Saurabh Deshpande

PhD in Machine Learning : Linkedin

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EDUCATION

University of Luxembourg: Doctoral Program in Computational Sciences
MSCA PhD candidate. Supervisor: Prof. Stéphane Bordas   *Aug 19 - present*

Indian Institute of Technology, Madras, India   **CGPA: 8.5/10.0**
Dual Degree: B.Tech (Mechanical) & M.Tech (Product Design),   *Jul 12 - May 17*
Minor: Industrial Engineering

RESEARCH VISITS

Team Mimesis - INRIA, Strasbourg
Deep learning for biomechanical simulations. Host: Prof. Stéphane Cotin   *March 22 - April 22*

Technical University of Munich
Semester abroad/research assistant, Mechanical Engineering   *April 16 - July 16*

INTERESTS

My broad interests include scientific computing and the development of interpretable, scalable AI models for their applications to diverse fields. I aspire to be a versatile machine learning engineer, who can solve challenging real-world problems.

PUBLICATIONS

Google scholar
Researchgate
orcid

S. Deshpande, J. Lengiewicz, S.P.A. Bordas (2022). "*Probabilistic Deep Learning for Real-Time Large Deformation Simulations*". Computer Methods in Applied Mechanics and Engineering (CMAME) 398, 11530. https://doi.org/10.1016/j.cma.2022.115307

S. Deshpande, J. Lengiewicz, S.P.A. Bordas. "*MAgNET: A Graph U-Net Architecture for Mesh-Based Simulations*" (2022). arXiv. https://doi.org/10.48550/arxiv.2211.00713

S. Deshpande, R. I. Sosa, J. Lengiewicz, S.P.A. Bordas. "*Convolution, aggregation & attention based deep neural networks to accelerate simulations in mechanics*" (2022). arXiv. https://doi.org/10.48550/arxiv.2212.01386

CONFERENCE PRESENTATIONS & POSTERS

S. Deshpande, J. Lengiewicz, S.P.A. Bordas. "*Real Time Hyper-elastic Simulations with Probabilistic Deep Learning*". World Congress on Computational Mechanics (WCCM-XV), Japan (2022).

S. Deshpande, J. Lengiewicz, S.P.A. Bordas. "*Real-Time Large Deformation Simulations Using Probabilistic Deep Learning Framework*". The Platform for Advanced Scientific Computing (PASC) Conference, Basel (2022).

A. Mazier, T. Lavigne, J. Lengiewicz, **S. Deshpande**, S. Urcun, S. Bordas. "*Towards real-time patient-specific breast simulations: from full-field information to surrogate model*". World Congress of Biomechanics, Taipei (2022).

S. Deshpande, J. Lengiewicz, S.P.A. Bordas. "*Real-time large deformations: A probabilistic deep learning approach*". The 8th European Congress on Computational Methods in Applied Sciences and Engineering, Norway (2022).

S. Deshpande, S. Bordas, L. Beex, S. Cotin, A. Sarkica. "*Data Driven Surgical Simulations*". World Congress on Computational Mechanics (WCCM-XIV), Paris (2020).

S. Deshpande, S. Natarajan. "*Domain Decomposition Finite Element Method-FETI*". The First National Finite Element Developers Meet, Vikram Sarabhai Space Center, India (2017).

Review activities

Applied Mathematical Modeling (Journal, Impact factor: 5.1)

Skills

Languages: Python (proficient), C, C++ (intermediate)
Machine Learning Libraries: TensorFlow, TensorFlow Probability, Keras, PyTorch
Computational Tools: Matlab, Mathematica
Design: (Adobe-) Photoshop, Lightroom, Premier Pro, After Effects
Solid Modelling Tools: Autodesk Inventor, AutoCAD, CREO
Other: git, Markdown, [z|ba]sh, LaTeX

PhD Thesis

Scalable deep learning (DL) techniques for scientific simulations
Supervisor: Prof. Stéphane Bordas, University of Luxembourg   *Aug 19 - Ongoing*

- PhD candidate in 'Rapid Biomechanics Simulation for Personalized Clinical Design' (ITN RAINBOW), a Marie Sklodowska-Curie European Training Network.
- Developing DL predictive models for computational mechanics and computer vision applications.

Baysian CNNs for real-time large deformation simulations   *article*

- Developed a **Bayesian U-Net surrogate framework**, which can accurately predict **non-linear deformations** of soft bodies along with the associated aleatoric and epistemic uncertainties.

MAgNET: A geometric deep learning framework for mesh-based simulations   *preprint*

- A novel framework for efficient supervised learning on high dimensional graph-structured data.
- Proposed new deep learning layers: Multichannel Aggregation (MAg) and graph pooling/unpooling.
- MAg extends the concept of convolutional layers to arbitrary non-grid inputs such as graphs.
- Pooling layers enable efficient learning through reduced representations of arbitrary graphs.

Attention based deep neural networks for simulating mechanics of solids   *preprint*

- Implemented state-of-the-art attention mechanism-based network, Perceiver IO, to predict non-linear soft body responses in real-time, when given input forces.
- Performance of Perceiver IO, CNN U-Net and MAgNET is validated on real world geometries.

Retrieving full field deformations from partial observations of human organs   *in prep*

- Implemented above described MAgNET framework, which takes sparse partial surface displacement inputs and reconstructs accurate full-field organ position.

Detection of cell nuclei in the microscopic images   *in prep*

- Recently initiated project on DL predictive model for counting nuclei in microscopic images.
- Working with the experimental data from a research lab in France.

Professional Experience

Scientist/Engineer 'SC' in Indian Space Research Organisation (ISRO)
At Space Applications Centre, Department of Space, India   *Jul 17 - May 19*

- Member of the team developing mechanisms in satellite payloads & ground segments.

Development of ground segment mechanism for GSAT-29 satellite

- Developed **country's first indigenous** high accuracy optical telescope pointing mechanism.
- It involved DFX & simulation-based design, validation, fabrication, and final integration.
- My design concept was utilized in the onboard payload, which is currently in space.

Development of 6 meter deployable antenna

- Created a prototype for a foldable antenna whose surface is made from composite fiber mesh.
- Antenna has a fold-able metal outer ring and a cable mesh network made of composite threads
- Mathematically modeled the optimal mesh network for arbitrary paraboloid surface.

Gimbal mechanism for Active Radar Calibrator (ARC)

- Automated the existing manual mechanism of ARC, currently being used in Antarctica.
- My concept avoided human-intervention errors, improving measurement accuracy by several folds.

Automation of antenna testing procedure of Chandrayaan-2

- Developed a motor-controlled automated mechanism that reduced human intervention and decreased testing time by 95%.

OTHER TALKS	Informal PhD presentation (click on the year to see the talk) *2022*
	Team MIMESIS Seminar, INRIA *2022*
	Machine Learning Seminar, Team Legato, University of Luxembourg *2020, 2021, 2021*

AWARDS	- **MSCA fellowship** for pursuing doctorate degree in computational sciences. *2019-22*
	- Best presentation award at the Machine Learning School, University of Bern (400 CHF). *2022*
	- State Bank of India scholarship covering **95% of the tuition fee** at IIT Madras. *2012-17*
	- **Travel award** from IWR Heidelberg to attend Bangkok Summer School on Applied Mathematics & Computational Science. *2017*
	- **Travel grant** from IIT Madras to present at the First National Finite Element developers conference (One of the less than 10 undergraduates across the country). *2016*
	- **Travel grant** from IIT Madras to spend a semester at Technical University of Munich, Germany (accepted) and Seoul National University, South Korea. *2016*
	- **S**ecured a place among the top **0.3%** of **0.6 million** IIT-JEE aspirants, hence unlocking doors to IIT Madras, one of the best engineering institutes in India. *2012*
	- Recipient of the **KVPY fellowship** from the the Government of India (**top 0.5%**), offering full financial support to pursue a bachelor degree in pure sciences. *2012*
	- Recipient of the **INSPIRE fellowship** from the Government of India (**top 0.1%**), offering full financial support to pursue a bachelor degree in pure sciences. *2012*
	- Secured a region rank 6 & 26 in competitive **Regional Maths Olympiad**. *2009 & 11*
	- In the top 300 in India in National Standard Examination in Astronomy Olympiad. *2010*
	- State rank 21 in Maharashtra Talent Search Examination. *2008*

MASTERS RESEARCH	**Parallel Processing XFEM Solver for Weak Discontinuous Problems**
	M.Tech Thesis, Supervisor: Prof. Sundararajan Natarajan, IIT Madras Aug 16 - May 17
	- Developed a domain decomposition framework for solving large scale finite element problems involving inhomogneous materials in **less than 5%** time of the conventional approach.
	- Implemented eXtended Finite element (XFEM) along with Finite Element Tearing and interconnecting algorithm.
	Finite Element Tearing and Interconnecting (FETI) *May 16 - Jul 16*
	Research Assistant, Chair of Applied Mechanics, Technical University of Munich
	- Implemented massively **parallel, domain decomposition** numerical algorithm FETI to solve large scale static and dynamics problems arising in structural mechanics.
	- Predominantly worked on preprocessing issues of FETI, explored different finite element open source tools for creating partitions with conforming/non-conforming meshes.

STUDENT SUPERVISION	Hardik Jeldiya, "Design and synthesis of support net configuration for deployment space antenna reflector" - Masters thesis at the ISRO.
	Thomas Lavigne, "Surrogate Modeling of breast soft tissue deformation" - Masters thesis at the University of Luxembourg.
	Jiajia Wang, "An investigation of real-time interactive simulations for intuitive conceptual design" - First year PhD at the University of Luxembourg.

POSITIONS OF RESPONSIBILITIES	**Student Representative** *June 21 - Present*
	- For the Doctoral School in Science and Engineering, University of Luxembourg (∼600 PhDs)
	- For the Department of Computational Sciences, University of Luxembourg (∼60 PhDs)
	- For Marie Curie ITN Rainbow network (∼15 PhDs)

Mentor, Avanti Fellows: *Aug 14 - May 15*
Part of the team aiming to help students from less privileged backgrounds to clear competitive university entrance exams, personally mentored two students (one admitted to IIT Delhi).

Envisage Coordinator, **IIT Madras**: *May 13 - Jan 14*
Member of India's largest student organised techno-entertainment show with a 4000 footfall.

RELEVANT COURSEWORK

Oxford Machine Learning Summer School 2022, Deep Learning Specialisation: Coursera, Inverse problems: a probabilistic approach, Uncertainty Quantification, Operations Research, Advanced Discretisation methods

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EXTRA CURRICULAR ACTIVITIES

Outreach *2019*

Tech Fair: European Investment Bank Conference:
Demonstrated haptic technology for its uses in personalised medical simulations.

National Space Society Exhibition: Nashik Chapter: *2018*
Organised an exhibition to educate school children on space engineering and Indian space programs. Attended by 500+ students.

Sports:
- Represented the University of Luxembourg in the PCU Chess cup tournament held at Antwerp.
- Winner of the Space Application Center table tennis tournament, represented my center in inter ISRO competition.
- Represented IIT Madras in the **inter-college table tennis** tournament.
- Captain of the hostel squash and table tennis team at IIT Madras.
- **2 gold** and **2 silver** medals in squash and **1 gold** and **1 silver** in Waterpolo in the IIT Madras sports tournament (known as Schroeter).
- Represented my district in the **Maharashtra state-level** table tennis tournament.

Music:
- Written/composed two songs, around 5k+ listens on social platforms: Spotify for artist profile

Photography:
- One of the 10 shortlisted entries of the PCU sports photo contest 2021. My photograph was exhibited in 4 international expositions in Europe: virtual exhibition link
- Portfolio with more than 7 lakh views on Pexels as of Jan 23.