

TERRENCE C. STEWART

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RESEARCH INTERESTS

- Bridging high-level cognitive theory and low-level neuroscience
- Building complex cognitive algorithms using realistic neural models
- Adapting psychological theories into a control-theoretic framework
- Using neural models to evaluate theories of cognition

POSTDOCTORAL EXPERIENCE

- University of Waterloo**, Centre for Theoretical Neuroscience, *2008–present*
- Large-scale neural models of perception, action, and cognitive control, including motor control, planning, memory, and structured representation
 - Development of Nengo neural compiler and simulator <nengo.ca>

EDUCATION

- PhD Carleton University**, Institute of Cognitive Science, *2007*
Thesis: “A Methodology for Computational Cognitive Modelling”
- Developed research process for rigorously evaluating models of cognitive functions, integrating methods across disciplines

MPhil University of Sussex, Computer Science and A.I., *2000*
Thesis: “Learning in Artificial Life: Conditioning, Concept Formation, and Sensorimotor Loops”

BASc University of Waterloo, Systems Design Engineering, *1999*
Option in Cognitive Science

HONORS AND AWARDS

Most Promising New Neuromorph Award, 2011

- Telluride Neuromorphic Cognition Engineering Workshop

SHARCNET Postdoctoral Fellowship, 2009 – 2010

Winner of Technion Prediction Tournament (repetition condition), *2008*

- predictions of human performance in repeated binary choice task

Derbyshire Graduate Scholarship in Cognitive Science, 2004 – 2006

NSERC Post-Graduate Scholarship, 1999 – 2003

British Council Chevening Scholarship, 1999 – 2000

Colonel Hugh Heasley Engineering Scholarship, 1994 – 1999

Canada Scholarship, 1994 – 1999

**RESEARCH
EXPERIENCE**

Carleton University, Institute of Cognitive Science, 2003 – 2007

Lab Coordinator, Carleton Cognitive Modelling Lab

- Developed toolkit for implementing and evaluating cognitive models

Carleton University, School of Linguistics, 2005 – 2007

Research Assistant, Dr. Marie-Odile Junker

- Created on-line tools for teaching written Cree, linguistic atlas

University of Waterloo, Systems Design Engineering, 1999

Research Assistant, Pattern Analysis and Machine Intelligence Lab

- Redesigned motor control and visual system for soccer-playing robots

**TEACHING
EXPERIENCE**

Carleton University, Institute of Cognitive Science, Ottawa, Canada

Sessional Lecturer, *Fall 2005*

Sessional Lecturer, *Fall 2004*

Sessional Lecturer, *Winter 2004*

- Developed and taught *Cognition and Artificial Systems* course
- Neural Networks, Genetic Algorithms, Cognitive Architectures
- 6 to 14 graduate and upper year undergraduate students, some with no programming experience and some with extensive experience
- Average teaching evaluation: 4.5 out of 5

Sessional Lecturer, *Fall 2003*

- Taught Introduction to Computers for the Arts and Social Sciences
- 150 students; average teaching evaluation 4.35 out of 5

Teaching Assistant, Developmental Psychology, *Winter 2005*

Teaching Assistant, English for Engineers, *Winter 2003*

Teaching Assistant, First Year Seminar on Cognition, *Fall 2002*

**INDUSTRY
EXPERIENCE**

Software Developer, Sweet Caesar. *2007 – 2012 (occasional)*

- Lead software architect for BlackBerry, Android, & iOS applications

Freelance Programmer, Google, Inc. *Summer 2007*

- Creation of on-line repository for academic computational models

Consultant, Ambient Vector, Inc. *Fall 2005*

Consultant, Terrados. *Winter 2005*

Software Engineering, American Android, NJ. *Summer 2003, 2004*

- Verbal control of bipedal robots for NASA

Research and Development, Hummingbird, *Summer 2001*

- Automatic document classification

Software Engineering, Array Systems Computing, *Fall 1997, Summer 1998*

- Neural-network object recognition in airport X-ray images

DSP Research Engineering, Genesis Microchip, *Summer 1996, 1997*

- Algorithm evaluation, implementation for real-time video processing

Software Developer, Alias|Wavefront, *Fall 1995*

- API development for Maya 3D animation software

Hardware/Software Engineering, Applied AI Systems, *Winter 1995*

- First robotic implementation of SAGA evolutionary algorithm

**WORK IN
PROGRESS**

Schroder, T., Stewart, T.C., and Thagard, P. (submitted) Neural Dynamics of Intention, Emotion, and Action. *Cognitive Science*.

**JOURNAL
ARTICLES**

Eliasmith, C., Stewart, T.C., Choo, X., Bekolay, T., DeWolf, T, Tang, Y., Rasmussen, D. (in press). A large-scale model of the functioning brain. *Science*.

Stewart, T.C. and Eliasmith, C. (in press). Realistic neurons can compute the operations needed by quantum probability theory and other vector symbolic architectures. *Behavioral and Brain Sciences*. Commentary on: Pothos, E. and Bussemeyer, J. Can quantum probability provide a new direction for cognitive modeling?

Stewart, T.C., Bekolay, T., and Eliasmith, C. (2012) Learning to select actions with spiking neurons in the basal ganglia. *Frontiers in Neuroscience*, 6:2, 1-14.

Stewart, T.C. (2012) The Neural Engineering Framework. *AISB Quarterly*, 135.

Stewart, T.C., Bekolay, T., and Eliasmith, C. (2011) Neural representations of compositional structures: Representing and manipulating vector spaces with spiking neurons. *Connection Science: Special issue on Compositional Connectionism*. 23(2), 145-153.

Stewart, T.C., Tang, Y., and Eliasmith, C. (2011) A biologically realistic cleanup memory: Autoassociation in spiking neurons. *Cognitive Systems Research*, 12, 84-92.

Thagard, P. and Stewart, T.C. (2011) The AHA! experience: Creativity through emergent binding in neural networks. *Cognitive Science*, 35(1).

Stewart, T.C. and West, R.L. (2010) Testing for equivalence: A methodology for computational cognitive modelling. *Journal of Artificial General Intelligence*, 2(2), 69-87.

Erev, I., Ert, E., Roth, A., Haruvy, E., Herzog, S., Hau, R., Hertwig, R., Stewart, T., West, R., and Lebiere, C. (2010). A choice prediction competition for choices from experience and from description. *Journal of Behavioral Decision Making: Special Edition on Decisions from Experience*. 23(1), 15-47.

Stewart, T.C., Tripp, B., and Eliasmith, C. (2009) Python scripting in the Nengo simulator. *Frontiers in Neuroinformatics: Special edition on Python in Neuroscience*. 3(7), 1-9.

Stewart, T.C. and West, R.L. (2007) Deconstructing and reconstructing ACT-R: Exploring the architectural space. *Cognitive Systems Research*. 8(3), 227-236.

Chandrasekharan, S. and Stewart, T.C. (2007) The origin of epistemic structures and proto-representations. *Adaptive Behaviour*. 15(3) 329-359.

Stewart, T. C., West, R. L., and Coplan, R. (2007) Multi-agent models of social dynamics in children. *Cognitive Systems Research*. 8(1), 1-14.

BOOK CHAPTERS

- Eliasmith, C., Rasmussen, D., and Stewart, T.C. (in press). Biological cognition: Syntax. In C. Eliasmith, *How to build a brain: A neural architecture for biological cognition*. Oxford University Press.
- Eliasmith, C., Stewart, T.C., and Bobier, B. (in press). Biological cognition: Control. In C. Eliasmith, *How to build a brain: A neural architecture for biological cognition*. Oxford University Press.
- Stewart, T.C. and Eliasmith, C. (2012). Compositionality and biologically plausible models. In M. Werning, E. Machery, and W. Hinzen (Eds.), *Oxford Handbook of Compositionality*. Oxford University Press.
- Stewart, T.C. (2006) Embodied decisions: Models of decision making within a larger cognitive framework. In B. Hardy-Vallée (Ed.), *Cognitive Decision-Making: Empirical and Foundational issues*. Cambridge: Cambridge Scholars Press Ltd.

**REFEREED
CONFERENCE
TALKS
(WITH FULL
PROCEEDINGS
PUBLICATION)**

- Stewart, T.C., Choo, X., and Eliasmith, C. (2012). *Spaun: A perception-cognition-action model using spiking neurons*. 34th Meeting of the Cognitive Science Society.
- Stewart, T.C. and Eliasmith, C. (2011) *Neural planning and reasoning using the synaptic connections of the basal ganglia and thalamus*. 2nd International Conf. on Biologically Inspired Cognitive Architectures.
- Junker, M-O. and Stewart, T.C. (2011). *A linguistic atlas for endangered languages*. 3rd annual International Conference on Education and New Learning Technologies. Barcelona, Spain.
- Stewart, T.C., Choo, X., and Eliasmith, C. (2010). *Symbolic reasoning in spiking neurons: A model of the cortex/basal ganglia/thalamus loop*. 32nd Meeting of the Cognitive Science Society.
- Stewart, T.C., Choo, X., and Eliasmith, C. (2010). *Dynamic behaviour of a spiking model of action selection in the basal ganglia*. 10th International Conference on Cognitive Modelling.
- Stewart, T.C. and Eliasmith, C. (2010) *Neural symbolic decision making: A scalable and realistic foundation for cognitive architectures*. 1st International Conf. on Biologically Inspired Cognitive Architectures.
- Stewart, T.C. and Eliasmith, C. (2009) *Spiking neurons and central executive control: The origin of the 50-millisecond cognitive cycle*. 9th International Conference on Cognitive Modelling.
- Stewart, T.C., Tang, Y., and Eliasmith, C. (2009) *A biologically realistic cleanup memory: Autoassociation in spiking neurons*. 9th International Conference on Cognitive Modelling.
- Stewart, T.C. and West, R.L. (2007) *Equivalence: A novel basis for model comparison*. 29th Annual Meeting of the Cognitive Science Society.
- Junker, M-O. and Stewart T.C. (2007) *Building search engines for Algonquian languages*. 39th Algonquian Conference.
- Stewart, T.C. and West, R. L. (2006) *Deconstructing ACT-R*. 7th International Conference on Cognitive Modelling.
- Stewart, T.C. (2006) *Tools and techniques for quantitative and predictive cognitive science*. 28th Annual Meeting of the Cognitive Science Society.

- West, R., Stewart, T.C., Lebiere, C., and Chandrasekharan, S. (2005) *Stochastic resonance in human cognition: ACT-R versus game theory, associative neural networks, recursive neural networks, Q-learning, and humans*. 27th Annual Meeting of the Cognitive Science Society.
- Chandrasekharan, S. and Stewart, T.C. (2004) *Reactive agents learn to add epistemic structures to the world*. First Joint Conference of the Society for Philosophy and Psychology and the European Society for Philosophy and Psychology.
- Stewart, T.C. and West, R. (2001) *Levels of description: A role for robots in cognitive science education*. PHICS Graduate Student Conference, Carleton University.
- Stewart, T.C. (2001) *Extrema selection: Accelerated evolution on neutral networks*. IEEE Congress on Evolutionary Computation.
- Stewart, T.C. and Wood, S. (2001) *Conditioning and concept formation in embodied agents*. AAAI Spring Symposium.

**REFEREED
CONFERENCE
POSTERS
(WITH FULL
PROCEEDINGS
PUBLICATION)**

- Galluppi, F., Davies, S., Stewart, T., Eliasmith, E., and Furber, S. (2012). *Real Time On-Chip Implementation of Dynamical Systems with Spiking Neurons*. 2012 International Joint Conference on Neural Networks.
- Dethier, J., Nuyujukian, P., Stewart, T.C., Eliasmith, C., Shenoy, K., and Boahen, K. (2011) *A brain-machine interface operating with a real-time spiking neural network control algorithm*. 25th Annual Conference on Neural Information Processing Systems.
- Stewart, T.C. and Eliasmith, C. (2011) *Neural cognitive modelling: A biologically constrained spiking neuron model of the Tower of Hanoi task*. 33rd Annual Meeting of the Cognitive Science Society.
- Stewart, T.C., West, R., and Lebiere, C. (2009) *Applying cognitive architectures to decision-making: How cognitive theory and the equivalence measure triumphed in the Technion prediction tournament*. 31st Annual Meeting of the Cognitive Science Society.
- Gormley, A. and Stewart, T.C. (2009) *Errors in speech production: Explaining mismatch and accommodation*. 31st Annual Meeting of the Cognitive Science Society.
- Stewart, T.C. and Eliasmith, C. (2008) *Building production systems with realistic spiking neurons*. 30th Meeting of the Cognitive Science Society.
- Stewart, T.C. and West, R.L. (2007). *Cognitive redeployment in ACT-R: Saliency, vision, and memory*. 8th International Conference on Cognitive Modelling.
- Stewart, T.C. (2004) *Teaching computational modelling to non-computer scientists*. 6th International Conference on Cognitive Modelling.
- Stewart, T.C., West, R., and Coplan, R. (2004) *A dynamic, multi-agent model of peer group formation*. 6th International Conference on Cognitive Modelling.
- Stewart, T.C. and Chandrasekharan, S. (2004) *Simple agents learning to add useful structures to the world*. 6th International Conference on Cognitive Modelling.

**TECHNICAL
REPORTS**

- Stewart, T.C. (2012) *A technical overview of the Neural Engineering Framework*. Centre for Theoretical Neuroscience Technical Report, University of Waterloo.
- Stewart, T.C. (2005) *Notes for the development of a philosophy of computational modelling*. Carleton University Cognitive Science Technical Report 2005-04.
- Stewart, T.C. and Chandrasekharan, S. (2005) *Two cognitive descriptions of Q-learning*. Carleton University Cognitive Science Technical Report 2005-03.
- Stewart, T.C. and Brook, A. (2003) *Four forms of information*. Carleton University Cognitive Science Technical Report 2003-06.
- Stewart, T.C. (2000) *Neural models of concept formation and conditioning: A literature review*. Technical Report, CSRP-524, School of Cognitive and Computing Sciences, University of Sussex.

**CONFERENCE
DEMOS**

- Galluppi, F., Conradt, J., Stewart, T.C., Eliasmith, C., Horiuchi, T., Tapson, J., Tripp, B., Etienne-Cummings, R., Furber, S. (2012) *Spiking ratSLAM: Rat Hippocampus Cells in Spiking Neural Hardware*. Biomedical Circuits and Systems Conference.

**CONFERENCE
TALKS
(ABSTRACT-ONLY
PUBLICATION)**

- Stewart, T. C., Tripp, B., and Eliasmith, C. (2008) *Supplementing neural modelling with ACT-R*. 15th Annual ACT-R Workshop.
- Stewart, T. C. and Eliasmith, C. (2008) *Implementing the ACT-R production system in spiking Neurons*. 15th Annual ACT-R Workshop.
- Stewart, T. C. and West, R. L. (2006) *ACT-R versus not-ACT-R: Demonstrating cross-domain validity*. 13th Annual ACT-R Workshop.
- West, R. L., Stewart, T. C., Pyke, A., and Emond, B. (2006) *Modeling emotion in ACT-R*. 13th Annual ACT-R Workshop
- Stewart, T.C. (2005) *Embodied decisions: Models of decision making within a larger cognitive framework*. Cognitio 2005: Graduate Student Conference in Cognitive Science.
- Stewart, T.C. and West, R. L. (2005) *Python ACT-R: A new implementation and a new syntax*. 12th Annual ACT-R Workshop.

**CONFERENCE
POSTERS**

- Bobier, B., Stewart, T.C., and Eliasmith, C. (2011) *The attentional routing circuit: receptive field modulation through nonlinear dendritic interactions*. 8th Computational and Systems Neuroscience Meeting.
- Bobier, B., Stewart, T.C., and Eliasmith, C. (2010) *The dynamic routing model of visuospatial attention*. 7th Computational and Systems Neuroscience Meeting.
- Eliasmith, C., Stewart, T.C., Rasmussen, D., and Choo, X. (2010) *How brains think*. Canada Research Chair Recognition Event, Toronto, Ontario.
- Stewart, T.C. (2009) *Spiking neurons and cognitive decisions at the 50-millisecond time scale*. SHARCNET Research Day, University of Waterloo.

Stewart, T.C. (2005) *The philosophy of cognitive modelling: When to do it, Why to do it, and How to do it*. Cognitive Science Spring Conference 2005, Institute of Cognitive Science, Carleton University.

**CONFERENCE
TALKS (NO
PUBLICATION)**

Stewart, T. C. (2006) *Dealing with complexity: The analysis of embodied behaviour*. Cognitio 2006: Graduate Student Conf. in Cognitive Science.
Junker, M-O. and Stewart, T. C. (2005) *Building a search that allows spelling mistakes for the EastCree dictionary on the web*. Algonquin Dictionaries Round Table at the 37th Algonquin Conference.

**INVITED
LECTURES,
TUTORIALS,
WORKSHOPS**

Tutorial, “Nengo and the Neural Engineering Framework: From spikes to cognition,” 34th *Annual Meeting of the Cognitive Science Society*, 2012
Tutorial, “Nengo and the Neural Engineering Framework: Connecting cognitive theory to neuroscience,” 33rd *Annual Meeting of the Cognitive Science Society*, 2011
Workshop, “Vision and the Brain: What we see and what we think we see,” *Waterloo Unlimited high school enrichment*, 2008, 2009, 2010, 2011
Workshop, “Designing Virtual Worlds,” *Waterloo Unlimited high school enrichment*, 2009, 2010, 2011
Colloquium Talk, “How Brains Think,” *Carleton University Cognitive Science Colloquium*, 2010

Colloquium Talk, “The Neural Engineering Framework: Bridging cognitive science and neuroscience,” *Franklin & Marshall College, Department of Psychology*, 2010.

Workshop, “The Mind: What it is, what it does, and how to study it,” *Shad Valley high school enrichment program*, 2010

Tutorial, “Nengo and the Neural Engineering Framework: Connecting cognitive theory to neuroscience,” 32nd *Annual Meeting of the Cognitive Science Society*, 2010

Sole Presenter, “Cognitive Modelling 2-Day Workshop,” *University of Basel, Department of Psychology, Switzerland*, 2009

Sole Presenter, “Python ACT-R Workshop,” *Ben-Gurion University of the Negev, Dept. of Industrial Engineering and Management, Israel*, 2009

Tutorial, “Cognitive modelling with the Neural Engineering Framework,” 9th *International Conference on Cognitive Modelling*, 2009

Colloquium Talk, “Evaluating cognitive theories via neurological evidence: Working memory and compositionality,” *Carleton University Institute of Cognitive Science Distinguished Lecture Series*, 2008

**PROFESSIONAL
AFFILIATIONS**

Biologically Inspired Cognitive Architecture Society, 2010 – present

- Founding Member

Behavioral & Brain Sciences Associate, 2005 – present

Cognitive Science Society Member, 2002 – present

**PROFESSIONAL
SERVICE**

Conference Co-Chair

- International Conference on Cognitive Modelling, *2013*

Workshop and Tutorial Committee

- Cognitive Science Society Annual Meeting, *2011, 2012*

Program Committee

- Biologically Inspired Cognitive Architectures, *2010, 2011*

Awards Committee

- International Conference on Cognitive Modelling, *2010*

Peer-Reviewed Articles for Journals

- Biologically Inspired Cognitive Architectures, *2012*
- Cognitive Science, *2011 – 2012*
- Philosophical Psychology, *2011*
- Games, *2011*
- Minds and Machines, *2010*
- Frontiers in Neuroinformatics, *2008*

Peer-Reviewed Submissions for Conferences

- Cognitive Science Society, *2005 – 2012*
- International Conference on Cognitive Modelling, *2009, 2010, 2012*
- Cognition student conference, *2006, 2007*
- European Cognitive Science Society, *2007*