

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ACTIVISION BLIZZARD, INC.,
ELECTRONIC ARTS INC.,
TAKE-TWO INTERACTIVE SOFTWARE, INC.,
2K SPORTS, INC., and
ROCKSTAR GAMES, INC.,
Petitioners,

v.

ACCELERATION BAY, LLC,
Patent Owner.

Case No. IPR2016-00747
Patent 6,732,147

**DECLARATION OF MICHAEL GOODRICH, Ph.D. IN SUPPORT OF
PATENT OWNER'S PRELIMINARY RESPONSE TO PETITION**

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I, Michael Goodrich, Ph.D., declare and state as follows:

I. QUALIFICATIONS

1. I make this Declaration based upon my own personal knowledge, information, and belief, and I would and could competently testify to the matters set forth herein if called upon to do so.

2. I received a Bachelor of Arts (“BA”) degree in Mathematics and Computer Science from Calvin College in 1983 and a PhD in Computer Sciences from Purdue University in 1987.

3. I am a Chancellor's Professor in the Department of Computer Science at the University of California, Irvine, where I have been a faculty member since 2001. The Chancellor's Professor title at University of California, Irvine is designed for persons who have earned the title of Professor and who have demonstrated unusual academic merit and whose continued promise for scholarly achievement is unusually high. In addition, I am technical director for the Center for Algorithms and Theory of Computation in the Donald Bren School of Information and Computer Sciences at University of California, Irvine. I was a professor in the Department of Computer Science at Johns Hopkins University from 1987-2001.

4. I have authored or coauthored over 300 publications, including several widely adopted books, such as *Introduction to Computer Security* and *Algorithm*

Design and Applications. My research includes contributions to data structures and algorithms, information security and privacy, networking, graph algorithms, computational geometry, distributed and parallel algorithms, and cloud security. My research is supported by grants from the Defense Advanced Research Projects Agency (DARPA) and the National Science Foundation (NSF).

5. In addition, I have consulting experience in matters involving algorithms, cryptography, machine learning, digital rights management, computer security, networking, software, and storage technologies.

6. I am an ACM Distinguished Scientist, a Fellow of the American Association for the Advancement of Science (AAAS), a Fulbright Scholar, a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), and a Fellow of the Association for Computing Machinery (ACM). I am also a recipient of the IEEE Computer Society Technical Achievement Award and the Pond Award for Excellence in Undergraduate Teaching.

7. Attached hereto as Appendix A is a true and correct copy of my Curriculum Vitae (CV).

8. In developing my opinions below, I have considered the materials cited herein, including the subject Petition and all the exhibits cited therein and identified on Petitioners' Exhibit List. In addition, I have reviewed the documents

cited by Dr. David R. Karger in his declaration to the Petition (Dr. Karger's declaration hereinafter referred to as "Karger Decl").

9. To the extent that I am presented with new information concerning the subject matter of this declaration or affecting any assumptions made herein, I reserve the right to supplement this declaration accordingly.

II. SCOPE OF ASSIGNMENT AND APPROACH

10. I have been retained as an expert on behalf of Patent Owner, Acceleration Bay LLC, ("Acceleration Bay"), to provide information and opinions to the Patent Trial and Appeal Board (hereinafter "the Board") to assist in the determination of whether or not the Board should institute *inter partes* review of one or more claims of Acceleration Bay's U.S. Patent No. 6,732,147 (the "'147 Patent"). Specifically, counsel for Acceleration Bay asked me to provide opinions regarding the validity of claims 1-16 of the '147 Patent in view of certain prior art references cited by Activision Blizzard, Inc., Electronic Arts Inc., Take-Two Interactive Software, Inc., 2K Sports, Inc., and Rockstar Games, Inc. (collectively, "Petitioners"). In my opinion, claims 1-16 of the '147 Patent are valid in light of the prior art and arguments presented in the Petition and the Karger Decl.

11. I have been informed by counsel and I understand that the analysis of whether a patent is anticipated or obvious is performed from the perspective of a person of ordinary skill in the art at the time of the patented inventions. The

relevant timeframe for the challenged claims of the '147 Patent is at least July 2000.

III. APPLICABLE STANDARDS AND CONTROLLING PRINCIPLES

A. Anticipation

12. Counsel has informed me, and I understand, that an issued patent claim is invalid as anticipated if each and every element of that claim is disclosed in a single prior art reference that enables a person of ordinary skill in the art to make the allegedly anticipating subject matter. I understand that to be anticipatory, a reference must enable one of skill in the art to practice an embodiment of the claimed invention without undue experimentation.

13. Counsel has informed me, and I understand, that if a prior art reference does not disclose a given element expressly, it may do so inherently. I have been informed by counsel and I further understand that a prior art reference will inherently anticipate a claimed invention if any claim elements or other information missing from the reference would nonetheless be known by the person of ordinary skill in the art to be necessarily present in the subject matter of the reference.

B. Obviousness

14. Counsel has informed me, and I understand, that an issued patent claim is invalid as obvious if it can be shown that the differences between the patented subject matter and the prior art are such that the subject matter as a whole

would have been obvious, at the time the invention was made, to a person having ordinary skill in the art. Relevant considerations include the level of ordinary skill in the art; the scope and content of the prior art; differences between the prior art and the claims at issue; and the so-called objective secondary factors of nonobviousness.

15. Counsel has informed me, and I understand, that in order to evaluate the obviousness of any claim of the '147 Patent over a given prior art combination, I should analyze whether the prior art references, included collectively in the combination, disclose each and every element of the allegedly invalid claim as those references are read by the person of ordinary skill in the art at the time of the invention. Then I am to determine whether that combination makes the claims of the '147 Patent obvious to the person of ordinary skill in the art by a preponderance of the evidence, at the time of the inventions. I understand that such preponderance of the evidence is satisfied if the proposition is more likely to be true than not true.

16. Counsel has informed me, and I understand, that the obviousness inquiry requires that the prior art be considered in its entirety. I am further informed and I understand that an invention cannot be obvious to try where “the breadth of the[] choices and the numerous combinations indicate that the[] disclosures would not have rendered the claimed invention obvious to try.”

17. Counsel has informed me, and I understand, that even where all of the claim limitations are expressly disclosed in the prior art references, there must be some showing that a person of ordinary skill in the art would have been motivated to combine such prior art references and that there would have been a reasonable expectation of successfully achieving the claimed invention from such combination.

18. Counsel has informed me, and I understand, in considering the obviousness of a claimed invention, one should not view the invention and the prior art with the benefit of hindsight. It is for that reason, I am informed and I understand, that obviousness is assessed by the person of ordinary skill in the art at the time the invention was made. In this regard, I am informed and I understand that the invention cannot be used as a guide to selecting and understanding the prior art. I understand that the appropriate standard is to determine whether a person of skill in the art *would* be motivated to combine references, not whether they *could*.

19. Counsel has informed me, and I understand, that obviousness cannot be predicated on what was unknown at the time of the invention, even if the inherency of a certain feature is later established. Counsel has also informed me, and I understand, that unknown properties of the prior art may not be relied upon

to provide the rationale for modifying or combining the prior art to reach the claimed subject matter.

20. Counsel has informed me, and I understand, that a reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, or would be led in a direction divergent from the path that was taken by the applicant.

21. Counsel has informed me, and I understand, that the “time of invention” applicable to the inventions of claims 1-16 the ‘147 Patent is no later than July 31, 2000, which I understand to be the priority date on the face of the ‘147 Patent.

C. Person Of Ordinary Skill In The Art

22. Counsel has informed me, and I understand, that the “person of ordinary skill in the art” (“POSITA”) is a hypothetical person who is presumed to be familiar with the relevant scientific field and its literature at the time of the invention. This hypothetical person is also a person of ordinary creativity capable of understanding the scientific principles applicable to the pertinent field.

23. I am informed by counsel and I understand that the level of ordinary skill in the art may be determined by reference to certain factors, including (1) the type of problems encountered in the art, (2) prior art solutions to those problems, (3) the rapidity with which innovations are made, (4) the sophistication of the

technology, and (5) the educational level of active workers in the field. I further understand that the face of the '147 Patent claims a priority date of July 31, 2000.

24. It is my opinion that the person of ordinary skill in the art in the field of the '147 Patent would have been someone with a bachelor's degree in computer science or related field, and either (1) two or more years of industry experience and/or (2) an advanced degree in computer science or related field.

25. Based on my training and experience, I believe that I am (and was as of July 2000) a person of greater than ordinary skill in the relevant art, which permits me to give an opinion about the qualifications of one of ordinary skill at the time of the invention.

26. I note that Dr. Karger's opinion on a person of ordinary skill in the art in his declaration is:

In my opinion, a POSITA at the time of the alleged inventions claimed by the '147 and '069 patents would have a minimum of: (i) a bachelor's degree in computer science, computer engineering, applied mathematics, or a related field of study; and (ii) four or more years of industry experience relating to networking protocols and network topologies. Additional graduate education could substitute for professional experience, or significant experience in the field could substitute for formal education.

Karger Decl. at ¶ 19.

27. My opinions stated in this declaration would be the same if rendered from the perspective of a person of ordinary skill in the art set out by Dr. Karger.

IV. THERE IS NO MOTIVATION TO COMBINE SHOUBRIDGE AND DENES AND RUFINO

28. A POSITA would not be motivated to combine Peter J. Shoubridge et al., *Hybrid Routing in Dynamic Networks*, IEEE International Conference on Communications (Ex. 1005, “Shoubridge”); Tamás Denes, *The “Evolution” of Regular Graphs of Even Order by their Vertices*, Matematikai Lapok, 27, 3–4 (Ex. 1016, “Denes”); and Jose Rufino et al., *A Study on the Inaccessibility Characteristics of ISO 8802/4 Token-Bus LANs*, IEEE INFOCOM ’92: The Conference on Computer Communications (Ex. 1011, “Rufino”).

29. In my opinion, a POSITA would not be motivated to combine Shoubridge with Denes and Rufino because they “address the problem of dynamic networks” and “the problem of maintaining a non-complete regular topology.” Petition at 17-19; Karger Decl. at ¶¶ 119-127.

30. I disagree with Petitioners and Dr. Karger’s assessment. As an initial matter, Shoubridge discloses a hybrid routing algorithm using a simulation model, not a real dynamic network. Shoubridge at 1381. Shoubridge creates a 64-node network simulations that has been wrapped around itself to remove real world “edge effects.” Shoubridge at 1383. Shoubridge’s “dynamic network” simulates

changes that “are evenly distributed across all links.” Shoubridge at 1383. In my opinion, a POSITA would not have not have been motivated to combine Shoubridge with Denes and Rufino because neither Denes or Rufino provide any basis to improve the hybrid routing algorithm, which is the essence of Shoubridge, or to his simulation. Petitioners argue that Denes discloses a mathematical principal to remove a node from a network. Petition at 18. Even if true, it is irrelevant. Shoubridge discloses his method of simulating a network node change by adjusting the link costs. Shoubridge at 1383 (“To reflect some stochastic behaviour in the simulation model, link cost change events are scheduled with event times derived from two negative exponential probability distributions.”). A POSITA would not have sought to add the teachings of Denes in Shoubridge because the simulation of a dynamic network was sufficient for its intended purpose, to test a specific hybrid routing algorithm. Moreover, Shoubridge’s simulation of a dynamic network was based on simulating the links, not adding or removal of nodes. Similarly, a POSITA would not have sought to add Rufino into the mix because there were no actual nodes to remove nor does Rufino relate to the overall simulation or the hybrid routing algorithm. Rather Rufino relates to token rings.

31. One of skill in the art at the time understood that token rings are not a “broadcast medium, but a collection of individual point to point links that happen

to form a circle.” Ex. 2002, Tanenbaum at 292 (explaining how one of the many attractive features of ring networks “is the fact that a ring is not really a broadcast medium, but a collection of individual point to point links that happen to form a circle.”). In contrast to the claimed computers of the “broadcast channel,” more than one station of the token ring cannot send messages (e.g. disconnect or connection port messages). Rather token rings rely on token passing where only one station can transmit at a given instant, namely because there is only one token. Rufino at 0959 (“Access control is performed by a token passing protocol, which establishes a logical ring over the physical bus. Access to the shared broadcast medium for data transmission is only granted to the station which currently holds the token.”); *see also* Ex. 2002, Tanenbaum at 293 (“When a station wants to transmit a frame, it is required to seize the token and remove it from the ring before transmitting... Because there is only one token, only one station can transmit at a given instant...”). As such, Rufino is discussing a token-passing bus that is essentially a wire that each station is holding on to, if one station puts electricity on this wire, the rest of the stations in the ring feel the jolt. If one station in the ring has the "token" and is sending a message on this wire, the rest of the stations in the ring all get it immediately. The token-ring part is just so that we can perform computations that require that we "take turns" by moving an imaginary token around a "ring." For example, what if ten of us around a ring have ten numbers we

want to add up? The token ring part is a great way to do this, using a traveling message that stores a partial sum. On the other hand, no POSITA would use the teachings of the prior art to make the claimed system as the prior art teaches that it is “not really a broadcast medium.” Ex. 2002, Tanenbaum at 292 (“Among their many attractive features is the fact that a ring is not really a broadcast medium, but a collection of individual point to point links that happen to form a circle.”).

32. Moreover, Rufino, teaches away from the specialized point-to-point graphs solutions proposed by Shoubridge and Denes by stating because these solutions are “costly and complex.” See Rufino at 0958 (criticizing specialized graph solutions such as “costly and complex.”) Thus, these three systems operate in fundamentally different ways that would completely redesign Rufino’s system to be contrary to its stated goals. Therefore, Shoubridge in view of Denes and Rufino do not disclose all elements of claims 1-16 of the ‘147 Patent and, in any case, there is no motivation to combine the references in the manner claimed.

V. THERE IS NO MOTIVATION TO COMBINE SHOUBRIDGE AND DENES AND RUFINO AND HIRVINIEMI OR BALPH OR TODD

33. A POSITA would not be motivated to combine Shoubridge with Denes and Rufino as discussed above. I understand that Petitioners have identified several other references in combination and Shoubridge with Denes and Rufino. A POSITA would not have been motivated to combine Shoubridge with Denes and

Rufino with either Hirviniemi *et al.*, U.S. Patent No. 5,802,285 (Ex. 1021, “Hirviniemi”), Balph *et al.*, U.S. Patent No. 4,700,185 (Ex. 1022, “Balph”), or T. Todd, *The Token Grid Network*, IEEE/ACM Transactions on Networking, 2.3, 279–287 (Ex. 1019, “Todd”).

34. Petitioners argue that it would have been obvious to a person of ordinary skill in the art to implement the teachings of Hirvineimi to Shoubridge, Denes and Rufino, solely on the basis that a POSITA would have been motivated to include the “Internet” and “TCP/IP” communications. Petition at 55-56. I disagree. Shoubridge is about a routing algorithm related mobile radio communications. Shoubridge at 1381. The authors, Drs. Shoubridge and Dadej, are both in the field of telecommunications based on the contact information in Shoubridge. The Shoubridge paper appears to be from 1997. In my opinion they would have known about the Internet and TCP/IP networks. Shoubridge specifically does not talk about the Internet and TCP/IP networks because it is about a hybrid routing algorithm for communications on a mobile radio network such as X.25. Thus, a POSITA would not have been motivated to apply Shoubridge to TCP/IP network because the goal and purpose was for a different system.

35. For Ground 4, Petitioner proposes adding a fourth reference (Todd) to the proposed combination to cure the previously noted deficiencies of Rufino,

namely modifying Rufino “from a 2-regular topology to a 4-regular topology.”

Petition at 58. But Todd suffers from the same deficiencies as Rufino. In particular, Rufino, does not disclose disconnecting from a m -regular graph where m is at least 3. At most, Petitioner asserts that Rufino’s token ring is two-connected not “ m -regular graph where m is at least 3.” Petition at 24 (“Rufino discloses broadcasting messages on the broadcast channel to maintain a 2-regular graph.”). Similarly, Todd makes clear that “each station is two-connected” in the resulting token grid system proposed by Todd. Todd at 1 (“In this paper, a token grid network is introduced where media access is performed over a two-dimensional mesh. In the resulting system, each station is two-connected and has the same transmission hardware and small station latency as in a dual token ring.”). Thus, Todd’s token grid network does not cure Rufino’s failure to disclose disconnecting from a “ m -regular graph where m is at least 3.”

36. Just like Rufino, Todd also makes clear that its token grid network relies on token rings, including “the same transmission hardware and small station latency as in a dual token ring.” Todd at 1. As described above, one of skill in the art at the time understood that token rings are not a “broadcast medium, but a collection of individual point to point links that happen to form a circle.” Ex. 2002, Tanenbaum at 292 (explaining how one of the many attractive features of

ring networks “is the fact that a ring is not really a broadcast medium, but a collection of individual point to point links that happen to form a circle.”).

37. In contrast to the claimed computers of the “broadcast channel,” more than one station of the token ring cannot send messages (e.g. disconnect or connection port messages). Rather token rings rely on token passing where only one station can transmit at a given instant, namely because there is only one token. Rufino at 0959 (“Access control is performed by a token passing protocol, which establishes a logical ring over the physical bus. Access to the shared broadcast medium for data transmission is only granted to the station which currently holds the token.”); *see also* Ex. 2002, Tanenbaum at 293 (“When a station wants to transmit a frame, it is required to seize the token and remove it from the ring before transmitting... Because there is only one token, only one station can transmit at a given instant...”). Thus, Todd fails to cure the previously noted deficiencies of Rufino because Todd relies on token rings and thus suffers from the same deficiencies as Rufino.

38. Furthermore, I disagree with Petitioner’s statement that a POSITA would be motivated to modify Rufino because it “can be done in ‘very simple fashion’ by overlapping token rings.” Petition at 60. To the contrary, modifying Rufino to apply Todd would be very complex. Here, Petitioner takes the quote “very simple fashion” out of context, as Todd only states that “[c]ouplings between

the rings are implemented by the user stations in a very simple fashion and under token control.” Todd at 1. In order for transmissions to occur using these multiple LANs, Todd requires a convoluted Token Grid Protocol as shown below:

PROTOCOL 1: BASIC TOKEN GRID PROTOCOL	
<u>Column Token j Arrives To Station (i, j):</u>	
1.	Capture the token.
2.	If a packet is available, transmit onto Column Ring j .
3.	Hold Column Token j . Wait for Row Token i .
4.	Done.
<u>Row Token i Arrives To Station (i, j):</u>	
1.	Capture the token if a packet is available for Row Ring i or if Column Token j is being held.
2.	Transmit onto Row Ring i if a packet is available.
3.	If the station is not holding Column Token j then release Row Token i and go to 5.
4.	Enter the SR state. Generate and release Row/Column Token i, j .
5.	Done.
<u>Row/Column Token i, j Arrives To Station (i, k):</u>	
1.	Capture the token if a packet is available for Row/Column Ring i, j or if $k = j$.
2.	If a packet is available then transmit onto Row/Column Ring i, j .
3.	If $k \neq j$ then release the token and go to 5.
4.	Generate and release Column/Row Token i, j .
5.	Done.
<u>Column/Row Token i, j Arrives To Station (k, j):</u>	
1.	Capture the token if a packet is available for Column/Row Ring i, j or if $k = i$.
2.	If a packet is available then transmit onto Column/Row Ring i, j .
3.	If $k \neq i$ then release the token and go to 5.
4.	Enter the DR state. Regenerate and release Column Token j and Row Token i .
5.	Done.

See Todd at 3 (Protocol 1); *see also* Todd at 3 (“Transmission to a station on a different row and column can only be accomplished when a ring merge has occurred...A formal description of the basic algorithm is shown in Protocol 1.”) Requiring such a complex protocol is contrary to the goal of Rufino. In fact, Rufino, teaches away from such specialized solutions using multiple LANs because these solutions are “costly and complex.” See Rufino at 0958 (discussing specialized solutions such as “point-to-point graphs [6] or multiple LANs [7]. These solutions are however costly and complex.” Thus, both systems operate in fundamentally different ways that would completely redesign Rufino’s system to

be contrary to its stated goals. Therefore, Shoubridge in view of Denes, Rufino and Todd do not disclose all elements of claims 1-16 of the '147 Patent and, in any case, a POSITA would not have been motivated to combine the references in the manner claimed.

DECLARATION

I declare that all statements made herein on my own knowledge are true and that all statements made on information and belief are believed to be true, and further, that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Executed in Irvine, California on this 26th day of June, 2016.



Michael Goodrich, Ph.D.

APPENDIX A

CURRICULUM VITAE

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CITIZENSHIP: U.S.A.

EDUCATION

Ph.D.	1987	<i>Efficient Parallel Techniques for Computational Geometry</i> Computer Sciences, Purdue Univ. (M.J. Atallah, advisor)
M.S.	1985	Computer Sciences, Purdue Univ.
B.A.	1983	Mathematics and Computer Science, Calvin College

PROFESSIONAL EXPERIENCE

April '07 to present	Chancellor's Professor, Dept. of Computer Science Univ. of California, Irvine
July '12 to June '13	Chair, Dept. of Computer Science Univ. of California, Irvine
October '06 to June '12	Assoc. Dean for Faculty Dev., Bren School of Info. and Comp. Sci. Univ. of California, Irvine
July '01 to March '07	Professor, Dept. of Computer Science Univ. of California, Irvine
Fall '00	Visiting Professor of Computer Science Brown Univ.
July '96 to June '02	Professor of Computer Science (on leave, from July '01) Johns Hopkins Univ.
July '92 to June '96	Associate Professor of Computer Science Johns Hopkins Univ.
Spring '94	Visiting Associate Professor of Computer Science Univ. of Illinois, Urbana-Champaign
July '87 to June '92	Assistant Professor of Computer Science Johns Hopkins Univ.

RESEARCH INTERESTS

Algorithm and Data Structure Design
Information Assurance and Security
Parallel and Distributed Computing
Graph and Geometric Algorithms

HONORS AND AWARDS

- *Compere Loveless Fellowship in Computer Sciences*, Purdue Univ., 1985
- *Research Initiation Award*, National Science Foundation, 1988
- *Oraculum Award for Excellence in Teaching*, Johns Hopkins, 1993, 1994, 1995
- *ACM Recognition of Service Award*, 1996
- *Robert B. Pond, Sr. Award for Excellence in Undergraduate Teaching*, Johns Hopkins, 1998
- *Elected Senior Member*, the Institute of Electrical and Electronics Engineers (IEEE), 1999
- *Spirit of Technology Transition Award*, DARPA Dynamic Coalitions Program, 2002

- *Brown Univ. Award for Technological Innovation* (with R. Tamassia, N. Triandopoulos, D. Yao, and D. Ellis), 2006
- *ACM Distinguished Scientist*, 2006
- *2006 IEEE Computer Society Technical Achievement Award*, “for outstanding contributions to the design of parallel and distributed algorithms for fundamental combinatorial and geometric problems”
- *Fulbright Scholar*, 2007, for senior specialist service to University of Aarhus, Denmark
- *Fellow of the San Diego Supercomputer Center*, 2007
- *Fellow of the American Association for the Advancement of Science (AAAS)*, “for distinguished contributions to parallel and distributed algorithms for combinatorial and geometric problems, and excellence in teaching, academic and professional service, and textbook writing,” 2007
- *Fellow of the Institute of Electrical and Electronics Engineers (IEEE)*, “for contributions to parallel and distributed algorithms for combinatorial and geometric problems,” 2009
- *Fellow of the ACM*, “for contributions to data structures and algorithms for combinatorial and geometric problems,” 2009
- *ICS Dean’s Award for Research*, “for his contributions in the area of parallel and distributed algorithms,” 2014
- *Chancellor’s Award for Excellence in Fostering Undergraduate Research*, Univ. of California, Irvine, 2016

PUBLICATIONS

Patents and Patent Applications:

- P-1. G. Ateniese, B. de Medeiros, and M.T. Goodrich, “Intermediated Delivery Scheme for Asymmetric Fair Exchange of Electronic Items,” U.S. Patent Application US 2004/0073790 A1, April 15, 2004.
- P-2. M.T. Goodrich and R. Tamassia, “Efficient Authenticated Dictionaries with Skip Lists and Commutative Hashing,” U.S. Patent 7,257,711, August 14, 2007.
- P-3. J.W. Green, J.L. Schultz, Y. Amir, and M.T. Goodrich, “High Refresh-Rate Retrieval of Freshly Published Content using Distributed Crawling,” U.S. Patent 7,299,219, November 20, 2007.
- P-4. R. Tamstorf, M.T. Goodrich, D. Eppstein, “Attribute Transfer Between Computer Models Including Identifying Isomorphic Regions in Polygonal Meshes,” U.S. Patent 8,681,145, March 25, 2014. (also Application US 2010/0238166 A1, September 23, 2010).
- P-5. N. Triandopoulos, M.T. Goodrich, D. Nguyen, O. Ohrimenko, C. Papamanthou, R. Tamassia, C.V. Lopes, “Techniques for Verifying Search Results Over a Distributed Collection,” U.S. Patent, 9,152,716, October 6, 2015.

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- B-1. M.T. Goodrich and R. Tamassia, *Data Structures and Algorithms in Java*, John Wiley and Sons, Inc., 1998.
- B-2. M.T. Goodrich and C.C. McGeoch, eds., *Algorithm Engineering and Experimentation*, Lecture Notes in Computer Science (LNCS), Vol. 1619, Springer-Verlag, 1999.
- B-3. M.T. Goodrich and R. Tamassia, *Data Structures and Algorithms in Java, Second Edition*, John Wiley and Sons, Inc., 2001.

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- B-5. M.T. Goodrich and S.G. Kobourov, eds., *10th International Symposium on Graph Drawing (GD)*, Lecture Notes in Computer Science, Vol. 2528, Springer-Verlag, 2002.
- B-6. M.T. Goodrich, R. Tamassia, and D. Mount, *Data Structures and Algorithms in C++*, John Wiley and Sons, Inc., 2004.
- B-7. M.T. Goodrich and R. Tamassia, *Data Structures and Algorithms in Java, Third Edition*, John Wiley and Sons, Inc., 2004.
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- B-9. M.T. Goodrich and R. Tamassia, *Data Structures and Algorithms in Java, Fifth Edition*, John Wiley and Sons, Inc., 2011.
- B-10. M.T. Goodrich and R. Tamassia, *Introduction to Computer Security*, Addison-Wesley, Inc., 2011.
- B-11. M.T. Goodrich, R. Tamassia, and D. Mount, *Data Structures and Algorithms in C++*, *Second Edition*, John Wiley and Sons, Inc., 2011.
- B-12. M.T. Goodrich, R. Tamassia, and M. Goldwasser, *Data Structures and Algorithms in Python*, John Wiley and Sons, Inc., 2013.
- B-13. M.T. Goodrich, R. Tamassia, and M. Goldwasser, *Data Structures and Algorithms in Java*, *Sixth Edition*, John Wiley and Sons, Inc., 2014.
- B-14. M.T. Goodrich and R. Tamassia, *Algorithm Design and Applications*, Wiley, 2015.

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- Ch-1. M.J. Atallah and M.T. Goodrich, “Deterministic Parallel Computational Geometry,” in *Synthesis of Parallel Algorithms*, J.H. Reif, ed., Morgan Kaufmann, 497–536, 1993.
- Ch-2. M.T. Goodrich, “The Grand Challenges of Geometric Computing,” in *Developing a Computer Science Agenda for High-Performance Computing*, U. Vishkin, ed., ACM Press, 64–68, 1994.
- Ch-3. M.T. Goodrich, “Parallel Algorithms in Geometry,” *CRC Handbook of Discrete and Computational Geometry*, J.E. Goodman and J. O’Rourke, eds., CRC Press, Inc., 669–682, 1997.
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- C-139. G. Wang, T. Luo, M.T. Goodrich, W. Du, and Z. Zhu, “Bureaucratic Protocols for Secure Two-Party Sorting, Selection, and Permuting,” *5th ACM Symposium on Information, Computer and Communications Security*, 2010, 226–237.
- C-140. M.T. Dickerson, M.T. Goodrich, and T.D. Dickerson, “Round-Trip Voronoi Diagrams and Doubling Density in Geographic Networks,” *7th Int. Symp. on Voronoi Diagrams in Science and Engineering (ISVD)*, IEEE Press, 132–141, 2010. (Preliminary version of J-74.)
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- C-144. C.A. Duncan, D. Eppstein, M.T. Goodrich, S. Kobourov, and M. Nöllenburg, “Drawing Trees with Perfect Angular Resolution and Polynomial Area,” *Proc. 18th Int. Symp. on Graph Drawing (GD)*, LNCS, vol. 6502, 2010, 183–194. (Preliminary version of J-82.)
- C-145. A.U. Asuncion and M.T. Goodrich, “Turning Privacy Leaks into Floods: Surreptitious Discovery of Social Network Friendships and Other Sensitive Binary Attribute Vectors,” *Proc. Workshop on Privacy in the Electronic Society (WPES)*, held in conjunction with the 17th ACM Conference on Computer and Communications Security (CCS), 2010, 21–30. (Preliminary version of J-81.)
- C-146. D. Eppstein, M.T. Goodrich, D. Strash, and L. Trott, “Extended Dynamic Subgraph Statistics Using h-Index Parameterized Data Structures,” *4th Annual International Conference on Combinatorial Optimization and Applications (COCO)*, LNCS, vol. 6508, 2010, 128–141. (Preliminary version of J-79.)
- C-147. M.T. Goodrich and D. Strash, “Priority Range Trees,” *Proc. 21st International Symposium on Algorithms and Computation (ISAAC)*, LNCS, vol. 6506, 2010, 97–108.
- C-148. D. Eppstein, M.T. Goodrich, R. Tamassia, “Privacy-Preserving Data-Oblivious Geometric Algorithms for Geographic Data,” *Proc. 18th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (ACM GIS)*, 2010, 13–22.
- C-149. M.T. Goodrich, “Spin-the-bottle Sort and Annealing Sort: Oblivious Sorting via Round-robin Random Comparisons,” *8th annual Workshop on Analytic Algorithmics and Combinatorics (ANALCO)*, in conjunction with the ACM-SIAM Symposium on Discrete Algorithms (SODA), 2011. (Preliminary version of J-85.)
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- C-151. M.T. Goodrich, “Data-Oblivious External-Memory Algorithms for the Compaction, Selection, and Sorting of Outsourced Data,” *23rd ACM Symposium on Parallelism in Algorithms*

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- C-154. D. Eppstein, M.T. Goodrich, and M. Löffler, “Tracking Moving Objects with Few Handovers,” *Algorithms and Data Structures Symposium* (formerly WADS), 362–373, LNCS, vol. 6844, 2011.
- C-155. M.T. Goodrich and M. Mitzenmacher, “Privacy-Preserving Access of Outsourced Data via Oblivious RAM Simulation,” *38th International Colloquium on Automata, Languages and Programming (ICALP)*, LNCS, vol. 6756, 2011, 576–587.
- C-156. M.T. Goodrich and P. Pszona, “External-Memory Network Analysis Algorithms for Naturally Sparse Graphs,” *European Symposium on Algorithms (ESA)*, LNCS, vol. 6942, 664–676, 2011.
- C-157. C. Duncan, D. Eppstein, M.T. Goodrich, S.G. Kobourov and M. Löffler, “Planar and Poly-Arc Lombardi Drawings,” *Int. Symp. Graph Drawing (GD)*, LNCS, vol. 7034, 308–319, 2011.
- C-158. R. Chernobelskiy, K. Cunningham, M.T. Goodrich, S.G. Kobourov and L. Trott, “Force-Directed Lombardi-Style Graph Drawing,” *Int. Symp. Graph Drawing (GD)*, LNCS, vol. 7034, 320–331, 2011.
- C-159. M.T. Goodrich and M. Mitzenmacher, “Invertible Bloom Lookup Tables,” *49th Allerton Conference on Communication, Control, and Computing*, IEEE Press, **invited paper**, 2011.
- C-160. M.T. Goodrich, M. Mitzenmacher, O. Ohrimenko, and R. Tamassia, “Oblivious RAM Simulation with Efficient Worst-Case Access Overhead,” *ACM Cloud Computing Security Workshop (CCSW)*, in conjunction with the 17th ACM Conf. on Computer and Communications Security (CCS), 95–100, 2011.
- C-161. M.T. Goodrich and J.A. Simons, “Fully Retroactive Approximate Range and Nearest Neighbor Searching,” *22nd International Symposium on Algorithms and Computation (ISAAC)*, Springer, LNCS, vol. 7074, 292–301, 2011.
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- C-164. D. Eppstein, M.T. Goodrich, M. Löffler, D. Strash and L. Trott, “Category-Based Routing in Social Networks: Membership Dimension and the Small-World Phenomenon,” *IEEE Int. Conf. on Computational Aspects of Social Networks (CASoN)*, 102–107, 2011. (Preliminary version of J-84.)
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- C-166. M.T. Goodrich, O. Ohrimenko, M. Mitzenmacher, and R. Tamassia, “Practical Oblivious Storage,” *2nd ACM Conf. on Data and Application Security and Privacy (CODASPY)*, 13–24, 2012.

- C-167. M.T. Goodrich and M. Mitzenmacher, “Anonymous Card Shuffling and its Applications to Parallel Mixnets,” 39th International Colloquium on Automata, Languages and Programming (ICALP), Springer, LNCS, vol. 6756, 576–587, 2012.
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- C-173. D. Eppstein, M.T. Goodrich, and D.S. Hirschberg, “Combinatorial Pair Testing: Distinguishing Workers from Slackers,” Algorithms and Data Structures Symposium, Springer, LNCS, vol. 8037, 316–327, 2013.
- C-174. D. Eppstein, M.T. Goodrich, and J.A. Simons, “Set-Difference Range Queries,” 25th Canadian Conference on Computational Geometry (CCCG), 2013, <http://www.cccg.ca/proceedings/2013/>.
- C-175. M.T. Goodrich and P. Pszona, “Cole’s Parametric Search Technique Made Practical,” 25th Canadian Conference on Computational Geometry (CCCG), 2013, <http://www.cccg.ca/proceedings/2013/>.
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- C-177. M.T. Goodrich and P. Pszona, “Achieving Good Angular Resolution in 3D Arc Diagrams,” Int. Symp. Graph Drawing (GD), Springer, LNCS, vol. 8242, 161–172, 2013.
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- C-180. D. Eppstein, M.T. Goodrich, M. Mitzenmacher, and P. Pszona, “Wear Minimization for Cuckoo Hashing: How Not to Throw a Lot of Eggs into One Basket,” Symposium on Experimental Algorithms (SEA), Springer, LNCS, vol. 8504, 162–173, 2014.
- C-181. O. Ohrimenko, M.T. Goodrich, and R. Tamassia, and E. Upfal, “The Melbourne Shuffle: Improving Oblivious Storage in the Cloud,” 41st International Colloquium on Automata, Languages, and Programming (ICALP), Springer, LNCS, vol. 8573, 556–567, 2014.
- C-182. M.J. Bannister, W.E. Devanny, M.T. Goodrich, J.A. Simons, and Lowell Trott, “Windows into Geometric Events: Data Structures for Time-Windowed Querying of Temporal Point

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- C-183. M.J. Bannister, W.E. Devanny, D. Eppstein and M.T. Goodrich, “The Galois Complexity of Graph Drawing: Why Numerical Solutions are Ubiquitous for Force-Directed, Spectral, and Circle Packing Drawings,” *Int. Symp. Graph Drawing (GD)*, Springer, LNCS, vol. 8871, 149–161, 2014. (Preliminary version of J-86.)
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- C-189. E. Ghosh, M.T. Goodrich, O. Ohrimenko, and R. Tamassia, “Poster: Zero-Knowledge Authenticated Order Queries and Applications,” *IEEE Symp. on Security and Privacy*, 2015. (See also <https://eprint.iacr.org/2015/283>.)
- C-190. M.T. Goodrich and A. Eldawy, “Parallel Algorithms for Summing Floating-Point Numbers,” 28th ACM Symp. on Parallel Algorithms and Architectures (SPAA), 2016.
- C-191. W.E. Devanny, M.T. Goodrich, and K. Jetviroj, “Parallel Equivalence Class Sorting: Algorithms, Lower Bounds, and Distribution-Based Analysis,” 28th ACM Symp. on Parallel Algorithms and Architectures (SPAA), 2016.
- C-192. D. Eppstein, M.T. Goodrich, J. Lam, N. Mamano, M. Mitzenmacher, and M. Torres, “Models and Algorithms for Graph Watermarking,” 19th Information Security Conference (ISC), 2016.

Other Publications:

- O-1. M.T. Goodrich, “Guest Editor’s Introduction,” *International Journal of Computational Geometry & Applications*, **2**(2), 1992, 113–116.
- O-2. M.T. Goodrich, “Parallel Algorithms Column 1: Models of Computation,” *SIGACT News*, **24**(4), 1993, 16–21.
- O-3. M.T. Goodrich, V. Mirelli, M. Orletsky, and J. Salowe, “Decision tree construction in fixed dimensions: Being global is hard but local greed is good,” Technical Report TR-95-1, Johns Hopkins University, Department of Computer Science, Baltimore, MD 21218, May 1995.
- O-4. R. Tamassia, P.K. Agarwal, N. Amato, D.Z. Chen, D. Dobkin, R.L.S. Drysdale, S. Fortune, M.T. Goodrich, J. Hershberger, J. O’Rourke, F.P. Preparata, J.-R. Sack, S. Suri, I.G. Tollis, J.S. Vitter, and S. Whitesides, “Strategic Directions in Computational Geometry Working Group Report,” *ACM Computing Surveys*, **28A**(4), December 1996.
- O-5. G.A. Gibson, J.S. Vitter, and J. Wilkes, A. Choudhary, P. Corbett, T.H. Cormen, C.S. Ellis, M.T. Goodrich, P. Highnam, D. Kotz, K. Li, R. Muntz, J. Pasquale, M. Satyanarayanan,

- D.E. Vengroff, “Report of the Working Group on Storage I/O Issues in Large-Scale Computing,” *ACM Computing Surveys*, **28A**(4), December 1996.
- O-6. T.H. Cormen and M.T. Goodrich, “A Bridging Model for Parallel Computation, Communication, and I/O,” *ACM Computing Surveys*, **28A**(4), December 1996.
- O-7. M.T. Goodrich, “Computer Science Issues in the National Virtual Observatory,” in *Virtual Observatories of the Future*, ASP Conference Series, vol. 225, R.J. Brunner, S.G. Djorgovski, and A.S. Szalay, eds., 329–332, 2001.
- O-8. M.T. Dickerson and M.T. Goodrich, “Matching Points to a Convex Polygonal Boundary,” Proceedings of the 13th Canadian Conference on Computational Geometry (CCCG’01), 89–92, 2001.
- O-9. M.T. Goodrich, “Guest Editor’s Foreword,” *Algorithmica*, **33**(3), 271, 2002.
- O-10. M.T. Goodrich, M. Shin, C.D. Straub, and R. Tamassia, “Distributed Data Authentication (System Demonstration),” Proc. DARPA Information Survivability Conference and Exposition, IEEE Press, Volume 2, 58–59, 2003.
- O-11. M.T. Goodrich and R. Tamassia, “Efficient and Scalable Infrastructure Support for Dynamic Coalitions,” Proc. DARPA Information Survivability Conference and Exposition, IEEE Press, Volume 2, 246–251, 2003.
- O-12. M.T. Goodrich, “Simulating Parallel Algorithms in the MapReduce Framework with Applications to Parallel Computational Geometry,” Second Workshop on Massive Data Algorithmics (MASSIVE), 2010.

PROFESSIONAL SERVICE

Guest Editor:

Int. Journal of Computational Geometry & Applications, **2**(2), 1992
Journal of Computer & System Sciences, **52**(1), 1996
Computational Geometry: Theory and Applications, **12**(1–2), 1999.
Algorithmica, **33**(3), 2002.

Editorial Board Membership:

Computational Geometry: Theory and Applications, 2006–2015
Journal of Computer & System Sciences, 1994–2011
Journal of Graph Algorithms and Applications, 1996–2011
Int. Journal of Computational Geometry & Applications, 1993–2010
Information Processing Letters, 1995–1997

Journal Advisory Board Membership:

Int. Journal of Computational Geometry & Applications, 2010–
Journal of Graph Algorithms and Applications, 2011–

Program Committee Service:

7th ACM Symp. on Computational Geometry (SCG), 1991
 1991 Workshop on Algorithms and Data Structures (WADS)
 8th ACM Symp. on Computational Geometry (SCG), 1992
 25th ACM Symp. on Theory of Computing (STOC), 1993
Chair, 26th ACM Symp. on Theory of Computing (STOC), 1994
 11th ACM Symp. on Computational Geometry (SCG), 1995

DAGS '95 Conf. on Electronic Publishing and the Information Superhighway
 1996 SIAM Discrete Mathematics Conference
 1997 Workshop on Algorithms and Data Structures (WADS)
 International Symposium on Graph Drawing (GD), 1997
 1999 Workshop on Algorithms and Data Structures (WADS)
Co-chair, Workshop on Algorithm Engineering and Experimentation (ALENEX), 1999
 International Symposium on Graph Drawing (GD), 2000
 2000 Workshop on Algorithm Engineering (WAE)
 41st IEEE Symp. on Foundations of Computer Science (FOCS), 2000
 2001 Workshop on Algorithms and Data Structures (WADS)
 International Symposium on Graph Drawing (GD), 2001
 Workshop on Algorithm Engineering and Experimentation (ALENEX), 2002
 18th ACM Symp. on Computational Geometry (SCG), 2002
 13th ACM-SIAM Symp. on Discrete Algorithms (SODA), 2002
Co-Chair, Graph Drawing 2002
 International Symposium on Graph Drawing (GD), 2003
 16th ACM-SIAM Symp. on Discrete Algorithms (SODA), 2005
 32nd Int. Colloq. on Automata, Languages and Programming (ICALP), 2005
 12th Int. Computing and Combinatorics Conference (COCOON), 2006
 13th ACM Conf. on Computer and Communication Security (CCS), 2006
 15th Annual European Symposium on Algorithms (ESA), 2007
 5th International Conference on Applied Cryptography and Network Security (ACNS), 2007
 21st IEEE International Parallel & Distributed Processing Symposium (IPDPS), 2007
 19th ACM Symposium on Parallelism in Algorithms and Architectures (SPAA), 2007
 5th Workshop on Algorithms and Models for the Web-Graph (WAW), 2007
 7th International Workshop on Experimental Algorithms (WEA), 2008
 Second International Frontiers of Algorithmics Workshop (FAW), 2008
 16th ACM Int. Symp. on Advances in Geographic Information Systems (ACM GIS), 2008
 17th ACM Int. Symp. on Advances in Geographic Information Systems (ACM GIS), 2009
 31st IEEE Symposium on Security and Privacy (SSP), 2010
 18th Int. Symp. on Graph Drawing (GD), 2010
 2011 Workshop on Analytic Algorithmics and Combinatorics (ANALCO)
 8th Workshop on Algorithms and Models for the Web Graph (WAW), 2011
 19th International Symposium on Graph Drawing (GD), 2011
 24th ACM Symposium on Parallelism in Algorithms and Architectures (SPAA), 2012
 20th European Symposium on Algorithms (ESA), 2012
 2013 IEEE Int. Conf. on Big Data (BigData), 2013
 30th IEEE Int. Conf. on Data Engineering (ICDE), 2014
 21st ACM Conf. on Computer and Communication Security (CCS), 2014
 Symposium on Algorithms and Data Structures (WADS), 2015
 ACM Cloud Computing Security Workshop (CCSW), 2015
 International Symposium on Graph Drawing (GD), 2015
co-chair, 2016 Workshop on Algorithm Engineering and Experiments (ALENEX)
 2016 Workshop on Massive Data Algorithmics (MASSIVE)
 2016 Int. Symposium on Algorithms and Computation (ISAAC)

Conference Committee Service:

Conference chair, 12th ACM Symposium on Computational Geometry, 1996
 Organizer, 1st CGC Workshop on Computational Geometry, 1996
 Co-chair, 1999 Dagstuhl Workshop on Computational Geometry, 1999

Conference chair, Graph Drawing 2002

Steering Committee and Executive Committee Service:

Member at large, ACM SIG on Algorithms & Comp. Theory (SIGACT) Exec. Comm., 1993–97

Member, Exec. comm. for 1996 Federated Computing Research Conference (FCRC)

co-Founder and member, Steering Comm. for Workshop on Algorithm Engineering
and Experimentation (ALENEX), 1999– (chair since 2014)

co-Chair, Steering Comm. for ACM Symposium on Computational Geometry, 1999–2001

Member, Steering Comm. for Graph Drawing Conference, 2000–2003, 2014–

Conference Chair, ACM SIG on Algorithms & Comp. Theory (SIGACT), 2005–2009

Review Panelist:

National Science Foundation, 2000–2013

Ph.D. Advisees:

Mujtaba Ghouse	“Randomized Parallel Computational Geometry in Theory and Practice,” May 1993.
Paul Tanenbaum	“On Geometric Representations of Partially Ordered Sets,” May 1995 (co-advised with Prof. Edward Scheinerman).
Mark Orletsky	“Practical Methods for Geometric Searching Problems with Experimental Validation,” May 1996.
Kumar Ramaiyer	“Geometric Data Structures and Applications,” Aug. 1996.
Christian Duncan	“Balanced Aspect Ratio Trees,” Aug. 1999.
Christopher Wagner	“Graph Visualization and Network Routing,” Oct. 1999 (co-advised with Prof. Lenore Cowen).
Stephen Kobourov	“Algorithms for Drawing Large Graphs,” May 2000.
Amitabha Bagchi	“Efficient Strategies for Topics in Internet Algorithmics,” Oct. 2002.
Amitabh Chaudhary	“Applied Spatial Data Structures for Large Data Sets,” Oct. 2002.
Jeremy Yu Meng	“Confluent Graph Drawing,” June 2006.
Jonathan Zheng Sun	“Algorithms for Hierarchical Structures, with Applications to Security and Geometry,” August 2006.
Nodari Sitchinava	“Parallel External Memory Model—A Parallel Model for Multi-core Architectures,” Sept. 2009.
Darren Strash	“Algorithms for Sparse Geometric Graphs and Social Networks,” May 2011.
Lowell Trott	“Geometric Algorithms for Social Network Analysis,” May 2013.
Joseph Simons	“New Dynamics in Geometric Data Structures,” May 2014.
Pawel Pszona	“Practical Algorithms for Sparse Graphs,” May 2014.

Ph.D. Committee Service:

John Augustine	UC-Irvine	Advancement to candidacy, September 2003
Nikos Triandopoulos	Brown U.	Thesis prelim., February 2004
Einar Mykletun	UC-Irvine	Advancement to candidacy, March 2004
Kartic Subr	UC-Irvine	Advancement to candidacy, September 2004
S. Joshua Swamidass	UC-Irvine	Advancement to candidacy, April 2005
Jeong Hyun Yi	UC-Irvine	Thesis defense, August, 2005
Nodari Sitchinava	UC-Irvine	Advancement to candidacy, chair, December 2005
John Augustine	UC-Irvine	Thesis defense, July 2006
Maithili Narasimha	UC-Irvine	Thesis defense, August, 2006
Josiah Carlson	UC-Irvine	Advancement to candidacy, August 2006

Xiaomin Liu	UC-Irvine	Advancement to candidacy, September 2006
Gabor Madl	UC-Irvine	Advancement to candidacy, September 2006
Nikos Triandopoulos	Brown U.	Thesis defense, September 2006
Rabia Nuray-Turan	UC-Irvine	Advancement to candidacy, May 2007
S. Joshua Swamidass	UC-Irvine	Thesis defense, June 2007
Michael Sirivianos	UC-Irvine	Advancement to candidacy, June 2007
Kevin Wortman	UC-Irvine	Advancement to candidacy, August 2007
Di Ma	UC-Irvine	Advancement to candidacy, December 2007
Josiah Carlson	UC-Irvine	Thesis defense, December 2007
Michael Nelson	UC-Irvine	Advancement to candidacy, chair, March 2008
Minas Gjoka	UC-Irvine	Advancement to candidacy, June 2008
Sara Javanmardi	UC-Irvine	Advancement to candidacy, June 2008
Ali Zandi	UC-Irvine	Advancement to candidacy, September 2008
Jihye Kim	UC-Irvine	Thesis defense, September 2008
Darren Strash	UC-Irvine	Advancement to candidacy, December 2008
Kevin Wortman	UC-Irvine	Topic defense, January 2009
Nodari Sitchinava	UC-Irvine	Topic defense, chair, June 2009
Fabio Soldo	UC-Irvine	Advancement to candidacy, July 2009
Emil De Cristofaro	UC-Irvine	Advancement to candidacy, July 2009
Di Ma	UC-Irvine	Thesis defense, August 2009
Yanbin Lu	UC-Irvine	Advancement to candidacy, December 2009
Anh Le	UC-Irvine	Advancement to candidacy, April 2010
Lowell Trott	UC-Irvine	Advancement to candidacy, June 2010
Xiaomin Liu	UC-Irvine	Thesis defense, August 2010
Josh Olsen	UC-Irvine	Advancement to candidacy, September 2010
Yasser Altowim	UC-Irvine	Advancement to candidacy, December 2010
Angela Wong	UC-Irvine	Advancement to candidacy, May 2011
Joshua Hill	UC-Irvine	Advancement to candidacy, September 2011
Alex Abatzoglou	UC-Irvine	Advancement to candidacy, September 2011
Michael Wolfe	UC-Irvine	Masters Thesis defense, October 2011
Olya Ohrimenko	Brown Univ.	PhD Thesis proposal, October 2011
Yanbin Lu	UC-Irvine	PhD Thesis defense, November 2011
Chun Meng	UC-Irvine	Advancement to candidacy, December 2011
Abinesh Ramakrishnan	UC-Irvine	Advancement to candidacy, March 2012
Pegah Sattari	UC-Irvine	PhD Thesis defense, April 2012

University Service:

Ph.D. Requirements Committee, Dept. of Computer Science, chair: 1987–89
Graduate Admissions Committee, Dept. of Computer Science, 1991–1993 (chair: 1992)
Faculty Recruiting Committee, Dept. of Computer Science, 1993,95,96 (chair: 1996)
Steering Committee, Whiting School of Engineering, 1990–93 (chair, 1993)
Johns Hopkins Homewood Academic Computing Oversight Committee, 1990–93
Curriculum Committee, Whiting School of Engineering, 1994–96
Strategic Planning Committee, Whiting School of Engineering, 1999–00
Graduate Policy Committee, UCI Dept. of Information & Computer Science (ICS), 2001–02
Faculty Search Committee in Cryptography, UCI Dept. of ICS, 2001–03

School of Info. and Computer Science Executive Committee, 2002–04
 UCI Committee on Educational Policy (CEP), 2002–03, 2004–06
 UCI Change of Major Criteria Committee, 2002–03
 UCI CEP Policy Subcommittee, 2002–2003
 Distinguished Faculty Search Committee, Bren School of ICS, 2004–11 (chair, 2007–08)
 Equity Advisor, Bren School of ICS, 2005–09
 Dean’s Advisory Council, Bren School of ICS, 2007–13
 Associate Dean for Faculty Development, Bren School of ICS, 2006–12
 Chair, Department of Computer Science, Bren School of ICS, 2012–13

Courses Taught and Developed:

Advanced Parallel Computing (developed and taught at Hopkins)
 Cyber-Puzzlers (designed and taught at UCI)
 Computer Literacy (taught at Purdue, developed at Hopkins)
 Computer Programming for Scientists and Engineers (taught at Purdue)
 Computer Security Algorithms (developed and taught at UCI)
 Computational Models (revised and taught at Hopkins)
 Computational Geometry (revised and taught at Hopkins and UCI)
 Compiler Theory and Design (revised and taught at Hopkins)
 Computer Graphics (taught at Hopkins)
 Cyber-Fraud Detection and Prevention (designed and taught at UCI)
 Data Structures (revised and taught at Hopkins and UCI)
 Graph Algorithms (revised and taught at UCI)
 Formal Languages and Automata Theory (revised and taught at UCI)
 Introduction to Algorithms (developed and taught at Hopkins and UCI)
 Internet Algorithmics (developed and taught at Hopkins, Brown, and UCI)
 Design and Analysis of Algorithms (revised and taught at Hopkins and UCI)
 Parallel Algorithms (developed and taught at Hopkins and Univ. of Illinois)

Scientific Consulting:

APAC Security, Inc., 2005
 Algomagic Technologies, Inc., 2000–2005
 Army Research Laboratory, Fort Belvoir, 1995
 AT&T, 1998
 Battelle Research Triangle, Columbus Division, 1996
 Brown University, 2000–2007
 3M, 2015
 Purdue University, 2002
 The National Science Foundation, 1990–2016
 Univ. of Miami, 1999
 Walt Disney Animation Studios, 2009

Technical Expert Consulting:

- 2011–12, Technical expert, Sidley Austin LLP (Los Angeles) and IGT Technologies
- 2012, Technical expert and deponent, Jones Day (Irvine) and Quiksilver

- 2013–14, Technical expert and deponent, Kirkland & Ellis, LLP (New York) and ContentGuard Holdings
- 2013–14, Technical expert, Kirkland & Ellis, LLP (Chicago) and Apple
- 2013–14, Technical expert and deponent, Jeffer Mangels Butler & Mitchell, LLP (Irvine) and Uniloc
- 2014–15, Technical expert, deponent, and testifying witness, McKool Smith, PC (Dallas) and ContentGuard Holdings
- 2014–16, Technical expert and deponent, Fenwick & West, LLP (San Francisco) and Symantec
- 2014–, Technical expert, Kirkland & Ellis, LLP (Chicago)
- 2016, Technical expert, deponent, and testifying witness, Dentons US LLP

GRANTS AND CONTRACTS

1. PI, “Research Initiation Award: Parallel and Sequential Computational Geometry,” National Science Foundation (NSF Grant CCR-8810568), \$32,914, 1988–90.
2. co-PI, “Paradigms for Parallel Algorithm Design,” NSF and DARPA (as NSF Grant CCR-8908092), \$523,837, 1989–93 (with S.R. Kosaraju (PI), S. Kasif, and G. Sullivan).
3. PI, “Parallel Computation and Computational Geometry,” NSF (Grant CCR-9003299), \$67,436, 1990–93.
4. co-PI, “A Facility for Experimental Validation,” NSF (Grant CDA-9015667), \$1,476,147, 1991–96 (with G. Masson (PI), J. Johnstone, S. Kasif, S.R. Kosaraju, S. Salzberg, S. Smith, G. Sullivan, L. Wolff, and A. Zwarico).
5. PI, “Parallel Network Algorithms for Cell Suppression,” The Bureau of the Census (JSA 91-23), \$14,998 1991–92.
6. PI, “A Geometric Framework for the Exploration & Analysis of Astrophysical Data,” NSF (Grant IRI-9116843), \$535,553, 1991–96 (with S. Salzberg and H. Ford (from Physics and Astronomy Dept.)).
7. PI, “Research Experiences for Undergraduates supplement to IRI-9116843,” NSF, \$4,000, 1993–94 (with S. Salzberg and H. Ford).
8. PI, “Constructing, Maintaining, and Searching Geometric Structures,” NSF (Grant CCR-9300079), \$134,976, 1993–96.
9. co-PI, “Robust and Applicable Geometric Computing,” Army Research Office (ARO MURI Grant DAAH04-96-1-0013), \$4,500,000, 1996–2000 (with F. Preparata (PI, Brown U.), R. Tamassia (Brown U.), S. Rao Kosaraju, J. Vitter (Duke U.), and P. Agarwal (Duke U.)). Subaward size: \$1,466,640.
10. PI, “Application-Motivated Geometric Algorithm Design,” NSF (Grant CCR-9625289), \$107,389, 1996–98.
11. co-PI, “vBNS Connectivity for the Johns Hopkins University,” NSF, \$350,000, 1997–99 (with T.O. Poehler (PI), D.J. Binko, J.G. Neal, and A.S. Szalay).
12. co-PI, “Product Donation, Technology for Education Program,” Intel Corporation, \$480,071, 1997–2001 (with T.O. Poehler (PI), J.H. Anderson, A.S. Szalay, and M. Robbins).
13. co-PI, “A Networked Computing Environment for the Manipulation & Visualization of Geometric Data” (Research Infrastructure), NSF, \$1,638,785, 1997–2003 (with L.B. Wolff (PI), Y. Amir, S.R. Kosaraju, S. Kumar, R. Tamassia (Brown U.), R.H. Taylor, and D. Yarowsky).
14. PI, “Geometric Algorithm Design and Implementation,” NSF, Grant CCR-9732300, \$224,982, 1998–2002.

15. PI, "Certification Management Infrastructure – Certificate Revocation," \$52,023, 1998, NSA LUCITE grant.
16. PI, "Software Engineering Data Loading, Analysis, and Reporting," \$41,614, 1998, NSA LUCITE grant.
17. PI, "Establishing a LUCITE Collaboration Environment," \$10,018, 1998, NSA LUCITE grant.
18. PI, "In Support of a Secure Multilingual Collaborative Computing Environment," \$51,471, 1999-2000, NSA LUCITE grant.
19. PI, "Accessing Large Distributed Archives in Astronomy and Particle Physics," \$199,981. subcontract to UCI from Johns Hopkins Univ. on NSF Grant PHY-9980044 (total budget, \$2,500,000), 1999–2004.
20. PI, "Efficient and Scalable Infrastructure Support for Dynamic Coalitions," \$1,495,000, DARPA Grant F30602-00-2-0509, 2000-2003 (with Robert Cohen and Roberto Tamassia), including \$227,893 subaward to UCI (with Gene Tsudik).
21. PI, "Graph Visualization and Geometric Algorithm Design," \$400,000, NSF Grant CCR-0098068, 2001-2004 (with Roberto Tamassia).
22. PI, "Collaborative Research: Teaching Data Structures to the Millennium Generation," \$125,00, NSF Grant DUE-0231467, 2003–2005.
23. PI, "Collaborative Research: An Algorithmic Approach to Cyber-Security," \$100,000, NSF Grant CCR-0311720, 2003–2006.
24. PI, "The OptIPuter," \$900,000, subcontract from UCSD on NSF ITR grant CCR-0225642 (total budget, \$13.5 million), 2002–2007 (with Padhraic Smyth and Kane Kim).
25. PI, "ITR: Algorithms for the Technology of Trust," \$300,000, NSF Grant CCR-0312760, 2003–2009.
26. co-PI, "SDCI Data New: Trust Management for Open Collaborative Information Repositories: The CalSWIM Cyberinfrastructure," NSF grant OCI-0724806, \$1,103,590, 2007–2012.
27. co-PI, "Support for Machine Learning Techniques for Cyber-Fraud Detection," Experian Corporation, \$200,000 gift, 2008.
28. PI, "IPS: Collaborative Research: Privacy Management, Measurement, and Visualization in Distributed Environments," NSF Grant IIS-0713046, \$224,851, 2007–2009.
29. PI, "Collaborative Research: Algorithms for Graphs on Surfaces," \$400,000, NSF Grant CCR-0830403, 2008–2011.
30. PI, "ROA Supplement: IPS: Collaborative Research: Privacy Management, Measurement, and Visualization in Distributed Environments," NSF Grant IIS-0847968, \$25,000, 2008–2009.
31. co-investigator, "Scalable Methods for the Analysis of Network-Based Data," Office of Naval Research: Multidisciplinary University Research Initiative (MURI) Award, number N00014-08-1-1015, \$529,152, 2008–2014.
32. PI, "EAGER: Usable Location Privacy for Mobile Devices," NSF Grant 0953071, \$300,000, 2009–2011.
33. PI, "TC:Large:Collaborative Research: Towards Trustworthy Interactions in the Cloud," NSF Grant 1011840, \$500,000, 2010-2015.
34. PI, "TWC: Medium: Collaborative: Privacy-Preserving Distributed Storage and Computation," NSF Grant 1228639, \$390,738, 2012-2016.
35. PI, "Support for Research on Geometric Motion Planning," 3M Corporation, \$40,000 gift,

- 2014.
36. PI, "A4V: Automated Analysis of Algorithm Attack Vulnerabilities," subcontract 10036982-UCI from University of Utah for DARPA agreement no. AFRL FA8750-15-2-0092, \$980,000, 2015–2019.
 37. PI, "TWC: Small: Collaborative: Practical Security Protocols via Advanced Data Structures," NSF Grant 1526631, \$166,638, 2015–2017.

SELECTED INVITED TALKS (RECENT YEARS ONLY)

- "Probabilistic Packet Marking for Large-Scale IP Traceback," Purdue Univ., 2003
- "Algorithms for Data Authentication," Harvey Mudd College, 2003
- "Efficient Tree-Based Revocation in Groups of Low-State Devices," Univ. of Arizona, 2004
- "Leap-Frog Packet Linking and Diverse Key Distributions for Improved Integrity in Network Broadcasts," Southern California Security and Cryptography Workshop, 2005
- "Is Your Business Privacy Protected?," NEXT Connections, 2005
- "Distributed Peer-to-peer Data Structures," Harvard Univ., 2006
- "Balancing Life with an Academic Research Career," Grace Hopper Conference, 2006
- "Computer Security in the Large," Univ. Texas, San Antonio, 2006
- "Inspirations in Parallelism and Computational Geometry," Brown Univ., 2006
- "Efficiency and Security Issues for Distributed Data Structures," Computer Science Distinguished Lecture Series, Johns Hopkins Univ., 2006
- "Efficiency and Security Issues for Distributed Data Structures," UCLA, 2006
- "Efficiency and Security Issues for Distributed Data Structures," Edison Distinguished Lecturer Series, Univ. of Notre Dame, 2006
- "Efficiency and Security Issues for Distributed Data Structures," Computer Science Distinguished Lecturer Series, Texas A & M Univ., 2006
- "Algorithms for Secure Computing and Searching with Applications to Medical Informatics," Purdue Univ., 2006
- "Blood on the Computer: How Algorithms for Testing Blood Samples can be Used for DNA Sequencing, Wireless Broadcasting, and Network Security," Univ. of Southern California, 2007
- "Blood on the Computer: How Algorithms for Testing Blood Samples can be Used for DNA Sequencing, Wireless Broadcasting, and Network Security," Univ. California, San Diego, 2007
- "Blood on the Computer: How Algorithms for Testing Blood Samples can be Used for DNA Sequencing, Wireless Broadcasting, and Network Security," Univ. Minnesota, 2007
- "Blood on the Database: How Algorithms for Testing Blood Samples can be Used for Database Integrity," Invited Keynote, 21st Annual IFIP WG 11.3 Working Conference on Data and Applications Security (DBSec), 2007
- "Space-Efficient Straggler Identification," ALCOM Seminar, Univ. of Aarhus, 2007
- "Blood on the Computer: How Algorithms for Testing Blood Samples can be used in Modern Applications," ALCOM Seminar, Univ. of Aarhus, 2007
- "Studying Road Networks Through an Algorithmic Lens," ALCOM Seminar, Univ. of Aarhus, 2008
- "Studying Geometric Graph Properties of Road Networks Through an Algorithmic Lens," International Workshop on Computing: from Theory to Practice, 2009

- “Randomized Shellsort: A Simple Oblivious Sorting Algorithm,” Distinguished Lecture Series, Department of Computer Science, Brown University, 2009
- “Simulating Parallel Algorithms in the MapReduce Framework with Applications to Parallel Computational Geometry,” MASSIVE 2010
- “Data Cloning Attacks for Nearest-Neighbor Searching based on Retroactive Data Structures,” Department of Computer Science, UCSB, 2011
- “Turning Privacy Leaks into Floods: Surreptitious Discovery of Social Network Friendships and Other Sensitive Binary Attribute Vectors,” Department of Computer Science Distinguished Lecturer Series, Univ. of Illinois, Chicago, 2011
- “Turning Privacy Leaks into Floods: Surreptitious Discovery of Social Network Friendships and Other Sensitive Binary Attribute Vectors,” Department of Computer Sciences, Purdue Univ., 2011
- “Spin-the-bottle Sort and Annealing Sort: Oblivious Sorting via Round-robin Random Comparisons,” Department of Computer Science, Brown Univ., 2012
- “Using Data-Oblivious Algorithms for Private Cloud Storage Access,” Qatar University, 2013
- “Using Data-Oblivious Algorithms for Private Cloud Storage Access,” Department of Computer Science and Engineering Distinguished Speaker Series, University of Buffalo, 2013
- “Force-Directed Graph Drawing Using Social Gravity and Scaling,” invited talk, ICERM Workshop on Stochastic Graph Models, Providence, RI, 2014
- “Invertible Bloom Lookup Tables and Their Applications in Large-Scale Data Analysis,” invited key-note speaker, Algorithms for Big Data, Frankfurt, Germany, 2014
- “Invertible Bloom Lookup Tables and Their Applications in Large-Scale Data Analysis,” Brown University, Providence, RI, 2014
- “Studying Road Networks Through an Algorithmic Lens,” Bold Aspirations Visitor and Lecture, University of Kansas, 2015

PROFESSIONAL SOCIETY MEMBERSHIPS

American Association for the Advancement of Science (AAAS), Fellow
 IEEE and IEEE Computer Society, Fellow
 Association for Computing Machinery (ACM), Fellow