

## Dr. Joshua Clifford Bongard, BSc, MSc, PhD

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Department of Computer Science  
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**Nationality:** Canadian  
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**Date of Birth:** April 17, 1974  
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### Education

**2003-2006** Cornell University, Ithaca, USA  
Computational Synthesis Laboratory  
Sibley School of Mechanical and Aerospace Engineering and  
Faculty of Computing and Information Science  
Postdoctoral Associate

**1999-2003** University of Zürich, Zürich, Switzerland  
Department of Information Technology  
Artificial Intelligence Laboratory (Prof. Dr. R. Pfeifer)  
Software Engineering Group (Prof. Dr. H. Schauer)  
Combined Doctoral appointment

**PhD Thesis:**

"Incremental Approaches to the Combined Evolution of a Robot's Body and Brain"

**1998-1999** University of Sussex, Brighton, United Kingdom  
Cognitive and Computing Sciences Graduate Research Centre  
MSc, Evolutionary and Adaptive Systems  
Graduated with Distinction

**MSc Thesis:**

"Evolving Heterogeneity: Implications for Agent-Based Systems and Collective Problem Solving"

**1993-1997** McMaster University, Hamilton, Canada  
Department of Computer Science and Systems  
BSc Honours, Computer Science *Summa Cum Laude*

**August 1994** Oxford University, Oxford, United Kingdom  
Corpus Christi College / Detroit Mercy study abroad programme  
Equivalent of 4.0 GPA in British Literature

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### Publications

#### Books

1. Lipson, H. and J. Bongard (2006) ***Co-evolutionary Methods For System Design and Analysis in Engineering***, Cambridge University Press, signed contract, scheduled for Dec. 2007 delivery.
2. Pfeifer, R. and J. Bongard (2006) ***How the Body Shapes the Way We Think: A New View of Intelligence***, Boston, MA: MIT Press.

#### Journal Articles

3. Bongard, J. and H. Lipson (2007) "Automated reverse engineering of nonlinear dynamical systems", ***Proceedings of the National Academy of Sciences***, 104(24): 9943-9948.
4. Bongard, J., V. Zykov and H. Lipson (2006) "Resilient Machines Through Continuous Self-Modeling", ***Science***, 314: 1118-1121.
5. Kouchmeshky, B., W. Aquino, H. Lipson and J. Bongard (2006) "Co-Evolutionary Strategy for Structural Damage Identification Using Minimal Physical Testing", ***International Journal for Numerical Methods in Engineering***, 69(5): 1085-1107.

6. Bongard, J. and H. Lipson (2005) "Active Coevolutionary Learning of Deterministic Finite Automata", ***Journal of Machine Learning Research***, 6(Oct): 1651-1678.
7. Bongard, J. and H. Lipson (2005) "Nonlinear System Identification using Coevolution of Models and Tests", ***IEEE Transactions on Evolutionary Computation***, 9(4): 361-384.
8. Pfeifer, R., F. Iida and J. Bongard (2005) "New Robotics: Design Principles for Intelligent Systems", ***Artificial Life, Special Issue on New Robotics, Evolution and Embodied Cognition***, 11(1-2): 99-120.
9. Bongard, J. and R. Pfeifer (2003) "Evolving Complete Agents Using Artificial Ontogeny", in Hara, F. & R. Pfeifer, (eds.), ***Morpho-functional Machines: The New Species (Designing Embodied Intelligence)***, Springer-Verlag, pp. 237-258.

### **Peer-Reviewed Conference Publications**

10. Bongard, J. (2007) "Synthesizing Physically-Realistic Environmental Models from Robot Exploration", *Advances in Artificial Life: 9th European Conference*, Springer-Verlag, Berlin, pp. 806-815.
11. Bongard, J. (2007) "Action-Selection and Crossover Strategies for Self-Modeling Machines", *Proceedings of the 9th Annual Conference on Genetic and Evolutionary Computation*, ACM Press, New York, NY, pp. 198-205.
12. Bongard, J. (2007) "Exploiting Multiple Robots to Accelerate Self-Modeling", *Proceedings of the 9th Annual Conference on Genetic and Evolutionary Computation*, ACM Press, New York, NY, pp. 214-221.
13. Lipson, H., J. Bongard, V. Zykov and E. Malone (2006) "Evolutionary Robotics for Legged Machines: From Simulation to Physical Reality", Arai, T. et al. (eds.), *Intelligent Autonomous Systems 9 (IAS-9)*, 11-18.
14. Bongard, J., V. Zykov and H. Lipson (2006) "Automated Synthesis of Body Schema using Multiple Sensor Modalities", *The Tenth International Conference on the Simulation and Synthesis of Living Systems (ALIFE10)*, 220-226.
15. Bongard, J. and H. Lipson (2005) "Automatic Synthesis of Multiple Internal Models Through Active Exploration", *AAAI Fall Symposium on Reactive to Anticipatory Cognitive Embodied Systems*, Arlington, VA, November 2005.
16. Bongard, J. and H. Lipson (2005) "'Managed Challenge' Alleviates Disengagement in Co-evolutionary System Identification", in *Proceedings of the 2005 Genetic and Evolutionary Computation Conference (GECCO)*, ACM, pp. 531-538.
17. White, P., V. Zykov and J. Bongard (2005) "Three Dimensional Stochastic Reconfiguration of Modular Robots", *Robotics: Science and Systems*, Cambridge, MA.
18. Bongard J. and Lipson H. (2005) "Reinventing the Wheel: Experiments in Evolutionary Geometry", *Late Breaking Papers of the 2005 Genetic and Evolutionary Computation Conference*, June, Washington DC.
19. Zykov, V., J. Bongard and H. Lipson (2005) "Co-evolutionary Variance Can Guide Physical Testing in Evolutionary System Identification", *The 2005 NASA/DoD Conference on Evolvable Hardware*, June, Washington DC, pp. 213-220.
20. Lipson, H. and J. Bongard (2004) "An Exploration-Estimation Algorithm for Synthesis and Analysis of Engineering Systems Using Minimal Physical Testing", in *Proceedings of the 2004 ASME Design Engineering Technical Conferences and Computer and Information in Engineering Conference*, Salt Lake City, UT.
21. Zykov, V., J. Bongard and H. Lipson (2004) "Evolving Dynamics Gaits on a Physical Robot", in *Late Breaking Papers for the 2004 Genetic and Evolutionary Computation Conference (GECCO)*, Seattle, WA.
22. Bongard, J. and H. Lipson (2004) "Once More Unto the Breach: Co-evolving a Robot and its Simulator", in *Proceedings of the Ninth International Conference on the Simulation and Synthesis of*

*Living Systems (ALIFE9)*, pp. 57-62.

23. Bongard, J. and H. Lipson (2004) "Automated Robot Function Recovery after Unanticipated Failure or Environmental Change using a Minimum of Hardware Trials", in *Proceedings of the NASA/DoD Conference on Evolvable Hardware*, IEEE Computer Society, pp. 169-176.
24. Bongard, J. and H. Lipson (2004) "Automating Genetic Network Inference with Minimal Physical Experimentation Using Coevolution", in *Proceedings of the 2004 Genetic and Evolutionary Computation Conference (GECCO)*, Springer, pp. 333-345.
25. Bongard, J. and H. Lipson (2004) "Automated Damage Diagnosis and Recovery for Remote Robotics", in *Proceedings of the 2004 International Conference on Robotics and Automation (ICRA)*, Omnipress, pp. 3545-3550.
26. Bongard, J. (2002) "Evolved Sensor Fusion and Dissociation in an Embodied Agent", in *Proceedings of the EPSRC/BBSRC International Workshop on Biologically-Inspired Robotics: The Legacy of W. Grey Walter*, pp. 102-109.
27. Frutiger, D. R., Bongard, J. and F. Iida (2002) "Iterative Product Engineering: Evolutionary Robot Design", in Bidaud, P. & F. B. Amar (eds.), *Proceedings of the Fifth International Conference on Climbing and Walking Robots*, Professional Engineering Publishing, pp. 619-629.
28. Bongard, J. and R. Pfeifer (2002) "A Method for Isolating Morphological Effects on Evolved Behaviour", in Hallam, B., Floreano, D. et al (eds.), *Proceedings of the Seventh International Conference on the Simulation of Adaptive Behaviour (SAB2002)*, MIT Press, pp. 305-311.
29. Bongard, J. and R. Pfeifer (2002) "Relating Neural Network Performance to Morphological Differences in Embodied Agents", in *Proceedings of the Sixth International Conference on Cognitive and Neural Systems*, Boston, USA.
30. Bongard, J. (2002) "Evolving Modular Genetic Regulatory Networks", in *Proceedings of the IEEE 2002 Congress on Evolutionary Computation (CEC2002)*, IEEE Press, pp. 1872-1877.
31. Paul, C. and J. Bongard (2001) "The Road Less Travelled: Morphology in the Optimization of Biped Robot Locomotion", in *Proceedings of The IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2001)*, Hawaii, USA.
32. Bongard, J. and C. Paul (2001) "Making Evolution an Offer It Can't Refuse: Morphology and the Extradimensional Bypass", in J. Keleman & P. Sosik (eds.), *Proceedings of the Sixth European Conference on Artificial Life*, (Springer-Verlag), pp. 401-412.
33. Bongard, J. and R. Pfeifer (2001) "Repeated Structure and Dissociation of Genotypic and Phenotypic Complexity in Artificial Ontogeny", in *Proceedings of the 2001 Genetic and Evolutionary Computation Conference*. San Francisco, CA: Morgan Kaufmann, pp. 829-836.
34. Bongard, J. and C. Paul (2000) "Investigating Morphological Symmetry and Locomotive Efficiency using Virtual Embodied Evolution", in *From Animals to Animats: The Sixth International Conference on the Simulation of Adaptive Behaviour*. (MIT Press) pp. 420-429.
35. Bongard, J. (2000) "Reducing Collective Behavioural Complexity through Heterogeneity", in *Artificial Life VII: Proceedings of the Seventh International Conference*. (MIT Press), pp. 327-336.
36. Bongard, J. (2000) "The Legion System: A Novel Approach to Evolving Heterogeneity for Collective Problem Solving", in R. Poli, W. Banzhaf et al (eds.), *Genetic Programming: Third European Conference*. (Springer-Verlag) pp. 25-37.
37. Bongard, J. (1999) "Coevolutionary Dynamics of a Multi-Population Genetic Programming System", in Floreano, D., J.-D. Nicoud & F. Mondada (eds.), *Proceedings of the Fifth European Conference on Artificial Life*. (Springer-Verlag) pp. 316-321.

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#### Grants and Awards

Bongard J. (2007) New Faculty Fellowship, Microsoft Award, \$200,000, 2007—  
Bongard J. (2007) "Exploiting 'Like Me' Hypotheses for Learning Robots", NSF, \$192,391, 2007-2009  
Rizzo, D., Eppstein, M., Bongard, J., Goodnight, C., Stevens, L., Hoffman, J. Molofsky, J. (2007) "Complex Systems Modeling for Environmental Problem Solving", NSF, \$6,750,000, 2007-2010.

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## Experience

**External reviewer:** The Austrian Science Fund (FWF), Austria's national scientific funding body  
**Member, Editorial Board:** Evolutionary Computation Journal (MIT Press)  
**Ad hoc reviewer:** Journal of Machine Learning Research, IEEE Transactions on Evolutionary Computation, IEEE Transactions on Robotics, Artificial Life, Adaptive Behavior, IEEE Transactions on Systems, Man, and Cybernetics, Journal of Neurorobotics, Neural Computation  
**Co-organizer:** "The 50th Anniversary Summit of Artificial Intelligence: Trends and Challenges in the 21st Century", Monte Verita, Switzerland, summer 2006

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## Teaching

**Instructor:** *Software Engineering, Human-Computer Interaction*, University of Vermont Computer Science Department  
**Advisor:** Zhenyu Lu, current PhD student.  
**Mentor:** Over 20 undergraduate and graduate student projects at Cornell, 2003-present.  
**Leader:** Student workshop on embodied Artificial Intelligence, University of Ilmenau, 2002.  
**Organizer and Instructor:** MIGROS Summer Course on Robotics and Artificial Intelligence, Zurich, 2002.

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## Selected Invited Talks

- Department of Cognitive and Neural Systems, Boston University (January 2008)
  - National Science Foundation's *Future Challenges for the Science of Learning* workshop (August 2007)
  - Department of Information Technology, University of Zurich, Switzerland (2004)
  - EPSRC Network on Evolvability in Biological and Software Systems Symposium, Hertfordshire, UK (2003)
  - Division of Cell Biology, Biozentrum, University of Basel, Switzerland (2002)
  - AI Lab, Massachusetts Institute of Technology, Boston (2002)
  - Marine Biological Laboratory, Woods Hole, MA (2002)
  - Center for Research in Cognitive Science, Sussex, UK (2002)
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## Media

**Nature News:** "Injured Robot Learns to Limp" (November 2006)  
**Science News:** "New Robot Shrugs Off Injury" (November 2006)  
**MIT Technology Review:** "Robotic Recovery" (November 2006)  
**Discovery Channel:** "Self-Aware Robots" (November 2006)  
**Forbes:** "New Robot Can Sense Damage, Recover" (November 2006)  
**USA Today:** "New Robot Can Sense Damage and Compensate" (November 2006)  
**Scientific American:** "Resilient Robot Hobbles Along, Even if Injured" (November 2006)  
**Die Zeit:** "The GOLEM in the machine" (January 2007)  
**New Scientist:** "'Animals' grown from an artificial embryo" (August 2002)

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## Scholarships and Prizes

**2007** One of *MIT Technology Review's* TR35: The Top 35 Young Innovators under 35  
**2007** Microsoft New Faculty Fellowship  
**2002** Best Paper Award, Seventh Intl. Conf. on the Simulation of Adaptive Behaviour (SAB-2002)  
**1999** Santa Fe Institute Complex Systems Summer School alumnus  
**1993-1997** McMaster University Dean's Honour List

## Professional References

**1. Prof. Dr. Hod Lipson**

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Ithaca, NY 14853-7501 USA

**2. Prof. Dr. Rolf Pfeifer**

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**3. Prof. Dr. Phil Husbands**

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**4. Prof. Dr. Wilkins Aquino**

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**5. Dr. Inman Harvey**

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