

# Hristo N. Djidjev

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## Research Interests

- *Quantum computing*: quantum annealing, problem embedding, scalability, performance tuning
- *Combinatorial optimization*: graph algorithms, discrete optimization, graph partitioning
- *Machine learning*: unsupervised learning, tensor networks, nonnegative tensor factorization
- *Bioinformatics*: protein structure prediction, protein classification, computational genomics

## Professional Experience

- Researcher, Institute of Information and Communication Technologies, Sofia, Bulgaria, 15/06/2021–current
- Guest Scientist, Los Alamos National Laboratory, Los Alamos, USA, 03/05/2021–current
- *Scientist*, Los Alamos National Laboratory, Los Alamos, USA, 11/10/2005–30/04/2021
- *Research Adjunct Professor*, Carleton University, Ottawa, Canada, 01/10/1998–current
- *Assistant Professor and Research Scientist*, Department of Computer Science, Rice University, USA, 01/01/1992–30/09/1998
- *Visiting Professor*, School of Computer Science, Carleton University, Ottawa, Canada, 01/09/1988–15/12/1988, 01/09/1989–31/12/1989, 01/10/1990–30/04/1991
- *Visiting Professor*, Dept. Computer Science, Duke University, USA, 16/12/1988–16/03/1989
- *Research Associate*, Center of Informatics and Computer Technology, Bulgarian Academy of Sciences, Sofia, Bulgaria, 01/06/1986–31/12/1991
- *Research Associate*, Institute of Mathematics, Bulgarian Academy of Sciences, Sofia, Bulgaria, 01/01/1983–31/05/1986

## Education

- Ph. D., Sofia University, 10/01/1984
- M. S., Sofia University, 30/06/1980
- B. S., Sofia University, 30/06/1979

## Professional Activities

- Member of the standing committee and editor of *Parallel Processing Letters*, 1991-2017
- Editor of *Discrete Mathematics and Theoretical Computer Science* 1999-2002

- Chairman of the organizing committee of the international workshop on *Optimal Algorithms*
- Editor of vol. 401 of Lecture Notes of Computer Science
- Reviewer for *Algorithmica*, *SIAM Journal of Discrete Mathematics*, *SIAM Journal on Computing*, *Computational Geometry: Theory and Applications*, *Journal of Algorithms*, *Information and Computation*, *Information Processing Letters*, *Networks*, *Theoretical Computer Science*, EPSRC, National Science Foundation, and many others

## Funding and Awards

- R&D 100 Winner, 2021, project “SmartTensors AI Platform,” Los Alamos National Laboratory team.
- Tensor Networks: Robust Unsupervised Machine Learning for Big-Data Analytics, Laboratory Directed Research and Development Program, 20190020DR, **co-PI**, USA, 2018-2021
- Taming Defects in Quantum Computers, Laboratory Directed Research and Development Program, 20190065DR, **co-investigator**, USA, 2018-2021
- HipcoGen: High-Performance Combinatorial Optimization for Computational Genomics, INRIA/IRISA–France, Associate Team program, **PI** for LANL, USA, 2017-2020
- Postprocessing Algorithms for Boosting Quantum Annealing Scalability, Laboratory Directed Research and Development Program, 20180267ER, **PI**, USA, 2017-2020.
- Global Optimization Methods for Structural Bioinformatics, Laboratory Directed Research and Development Program, 20160317ER, **PI**, USA, 2015-2018
- Scalable Codesign Performance Prediction for Computational Physics, Laboratory Directed Research and Development Program, 20150098DR, **co-investigator**, USA, 2014-2017.
- Next Generation Quantum Molecular Dynamics, Laboratory Directed Research and Development Program, 20140074DR, **co-investigator**, USA, 2013-2016.
- Software/Hardware Mapping for Data Locality Optimization, Laboratory Directed Research and Development Program, 20130252ER, **PI**, USA, 2012-2015.
- Optimization Principles for Co-Design Applied to Molecular Dynamics, Laboratory Directed Research and Development Program, 20120038DR, **co-investigator**, USA, 2011-2014.
- Algorithmic Co-Design: Paradigms for Unstructured Problems on Accelerated Architectures, Laboratory Directed Research and Development Program, 20110195ER, **co-PI**, USA, 2010-2013.
- Multi-Perspective Network-Scale Modeling and Detection for Cyber Systems, Laboratory Directed Research and Development Program, 20110093DR, **co-investigator**, USA, 2010-2013.
- Ultra-Fast DFT-Quality Forces for Molecular Dynamics Simulations of Materials, Laboratory Directed Research and Development Program, 20100366ER, **co-investigator**, USA, 2009-2012.
- EPA Award R82-5207-010: *Partitioning algorithms and their application to massively parallel computations of multiphase fluid flows in porous media*, **PI**, USA, 1996–2000.

- NSF Award CCR-9409181 *RIA: Efficient algorithms for special classes of graphs*, **PI**, USA, 1994-1997.
- First Prizes at the 1983 and 1984 Annual National Review of the Scientific and Technical Achievements of Young Researchers, Bulgaria.
- First Prize at the International Competition for Young Researchers in Mathematics from Balkan Nations, Pitesti, Romania, September 1982.

## Selected Recent Journal and Refereed Conference Papers

- A Barbosa, E Pelofske, G Hahn, HN Djidjev, Using machine learning for quantum annealing accuracy prediction, *Algorithms* 14 (6), 187, 2021.
- E Pelofske, G Hahn, D O'Malley, H Djidjev, B Alexandrov, Boolean Hierarchical Tucker networks on a quantum annealer, *Large-Scale Scientific Computations*, 2021 (**Best Paper award**).
- E Pelofske, G Hahn, H Djidjev, Advanced anneal paths for improved quantum annealing, *IEEE International Conference on Quantum Computing and Engineering*, 2020.
- H Djidjev, Automaton-based methodology for implementing optimization constraints for quantum annealing, *17th ACM International Conference on Computing Frontiers*, 118-125, 2020.
- H Carrillo-Cabada, E Skau, G Chennupati, B Alexandrov, H Djidjev, An Out of Memory tSVD for Big-Data Factorization, *IEEE Access Journal* 8, 107749-107759, 2020.
- S Zbinden, A Bärtschi, H Djidjev, S Eidenbenz, Embedding Algorithms for Quantum Annealers with Chimera and Pegasus Connection Topologies, *ISC High Performance*, 187-206, 2020.
- E Pelofske, G Hahn, H Djidjev, Decomposition Algorithms for Solving NP-hard Problems on a Quantum Annealer, *Journal of Signal Processing Systems*, 1-16, 2020.
- G Chennupati, R Vangara, E Skau, H Djidjev, B Alexandrov, Distributed non-negative matrix factorization with determination of the number of latent features, *The Journal of Supercomputing*, 1-31, 2020.
- H Djidjev, G Hahn, SM Mniszewski, CFA Negre, A Niklasson, Using Graph Partitioning for Scalable Distributed Quantum Molecular Dynamics, *Algorithms* 12 (9), 187, 2019.
- R. Andonov, H. Djidjev, S. Francois, D. Lavenier, Complete Assembly of Circular and Chloroplast Genomes Based on Global Optimization, *Journal of Bioinformatics and Computational Biology*, 17 (03), 1950014, 2019.
- E Pelofske, G Hahn, H Djidjev, Peering into the Anneal Process of a Quantum Annealer, 20th International Conference on Parallel and Distributed Computing, Applications and Technologies (PDCAT), 184-189, 2019 (**Distinguished Paper award**).
- E Pelofske, G Hahn, H Djidjev, Optimizing the spin reversal transform on the D-Wave 2000Q, *IEEE International Conference on Rebooting Computing (ICRC)*, 1-8, 2019.
- N Akhter, G Chennupati, H Djidjev, A Shehu, Unsupervised Learning for Decoy Selection in Protein Structure Prediction, *Biophysical Journal* 116 (3), 192a, 2019.

- T Vyskocil, H Djidjev, Simple Constraint Embedding for Quantum Annealers, *IEEE International Conference on Rebooting Computing (ICRC)*, 1-11, 2018.
- S Francois, R Andonov, D Lavenier, H Djidjev, Global optimization approach for circular and chloroplast genome assembly, *10th International Conference on Bioinformatics and Computational Biology (BIBOB)*, 2018, **Best Paper award**.
- G Chapuis, H Djidjev, G Hahn, G Rizk, Finding maximum cliques on the D-Wave quantum annealer, *Journal of Signal Processing Systems*, 1-15, 2018.
- S Francois, R Andonov, D Lavenier, H Djidjev, Global Optimization for Scaffolding and Completing Genome Assemblies, *Electronic Notes in Discrete Mathematics* v. 64, 185-194, 2018.
- G. Chapuis, H. Djidjev, G. Hahn, G. Rizk, Improved Decoy Selection via Machine Learning and Ranking, Finding Maximum Cliques on a Quantum Annealer, *ACM Computing Frontiers Conference*, 63-70, 2017.
- G. Hahn, H. Djidjev, Reducing Binary Quadratic Forms for More Scalable Quantum Annealing, *IEEE International Conference on Rebooting Computing*, 2017.
- N. Prajapati, W. Ranasinghe, S. Rajopadhye, R. Andonov, H. Djidjev, Simple, Accurate, Analytical Time Modeling and Optimal Tile Size Selection for GPGPU Stencils, *ACM SIGPLAN Symposium on Principles and Practice of Parallel Programming*, pp. 163-177, 2017.
- A. Niklasson, S. Mniszewski, C. Negre, M. Cawkwell, P. Swart, J. Mohd-Yusof, T. Germann, M. Wall, N. Bock, E. Rubensson, and H. Djidjev, Graph-based linear scaling electronic structure theory, *Journal of Chemical Physics*, 2016.
- S François, R Andonov, H Djidjev, D Lavenier, Global Optimization Methods for Genome Scaffolding, *12th International Workshop on Constraint-Based Methods for Bioinformatics*, 2016.
- H. Djidjev, G. Hahn, S. Mniszewski, C. Negre, A. Niklasson, and V. Sardeshmukh, Graph Partitioning Methods for Fast Parallel Quantum Molecular Dynamics, *SIAM Workshop on Combinatorial and Scientific Computing*, 2016.
- G. Chapuis and H. Djidjev, Parallel computation of betweenness centrality for large planar graphs, *SIAM Workshop on Network Science*, poster, 2016.
- H. Djidjev, G. Chapuis, R. Andonov, S. Thulasidasan, D. Lavenier, All-Pairs Shortest Path algorithms for planar graph for GPU-accelerated clusters, *Journal of Parallel and Distributed Computing*, Volume 85, Pages 91-103, 2015.
- G. Chapuis, H. Djidjev. Shortest-Path Queries in Planar Graphs on GPU-Accelerated Architectures, Large-Scale Scientific Computing (LSSC), *Lecture Notes in Computer Science* Vol. 9374, pp. 53–60, Springer-Verlag, 2015.
- G. Chapuis, M. Boudic-Jamin, R. Andonov, H. Djidjev, D. Lavenier, Parallel seed-based approach to multiple protein structure similarities detection, *Scientific Programming Journal*, 2015.
- R. Andonov, H. Djidjev, G. Klau, M. Le Boudic-Jamin, I. Wohlers, Automatic Classification of Protein Structure Using the Maximum Contact Map Overlap Metric, *Algorithms*, 8(4), 850-869, 2015.

- I. Wohlers, M. Le Boudic-Jamin, H. Djidjev, G.W. Klau, R. Andonov, Exact Protein Structure Classification Using the Maximum Contact Map Overlap Metric, *International Conference on Algorithms for Computational Biology (AlCoB)*, LNBI 8542, pp. 262-273, 2014.
- G. Chapuis, M. Le Boudic-Jamin, R. Andonov, H. Djidjev, and D. Lavenier, Parallel seed-based approach to multiple protein structure similarities detection, *Scientific Programming Journal*, Article ID 279715, 12 pages, 2014.
- H. Djidjev, R. Andonov, G. Chapuis, D. Lavenier, S. Thulasidasan, Efficient Multi-GPU Computation of All-Pairs Shortest Paths, *International Parallel & Distributed Processing Symposium (IPDPS)*, pp. 360-369, 2014.
- L. Aleksandrov, H. Djidjev, A. Maheshwari, J.-R. Sack, An Approximation Algorithm for Computing Shortest Paths in Weighted 3-d Domains, *Discrete & Computational Geometry*, volume 50, Issue 1, pp 124-184, 2013.
- Hristo Djidjev and Melih Onus, Using Graph Partitioning for Efficient Network Modularity Optimization, in Graph Partitioning and Graph Clustering, *Contemporary Mathematics*, AMS, pp. 103-112, 2013.
- Hristo Djidjev and Melih Onus, Scalable and Accurate Graph Clustering and Community Structure Detection, *IEEE Transactions on Parallel and Distributed Systems*, vol.24, no.5, pp.1022-1029, 2013.
- Hristo Djidjev and Imrich Vrt'ko: Planar Crossing Numbers of Graphs of Bounded Genus. *Discrete & Computational Geometry* 48(2): 393-415 (2012).
- Hristo Djidjev. Approximation algorithms for computing minimum exposure paths in a sensor field. *ACM Transactions of Sensor Networks*, vol. 7, no. 3, pp. 1-23, 2010.

## Books and Book Chapters

- G. Chapuis, H. Djidjev, D. Lavenier, R. Andonov, GPU-accelerated shortest paths computations for planar graphs, book chapter, *Advances in GPU Research and Practice*, Elsevier, 2016.
- Hristo Djidjev and Miodrag Potkonjak, Coverage Problems in Sensor Networks, book chapter, *Intelligent Sensor Networks: Across Sensing, Signal Processing, and Machine Learning*, CRC Press, 2012.
- A. Maheshwari, J.R. Sack, and H. Djidjev, Link Distance Problems, book chapter, *Handbook on Computational Geometry*, Elsevier, 2000, pp. 519–558.
- H. Djidjev (ed.), *Optimal Algorithms*, Lecture Notes in Computer Science vol. 401, Springer-Verlag, conference proceedings, 1989.
- V. Aleksandrov, R. Andonov, H. N. Djidjev, V. Josifov, and C.Ostromski, *Mathematical Aspects of VLSI Design*, book, Sofia, 1989 (in Bulgarian).
- A. Andreev, H. N. Djidjev, Bl. Sendov, N. Yanev, *Survey on Parallel Computing*, book, Sofia, 1986 (in Bulgarian).
- R. Lazarov, K. Bojanov, H. N. Djidjev, P. Vassilevsky, L. Aleksandrov, *New Generations High Performance Computing Systems*, book, Sofia, 1986 (in Bulgarian).