

# Souvik Roy

Assistant Professor,  
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## Research interests

- Big data problems in medicine and life sciences.
- Optimal control framework for stochastic processes, optimization theory.
- Inverse problems in medical imaging and fluid flows.
- Numerical analysis and numerical linear algebra.
- Data assimilation.
- Numerical methods for fluid flows.
- 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.
- GITHUB- Web-based Git repository hosting service.

## Academic Positions

- **Tata Institute of Fundamental Research, CAM** Bangalore, India  
*Visiting fellow* March 2018 – present  
– Working with Dr. Venkateswaran P. Krishnan on inverse problems in medical imaging.
- **University of Würzburg** Würzburg, Germany  
*Post doctoral fellow* Sep 2016 – Sep 2017  
– Worked with Prof. Dr. Alfio Borzi on Fokker-Planck Kolmogorov optimal control problems and inverse problems in medical imaging related to acousto-electric tomography
- **ICTS, Bangalore and University of Nice** India and France  
*Post doctoral fellow* Jan 2016 – August 2016  
– Worked 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.

## 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 .

## Students Supervised

1. **Jan Bartsch**

Würzburg, Germany

*M.Sc.*

Sep 2016 – Sep 2017

- Thesis title- Optimal control problems governed by Liouville models-Theoretical analysis and implementation

## Publications, Research Problems and Projects

### Publications/Submitted for publication

1. 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.
2. 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.
3. Praveen Chandrashekar, Souvik Roy and A. S. Vasudeva Murthy. A variational approach to estimate incompressible fluid flows. *Proceedings of Mathematical Sciences, Springer*, 127(1):175–201, 2017.
4. Gaik Ambartsoumian and Souvik Roy. Numerical inversion of a broken ray transform arising in single scattering optical tomography *IEEE Transactions on Computational Imaging*, 2(2): 166–173, 2016.
5. Souvik Roy, Mario Annunziato and Alfio Borzì. A Fokker–Planck feedback control-constrained approach for modelling crowd motion. *Journal of Computational and Theoretical Transport*, 45(6): 452–458, 2016.
6. Souvik Roy and Alfio Borzì. Numerical investigation of a class of Liouville control problems. *Journal of Scientific Computing*, 73(1):178–202, 2017.
7. Souvik Roy, Mario Annunziato, Alfio Borzì and Christian Klingenberg. A Fokker-Planck approach to control collective motion. *Computational Optimization and Applications*, 69(2):423–459, 2018.

8. Gaik Ambartsoumian, Rim-Gouia-Zarrad, Venkateswaran P. Krishnan and Souvik Roy. Image reconstruction from radially incomplete spherical Radon data. *European Journal of Applied Mathematics*, 29(3): 470–493, 2018.
9. Souvik Roy, Alfio Borzi and Abderrahmane Habbal. Pedestrian motion constrained by FP-constrained Nash games, *Royal Society Open Science*, 4(9):170648, 2017.
10. Souvik Roy and Alfio Borzi. A new optimisation approach to sparse reconstruction of log-conductivity in acousto-electric tomography, *SIAM Journal of Imaging Sciences*, 11(2):1759–1784, 2018.
11. Bolaji Adesokan, Kim Knudsen, Venkateswaran P. Krishnan and Souvik Roy. A fully non-linear optimization approach to acousto-electric tomography, *Inverse Problems* (to appear), doi: <https://arxiv.org/abs/1804.02507>, 2018.
12. Anisa MHC and Souvik Roy. How to place an obstacle having a dihedral symmetry centered at a given point inside a disk so as to optimize the fundamental Dirichlet eigenvalue, (*under review*), doi: [arxiv.org/abs/1707.01368v2](https://arxiv.org/abs/1707.01368v2), 2018.

## Technical reports

1. Gaurav Sharma and Souvik Roy. Bubble drag coefficient formulation and stability analysis for multiphase-turbomachinery problems(Shear flow/breakup GE2), *Modeling week and study group meeting on industrial problems, Supercomputer education research center*, 58-73, 2011.
2. Andrew A. Lacey, A. S. Vasudeva Murthy and Souvik Roy. Fish feeding. *Modeling week and study group meeting on industrial problems, Supercomputer education research center*, 32-55, 2011.

## Preprints/Works Under Preparation

1. Amit Apte, Didier Auroux, Mythily Ramaswamy, Souvik Roy and Vishal Vasan. Observers for tracking an image driven by compressible Navier-Stokes equations. (*under preparation*), 2017.
2. Jan Bartsch, Alfio Borzi, Francesco Fanelli and Souvik Roy. A theoretical investigation of Brockett’s ensemble optimal control problems (*under preparation*), 2018.

## 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.

## Awards, Grants & Honours

- H.C. Ørsted COFUND fellowship (under Marie Skłodowska-Curie Actions grant no. 609405 (FP7) and 713683 (H2020)) for postdoctoral studies at Denmark Technical University (declined), 2017
- DFG grant for postdoctoral studies at University of Würzburg, Germany. Sep 2016–Sep 2017
- IFCAM visiting scientist fellowship for postdoctoral studies at University of Nice, France. April 2016–June 2016
- ICTS postdoctoral fellowship Jan 2016–August 2016
- Postdoctoral fellowship under the project “Multi-ITN Strike” at University of Würzburg. July 2015–Dec 2015
- University of Texas, Arlington and EADS fellowship for postdoctoral 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

## 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 Invited Talks

- **A Fokker-Planck Nash differential game to model crowd motion with avoidance**  
*DTU, Denmark* *August, 2017*
- **A novel numerical method for a class of Liouville control problems**  
*OCIP, TUM Munich, Germany* *April, 2017*
- **Numerical inversion of a broken ray transform arising in SSOT**  
*Radon100 conference, JKU, Linz, Austria* *March, 2017*
- **Numerical investigation of a class of Liouville control problems**  
*University of Nice, France* *March, 2017*
- **Numerical inversion of a broken ray transform arising in SSOT**  
*ICTS-TIFR, Bangalore* *July, 2016*
- **Inversion of a spherical Radon transform in a spherical shell**  
*Paper presentation, Inverse problems in modelling and simulation, Turkey* *May, 2016*
- **A Fokker-Planck approach to control collective motion**  
*ICTS, Bangalore* *October, 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

- **Numerical Methods for Optimal Control and Inverse Problems** Munich, Germany  
*TUM, Munich* 2017
- **100 Years of the Radon Transform** Linz, Austria  
*RICAM* 2017
- **8<sup>th</sup> International Conference on Inverse Problems (IPMS)** Fethiye, Turkey  
*IPMS* 2016
- **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
- **MTTS Programme** Kolkata, India  
*Jadavpur University* 2006