

David Cox, Ph.D.

Curriculum Vitae | June 2011

Contact Information

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Research Appointment

The Rowland Institute at Harvard – 2007-present

Rowland Junior Fellow; Principal Investigator, Visual Neuroscience Laboratory
Harvard University, School of Engineering and Applied Sciences

Education

Massachusetts Institute of Technology, Cambridge, MA – 2002-2007

Ph.D. in Neuroscience (major area of concentration in computational neuroscience)
Advisor: James DiCarlo, M.D., Ph.D.

Harvard University, Cambridge, MA – 1996-2000

A.B. Biology and Psychology
Magna Cum Laude with Highest Honors in Biology and Psychology

Research Summary

We recognize visual objects with such ease that it is easy to overlook what an impressive computational feat this represents. Any given object in the world can cast an infinite number of different images onto the retina, depending on its position relative to the viewer, the configuration of light sources, and the presence of other objects in the visual field. In spite of this extreme variation, biological visual systems are able to effortlessly recognize hundreds of thousands of distinct object classes—a feat that no current artificial system can come close to achieving.

My laboratory seeks to understand the computational underpinnings of object recognition through a concerted effort on two fronts. First, we endeavor to understand the workings of biological visual systems using a variety of experimental techniques, ranging from microelectrode recordings to visual psychophysics. Second, we attempt to instantiate what we have learned into artificial object recognition systems, leveraging recent advances in parallel computing to build systems that begin to approach the scale of natural systems. By combining reverse- and forward-engineering approaches, we hope to accelerate progress in both domains.

Publications

Journal Papers

1. Zoccolan D, Graham B, **Cox DD** (2010) A Self-Calibrating Infrared Eye-Tracking System for Use with Rodents. *Frontiers in Neuroscience Methods*. doi:10.3389/fnins.2010.00193.
2. Zoccolan, DF, Oertelt, N, DiCarlo, JJ, **Cox, DD**. (2009) A Rodent Model for the Study of Invariant Visual Object Recognition. *Proceedings of the National Academy of Sciences* doi:10.1073/pnas.0811583106
3. Pinto N, Doukhan D, DiCarlo JJ, and **Cox DD**. (2009) A High-Throughput Approach to Biologically-Inspired Object Recognition. *PLoS Computational Biology*. 5(11): e1000579. doi:10.1371/journal.pcbi.1000579.
4. Li N, **Cox DD**, Zoccolan D, DiCarlo JJ (2009) What response properties do individual neurons need to underlie position and clutter “invariant” object recognition? *Journal of Neurophysiology* 102(1): 360-76.
5. **Cox DD**, DiCarlo JJ (2008) Does Learned Shape Selectivity in Inferior Temporal Cortex Automatically Generalize Across Retinal Position? *Journal of Neuroscience*, 28(40):10045-10055.
6. **Cox DD**, Papanastassiou A, Oreper D, Andken B, DiCarlo JJ (2008) High-Resolution Three-Dimensional Microelectrode Brain Mapping Using Stereo Microfocal X-Ray Imaging. *Journal of Neurophysiology* 100(5):2966-76.
7. Mujica-Parodi L, Strey H, Frederick B, Savoy RL, **Cox DD**, Botanov Y, Tolkunov D, Rubin D, Weber J (2008) Chemosensory Cues to Conspecific Emotional Stress Activate the Amygdala in Humans. *PLoS ONE* 4(7):e6415
8. Pinto N*, **Cox DD*** (contributed equally), DiCarlo JJ. (2008) Why is Real World Object Recognition Hard? *PLoS Computational Biology* 4(1):e27
9. Balas B, **Cox DD**, Conwell E (2007) The Effect of Real-World Personal Familiarity on the Speed of Face Information Processing. *PLoS One* 2(11):e1223
10. DiCarlo JJ and **Cox DD**. (2007) “Untangling” Invariant Object Recognition. *Trends in Cognitive Science*, 11(8): 333-341.
11. **Cox DD**, Meier P, Oertelt N, DiCarlo JJ (2005) 'Breaking' Position-Invariant Object Recognition. *Nature Neuroscience*, 8: 1145-1147.
12. Zoccolan DF*, **Cox DD*** (contributed equally), DiCarlo JJ (2005) Multiple object response normalization in monkey inferotemporal cortex. *Journal of Neuroscience*, 25(36): 8150-8164.
13. **Cox D**, Meyers E, Sinha P (2004) Contextually Evoked Object-Specific Responses in Human Visual Cortex. *Science* 304:115-117.
14. **Cox DD** & Savoy RL (2003) Functional Magnetic Resonance Imaging (fMRI) “Brain Reading:” Detecting and Classifying Distributed Patterns of fMRI Activity in Human Visual Cortex. *NeuroImage* 19: 261-270.

Rigorously-Reviewed Conference Papers (Computer Science)

15. Pinto N, **Cox DD** (2011) Scaling up Biologically-Inspired Computer Vision: a Case Study in Unconstrained Face Recognition on Facebook. *Workshop on Biologically Consistent Computer Vision at CVPR 2011*.
16. Pinto N, **Cox DD** (2011) Beyond Simple Features: A Large-scale Feature Search Approach to Unconstrained Face Recognition. *IEEE Automated Face and Gesture Recognition*.
17. Pinto N, **Cox DD** (2010) Evaluating the Invariance Properties of a Successful Biologically-Inspired Face Recognition System *ICST Bio-Inspired Models of Network, Information, and Computing Systems (BIONETICS 2010)*.
18. Sriram V, Tsoi K, Luk W, **Cox DD** (2010) Towards an Embedded Biologically-Inspired Machine Vision Processor. *IEEE Field Programmable Technology*.
19. Sriram V, Tsoi K, Luk W, **Cox DD** (2010) Design-Space Exploration of Biologically-Inspired Visual Object Recognition Algorithms Using CPUs, GPUs, and FPGAs. *Many-Core and Reconfigurable Supercomputing 2010*.
20. Pinto N, DiCarlo JJ, and **Cox DD**. (2009) How far can you get with a modern face recognition test set using only simple features? *IEEE Conf. on Computer Vision and Pattern Recognition 2009*
21. Pinto N, DiCarlo JJ, **Cox DD** (2008) Establishing Good Baselines and Benchmarks for Face Recognition. *Proceedings of the Faces in Real Life Images Workshop, ECCV 2008*.
oai:hal.inria.fr:inria-00326721_v1

Book Chapters

22. Pinto N, **Cox DD** (2011) GPU Meta-programming. *GPU Computing Gems, Volume 2*, to be published by Morgan Kaufman.

Select Abstracts

- Graham BJ, Carouso SV, Cox DD (2011) "3D Structured Illumination Imaging for Precise Stereotaxy and Electrode Placement in Rodents" Society for Neuroscience Annual Meeting 2011.
- Cox DD and Pinto N (2010) "Bridging GPU-computing, Neuroscience and Large-scale Face Recognition" NVIDIA GPU Technology Conference.
- Cox DD (2010) "A Large-Scale Feature-Search Approach to Invariant Object Recognition" Snowbird Learning Workshop.
- Cox DD (2008) "Untangling Invariant Visual Object Representations." COSYNE 08 Workshops
- Li N, Cox DD, Zoccolan D, DiCarlo JJ (2006) Flexible and robust object recognition supported by neurons with limited position and clutter tolerance. Society for Neuroscience Annual Meeting. Atlanta, GA
- Cox DD, DiCarlo JJ (2005) Is the Binding Problem Really a Problem in Inferotemporal Cortex? Society for Neuroscience Annual Meeting. Washington D.C.

Cox DD, DiCarlo JJ (2004) The Effect of Visual Experience on the Position Tolerance of Primate Object Representations. Society for Neuroscience Annual Meeting. San Diego, CA.

Cox DD, Savoy RL (2002) A Statistical Pattern Recognition Approach to fMRI. Annual Meeting of the Organization for Human Brain Mapping, Sendai, Japan.

Cox DD, Savoy RL (2001) Detecting and Classifying Distributed Patterns of Activity in Human Visual Cortex. Society for Neuroscience Annual Meeting. San Diego, CA.

Presentations and Invited Lectures

Workshop on Biologically Consistent Vision at IEEE CVPR (2011) Keynote Lecture. "Ten things every computer vision researcher should know about neuroscience"

Brown University (2011)

Qualcomm Research, San Diego, CA (2011) "Scaling-up Biologically-Inspired Machine Vision"

Many Core and Reconfigure Supercomputing Conference, Rome, Italy (2010)

GPU Technology Conference, San Jose, CA (2010)

Harvard University, Bioengineering Symposium (2009)

Aptina Corporation, San Jose, CA (2010)

Snowbird Learning Workshop (2010)

Harvard University, Department of Computer Science (2009)

National Center for Supercomputing Applications, Great Lakes Virtual School on Petascale Computing. Keynote Lecture (2009)

NVISION, San Jose, CA (2008)

Harvard University, Center for Brain Science (2008)

Computational System Neuroscience, Multivariate Analysis Workshop (2008)

Massachusetts Institute of Technology, Dept. of Brain and Cognitive Sciences (2005)

fMRI Visiting Fellowship Program, Athinoula A. Martinos Center (2004)

American Psychological Association Advanced Training Institute, MGH (2003)

McGovern Institute 1st Annual Retreat, Massachusetts Institute of Technology (2003)

Athinoula A. Martinos Center, Massachusetts General Hospital (2002)

Awards, Honors, and Fellowships

Rowland Junior Fellowship, Harvard University – 2007-present

National Defense Science and Engineering Graduate Fellowship – 2003-2006

Harvard Committee on Undergraduate Education Certificate of Distinction in Teaching – 2000, 2001

Funding

Internal Funding

Rowland Junior Fellowship: 5-year, open-ended, direct endowment funding for lab operations. 2007-2012.

External Grants

IOS 0947777: “A Novel Rodent Model for the Neurophysiology of Visual Object Recognition.” NSF. 2009-2011. \$150,000

IIS 0963668: “Collaborative Research: Unlocking Biologically-Inspired Computer Vision: A High-Throughput Approach.” NSF. Co-PI: James DiCarlo. 2010-2013. \$820,000.

2010 Google Research Award. “A Large-Scale Feature Search Approach to Biologically-Inspired Computer Vision for the Analysis of Video.” \$72,000.

Resource/In-Kind Grants

TeraGrid Startup Allocation. “A High-Throughput Approach to Biologically-Inspired Computer Vision.” 35,000 compute-hours on the National Center for Supercomputing Applications “Lincoln” CPU/GPU Cluster

Amazon Web Services. In-kind cloud computing services.

NVIDIA Professor Partnership Program. In-kind GPU computing hardware.

Student and Postdoctoral Supervision

Undergraduate Students

Pauline Gassman (University of Iowa, class of 2009), Summer 2007, 2008

Kyle Marra (Boston College, class of 2012) Summer of 2011

Christine Lee (Duke University, class of 2014) Summer of 2011

Visiting Graduate Students

Chuan-Yung Tsai (National Taiwan University), 2011

Postdoctoral Fellows

Davide Zoccolan, Ph.D. (2007-2009) *A novel rodent model for studying invariant visual object recognition*. Current position: Assistant Professor, International School for Advanced Studies (SISSA), Trieste, Italy.

Vinay Sriram, Ph.D. (2009-2010) *Hardware architectures for embedded biologically-inspired machine vision*. Current position: Director of Engineering IPACS Australia Pty Ltd.

Brett Graham, Ph.D. (2010-present) *Neuronal substrates of high-level vision in rodents*.

Nicolas Pinto, Ph.D. (2011-present) *High-throughput biologically-inspired visual object recognition*.

Nicolas Poilvert, Ph.D. (2011-present)

James Bergstra, Ph.D. (2011-present)

Teaching

Guest Lecture ("Parallel Computing for Biologically-Inspired Vision") CS 264: Massively Parallel Computing (Harvard), Fall 2009.

Keynote Lecture, NCSA / Great Lakes Consortium for Petascale Computation Summer School: Many-Core Processors for Science and Engineering Applications, 2009

Guest Lecture ("Unlocking Biologically-Inspired Computer Vision: A High-Throughput Approach"), 6.963: CUDA@MIT (MIT), 2009

Guest Lecture ("Resampling Statistics"), 9.07: Introduction to Statistical Methods (MIT) – Spring 2006

Teaching Assistant, 9.02: Brain Laboratory (MIT) – Spring 2006

Invited Speaker, Advanced Training Institute in Functional MRI (American Psychological Association) – 2005

Teaching Assistant, 9.011 Systems Neuroscience (MIT) – Fall 2004

Teaching Assistant, 9.00 Introduction to Psychology (MIT) – Fall 2003

Teaching Assistant, Functional MRI Visiting Fellowship Program (Massachusetts General Hospital) – 2000-2006

Teaching Assistant, Psychology 1251, Introduction to Functional Neuroimaging Methods (Harvard) – Fall 2000, 2001

Professional Service

Peer Review

Reviewer for *Neuron*, *Journal of Neurophysiology*, *Journal of Neuroscience*, *Journal of Vision*, *Cortex*, *Cerebral Cortex*, *Cognitive Science*, *NeuroImage*, *Human Brain Mapping*, *IEEE Transactions in Medical Imaging*, *Neural Processing Letters*, *PLoS One*, *PLoS Computational Biology*, *Trends in Cognitive Science*, and *Brain and Behavioral Sciences*

Ad hoc and panel reviewer for National Science Foundation

Conference / Workshop Organization

Program Committee, Computational Systems Neuroscience (Cosyne) 2011

Program Committee, ICST Bio-Inspired Models of Network, Information, and Computing Systems 2010.

Organizing Committee, Workshop on Biologically-Consistent Computer Vision, IEEE CVPR 2011