

Elhanan Borenstein

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Education

- 2000 – 2006 **Ph.D. with distinction, Computer Science, Tel-Aviv University**
(w/ 1 yr recess) Evolutionary Dynamics of Adaptive Populations: The Effect of Phenotypic Plasticity, Imitation and Culture on Evolution; Prof. Eytan Ruppin's Lab
GPA: 99/100
- 1994 – 1996 **B.Sc. Summa Cum Laude, Physics and Computer Science, Tel-Aviv Univ'**
Program for the Fostering of Excellence (outstanding students special program)
GPA: 97/100

Postgraduate Training

- 2007 – 2009 **Postdoctoral Fellow, Stanford University** (with Prof. Marc Feldman)
- 2007 – 2009 **Omidyar Fellow, Santa Fe Institute** (with Prof. David Krakauer)

Additional Training:

- April 2006 Evolutionary and Ecological Genomics, Ben-Gurion University of the Negev
- Aug-Sep 2005 Research residency, Philip Steinmetz Fellow, Santa Fe Institute
- Jan 2005 Biological Networks & Evolution, The Hebrew Univ', Inst' for Advanced Studies
- Jun 2004 Complex Systems Summer School, Santa Fe Institute

Faculty Positions

- 07/2014 – present **Adjunct Associate Professor**, Computer Science and Engineering, UW
- 07/2014 – present **Associate Professor, Genome Sciences, University of Washington**
- 07/2011 – present **External Professor, Santa Fe Institute**
- 05/2011 – 06/2014 **Adjunct Assistant Professor**, Computer Science and Engineering, UW
- 12/2009 – 06/2014 **Assistant Professor, Genome Sciences, University of Washington**

Additional Affiliations:

- 2010 – present Computational and Molecular Biology Interdisciplinary Program, UW
- 2010 – present Molecular and Cellular Biology Graduate Program, UW

Honors, Fellowships & Awards

- 2012 – 2017 **NIH Director's New Innovator Award**
- 2011 – 2013 **Alfred P. Sloan Research Fellowship** in molecular biology
(two-year fellowship for outstanding early-career scientists, \$50,000)
- 2012 **UW nominee for Pew Biomedical Scholars Award**
- 2011 **Keynote speaker, NIH, Annual MSM consortium meeting**
- 2011 – present **Faculty of 1000 Member**, Genomics & Genetics

2011	UW nominee for Searle Scholars Program
2007 – 2009	Omidyar Fellowship , Santa Fe Institute
2007 – 2009	Postdoctoral Fellowship , Stanford University
2005	Philip Steinmetz Fellowship , Santa Fe Institute
2005	Best Teacher , School of Computer Science, Tel-Aviv University
2004 – 2006	Yeshaya Horowitz Association Scholarship in Complexity Science (three years research grant for Ph.D. students, \$22,000 per year)
2004	Aharon Katzir Center Training Fellowships for Ph.D. , Weizmann Institute
2004	The Don & Sara Marejn Scholarship for Outstanding Ph.D. Student
2004	School of Computer Science Award for Ph.D. Student , Tel-Aviv University
2004	Travel Scholarships: ALIFE9 Student Scholarship, CSSS Scholarship (SFI)
2003	Best Teaching Assistant Prize , School of Computer Science, Tel-Aviv Univ'
1996	B.Sc. Summa Cum Laude (graduated first in the class, GPA 97)
1994 – 1996	Dean's List (3 years)
1994 – 1996	Program for the Fostering of Excellence (Three year merit-based stipend and scholarship, Tel-Aviv University)

Teaching Experience

Courses Taught - University of Washington:

Spring 2015	GENOME 373: Genomic Informatics; [with D. Fowler] Instructor (responsible for 15 contact hrs/5 weeks)
Winter 2015	GENOME 559: Intro' to Statistical and Computational Genomics; [with J. Thomas] Instructor (responsible for 15 contact hrs/5 weeks)
Spring 2014	GENOME 373: Genomic Informatics; [with J. Thomas] Instructor (responsible for 15 contact hrs/5 weeks)
Spring 2014	GENOME 541: Intro' to Computational Molecular Biology; [with multiple faculty] Co-instructor (responsible for 3 contact hrs/1 week)
Winter 2014	GENOME 559: Intro' to Statistical and Computational Genomics; [with J. Thomas] Instructor (responsible for 15 contact hrs/5 weeks)
Spring 2013	GENOME 373: Genomic Informatics; [with J. Thomas] Instructor (responsible for 15 contact hrs/5 weeks);
Spring 2013	GENOME 541: Intro' to Computational Molecular Biology; [with multiple faculty] Co-instructor (responsible for 3 contact hrs/1 week)
Winter 2013	GENOME 559: Intro' to Statistical and Computational Genomics; [with J. Thomas] Instructor (responsible for 15 contact hrs/5 weeks)
Spring 2012	GENOME 373: Genomic Informatics; [with J. Shendure] Instructor (responsible for 15 contact hrs/5 weeks);
Spring 2012	GENOME 541: Intro' to Computational Molecular Biology; [with multiple faculty] instructor (responsible for 3 contact hrs/1 week)
Winter 2012	GENOME 559: Intro' to Statistical and Computational Genomics; [with J. Thomas] Instructor (responsible for 15 contact hrs/5 weeks)
Spring 2011	GENOME 541: Intro' to Computational Molecular Biology; [with multiple faculty] instructor (responsible for 3 contact hrs/1 week)

- Winter 2011 **GENOME 559:** Intro' to Statistical and Computational Genomics; [with J. Thomas]
Instructor (responsible for 15 contact hrs/5 weeks)
- Spring 2010 **GENOME 541:** Intro' to Computational Molecular Biology; [with multiple faculty]
instructor (responsible for 3 contact hrs/1 week)

Courses Mentored - University of Washington:

- 2010-2013 **CSE 590C:** Reading & Research in Computational Biology; [with multiple faculty]
(7 quarters) Co-mentor
- 2010- 2011 **GENOME 580:** Ethics in Biomedical Research & Teaching; [with multiple faculty]
(2 quarters) Guest session leader (2hr)
- 2010- 2015 **GENOME 599B:** Journal Club Preparation
(5 quarters) Co-mentor

Courses Taught - Tel-Aviv University:

- Spring 2005 **Object Oriented Programming**
Senior Lecturer (responsible for ~42 contact hrs/14 week)
- Spring 2004 **Object Oriented Programming**
Senior Lecturer (responsible for ~42 contact hrs/14 week)
- Spring 2004 **Artificial Life Workshop**
Teaching Assistant
- Summer2003 **Object Oriented Programming**
Lecturer (responsible for ~42 contact hrs/14 week)
- Spring 2003 **Object Oriented Programming**
Lecturer (responsible for ~42 contact hrs/14 week)
- Spring 2003 **Artificial Life Workshop**
Teaching Assistant
- Fall 2004 **Software 1**
Teaching Assistant
- Fall 2003 **Software 1**
Teaching Assistant

Summer Schools and Workshops:

- Apr 2014 **Keystone Symposium**, Montana, USA
Workshop on "Reconstructing and Analyzing Metabolic Networks"
- Jun 2013 **Complex Systems Summer School**, Santa Fe Institute
Lecture series on "Models of Microbial Communities" (total 3 hrs)
- Jun 2012 **Complex Systems Summer School**, Santa Fe Institute
Lecture series on "Modeling Microbial Metabolism" (total 4.5 hrs)

Mentoring and Trainees:

Postdoctoral Fellows:

- 2013 – present **Ohad Manor**
Project: Computational methods for comparative metagenomics
- 2014 – 2014 **Jody Wright** (now at an environmental stewardship nonprofit organization)
Project: Modeling microbial interaction networks in the human microbiome
- 2011 – 2015 **Hsuan-Chao Chiu** (now at MediaTek, Taiwan)
Project: Metabolic models of multi-species systems

2011 – 2014 **Rogan Carr** (now at Microsoft)
Project: Computational deconvolution of metagenomic data

Additional Postdoctoral Mentoring:

2014 – present **Attila Kertesz-Farkas**, University of Washington (Career Advisor)

2014 – present **Eric Libby**, Omidyar fellow, Santa Fe Institute (External Advisor)

Ph.D. Students:

2014 – present **Cecilia Noecker**, Genome Sciences, University of Washington
Project: Integrative analysis of multi-meta-omic data
IGERT Big Data Fellowship (2014-present)

2014 – present **Alex Eng**, Genome Sciences, University of Washington
Project: Algorithms for synthetic microbial community design

2014 – present **Colin McNally**, Genome Sciences, University of Washington
Project: Modeling the evolution of mutualism in microbial communities
Genome Training Grant Fellowship (2014-present)

2011 – present **Maximilian Press**, Genome Sciences, University of Washington
Project: Co-Evolutionary inference of microbial genes' function

2010 – 2014 **Sharon Greenblum**, Genome Sciences, University of Washington
Project: Systems biology analysis of the human microbiome
Departmental nominee for the UW distinguished thesis award

2010 – 2015 **Roie Levy**, Molecular and Cellular Biology, University of Washington
Project: *In-silico* models of species interactions in microbial communities
NSF Graduate Fellowship (2011-2014)

Doctoral and Master's Supervisory Committee:

2015 – present **Mahsa Khorasani**, Environmental/Forest Sciences, University of Washington

2015 – present **Aaron Goodman**, Department of Biological Sciences, Stanford University

2015 – present **Moriah Echlin**, Molecular and Cellular Biology, University of Washington

2015 – present **Gili Zilberman**, Department of Immunology, Weizmann Institute of Science

2015 – present **Timothy Durham**, Genome Sciences, University of Washington

2015 – 2015 **Kaitlyn LaCourse**, Microbiology (qualifying exam), University of Washington

2014 – present **Daniel Chee**, Genome Sciences, University of Washington

2014 – 2014 **Arend Voorman**, Biostatistics, University of Washington

2013 – present **Rob Lawrence**, Molecular and Cellular Biology, University of Washington

2013 – present **David Young**, Medical Scientist Training Program, University of Washington

2011 – present **Katharine Marshall**, School of Oceanography, University of Washington

2011 – present **Aaron Miller**, Genome Sciences, University of Washington

2011 – 2012 **Samuel Lancaster**, Epidemiology, Fred Hutchinson Cancer Research Center

2010 – 2014 **Jennifer Lachowiec**, Molecular and Cellular Biology, University of Washington

2010 – 2014 **Aaron Brooks**, Molecular and Cellular Biology, University of Washington

2010 – 2012 **Matthew Maurano**, Genome Sciences, University of Washington

Rotation Students:

Winter 2014 **Cecilia Noecker**, Genome Sciences, University of Washington

- Project: Dynamic co-occurrence network analysis in the gut microbiome
- Autumn 2013 **Seungsoo Kim**, Genome Sciences, University of Washington
Project: Genome-level comparative analysis of the human microbiome
- Autumn 2013 **Colin McNally**, Genome Sciences, University of Washington
Project: Modeling the evolution of mutualism
- Winter 2013 **Daniel Chee**, Genome Sciences, University of Washington
Project: Metagenomic co-occurrence.
- Spring 2012 **Jorgen Nelson**, Genome Sciences, University of Washington
Project: Genetic co-occurrence networks across metagenomic samples.
- Autumn 2011 **Brandon Blakeley**, Computer Science and Engineering
Project: Functional complementarity in co-occurring microbes.
- Winter 2011 **Benjamin Vernot**, Genome Sciences, University of Washington
Project: Associations between bacterial vaginosis clinical and genomic data.
- Winter 2011 **Maximilian Press**, Genome Sciences, University of Washington
Project: Applying expression profile analysis to study perturbed microbiomes.
- Autumn 2010 **Josh Burton**, Genome Sciences, University of Washington
Project: A framework for metabolic modeling of multi-species systems.
- Autumn 2010 **Alexander Nuttle**, Genome Sciences, University of Washington
Project: Transitions in the developing infant gut microbiome.
- Winter 2010 **Sharon Greenblum**, Genome Sciences, University of Washington
Project: Phylogenetic and functional modularity in microbial communities.
- Winter 2010 **Roie Levy**, Molecular and Cellular Biology, University of Washington
Project: The effect of environmental switching on the evolution of modularity
- Spring 2010 **Caitlin Connelly**, Genome Sciences, University of Washington
Project: Modularity and capacitance in gene interaction networks

Undergraduate Students, Summer Students, and Outreach:

- 2014 – present **Sierra Anderson**, Undergraduate Researcher
Project: A pipeline for comparative metagenomic analysis
- Summer 2014 **Jameson Boslough**, UW Amgen Scholars Program
Project: Species-focused methods for comparative metagenomics
- Spring 2014 **Lane Felker**, Undergraduate Researcher
Project: A software package for metagenomics annotation
- Summer 2013 **Clara Amorosi**, UW Amgen Scholars Program
Project: Scaling laws in the gut microbiome
- Summer 2010 **Lovenoor Aulck**, Genomics Outreach program, University of Washington
Project: Topological properties of gut dwelling microbes

National Service

Reviewer for Journals:

Science, Cell, PNAS (Proc. Natl. Acad. Sci. USA), Nature Review Genetics, Nature Biotechnology, Genetics, Nature Communications, Genome Biology, Genome Research, Cell Metabolism, PLoS Computational Biology, Evolution, Journal of Evolutionary Biology, Microbiology and Molecular Biology Review (ASM), International Society for Microbial Ecology Journal (ISMEJ), Scientific Reports, Molecular Biology and Evolution, Journal of the Royal Society Interface, BMC Bioinformatics, BMC Systems Biology, BMC Evolutionary Biology, Evolutionary Ecology, Nucleic Acids Research, BioSystems, Oikos, Ecological Modelling, Artificial Intelligence, Neurocomputing,

Cognitive Science, Artificial Life, Bioinformatics , Journal of Theoretical Biology, Theoretical Population Biology

Reviewer for Conferences:

The 16th Annual International Conference on Research in Computational Molecular Biology (RECOMB 2012), RECOMB Regulatory Genomics & Systems Biology 2009, Pacific Symposium on Biocomputing (PSB 2009), The 10th Annual International Conference on Research in Computational Molecular Biology (RECOMB 2006), The 14th Annual International conference on Intelligent Systems for Molecular Biology (ISMB 2006), The 15th annual Computational Neuroscience meeting (CNS*2006), The 8th European Conference on Artificial Life (ECAL2005), The 9th International Conference on the Simulation and Synthesis of Living Systems (ALIFE9), The Computational Neuroscience meeting (CNS*2004)

Committees, Study Sections, and Others:

2015 – present **External Advisory Committee**, Microbiomes in Transition, Pacific Northwest National Laboratory (PNNL)

2015 **Invited Editor**, *mBio*

2014 **Expert Reviewer**, Novo Nordisk Foundation (NNF)

2013 **Guest Editor**, *PLoS Computational Biology*

2013 **Scientific Panel**, NIH Human Microbiome Science: Vision for the Future

2013 **Session Convener**, American Society for Microbiology Meeting (ASM2013)

2013 **NIH/Common Funds Study Section, member**, Dynamics of Host-Associated Microbial Communities (declined due to scheduling conflicts)

2013 **NIH/MIGMS Study Section, member**, Human Microbiome's Role in Health and Disease (declined due to scheduling conflicts)

2013 **Ad hoc grant reviewer**, Provincia Autonoma di Trento, Grandi Progetti 2012

2012 – present **Authored multiple recommendations**, Faculty of 1000, Genomics & Genetics

2012 **Program Committee**, 16th Annual International Conference on Research in Computational Molecular Biology (RECOMB2012)

2011 **NIH/NSF Study Section Member**. DMS/NIGMS panel

2011 – present **Member**, Population Modeling Group, Interagency Modeling and Analysis Group & Multi-Scale Modeling Consortium, NIH

2009 **Program Committee**, 17th annual International Conference on Intelligent Systems for Molecular Biology (ISMB) and 8th European Conference on Computational Biology (ECCB); Bioinformatics of Disease

2005 **Program Committee**, Memetic Theory in Artificial Systems and Societies (METAS 2005)

Science Communication, Public Lectures, and Outreach:

2014 – 2015 **Content advisory Committee, Pacific Science Center**

2015 **Host**, Ballard High school students visit

2014 **Public lecture**, John Von Neumann Public Lecture Series in Complexity & Computation, University of Wisconsin, Madison, USA

2014 **Public panel lecture**, Conversation about Diabetes, Pacific Northwest Diabetes Research Institute (PNDRI), Seattle, USA

2011 **Public lecture**, Wednesdays at the Genome, UW, Seattle, USA

University and Departmental Service

2015 Member, Biomedical Informatics and Medical Education (BIME) Precision Medicine faculty Search

2015 Member, Genome Sciences Seminar Committee

2015 Organizer, Wednesdays Evenings at the Genome, Public Lecture Series

2014 Faculty, University of Washington Amgen Scholars Program

2014 Co-organizer, Wednesdays Evenings at the Genome, Public Lecture Series

2014 Genome Science, graduate program recruiting visits, introductory presentation

2013 Faculty recruitment for a joint GI/AID position, FHCRC

2013 Faculty, University of Washington Amgen Scholars Program

2013 Co-organizer, Genome Science Retreat

2012 – present Member, UW Cancer Innovation Group

2012 Co-organizer, Genome Science Retreat

2011 Reviewer, University of Washington, Royalty Research Funds

2011 Member, Genome Sciences Seminar Committee

2011 Member, Genome Sciences Faculty Search Committee

2010 Member, Genome Sciences Seminar Committee

2010 Genome Science, graduate program recruiting visits, introductory presentation

2009 Co-organizer, Complex Networks Initiative, Stanford

2008 Co-organizer, CompBio Workgroup, Stanford

Ongoing

2011 – present Participant in MCB graduate student recruitment

2011 – present Participant in CSE graduate student recruitment and prospective students visit

2011 – present Participant in MSTP graduate student recruitment

2011 – present Lunch presentations to first year students and outreach summer students

Research Funding

DP2 AT 007802-01 (PI: Borenstein) Total Direct Costs (Borenstein Lab): \$1,500,000
NIH New Innovator Award Period: 9/30/12–9/29/17

A Computational Framework for Designing Microbiome Manipulation

Microbiome manipulation is an exciting clinical frontier with numerous promising medical applications. This project aims to develop a novel computational framework, integrating a predictive model of the microbiome and its impact on the host with optimization methods, for designing manipulations of the gut microbiome and for informing clinical intervention efforts.

1R01DK095869 (PI: Hoffman) Total Direct Costs (Borenstein Lab): ~\$390,000
NIDDK/NIH Period: 1/1/15-12/31/19

The relationship of fecal microbiomes and nutritional status in CF

The goal of this project is to test the hypothesis that the compositions of the intestinal microbiomes of infants with CF correlate with gastrointestinal dysfunction and early growth parameters.

Role: Co-Investigator

R15 AI112985-01 (PI: Bucci) Total Direct Costs (Borenstein Lab): \$40,000
NIH Period: 2/5/2015-1/31/2018

Mathematical modeling from Metagenomics: Minimizing risk of enteric diseases

The goal of this project is to combine recently developed and novel mathematical modeling tools with metabolic pathways inference and experimentation to predict the risk of enteric diseases and to prototype rationally designed fecal transplantation therapies to minimize it.

Role: Co-Investigator (subcontract)

BR2011-112 (PI: Borenstein) Total Direct Costs (Borenstein Lab): \$50,000
Alfred P. Sloan Foundation Period: 9/15/11–9/15/13

Computational Systems Biology and Reverse-Ecology of the Human Microbiome

This is an early-career fellowship for scientists and scholars of outstanding promise, awarded yearly in recognition of distinguished performance and a unique potential to make substantial contributions to various research topics.

P30 DK 89507 (PI: Ramsey/Greenberg) Total Direct Costs (Borenstein Lab): \$113,407
NIDDK/NIH Period: 6/1/12-5/31/14

Computational tools for identifying compositional shifts in the CF gut microbiome

The aim of this pilot project is to develop a suite of novel computational methods for identifying associations between the composition of the microbiome and specific host phenotypes such as CF status and clinical parameters. These methods are especially tailored to identify subtle differences in highly-multidimensional data with a relatively small sample size

Role: Pilot Project PI

OPP1098757 (PI: Rabinowitz) Total Direct Costs (Borenstein Lab): \$8,442
Bill & Melinda Gate Foundation Period: 11/1/13-4/30/15

Grand Challenges: *One House-One Health Approach to Child Growth and Development*

The aim of this application is to identify high-risk household microbiomes in developing countries by comparing human and animal gut microbiomes within households, and to explore whether resetting abnormal animal microbiomes improves the microbiome of children within the household.

Publications - (●): Corresponding author

Journal Papers

1. **Borenstein E** and Ruppin E. Enhancing Autonomous Agents' Evolution with Learning by Imitation. *Journal of Artificial Intelligence and the Simulation of Behavior (AISBJ)*, 1(4), 2003.
2. **Borenstein E** and Ruppin E. The Evolutionary Link between Mirror Neurons and Imitation: An Evolutionary Adaptive Agents Model. *Behavioral and Brain Sciences*, 28:2, 127-128, 2005.
3. (●) **Borenstein E** and Ruppin E. The Evolution of Imitation and Mirror Neurons in Adaptive Agents. *Cognitive Systems Research* (special issue on Epigenetic Robotics), 6(3), 229-242, 2005.
4. (●) **Borenstein E**, Kendal J, and Feldman MW. Cultural Niche Construction in a Metapopulation. *Theoretical Population Biology*, 70(1), 92-104, 2006.
5. (●) **Borenstein E**, Meilijson I, and Ruppin E. The Effect of Phenotypic Plasticity on Evolution in Multi-peaked Fitness Landscapes. *Journal of Evolutionary Biology*, 19(5), 1555-1570, 2006.
6. (●) **Borenstein E** and Ruppin E. Direct Evolution of Genetic Robustness in MicroRNA. *PNAS (Proc. Natl. Acad. Sci. USA)*, 103(17), 6593-6598, 2006.
7. (●) **Borenstein E***, Shlomi T*, Ruppin E, and Sharan R (*equal contribution). Gene Loss Rate: A Probabilistic Measure for the Conservation of Eukaryotic Genes. *Nucleic Acids Research*, 35(1), e7, 2007.
8. **Borenstein E**, Feldman MW, and Aoki K. Evolution of Learning in Fluctuating Environments: When Selection Favors Both Individual and Social Learning. *Evolution*, 62 (3), 586–602, 2008.

9. Kreimer A*, **Borenstein E***, Gophna U, and Ruppin E (*equal contribution). The Evolution of Modularity in Bacterial Metabolic Networks. *PNAS (Proc. Natl. Acad. Sci. USA)*, 105(19), 6976-6981, 2008.
10. Lehmann L, Foster KR, **Borenstein E**, and Feldman MW. Social and Individual Learning of Helping in Humans and Other Species. *Trends in Ecology & Evolution*, 23(12), 664-671, 2008.
11. (●) **Borenstein E**, Kupiec M, Feldman MW, and Ruppin E. Large-Scale Reconstruction and Phylogenetic Analysis of Metabolic Environments. *PNAS (Proc. Natl. Acad. Sci. USA)*, 105(38), 14482-14487, 2008.
 - Reviewed in Genome Biology, 9:239, 2008 (see media coverage)
 - Recommended by Faculty of 1000 Biology
 - Featured in Astrobiology Magazine, Science 2.0
12. (●) **Borenstein E** and Krakauer DC. An End to Endless Forms: Epistasis, Phenotype Distribution Bias, and Non-Uniform Evolution. *PLoS Computational Biology*, 4(10), 2008.
 - Featured in Nature Reviews Genetics, 9(12), 2008 (see media coverage)
13. (●) **Borenstein E** and Feldman MW. Topological Signatures of Species Interactions in Metabolic Networks. *Journal of Computational Biology*, 16(2), 191-200, 2009.
 - Featured in Stanford Report, Feb 25, 2009 (see media coverage)
 - Reviewed in Frontiers in Ecology & the Environment, April, 2009
14. Cai J, **Borenstein E**, Chen R, and Petrov DA. Similarly Strong Purifying Selection Acts on Human Disease Genes of All Evolutionary Ages. *Genome Biology and Evolution*, 1(1), 131-144, 2009.
15. Freilich S, Kreimer A, **Borenstein E**, Yosef N, Sharan R, Gophna U, and Ruppin E. Metabolic-Network Driven Analysis of Bacterial Ecological Strategies. *Genome Biology*, 10(6), 2009.
16. Freilich S, Kreimer A, **Borenstein E**, Gophna U, Sharan R, and Ruppin E. Decoupling Environment-Dependent and Independent Genetic Robustness across Bacterial Species. *PLoS Computational Biology*, 6(2), 2010.
17. Cai J, **Borenstein E**, and Petrov DA. Broker Genes in Human Disease. *Genome Biology and Evolution*, 2, 815-825, 2010.
18. (●) Carr R and **Borenstein E**. NetSeed: A network-based reverse-ecology tool for calculating the metabolic interface of an organism with its environment. *Bioinformatics*, 28(5), 734-735, 2012.
19. Pinho R, **Borenstein E**, and Feldman MW. Most networks in Wagner's model are cycling. *PLoS ONE*, 7(4), e34285, 2012.
20. (●) Greenblum S, Turnbaugh P, and **Borenstein E**. Metagenomic Systems Biology of the Human Gut Microbiome Reveals Topological Shifts Associated with Obesity and IBD. *PNAS (Proc. Natl. Acad. Sci. USA)*, 109(2), 594-599, 2012.
 - Featured in This Week in PNAS, "Obesity, IBD-related topologies in the human gut microbiome"
 - Featured in Nature Reviews Microbiology, 10(674), 2012, Genome Watch
 - Featured in UW Today
 - Featured in Microbe Magazine, American Society for Microbiology
 - Featured in The Seattle Times
21. Kreimer A, Doron A, **Borenstein E**, and Freilich S. NetCmpt: A network-based tool for calculating the metabolic competition between bacterial species. *Bioinformatics*, 28 (16), 2195-2197, 2012.

22. (●) Levy R and **Borenstein E**. Reverse Ecology: From systems to environments and back. *Advances in Experimental Medicine and Biology*, 751 (Evolutionary Systems Biology), 751, 329-345, 2012.
23. O’Roak BJ, Vives L, Girirajan S, Karakoc E, Krumm N, Coe BP, Levy R, Ko A, Lee C, Smith JD, Turner EH, Stanaway IB, Vernot B, Malig M, Baker C, Reilly B, Akey JM, **Borenstein E**, Rieder MJ, Nickerson DA, Bernier R, Shendure J, and Eichler EE. Sporadic autism exomes reveal a highly interconnected protein network of de novo mutations. *Nature*, 485, 246-250, 2012.
 - Featured in Nature Reviews Genetics - see Fruits of exome sequencing for autism
 - Featured in The New York Times front page (see media coverage)
 - Featured in UW Today, "Autism mutations, scattered across genes, merge into network of interactions"
 - Recommended by Faculty of 1000 Biology
24. (●) **Borenstein E**. Computational systems biology and in silico modeling of the human microbiome. *Briefings in Bioinformatics*, 13(6), 769-780, 2012.
 - Recommended by Faculty of 1000 Biology
25. (●) Neph S, Stergachis AB, Reynolds A, Sandstrom R, **Borenstein E**^{*}, and Stamatoyannopoulos JA^{*} (✳ co-corresponding authors). Circuitry and dynamics of human transcription factor regulatory networks. *Cell*, 150(6), 1274-1286, 2012.
26. O’Roak BJ, Vives L, Fu W, Egertson JD, Stanaway IB, Phelps IG, Carvill G, Kumar A, Lee C, Ankenman K, Munson J, Hiatt JB, Turner EH, Levy R, O’Day DR, Krumm N, Coe BP, Martin BK, **Borenstein E**, Nickerson DA, Mefford HC, Doherty D, Akey JM, Bernier R, Eichler EE, and Shendure J. Multiplex Targeted Sequencing Identifies Recurrently Mutated Genes in Autism Spectrum Disorders. *Science*, 338, 1619-1622, 2012.
27. (●) Greenblum S, Chiu HC, Levy R, Carr R, and **Borenstein E**. Towards a Predictive Systems-Level Model of the Human Microbiome: Progress, Challenges, and Opportunities. *Current Opinion in Biotechnology*, 24, 810-820, 2013.
28. (●) Press MO^{*}, Li H^{*}, Creanza N, Kramer G, Queitsch C, Sourjik V, and **Borenstein E**. Genome-Scale Co-Evolutionary Inference Identifies Functions and Clients of Bacterial Hsp90. *PLoS Genetics*, 9(7), 2013.
29. (●) Levy R, and **Borenstein E**. Metabolic Modeling of Species Interaction in the Human Microbiome Elucidates Community-Level Assembly Rules, *PNAS (Proc. Natl. Acad. Sci. USA)*, 110(31), 12804-12809, 2013.
 - Featured in UW Today
 - Recommended by Faculty of 1000 Biology
30. (●) Carr R, Shen-Orr SS, and **Borenstein E**. Reconstructing the Genomic Content of Microbiome Taxa through Shotgun Metagenomic Deconvolution, *PLoS Computational Biology*, 9(10), 2013.
 - Recommended by Faculty of 1000 Biology
31. Hoffman LR, Pope CE, Hayden HS, Levy R, McNamara S, Jacobs MA, Rohmer L, Radey M, Heltshe SL, Ramsey BW, Brittnacher MJ, **Borenstein E**, and Miller SI. Escherichia Coli Dysbiosis Correlates with Gastrointestinal Dysfunction in Children with Cystic Fibrosis. *Clinical Infectious Diseases*, 58(3), 396-399, 2014.
32. (●) Levy R and **Borenstein E**. Metagenomic systems biology and metabolic modeling of the human microbiome: From species composition to community assembly rules, submitted to *Gut Microbes*, 5:23 – 22, 2014.
33. (●) Chiu HC, Levy R, and **Borenstein E**. Emergent Biosynthetic Capacity in Simple Microbial Communities. *PLoS Computational Biology*, 10(7), 2014.

34. (●) Manor O, Levy R, and **Borenstein E**. Mapping the inner workings of the microbiome: Genomic- and metagenomic-based study of metabolism and metabolic interactions in the human microbiome. *Cell Metabolism*, 20(5), 742-752, 2014.
35. (●) Carr R and **Borenstein E**. Comparative Analysis of Functional Metagenomic Annotation and the Mappability of Short Reads. *PLoS ONE*, 9(8), 2014.
36. Stergachis A, Neph A, Sandstrom R, Haugen E, Reynolds AP, Zhang M, Byron R, Canfield T, Stehling-Sun S, Lee K, Thurman RE, Vong S, Bates D, Neri F, Diegel M, Giste E, Dunn D, Vierstra J, Hansen R, Johnson AK, Sabo PJ, Wilken MS, Reh T, Treuting PM, Kaul R, Groudine M, Bender MA, **Borenstein E**, and Stamatoyannopoulos JA. Conservation of trans-acting networks during mammalian regulatory evolution. *Nature*, 515, 365-370, 2014.
 - Featured in Nature News & Views
 - Featured in Science Daily
37. (●) Lachowiec J, Lemus T, **Borenstein E***, and Queitsch C* (¥ co-corresponding authors). Hsp90 promotes kinase evolution. *Molecular Biology and Evolution*, 32(1), 91-99, 2015.
38. Waldor MK, Tyson G, **Borenstein E**, Ochman H, Moeller A, Finlay BB, Kong HH, Gordon JI, Nelson KE, Dabbagh K, and Smith H. Where next for microbiome research? *PLoS Biology*, 13(1), 2015.
39. Hormozdiari F, Penn O, Borenstein E, and Eichler E. The discovery of integrated gene networks for autism and related disorders. *Genome Research*, 25(1), 142-154, 2015.
40. (●) Manor O, and **Borenstein E**. MUSiCC: A marker genes based framework for metagenomic normalization and accurate profiling of gene abundances in the microbiome. *Genome Biology*, 16:53, 2015.
41. (●) Greenblum S, Carr R, and **Borenstein, E**. Extensive strain-level copy number variation across human gut microbiome species. *Cell*, 160, 583-594, 2015.
 - Main feature on **Cell cover**
 - Altmetric score: 108 (in 99th percentile compared to all articles; in 98th percentile compared to all articles in Cell)
 - Featured in UW NewsBeat
 - Featured in *Genomeweb*
 - Featured in Science Daily
42. (●) Levy R, Carr R, Kreimer A, Freilich S, and **Borenstein E**. NetCooperate: A network-based tool for inferring host-microbe and microbe-microbe cooperation. *BMC Bioinformatics*, 16:164, 2015.

Submitted

In Preparation

1. (●) Eng A and **Borenstein E**. Designing microbial communities with desired metabolic capacities.
2. (●) Levy R and **Borenstein E**. Functional Complementarity in Microbial Ecosystems.
3. (●) Chiu HC and **Borenstein E**. A gut microbiome-scale metabolic model for designing precise dietary interventions.
4. (●) Manor O, Levy R, Pope C, Hayden H, Brittnacher M, Carr R, Miller S, Hoffman LR* and **Borenstein E***. Metagenomic evidence for altered fatty acid metabolism due to fecal dysbiosis in children with cystic fibrosis.
5. (●) Press M, Queitsch C, **Borenstein E**. Evolutionary assembly patterns of prokaryotic genomes.

6. (●) Manor O and **Borenstein E**. Taxonomic drivers of functional shifts in the human microbiome.
7. (●) Greenblum S and **Borenstein E**. Effect of Host Diet on Network Topology of the Mammalian Gut Microbiome.
8. (●) Amorosi C, Carr R, and **Borenstein E**. Scaling Laws in the Human Gut Microbiome.

Conference Papers and Other Publications

1. **Borenstein E** and Ruppin E. Enhancing Autonomous Agents' Evolution with Learning by Imitation. *Proceedings of the AISB 2003 Convention: Cognition in Machines and Animals*, 2003.
2. **Borenstein E** and Ruppin E. Evolving Imitating Agents and the Emergence of a Neural Mirror System. *Proceedings of the Ninth International Conference on the Simulation and Synthesis of Living Systems (ALife IX)*, MIT Press, 146-151, 2004.
3. **Borenstein E** and Cline E. Cellular automata model of cystogenesis and tubulogenesis. *Proceedings of the Santa-Fe Institute Complex Systems Summer School*, June 2004.
4. **Borenstein E**, Kupiec M, *Feldman MW* and *Ruppin E*. Large-Scale Reconstruction and Analysis of Growth Environments. *Proceedings of the Eighth International Conference on Systems Biology (ICSB 2007)*, 2007.
5. **Borenstein E** and *Feldman MW*. Topological Signatures of Species Interactions in Metabolic Networks. *4th Annual RECOMB Satellite on Systems Biology*, 2008.

Abstracts and Posters

See online

Invited Talks

- | | |
|----------|---|
| Nov 2015 | 25th Annual Beckman Symposium on Microbiota in Health in Disease, Duarte, USA (upcoming) |
| Sep 2015 | Cell Symposium on <i>Human Immunity and the Microbiome in Health and Disease</i> , Montreal, Canada (upcoming) |
| Sep 2015 | Multi-omics for Microbiomes Conference, Pacific Northwest National Laboratory, Kennewick, USA (upcoming) |
| Jun 2015 | CF Seminar Series, University of Washington, Seattle, USA |
| Jun 2015 | Gladstone Institutes, UCSF, San Francisco, USA |
| May 2015 | Center for Bioinformatics and Computational Biology, University of Maryland, College Park, USA |
| Mar 2015 | COBRA Workshop on Modelling Microbial Communities, Luxemburg |
| Mar 2015 | The American Society for Biochemistry and Molecular Biology (ASBMB) Annual Meeting, Boston, USA |
| Mar 2015 | Weizmann Institute of Science Systems Biology Conference, "two2many", Rehovot, Israel |
| Feb 2015 | AAAS Symposium on Obesity and Microbiome, Jan Jose, CA, USA |
| Feb 2015 | Math Model Affinity Group, Fred Hutchinson Cancer Research Center, Seattle, USA |
| Dec 2014 | ECOFECT international colloquium on modeling infectious diseases (EMOTIONS 2014), Lyon, France |
| Nov 2014 | Conversation about Diabetes, Public Panel Talk, Pacific Northwest Diabetes Research Institute (PNDRI), Seattle, USA |

- Nov 2015 Urban Ecology Research Laboratory, Department of Urban Design and Planning, University of Washington, Seattle, USA
- Oct 2014 Diabetes and the Microbiome Research Symposium, organized by ADA and JDRF, Washington, DC, USA (canceled)
- Sep 2014 ASM Conference on Beneficial Microbes, Washington, DC, USA
- Sep 2104 **John Von Neumann Public Lecture Series in Complexity & Computation**, University of Wisconsin, Madison, USA
- Aug 2014 META Center Symposium on Host-Microbe Systems Biology, *Modeling Our Microbial Selves*, University of Oregon, Eugene, USA
- May 2014 **Keynote Speaker:** Inland Northwest Genomics Research Symposium (INWGRS), Moscow, ID, USA
- May 2014 UW Diabetes and Metabolism Symposium, Seattle, USA
- Apr 2014 Keystone Symposium, Exploiting and Understanding Chemical Biotransformations in the Human Microbiome, Montana, USA
- Feb 2014 Lecture Series in Biomedical & Health Informatics, University of Washington, Seattle, USA
- Feb 2014 The Henk van Verseveld lecture, Nature of Life (NOL) lecture series, Department of Ecological Sciences, VU Amsterdam University
- Feb 2014 Genome Sciences Combi Seminars, University of Washington, Seattle, USA
- Jan 2014 University of Missouri, Department of Biological Sciences, Columbia, USA
- Nov 2013 Northwest Branch of the American Society for Microbiology meeting, Seattle, USA
- Aug 2013 Cystic Fibrosis Annual Retreat, University of Washington, Seattle, USA
- Jul 2013 IUPS Satellite Meeting on Multiscale Systems Biology, Buckinghamshire, UK (upcoming)
- May 2013 Mathematical tools for evolutionary systems biology, Banff International Research Station, Banff, Canada
- May 2013 American Society for Microbiology General Meeting (ASM2013), Denver, USA
- May 2013 Cell Symposium on *Microbiome and Host Health*, Lisbon, Portugal
- Feb 2013 Stanford University, Stanford, USA
- Feb 2013 VA Palo Alto Health Care System, Palo Alto, USA
- Nov 2012 META Center for Systems Biology, University of Oregon, Eugene, USA
- Jul 2012 Hopkins Marine Station Microbiology Course, Stanford University, Pacific Grove, USA
- Oct 2012 Bertinoro international Center for informatics, Bertinoro, Italy (canceled)
- Aug 2012 Current Challenges in Computing: Network Science, LLNL & IBM, Napa, USA (canceled)
- Jun 2012 Santa Fe Institute, Santa Fe, USA
- May 2012 Diabetes and metabolism seminar series, Diabetes Research Center, UW, Seattle, USA
- Nov 2011 Institute of Ecology and Evolution (IE²), University of Oregon, Eugene, USA
- Oct 2011 **Keynote Speaker:** Multiscale Modeling Consortium Meeting, NIH, Rockville, USA
- Jul 2011 *Wednesdays at the Genome* (Public Lecture Series), UW, Seattle, USA
- May 2011 The 5th Computational Molecular Biology Spring Symposium, UW, Seattle USA
- Mar 2011 AACR-NCI Conference on Systems Biology: Confronting the Complexity of Cancer,

La Jolla, USA

- Dec 2010 Next Generation Sequencing seminar, Department of Biology, UW, Seattle USA
- Jun 2010 Computational Biology Seminar Series, Fred Hutchinson Cancer Research Center, Seattle, USA
- May 2010 Genome Sciences Seminars, University of Washington, Seattle, USA
- Jul 2009 Complex Networks Initiative, Stanford University, USA
- Apr 2008 Workshop on *The Role of Variation in Cultural Change*, Santa-Fe Institute, USA
- Jul 2007 Santa-Fe Institute, Santa Fe, USA
- Nov 2006 Department of Computer Science (*Barash Group*), Ben-Gurion University, Israel
- Jun 2006 Department of Biological Chemistry (*Tawfik Group*), Weizmann Institute of Science, Israel
- Apr 2006 *Camp Evolution II: Evolutionary and Ecological Genomics*, Blaustein Institute for Desert Research, Ben-Gurion University of the Negev, Israel

Contributed Talks

- Apr 2015 International Human Microbiome Congress, Luxemburg
- Mar 2011 International Human Microbiome Congress, Vancouver, Canada
- Nov 2010 6th Annual RECOMB Satellite on Systems Biology, New York, USA
- Dec 2009 5th Annual RECOMB Satellite on Systems Biology, Boston, USA
- Oct 2008 4th Annual RECOMB Satellite on Systems Biology, Boston, USA
- Oct 2007 Biomedical Computation at Stanford (BCATS), Stanford, USA
- Oct 2007 **Plenary talk:** The 8th Int'l Conference on Systems Biology, Long Beach, USA
- Sep 2004 The 9th Int'l Conference on the Simulation and Synthesis of Living Systems, Boston, USA
- Apr 2003 The AISB 2003 Convention: Cognition in Machines and Animals, Aberystwyth, Wales

Media Coverage

- Microbiome models, on computers and in lab dishes, see progress, *Nature Medicine*, June 2015
- Analysis Highlights Strain Diversity in Gut Microbiome, *GenomeWeb*, January 2015
- Among gut microbes, strains, not just species, matter, *UW News Beat*, January 2015
- Mice in the ENCODE spotlight, *Nature News & Views*, November 2014
- New view of mouse genome finds many similarities, striking differences with human genome, *Science Daily*, November 2014
- Ecological forces structure your body's personal mix of microbes, *UW Today*, July 2013
- Metagenomics with guts, *Genome Watch*, *Nature Reviews Microbiology*, 10(674), Oct 2012
- Digestive microbes work differently in fat, lean, *The Seattle Times*, Feb 2012
- Fruits of exome sequencing for autism, *Nature Review Genetics*, 13(6), 2012
- Autism mutations, scattered across genes, merge into network of interactions, *UW Today*, 2012
- Scientists link gene mutation to autism risk, *The New York Times* (front page), April 2012
- Audio Interview, *Microbe Magazine*, March 2012

- Gut microbe networks differ from norm in obese people, systems biology approach reveals, *UW Today & Science Daily*, 2012
- Reverse Ecology, *Astrobiology Magazine*, March, 2009
- Reconstructing Bacterial Environments From Millions Of Years Ago, *Science 2.0*, Feb 2009
- Reverse ecology uses genes to predict environment, *Frontiers in Ecology & the Environment*, 2009
- Reversing ecology reveals ancient environments, *Stanford Report & Science Daily*, 2009
- Network-based approaches for linking metabolism with environment, *Genome Biology*, 9:239, 2008
- Modelling the evolutionarily possible, *Nature Reviews Genetics*, 9(11), 2008
- Development puts an end to the evolution of endless forms, *Science Daily*, 2008
- Santa Fe Institute researcher figures out factors that make bacteria more modular, *Medical News Today*, 2008
- Factors that make bacteria more modular detailed, *Science Daily*, 2008

Professional Positions

Extensive professional experience in the IDF and hi-tech industry, holding top professional and management positions.

2000 – 2001	Co-Founder and Chief Technology Officer, Gate42 Technologies Ltd.
1997 – 1999	Vice President Research & Development, Veon Ltd. (acquired by Philips Electronics in 2000)
1995 – 1996	Software Project Leader, Veon Ltd.
1993 – 1994	Software engineer, Efrat Technologies (now Comverse)
Military service	Lieutenant, Section head, HM"N Talpiot (an elite R&D unit, Israel Defense Forces)

Patents (with other co-inventors)

- System and method and linking information to a video (US6570587)
- Linking information to and accessing information from a video (EP0922259, WO1998004984)
- System and method for guided media sequences (WO0203247; application)
- Streaming hypervideo and dynamic hypervideo (WO9910822, EP1005680)