Varad Deshmukh

CONTACT INFORMATION	1300 30th St. Apt B3-14 Boulder, CO 80303	707-567-8795 varad.deshmukh@colorado.edu

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)
- Advisor: Prof. Elizabeth Bradley
- 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**, Elizabeth Bradley, Joshua Garland, and James D. Meiss. "A Curvature-Based Heuristic for Delay Reconstruction". (*Under Review*).

2. **Varad Deshmukh**, Thomas Berger, Elizabeth Bradley and James Meiss. "Leveraging the Mathematics of Shape for Solar Magnetic Eruption Prediction." *Journal of Space Weather and Space Climate* (*Accepted*).

3. **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.

4. **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.

5. 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.

   - *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.*

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/csat/`

INDUSTRY
EXPERIENCE

National Renewable Energy Laboratory, Golden, CO

Intern   *May 2018 – August 2018*

- Worked on wind time-series scenario generation for stochastic economic dispatch of the grid.
- Developed machine learning models based on sparse identification (SINDy) and inferencing stochastic differential equations (Ornstein-Uhlenbeck process) to generate scenarios.
- Provided statistical comparison of generated scenarios with real data.

International Business Machines, Austin, TX

Hardware Performance Analyst   *August 2015 – June 2017*

- Worked on Hardware Performance Modeling for IBM Power server systems.
- Modeled PCIe, PowerBus and L3 Cache for bottleneck analysis and optimizations.
- Generated and analysed hardware traces for CPU-GPU and in-memory database workloads.

Qualcomm Inc., San Diego, CA

Software Engineer   *June 2013 – August 2015*

- Worked on Android and Linux Kernel optimization for Qualcomm chipsets.
- Improved application launch latencies and system boot-time via framework/kernel optimization.
- Tuned kernel memory management features – zram, zswap, low memory killer and page cache.

Qualcomm Inc., San Diego, CA

Engineering Intern   *June 2012 – September 2012*
- Worked on Linux Kernel performance development for UX improvement.
- Developed a power-optimal feature to enable core frequency scaling based on thread migrations.

Tata Computational Research Laboratories, Pune, India

Intern   *May 2010 – August 2010*
- Investigated compiler vectorization and cache locality optimization for GCC on x86 architecture.
- Optimized a seismic application using an innovative cache-optimal vectorizable data structure.

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

AWARDS &
ACHIEVEMENTS

- 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.
- 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