Lenwood Scott Heath  
Curriculum Vitae  
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**Education**

Ph.D., Computer Science, University of North Carolina, Chapel Hill, 1985  
Dissertation: **Algorithms for Embedding Graphs in Books**

M.S., Mathematics, University of Chicago, 1976

B.S., Mathematics, University of North Carolina, Chapel Hill, 1975

**Research Interests**

Algorithms, theoretical computer science, graph theory, bioinformatics, computational biology, computational epidemiology, genomics, probability, symbolic computation, computational algebra, parallel architectures, graph embeddings, topology, computational geometry
PROFESSIONAL EXPERIENCE

2021– Affiliated Faculty of the Center for Advanced Innovation in Agriculture (CAIA), Virginia Polytechnic Institute and State University, Blacksburg, VA

2020– Affiliated Faculty of the Center for Emerging, Zoonotic, and Arthropod-borne Pathogens (CeZAP), Virginia Polytechnic Institute and State University, Blacksburg, VA

2019–2021 Member of the Quantum Information Science and Engineering (QISE) Working Group, Virginia Polytechnic Institute and State University, Blacksburg, VA

2018– Member of Microbial Systems, Virginia Polytechnic Institute and State University, Blacksburg, VA

2014– Faculty of Health Sciences, Virginia Polytechnic Institute and State University, Blacksburg, VA

2011– Sanghani Center for Artificial Intelligence and Data Analytics (Formerly, the Discovery Analytics Center (DAC)), Virginia Polytechnic Institute and State University, Blacksburg, VA

2003– Faculty of the Genomics, Bioinformatics, and Computational Biology PhD program, Founding Faculty Member, Virginia Polytechnic Institute and State University, Blacksburg, VA

2003– Professor of Computer Science, Virginia Polytechnic Institute and State University, Blacksburg, VA

1993–2003 Associate Professor of Computer Science, Virginia Polytechnic Institute and State University, Blacksburg, VA

1987–1993 Assistant Professor of Computer Science, Virginia Polytechnic Institute and State University, Blacksburg, VA

1985–1987 Instructor of Applied Mathematics, Theoretical Computer Science Group, Department of Mathematics, Massachusetts Institute of Technology, Cambridge, MA

JOURNAL PAPERS

Published

[1] “HT-ARGfinder: A Comprehensive Pipeline for Identifying Horizontally Transferred Antibiotic Resistance Genes and Directionality in Metagenomic Sequencing Data,” Badhan Das, Muhit Islam Emon, Nazifa Ahmed Moumi, Justin Sein, Amy Pruden, Lenwood S. Heath, and Liqing Zhang. Frontiers in Environmental Science 10, 2022, 9 pages.

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“MetaCompare: A Computational Pipeline for Prioritizing Environmental Resistome Risk,” Min Oh, Amy Pruden, Lenwood S. Heath, Kang Xia, and Liqing Zhang. *FEMS Microbiology Ecology* 94, 2018, 9 pages.

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“PEAK: Integrating Curated and Noisy Prior Knowledge in Gene Regulatory Network Inference,” Doaa Altarawy, Fatma-Elzahraa Eid, and Lenwood S. Heath. *Journal of Computational Biology* 24, 2017, 863–873.

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“Molecular and Physiological Adaptation to Prolonged Drought Stress in the Leaves of two Andean Potato Genotypes,” Srinivasrao P. Mane, Cecilia Vasquez Robinet, Alexander Ulanov, Roland Schaffeitner, Luz Tincopa, Amelie Gaudin, Giannina Nomberto, Carlos Alvarado, Christian Solis, Luis Avila Bolivar, Raul Blas, Oscar Ortega, Julio Solis, Ana Panta, Cristina Rivera, Ilanit Samolski, Doris H. Carabajulca, Meredith Bonierbale, Amrita Pati, Lenwood S. Heath, Hans J. Bohnert and Ruth Grene, Functional Plant Biology 35, 2008, pp. 669–688.

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Published

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[8] USDA Animal and Plant Health Inspection Service (APHIS): Genome-based Circumscription and Phenotyping of Regulated Microbes, Especially the Select Agent Ralstonia solanacearum, $261,207. 08/01/19 - 08/01/21. PI: Kellye Eversole. Co-PIs: Caitilyn Allen, Mohammad Arif, Gwyn Beattie, Lenwood S. Heath, Michael Stulberg (USDA-APHIS), Boris A. Vinatzer (VT-SPES). VT share: $129,210. Personal share: 50% of VT share.

[9] IARPA: Integrative Genomics Approach to Computational Assessment of Threats (IGACAT), $12,622,546. 03/01/17 - 05/31/20. PI: Stephen Eubank. Research Scientist: Lenwood S. Heath. Personal share: 4%.

[10] National Science Foundation 1545756: PIRE: Halting Environmental Antimicrobial Resistance Dissemination (HEARD), $3,333,000. 10/01/15 - 09/30/20. PI: Peter Vikesland. Co-PIs: Pedro Alvarez, Diana Aga, Amy Pruden, Krista Wigginton. Senior Personnel: Lenwood S. Heath, Liqing Zhang, et al. Personal share: 0%.

[11] Virginia Tech Microbiology at the Nexus of Food, Energy, Water, and Health Systems (MicroFEWHS) concept area: Continued Development and Enhancement of DeepARG, a Web Service for Accurate Annotation of Antibiotic Resistance Genes, $3,725. 12/01/2019 - 05/15/2020. PI: Liqing Zhang. Co-PIs: Lenwood S. Heath. Personal share: 50%.

[12] Virginia Tech Microbiology at the Nexus of Food, Energy, Water, and Health Systems (MicroFEWHS) concept area: Developing ARGminer, a Powerful Web Platform for Crowdsourcing-based Curation of Antibiotic Resistance Genes, $3,000. 12/01/2018 - 05/15/2019. PI: Liqing Zhang. Co-PIs: Lenwood S. Heath. Personal share: 50%.

[13] Virginia Tech College of Agriculture and Life Sciences (CALS): Identifying Select Agents Using a Nanopore Sequencing and Secure Cyberphysical System, $20,000. 05/15/2018 - 12/31/2018. PI: Song Li. Co-PIs: Lenwood S. Heath, Boris Vinatzer. Personal share: 25%. 
[14] National Science Foundation 1238057: GEPR-Evolutionary Gain and Loss of Function in Parasitic Plant Genomes, $3,406,833. 08/01/13 - 07/31/18. PI: James H. Westwood. Co-PIs: Eva Collakova, Claude W. dePamphilis, Lenwood S. Heath, Aaron Mackey, Michael P. Timko, John I. Yoder. Personal share: 10%. VT share: $934,389.

[15] National Science Foundation DBI-1062472: ABI Development: Representation, Visualization, and Modeling of Signaling Pathways in Higher Plants, Advances in Biological Informatics (ABI), $1,057,337. 04/15/11 - 03/31/17. PI: Lenwood S. Heath. Co-PIs: Ruth Grene, Andy Pereira. Personal share: 37%.

[16] National Institutes of Health Grant 1 R25 GM066354-06: VT Post Baccalaureate Research and Education, National Institute of General Medical Sciences. First year: $275,603; second year: $276,635; third year: $277,689; fourth year: $278,793. 03/01/2009 - 01/31/2013. PI: Edward J. Smith; Research Mentor: Lenwood S. Heath, et al.

[17] National Science Foundation ITR-0428344: ITR-(NHS)-(sim): Computational Models for Gene Silencing: Elucidating a Pervasive Biological Defensive Response, Information Technology Research (ITR), $1,500,000. 09/01/04 - 08/31/10. PI: Lenwood S. Heath. Co-PIs: Richard F. Helm, Alexey Onufriev, Malcolm Potts, Naren Ramakrishnan.

[18] National Institutes of Health Grant 1 R25 GM066354-01A1: VT Post Baccalaureate Research and Education, National Institute of General Medical Sciences. First year: $254,871; second year: $411,184; third year: $413,757; fourth year: $416,407; fifth year: $419,135. 08/04/2003 - 07/31/2008. PI: Edward J. Smith; Research Mentor: Lenwood S. Heath, et al.

[19] Department of Defense Multidisciplinary University Research Initiative (MURI), Defense Advanced Research Projects Agency Grant N00014-01-1-0852: Dryophile Genes to Engineer Stasis-Recovery of Human Cells, $4,532,622: $2,602,790 (basic 3-year) plus $1,929,832 (2-year option), 05/01/2001 – 05/31/2007. Principal investigator: Malcolm Potts. Senior Personnel: Lenwood S. Heath, Richard F. Helm, Naren Ramakrishnan, Thomas O. Sitz (Virginia Tech), Frederic Bloom, Paul Price (Life Technologies), and John Battista (Louisiana State University).

[20] National Science Foundation Grant ITR-0219322: ITR: Understanding Stress Resistance Mechanisms in Plants: Multimodal Models Integrating Experimental Data, Databases, and the Literature, Division of Integrative Biology and Neuroscience (BIO/IBN) — ITR Small grants, $499,973. 09/15/2002 - 08/31/2005. PI: Lenwood S. Heath; Co-PIs: Ruth G. Alscher, Boris I. Chevone, Naren Ramakrishnan, and Layne T. Watson. Supplemental funding of $70,705 received February, 2005; expiration extended until 12/31/2006.

[21] National Science Foundation Grant EIA-01903660: A Microarray Experiment Management System, $600,000. 8/01/2001 – 8/31/2004. Principal investigators: Naren Ramakrishnan, Lenwood S. Heath, Layne T. Watson, Ruth G. Alscher, and Jennifer W. Weller (VBI).

[22] Virginia Tobacco Settlement Foundation (VTSF): Using Molecular Genetics to Target “High Risk” Youth Smokers. Initial participation with the Virginia Tobacco Prevention Research Consortium, in particular, research in furthering the Expresso project and applying it to the needs of the consortium. $96,000. 3/16/2002 – 3/15/2002. Principal investigators: Naren Ramakrishnan, Lenwood S. Heath.
[23] National Science Foundation Grant INT-0000424: *U.S.-Brazil Cooperative Research: The Fine Algebraic Structure of Derivations and Hochschild Cohomology*. $24,900, 9/1/00–8/31/03. Principal investigators: Daniel R. Farkas, Edward L. Green, and Lenwood S. Heath.

[24] National Science Foundation Grant CCR-9732068: *A System for Symbolic Computation in Hopf Algebras*. $180,000, 8/16/98–8/31/01. Principal investigators: Edward L. Green and Lenwood S. Heath.

[25] Arts and Sciences Pilot Research Project Grant: *Experimenting With Algorithms for Difficult, Non-numeric Problems*. $3,000, 12/96–12/98.

[26] National Science Foundation Grant IRI-9116991: *A User-Centered Database from the Computer Science Literature (REU Supplement)*. $8,000, 5/15/92–5/15/93. Principal investigator. Funding to pay two undergraduates to participate in research.

[27] National Science Foundation Grant IRI-9116991: *A User-Centered Database from the Computer Science Literature*. $443,391, 9/15/91–2/28/95. Equipment supplement $29,941, 1992. Principal investigators: Edward A. Fox, Lenwood S. Heath, and Deborah Hix.

[28] National Science Foundation Grant CCR-9009953: *Analyzing Parallel Architectures With Algebraic Topology*. $40,000, 7/15/90–12/31/92. Principal investigator.

**Doctoral Students Supervised**

[1] Siddharth Krishnan, “Seeing the Forest for the Trees: New Approaches to Characterizing and Forecasting Cascades,” 2018.

[2] Hanaa A. Torkey, “Machine Learning Approaches for Identifying microRNA Targets and Conserved Protein Complexes,” 2017.

[3] Fatma Elzahraa Sobhy Eid, “Predicting the Interactions of Viral and Human Proteins,” 2017.

[4] Doaa Abdelsalam Ahmed Mohamed Altarawy, “DeTangle: A Framework for Interactive Prediction and Visualization of Gene Regulatory Networks,” 2017.

[5] Haitham Abdulrahman Elmarakeby, “Deep Learning for Biological Problems,” 2017.

[6] Andrew Scott Warren, “Methods for Analysis of Prokaryotic Genome Architecture,” 2017.

[7] Eman Badr, “Identifying Splicing Regulatory Elements with de Bruijn Graphs,” 2015.

[8] Kuan Yang, “Ancestral Genome Reconstruction in Bacteria,” 2012. Ph.D. in Genetics, Bioinformatics, and Computational Biology. Co-advisor with João C. Setubal of the Virginia Bioinformatics Institute.

[9] Nahla A. Belal, “Two Problems in Computational Genomics,” 2011.

[10] Amrita Pati, “Graph-Based Genomic Signatures,” 2008.
[11] Allan A. Sioson, “Multimodal Networks in Biology,” 2005.
[12] Douglas J. Slotta, “Evaluating Biological Data Using Rank Correlation Methods,” 2005.
[13] Craig A. Struble, “Analysis and Implementation of Algorithms for Noncommutative Algebra,” 2000. Co-advisor with Edward L. Green of the Department of Mathematics.
[14] John Paul A. Vergara, “Sorting by Bounded Rearrangements,” 1997.
[15] Benjamin J. Keller, “Algorithms and Orders for Finding Noncommutative Gröbner Bases,” 1997. Co-advisor with Edward L. Green of the Department of Mathematics.
[16] Ramana R. Juvvadi, “Perfect Hashing and Some Related Problems,” 1993.
[17] Sriram V. Pemmaraju, “Exploring the Powers of Stacks and Queues via Graph Layouts,” 1992.

Masters Thesis Students Supervised

[1] Aarathi Raghuraman, “Predicting Mutational Pathways of Influenza A H1N1 Virus using Q-learning,” 2021.
[2] Ashkan Nazari, “Machine Learning Application in Energy Storage System’s State Estimation: State of Health (SOH),” 2021.
[3] Jeffrey A. Robertson, “Entropy Measurements and Ball Cover Construction for Biological Sequences,” 2018.
[4] Yanshen Yang, “MCAT: Motif Combining and Association Tool,” 2018.
[5] Rathna Senthil, “IDLE: A Novel Approach to Improving Overlapping Community Detection in Complex Networks,” 2016.
[6] Ying Ni, “A Machine Learning Approach to Predict Gene Regulatory Networks in Seed Development in Arabidopsis Using Time Series Gene Expression Data,” 2016.
[7] Deepti Aggarwal, “Inferring Signal Transduction Pathways from Gene Expression Data using Prior Knowledge,” 2015.
[8] Nidhi Kiranbhai Parikh, “Generating Random Graphs with Tunable Clustering Coefficient,” 2011.
[9] Amrita Pati, “Modeling and Analysis of Regulatory Elements in Arabidopsis thaliana from Annotated Genomes and Gene Expression Data,” 2005.
[10] Maulik Shukla, “GeneSieve: A Probe Selection Strategy for cDNA Microarrays,” 2004.
[11] Harsha K. Rajasimha, “PathMeld: A Methodology for The Unification of Metabolic Pathway Databases,” 2004.
[12] Guillermo Averboch, “A System for Document Analysis, Translation, and Automatic Hypertext Linking,” 1995.
[13] Fred L. Drake, Jr., “odb/Tools Project Report,” 1995.

[14] Dennis J. Brueni, “Minimal PMU Placement for Graph Observability: A Decomposition Approach,” 1993.

[15] John Paul A. Vergara, “Edge-packing by Isomorphic Subgraphs,” 1990.

[16] Thurman W. Tunnell, “Development of New Heuristics for the Euclidean Traveling Salesman Problem,” 1989.

Professional Organizations

Association of Computing Machinery, Member
Institute of Electrical and Electronics Engineers (IEEE), Lifetime Senior Member
IEEE Computer Society, Lifetime Member
Models of Infectious Disease Agent Study (MIDAS) Network, Member
Society for Industrial and Applied Mathematics (SIAM), Lifetime Member
SIAM Activity Group on Discrete Mathematics
SIAM Activity Group on Life Sciences

Professional Service

2021  Program Committee Member, IEEE International Conference on Bioinformatics and Biomedicine (BIBM), 2021.

2020  Program Committee Member, IEEE International Conference on Bioinformatics and Biomedicine (BIBM), 2020.

2017–20 Associate Editor, Mathematical Foundations of Computing (MFOC).

2017–  Managing Editor, Journal of Interconnection Networks (JOIN).

2017  Guest editor-in-chief of the Special Issue of the Proceedings of the IEEE on Bioinformatics of DNA, March, 2017. Other guest editors are Hector Corrada Bravo, Mario Caccamo, and Michael Schatz. “Scanning the Issue: Bioinformatics of DNA,” Lenwood S. Heath, Hector Corrada Bravo, Mario Caccamo, and Michael Schatz. Guest editor introduction. Proceedings of the IEEE 105, 2017, 419–421.

2013–17 Editor, New Journal of Science.

2011–14 Editor, ISRN Computational Mathematics

2011  Member of program committee of First IEEE Conference on Healthcare Informatics, Imaging, and Systems Biology (HISB) 2011.

2010  Member of program committee of 33rd Annual ACM SIGIR Conference 2010.
2005  Member of program committee of **Brazilian Symposium on Bioinformatics 2005.**

**Moderator for panel on systems biology at the Biomedical Engineering Research and Science Conference,** March 4, 2005. Sponsored by the Virginia Tech National Capital Region and College of Engineering and by the Wake Forest University School of Medicine.

2003–16 Editor, Journal of Interconnection Networks (JOIN).

2002  Guest editor, with Naren Ramakrishnan, of the **Special Issue of IEEE Computer on Bioinformatics Software,** July, 2002.

Member of program committee of **High Performance Computing Symposium 2002 (HPC 2002),** accepted six papers for two tracks on Bioinformatics Applications.

1995–2000

ACM Special Interest Group on Automata and Computability Theory (SIGACT) Theory Calendar. Maintained WWW calendar of conferences and other events of interest to the theory community. Calendar also appeared as a column four times a year in **SIGACT News.**

**Honors and Awards**

Sigma Xi, The Scientific Research Honor Society, 1991

Department of Computer Science, Virginia Tech, Outstanding Department Contributor Award for Exemplary Faculty Service, 2019

Institute of Electrical and Electronics Engineers, Lifetime Senior Member, 2018

Institute of Electrical and Electronics Engineers, Senior Member, 1999

Board of Governor’s Fellowship in Science and Technology, University of North Carolina, Chapel Hill, 1984

Archibald Henderson Prize for outstanding undergraduate in mathematics, University of North Carolina, Chapel Hill, 1975

Phi Beta Kappa, University of North Carolina, Chapel Hill, 1973

Jackson Tuition Scholarship, University of North Carolina, Chapel Hill, 1971

National Merit Scholarship, 1971

Westinghouse Science Talent Search winner, 1971

National Science Foundation Student Science Training Program, University of North Carolina, Chapel Hill, Summer 1970; first in mathematics class

Governor’s School, Winston-Salem, NC, Summer, 1969