

Gautam Pendse

Statistical Software Developer

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"Truth is ever to be found in the simplicity, and not in the multiplicity and confusion of things" - Sir Isaac Newton

PERSONAL INFORMATION

US legal status Permanent resident (Green card holder)

SCIENTIFIC INTERESTS

Machine Learning Supervised and unsupervised learning, ICA, Kernel machines, Neural networks, Deep learning, Reinforcement learning, Feature extraction

Statistics Likelihood and Bayesian methods, Non-parametric regression and density estimation, MCMC, Bayesian networks, Mixture models, Markov models, Bootstrap and permutation based inference, Variational methods

Optimization Least squares, Non-linear equations, Constrained optimization, Quadratic programming, Augmented Lagrangian methods, Sequential Quadratic Programming, Interior Point Methods, Derivative free optimization

Applications fMRI analysis, Financial analysis, Data mining, Image processing

EMPLOYMENT HISTORY

2011–Present **Statistical Software Developer,**
The MathWorks, Natick, MA, USA.

2005–2011 **Algorithm Developer,**
PAIN Group, McLean Hospital, Harvard Medical School, Belmont, MA, USA.

Apply concepts of machine learning, optimization and statistics to the analysis of functional magnetic resonance imaging (fMRI) data. Develop, implement and deploy new analytic techniques/tools. Prepare manuscripts for refereed journal publication.

2007–2009 **Scientific Programmer,**
Imaging Consortium for Drug Development (ICD), McLean Hospital, Harvard Medical School, Belmont, MA, USA.

ICD was a collaborative research effort between academia and pharmaceutical companies (Merck, Lilly and Sepracor) for the development of novel drugs to treat central nervous system (CNS) disorders. Developed a Java Enterprise Edition (JEE) platform based web software for distributed computing, the *Analysis Engine*. Integrated advanced mathematical algorithms into the web based software to develop an industry standard, automated parallel computing environment.

- 2003–2004 **Research Assistant,**
Department of Mathematics, Arizona State University, Tempe, AZ, USA.
- Developed novel optimization based framework for system identification of highly interactive process systems.
- Achieved a uniformly distributed output state space for implementing data mining technologies like Model on Demand (MOD).
 - Successfully applied the optimization framework to 3 case studies of increasing difficulty. The optimization problems had on an average 45000 variables and 44000 constraints.
 - Undertook numerical experiments to study the effect of design variables in the optimization framework.
- 2003 **Research Assistant - Book Project,**
Department of Mathematics, Arizona State University, Tempe, AZ, USA.
- Designed exercises and solutions for a book on Linear Cyclic Methods.
- These are novel numerical methods for the solution of Ordinary Differential Equations. In association with my advisor Dr. Hans Mittelmann, Dr. Albrecht was planning to write a book on Linear Cyclic Methods.
 - I was asked to design exercises for the new textbook during the summer of 2003. I designed interesting exercises and developed complete written solutions. I also wrote and documented computer program(s) required for the solution.
- 2002-2003 **Teaching Assistant - Discrete Mathematics,**
Department of Mathematics, Arizona State University, Tempe, AZ, USA.
- Graded projects, reports and computer submissions.
 - Appointed as a tutor in the Mathematics department tutor center.
 - Helped the faculty during in-class assignments and activities.
- 2001-2002 **Research Assistant,**
Department of Chemical Engineering, Michigan Tech. University, Houghton, MI, USA.
- Developed novel theoretical models in three different areas of controlled drug delivery using the principles of transport phenomenon, optimal control theory and mathematical modeling.
- Formulated a PDE constrained problem to find the optimal shape of a diffusive drug delivery device and solved it using MATLAB.
 - Developed a theoretical model to study the phenomenon of swelling, carried out asymptotic analysis and confirmed the experimentally observed behavior.
 - Developed a 2D simulation of drug delivery by erosion and carried out numerical experiments to study the release profiles of various shapes.
- 2001 **Teaching Assistant - Mass and Energy Balances,**
Department of Chemical Engineering, Michigan Tech. University, Houghton, MI, USA.
- Taught a class on Chemical Process Principles in the summer.
 - Designed and graded tests and examinations.
- 2001 **Summer Youth Counselor,**
Department of Chemical Engineering, Michigan Tech. University, Houghton, MI, USA.

- Made presentations to undergraduate students on the field of chemical engineering.
- Supervised experiments in the process control laboratory.
- Gave a guided tour of the department to prospective undergraduate students.

2000-2001 **Teaching Assistant - Process Analysis and Design,**
Department of Chemical Engineering, Michigan Tech. University, Houghton, MI, USA.

- Held regular office hours.
- Helped the faculty in examination and project design.
- Graded projects and homework assignments.

SELECTED SCIENTIFIC SOFTWARE

All the software listed below has been developed from **scratch**.

- iBET **A graph theoretic brain stripping tool.**
 Highly accurate semi-automatic tool for robust brain extraction from noisy data.
- RAICARNTool **A toolbox for reproducible resting state network detection in fMRI.**
 Estimates the null distribution of reproducibility index for non-reproducible independent components (ICs) and provides an objective way of identifying reproducible ICs.
- BSVMTool **A toolbox for fitting a BSVM model.**
 Solves a quadratic programming problem to estimate a banded support vector machine (BSVM) model which is a generalization of the standard SVM model. BSVM can be applied to regression and classification.
- PMOGTool **A toolbox for estimating a PMOG model.**
 Estimates the parameters of a projected mixture of Gaussians (PMOG) model and performs blind source separation.
- PPCAMMTool **A toolbox for estimating a mixture of PPCA model.**
 Estimates the parameters of a mixture of probabilistic PCA analyzers model of Tipping et al. (1999).
- INVCOVTool **Regularized inverse covariance estimation.**
 An algorithm for solving the L1 regularized inverse co-variance problem discussed in Banerjee et al. (2006). Includes tools for solving the L1 regularized LASSO problem via the "shooting" algorithm.
- PERMTool **Toolbox for randomization based hypothesis testing.**
 A tool for making non-parametric permutation or bootstrap based inferences about the parameters of a GLM in the presence of nuisance variables.
- RVMTTool **Toolbox for fitting RVMs for regression.**
 An implementation of Tipping et al. (2001)'s sparse learning machine using both the "standard" and "sequential" approach. Provides tools for kernel bandwidth selection via cross-validation.

- SVMTool** **Toolbox for fitting SVMs for regression and classification.**
Solves the SVM dual problem via quadratic programming (using NLPsolve, see below) and provides tools for cross-validation based grid search for the regularization parameter and kernel width.
- OSCAR** **Optimal, Stable Consistent and Artifact Resistant pattern identification.**
Toolbox for identification of reliable and informative patterns in fMRI data. Uses rigorous simulation based statistical tests for sensitivity and negative entropy of source patterns.
- GENMIX** **Bayesian model search over general mixture spaces.**
Toolbox to perform any type of mixture modeling. Optimizes for both the best model and the best parameter set by using a sophisticated Filter based optimization strategy. Estimates parameters of a hidden Markov random field (MRF) using iterated conditional modes (ICM).
- SMART** **Simultaneous Bias, Variance and Residual Optimization toolbox.**
Performs exact numerical optimization of an objective function capturing bias, variance and residual to compute optimal design matrices for GLM analyses.
- ADIS** **Probabilistic Projection Pursuit toolbox.**
Uses state-of-the-art optimization core, automated latent dimensionality estimation, user specified objective and constraints and produced *verified optimal* blind source estimates.
- WADE** **Wavelet Decomposer toolbox.**
Computes approximation and detail fMRI images using a variety of wavelets such as Haar, Daubechies, and Symmlets of various orders. Provides advanced algorithms for wavelet thresholding, denoising and fractal dimension estimation. Extracts features for low dimensional data projection.
- NLPsolve** **Constrained Optimization toolbox.**
Solves user specified constrained optimization problems using augmented lagrangian bound constrained optimization. Highly vectorized, can handle thousands of constraints. Optimization code has been benchmarked using GAMS performance library. Provides options for limited memory SR1/BFGS updating along with modified and incomplete Cholesky preconditioners.
- NCutTool** **Normalized Graph cut toolbox.**
Provides the ability to detect non-convex clusters by solving normalized cut (NCut) graph partitioning problems. Enables an adaptive multiway hierarchical decomposition using the random walk view of graph partitioning. Uses self-tuning neighborhood size for local structure detection.
- GFDRTool** **Generalized FDR toolbox.**
Provides tools for thresholding statistical maps via a Generalization of the False Discovery Rate (FDR) approach. Uses an adaptive null hypothesis to improve the control of FDR.
- MMTool** **Mixture Modeling toolbox.**
Provides tools for doing constrained Gaussian and Generalized Gaussian mixture modeling using expectation maximization (EM) algorithms. Provides tools for spatial regularization using adaptive Markov random fields. High dimensional data is handled using naive Bayes adaptation of mixture models.

- DECONVTool **Bayesian deconvolution tool.**
Uses a Markov random field (MRF) prior to enforce smooth deconvolved output.
- REGDIAG **Regression diagnostics toolbox.**
Provides diagnostic tools for checking the quality of a regression fit. Provides tools for non-parametric pre-whitening and outlier detection via both temporal and spatial analysis.
- CVTool **Component Analysis toolbox.**
Provides tools for applying modern statistical techniques such as Autocorrelated component analysis (ACA), Canonical correlation analysis (CCA) and Partial least squares (PLS) to fMRI data. Decomposes the 4-D fMRI data into a sequence of spatial maps and their associated time courses based on specified user criterion.
- DISCTool **Discriminant Analysis toolbox.**
Provides tools for doing linear, quadratic and mixture discriminant analysis. Provides techniques for doing kernel discriminant analysis (KDA).
- KPCATool **Kernel PCA toolbox.**
Generalization of linear PCA. Provides tools for doing non-linear projection of input data via Kernel PCA (KPCA).
- GPRTool **Gaussian Process Regression toolbox.**
A toolbox for non-parametric regression using Gaussian Processes. Provides tools for automated kernel composition and learning of kernel hyper-parameters from the data.
- FCTool **Fuzzy clustering toolbox.**
Provides tools such as fuzzy clustering (FCM) and graph based probabilistic clustering tools for fMRI. Provides tools for automated estimation of optimal clusters using bootstrap simulations.

PUBLICATIONS

BOOK CHAPTERS, THESES AND TUTORIALS

- System Identification Hans Mittelmann and Gautam V. Pendse. *Optimal Input Signal Design in Data-Centric System Identification*. Book chapter in [Modern Mathematical Models, Methods and Algorithms for Real World Systems](#), A. H. Siddiqi, I. Duff, and O. Christensen (eds.), Anamaya Publishers, New Delhi-London, 2006:14-59. [Link to preprint](#), [Amazon.com](#)
- Master's Thesis Mathematics Gautam V. Pendse. *Optimization based formulations using the Weyl criterion for input signal design in system identification*. [Department of Mathematics, Arizona State University](#), 2004.
- Master's Thesis Chemical Engineering Gautam V. Pendse. *Fundamentals of Novel drug delivery systems*. [Department of Chemical Engineering, Michigan Tech. University](#), 2002.
- LASSO shooting tutorial Gautam V. Pendse. *A tutorial on the LASSO and the "shooting" algorithm*. 2011. [LASSO shooting website](#)

MACHINE LEARNING, STATISTICS, OPTIMIZATION AND CONTROL

- Statistics Applications Gautam V. Pendse, David Borsook and Lino Becerra. *A simple and objective method for reproducible resting state network (RSN) detection in fMRI*. [arXiv:1108.2248v1](#) [stat.AP], 2011. [RAICAR-N website](#)
- Machine Learning Gautam V. Pendse. *BSVM: A Banded Support Vector Machine*. [arXiv:1107.2347v1](#) [stat.ML], 2011. [BSVM website](#)
- Machine Learning Gautam V. Pendse. *PMOG: The projected mixture of Gaussians model with application to blind source separation*. [arXiv:1008.2743v1](#) [stat.ML], 2010. [PMOG website](#)
- Machine Learning Gautam V. Pendse, Richard Baumgartner, Adam Schwarz, Alexandre Coimbra, David Borsook and Lino Becerra. *A statistical framework for optimal design matrix generation with application to fMRI*. *IEEE Transactions on Medical Imaging*, 2010 29(9):1573-611. [doi:10.1109/TMI.2010.2044512](#), [arXiv:0903.1880v1](#)
- Imaging Statistics Gautam V. Pendse, Adam Schwarz, Richard Baumgartner, Alexandre Coimbra, David Borsook and Lino Becerra. *Robust, unbiased general linear model estimation of phMRI amplitude in the presence of variation in the temporal response profile*. *Journal of Magnetic Resonance Imaging*, 2010 31(6):1445-57. [doi:10.1002/jmri.22180](#)
- Imaging Statistics Gautam V. Pendse, David Borsook and Lino Becerra. *Enhanced false discovery rate using Gaussian mixture models for thresholding fMRI statistical maps*. *NeuroImage*, 2009 47(1):231-261. [doi:10.1016/j.neuroimage.2009.02.035](#)
- Machine Learning Gautam V. Pendse, David Borsook and Lino Becerra. *ADIS: A robust pursuit algorithm for probabilistic, constrained and non-square blind source separation with application to fMRI*. [arXiv:0902.4879v1](#) [stat.CO], 2009.
- Optimization Hans Mittelmann, Gautam V. Pendse, Daniel Rivera, and Hyunjin Lee. *Optimization-based Design of Plant-Friendly Multisine Signals using Geometric Discrepancy Criteria*. *Computational Optimization and Applications*, 2007 38:173-190. [Link to preprint](#)
- System Identification H. Lee, D. E. Rivera, H. D. Mittelmann, and Gautam V. Pendse. *Optimization-based Design of Plant-Friendly Input Signals for Model-On-Demand Estimation and Model Predictive Control*. in *Proceedings of American Control Conference (ACC)*, 2007 1560-1565 [Link to preprint](#)
- Process control D. E. Rivera, H. Lee, H. D. Mittelmann, and Gautam V. Pendse. *Optimization-based Design of Plant-Friendly Input Signals for Data-Centric Estimation and Control*. *Annual AIChE Meeting*, paper 242k, Cincinnati, OH, October 31 - November 4, 2005 [Link to preprint](#) [[CAST Directors' Award Honorable Mention](#)]

IMAGING APPLICATIONS

- Imaging Drugs Upadhyay J., Anderson J., Schwarz A. J., Coimbra A., Baumgartner R., Pendse G., George E., Nutile L., Wallin D., Bishop J., Neni S., Maier G., Iyengar S., Evelhoch J. L., Bleakman D., Hargreaves R., Becerra L., Borsook D. *Imaging Drugs with and without Clinical Analgesic Efficacy*. [Neuropsychopharmacology](#), 2011 in press
- Cerebellum fMRI Moulton E. A., Elman I., Pendse G., Schmahmann J., Becerra L., Borsook D. *Aversion-related circuitry in the cerebellum: responses to noxious heat and unpleasant images*. [Journal of Neuroscience](#), 2011 31(10):3795-804.
- Temporal Pole Migraine Moulton E. A., Becerra L., Maleki N., Pendse G., Tully S., Hargreaves R., Burstein R., Borsook D. *Painful heat reveals hyperexcitability of the temporal pole in interictal and ictal migraine States*. [Cerebral Cortex](#), 2011 21(2):435-48.
- Prescription Opioids Upadhyay J., Maleki N., Potter J., Elman I., Rudrauf D., Knudsen J., Wallin D., Pendse G., McDonald L., Griffin M., Anderson J., Nutile L., Renshaw P., Weiss R., Becerra L., Borsook D. *Alterations in brain structure and functional connectivity in prescription opioid-dependent patients*. [Brain](#), 2010 133(7):2098-114.
- BOLD response Upadhyay J., Pendse G., Anderson J., Schwarz A. J., Baumgartner R., Coimbra A., Bishop J., Knudsen J., George E., Grachev I., Iyengar S., Bleakman D., Hargreaves R., Borsook D., Becerra L. *Improved characterization of BOLD responses for evoked sensory stimuli*. [NeuroImage](#), 2010 49(3):2275-86.
- Neurotransmitters Migraine Prescott A., Becerra L., Pendse G., Tully S., Jensen E., Hargreaves R., Renshaw P., Burstein R., Borsook D. *Excitatory neurotransmitters in brain regions in interictal migraine patients*. [Molecular Pain](#), 2009 30:5-34.
- Ketamine CRPS Becerra L., Schwartzman R. J., Kiefer R. T., Rohr P., Moulton E. A., Wallin D., Pendse G., Morris S., Borsook D. *CNS Measures of Pain Responses Pre- and Post-Anesthetic Ketamine in a Patient with Complex Regional Pain Syndrome*. [Pain Med.](#), 2009 in press
- Neuropathic pain structural and functional DaSilva A. F., Becerra L., Pendse G., Chizh B., Tully S., Borsook D. *Colocalized structural and functional changes in the cortex of patients with trigeminal neuropathic pain*. [PLoS One](#), 2008 3(10):e3396.
- CRPS fMRI Lebel A., Becerra L., Wallin D., Moulton E. A., Morris S., Pendse G., Jasciewicz J., Stein M., Aiello-Lammens M., Grant E., Berde C., Borsook D. *fMRI reveals distinct CNS processing during symptomatic and recovered complex regional pain syndrome in children*. [Brain](#), 2008 131(7):1854-79.
- Somatotopy Face Moulton E. A., Pendse G., Morris S., Aiello-Lammens M., Becerra L., Borsook D. *Segmentally arranged somatotopy within the face representation of human primary somatosensory cortex*. [Human Brain Mapping](#), 2009 30(3):757-65.

Tic Doloureux Borsook D., Moulton E. A., Pendse G., Morris S., Cole S. H., Aiello-Lammens M., Scrivani S., Becerra L. *Comparison of evoked vs. spontaneous tics in a patient with trigeminal neuralgia (tic doloureux)*. [Molecular Pain](#), 2007 6:3-34.

Capsaicin Sensitization Moulton E. A., Pendse G., Morris S., Strassman A., Aiello-Lammens M., Becerra L., Borsook D. *Capsaicin-induced thermal hyperalgesia and sensitization in the human trigeminal nociceptive pathway: an fMRI study*. [NeuroImage](#), 2007 35(4):1586-600.

CNS pain with mechanical and thermal Becerra L., Morris S., Bazes S., Gostic R., Sherman S., Gostic J., Pendse G., Moulton E., Scrivani S., Keith D., Chizh B., Borsook D. *Trigeminal neuropathic pain alters responses in CNS circuits to mechanical (brush) and thermal (cold and heat) stimuli*. [Journal of Neuroscience](#), 2006 26(42):10646-57.

SCIENTIFIC ACTIVITIES

Reviewer Human Brain Mapping, NeuroImage, IEEE Transactions on Medical Imaging, Journal of Magnetic Resonance Imaging

Conferences Human Brain Mapping, Society for Neuroscience, International Society for Magnetic Resonance Imaging

COMPUTER SKILLS

OPERATING SYSTEMS

Microsoft Windows, Linux, MacOS

PROGRAMMING LANGUAGES

Scientific MatLab, R, Mathematica, Maple, MathCad

Object-Oriented Java, C++

Procedural C, Perl, Fortran

Scripting bash, JavaScript

Web HTML, CSS

OTHER TOOLS

Database query Oracle SQLPlus

Word processing T_EX, L^AT_EX, Microsoft Office, Adobe Illustrator

EDUCATION

2002–2004 **M.A Mathematics**, *Department of Mathematics and Statistics*
Arizona State University, Tempe, AZ, USA.
 GPA 4.00 out of 4.00

THESIS

title *Optimization based input signal design framework for identification of highly interactive process systems*

supervisor **Dr. Hans D. Mittelmann**

description Optimization of geometric discrepancy with application to system identification

2000–2002 **M.S Chemical Engineering**, *Department of Chemical Engineering Michigan Tech. University*, Houghton, MI, USA.
GPA 4.00 out of 4.00

THESIS

title *Analytical modeling and development of novel transport systems using the principles of transport phenomenon and optimal control theory*

supervisor **Dr. Jason M. Keith**

description Mathematical modeling and design of novel drug delivery systems

1996–2000 **B.E Chemical Engineering**, *Department of Chemical Engineering The Maharaja Sayajirao University*, Baroda, India.
GPA 3.99 out of 4.00

HONORS AND SCHOLARSHIPS

Graduate school Awarded full scholarship (tuition waiver and support as a TA/RA) at both **Arizona State University** (while pursuing M.A Mathematics) and **Michigan Tech University** (while pursuing M.S Chemical Engineering)

Poster award **Computing and Systems Technology (CAST) Directors Award** - Honorable mention for best poster presentation at the **AICHE** annual meeting 2005. Poster title: *Optimization-based Design of Plant Friendly Input Signals for Data-Centric Estimation and Control*

Undergraduate **Reliance Industries** scholarship for academic excellence

High school Stood 2nd at the **Gujarat Higher Secondary Certificate Examination** in **Vadodara**, Gujarat, India out of a pool of 53,000 candidates

UPDATED

August 19, 2011