

# Curriculum Vitae

Geoffrey E. Hinton

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Citizenship: Canadian (also British)

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## Higher Education and Qualifications

1967 - 1970 Cambridge University, B.A. Hons (Experimental Psychology)

1972 - 1975 Edinburgh University, PhD. in Artificial Intelligence (awarded 1978)

## Professional Experience

Jan 76 - Sept 78 Research Fellow  
Cognitive Studies Program, Sussex University, England

Oct 78 - Sept 80 Visiting Scholar  
Program in Cognitive Science, University of California, San Diego

Oct 80 - Sept 82 Scientific Officer  
MRC Applied Psychology Unit, Cambridge, England

Jan 82 - June 82 Visiting Assistant Professor  
Psychology Department, University of California, San Diego

Oct 82 - June 87 Assistant Professor then Associate Professor  
Computer Science Department, Carnegie-Mellon University, Pittsburgh, USA

Jul 87 - June 98 Professor  
Computer Science Department, University of Toronto, Canada

Jul 98 - Sep 01 Founding Director of the Gatsby Computational Neuroscience Unit  
University College London, England

Oct 01 - Professor  
Computer Science Department, University of Toronto, Canada  
(Promoted to "University Professor" in 2006)

## Professional Recognition

### Fellowships

Honorary Foreign Member of the American Academy of Arts and Sciences (2003)  
Fellow of the Royal Society (1998)  
Fellow of the Royal Society of Canada (1996)  
Fellow, Canadian Institute for Advanced Research (1987-1998; 2004-2012)  
Fellow of the Cognitive Science Society (2003)  
Fellow, Association for the Advancement of Artificial Intelligence (1991)

### Awards and Honorary Degrees

2011 Honorary Degree of Doctor of Science, To be awarded by University of Sussex  
2005 IJCAI Research Excellence Award  
2001 Honorary Degree of Doctor of Science, University of Edinburgh  
2001 The David E. Rumelhart Prize (\$100,000)  
1998 IEEE Neural Networks Pioneer Award  
1992 ITAC/NSERC award for academic excellence.  
1990 IEEE Signal Processing Society Senior Award

## PUBLICATIONS

### Refereed Journal Papers

1. Hinton, G. E. Learning to represent visual input. (2010) *Philosophical Transactions of the Royal Society, B*, **365**, pp 177-184.
2. Memisevic, R. and Hinton, G. E. (2010) Learning to represent spatial transformations with factored higher-order Boltzmann machines. *Neural Computation*, **22**, pp 1473-1492.
3. Sutskever, I. and Hinton, G. E. (2010) Temporal Kernel Recurrent Neural Networks *Neural Networks*, **23**, pp 239-243
4. Salakhutdinov, R. and Hinton, G. E. (2009) Semantic Hashing. *International Journal of Approximate Reasoning*, **50**, pp 969-978.
5. van der Maaten, L. J. P. and Hinton, G. E. (2008) Visualizing Data using t-SNE. *Journal of Machine Learning Research*, **9**(Nov) pp 2579-2605.
6. Sutskever, I. and Hinton, G. E. (2008) Deep Narrow Sigmoid Belief Networks are Universal Approximators *Neural Computation*, **20**, pp 2629-2636.
7. Mnih, A., Yuecheng, Z., and Hinton, G. E. (2008) Improving a statistical language model through non-linear prediction. *NeuroComputing*, **72**, pp 7-9.
8. Hinton, G. E. (2007) Learning multiple layers of representation. *Trends in Cognitive Science*, **11**, pp 428-434.
9. Hinton, G. E. and Salakhutdinov, R. (2006) Non-linear dimensionality reduction using neural networks. *Science*, **313**, pp 504-507, July 28 2006.

10. Hinton, G. E., Osindero, S., Welling, M. and Teh, Y. (2006) Unsupervised discovery of non-linear structure using contrastive back-propagation. *Cognitive Science*, **30**, (4), pp 725-731.
11. Hinton, G. E., Osindero, S. and Teh, Y. (2006) A fast learning algorithm for deep belief nets. *Neural Computation*, **18**, pp 1527-1554.
12. Osindero, S., Welling, M. and Hinton G. E. (2006) Topographic Product Models Applied To Natural Scene Statistics. *Neural Computation*, **18**, pp 381-414.
13. Memisevic, R. and Hinton, G. E. (2005) Improving dimensionality reduction with spectral gradient descent. *Neural Networks*, **18**, pp 702-710.
14. Sallans, B and Hinton, G. E. (2004) Reinforcement Learning with Factored States and Actions. *Journal of Machine Learning Research*, **5** pp 1063–1088.
15. Welling, M., Zemel, R. and Hinton, G. E. (2004) Probabilistic sequential independent components analysis. *IEEE Transactions on Neural Networks*, **15**, pp 838-849.
16. Teh, Y. W, Welling, M., Osindero, S. and Hinton G. E. (2003) Energy-Based Models for Sparse Overcomplete Representations. *Journal of Machine Learning Research*, **4**, pp 1235-1260.
17. Friston, K.J., Penny, W., Phillips, C., Kiebel, S., Hinton, G. E., and Ashburner, J. (2002) Classical and Bayesian Inference in Neuroimaging: Theory. *NeuroImage*, **16**, pp 465-483.
18. Hinton, G. E.(2002) Training Products of Experts by Minimizing Contrastive Divergence. *Neural Computation*, **14**, pp 1771-1800.
19. Mayraz, G. and Hinton, G. E. (2001) Recognizing hand-written digits using hierarchical products of experts. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, **24**, pp 189-197.
20. Paccanaro, A., and Hinton, G. E. (2000) Learning distributed representations of concepts from relational data using linear relational embedding. *IEEE Transactions on Knowledge and Data Engineering*, **13**, 232-245.
21. Ueda, N. Nakano, R., Ghahramani, Z. and Hinton, G. E. (2000) SMEM Algorithm for Mixture Models. *Neural Computation*, **12**, 2109-2128.
22. Ghahramani, Z. and Hinton, G.E. (2000) Variational Learning for Switching State-space Models. *Neural Computation*, **12**, 831-864.
23. Ueda, N. Nakano, R., Ghahramani, Z. and Hinton, G. E. (1999) Split and Merge EM Algorithm for Improving Gaussian Mixture Density Estimates. *Journal of VLSI Signal Processing Systems*, **26**, 133-140.
24. Frey, B. J., and Hinton, G. E. (1999) Variational Learning in Non-linear Gaussian Belief Networks. *Neural Computation*, **11**, 193-214.
25. Ennis M, Hinton G, Naylor D, Revow M, Tibshirani R. (1998) A comparison of statistical learning methods on the GUSTO database. *Statistics in Medicine*, **17** 2501-2508.
26. Tibshirani, R. and Hinton, G.E. (1998) Coaching variables for regression and classification. *Statistics and Computing*, **8**, 25-33.
27. de Sa, V. R. and Hinton, G. E. (1998) Cascaded Redundancy Reduction. *Network: Computation in Neural Systems*, **9**, 73-84.
28. Fels, S. S. and Hinton, G. E. (1997) Glove-TalkII: A neural network interface which maps gestures to parallel formant speech synthesizer controls. *IEEE Transactions on Neural Networks*, **8**, 977-984.
29. Hinton, G. E. and Ghahramani, Z. (1997) Generative Models for Discovering Sparse Distributed Representations. *Philosophical Transactions of the Royal Society, B*. **352**, 1177-1190.

30. Frey, B. J., and Hinton, G. E. (1997) Efficient stochastic source coding and an Application to a Bayesian Network Source Model. *The Computer Journal*, **40** (2).
31. Hinton, G. E., Dayan, P. and Revow M. (1997) Modeling the manifold of images of handwritten digits. *IEEE Transactions on Neural Networks*, **8**, 65-74.
32. Williams, C. K. I., Revow, M. and Hinton, G. E. (1997) Instantiating deformable models with a neural net. *Computer Vision and Image Understanding*. **68**, 120-126
33. Dayan, P. and Hinton, G. E. (1997) Using Expectation-Maximization for Reinforcement Learning. *Neural Computation*, **9**, 271-278.
34. Oore, S., Hinton, G. E. and Dudek, G. (1997) A mobile robot that learns its place. *Neural Computation*, **9**, 683-699.
35. Dayan, P. and Hinton, G. E. (1996) Varieties of Helmholtz Machine. *Neural Networks*, **9**, 1385-1403.
36. Revow, M., Williams, C. K. I. and Hinton, G. E. (1996) Using Generative Models for Handwritten Digit Recognition. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, **18**, 592-606.
37. Dayan, P., Hinton, G. E., Neal, R., and Zemel, R. S. (1995) Helmholtz Machines. *Neural Computation*, **7**, 1022-1037.
38. Hinton, G. E., Dayan, P., Frey, B. J. and Neal, R. (1995) The wake-sleep algorithm for self-organizing neural networks. *Science*, **268**, pp 1158-1161.
39. Zemel, R. S. and Hinton, G. E. (1995) Learning Population Codes by Minimizing Description Length *Neural Computation*, **7**, 549-564.
40. Becker, S. and Hinton, G. E. (1993) Learning mixture models of spatial coherence. *Neural Computation*, **5**, 267-277.
41. Nowlan. S. J. and Hinton, G. E. (1993) A soft decision-directed LMS algorithm for blind equalization. *IEEE Transactions on Communications*, **41**, 275-279.
42. Fels, S. S. and Hinton, G. E. (1992) Glove-Talk: A neural network interface between a data-glove and a speech synthesizer. *IEEE Transactions on Neural Networks*, **3**.
43. Becker, S. and Hinton, G. E. (1992) A self-organizing neural network that discovers surfaces in random-dot stereograms. *Nature*, **355:6356**, 161-163.
44. Nowlan. S. J. and Hinton, G. E. (1992) Simplifying neural networks by soft weight sharing. *Neural Computation*, **4**, 173-193.
45. Jacobs, R., Jordan, M. I., Nowlan. S. J. and Hinton, G. E. (1991) Adaptive mixtures of local experts. *Neural Computation*, **3**, 79-87.
46. Hinton, G. E. and Shallice, T. (1991) Lesioning an attractor network: Investigations of acquired dyslexia. *Psychological Review* **98**, 74-95.
47. Hinton, G. E. (1990) Mapping part-whole hierarchies into connectionist networks. *Artificial Intelligence*, **46**, 47-75.
48. Hinton, G. E. and Nowlan, S. J. (1990) The bootstrap Widrow-Hoff rule as a cluster-formation algorithm. *Neural Computation*, **2**, 355-362.
49. Lang, K., Waibel, A. and Hinton, G. E. (1990) A Time-Delay Neural Network Architecture for Isolated Word Recognition. *Neural Networks*, **3**, 23-43.
50. Hinton, G. E. (1989) Connectionist learning procedures. *Artificial Intelligence*, **40**, 185-234.

51. Waibel, A. Hanazawa, T. Hinton, G. Shikano, K. and Lang, K. (1989) Phoneme Recognition Using Time-Delay Neural Networks. *IEEE Acoustics Speech and Signal Processing*, **37**, 328-339.
52. Hinton, G. E. (1989) Deterministic Boltzmann learning performs steepest descent in weight-space. *Neural Computation*, **1**, 143-150.
53. Touretzky, D. S. and Hinton, G. E. (1988) A distributed connectionist production system. *Cognitive Science*, **12**, 423-466.
54. Hinton, G. E. and Parsons, L. A. (1988) Scene-based and viewer-centered representations for comparing shapes. *Cognition*, **30**, 1-35.
55. Hinton, G. E. (1987) The horizontal-vertical delusion. *Perception*, **16**.
56. Plaut, D. C. and Hinton, G. E. (1987) Learning sets of filters using back-propagation. *Computer Speech and Language*, **2**, 35-61.
57. Hinton, G. E. and Nowlan, S. J. (1987) How learning can guide evolution. *Complex Systems*, **1**, 495-502.
58. Fahlman, S. E. and Hinton, G. E. (1987) Connectionist architectures for Artificial Intelligence. *IEEE Computer*, **20**, 100-109.
59. Sejnowski, T. J., Kienker, P. K., and Hinton, G. E. (1986) Learning symmetry groups with hidden units: Beyond the perceptron. *Physica D*, **22**, 260-275.
60. Rumelhart, D. E., Hinton, G. E., and Williams, R. J. (1986) Learning representations by back-propagating errors. *Nature*, **323**, 533-536.
61. Kienker, P. K., Sejnowski, T. J., Hinton, G. E., and Schumacher, L. E. (1986) Separating figure from ground with a parallel network. *Perception*, **15**, 197-216.
62. Ackley, D. H., Hinton, G. E., and Sejnowski, T. J. (1985) A learning algorithm for Boltzmann machines. *Cognitive Science*, **9**, 147-169.
63. Hutchins, E. L. and Hinton, G. E. (1984) Why the islands move. *Perception*, **13**, 629-632.
64. Hinton, G. E. (1984) Parallel computations for controlling an arm. *The Journal of Motor Behavior*, **16**, 171-194.
65. Ballard, D. H., Hinton, G. E., and Sejnowski, T. J. (1983) Parallel visual computation. *Nature*, **306**, 21-26.
66. Hinton, G. E. (1979) Some demonstrations of the effects of structural descriptions in mental imagery. *Cognitive Science*, **3**, 231-250.
67. Hinton, G. E. (1978) Respectively reconsidered. *Pragmatics Microfiche*, May issue.

## Refereed Conference Papers

68. Ranzato, M. and Hinton, G. E. (2010) Modeling pixel means and covariances using factored third-order Boltzmann machines. *To appear in IEEE Conference on Computer Vision and Pattern Recognition*.
69. Taylor, G., Sigal, L., Fleet, D. and Hinton, G. E. (2010) Dynamic binary latent variable models for 3D human pose tracking. *To appear in IEEE Conference on Computer Vision and Pattern Recognition*.
70. Ranzato, M., Krizhevsky, A. and Hinton, G. E. (2010) Factored 3-way restricted Boltzmann machines for modeling natural images. *To appear in Proc. Thirteenth International Conference on Artificial Intelligence and Statistics*.

71. Mnih, V. and Hinton, G. E. (2010) Learning to detect roads in high-resolution aerial images. *To appear in European Symposium on Artificial Neural Networks ESANN-2010.*
72. Mohamed, A. R. and Hinton, G. E. (2010) Phone recognition using restricted Boltzmann machines. *ICASSP-2010*
73. Mohamed, A. R., Dahl, G. and Hinton, G. E. (2009) Deep belief networks for phone recognition. *NIPS 22 workshop on deep learning for speech recognition*
74. Salakhutdinov, R. and Hinton, G. E. (2009) Replicated Softmax: An Undirected Topic Model. *Advances in Neural Information Processing Systems 22*, Y. Bengio, D. Schuurmans, J. Iafferty, C. K. I. Williams, and A. Culotta (Eds.), pp 1607-1614.
75. Nair, V. and Hinton, G. E. (2009) 3-D Object recognition with deep belief nets. *Advances in Neural Information Processing Systems 22*, Y. Bengio, D. Schuurmans, J. Iafferty, C. K. I. Williams, and A. Culotta (Eds.), pp 1339-1347.
76. Palatucci, M, Pomerleau, D. A., Hinton, G. E. and Mitchell, T. (2009) Zero-Shot Learning with Semantic Output Codes. *Advances in Neural Information Processing Systems 22*, Y. Bengio, D. Schuurmans, J. Iafferty, C. K. I. Williams, and A. Culotta (Eds.), pp 1410-1418.
77. Heess, N., Williams, C. K. I. and Hinton, G. E. (2009) Learning generative texture models with extended Fields-of-Experts. In *Proc. British Machine Vision Conf.*
78. Taylor, G. W. and Hinton, G. E. (2009) Products of Hidden Markov Models: It Takes N<sub>i</sub>1 to Tango. *Proc. of the 25th Conference on Uncertainty in Artificial Intelligence.*
79. Taylor, G. W. and Hinton, G. E. (2009) Factored Conditional Restricted Boltzmann Machines for Modeling Motion Style. *Proc. 26th International Conference on Machine Learning*, pp 1025-1032. Omnipress, Montreal, Quebec.
80. Tieleman, T. and Hinton, G. E. (2009) Using Fast Weights to Improve Persistent Contrastive Divergence. *Proc. 26th International Conference on Machine Learning*, pp 1033-1040. Omnipress, Montreal, Quebec.
81. Zeiler, M.D., Taylor, G.W., Troje, N.F. and Hinton, G.E. (2009) Modeling pigeon behaviour using a Conditional Restricted Boltzmann Machine. In *European Symposium on Artificial Neural Networks ESANN-2009*.
82. Salakhutdinov, R. and Hinton, G. E. (2009) Deep Boltzmann Machines. In D. van Dyk and M. Welling (Eds.), *Proc. Twelfth International Conference on Artificial Intelligence and Statistics*, JMLR: W&CP 5, pp 448-455, Clearwater Beach, Florida, April 2009.
83. Mnih, A. and Hinton, G. E. (2009) A Scalable Hierarchical Distributed Language Model. *Advances in Neural Information Processing Systems 21*, MIT Press, Cambridge, MA  
PLEASE NOTE: In 2009 NIPS changed from publishing in the year after the conference to publishing in the same year. So both NIPS22 and NIPS 21 were published in 2009
84. Nair, V. and Hinton, G. E. (2009) Implicit Mixtures of Restricted Boltzmann Machines. *Advances in Neural Information Processing Systems 21*, MIT Press, Cambridge, MA
85. Sutskever, I. and Hinton, G. E. (2009) Using matrices to model symbolic relationships. *Advances in Neural Information Processing Systems 21*, MIT Press, Cambridge, MA
86. Sutskever, I., Hinton, G. E. and Taylor, G. W. (2009) The Recurrent Temporal Restricted Boltzmann Machine. *Advances in Neural Information Processing Systems 21*, MIT Press, Cambridge, MA
87. Schmah, T., Hinton, G. E., Zemel, R., Small, S. and Strother, S. (2009) Generative versus Discriminative Training of RBM's for classification of fMRI images. *Advances in Neural Information Processing Systems 21*, MIT Press, Cambridge, MA

88. Nair, V., Susskind, J., and Hinton, G.E. (2008) Analysis-by-Synthesis by Learning to Invert Generative Black Boxes. *ICANN-08: International conference on Artificial Neural Networks*, Prague.
89. Yuecheng, Z, Mnih, A, and Hinton, G (2008) Improving a statistical language model by modulating the effects of context words. *16<sup>th</sup> European Symposium on Artificial Neural Networks*, pages 493–498.
90. Osindero, S. and Hinton, G. E. (2008) Modeling image patches with a directed hierarchy of Markov random fields. *Advances in Neural Information Processing Systems 20*, J.C. Platt and D. Koller and Y. Singer and S. Roweis (eds.), MIT Press, Cambridge, MA
91. Salakhutdinov, R. and Hinton, G. E. (2008) Using Deep Belief Nets to Learn Covariance Kernels for Gaussian Processes. *Advances in Neural Information Processing Systems 20*, J.C. Platt and D. Koller and Y. Singer and S. Roweis (eds.), MIT Press, Cambridge, MA
92. Salakhutdinov R. R, and Hinton, G. E. (2007) Semantic Hashing. *Proceedings of the SIGIR Workshop on Information Retrieval and Applications of Graphical Models*, Amsterdam.
93. Memisevic R. F. and Hinton, G. E. (2007) Unsupervised learning of image transformations. *IEEE Conference on Computer Vision and Pattern Recognition* Pages: 508-515.
94. Mnih, A. and Hinton, G. E. (2007) Three New Graphical Models for Statistical Language Modelling *International Conference on Machine Learning*, Corvallis, Oregon.
95. Salakhutdinov, R., Mnih, A. and Hinton, G. E. (2007) Restricted Boltzmann Machines for Collaborative Filtering *International Conference on Machine Learning*, Corvallis, Oregon.
96. Salakhutdinov R.R, and Hinton, G. E. (2007) Learning a non-linear embedding by preserving class neighbourhood structure. (Meila, M. and Shen, X. eds), pp 409-416, *Proc. Eleventh International Conference on Artificial Intelligence and Statistics*, The Society for AI and Statistics, Puerto Rico.
97. Sutskever, I. and Hinton, G. E. (2007) Learning multilevel distributed representations for high-dimensional sequences. (Meila, M. and Shen, X. eds), *Proc. Eleventh International Conference on Artificial Intelligence and Statistics*, pp 544-551, The Society for AI and Statistics, Puerto Rico.
98. Cook, J. A., Sutskever, I., Mnih, A. and Hinton, G. E. (2007) Visualizing similarity data with a mixture of maps. (Meila, M. and Shen, X. eds), *Proc. Eleventh International Conference on Artificial Intelligence and Statistics*, pp 65-72, The Society for AI and Statistics, Puerto Rico.
99. Taylor, G. W., Hinton, G. E. and Roweis, S. (2007) Modeling human motion using binary latent variables. *Advances in Neural Information Processing Systems 19* MIT Press, Cambridge, MA
100. Hinton, G. E. and Nair, V. (2006) Inferring motor programs from images of handwritten digits. *Advances in Neural Information Processing Systems 18* pp 515-522, MIT Press, Cambridge, MA
101. Memisevic, R. and Hinton, G. E. (2005) Embedding via clustering: Using spectral information to guide dimensionality reduction. *IEEE International Joint Conference on Neural Networks (IJCNN 2005)* Pages: 3198-3203
102. Mnih, A. and Hinton, G. E. (2005) Learning Unreliable Constraints using Contrastive Divergence. *IJCNN 2005*
103. Carreira-Perpignan, M. A. and Hinton, G. E. (2005) On Contrastive Divergence Learning. *Artificial Intelligence and Statistics, 2005*, Barbados.
104. Hinton, G. E., Osindero, S. and Bao, K. (2005) Learning Causally Linked Markov Random Fields. *Artificial Intelligence and Statistics, 2005*, Barbados.
105. Welling, M., Rosen-Zvi, M. and Hinton, G. E. (2005) Exponential Family Harmoniums with an Application to Information Retrieval. *Advances in Neural Information Processing Systems 17* MIT Press, Cambridge, MA

106. Memisevic, R. and Hinton, G. E. (2005) Multiple Relational Embedding. *Advances in Neural Information Processing Systems* **17** MIT Press, Cambridge, MA
107. Goldberger, J., Roweis, S., Salakhutdinov, R. and Hinton, G. E. (2005) Neighborhood Components Analysis *Advances in Neural Information Processing Systems* **17** MIT Press, Cambridge, MA
108. Bishop, C. M., Svensen, M. and Hinton, G. E. (2004) Distinguishing Text from Graphics in On-line Handwritten Ink. In Kimura, F. and Fujisawa, H. (eds.), *Proceedings Ninth International Workshop on Frontiers in Handwriting Recognition, IWFHR-9*, Tokyo, Japan, pp. 142147.
109. Hinton, G. E., Welling, M. and Mnih, A. (2004) Wormholes Improve Contrastive Divergence. *Advances in Neural Information Processing Systems* **16** pages 417-424. MIT Press, Cambridge, MA
110. Welling, M., Zemel, R. S., and Hinton, G. E. (2003) Efficient parametric projection pursuit density estimation. In *UAI-2003: 19th Conference on Uncertainty in Artificial Intelligence*.
111. Welling, M., Hinton, G. E. and Osindero, S. (2003) Learning Sparse Topographic Representations with Products of Student-t Distributions. *Advances in Neural Information Processing Systems* **15** MIT Press, Cambridge, MA
112. Welling, M., Zemel, R. and Hinton, G. E. (2003) Self-Supervised Boosting. *Advances in Neural Information Processing Systems* **15** MIT Press, Cambridge, MA
113. Hinton, G. E. and Roweis, S. (2003) Stochastic Neighbor Embedding. *Advances in Neural Information Processing Systems* **15** MIT Press, Cambridge, MA
114. Welling, M. and Hinton, G. E. (2002) A New Learning Algorithm for Mean Field Boltzmann Machines. *International Joint Conference on Neural Networks*, Madrid.
115. Oore, S., Terzopoulos, D. and Hinton, G. E. (2002) Local Physical Models for Interactive Character Animation. *Eurographics 2002*, **21**, Blackwell Publishers, Oxford.
116. Oore, S., Terzopoulos, D. and Hinton, G. E. (2002) A Desktop Input Device and Interface for Interactive 3D Character Animation. *Graphics Interface*, to appear
117. Roweis, S., Saul, L. and Hinton, G. E. (2002) Global Coordination of Local Linear Models *Advances in Neural Information Processing Systems* **14** MIT Press, Cambridge, MA
118. Paccanaro, A., and Hinton, G. E. (2002) Learning Hierarchical Structures with Linear Relational Embedding. *Advances in Neural Information Processing Systems* **14** MIT Press, Cambridge, MA
119. Brown, A. D. and Hinton, G. E. (2002) Relative Density Nets: A New Way to Combine Backpropagation with HMM's. *Advances in Neural Information Processing Systems* **14** MIT Press, Cambridge, MA
120. Paccanaro, A. and Hinton, G. E. (2001) Learning distributed representations of relational data using linear relational embedding. Proceedings of the 12th Italian Workshop on Neural Nets. WIRN VIETRI-2001.
121. Brown, A. D. and Hinton, G. E. (2001). Products of Hidden Markov Models. *Proceedings of Artificial Intelligence and Statistics 2001*
122. Mayraz, G. and Hinton, G. E. (2001) Recognizing Hand-Written Digits Using Hierarchical Products of Experts. *Advances in Neural Information Processing Systems* **13**. MIT Press, Cambridge, MA
123. Sallans, B. and Hinton, G. E. (2001) Using Free Energies to Represent Q-values in a Multiagent Reinforcement learning Task. *Advances in Neural Information Processing Systems* **13**. MIT Press, Cambridge, MA
124. Teh, Y. and Hinton, G. E. (2001) Rate-coded Restricted Boltzmann Machines for Face Recognition. *Advances in Neural Information Processing Systems* **13**. MIT Press, Cambridge, MA

125. Hinton, G. E. and Teh, Y. (2001) Discovering multiple constraints that are frequently approximately satisfied. In *Proceedings of the Seventh Conference on Uncertainty in Artificial Intelligence*, pp 227-234.
126. Paccanaro, A. and Hinton, G. E. (2000) Extracting Distributed Representations of Concepts and Relations from Positive and Negative Propositions. In *Proceedings of the International Joint Conference on Neural Networks, IJCNN 2000*.
127. Paccanaro, A. and Hinton, G. E. (2000) Learning Distributed Representations by Mapping Concepts and Relations into a Linear Space. In P. Langley (Ed.) *Proceedings of the Seventeenth International Conference on Machine Learning, ICML2000*, pp 711-718, Morgan Kaufmann Publishers, San Francisco.
128. Hinton, G.E., Ghahramani, Z. and Teh, Y.W. (2000) Learning to Parse Images. In S. A. Solla, T. K. Leen, K.-R. Muller, (Eds.) *Advances in Neural Information Processing Systems 12*. Cambridge, MA: MIT Press.
129. Hinton, G. E. and Brown, A. (2000) Spiking Boltzmann Machines. In S. A. Solla, T. K. Leen, K.-R. Muller, (Eds.) *Advances in Neural Information Processing Systems 12*. Cambridge, MA: MIT Press.
130. Ghahramani, Z., Korenberg, A., and Hinton, G.E. (1999) Scaling in a Hierarchical Unsupervised Network. *ICANN 99: Ninth international conference on Artificial Neural Networks*, Edinburgh.
131. Ueda, N., Nakano, R., Ghahramani, Z. and Hinton, G.E. (1999) SMEM Algorithm for Mixture Models. In M. S. Kearns, S. A. Solla, D. A. Cohn, (eds.) *Advances in Neural Information Processing Systems 11*. Cambridge, MA: MIT Press.
132. Grzeszczuk, R., Terzopoulos, D., and Hinton, G. E. (1999) Fast Neural Network Emulation of Dynamical Systems for Computer Animation. In M. S. Kearns, S. A. Solla, D. A. Cohn, (eds.) *Advances in Neural Information Processing Systems 11*. Cambridge, MA: MIT Press, pp 882-889.
133. Ueda, N., Nakano, R., Ghahramani, Z. and Hinton, G.E. (1999) Pattern classification using a mixture of factor analyzers. *IEEE Neural Networks for Signal Processing (NNSP99)*, pp. 525-533.
134. Ueda, N., Nakano, R., Ghahramani, Z. and Hinton, G.E. (1998) Split and Merge EM Algorithm for Improving Gaussian Mixture Density Estimates. *IEEE Neural Networks for Signal Processing (NNSP98)*, pp. 274-283.
135. Ghahramani, Z. and Hinton, G. E. (1998) Hierarchical Non-linear Factor Analysis and Topographic Maps. *Advances in Neural Information Processing Systems 10*. M. I. Jordan, M. J. Kearns, and S. A. Solla (Eds.) MIT Press: Cambridge, MA.
136. Grzeszczuk, R., Terzopoulos, D., and Hinton, G. E. (1998) NeuroAnimator: Fast Neural Network Emulation and Control of Physics-Based Models. *Proc. ACM SIGGRAPH-98, Computer Graphics Proceedings, Annual Conference Series*, pp 9-20.
137. Bishop, C. M., Hinton, G. E. and Strachan, I. D. G. (1997) GTM through time. *Proceedings IEE Fifth International Conference on Artificial Neural Networks*. pp 111–116. IEE, London.
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259. Hinton, G. E. (1990) Review of Aleksander and Morton *Introduction to Neuro-Computing*, In *Nature*, **347**, 627-628.
260. Hinton, G. E., and LeCun, Y. (1988) Review of: R. K. Miller *Neural Networks: Implementing associative memory models in neurocomputers*, In *Canadian Artificial Intelligence*, **41**.
261. Hinton, G. E. (1987) Models of human inference. Invited commentary on a paper by D. McDermott. *Computational Intelligence*, **3**, 189-190.
262. Hinton, G. E. (1987) Boltzmann Machines. In S. Shapiro (Ed.) *The Encyclopedia of Artificial Intelligence*, New York: Wiley and Sons.
263. Hinton, G. E. (1982) Review of: S. E. Fahlman *NETL: A system for representing and using real-world knowledge*. In *A.I.S.B. Quarterly*, **42/43**.
264. Hinton, G. E. (1985) Three frames suffice. Invited commentary on a paper by J. Feldman. *The Behavioral and Brain Sciences*,
265. Hinton, G. E. (1980) Inferring the meaning of direct perception. Invited commentary on a paper by Ullman, S. *The Behavioral and Brain Sciences*, **3**, 387-388.
266. Hinton, G. E. (1979) Imagery without arrays. Invited commentary on a paper by S. M. Kosslyn, S. Pinker, G.E. Smith, and S. P. Shwartz. *The Behavioral and Brain Sciences*, **2**, 555-556
267. Hinton, G. E. (1979) Report on The La Jolla Conference on Cognitive Science, In *A.I.S.B. Quarterly*, **35**.
268. Hinton, G. E. (1979) Review of: D. C. Dennett *Brainstorms*. In *Contemporary Psychology*, **24**, 746-748.
269. Hinton, G. E. (1979) Review of: E. L. J. Leeuwenberg and H. F. J. M. Buffart (Eds.) *Formal theories of visual perception*. In *Journal of the Optical Society of America*, **69**, p.1492.
270. Hinton, G. E. (1978) Review of: J. Metzler (Ed.) *Systems Neuroscience*. In *Perception*, **7**, 364-365.

## Named Lectures

- 1986:** The David Marr memorial lecture. Kings College Cambridge
- 1987:** The Weigand Lecture. University of Toronto
- 1989:** The fourth annual Hebb lecture, Dalhousie University, Halifax.
- 1989:** The Sun Annual Lectures, University of Manchester (8 lectures)
- 1991:** The St Andrews Easter Lectures, St Andrews (6 lectures).
- 1992:** The Benjamin Meaker Lectures, Bristol University (5 lectures).
- 1993:** The Herzberg Lecture, Ottawa.
- 1993:** The Broadbent Lecture, London, UK.
- 1995:** The Rockwood Memorial Lecture, UC San Diego
- 1998:** The Rockwood Memorial Lecture, UC San Diego
- 2001:** The David E. Rumelhart Prize Lecture, Edinburgh
- 2003:** The Pinkel Lecture, University of Pennsylvania
- 2006:** The Graham Lecture, University of Toronto
- 2009:** The Ian Howard Lecture, York University
- 2009:** The Ed Posner Lecture, NIPS-09, Vancouver
- 2010:** The Rockwood Memorial Lecture, UC San Diego
- 2010:** The "Big Thinkers" lecture, Yahoo, San Jose

## Invited Conference Addresses

*this does not include talks accompanying refereed conference papers.*

### 1981

Seventh International Joint Conference on A. I., Vancouver BC, Canada.  
Third Annual Conference of the Cognitive Science Society, Berkeley CA.  
Annual Meeting of the British Experimental Psychology Society, Oxford.

### 1983

Fifth Annual Conference of the Cognitive Science Society, Rochester NY.

### 1984

Conference on “Statistical Physics in Computer Engineering and Models of Perception.”  
IBM Watson Research Center, Yorktown Heights NY.  
Conference on “Visual Perception.” Lake Ontario Visual Establishment, Canada.  
Sixth Annual Conference of the Cognitive Science Society, Boulder CO.  
Workshop on “Cognitive Neuroscience”, Moorea.

### 1985

British Pattern Recognition Society (Keynote lecture plus additional lecture)  
“From Neurons to Thought”, Florence Center for the History and Philosophy of Science.  
Society for Artificial Intelligence and the Simulation of Behaviour.  
Cognitiva 85. Paris

### 1986

American Association for Artificial Intelligence, Philadelphia PA.  
Eighth Annual Conference of the Cognitive Science Society, Amherst Mass.  
Conference on “Organizing Principles of Sensory Processing.” Pittsburgh.

### 1987

Neural Network Conference, Snowbird, Utah.  
Philosophy of Mind Conference, Pittsburgh PA.  
Annual Meeting of the British Experimental Psychology Society, Oxford.  
European Psychology Society Summer School, Bernried, West Germany

### 1988

Canadian Society for Artificial Intelligence, Edmonton.  
McDonnell Foundation workshop on vision, Monterey, CA.  
Machine Learning Conference, Ann Arbor.  
Workshop on Parallel Distributed Processing, Emory University (4 lectures).  
Connectionist Summer School, Carnegie-Mellon.  
Conference on “How the Brain Works”, Boston (Organized by *Nature*)  
Canadian Institute for Artificial Intelligence meeting, Whistler, BC  
International Neural Network Society Conference, Boston  
Canadian Institute for Artificial Intelligence meeting, Mt. St. Marie, Quebec  
Fourth biennial conference on cellular mechanisms of conditioning and behavioral plasticity  
Toronto, Canada.

### 1989

First International Conference on Knowledge Representation, Toronto, Ontario  
International Joint Conference on A. I., Detroit, Michigan.  
Annual Conference of the Cognitive Science Society, Ann Arbor, Michigan.

**1990**

International Joint Conference on Neural Networks, Washington DC.  
Conference on "Connectionism: Theory and Practice." Vancouver, BC.  
Workshop on Neural Networks, Niagara, Ontario

**1991**

Snowbird Neural Networks Conference, Utah  
Neural Network Summer School, Cambridge, UK  
International Joint Conference on Neural Networks, Seattle, WA.  
Cognitive Science Society Conference, Chicago, MI.  
Conference on Computational Learning Theory and Natural Learning Systems, Berkeley

**1992**

Neural Networks Applications Forum, Birmingham UK  
Canadian Institute for Artificial Intelligence meeting, Montreal  
Applications of Artificial Intelligence in Engineering, Waterloo, Ontario  
American Statistical Association, Boston, Mass.  
Santa Fe Institute meeting on supervised learning, Santa Fe, NM.  
International Conference on Neural Networks, Brighton, UK  
Neural Network Summer School, Cambridge, UK

**1993**

Australian Neural Networks Society Conference, Melbourne  
Australian Cognitive Science Society Conference, Melbourne  
Third International Workshop on Frontiers of Handwriting Recognition, Buffalo, NY  
Cognitive Science Society Conference, Boulder, Colorado  
Connectionist Summer School, Boulder, Colorado  
Computational Learning Theory Conference (COLT-93), Santa Cruz, CA  
International Conference on Neural Networks, Amsterdam  
Neural Network Summer School, Cambridge, UK

**1994**

The Royal Society of Canada, Symposium, Calgary  
Cognitive Science Summer School, Buffalo  
American Statistical Association, Toronto  
American Association for Artificial Intelligence, Seattle  
Neural Information Processing Conference, Denver

**1995**

Machines that Learn, Snowbird, Utah.  
Conference on Visual Coding, York University, Ontario  
Neural Network Summer School, Cambridge, UK  
37<sup>th</sup> Metal Working and Steel Processing Conference, Hamilton, Ontario  
Workshop on Belief nets, Vail Colorado

**1996**

Workshop on Neural Networks, Montreal.  
Connectionism for Cognitivists Conference, Carleton University, Ottawa  
Workshop on Neuromorphic Engineering, Telluride, Colorado  
Cognitive Science Society Conference, San Diego, CA.

**1997**

Royal Society Meeting on the role of knowledge in perception. London, UK.

Canadian Applied Mathematics Society Conference. Toronto  
IEEE International Conference on Neural Networks. Houston, Texas  
Canadian Workshop on Information Theory. Toronto  
Nato workshop on Neural Networks and Generalization. Cambridge, UK

#### **1998**

NEC/NYU Workshop on Learning in Vision, New York

#### **1999**

Connectionist Models Summer School, Oxford.  
Cognitive Neuroscience Autumn School, Oxford.  
International Conference on Artificial Neural Networks, Edinburgh

#### **2000**

NICE 2000, Grindelwald, Switzerland  
Neural networks for Computing, Snowbird, Utah  
Model selection and learning in Computer vision, Grasmere, UK  
Artificial Intelligence and the Simulation of Behaviour, Birmingham  
Neural Applications Computing Forum, London  
Tenth anniversary neural networks workshop, Kings College London  
XIII International Congress on Mathematical Physics, London  
American Association for Artificial Intelligence, Austin, Texas  
Cambridge Philosophical Society, Cambridge

#### **2001**

Workshop on Innovation in Speech Processing, Stratford-on-Avon  
International Conference on Artificial Neural Networks and Genetic Algorithms, Prague  
European Congress of Psychology, London  
Conference on Uncertainty in Artificial Intelligence, Seattle  
Third International Workshop on Energy Minimization Methods  
in Computer Vision and Pattern Recognition, Sophia-Antipolis  
Autumn School in Cognitive Neuroscience, Oxford  
ICA-2001, San Diego

#### **2002**

CIAR Workshop on Machine Learning, Toronto.  
KDD-02 (Data-Mining Conference), Edmonton  
CASCON workshop on machine learning, Toronto

#### **2003**

Uncertainty in Artificial Intelligence, Key West, Florida  
Workshop on “The Probabilistic Brain”, Cambridge, UK  
CIAR Workshop on Computational Neuroscience, Vancouver

#### **2004**

Symposium on the Mind, University College, University of Toronto  
Southern California Neural Computation Workshop (keynote address), UC Irvine  
Workshop on Object Recognition, Sicily  
Workshop on learning for object recognition, Vancouver BC

#### **2005**

Robotics: Science and Systems, Cambridge Mass. June 2005.  
CIAR workshop on the perception of human motion, Toronto, July 2005  
International Joint Conference on AI, Edinburgh, Aug 2005.

Society for Computers in Psychology (keynote address), Toronto, Nov 2005.  
Sunnybrook Artificial Intelligence in Medicine workshop, Toronto, Oct 2005.  
CIAR workshop on sequential vision, Vancouver, Dec 2005  
CIAR workshop on learning energy-based models, Vancouver, Dec 2005

## **2006**

CIAR workshop on computational neuroscience, Alton, Ontario, April 2006  
XXVIIIth International Symposium on computational neuroscience, Montreal, May 2006  
Canadian AI conference (keynote talk), Quebec City, June 2006  
CIAR workshop on “Learning and Vision”, Toronto, Oct 2006  
CIAR workshop on Cortical Learning Mechanisms, Vancouver, Dec 2006

## **2007**

Poster (with S. Becker) at Computational and Systems Neuroscience, Utah, Feb 2007  
Frontiers of Theoretical Neuroscience, Waterloo, April 13 2007  
“Brain Day”, Waterloo, April 27 2007  
Microsoft Research Laboratory Cambridge 10 year celebration, invited plenary talk, June 2007.  
Talk at CIAR workshop on “Achieving Perceptual Invariance”, Vancouver BC, Dec 2007.  
Talk at NIPS workshop on “Deep Belief Nets”, Vancouver, BC, Dec 2007

## **2008**

Talk at CIFAR workshop on “Inhibitory Interneurons”, Toronto, ON, Apr 2008  
Talk at NIPS workshop on “New Multi-level Models for High-dimensional Sequential Data”, Whistler, BC, Dec 2008  
Talk at CIFAR workshop on “Recent Developments in Deep Learning”, Vancouver, BC, Dec 2008

## **2009**

The Ed Posner lecture (plenary invited talk) at NIPS, Vancouver, BC, Dec 2009  
Talk at CIFAR workshop on “Image retrieval using deep auto-encoders”, Vancouver, BC, Dec 2009  
talk at NIPS workshop on “Deep learning for speech recognition”, Whistler, BC, Dec 2009.

## **2010**

Talk at Computational and Systems Neuroscience 2010, Salt Lake City, Utah, Feb 2010.  
Talk at First Annual Mini-Symposium, Center for Mind, Brain, and Computation. Stanford university, March 2010.  
Talk at a conference on “Taming Complexity”, CUNY, New York

## **Invited Lectures**

### **1978**

University of Maryland, Computer Vision Group

### **1979**

University of California at Berkeley, Computer Science Department  
Yale University, Computer Science Department  
Brown University, Cognitive Science Group  
University of Rochester, Cognitive Science Group  
Bolt, Beranek and Newman, Cambridge Mass  
Applied Psychology Unit, Cambridge England  
Sussex University, Cognitive Studies Group  
Warwick University, Psychology Department

Bristol University, Psychology Department

### 1980

Stanford University, A.I. group

University of California at Berkeley, Psychology Department

University of California at Berkeley, Computer Science Department

IBM, San Jose

Stanford University, Psychology Department

Lawrence Berkeley Laboratory

Brown University, Cognitive Science Group

University of Rochester, Computer Science Department

M.I.T., Artificial Intelligence Laboratory

Essex University, Cognitive Science Group

Sussex University, Cognitive Studies Group

Cambridge University, Psychology Department

### 1981

University of California at Berkeley, Computer Science Department

University of California at San Diego, Computer Science Department

Hewlett Packard, Palo Alto

Stirling University, Psychology Department

Carnegie-Mellon University, Computer Science Department

Carnegie-Mellon University, Psychology Department

Sussex University, Cognitive Studies Group

System Development Foundation, Palo Alto

Manchester University, Psychology Department

London University, Birkbeck College

Hatfield Polytechnic, Psychology Department

Warwick University, Psychology Department

### 1983

University of Pennsylvania, Computer Science Department

M.I.T., Artificial Intelligence Laboratory

University of Rochester, Computer Science Department

University of California at San Diego, Center for Human Information Processing

Fairchild AI Lab, Palo Alto

University of Pennsylvania, Psychology Department

University of California at Berkeley, Cognitive Science Group

California Institute of Technology, Parallel Computation Group

Bell Labs, Murray Hill New Jersey

### 1984

Applied Psychology Unit, Cambridge England

University of Pennsylvania, Psychology Department

University of Pittsburgh, Neuroscience Program

Sussex University, Cognitive Studies Group

Brown University, Psychology Department

Harvard University, Computer Science Department

Bolt, Beranek and Newman, Cambridge Mass

IBM, Yorktown Heights, Physics Group

Princeton University, Cognitive Science Group

M.I.T., Cognitive Science Seminar

University of Toronto, Computer Science Department

University of Toronto, Psychology Department

**1985**

Sussex University, Institute for Cognitive and Information Sciences  
Applied Psychology Unit, Cambridge, England  
University of Rhode Island, Computer Science Department  
The Open University, England, Psychology Department  
Imperial College London, Computer Science Department  
University of Michigan, Psychology Department  
Georgia Institute of Technology, Computer Science Department  
Johns Hopkins University, Psychology Department  
Yale University, Computer Science Department  
M.I.T, Artificial Intelligence Laboratory

**1986**

Imperial College London, Computer Science Department (4 lectures)  
Edinburgh University, Artificial Intelligence Department  
Oxford University, Psychology Department  
Applied Psychology Unit, Cambridge, England  
Center for the Study of Systems and Advanced Technology, Paris  
Sussex University, Institute for Cognitive and Information Sciences  
M.I.T, Artificial Intelligence Laboratory  
Memphis State University, Psychology Department (2 lectures)  
Bolt, Beranek and Newman, AI group and Speech Recognition group

**1987**

Stanford University, Psychology Department  
University of California at Berkeley, Psychology Department  
University of California at Berkeley, Cognitive Science Group (2 talks)  
University of California at Santa Barbara, Cognitive Science Group  
University of California at Los Angeles, Cognitive Science Group  
University of California at Los Angeles, Computer Science Department  
University of California at San Diego, Center for Human Information Processing  
Columbia University, Psychology Department  
University of Toronto, Psychology Department  
University of Toronto, Computer Science Department  
University of Maryland, Computer Science Department  
York University, Psychology Department  
York University, Vision Group  
University of Rochester, Computer Science Department  
Cornell University, Computer Science Department

**1988**

University of Sussex, Psychology Department (2 talks)  
University of Western Ontario, Cognitive Science Group  
Oregon Graduate Center, Beaverton  
University of Oregon, Psychology Department  
University of Toronto, Anatomy Department  
Brown University, Computer Science Department  
Brown University, Philosophy Department  
McMaster University, Psychology Department  
University of Waterloo, Psychology Department  
Ontario Institute for Studies in Education  
International Computer Science Institute, Berkeley

**1989**

IBM Canada, Toronto  
Carnegie-Mellon University, Computer Science Department  
Queens University, Psychology Department  
University of Waterloo, Computer Science Department  
Stanford University, Psychology Department  
McGill University, Computer Science Department  
McGill University, Psychology Department  
University of Manitoba, Computer Science Department  
University of Manitoba, Psychology Department  
University of Toronto, Non-Linear Systems Group

**1990**

University of California, Berkeley, Cognitive Science Group  
Synaptics Inc., San Jose  
International Computer Science Institute, Berkeley  
University of Toronto, Physics Department Colloquium  
University of California, San Diego, Institute for Neural Computation  
California Institute of Technology, Division of Biology  
University of Pennsylvania, Cognitive Science Group  
MIT, Department of Cognitive and Brain Sciences  
Brandeis University, Computer Science Department  
Purdue University, Computer Science Department  
University of Indiana, Psychology Department  
University of Illinois, Computer Science Department  
Northwestern University, Psychology Department  
University of Toronto, Biomedical Engineering Department  
NCR Waterloo, Recognition Modules Group  
SUNY Buffalo, Computer Science Department

**1991**

Rotman Institute, Toronto, Neuropsychology Group  
University of North Carolina, Cognitive Science Group  
North Carolina Triangle Park Neural Networks Group  
University of California, San Diego, Computer Science Department  
Synaptics Inc., San Jose  
Bell Northern Research, Ottawa  
The Salk Institute, California  
University of Wisconsin, Computer Science Department  
University of Waterloo, Electrical Engineering Department  
Synaptics Inc., San Jose  
Apple Computer, San Jose  
University of Toronto, Semiotics Group  
Yale University, Computer Science Department  
University of Massachusetts, Computer Science Department  
University of Toronto, Statistics Department Colloquium

**1992**

University of Ottawa, Physics Department  
NCR Waterloo, Recognition Modules Group  
McGill University, Electrical Engineering Department  
Montreal Neurological Institute  
Oxford University, Psychology Department  
University of Cardiff, Computer Science Department

Oxford University, Department of Theoretical Physics  
Synaptics Inc., San Jose  
University of British Columbia, Computer Science Department  
University of British Columbia, Physics Department  
SUNY Buffalo, Center of Excellence for Document Analysis and Recognition  
University of Rochester, Computer Science Department

### 1993

University of Sydney, Psychology Department  
MIT, Department of Brain and Cognitive Sciences  
MIT, Center for Biological and Computational Learning  
Queens University, Computer Science Department  
Queens University, Cognitive Science  
Carleton University, Computer Science Department  
IEEE Chapter, Waterloo, Ontario  
Synaptics Inc., San Jose  
International Computer Science Institute, Berkeley  
Carnegie-Mellon University, Psychology Department (2 lectures)

### 1994

University of Sussex, Cognitive Studies Group  
University of Waterloo, Cognitive Science  
Sunnybrook Hospital, Toronto, Imaging Research Group  
Northwestern University, Institute for Learning Studies  
International Center for Advanced Studies, Trieste, Italy

### 1995

Princeton University, Psychology Department  
Clark Institute of Psychiatry, Toronto  
University of California, Berkeley, Cognitive Science Group  
University of California at Berkeley, Statistics Department  
Synaptics Inc., San Jose  
MIT, Department of Brain and Cognitive Sciences  
Stanford University, Electrical Engineering Department  
MIT, Artificial Intelligence Laboratory  
Aston University, Neural Networks Group (3 talks)  
Fields Institute, Toronto, Financial Mathematics lecture series

### 1996

Carnegie-Mellon University, Computer Science Department  
University of Toronto, Physiology Department  
AT&T Research, Machine Learning Group  
California Institute of Technology, Neural Computation Program  
CIPS/CIAR meeting, Toronto  
Brandeis University, Computer Science Department

### 1997

Imperial College London, Neural networks group  
University of Colorado at Boulder, Psychology Department  
University of Colorado at Boulder, Computer Science Department  
Cornell University, Psychology Department  
Cornell University, Cognitive Science Group

### 1998

University of Pennsylvania, Computer Science Department  
Brown University, Computer Science Department  
Caltech, Neuromorphic Engineering Group  
Salk Institute, Computational Neurobiology Laboratory  
University College London, Department of Statistical Science  
Oxford University, Cognitive Neuroscience group  
Applied Psychology Unit, Cambridge

#### **1999**

University College London, Computer Science Department  
University of Edinburgh, Cognitive Science Group  
University of Edinburgh, Computer Science  
University of Bristol, Psychology Department  
University of Glasgow, Statistics Department  
Imperial College London, Neural networks group  
University College London, Institute of Cognitive Neuroscience  
University of Toronto, Department of Computer Science  
University of Warwick, Psychology Dept  
University of Edinburgh, Electrical Engineering  
Microsoft Research Laboratories, Cambridge

#### **2000**

Cambridge University, Astrophysics Department  
Rutgers University, Cognitive Science Department  
University of Exeter, Computer Science.  
University of Colorado at Boulder, Computer Science  
University of Waterloo, Computer Science  
University of Toronto, Computer Science  
University of California at Berkeley, Computer Science  
Salk Institute, Computational Neurobiology Laboratory  
University of Montreal  
University of Southampton, Electronics and Computer Science

#### **2001**

Sussex University, COGS department (2 talks)  
Stanford University, Computer Science and Statistics  
University of Oxford, Engineering Science

#### **2002**

Yale University, Computer Science Department  
University of Montreal, Dept. IRO  
McGill University, Psychology Department  
University of Chicago, Departments of Statistics and Computer Science  
York University, Vision Group  
University of Toronto, Computational Neuroscience Group  
Georgetown University, Medical School  
Johns Hopkins, Speech and Language group  
Ohio State University, Computer Science  
MIT, AI laboratory  
Carnegie-Mellon University, Computer Science Department  
UC Irvine, Computer Science Department  
Microsoft Research Laboratories, Redmond  
University of Alberta, Computer Science Department  
University of British Columbia, Computer Science Department

**2003**

University of California San Diego, Institute for Neural Computation  
Redwood Neuroscience Institute, CA  
Stanford University, Computational Neuroscience Lecture Series  
University of Rochester, Computer Science

**2004**

Salk Institute, Computational Neurobiology Lab.  
UC San Diego, Computer Science Department  
Caltech, Neural Computation program  
Redwood Neuroscience Institute, CA (2 talks)  
Microsoft Research Laboratory, Cambridge  
MRC Cognition and Brain Sciences Unit, Cambridge, UK  
Gatsby Computational Neuroscience Unit, University College London  
Cambridge University, Physics Department  
Simon Fraser University, Computer Science Department

**2005**

University of Montreal, , Dept. IRO  
MIT, AI Laboratory  
Microsoft Research Laboratory, Cambridge  
Gatsby Computational Neuroscience Unit, University College London  
Cambridge University, Inference and Learning Group, Physics Department

**2006**

McGill University, Psychology Department  
University of Toronto, Scarborough, Mathematical Sciences Dept  
University of Montreal, Dept. IRO  
McGill University, Physics Department

**2007**

New York University, Computer Science Department  
Columbia University, Theoretical Neuroscience Group  
Carnegie-Mellon University, Computer Science Department  
Microsoft Research Laboratory, Cambridge U.K (via video link)  
MacMaster University, Electrical Engineering Group  
Salk Institute, Computational Neurobiology Lab.  
UC San Diego, Computer Science Department  
UC Irvine, Computer Science Department  
Caltech, Neural Computation program  
UC Berkeley, Redwood Neuroscience Institute  
Stanford University, Computer Science Department  
Google, Mountain View, CA  
UC Berkeley, Electrical Engineering and Computer Science

**2008**

University of Waterloo, Statistics Department  
Brown University, Computer Science Department  
MIT, Brain and Behavioural Sciences (90 mins)  
MIT, Electrical and Computer Engineering Department  
IBM, Watson Research Center, Yorktown Heights  
New York University, Computer Science Department  
McGill University, CRM Applied Mathematics Seminar

University of Montreal, Dept. Computer Science and Operations Research  
University of British Columbia, Dept. Computer Science

## **2009**

Toyota Technology Institute, Chicago  
University of Montreal, Machine Learning Group.  
Cambridge University, Inference and Learning Group, Physics Department  
Microsoft Research Laboratory, Cambridge  
Sussex University, Informatics Department  
University of Oxford, Engineering Science  
Edinburgh University, Informatics Department  
Gatsby Computational Neuroscience Unit, University College London  
University of Hertfordshire, Computer Science Department  
Manchester University, Computer Science Department (two talks)  
University of Quebec at Montreal, Cognitive Science Group.  
Dalhousie University, School of Computer Science  
“C2C” video lecture broadcast to universities across Canada  
Microsoft Research Redmond (talk on object recognition)  
Microsoft Research Redmond (talk on image retrieval)  
Microsoft Research Redmond (talk on language modeling)

## **2010**

Queens University, Neuroscience Program  
University of Waterloo, Computer Science  
Stanford University, Statistics Department  
University of California, Los Angeles, Computer Science  
University of California, Irvine, Computer Science  
Caltech, Computer Vision Group  
University of California, Berkeley, Redwood Neuroscience Institute  
Google, Mountain View, Machine Learning Group  
Johns Hopkins University, Computer Science  
MIT, Behavioural and Brain Sciences  
IBM Yorktown Heights, Speech and learning groups

## **Grants Awarded**

### **1982:**

\$462,011 from the System Development Foundation for the period Oct 1 1982 to Sept 30 1985. The grant was for studying ways of organizing computation in massively parallel networks of neuron-like processors.

### **1983:**

\$62,000 from the Alfred P. Sloan Foundation for the period Jan 1 1984 to Dec 31 1985 (Jointly with T. J. Sejnowski). The grant was for running a series of workshops.

### **1984:**

\$61,709 from the System Development Foundation for the purchase of a Symbolics 3600 Lisp Machine and for organizing a small workshop.

### **1985:**

\$47,503 from the System Development Foundation to continue research on Boltzmann Machines for the period Oct 1 1985 to Dec 31 1985.

**1986:**

\$394,843 from the Office of Naval Research for the period Jan 1 1986 to Dec 31 1987 (jointly with J.L. McClelland). The grant was for studying "Learning in massively parallel networks".

\$70,735 from the National Science Foundation for the period May 1 1986 to April 30 1987. The grant was for studying "Search methods for massively parallel networks".

**1987:**

\$70,735 from the National Science Foundation for the period May 1 1987 to April 30 1988. Renewal of previous NSF grant.

\$200,000 (US) from the Alfred P. Sloan Foundation for the period Jan 1 1987 to Dec 31 1989 (Jointly with M. Farah). The grant was for studying "The Neural Basis of Spatial Cognition".

\$108,000 (\$36,000 per year for three years) from the Natural Science and Engineering Research Council of Canada for the period May 1 1987 to April 30 1990. Operating grant.

\$36,157 from the Natural Science and Engineering Research Council of Canada. Equipment grant.

**1988:**

\$148,527 from the Information Technology Research Center.

\$65,858 from the Natural Science and Engineering Research Council of Canada. Equipment grant.

\$50,000 (US) from DuPont for investigating applications of artificial neural networks.

\$50,000 (US) from Apple for investigating applications of artificial neural networks to speech recognition.

\$62,500 (US) from DuPont. Contract for "Neural nets, parallel computation, and the prediction of structures for biological molecules

**1989:**

\$212,000 from the Information Technology Research Center.

\$50,000 (US) from Apple for continued investigation of applications of artificial neural networks to speech recognition.

**1990:**

\$279,517 from the Institute for Robotics and Intelligent Systems (A federal network of centres of excellence) for applying connectionist learning techniques to the development of adaptive interfaces.

\$166,284 (\$55,428 per year for three years) from the Natural Science and Engineering Research Council of Canada for the period May 1 1990 to April 30 1993. Operating grant.

\$51,000 from the Natural Science and Engineering Research Council of Canada. Equipment grant.

\$175,800 (\$58,600 per year for three years) from the Natural Science and Engineering Research Council of Canada. Strategic Grant for developing the Xerion neural network simulator.

**1991:**

\$218,000 from the Information Technology Research Center (jointly with D. Terzopoulos).

\$50,000 (US) from Apple for research on handwritten character recognition using neural networks.

**1993:**

\$185,250 (\$61,750 per year for three years) from the Natural Science and Engineering Research Council of Canada for the period May 1 1993 to April 30 1996. Operating grant.

\$55,467 from the Natural Science and Engineering Research Council of Canada. Equipment grant.

\$250,000 from the Information Technology Research Center. Two year grant.

\$9,800 from Burns Fry Analytics for the period June 1 to Dec 31 1993 for applying neural networks to financial forecasting.

\$214,000 (over 3 years) from the Natural Science and Engineering Research Council of Canada. Strategic grant.

**1994:**

\$669,376 (over 4 years) from the Institute for Robotics and Intelligent Systems, a federal network of centres of excellence (with R. Tibshirani, D. Lowe and M. Leblanc).

**1995:**

\$123,593 from the Natural Science and Engineering Research Council of Canada. Equipment grant (I was the principal investigator and there were 17 co-investigators).

\$186,000 (over 2 years) from the Information Technology Research Center

**1996:**

\$412,500 (\$82,500 per year for five years) from the Natural Science and Engineering Research Council of Canada for the period Apr 1 1996 to Mar 31 2001. Research grant.

\$10,000 from Ontario Hydro Technologies.

**1997:**

\$71,803 from the Natural Science and Engineering Research Council of Canada for equipment.

**1998:**

10,000,000 pounds for the period 1998-2008 from the Gatsby Foundation

**2002:**

\$484,000 (\$121,000 per year for five years) from the Natural Science and Engineering Research Council of Canada for the period Apr 1 2002 to Mar 31 2006. Research grant.

\$487,714 from the Canada Foundation for Innovation and the Ontario Innovation Trust for the period Aug 2002 to July 2006 for the purchase of computing equipment and software.

\$1,400,000 (\$200,000 per year for seven years) for a Tier 1 Canada Research Chair in Machine Learning.

**2003**

\$1,500,000 (\$300,000 per year for 5 years from CIHR.

“Modern Statistical Approaches in High-Throughput Genomic Research”

with M. Escobar (principal applicant), C. Boone, T. Hughes, T. Westwood and R. Kustra

\$10,000 from the Canadian Institute for Advanced Research to develop a proposal for a program in “Neural Computation and Adaptive Perception”.

**2004**

\$2,500,000 (for a 5 year program) from the Canadian Institute for Advanced Research. The funding is for a program on “Neural Computation and Adaptive Perception” that I will direct. The program will involve researchers across Canada and international researchers.

**2007:**

\$610,000 (\$122,000 per year for five years) from the Natural Science and Engineering Research Council of Canada for the period Apr 1 2007 to Mar 31 2012. Research grant.

**2007:**

\$10,000 unsolicited gift from Microsoft for “the general support of Hinton’s research”.

**2007:**

\$50,000 from Merfin LLC (a US company) to support a postdoc for part of 2008.

**2008:**

\$40,000 solicited gift from Google. For research on Semantic Hashing.

**2008:**

\$194,000 (\$97,000 per year for two years) from the Natural Science and Engineering Research Council of Canada for the period Apr 1 2008 to Mar 31 2010. PI of Strategic Research Grant (jointly with Richard Zemel)

**2009**

\$2,500,000 (for a 5 year renewal) from the Canadian Institute for Advanced Research. The funding is for a program on “Neural Computation and Adaptive Perception” that I direct. The program involves researchers across Canada and international researchers.

**2010:**

\$20,000 unsolicited gift from Microsoft.

**Editorial Boards**

Currently: Neural Computation, The Journal of Machine Learning Research

Formerly: Artificial Intelligence, Cognitive Science, Machine Learning

**Governing boards & committees outside my university**

McDonnell Foundation committee on Attention and Perception (1987-88)

Cognitive Science Society Governing Board (1986-1991)

President, Cognitive Science Society (1992-1993)

American Association for Artificial Intelligence Governing Council (1988-1991)

American Association for Artificial Intelligence, Fellows Selection Committee (1993-1996)

Information Technology Research Center of Ontario: Area coordinator for AI, (1990-1995)

**Conferences Organized or Co-Organized**

“Dense Representations”, La Jolla, Jan 1979

“Associative Memory and Parallel Computation”, La Jolla, June 1979

“Parallel Models of Biological Computation”, Carnegie-Mellon, June 1983.

“Stochastic Parallel Computation”, Boston, May 1984.

“Connectionist Models of Symbol Processing”, Maryland, Oct 1985

“The Connectionist Summer School”, Pittsburgh, June 1986  
 “Connectionist Models of Attention and Perception”, Pajaro Dunes, CA, Jan 1988.  
 “The Connectionist Summer School”, Pittsburgh, June 1988  
 “The Connectionist Summer School”, San Diego, June 1990  
 “Mixture Day”, Gatsby Computational Neuroscience Unit, May 1999  
 “Inference and Learning”, Gatsby Computational Neuroscience Unit, May 2001  
 CIAR workshop on “The Future of Machine Learning”, Toronto, July 2002  
 CIAR workshop on “Neural Computation”, Vancouver BC, Dec 2003  
 CIAR workshop on “Learning for Object Recognition”, Vancouver BC, Dec 2004  
 CIAR workshop on “The Perception of Human Motion”, Toronto, July 2004  
 Five-day Summer School on “Neural Computation and Adaptive Perception” Toronto, July 2005  
 CIAR workshop on “The Sequential Organization of Vision”, Vancouver BC, Dec 2005  
 CIAR workshop on “Energy-Based Learning Algorithms”, Vancouver BC, Dec 2005  
 CIAR workshop on “Energy-Based Learning Algorithms”, Alton, Ontario, April 2006  
 Five-day Summer School on “Neural Computation and Adaptive Perception” Toronto, August 2006  
 CIAR workshop on “Cortical learning mechanisms”, Vancouver BC, Dec 2006  
 CIAR workshop on “The perception of wholes and parts”, Vancouver BC, Dec 2006  
 Five-day Summer School on “Neural Computation and Adaptive Perception” Toronto, August 2007  
 CIAR workshop on “Modeling time-series”, Alton, Ontario, June 2007  
 CIAR workshop on “Achieving Perceptual Invariance”, Vancouver BC, Dec 2007  
 CIAR workshop on “Modeling Animate Motion”, Vancouver BC, Dec 2007  
 CIAR workshop on “Inhibitory Interneurons”, Toronto, ON, Apr 2008

## Tutorials and Consulting

I have consulted for Dragon Systems, DuPont, Apple, Synaptics, Nesbitt-Burns, Ontario Hydro Technologies, Morphometrics, and Athene. I was on the Technical Advisory Board of the Microsoft Research Laboratory in Cambridge, UK. from 2000 to 2006.

I have taught the following tutorials on neural networks:

- 1987:** American Association for Artificial Intelligence (4 hours)
- 1988:** AT&T Bell Labs (2 days)
  - Technology Transfer Institute: Los Angeles (3 days)
  - Technology Transfer Institute: Washington (3 days)
  - Technology Transfer Institute: San Francisco (3 days)
  - American Association for Artificial Intelligence (4 hours)
  - Information Technology Research Center of Ontario (2 days)
- 1989:** Apple, Cupertino CA (1 day)
  - Information Technology Research Center of Ontario (2 days)
- 1990:** International Joint Conference on Neural Networks (1 hour)
  - Digital Equipment Corporation (2 days)
  - American Association for Artificial Intelligence (4 hours)
  - Information Technology Research Center of Ontario (2 days)
- 1991:** American Association for Artificial Intelligence (4 hours)
  - Information Technology Research Center of Ontario (2 days)
- 1993:** Sydney University (2 days)
  - Information Technology Research Center of Ontario (2 days)
- 1994:** Canadian Government, Ottawa (2 days)
  - Information Technology Research Center of Ontario (2 days)
- 1995:** Neural Information Processing Systems Conference (2 hours)

- Information Technology Research Center of Ontario (2 days)
- 1996:** Information Technology Research Center of Ontario (2 days)  
Tutorial on Neural Networks and Machine Learning (with Mike Jordan), Boston (2 days)
- 1997:** Information Technology Research Center of Ontario (2 days)  
Tutorial on Neural Networks and Machine Learning (with Mike Jordan), Washington D.C. (2 days)  
Tutorial on Neural Networks and Machine Learning (with Mike Jordan), Los Angeles (2 days)
- 1998:** Canadian Government, Ottawa (1 day)  
Information Technology Research Center of Ontario (1 day)
- 1999:** Gatsby Computational Neuroscience Unit Tutorial (4 hours).
- 2007:** Neural Information Processing Systems Conference (2 hours)
- 2009:** Tutorial on “Deep Learning” at University College London (3 hours)  
Tutorial on “Deep Learning” at Cambridge University Summer School (3 hours)  
Tutorial on “Deep Learning” at NIPS speech workshop, Whistler BC (1.5 hours)

## Graduate students

I have been the adviser for 21 completed MSc’s and the following 28 completed PhD’s:

**Peter Brown** (1987)

The Acoustic-Modeling Problem in Automatic Speech Recognition.

**David Ackley** (1987)

Stochastic Iterated Genetic Hillclimbing.

**Mark Derthick** (1988)

Mundane Reasoning by Parallel Constraint Satisfaction.

**Richard Szeliski** (1988)

Bayesian Modeling of Uncertainty in Low-Level Vision.

**Kevin Lang** (1989)

Phoneme Recognition Using Time-Delay Neural Nets.

**Steven Nowlan** (1991)

Soft Competitive Adaptation.

**David Plaut** (1991)

Connectionist Neuropsychology.

**Conrad Galland** (1991)

Learning in Deterministic Boltzmann Machine Networks.

**S. Becker** (1992)

An Information Theoretic Unsupervised Learning Algorithm for Neural Networks.

**Richard Zemel** (1994)

A Minimum Description Length Framework for Unsupervised Learning.

**Tony Plate** (1994)

Distributed Representations and Nested Compositional Structure.

**Sidney Fels** (1994)

Glove-TalkII: Mapping Hand Gestures to Speech Using Neural Networks.

**Christopher Williams** (1994)

Combining Deformable Models and Neural Networks for Handprinted Digit Recognition.

- Radford Neal** (1994)  
Bayesian Learning in Neural Networks
- Carl Rasmussen** (1996)  
Evaluation of Gaussian Processes and Other Methods for Non-linear Regression.
- Evan Steeg** (1997)  
Automated Motif Discovery in Protein Structure Prediction.
- Brendan Frey** (1997)  
Bayesian Networks for Pattern Classification, Data Compression and Channel Coding
- Brian Sallans** (2002)  
Reinforcement Learning for Factored Markov Decision Processes.
- Sageev Oore** (2002)  
Digital Marionette: Augmenting Kinematics with Physics for Multi-Track Desktop Performance Animation.
- Andrew Brown** (2002)  
Product Models for Sequences.
- Alberto Paccanaro** (2002)  
Learning Distributed Representations of Relational Data using Linear Relational Embedding.
- Yee-Whye Teh** (2003)  
Bethe Free Energy and Contrastive Divergence Approximations for Undirected Graphical Models.
- Simon Osindero** (2004)  
Contrastive Topographic Models: Energy-based density models applied to the understanding of sensory coding and cortical topography.
- Roland Memisevic** (2007)  
Non-linear Latent Factor Models for Revealing Structure in High-dimensional Data.
- Ruslan Salakhutdinov** (2009)  
Learning deep generative models.
- Graham Taylor** (2009)  
Composable, distributed-state models for high-dimensional time-series.
- Andriy Mnih** (2009)  
Learning distributed representations for language modeling and collaborative filtering.
- Vinod Nair** (2010)  
Visual object recognition using generative models of images.