

HEATHER D. COUTURE

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RESEARCH INTERESTS

Image analysis, computer vision, and machine learning techniques applied to digital pathology, planetary science, and other science applications.

EDUCATION

- 2012–2018 **University of North Carolina at Chapel Hill**, Chapel Hill, NC
Ph.D. in Computer Science
Research areas: medical image analysis, computer vision, machine learning
Advisor: Marc Niethammer
Dissertation: *Discriminative Representations for Heterogeneous Images and Multimodal Data*
- 2005–2006 **Carnegie Mellon University**, Pittsburgh, PA
Master of Science in Robotics
Research areas: computer vision, machine learning, autonomous science
Advisor: David Wettergreen
Thesis: *Automatic Rock Detection and Classification in Natural Scenes*
- 2000–2005 **University of Waterloo**, Waterloo, ON
Bachelor of Mathematics
Honours Computer Science, Co-operative Program, Physics Minor

PROFESSIONAL EXPERIENCE

Academic Experience

- 8/2012 – 12/2018 **Research Assistant**
Department of Computer Science, University of North Carolina at Chapel Hill, Chapel Hill, NC
- Quantitative image analysis of digital pathology for skin and breast cancer.
 - Deep learning and traditional machine learning techniques.
 - Integration of image and genomic information to form more powerful models.
 - Application to diagnosis, prognosis, and subtyping of tumors.
 - Prediction of tumor properties not previously known to be possible from H&E alone.
- 10/2006 – 2/2007 **Research Technician**
Mars Space Flight Facility, Arizona State University, Tempe, AZ
- Research and development of methods for the detection and size estimation of craters in satellite images of Mars.
 - Development of a system to detect rocks in high-resolution Mars satellite imagery; formation of rock distribution maps for selecting a landing site for the Phoenix spacecraft.
- 1/2006 – 8/2006 **Research Assistant**
Robotics Institute, Carnegie Mellon University, Pittsburgh, PA
- Research, analysis, and development of methods for automatic detection and classification of rocks, including: detection of rocks with an accurately delineated boundary, characterization of rock shape, geologic classification with color, texture, and shape features.

Industry Experience

10/2012 – present **Independent Consultant and Researcher**

Pixel Scientia Labs, Raleigh, NC

- Research, design, implementation, and evaluation of image analysis, computer vision, and machine learning algorithms.
- Selected projects:
 - 3D segmentation of human and mouse retina layers from optical coherence tomography.
 - Keyword prediction from movie and TV series metadata, including: pre-processing, cleaning, and transformation of data; imputation; classification with weak labels; development of performance metrics.

5/2007 – 8/2012

Image Computational Engineer

7/2009 – 8/2012

R&D Team Lead

Digitalsmiths, Durham, NC

- Research and development of image/video indexing and retrieval algorithms.
- Evaluation of new tools, prototyping algorithms, implementation of product components.
- Creation of metrics to quantify different aspects of an algorithm's performance.
- Collaboration with engineering teams to aid delivery of algorithms into production systems.
- Communication of methods and results to management.
- Projects include: scene classification of images and video (e.g., beach, forest, urban); face detection, tracking, and grouping; shot and scene boundary detection; clip retrieval using video signature.

5/2004 – 8/2004

Software Developer/Tester

Xiris Automation, Burlington, ON

- Development on applications for Ident code verification and printed graphics inspection of optical discs.
- Application testing, debugging, documentation.

9/2003 – 12/2003

Software Developer

Discreet Logic, Montreal, QC

- C++ development in a Unix environment on a high performance visual effects package.
- Integration of 3-D lookup table functionality into Flame.

9/2002 – 4/2003

Machine Vision Programmer

Agris-Schoen Vision Systems, Alexandria, VA

- Assisting in software design process and writing functional specifications.
- Development of object-oriented software modules from design/functional specifications.
- Evaluation of signature matching algorithms.
- Implementation of machine vision feasibility studies on client samples sent for evaluation.

1/2002 – 4/2002

Software Developer

Alias|Wavefront, Toronto, ON

- Tool development for automating renovation of a large C++ code base.

- 5/2001 – 8/2001 **Software Developer**
Sun Microsystems/Isopia, Toronto, ON
- Development of client-specific user interfaces for a web-based e-learning management system.
- 8/1999 **Programmer**
IBM, Toronto, ON
- "Editor-in-chief" of the Frequently Asked Questions database for VisualAge for C++.

ADDITIONAL TRAINING

Medical Imaging Summer School, Italy, *July 2014*
International Computer Vision Summer School, Italy, *July 2011*

HONORS AND AWARDS

2018	MICCAI NIH Travel Award
2012–2017	Chancellor's Fellowship, University of North Carolina
2000–2005	Nortel Networks Undergraduate Scholarship, University of Waterloo

BIBLIOGRAPHY

Journal Articles

- H. D. Couture, L. Williams, J. Geradts, S. Nyante, E. Butler, J. Marron, C. Perou, M. Troester, and M. Niethammer, "Image analysis with deep learning to predict breast cancer grade, ER status, histologic subtype, and intrinsic subtype," *npj Breast Cancer*, 2018.
- J. Vicory, H. D. Couture, N. E. Thomas, D. Borland, J. Marron, J. Woosley, and M. Niethammer, "Appearance normalization of histology slides," *Computerized Medical Imaging and Graphics*, vol. 43, pp. 89–98, 2015.
- J. Percy, H. Dunlop, L. Kassim, and R. Thompson, "Periods of 25 pulsating red giants," *International Astronomical Union -Information Bulletin on Variable Stars*, vol. 5041, 2001.

Conference Papers

- H. D. Couture, J. S. Marron, C. M. Perou, M. A. Troester, and M. Niethammer, "Multiple instance learning for heterogeneous images: Training a CNN for histopathology," in *Proc. MICCAI*, 2018.
- H. Couture, J. Marron, N. Thomas, C. Perou, and M. Niethammer, "Hierarchical task-driven feature learning for tumor histology," in *Proc. International Symposium on Biomedical Imaging*, 2015.
- N. Singh, H. Couture, J. Marron, C. Perou, and M. Niethammer, "Topological descriptors of histology images," in *Proc. MICCAI Workshop on Machine Learning and Medical Imaging*, 2014.
- H. Dunlop, "Scene classification of images and video via semantic segmentation," in *Proc. CVPR Workshop on Perceptual Organization in Computer Vision*, 2010.
- H. Dunlop, D. Thompson, and D. Wettergreen, "Multi-scale features for detection and segmentation of rocks in Mars images," in *Proc. CVPR*, 2007.

Other Publications

H. D. Couture, *Discriminative Representations for Heterogeneous Images and Multimodal Data*. PhD thesis, Department of Computer Science, University of North Carolina at Chapel Hill, Chapel Hill, NC, 2019.

H. Dunlop, "Automatic rock detection and classification in natural scenes," Master's thesis, Robotics Institute, Carnegie Mellon University, Pittsburgh, PA, August 2006.

Patents

H. D. Couture, L. A. Williams, S. Nyante, J. Marron, C. Perou, M. Troester, M. Niethammer, J. Geradts, and E. Butler, "Methods, systems, and computer readable media for image analysis with deep learning to predict breast cancer grade, estrogen receptor (ER) status, histologic subtype, and intrinsic subtype," Nov. 8 2018. US Patent Application No. 62/757,716.

H. Dunlop and M. G. Berry, "Systems and methods for semantically classifying and normalizing shots in video," Aug. 2 2016. US Patent No. 9,405,976.

H. Dunlop and M. G. Berry, "Systems and methods for semantically classifying and extracting shots in video," Apr. 28 2015. US Patent No. 9,020,263.

H. Dunlop and M. G. Berry, "Systems and methods for semantically classifying shots in video," Nov. 13 2012. US Patent No. 8,311,344.