EUGENE BREVDO

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EDUCATION

Ph.D., Department of Electrical Engineering, Princeton University (2005-2011)
Advisers: Peter Ramadge and Ingrid Daubechies.
Dissertation Topics: Wavelet-like constructions for inverse problems in geophysics. Instantaneous
Frequency Estimation with applications to biomedical engineering and climatology. Manifold learning.

B.S., Electrical, Computer & Systems Engineering, Rensselaer Polytechnic Institute (2001-2005)
GPA: 4.00/4.00. Senior Thesis: Design and analysis of an image processing system for the automated
classification of small factory floor parts.

RESEARCH AND PROFESSIONAL EXPERIENCE

Research Scientist: Bioinformatics (NGS) and Machine Learning (March 2013 – Present)
SVBio, Foster City, CA
- Designed & implemented novel estimators of pathogenicity for de novo variants (mutations).
- Ingested and processed new germline and somatic variant datasets.
- Designed and automated the deployment of the in-house pipeline into a HIPAA/CLIA compliant
  production distributed workflow on Amazon AWS infrastructure. Touched every part of:
  Assembly → Variant Calling → Annotation → Pathogenicity Scoring, and CLIA workflow.
- Open source contributions: snpEff, boto, s3cmd, starcluster, ansible.

Senior Data Scientist: Computational Climatology, Agronomy Modeling (July 2011 – Feb 2013)
The Climate Corporation (formerly Weatherbill), San Francisco, CA
- Led a team of 3 statisticians/engineers to an agronomy model product release.
- Led the design and generation of large-scale precipitation reconstructions.
- Designed and optimized large-scale learning and optimization algorithms: Constrained
  Stochastic Gradient Descent (SGD), Bayesian clustering and regression (MCMC).
- Numerous time-sensitive projects leading up to product releases in 2011 and 2012.
- Open source contributions: Mahout, cvxpy, incanter, scidata.

Ph.D. Dissertation Research (2005 – 2011)
Department of Electrical Engineering, Princeton University, Princeton, NJ
Advisers: Peter Ramadge and Ingrid Daubechies
Coursework: Random Processes, Information Theory, Detection and Estimation, Real Analysis,
              Artificial Intelligence, Convex Optimization, Wavelet Theory
Dissertation Topics:
- Compressive Sensing and Wavelet-like dictionary construction for inverse problems.
- Instantaneous frequency estimation and applications in medical imaging, geosciences.
- Geometry of learning and Manifold learning.
- Signal analysis and classification via Wavelet-based Bayesian Network models.

Research Intern: Compressive Sensing / Inverse Problems in Medical Imaging (Summer 2008)
Siemens Corporate Research, Princeton, NJ
Mentors: Michelle Yan, Tong Fang
- Developed CS-based estimator for Computational Tomography with Sinogram Occlusion.

- Developed a novel CS-based reconstruction technique for PET tomography (Poisson noise model). This work directly led to an Invention Disclosure/Provisional U.S. Patent Application.

Research Intern: Computer Vision for OCR (Google Book Search)   (Summer 2007)
Google, Mountain View, CA
Mentor: Ashok Popat
- Designed a testing framework and classifier for image-based detection of script and language from digital text images. This work directly led to a U.S. Patent (No. 8,233,726 B1).

Research Scholar: Signal Processing and Inverse Problems   (Summers, 2004-2005)
Air Force Research Laboratories, Maui Optical and Supercomputing Site, Kihei, HI
Advisers: Kim Luu, Chris Sabol
- Studied the spectral unmixing problem: classify distant satellites via hyperspectral imagery.
- Designed algorithms for estimating the shape and material composition of such satellites (sub-pixel classification) using covariance estimates.

Undergraduate Research: Medical Imaging / Image Reconstruction   (Fall 2004-Spring 2005)
Electrical Impedance Tomography (EIT) Research Group, Rensselaer Polytechnic Institute, Troy, NY
Advisers: John Newell, David Isaacson, Gary Saulnier
- Implemented real-time variants of the NOSER algorithm (linearized phase-space PDE solution to Maxwell's equations) for use with a hand-held probe. Implemented this code in embedded C. This probe has since been shown to be effective for breast cancer detection.
- Designed imaging subsystems in the PC reconstruction software for use with all EIT probes.

Network Engineering Intern   (Nov. 2000 – Aug. 2003)
Factset Research Systems, Greenwich, CT and Boston, MA
Full-time summers and part-time during the school year
Mentors: Jeff Young, Michael Caruso
- Created a real-time network monitoring + distributed network polling system, web interface.
- Ported the 'Vision' Object Oriented database system to Linux.

OPEN SOURCE CONTRIBUTIONS

Matlab Synchrosqueezing Toolbox (instantaneous frequency analysis)
https://web.math.princeton.edu/~ebrevdo/synsq/

Github: https://github.com/ebrevdo

Contributor:
- [python]   StarCluster, boto, s3cmd, ansible
- [java]   Mahout, VFS-S3, Jackson (json serialization), snpEff (genomic annotation)
- [clojure]   Incanter (math/stats library)

Maintainer:
- [python]   scidata (objects for holding self-describing scientific data)

SKILLS

Signal Processing
- Wavelet construction / analysis on the line, plane, sphere, high dimensional surfaces, graphs
- Frequency analysis on the line, plane, sphere, graphs
- Instantaneous frequency analysis on the line
- Robust frequency analysis (Slepian analysis / Multitaper estimation) on the line, plane, sphere
- Iterative solutions to inverse problems in medical imaging, remote sensing, and geophysics
- Convex optimization (also dual relaxation, SDP modeling, non-interior point methods)

Statistical Learning
- Standard methods of regression/classification, SVD/PCA, PLS, Boosting, Random Forest.
- Significance testing: bootstrap, cross-validation, Monte Carlo, large deviations bounds.
- Large scale/online solutions for logistic and linear regression models with constraints
- Large scale solvers for linear/poisson regression with sparsity (e.g., compressive sensing)
- Mixture modeling (e.g. Dirichlet Process clustering and regression via Gibbs MCMC)
- Hidden Markov Models (HMM) and Trees (used in multiscale hierarchical image processing)
- Statistical estimation/optimization on non-standard geometries (e.g., Grassmannian manifolds)

Professional
- Led a 3 person team of statisticians and software engineers to product release (Climate Corp.)
- Moved in-house research pipeline to distributed production pipeline on Amazon AWS (SVBio)
- Scrum software development cycle, confluence, JIRA
- Experience interviewing research and software development candidates

Software Development
- Operating systems: Debian, Ubuntu, Mac OS X
- Languages: C, C++, Python, Java, clojure, MATLAB, R, Scala, perl
- Hadoop / MapReduce, Cascading + Python, cascalog, Spark, Graphlab, Open Grid Engine
- Python modeling: numpy, scipy, pymc, cvxopt, pandas, ipython, pyplot
- Java/clojure spatial analysis and modeling: Java Topology Suite (JTS), incanter, jblas, cascalog
- Bioinformatics: samtools, BWA, picard, GATK, SnpEff, VCF/BAM/FASTQ formats, etc
- Persistency: MySQL, PostgreSQL, BigQuery, hive, Shark, HDFS, jackson, kryo, hibernate
- Revision systems: cvs, svn, git (+gerrit), perforce
- Development: eclipse, intellij, emacs, QtCreator, gdb, jvisualvm

PUBLICATIONS

E. Brevdo and P. J. Ramadge. "Semisupervised Learning: The Regularized Laplacian, Geodesics, and the Small Viscosity Limit", Submitted.

G. Thakur, **E. Brevdo**, N.S. Fučkar, and H.T. Wu. "The Synchrosqueezing algorithm for time-varying spectral analysis: robustness properties and new paleoclimate applications", *Signal Processing* (2012).

F. J. Simons, I. Loris, **E. Brevdo,** and I. Daubechies. "Wavelets and wavelet-like transforms on the sphere and their application to geophysical data inversion", TR, arXiv:1109.1718, September 2011.

E. Brevdo and P. J. Ramadge. "Bridge Detection and Robust Geodesics Estimation via Random Walks", IEEE Int. Conference on Acoustics, Speech & Signal Processing, Dallas, Texas, March 2010.

S. Jafarpour, G. Polatkan, **E. Brevdo**, S. Hughes, A. Brasoveanu, and I. Daubechies, "Stylistic Analysis of Paintings Using Wavelets and Machine Learning," European Signal Proc. Conf. (EUSIPCO) 2009.

C. R. Johnson, Jr., E. Hendriks, I. Berezhnoy, **E. Brevdo**, S. Hughes, I. Daubechies, J. Li, E. Postma, and J.Z. Wang. "Image Processing for Artist Identification: Brushwork in the Paintings of Vincent Van Gogh," IEEE Signal Processing Magazine Special Issue on Visual Cultural Heritage, July 2008.

E. Brevdo, K.K. Luu. "Improving the Hyperspectral Linear Unmixing Problem with Unsupervised Clustering and Covariance Estimates", SPIE Defense and Security Symposium, Orlando Fl., April 2006.

J. Lambert, K.K. Luu, **E. Brevdo**. "Direct Inversion of Visible and Infrared Signatures", AMOS Technical Conference, Kihei, HI., September 2004.

Presentations

P. Machalek, S.M. Kim, R.D. Berry, A. Liang, T. Small, **E. Brevdo**, and A. Kuznetsova, "Using Python to generate AHPS-based precipitation simulations over CONUS using Amazon distributed computing," American Geophysical Union Fall Meeting, December 2012.

S. Hughes, **E. Brevdo**, and I. Daubechies, "Identifying Hidden Features: A Digital Characterization of Van Gogh's Style," First International Workshop on Image Processing for Artist Identication, Van Gogh Museum, Amsterdam, May 2007.

H. Xia, A. S. Ross, **E. Brevdo**, T-J Kao, Ning Liu, B. S. Kim, J.C. Newell, G. J. Saulnier, D. Isaacson. "The Application software of ACT4." Conference on Biomedical Applications of Electrical Impedance Tomography, University College London, June 2005.

Scholarships and Fellowships

2006-2011   NSF Graduate Research Fellowship
2006-2010   NDSEG (National Defense Science and Engineering Graduate) Fellowship
2005-2010   Gordon Wu Engineering Fellowship, Princeton University
2004-2005   NSF Computer Science, Engineering, and Mathematics Scholarship (CSEMS)
2003-2005   Linear Technology Corporation / Glenn Mueller '64 Memorial Scholarship

Formal Software Training

March 2012   Clojure training workshop (Relevance Inc.)
July 2012   Cascalog training workshop (Sam Ritchie)

Other Activities

Organizer, Internal research presentations at The Climate Corporation, 2011 - 2013
Reviewer, IEEE Transactions on Signal Processing, 2012
Reviewer, IEEE Workshop on Machine Learning for Signal Processing (MLSP), 2010
Reviewer, Conference on Information Sciences and Systems (CISS), 2010
Organizer, Student-run Information Sciences and Systems Seminar, Princeton University, 2007