Brian D. Bue

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Research Interests

- **Machine learning:** domain adaptation, metric learning, dimensionality reduction, semi-supervised learning, classification and clustering of high dimensional data
- **Remote sensing:** hyperspectral imaging, automated material identification, spectral unmixing, endmember detection, novelty/change/target detection
- **Planetary and Earth science applications:** onboard autonomy, crater counting
- **Scientific visualization:** information visualization for high-dimensional data

Education

- **Rice University, Houston, TX (Aug. 2007 – May 2013)**
  Ph.D. in Electrical and Computer Engineering (ECE)
  - Thesis title: Adaptive Similarity Measures for Material Identification in Hyperspectral Imagery
  - NASA GSRP fellow, advisor: Erzsébet Merényi, Dept. of Statistics and ECE, Rice University, GSRP technical advisor: Kiri Wagstaff, NASA JPL
  - Coursework: random processes, statistical signal processing, machine learning, artificial neural networks and information theory I and II, functional analysis
- **Purdue University, West Lafayette, IN (Aug. 2004 – May 2006)**
  Master of Science in Computer Science (CS)
  - Coursework: artificial intelligence, computer graphics, visualization, algorithms, programming languages, operating systems, numerical analysis, computational geometry, remote sensing
- **Augsburg College, Minneapolis, MN (Aug. 1999 – May 2003)**
  Bachelor of Science in Computer Science/Bachelor of Arts in Mathematics
  - GPA Overall: 3.6, CS: 3.8, Math 3.5
  - Graduated with Distinction and CS Departmental Honors

Journal Articles

- *B.D. Bue, D.R. Thompson, R.G. Sellar, E. Podest, M.L. Eastwood, M. Helmlinger, I. McCubbin and J. Morgan,* **"Leveraging In-scene Spectra for Robust Discrimination of Vegetation Species with MESMA-MDA,"** ISPRS Journal of Photogrammetry and Remote Sensing, submitted Jan. 2015.
- *B.D. Bue, D.R. Thompson, M.L. Eastwood, D. Keymeulen, B.-C. Gao, C.M. Sarture, A.S. Mazer, H.H. Luong and R. O. Green,* "**Real-time Atmospheric Correction for AVIRIS-NG imagery,**" IEEE Trans. on Geoscience and Remote Sensing, to appear, 2015.
- *K.L. Wagstaff, D.R. Thompson, B.D. Bue and T. Fuchs,* **"Autonomous Real-time Detection of Plumes and Jets from Moons and Comets,"** The Astrophysical Journal, v. 794 iss. 43, 2014.
- *B.D. Bue,* **"An Evaluation of Low-rank Mahalanobis Metric Learning Techniques for Hyperspectral Image Classification,"** IEEE Journal of Special Topics in Applied Earth Observation and Remote Sensing (JSTARS), Special Issue on Machine Learning for Remote Sensing Data Analysis, v. 7, iss. 4, p. 1079-1088, Apr. 2013.
- *D.R. Thompson, B. Bornstein, S. Chien, S. Schaffer, D. Tran, B.D. Bue, Rebecca Castaño, D.*

Gleeson, and A. Noell, "**Autonomous Spectral Discovery and Mapping Onboard the EO-1 Spacecraft,**" IEEE Trans. on Geoscience and Remote Sensing, v. 51 p. 3567-3579, Jun. 2013.

- *B.D. Bue and E. Merényi,* "**An Adaptive Similarity Measure for Classification of Hyperspectral Signatures**," IEEE Geoscience and Remote Sensing Letters, v. 10, iss. 2, p. 381-385, Mar. 2013.
- *B.D. Bue, E. Merényi and B. Csathó,* "**Automated Labeling of Materials in Hyperspectral Imagery,**" IEEE Trans. on Geoscience and Remote Sensing, v. 48, iss. 11, p. 4059-4070, Nov. 2010.
- *T.F. Stepinski, M.P. Mendenhall and B.D. Bue,* **"Machine Cataloging of Impact Craters on Mars,**" Icarus, v. 203, iss. 1, p. 77-87, Sep. 2009.
- *B.D. Bue and T.F. Stepinski*, **"Machine Identification of Martian Craters Using Digital Elevation Data,**" IEEE Trans. on Geoscience and Remote Sensing, v. 45, iss. 1, p. 265-274, Jan. 2007.
- *J. Huang, B.D. Bue, A. Pattath, D. Ebert and K. Thomas,* **"Interactive Illustrative Rendering on Mobile Devices**," IEEE Computer Graphics and Applications. v. 27, iss 3, p. 48-56, May 2007.
- *B.D. Bue and T.F. Stepinski,* "**Automated Classification of Landforms on Mars**," Elsevier Computers and Geosciences, v. 32, iss. 5, p. 604-614. Nov. 2005.

Conference Proceedings

- *B.D. Bue, U. Rebbapragada, K.L. Wagstaff, D.R. Thompson and B. Tang,* "**Using Machine Learning to Enable Big Data Analysis within Human Review Time Budgets,**" American Geophysical Union Fall Meeting, San Francisco, CA. Dec. 2014.
  B.D. Bue, K.L. Wagstaff, U. Rebbapragada, D.R. Thompson, and B. Tang, "**Astronomical Data Triage for Rapid Science Return,**" 2014 Conference on Big Data from Space (BiDS14). Rome IT. Nov. 2014.
- *B.D. Bue, D.R. Thompson, M.L. Eastwood, D. Keymeulen, B.-C. Gao, C.M. Sarture, A.S. Mazer, H.H. Luong and R.O. Green,* "**Real time, model-based reflectance retrieval for AVIRIS-NG imagery,"** 2014 HyspIRI Science Workshop, Pasadena, CA. Oct. 2014.
- *B.D. Bue, D.R. Thompson and R.G. Sellar,* **"HLB (Citrus Greening Disease) Detection using Reflectance Spectroscopy,"** 2014 HLB Working Group meeting, Fresno, CA. Sep. 2014.
- *B.D. Bue, and C. Jermaine,* "**Multiclass Domain Adaptation with Iterative Manifold Alignment**," IEEE WHISPERS 2013, Gainesville, FL. June 2013.
- *B.D. Bue, E. Merényi and J.M. Killian*, "**Classification and Diagnosis of Myopathy from EMG Signals**," 2nd Workshop on Data Mining for Medicine and Healthcare, Austin, TX, May. 2013.
- *D.R. Thompson, B. Bornstein, B.D. Bue, D. Tran, S. Chien and R. Castano.* "**Hyperspectral Feature Detection Onboard the Earth Observing One Spacecraft using Superpixel Segmentation and Endmember Extraction,"** International Symposium on Artificial Intelligence, Robotics and Automation in Space (iSAIRAS), Turin IT. 2012.
- *B.D. Bue and D.R. Thompson,* "**Multiclass Continuous Correspondence Learning**," NIPS 2011 Domain Adaptation Workshop, Granada ES. Dec. 2011.
- *B.D. Bue and E. Merényi,* "**An Evaluation of Class Knowledge Transfer from Synthetic to Real Hyperspectral Imagery,**" IEEE WHISPERS 2011. Lisbon PT. Jun. 2011.
- *B.D. Bue, D.R. Thompson, M. Gilmore and R. Castaño,* "**Metric Learning for Hyperspectral Image Segmentation,**" IEEE WHISPERS 2011. Lisbon PT. Jun. 2011.
- *B. Bornstein, S. Chien, R. Castaño, D.R. Thompson and B.D. Bue,* "**Efficient Spectral Endmember Detection Onboard the EO-1 Spacecraft,**" IEEE WHISPERS 2011. Lisbon PT. Jun. 2011.

- *D.R. Thompson, M. Gilmore, R. Castaño and B.D. Bue,* "**Automatic Detection of Water and Mafics in M3 Radiance Images,**" 42nd Lunar and Planetary Science Conference. Houston TX. Mar. 2011.
- *B.D. Bue and E. Merényi,* "**Using Spatial Correspondences for Hyperspectral Class Knowledge Transfer: Evaluation on Synthetic Data,**" IEEE WHISPERS 2010. Reykjavik IS. Jun. 2010.
- *B.D. Bue, E. Merényi and B. Csathó* "**Automated Labeling of Segmented Hyperspectral Imagery via Spectral Matching,**" IEEE WHISPERS 2009. Grenoble, FR. Aug. 2009.
- *J.L. Rich, B. Csathó, E. Merényi, B.D. Bue, C-L. Ping, and L. Everett,* **"Characterizing Polar Landscapes from Multi- and Hyperspectral Imagery**," 9th International Conference on Permafrost, Fairbanks, AK. Jul. 2008.
- *B. Bornstein, B.D. Bue, S. Lee, and L. Mandrake,* **"Autonomous Identification and Quantification of Chemical Species with the Vehicle Cabin Atmosphere Monitor (VCAM) for use Onboard the International Space Station (ISS)**," IEEE Aerospace Conference, Big Sky, MT. Mar. 2008.
- *L. Mandrake, B.D. Bue, S. Lee, and B. Bornstein,* **"Lessons Learned from Reverse Engineering and Porting the NIST AMIDS COTS Algorithm to Flight Software**," IEEE Aerospace Conference, Big Sky, MT. Mar. 2008.
- *R. Castaño, T. Estlin, D. Gaines, B. Bornstein, R.C. Anderson, B.D. Bue, C. Chouinard, and M. Judd,* **"Experiments in Onboard Rover Traverse Science**," IEEE Aerospace Conference, Big Sky, MT. Mar. 2008.
- *R. Castaño, K.L. Wagstaff, D. Gleeson, R. Pappalardo, S. Chien, D. Tran, L. Scharenbroich, B. Tang, B.D. Bue and T. Doggett,* **"Onboard Detection of Active Canadian Sulfur Springs: A Europa Analogue**," 9th International Symposium on Artificial Intelligence, Robotics and Automation for Space. Universal City, CA. Feb. 2008.
- *B. Moghaddam, B.D. Bue, K.L. Wagstaff and R. Castaño,* **"Surface Change Detection From Mars Orbital Imagery**," American Geophysical Union Fall Meeting. San Francisco, CA. Dec. 2007.
- *B.D. Bue, K.L. Wagstaff, R. Castaño and A. Davies,* "**Automatic Plume Detection for Planetary Bodies,**" American Geophysical Union Fall Meeting. San Francisco, CA. Dec. 2006.
- *K.L. Wagstaff, R. Castaño, A. Davies and B.D. Bue*, "**Automating the Detection of Enceladus-Style Plumes,**" 38th Meeting of the Division for Planetary Sciences. Pasadena, CA. Oct. 2006.
- *B.D. Bue and T.F. Stepinski,* "**Machine Detection of Martian Craters from Digital Topography,**" proc. 37th Lunar and Planetary Science Conference. Houston, TX. Mar. 2006.
- *B.D. Bue and T.F. Stepinski,* "**Automated Classification of Landforms in Terra Cimmeria, Mars,**" 36th Lunar and Planetary Science Conference. Houston, TX. Mar. 2005.
- *B.D. Bue and T.F. Stepinski,* "**Automatic Classification of Martian Topographical Data,**" Lunar and Planetary Institute 2004 Summer Intern Conference. Houston, TX. Aug. 2004.
- *B.D. Bue, J. Zoss and N. Petit,* "**Design and Implementation of Reliable Data Systems,**" 13th Undergraduate Research Symposium. Argonne National Laboratories, Argonne, IL. Oct. 2002.

Ph.D. Thesis

- *B.D. Bue, "***Adaptive Similarity Measures for Material Identification in Hyperspectral Imagery,**" Ph.D. thesis, Dept. of Electrical and Computer Engineering, Rice University, Apr. 2013.

Technical Reports

- *B.D. Bue, E. Merényi and K. Wagstaff,* "**Automatic Labeling of Hyperspectral Imagery via Semantic Modeling**," NASA Graduate Student Researchers Program final report, CL#11-0785.
- *B.D. Bue,* "**Composite Landmark Analysis and Extraction for Robot Navigation**," Technical Report TR01-13, NSF Research Experience for Undergraduates Program. Augsburg College. Aug. 2001.

Research Experience

- **Machine Learning and Instrument Autonomy group, NASA Jet Propulsion Laboratory, research technologist III:** Develop algorithms and software in support of NASA-based research and missions. Selected projects include:
  - HiiHAT Hyperspectral Analysis Toolkit: Developed an IDL/ENVI toolkit for superpixel-based hyperspectral image analysis, incorporates adaptive similarity measures for hyperspectral imagery from Ph.D. research (http://hyperspectral.jpl.nasa.gov)
  - Vehicle Cabin Atmospheric Monitor (VCAM): Implemented and evaluated mass spectral matching algorithms for analyzing gas chromatography/mass spectrometry data onboard the International Space Station. Implemented a resource-constrained version of the NIST AMDIS (http://www.amdis.net/) mass spectral matching algorithm in C (vxWorks) and python. (http://aemc.jpl.nasa.gov/instruments/vcam.cfm)
  - Rock Identification Toolkit (RockIT): A toolkit for image-based analysis of Martian geology from Mars Exploration Rover imagery, commonly used in the Oasis project (http://oasis.jpl.nasa.gov/). Added anomaly detection and multi-image analysis capabilities to the existing RockIT system.
  - Mars Surface Change Detection: Developed methods for detecting transient surface features using Mars Orbiter Camera (MOC) imagery using information theoretic measures of regional salience.
  - Automatic Volcanic Plume Detection from Imagery: Developed an automated image-based volcanic plume detection procedure by extending a spherical-harmonics-based planetary limb/terminator extraction algorithm to detect spherical abnormalities.

  (Associate member of technical staff: Jul. 2006 – Aug 2007, NASA GSRP Fellow: Aug. 2007 – Aug. 2010, Graduate research assistant/HiiHAT software developer: Sep. 2010– Aug. 2011, Research Technologist III: Jun. 2013 – present)
- **Rice University Hurricane Risk Assessment and Design of Evacuation Policies project, research assistant:** Worked with an interdisciplinary team of computer scientists, civil engineers and political scientists (Subramanian, PI) to assess hurricane damage risk for residential properties. Developed a model of "engineering risk" based on simulated flood, storm surge, and wind parameters, combined with tax appraisal data. Performed statistical analysis of the risk model with respect to phone survey results for approx. 500k properties in the Houston area affected by Hurricane Ike. (Fall 2008, Summer 2009)
- **Purdue University Rendering and Perceptualization Lab, research assistant:** Developed Tablet and PocketPC software for task adaptable information display intended to be used by training, maintenance and emergency response personnel. (Aug. 2005-Jul. 2006)
- **Lunar and Planetary Institute, visiting graduate student:** Employed techniques from computer vision and integral geometry to extend our landform classification algorithm to perform automatic crater counting and characterization. (Summer 2005)
- **Lunar and Planetary Institute/NASA Johnson Space Center, summer internship:** Developed an unsupervised landform classification application used to characterize Martian topographical data. Research involved multispectral image analysis techniques, data mining, and computer vision. Performed extensive testing and verification in Mathematica and R. (Summer 2004)
- **NSF-ITR Virtual Reality Localization project, research assistant:** Researched methods to

exploit visual cues for localization in virtual environments. Developed a glove manipulator in OpenScene-Graph/C++ for a 5DT wireless data glove and InterSense tracking system. (Summer 2003)

- **Ausburg Computer Science, Independent study:** Designed and implemented Augsburg's first Linux-based x86 Beowulf cluster. Developed a heterogeneous cluster management system in Perl/BASH. Implemented several parallel algorithms using PVM and LAM-MPI. Presented work at the 2003 Augsburg College Research and Scholarship fair, May 2003. (Spring 2003)
- **Automatic Geophysical Observatories project, research assistant:** Developed multithreaded, time-critical applications in C++ that measure input from search coil magnetometers currently positioned in the Arctic Circle. Aided in the installation of an unmanned data acquisition system in Sondrestrom, Greenland. Presented work at the 13th annual undergraduate research symposium at Argonne National Laboratories, Argonne IL, and at the 1st annual NSF CSEMS undergraduate research seminar at Augsburg College, Minneapolis, MN. (May 2002-Aug. 2003)
- **NSF Research Experience for Undergraduates program, summer internship:** Computer vision research focused on image analysis for robotic navigation. Developed a composite landmark extraction application utilizing least-squares regression techniques. (Summer 2001)
- **Taxi 2000 Corporation, Fridley, MN, application engineer:** Developed network layout applications for a personal rapid transit (PRT) system. Maintained and debugged legacy applications for translation from VB to C++/C#. Assisted in various Windows and UNIX system administration duties. (Mar. 2004-Jun. 2004)

Honors and Awards

- **NASA Board and Tech Brief Awards**
  - **NTR 46691: "Quantification of Trace Chemicals Using Vehicle Cabin Atmosphere Monitor,"** awarded to *S. Lee, L. Mandrake, B.D. Bue, and B. Bornstein.* (Apr. 2009)
  - **NTR 46563: "Adaptation of the AMDIS Method to Flight Status on the VCAM Instrument for ISS Installation in an Autonomous Manner,"** awarded to *L. Mandrake, B.D. Bue, S. Lee, and B. Bornstein.* (Feb. 2008)
- **NASA Graduate Student Researchers Program Fellowship** (Aug. 2007-Aug. 2010)
- **Rice University**
  - **NSF VIGRE Summer Graduate Fellowship, Dept. of Statistics** (Jun.-Aug. 2012)
  - **First-year Graduate Fellowship** (Aug. 2007-May 2008)
  - **Dean's Travel Grant, School of Engineering** (Aug. 2009, Jun. 2010, Jun. 2011)
- **Texas Space Grant Fellowship** (title only, Aug. 2007-May 2008)
- **Purdue University Space Shuttle Memorial Fund Scholarship** (Sep. 2005-May 2006)
- **Augsburg College**
  - **Computer Science, Engineering and Mathematics Scholarship** (Sep. 2001-May 2003)
  - **Departmental honors: Computer Science** (May 2003)
  - **Dean's list** (Sep. 2000-May 2003)
  - **Legacy and Regents Scholarships** (Sep. 2000)

Teaching Experience

- **Rice University, Houston, TX**
  - TA: COMP140-Introduction to Computational Thinking (undergrad. level CS, Prof. Subramanian)
    - Responsibilities: Assisting with grading homework and exams, developing course curriculum, assisting with weekly lab sessions, and giving occasional lectures.

- Grader: COMP540-Machine Learning (grad. level, ECE, Prof. Subramanian), ELEC502-Artificial Neural Networks and Information Theory (grad. level, ECE, Prof. Merényi)
  - Responsibilities: Assisting with grading homework, exams and giving occasional lectures.

○ **Purdue University, West Lafayette, IN**

- TA: C Programming Lab, Compilers: Principles and Practice (undergrad. level CS, Prof. Brylow)
  - Responsibilities: instruct weekly lab sessions, grade homework and exams.
  - Mean student evaluation scores: 4.4/5.0.

ACTIVITIES

○ **Reviewer:** Advances in Space Research (ASR), International Conference on the Association of the Advancement of Artificial Intelligence (AAAI), IEEE Transactions on Geoscience and Remote Sensing (TGRS), IEEE Transactions on Image Processing, IEEE Journal of Selected Topics in Applied Earth Observation and Applied Remote Sensing (JSTARS), IEEE Transactions on Neural Networks (TNN), EURASIP Journal on Advances in Signal Processing, International Journal of Remote Sensing (IJRS), IEEE Workshop on Hyperspectral Imaging – Evolution in Remote Sensing (WHISPERS), European Symposium on Artificial Neural Networks (ESANN), International Joint Conference on Neural Networks (IJCNN)

○ **Association of Computing Machinery (ACM):** Augsburg chapter founder/chair (2002-2003), student member (2009)

○ **American Geophysical Union (AGU):** student member (2007), member (2014)

○ **Institute of Electrical and Electronics Engineers (IEEE):** student member (2009)