Souvik Roy

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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.

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 Chandrashekhar .
- **Tata Institute of Fundamental Research, CAM** Bangalore, India
  M.Sc. Mathematics *2008 – 2010*
  - Graduated with a Masters in Mathematics .
  - Graduated with 1^{st} 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^{th} position in the University of Calcutta rank list .
  - Relevant courses: Mathematics, Physics, Computer Science .

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 Borzì 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 Borzì and Prof. Mario Annunziato on Fokker-Planck equations related to stochastic processes.

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 Borzì and Abderrahmane Habbal. Pedestrian motion constrained by FP-constrained Nash games, *Royal Society Open Science*, 4(9):170648, 2017.

10. Souvik Roy and Alfio Borzì. A new optimisation approach to sparse reconstruction of log-conductivity in acousto-electric tomography, *SIAM Journal of Imaging Sciences (accepted)*, 2018.

11. Bolaji Adesokan, Kim Knudsen, Venkateswaran P. Krishnan and Souvik Roy. A fully non-linear optimization approach to acousto-electric tomography, *(submitted)*, doi: https://arxiv.org/abs/1804.02507, 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. Praveen Chandrashekhar and Souvik Roy. Discontinuous Galerkin scheme for vorticity-velocity formulation of incompressible flows. *(under preparation, preprint available)*, 2017.

2. Amit Apte, Didier Auroux, Mythily Ramaswamy, Souvik Roy and Vishal Vasan. Tracer based observers for compressible Navier-Stokes equations . *(under preparation)*, 2017.

3. Jan Bartsch, Alfio Borzì, Francesco Fanelli and Souvik Roy. Analysis and optimal control of a Liouville model *(under preparation)*, 2018.

4. 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 preparation, preprint available)*, doi: arxiv.org/abs/1707.01368v2, 2018.

Awards, Grants & Honours

- H.C. Ørsted COFUND fellowship (under Marie Sklodowska-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^{st} position in M.Sc exams at Tata Institute of Fundamental Research, CAM — 2008–2010
- Achieved 3^{rd} position in CSIR-UGC NET exams — 2010
- Achieved 4^{th} position in B.Sc exams at University of Calcutta — 2005–2008
- Achieved 71^{st} (out of more than 10000 participants) rank in the National Science Olympiad, India — 2004

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.

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^{th} **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-á-Vis World of Experience'** Kolkata, India
  Bethune College *2008*
- **MTTS Programme** Kolkata, India
  Jadavpur University *2006*