

# RishuSaxena

## about

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<https://rishus.github.io/>

## programming

python, java, c++,  
cuda, scikit-learn,  
numpy, scipy, statpy,  
matplotlib, nltk,  
lapack, blas, pulp, GIS,  
gdb, latex,  
mathematica, linux,  
MapReduce,  
databases, matlab

## interests

Data analytics, big data, machine learning, image processing/analysis (of remote sensing, satellite images, medical images), high performance computing, mathematical modeling, numerical optimization.

## education

- since 2014 **M.S.** candidate in Computer Science Virginia Tech., Blacksburg, VA.  
*Towards a polyalgorithm for land use and land cover change detection.*
- 2003–2008 **Ph.D. Applied mathematics** Arizona State University, Tempe, AZ.  
*High Order Methods for Edge Detection and Applications.*
- 2000–2002 **M.Sc. Mathematics** Indian Institute of Technology, Kanpur, India.  
*Iterative methods for computing eigenvalues of large sparse matrices.*

## work experience

- since 2015 **Graduate Research Asst.** joint appointment with CS and Forestry Department, Virginia Tech, Blacksburg.  
*Scalable time series analysis of satellite images for land use/land cover monitoring.*
- 2012 - 2013 **Post Doctoral Fellow** Center for Applicable Mathematics, Tata Institute of Fundamental Research (TIFR), Bangalore.  
*Inversion of Circular Radon Transform on an Annulus.*
- 2011 - 2012 **Lecturer and Research Visitor** Department of Mathematics, University of California, San Diego.  
*Biomolecular surface reconstruction using variational implicit solvent model.*
- 2008 - 2009 **Post Doctoral Fellow** Department of Mathematics, Michigan State University, East Lansing, Michigan.  
*Biomolecular surface reconstruction using a multiscale model.*
- 2007 - 2008 **Guest Researcher** Oak Ridge National Labs, Oak Ridge, Tennessee.  
*Input parameter classification for multivariate stochastic PDEs (4 - 6D).*
- 2007 - 2008 **Graduate Research Assistant** Department of Mathematics, Arizona State University, Tempe.  
*High order methods for boundary detection in signals and images.*
- 2002 - 2003 **Research Assistant** Aerospace Engineering, Indian Institute of Technology, Kanpur.  
*Eigenvalues of large sparse matrices. Iterative methods for solving large, sparse linear systems.*

## projects/apps/tools

### **A convolution neural network (CNN) based classifier for detecting land use changes (LUC) from satellite data.**

Preliminary investigation of a novel application of CNN, viz., finding patches of earth surface where the cover type has significantly changed for a sustained time period. Examples of cover type changes include from forest to agriculture, or from agriculture to urban development and so on.

- Developed an algorithm that strategically combines known algorithms to produce high quality labeled datasets consisting of 'change' or 'stable' pixels.
- The CNN currently consists of three convolutional and two fully connected layers.
- All training and validation was done on NVIDIA p100 GPU which features 3584 1GHz cuda cores with 12GB of memory.
- The work has broader significance on detecting changes in image stream from motion camera and webcam.

Project Github page: <https://github.com/rishus/lulc-net>

### **Machine learning class projects.**

Worked with several classifiers on several textual open datasets.

- Text classification: Given snippet(s) of text(s), identify the source.
  1. Programmed a multinomial Naive Bayes Classifier with  $k$ - fold cross-validation for binary classification.
  2. Utilized (and extended, as required) built-in Python modules (scikit-learn and nltk) for standardizing the data.
  3. Implemented, experimented with, and analyzed the results of different estimators.
  4. Utilized Python inbuilt decision tree, nearest neighbor, and Naive Bayes classifiers for multiclass problems.
- Developed a Markov model that learns to write like a given author.
- Implemented Gaussian Naive Bayes and Multinomial Naive Bayes classifiers and utilized an already available tree-augmented Naive Bayes classifier for a multiclass problem.
- Designed, implemented, and investigated the functioning of a support vector machine for a binary dataset.
- Modeled binary classification problems on some datasets as linear programming problems and solved those using Python-Pulp (GLPK) module.

### **Time series analysis of satellite image archives for land use monitoring.**

Designed and implemented an

ensemble for change (anomaly/event) detection from spatio-temporal stacks of satellite images.

- The approach strategically collates answers from principally different techniques:
  1. dynamic programming based method,
  2. iterative linear regression (statistical inferences) based method,
  3. harmonic regression based learning methods.
  4. random forest method.
- Provided mathematical formulation to existing domain approaches.
- Developed scalable and parallel implementations in Fortran (OpenMP and MPI), Python (python.multiprocessing and python.parallel), and MapReduce (Hadoop, required also developing appropriate input data format).
- Achieved upto 49x scalability with Python and Fortran on 64-core machine.

In addition, gained working knowledge of R while working with several domain algorithms. Project Github page: <https://github.com/rishus/LandChangeUsingPolyAlgo>, [https://github.com/rishus/ipp\\_polyalgo](https://github.com/rishus/ipp_polyalgo)

**Detecting users with dependency traits in Twitter.** Developed a technique to identify users exhibiting dependence (anomously high activity) to a particular lifestyle such as cosmetics, shopping, etc.

- Developed a focussed crawler that, starting with a set of seed users, grows the potential pool of candidate users through biased exploration of the follower-followee graph.
- Developed a spam filter to clean the downloaded data.
- Analyzed approximately 10 million users, 10 billion tweets, 1 billion edges, and over 20 facets of the users.
- Analytics was written in Python while data management was done using SQL database. This allowed for concurrent processing of various phases of the analytics pipeline.

Project Github page: <https://github.com/rishus/DetectingDependencyTendenciesinTwitterUsers>

**Image compression using low rank approximation.** Implemented generalized low rank approximation (GLRA) for matrices and applied it for image compression.

- 30% data compression ratios were achieved, on an average.
- GLRA has better time complexity (several orders of magnitude faster) than SVD.
- GLRA-compressed images provide better reconstruction and classification than SVD-compressed images.
- Codes were implemented in Python.

**Reconstruction of medical images from circular radon transforms on an annulus.**

Circular

radon transforms arise in imaging modalities such as computed (CT), photoacoustic (PAT) and ultrasound reflection tomography. This project explored the numerical implementation of some then recently proposed explicit inversion formulae for reconstructing the Euclidean/physical domain image of the imaged object.

- Provided approximate solutions to the integral equations, as exact numerical solution turned out to be computationally demanding.
- Developed strategy to parallelize computation using linux threads.

**Interactive Android snake game.**

Developed an interactive (snake) game for Android using the

model-view-controller (MVC) framework.

- Used built-in Java synchronization primitives to coordinate the movement of snakes and interaction with the user, including dealing with the race condition.
- Wrote a comprehensive testing module for the game using the Java unit test framework.

## selected publications & presentations

**Towards a Polyalgorithm for Land Use Change Detection** R. Saxena, L.T. Watson, R.H. Wynne, E.B. Brooks, V.A. Thomas, and Y. Zhiqiang, *Computers & Geosciences*, submitted.

**Scaling Land Use Monitoring Algorithms** R. Saxena, L.T. Watson, R.H. Wynne, and V.A. Thomas, *Intl. Conf. on Scientific Computing*, CSREA Press, pp. 3–9, 2017.

**Scaling Constituent Algorithms of a Trend and Change Detection Polyalgorithm** R. Saxena, L.T. Watson, V.A. Thomas, and R.H. Wynne, *High Perf. Computing Symp. (HPC 2017)*, 12 pages, 2017.

**Identifying predisposition in user behaviour on Twitter**

R. Saxena, in preparation.

**Discontinuity Detection in Multivariate Space for Stochastic Simulations** R. Archibald, A. Gelb, R. Saxena, and D.B. Xiu, *Journal of Scientific Computation*, 228, pp. 2676–2689, 2009.

**High Order Method for Gradient Edge Detection**

R. Saxena, A. Gelb, and H. Mittelman, *Communications in Computational Physics*, 5(2-4), pp. 694–711, 2009.

**Landsat Images: Algorithms for Trend and Change Detection**

Landsat Science Team Meeting, Virginia Tech, January 2016.

**Singularity Detection in Unorganized Data: Local and Global Methods** Tata Institute of Fundamental Research, Bangalore (India), November 2012.

**Discontinuity Detection in Stochastic Computations**

Society for Industrial and Applied Mathematics (SIAM)

Annual Meeting & Conference on Imaging Science, San Diego, California, July 2008.

**Detection of Edges in Derivatives**

The International Conference On Spectral and High Order Methods,

ICOSAHOM, Beijing, China, June 2007.

## teaching experience

Winter - Spring 2012

**Lecturer**  
Linear Algebra

Department of Mathematics, University of California, San Diego.

Spring 2009

**Post Doctoral Fellow**  
Calculus

Department of Mathematics, Michigan State University.

Fall 2003 - Spring 2007

**Teaching Assistant in Instructor capacity**

Department of Mathematics &

Statistics, Arizona State University.

Calculus, Finite Mathematics, Algebra. Topics included linear algebra, linear programming, combinatorics, probability, statistics, mathematics of finance, differential and integral calculus. I was responsible for complete class organization, lecturing, preparing and grading exams, quizzes and homeworks as well as assigning the final course grade.

## awards/honors

- Travel awards from graduate school and professional organizations: Awards from Society for Industrial and Applied Mathematics (2008, 2012), Arizona State University (2007, 2008, 2009), International Committee on Spectral and Higher Order Methods (2007, 2009).
- Nominated for Faculty Women's Association Distinguished Research Award.
- Research Award (Block Grant), Division of Graduate Studies, ASU, Summer 2007.
- Recognized as 'Honors Disciplinary Faculty' by the Barrett Honors College, ASU, Spring 2007.
- Outstanding Teaching Assistant Award, Spring 2006.