Nikhil P. Singh

CONTACT INFORMATION

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RESEARCH INTERESTS

Statistics on Riemannian manifolds:

- Lie groups and diffeomorphisms
- Matrix groups and Grassman manifolds
- Longitudinal modeling of 3D shapes

Medical image analysis:

- Non-linear image registration
- Imaging feature extraction
- Image segmentation

Machine learning and statistical inference:

- Topological data analysis: persistence homology
- Kernel-based methods of classification and regression
- Sparsity regularization
- Sparse dictionary learning methods
- Non-parametric statistics
- Longitudinal mixed-effects models

Applications:

- Cancer histology image analysis.
- Computational anatomy, analysis of 3D volume human brain images.
- Multimodal image analysis: structural and functional.
- Predictive modeling of disease progression in Alzheimer's disease.

EDUCATION

The University of Utah, Salt Lake City, UT, USA

Ph.D., Computer Science (Oct 2013)

- Area of Study: Statistical learning and shape analysis
- Thesis Title: *Multivariate Regression of Shapes via Deformation Momenta: Application to Quantifying Brain Atropy in Aging and Dementia*
- Advisors: Dr. Thomas Fletcher and Dr. Sarang Joshi
- Developed algorithms for geometric and statistical models for summarizing anatomical shape and its variability across population and along time. Relate clinical progression and infinite dimensional anatomical changes under this representation to build predictive multivariate regression models.
- GPA: 3.99/4

M.S., Computer Science (2010)

- Advisor: Dr. Thomas Fletcher
- Area of Study: Statistical learning applied to medical image analysis
- GPA: 3.96/4

Indian Institute of Technology (BHU), Varanasi, UP, INDIA

B.Tech., Ceramic Engineering (with 'Honors'), 2006

Programming Skills C++, CMake, Python (scikit-learn, scikit-image, PIL), Matlab, R, shell (bash), CUDA, MPI, pthreads

Opensource Released Software

- Python/C++ implementation of splines for Diffeomorphic Image Regression: Algorithms for spline regression for longitudinal modeling of changes in images released for [C8]
- Vector momentum for Diffeomorphisms: Algorithms for mixed effects longitudinal modeling on diffeomorphisms in python and C++ released for [C4, C3]

  Git Source: git@bitbucket.org:scicompanat/vectormomentum.git
- PyCA: Shape analysis software in C++ with python bindings. Unified high-performance computing framework to use on CPU and GPU.

  Git Source: git@bitbucket.org:scicompanat/pyca.git

PhD Thesis

[T1] N. Singh. "Multivariate Regression of Shapes via Deformation Momenta: Application to Quantifying Brain Atropy in Aging and Dementia". 2014.

Journal Publications

[J3] N. Singh, J. Hinkle, S. Joshi, and P. T. Fletcher. "Hierarchical Geodesic Models in Diffeomorphisms". In: (2014). under review.

[J2] N. Singh, P.T. Fletcher, J. S. Preston, R. D. King, J. S. Marron, M. W. Weiner, and S. Joshi. "Quantifying anatomical shape variations in neurological disorders". In: *Medical image analysis* 18.3 (2014), pp. 616–633.

[J1] Y. Hong, B. D. Davis, J. S. Marron, R. Kwitt, N. Singh, et al. "Statistical atlas construction via weighted functional boxplots". In: *Medical image analysis* 18.4 (2014), pp. 684–698.

Conference Publications

[C10] N. Singh, H. D. Couture, J. S. Marron, C. Perou, and M. Niethammer. "Topological Descriptors of Histology Images". In: *Machine Learning in Medical Imaging (MLMI)*. to appear. 2014.

[C9] N. Singh, J. Hinkle, S. Joshi, and P. T. Fletcher. "An efficient parallel algorithm for hierarchical geodesic models in diffeomorphisms". In: *Biomedical Imaging (ISBI), 2014 IEEE 11th International Symposium on*. IEEE. 2014, pp. 341–344.

[C8] N. Singh and M. Niethammer. "Splines for Diffeomorphic Image Regression". In: *Medical Image Computing and Computer-Assisted Intervention (MICCAI)*. to appear. 2014.

[C7] Y. Hong, N. Singh, R. Kwitt, and M. Niethammer. "Time-warped Geodesic Regression". In: *Medical Image Computing and Computer-Assisted Intervention (MICCAI)*. to appear. 2014.

[C6] Y. Hong, R. Kwitt, N. Singh, B. Davis, N. Vasconcelos, and M. Niethammer. "Geodesic Regression on the Grassmannian". In: European Conference on Computer Vision (ECCV). 2014.

[C5] M. Zhang, N. Singh, and P. T. Fletcher. "Bayesian Estimation of Regularization and Atlas Building in Diffeomorphic Image Registration". In: *Information Processing in Medical Imaging (IPMI)*. Springer. 2013, pp. 37–48.

[C4] N. Singh, J. Hinkle, S. Joshi, and P. T. Fletcher. "A Hierarchical Geodesic Model for Diffeomorphic Longitudinal Shape Analysis". In: *Information Processing in Medical Imaging (IPMI)*. Springer. 2013, pp. 560–571.

[C3] N. Singh, J. Hinkle, S. Joshi, and P. T. Fletcher. "A Vector Momenta Formulation of Diffeomorphisms for Improved Geodesic Regression and Atlas Construction". In: *Biomedical Imaging (ISBI), 2013 IEEE 10th International Symposium on*. **Best Paper Award.** IEEE. 2013, pp. 1219–1222.

[C2] N. Singh, A. Y. Wang, P. Sankaranarayanan, P.T. Fletcher, and S. Joshi. "Genetic, Structural and Functional Imaging Biomarkers for Early Detection of Conversion from MCI to AD". In: *Medical Image Computing and Computer-Assisted Intervention (MICCAI)*. Vol. 7510. Springer, 2012, pp. 132–140. ISBN: 978-3-642-33414-6. DOI: 10.1007/978-3-642-33415-3_17.

[C1] N. Singh, P. T. Fletcher, J. S. Preston, L. Ha, R. King, J. S. Marron, M. Wiener, and S. Joshi. "Multivariate statistical analysis of deformation momenta relating anatomical shape to neuropsychological measures". In: *Medical Image Computing and Computer-Assisted Intervention (MICCAI)*. Vol. 6363. Springer, 2010, pp. 529–537. DOI: 10.1007/978-3-642-15711-0_66.

Invited Talks

[IT1] N. Singh. *Multivariate Regression of Shapes via Deformation Momenta*. Presented at Statistical and Applied Mathematical Sciences Institute (SAMSI), 2014.

Other Talks

[OT1] N. Singh. *Longitudinal Mixed-effect Models on Manifold of Diffeomorphisms*. Presented at the Shape FRG Meeting at John's Hopkins, 2013.

Awards

- Best student paper award [C3]
- National Science Foundation (NSF) scholar award (ISBI)
- Won an IPad 2.0 for Best Posters titled: "On Relating Brain Shape with Neurological Disorders" in the SCIx-2011 session on Statistical Analysis of Images and Shape.

Reviewer Responsibilities

Medical Image Computing and Computer Assisted Intervention (MICCAI 2011, 2012, 2013), International Jounal of Computer Vision (IJCV).

Graduate Courses

School of Computing, The University of Utah, Salt Lake City, Utah USA

- Advanced Algorithms
- Advanced Image Processing
- 3D Computer Vision
- Intro to Riemannian Manifolds
- Mathematics of Imaging
- Estimation Theory
- Machine Learning
- Non-parametric Statistical Methods
- Real Analysis
- Image Processing
- Operating Systems
- Advanced Computer Architecture

Work Experience

Department of Computer Science, University of North Carolina at Chapel Hill, NC, USA

Postdoc Research Associate **Nov 2013 to ongoing**

- Research on topological machine learning applied to cancer histology images.
- High-order registration models of time-series data.
- Python, C++.

Scientific Computing and Imaging Institute (SCI), Salt Lake City, UT, USA

Research Assistant **Aug 2008 to Oct 2013**

- Computational anatomy: Research on statistical shape analysis and high-dimensional pattern recognition applied to brain imaging.
- Development of high-performance scientific software on 64-Node, GPU NVIDIA Tesla cluster.
- C++, CUDA, MPI, Python, Matlab.

Infosys Technologies Limited, Bangalore, INDIA

Software Engineer **May 2006 to July 2008**

- Software design and implementation in a multi-tier application development environment.
- Developing software systems using C#, COM/DCOM, .NET, ASP.NET/ADO.NET, Web services (.NET/SOAP)
- Database design using PL/SQL (SQL Server, Oracle 9i/10g) - schema, stored procedures and triggers on large industrial datasets.

Certifications

Microsoft Certified Application Developer (MCAD)
Transcripts available *here* with Transcript id: *772011* and Acess code: *Microsoft*

Other Achievements

Science Olympiad Foundation

- NSO (2002) - National Science Olympiad **All India Rank 93**
- NSO (2001) - National Science Olympiad **All India Rank 124**

References Available to Contact

Dr. Marc Niethammer (e-mail: mn@cs.unc.edu; phone: 919-590-6149)
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University of North Carolina at Chapel Hill

Dr. Tom Fletcher (e-mail: fletcher@sci.utah.edu; phone: 801-587-9641)
Assistant Professor,
The Scientific Computing and Imaging (SCI) Institute, and
The School of Computing, University of Utah

Dr. Sarang Joshi (e-mail: sjoshi@sci.utah.edu; phone: 801-587-7961)
Associate Professor,
The Scientific Computing and Imaging (SCI) Institute, and
The Department of Bioengineering, University of Utah

Dr. Guido Gerig (e-mail: gerig@sci.utah.edu; phone: 801-587-0327)
Professor,
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