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RESEARCH INTERESTS Topological Data Analysis, Machine Learning and Time Series Analysis

EDUCATION **University of Colorado, Boulder**, Boulder, CO
Ph.D., Computer Science August 2017–June 2022 (Expected)
• Advisors: Prof. Elizabeth Bradley, Prof. James Meiss and Dr. Thomas Berger
• GPA - 3.93/4.0
• Courses: Deep Learning, Networks Analysis and Modeling, Chaotic Dynamics.

University of California, Santa Barbara, Santa Barbara, CA
M.S., Computer Science September 2011–April 2013
• Topic: *Matrix Reduction Techniques for Ordinary Differential Equations in Chemical Systems*
• Advisors: Prof. John Gilbert and Prof. Linda Petzold
• GPA - 3.9/4.0

College of Engineering, Pune, Pune, India
B.Tech., Computer Engineering June 2007–June 2011
• Project Topic: *Techniques for Benchmarking of Computer Micro-Architecture*
• Advisors: Dr. Shrirang Karandikar and Mr. Shirish Gosavi
• GPA - 9.2/10.0

PUBLICATIONS

1. **Varad Deshmukh**, Thomas Berger, Elizabeth Bradley & James D. Meiss. 2020. Shape-based Feature Engineering as an Effective Methodology for Machine Learning-based Solar Eruption Prediction. *Innovative Applications of Artificial Intelligence 2021* (In preparation).
2. **Varad Deshmukh**, Elizabeth Bradley, Joshua Garland, and James D. Meiss. A Curvature-Based Heuristic for Delay Reconstruction. *Chaos: An Interdisciplinary Journal of Nonlinear Science* 30 (6), 12.
3. **Deshmukh V**, Berger TE, Bradley E & Meiss JD. 2020. Leveraging the mathematics of shape for solar magnetic eruption prediction. *J. Space Weather Space Clim.* **10**, 13.
4. **Varad Deshmukh**, Nishchay Mhatre and Shrirang Karandikar. “FIRA - A novel method for benchmarking the cache hierarchy.” *COMPUTE 2012 : 1st Annual Conference of ACM Pune Professional Chapter*, Pune, 2012.
5. **Varad Deshmukh**, Nishchay Mhatre and Shrirang Karandikar. “Techniques for Benchmarking of CPU Micro-Architecture for Performance Evaluation.” *18th Annual International Conference on High Performance Computing: Student Research Symposium, Bangalore*, 2011.
6. Nishchay Mhatre, Mohit Karve, Rahul Bedarkar, Shravan Aras, Sanjeev MK, Gautam Akiwate, **Varad Deshmukh**. “Modular Generic Low Cost On Board Computer System for Nano/Pico Satellites.” *62nd International Astronautical Congress, Cape Town*, 2010.

TALKS

1. Leveraging Topological Data Analysis and Deep Learning for Solar Flare Prediction.
Varad Deshmukh, Elizabeth Bradley, James Meiss and Thomas Berger.
 - *Stanford Solar Seminar, Palo Alto, CA*, September 2020. (Upcoming)
 - *American Geophysical Union, San Francisco, CA*, December 2019.
 - *Inter University Center for Astronomy and Astrophysics Solar Journal Club, Pune, India*, November 2019. (Invited)
 - *National Solar Observatory Solar Focus Meeting, Boulder, CO*, November 2019. (Invited)
 - *Machine Learning in Heliophysics, Amsterdam, Netherlands*, September 2019.

2. Using curvature to understand the structure of dynamics.
Varad Deshmukh, Elizabeth Bradley, Joshua Garland and James Meiss.
 - *SIAM Dynamical Systems, Snowbird, UT, May 2019.*
 - *Santa Fe Institute, Santa Fe, NM, April 2019. (Invited)*
3. **Deshmukh V**, Bradley E and Bagenal F. Nonlinear time-series analysis of solar-wind data from Voyager 2 and New Horizons, *Voyager/New Horizons Workshop, 2018; John Hopkins University Applied Physics Laboratory, Laurel, MD.*

AWARDS & ACHIEVEMENTS

- Co-Investigator for NASA O2R Grant (496,260\$): *Application of Topological Data Analysis and Computational Geometry to Recurrent Deep Learning Algorithms for Solar Eruption Prediction.* (PI: Dr. Thomas Berger)
- NSF Award AGS 2001670 (792,387\$): *Harnessing the Data Revolution in Space Physics: Topological Data Analysis and Deep Learning for Improved Solar Eruption Prediction.* As a graduate student, I worked closely with the PI's on developing ideas, preparing the literature survey, conducting initial experiments and writing the proposal (PI: Dr. Liz Bradley).
- Dean Graduate Assistantship Award at University of Colorado, Boulder, 2017
- Best Paper Award at the 18th Annual International Conference on High Performance Computing, Bangalore: Student Research Symposium, 2011
- Computing Division Winner at the Jed-I Project Challenge, Indian Institute of Science, 2011
- Indian Institute of Technology - Joint Entrance Examination, 2007 – All India Rank 1503

INVENTIONS

1. **Varad Deshmukh**, Stephen Muckle, Bryan Huntsman, Veena Sambasivan, Srivatsa Vaddagiri. 2016. Temporary frequency adjustment of mobile device processors based on task migration. U.S. Patent 9,400,518, filed October 10, 2013, and issued July 26, 2016.

RESEARCH EXPERIENCE

Machine Learning and Heliophysics

June 2018 – Present

- Developing solar flare prediction models using a combination of Topological Data Analysis (TDA) and Deep Learning. Employing a feature engineering approach using computational topology and computational geometry-based methods.
- Applying novel variations in Convolutional Neural Networks to improve image-based solar flare prediction, with a focus on interpretability.
- Developing machine learning models for sunspot classification.

Application of Curvature to Dynamical Systems

January 2018 – Present

- Applying local and aggregated curvature to understand the behavior of dynamical systems such as identification of unstable hyperbolic equilibrium points. Demonstrated applications of aggregated curvature in delay co-ordinate embedding: the process of reconstructing a higher dimensional dynamical system from scalar time-series data.
- Developed a novel curvature-based heuristic to estimate the embedding delay.

Matrix Reduction Techniques for Ordinary Differential Equations

June 2012 – April 2013

- Developed model order reduction techniques to speed up numerical simulation of ODEs.
- Combined novel threshold-based Jacobian reduction techniques with a graph-based sparse matrix solver to optimize the linear solver procedure of implicit ODE schemes.

Swayam – Pico-satellite Design

May 2008 – May 2011

- Control Systems team lead for design and construction of a communication pico-satellite for enabling communication between ships and ground stations, launched by the Indian Space Research Organization in June, 2016.
- Developed models for satellite orbit, geomagnetic field, and passive magnetic control system to study satellite dynamics post-launch. The passive magnetic control system is the first of its kind for Indian satellites.
- Project web-site : <http://www.coep.org.in/csats/>

INDUSTRY EXPERIENCE	National Renewable Energy Laboratory , Golden, CO	
	<i>Intern</i>	<i>May 2018 – August 2018</i>
	International Business Machines , Austin, TX	
	<i>Hardware Performance Analyst</i>	<i>August 2015 – June 2017</i>
	Qualcomm Inc. , San Diego, CA	
	<i>Software Engineer</i>	<i>June 2013 – August 2015</i>
	Qualcomm Inc. , San Diego, CA	
	<i>Engineering Intern</i>	<i>June 2012 – September 2012</i>
	Tata Computational Research Laboratories , Pune, India	
	<i>Intern</i>	<i>May 2010 – August 2010</i>
TEACHING EXPERIENCE	Teaching Assistant	Spring 2020
	CSCI 2270 - Data Structures University of Colorado, Boulder	
	Teaching Assistant	Fall 2017
	CSCI 3104 - Algorithms University of Colorado, Boulder	
	Teaching Assistant	Winter 2013
	CS 140 - Parallel Scientific Computing University of California, Santa Barbara	
	Reader	Spring 2012
	CS 240 - Applied Parallel Computing University of California, Santa Barbara	
MENTORING EXPERIENCE	M.S. Independent Study, Computer Science	Fall 2020
	Srinivas Baskar Project: ML-based Evaluation of Shape-based Feature Engineering Approach for Solar Flare Prediction.	
	Discovery Learning Apperenticeship Program	Fall 2020
	Samuel Razumovskiy Project: An Autoencoder Approach to Classifying Active Regions.	
	LASP REU Summer Internship Program	Summer 2020
	Erika Bartosiewicz Project: Dataset Preparation for Machine Learning-based Active Region Classification.	
	LASP REU Summer Internship Program	Summer 2019
	Sara Housseal Project: Active Region Magnetic Field Compression and Reconstruction using Principal Component Analysis.	
SKILLS	<i>Programming Languages</i>	
	C, C++, Python, Java, Bash shell scripting, MATLAB, R	
	<i>Tools and Libraries</i>	
	PYTORCH, SCIKIT-LEARN, ASTROPY, PHETS, GUDHI, MPI, CUDA, CILK++	