

Richard B Watson

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Research Interests Temporal and spatial activity patterns in small populations of neurons, dynamical systems, natural computation, information theory, adaptive intelligence, complex networks, pattern recognition and synthesis, parameter exploration, visualization and interactivity. Seeking to model and characterize coupled dynamical systems that are complex, adaptive, or intelligent.

Education **University of California, Davis**; Davis, CA; September 2007 - June 2012 (predicted)
Ph.D. candidate in Applied Mathematics with focus in theoretical/computational neuroscience.
Supervisor: Jim Crutchfield; Thesis Committee: Timothy Lewis, Bruno Olshausen, Killian Koepsell.
Selected Coursework: Mathematical Biology; Natural Computation; Network Theory and Applications; Nonlinear Physics: Modelling Complexity and Chaos; Numerical Partial Differential Equations; Numerical Linear Algebra; Analysis.
Recent project (05/2009): [Information Theoretic Approaches to Spiking Models](http://www.math.ucdavis.edu/~watson/spiking/info)
<http://www.math.ucdavis.edu/~watson/spiking/info>

Massachusetts Institute of Technology; Cambridge, MA; August 1998 - June 2003
B.S. in Brain and Cognitive Science, with focus in Computation; Minor in Philosophy.
Selected Coursework: Neural Networks (Seung); Computational Neuroscience (Seung); Synaptic Plasticity (Tonegawa); Object and Face Recognition (Sinha); Structure and Interpretation of Computer Programs; Software Agents (Maes); Linear Algebra; Phil. of Evolution and Development.

Santa Fe Institute, Santa Fe, NM; June. 2009 - July 2009
SFI Complex Systems Summer School
Project: [Spiking Networks on the Cusp of Chaos](#)

University of Sussex, East Sussex, UK; Oct. 2000 - June 2001
Visiting student in School of Cognitive and Computing Sciences (COGS) at Sussex.
Selected Coursework: Machine Learning / Datamining, Neural Computation, Adaptive Systems, Non-Symbolic Artificial Intelligence, Animal and Machine Intelligence, and Philosophy of Mind.

Academic Magnet High School, North Charleston, SC; August 1996 – June 1998
Thesis: [One Step Closer to the Remote Control Workplace](#)

Teaching and Mentoring Teacher; MSRI Math Circle; created and taught lessons for middle and high school (2009-2010)
Teaching Assistant: Calculus; lead discussions for 90 students. (2008-2010)
Mentor for high school senior thesis exploring neural networks (2004-2005)
Tutored and managed two undergraduate students at the MIT Media Lab (2003-2004)
Conducted tutorial on machine learning optimization software I wrote at NASA ARC (2006)

Honors and Achievements **Best Paper** at EuroGP (2003) in the EvoMusArt workshop
Best Algorithm (lowest error) in supervised learning final project, Neural Computation course (2001)
Highest Honors, Senior Thesis on telerobotic control interfaces (1998)
Scholar, MIT Council of the Arts (2002-2003)

Research Experience **NASA Ames Research Center** (December 2005 – July 2007) Moffett Field, CA
Intelligent Data Understanding Group
Task lead investigating prognostic and exploratory machine learning in the context of: (1) anomaly detection in large data streams originating from sensors in the Space Shuttle Main Engine and (2) synthesis of sensor data for unavailable channels (frequency bands) in earth satellite science observations. Developed

methods including time delay embedded regression using neural network ensembles, Gaussian processes and linear/quadratic methods for supervised learning. Developed a parameter space search framework for optimizing regression algorithms, parameters and data subset selection on a given set of data. Also developed and installed in hardware hazard-avoidance-on-landing pattern recognition methods for a simulated autonomy mission to the moon. Algorithm development in Matlab, Java, C and Perl.

NASA Ames Research Center (January 2005 – December 2005)

Moffett Field, CA

Adaptive Control Technologies Group

Developed and optimized the Intelligent Flight Control system (IFC), software which serves to compensate for any introduced biases in an air or spacecraft's pilot control to aeronautical dynamics, such as physical damage to a wing or electrical failure between the control system and actuators. IFC compares the sensed plane dynamics to those expected by a reference model and compensates for calculated error accordingly with supplemental control commands delivered by a neural network. Development in C and Matlab/Simulink, working with in house flight simulation software.

NASA Ames Research Center (August 2004 – January 2005)

Moffett Field, CA

NeuroEngineering Group

As a primary researcher, studied and developed methods of capturing, processing and classifying subvocal speech, manifested as bioelectric signals recorded at the larynx. Contributions included developing and testing new classification algorithms, such as an 'eigenspeech' PCA-based heuristic and an 'eigenspeech subspace' algorithm as well as implementing and optimizing neural network code. Designed and constructed a novel architecture to identify optimal algorithms, parameters and preprocessing of data for any data and task provided. Investigated biologically inspired computation for the purpose of signal processing and appropriate action selection. Framework utilized oscillatory, resonating and 'bursting' dynamical system units, with behavior similar to collectives of neurons.

M.I.T. Media Laboratory (June 2001 – June 2004)

Cambridge, MA

Interactive Cinema Group

Lead programmer designing and developing (in C++ and Java) an adaptive environment for arrangement and orchestration of improvised multimedia performances. Introduced connectionist and dynamical system principles and employed a genetic algorithm to match user preference and suggest novel system configurations. Co-authored two papers and attended overseas conferences for this work. Trained and supervised undergraduate research assistants.

M.I.T. Media Laboratory (January 1999 - August 2000)

Cambridge, MA

Music, Minds and Machines Group

Devised, managed, and executed experiments for Eric Scheirer pertinent to his Ph.D. thesis, Music Perception Systems. Designed and developed an experimental user interface in Tcl/Tk as well as a Perl script to automate collection of musical samples from the Internet. Developed applications of Scheirer's music perception system which estimated similarity between novel pieces of music.

Medical University of South Carolina (August 1996 - August 1998)

Charleston, SC

Designed, implemented and administered databases and front-ends for management of clinical drug studies and patient information using Access and Visual Basic. Matched research team needs to user interface functionality.

M.I.T. Artificial Intelligence Laboratory (Summer 1997)

Cambridge, MA

Worked on high school senior thesis with a group designing a robot controlled remotely over the Internet using a combination of Virtual Reality Markup Language (VRML) and Java. Self taught these languages, then researched, designed and implemented my own user interface control system.

Publications

Nemirovsky, P., Watson, R. (2003). Genetic Improvisation Model: A framework for real-time performance environments. (**Best Paper award**) In the proceedings of *EvoMusArt*, *EuroGP*, Colchester, UK

Nemirovsky, P., Watson, R., Dickinson D. (2003). Emonic Environment – Implementation Report. In the proceedings of *MAXIS2003*, Leeds, UK

Selected Presentations Watson, R. (2009) Spiking Networks on the Cusp of Chaos. *Santa Fe Institute Complex Systems Summer School*, Santa Fe, NM, USA. July 2009.

Watson, R. (2009) Information Theoretic Approaches to Spiking Models. *SIAM Student Research Conference*, Davis, CA, USA. May 2009.

Watson, R. (2008) Topological Influences on Function in a Spiking Neural Network. *SIAM Student Research Conference*, Davis, CA, USA. May 2008.

Code Skills Python, Matlab/Simulink, Java, C, C++, Perl, LISP/Scheme, Tcl/Tk, Shell, SQL, Access / VBasic, VRML, Flash, HTML

Languages English (native), French (basic)

Selected Activities **Founder/Director**, Yuri's Night Bay Area at NASA Ames – Science and Sound Exposition (2007-2008); **Editor**, Rune – MIT Journal of Arts and Letters (1999-2003); **Photographer**, Technique – MIT yearbook (1998-2003); **Organizer**, Signals and Systems - monthly live music night (2001-2003); **Radio DJ** (WMBR 88.1 FM, Cambridge) (1999-2000). Enjoy wind/water/snow sports, cycling, climbing and travelling.

Website <http://math.ucdavis.edu/~watson>

References Jim Crutchfield
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Timothy Lewis
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