

# Souvik Roy

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## Research interests

- Big data problems in medicine and life sciences.
- Inverse problems in medical imaging and fluid flows.
- Numerical analysis and numerical linear algebra.
- Discontinuous Galerkin finite element schemes for 2D/3D incompressible Euler and Navier-Stokes equations.
- Optimal control framework for stochastic processes, optimization theory.
- Computer vision.
- Shape optimization.

## Softwares Known and Programming Language Skills

- C++ - a high-level object oriented programming language.
- FENICS- a Python programming oriented language for finite element method.
- COMSOL- Multiphysics interface for finite element method.
- DEAL.II- a C++ programming oriented library package for finite element method.
- MATLAB- for various areas like problems in medical imaging, industrial problems.
- OPENCV- a C++ programming oriented language used for Computer Vision problems.
- PARAVIEW- a plotting tool for .vtk file formats.
- VISIT- a plotting kit for .vtk and .eps file formats.
- CUDA- a GPU based parallel programming language.
- GITHUB- Web-based Git repository hosting service.

## Educational Detail

- **Tata Institute of Fundamental Research, Centre for Applicable Mathematics (CAM)** Bangalore, India  
*Ph.D. Mathematics* 2011 – 2015
  - Thesis title: Reconstruction of a class of fluid flows by variational methods and inversion of integral transforms in tomography – 2015.
  - Advisors: Prof. A. S. Vasudeva Murthy, Dr. Praveen Chandrashekar. and Dr. Venkateswaran P. Krishnan.
- **Tata Institute of Fundamental Research, CAM** Bangalore, India  
*M.Phil. Mathematics* 2010 – 2011
  - Thesis: Optical Flows – Determination of 2D velocities of a moving fluid .
  - Advisors: Prof. A. S. Vasudeva Murthy and Dr. Praveen Chandrashekar .
- **Tata Institute of Fundamental Research, CAM** Bangalore, India  
*M.Sc. Mathematics* 2008 – 2010
  - Graduated with a Masters in Mathematics .
  - Graduated with 1<sup>st</sup> position and a 79.25% score .
  - Relevant courses: Partial Differential Equations, Computational PDE, Numerical Analysis, Mechanics, Measure Theory .
- **Ramakrishna Mission Vidyamandira, Belur Math** West Bengal, India  
*University of Calcutta* 2005 – 2008  
*B.Sc. Mathematics*
  - Graduated with a major in Mathematics and a minor in Physics and Computer Science .
  - Graduated with Honours, a 82.5% score, and 4<sup>th</sup> position in the University of Calcutta rank list .
  - Relevant courses: Mathematics, Physics, Computer Science .

## Academic Positions

- **ICTS, Bangalore and University of Nice** India and France  
*Post doctoral fellow* Jan 2016 – present
  - Working jointly with Prof. Didier Auroux and Prof. Amit Apte on developing observers for compressible Navier Stokes equation.
- **University of Würzburg** Würzburg, Germany  
*Post doctoral fellow* July 2015 – Dec 2015
  - Worked with Prof. Dr. Alfio Borzi on a bang-bang optimal control problem for Liouville equation.
- **University of Texas, Arlington** Texas, USA  
*Post doctoral fellow* Jan 2015 – May 2015
  - Worked with Prof. Gaik Ambartsoumian on inverse problems related to medical imaging.
- **University of Würzburg** Würzburg, Germany  
*DAAD visiting scientist* Oct 2014 – Dec 2014

- Worked with Prof. Alfio Borzi and Prof. Mario Annunziato on Fokker-Planck equations related to stochastic processes.

## Awards, Grants & Honours

- IFCAM visiting scientist fellowship for post doctoral studies at University of Nice, France. Jan 2016–present
- ICTS post doctoral fellowship Jan 2016–present
- Post doctoral fellowship under the project “Multi-ITN Strike” at University of Würzburg. July 2015–Dec 2015
- University of Texas, Arlington and EADS fellowship for post doctoral studies at University of Texas, Arlington, USA Jan 2015–May 2015
- Received DAAD visiting scholar fellowship for research visit to University of Würzburg, Germany. Oct 2014–Dec 2014
- Received A.R.Drone for being one of the top 20 teams in EADS “Join the Spirit” contest. 2013
- Tata Institute of Fundamental Research doctoral fellowship 2010–2015
- Tata Institute of Fundamental Research masters fellowship 2008–2010
- Achieved 1<sup>st</sup> position in M.Sc exams at Tata Institute of Fundamental Research, CAM 2008–2010
- Achieved 3<sup>rd</sup> position in CSIR-UGC NET exams 2010
- Achieved 4<sup>th</sup> position in B.Sc exams at University of Calcutta 2005–2008
- Achieved 71<sup>st</sup> (out of more than 10000 participants) rank in the National Science Olympiad, India 2004

## Publications, Research Problems and Projects

### Publications/Submitted for publication

1. Souvik Roy, Praveen Chandrashekar and A. S. Vasudeva Murthy. A variational approach to optical flow estimation of unsteady incompressible flows. *International Journal of Advances in Engineering Sciences and Applied Mathematics*, Springer, 7(3):149–167, 2015.
2. Souvik Roy, Venkateswaran P. Krishnan, Praveen Chandrasekhar and A. S. Vasudeva Murthy. An efficient numerical algorithm for Radon transform inversion with applications in ultrasound imaging. *Journal of Mathematical Imaging and Vision*, Springer, 53:78–91, 2015.
3. Praveen Chandrashekar, Souvik Roy and A. S. Vasudeva Murthy. A variational approach to estimate incompressible fluid flows. *Proceedings of Mathematical Sciences*, Springer, (to appear), 2015.

4. Gaik Ambartsoumian and Souvik Roy. Numerical inversion of a broken ray transform arising in single scattering optical tomography (*to appear*), 2015.
5. Souvik Roy, Mario Annunziato, Alfio Borzi. A Fokker–Planck feedback control-constrained approach for modelling crowd motion. (*submitted*), 2015.
6. Souvik Roy, Mario Annunziato and Alfio Borzi. A Fokker-Planck approach to control pedestrian motion. (*submitted*), 2015.

## Preprints/Works Under Preparation

1. Anisa MHC and Souvik Roy. Extremal first Dirichlet eigenvalue in a class of doubly connected domains related to shape of musical instruments. (*under preparation, preprint available*), 2016.
2. Praveen Chandrashekhara and Souvik Roy. Discontinuous Galerkin scheme for vorticity-velocity formulation of incompressible flows. (*under preparation*), 2016.
3. Souvik Roy. A Fokker-Planck approach to control stock price trajectories. (*under preparation, preprint available*), 2016.
4. Gaik Ambartsoumian, Rim-Gouia-Zarrad, Venkateswaran P. Krishnan and Souvik Roy. Inversion of spherical Radon transform in a spherical shell. (*under preparation*), 2016.
5. Souvik Roy and Alfio Borzi. Analysis and higher-order solution of a Liouville bang-bang control problem. (*under preparation*), 2016.
6. Amit Apte, Didier Auroux, Mythily Ramaswamy and Souvik Roy. Observers for tracking an image driven by compressible Navier-Stokes equations. (*under preparation*), 2016.

## Other Completed Projects

1. Worked with Deep Ray of TIFR-CAM to develop an algorithm to compare human beings in photographs for the second phase of the global competition “Join The Spirit” organized by EADS-2013.
2. Worked with Deep Ray of TIFR-CAM to develop an algorithm to detect human beings for the global competition “Join The Spirit” organized by EADS-2013.
3. Worked along with Prof. Laxmivarahan, Prof. Ravi Nanjundiah and Prof. Mythily Ramaswamy to solve the Lorenz 63 model and the Ikeda map model using variational approach during the Data Assimilation workshop held at TIFR-CAM, Bangalore-2011.
4. Worked along with Prof. Andrew Lacey and Prof. A.S.Vasudeva Murthy and presented a report on the fish feeding problem during the Study Group Meeting on Industrial Problems held at Super Computer Education Research Center-IISc, Bangalore-2011.
5. Worked along with Prof. John Ockendon on the bubble growth problem during the Study Group Meeting on Industrial Problems held at Super Computer Education Research Center-IISc, Bangalore-2011.

## Current Research Problems and Projects

1. Currently working on semi-smooth Newtonian approach for sparse optimal control of geometric Brownian motion–2016.
2. Currently working with Prof. Dr. Alfio Borzi on a bang-bang optimal control problem for Liouville equation–2016.
3. Currently working with Prof. Gaik Ambartsoumian, Dr. Rim-Gouia-Zarrad and Dr. Venkateswaran P. Krishnan on inversion of spherical transforms in a ball–2016
4. Currently working with Dr. Anisa M.H.C. from IISER-Pune on shape optimization problem to determine the maximum and minimum of the first eigenvalue of the laplacian in the class of domains formed by the annular region between a disk and a non-concentric square–2016.
5. Currently working with Dr. Praveen Chandrashekar on vorticity-velocity discontinuous galerkin methods for 2D/3D incompressible Euler and Navier-Stokes flows–2016.
6. Currently working with Prof. Amit Apte, Prof. Didier Auroux and Prof. Mythily Ramaswamy on developing observers for tracking an image driven by compressible Navier-Stokes flow–2016.

## Teaching Experience

- **ODE and Linear Algebra-MATH 3319** University of Texas, Arlington, USA  
*Course Instructor* Spring 2015
  - Was instructor for the course, created assignments and examinations, evaluated assignments and examinations.
- **Mechanics (M.Sc.)** TIFR-CAM  
*Teaching Assistant* Spring 2014
  - Created assignments and examinations, evaluated assignments and examinations.
  - Held supplementary sessions for students.
- **Computational PDE (M.Sc.)** TIFR-CAM  
*Teaching Assistant* Spring 2012
  - Evaluated assignments, examinations, course notes, and taught a part of the course.
  - Held supplementary sessions for students.
- **ATML School for Lecturers** University of Vadodara  
*Teaching Assistant* Summer 2011
  - As an assist to Prof. A. S. Vasudeva Murthy, Prof. Mythily Ramaswamy and Dr. K. Sandeep, prepared numerical experiments for ODE theory taught in the school.

## Organized Events

- **Organizer of the Inverse Problem Seminar Series**  
*University of Texas, Arlington, USA* Spring, 2015

## Presentations and Talks Given

- **A Fokker-Planck approach to control collective motion**  
*ICTS, Bangalore* *October, 2015*
- **A Fokker-Planck approach to control pedestrian motion**  
*Paper presentation, ICTT, Taormina, Italy* *September, 2015*
- **Inverse problems in imaging**  
*Inverse Problem Seminar Series, University of Texas, Arlington, USA* *March, 2015*
- **A Variational approach to flow estimation of unsteady incompressible flows**  
*Paper presentation, Finite Element Meet, TIFR-CAM, Bangalore* *July, 2014*
- **Efficient numerical reconstruction from partial Radon data in imaging**  
*Poster presentation, SIAM Summer School, JKU, Linz, Austria* *August, 2014*
- **On some inverse problems in fluid flows and imaging**  
*Synopsis talk, TIFR-CAM, Bangalore* *July, 2014*
- **A DG vorticity-velocity formulation for incompressible 2D Euler flow.**  
*IISER Pune* *June, 2014*
- **Vorticity-velocity formulation for 2D Euler equation**  
*In-House Symposium, TIFR-CAM, Bangalore* *August, 2013*
- **Optimal control approach for estimation of incompressible fluid flows**  
*28th Annual Conference Of Ramanujam Mathematical Society, RIT, Bangalore* *June, 2013*
- **Motion estimation using computational techniques in PDE**  
*In-House Symposium, TIFR-CAM, Bangalore* *August, 2012*

## Participation in Workshops and Conferences

- **Conference on Computational PDE** *Bangalore, India*  
*TIFR-CAM, Bangalore* *2014*
- **Gene Golub SIAM Summer School** *Linz, Austria*  
*Johannes Kepler Universität* *2014*
- **AIS on Theoretical and Numerical Aspects of Inverse Problems** *Bangalore, India*  
*TIFR-CAM, Bangalore* *2014*
- **Scientific Writing Workshop** *Bangalore, India*  
*TIFR-CAM, Bangalore* *2014*
- **Workshop on Optimization with PDE Constraints** *Bangalore, India*  
*TIFR-CAM, Bangalore* *2013*
- **Summer School on Numerics and Control of PDEs** *Bangalore, India*  
*IISC, Bangalore* *2013*
- **Compact Course on Discontinuous Galerkin Methods (Prof. Shu)** *Bangalore, India*  
*TIFR-CAM, Bangalore* *2013*
- **International Conference on Conservation Laws and Applications** *Bangalore, India*  
*TIFR-CAM, Bangalore* *2013*
- **TCANW** *Mumbai, India*  
*IIT, Bombay* *2013*

- **Advanced Workshop on Non-Standard Finite Element Methods** Mumbai, India  
*IIT, Bombay* 2013
- **Course on Heterogeneous Parallel Programming** Online  
*University of Illinois* 2013
- **Instructional Workshop on Finite Element Methods** Bangalore, India  
*TIFR-CAM, Bangalore* 2012
- **School on Cocompact Embeddings and Profile Decompositions** Bangalore, India  
*TIFR-CAM, Bangalore* 2012
- **Monsoon School on Data Assimilation Research Programme** Bangalore, India  
*TIFR-CAM, Bangalore* 2011
- **Study Group Meeting on Industrial Problems** Bangalore, India  
*SERC-IISC, Bangalore* 2011
- **Workshop on Computational Science** Bangalore, India  
*SERC-IISC, Bangalore* 2011
- **Workshop on Scientific Discovery through Intensive Data Exploration** Bangalore, India  
*JNCASR, Bangalore* 2011
- **Mesh-Free Conference** Bangalore, India  
*IISC, Bangalore* 2011
- **Conference on Recent Trends in Non-Linear Elliptic PDEs** Bangalore, India  
*TIFR-CAM, Bangalore* 2011
- **IMI Workshop and Symposium on Mathematical Ecology** Kolkata, India  
*IISER, Kolkata* 2010
- **ICMPDE** Bangalore, India  
*TIFR-CAM, Bangalore* 2010
- **IMI Workshop and International Conference on Homogenization** Bangalore, India  
*IISC, Bangalore* 2010
- **Symposium on ‘Perspectives in Mathematics’** Mumbai, India  
*TIFR, Mumbai* 2009
- **Seminar on ‘Mathematics Vis-à-Vis World of Experience’** Kolkata, India  
*Bethune College* 2008
- **Course on Topology under Prof. Shobha Madan** Kanpur, India  
*IIT, Kanpur* 2007
- **0 – level of the MTTS Programme** Kolkata, India  
*Jadavpur University* 2006