial neural networks for the analysis of lossy and domain-shifted datasets of medical images. In *Nature Biomedical Engineering, 2021.*

HONORS AND AWARDS

- Reimagine Education Award (Silver), Student-led Innovation for Next Tech Lab *2018*
  Quacquarelli Symonds (QS), Wharton School, University of Pennsylvania
- Best Outgoing Student, Class of 2018 *2018*
  Department of Computer Science, SRM Institute of Science and Technology
- National Champion *2017*
  Smart India Hackathon (India's biggest Hackathon)

TECHNICAL STRENGTHS

Programming: Python (Pytorch, Tensorflow, Theano, Keras), Javascript, Matlab, C, C++, C#, Java
Experimental Techniques: Computational Modelling, Behavioral Psychophysics
Software & Tools: Unity3D, Robot Operating System(ROS), LaTeX
Statistics/Analysis: Non-parametric statistics, power analyses, simulation, resampling (bootstrapping), model comparison; factor analysis/principal component analysis, singular value decomposition

LEADERSHIP & ADVISING EXPERIENCE

Next Tech Lab, Founding Member and Advisor
Co-founded a student-run research lab at SRM Institute of Science and Technology. Co-led over 160 students concentrating on Artificial Intelligence, Machine Learning, Computational Biology, and Mixed Reality(AR/VR).

SELECT PERSONAL PROJECTS

- **Perceptual model for feature-based categorical attention:** Taking inspiration from work by Lindsay & Miller (2018), I isolated category-specific neurons in a pre-trained (on ImageNet) deep net (VGG-19). Category-wise normalized activation profiles were computed at the resolution of individual neurons and compared with the corresponding normalized gradient-based profiles/curves. Those neurons whose tuning and gradient profiles correlated significantly (hence had behavioral outcomes) were selected. Further analysis (t-tests) provided a stronger selection criterion. During the forward pass, these neurons are then modulated to improve categorization. An open question is to disentangle the attentional signals carried in feedforward, lateral, and top-down connections.
- **Exploring the latent feature space of face representations in a reconstruction-based network using Deep Feature Consistency:** Trained an adversarial variational autoencoder on the CelebA dataset. The KL divergence loss was replaced with an adversarial loss (Makhzani et al., 2016) and the pixel-wise loss was replaced with a deep feature consistent loss (Hou et al., 2016). Smooth interpolations in this latent space showed that the model was able to capture certain semantic aspects of different facial attributes.
- **Neural Artistic Style Transfer for Videos:** Produced results on a frame-by-frame basis and later improved it by initializing every new frame using optical flow from the previous frames.
- **Retrieving the latent space of a Generative Adversarial Network (input noise):** Designed an auxiliary GAN model with a cyclic network to map the generated image space back to its latent space. The discriminator was designed with an additional patch-based loss function and optimized with label smoothing.
- **Deep Sense:** A Restricted Boltzmann Machine (RBM) trained on a bunch of different songs by Hans Zimmer to produce novel monophonic music in his style.