Tobin A. Driscoll

Department of Mathematical Sciences
University of Delaware
Newark, DE 19716 USA
Voice: 302-831-3383; *Fax:* 302-831-4511
mailto:driscoll@udel.edu; http://www.math.udel.edu/~driscoll;

February 2014

Research interests

Numerical analysis, scientific computing, and applied mathematics, particularly:

- Spectral and high-order methods in space and time for PDE
- Radial basis functions and meshfree simulation
- Numerical software
- Numerical methods for thin film evolution (esp. human tear films)
- Numerical conformal mapping and applications
- Applications in the life sciences

My Google Scholar profile shows h-index=25, i10-index=37

Education

Ph.D. in Applied Mathematics, Cornell University, 1996

Thesis title: *Domain decomposition methods for conformal mapping and eigenvalue problems*
Advisor: Lloyd N. Trefethen

M.S. in Applied Mathematics, Cornell University, 1993

B.S. in Mathematics with honors, Pennsylvania State University, 1991

Honors thesis title: *Comparison of computational efficiency and sensitivity of several solution algorithms for the linear–quadratic optimal control problem*
Advisor: John E. Dzielski

B.S. in Physics, Pennsylvania State University, 1991

Professional experience

University of Delaware, 2010–present

Professor, Department of Mathematical Sciences
Director of Graduate Studies, Mathematical Sciences (2011–present)
Affiliated Faculty, Department of Biomedical Engineering (2014–present)

University of Delaware, 2004–2010

Associate Professor, Department of Mathematical Sciences

University of Delaware, 2000–2004

Assistant Professor, Department of Mathematical Sciences

University of Colorado at Boulder, 1996–2000

Research postdoctoral fellow, Department of Applied Mathematics

Honors

Winner, 100 Digit Challenge (SIAM), 2002

NSF VIGRE Postdoctoral Fellow, 1999–2000

NSF Mathematical Sciences Postdoctoral Research Fellow, 1996–1999

SIAM Outstanding Paper Prize, 1999

Runner-up, Richard C. DiPrima Dissertation Prize, 1998

Second Prize, Leslie Fox Competition, 1997

SIAM Student Paper Prize Honorable Mention, 1995

NSF Graduate Fellow, 1991–94

A. D. White Fellow (Cornell graduate), 1991–94

Braddock Scholar (Penn State undergraduate), 1987–91

Grants

M. McCulloch (PI), T. A. Driscoll, and G. Schleiniger (co-PIs). Computer simulation of the single ventricle anatomy and physiology explaining mechanisms for sudden cardiac death. NIH Delaware INBRE Grant, $44,182, 2013–2014.

T. A. Driscoll (PI) with 5 other key personnel. Meeting the need in mathematics at the University of Delaware. DOE Graduate Assitance in Areas of National Need, $527,700, 2012–2015.

R. J. Braun (PI) and T. A. Driscoll (co-PI), Modeling tear film dynamics. NSF DMS-1022706, $444,000, 2010–2013.

L. F. Rossi, T. Driscoll, and R. Luke (co-PIs), Strengthening mathematics instruction with automated algorithmic mastery activities. Center for Teaching Effectiveness (UD), $20,000, 2007.

R. Braun (PI), L. P. Cook, and T. A. Driscoll (co-PIs), Modeling the blink cycle and lipid dynamics in the tear film. NSF DMS-0616483, $325,000, 2006–2009.

H. B. White *et al.*, (co-PIs), with T. A. Driscoll and others as senior personnel. Howard Hughes Medical Institute Undergraduate Science Education grant, 2006–2010, $1,500,000.

R. Braun, T. A. Driscoll, P. Monk, L. F. Rossi (co-PIs). NSF Scientific Computing Research Environments for the Mathematical Sciences. NSF DMS-0322583, $68,460, 2003.

University of Delaware International Travel Award, 2003.

T. A. Driscoll (PI). Novel fast and accurate methods for partial differential equations. NSF DMS-0104229, $88,407, 2001–2004.

T. A. Driscoll (PI). Fast time stepping for the computational simulation of differential equations. University of Delaware Research Foundation, $21,042, 2001–2002.

T. A. Driscoll (PI). NSF Mathematical Sciences Postdoctoral Research Fellowship (University of Colorado). NSF DMS-9627677, $75,000, 1996–1999.

Books

T. A. Driscoll. *Learning MATLAB.* To appear from the Society for Industrial and Applied Mathematics, July 2009.

T. A. Driscoll and L. N. Trefethen. *Schwarz–Christoffel mapping.* Cambridge University Press, 2002.

Book chapters

T. A. Driscoll and B. Fornberg. Padé-based interpretation and correction of the Gibbs phenomenon. In *Advances in the Gibbs Phenomenon*, ed. by A. Jerri, Sigma Sampling Publishing, Potsdam, NY, 2007.

T. A. Driscoll and L. N. Trefethen. Numerical construction of conformal maps. Appendix to *Fundamentals of Complex Analysis with Applications to Engineering, Science, and Mathematics*, 3rd edition, by E. D. Saff and A. D. Snider, Prentice Hall, 2002.

Refereed publications

T. A. Driscoll. Optimal domain splitting for interpolation by Chebyshev polynomials. *SIAM J. Num. Analy.*, in revision.

Q. Deng, R. J. Braun, and T. A. Driscoll. Heat transfer and tear film dynamics over multiple blink cycles. *Phys. Fluids*, resubmitted.

Q. Deng, R. J. Braun, T. A. Driscoll, and P. E. King–Smith. A model for the tear film and ocular surface temperature for partial blinks. *Interfacial Phenomena and Heat Transfer* 1 (4), 357–381, 2013.

L. Li, R. J. Braun, T. A. Driscoll, W. D. Henshaw, J. W. Banks, and P. E. King–Smith. Coupling osmolarity dynamics within human tear film on an eye-shaped domain. *Bull. Amer. Phys. Soc.* 58 (18), 2013 (refereed abstract for Annual Meeting).

Q. Deng and T. A. Driscoll. A fast treecode for multiquadric interpolation with varying shape parameters. *SIAM J. Sci. Comput.* 34(2), A1126–A1140 (2012). DOI: 10.1137/110836225

W. M. Reid, T. A. Driscoll, M. F. Doty. Forming delocalized intermediate states with realistic quantum dots. *J. Applied Phys.* 111, 056102 (2012). DOI: 10.1063/1.3691113

A. Birkisson and T. A. Driscoll. Automatic Fréchet differentiation for the numerical solution of boundary-value problems. *ACM Trans. Math. Soft.* 38, Article 26 (2012). DOI: 10.1145/2331130.2331134

R. J. Braun, R. Usha, G. B. McFadden, T. A. Driscoll, L. P. Cook, and P. E. King–Smith. Thin film dynamics on a prolate spheroid with application to the cornea. *J. Eng. Math.* 73(1), 121–138 (2012). DOI: 10.1007/s10665-011-9482-4

A. M. Neves, T. A. Driscoll, A. R. H. Heryudono, A. J. Ferreira, C. M. Soares, and R. M. Jorge. Adaptive methods for analysis of composite plates with radial basis functions, *Mech. Adv. Materials Struct.* 18 (2011), 420–430. DOI: 10.1080/15376494.2010.528155

D. C. Usher, T. A. Driscoll, P. Dhurjati, J. A. Pelesko, L. F. Rossi, G. Schleiniger, K. Pusecker, and H. B. White. A transformative model for undergraduate quantitative biology education. *CBE Life Sci. Educ.* 9 (2010), 181–188. DOI: 10.1187/cbe.10030029

A. R. H. Heryudono and T. A. Driscoll. Radial basis function interpolation on irregular domain through conformal transplantation. *J. Sci. Comput.* 44 (2010), 286–300. DOI: 10.1007/s10915-010-9380-3

T. A. Driscoll. Automatic spectral collocation for integral, integro-differential, and integrally reformulated differential equations. *J. Comput. Phys.* 229 (2010), 5980–5998. DOI: 10.1016/j.jcp.2010.04.029

T. A. Driscoll, F. Bornemann and L. N. Trefethen. The chebop system for automatic solution of differential equations. *BIT* 48 (2008), 701–723. DOI: 10.1007/s10543-008-0198-4

K. L. Maki, R. J. Braun, T. A. Driscoll, and P. E. King-Smith. An overset grid method for the study of reflex tearing. *Math. Medicine and Biology* 25 (2008), 187–214. DOI: 10.1093/imammb/dqn013

T. DeLillo, T. Driscoll, A. Elcrat, and J. Pfaltzgraff. Radial and circular slit maps of unbounded multiply connected circle domains. *Proc. Roy. Soc. A* 464 (2008), 1719–1737.

A. Heryudono, R. J. Braun, T. A. Driscoll, K. L. Maki and L. P. Cook. Single-equation models for the tear film in a blink cycle: realistic lid motion. *Mathematical Medicine and Biology* 24 (2007), 347–377. DOI: 10.1093/imammb/dqm004

T. A. Driscoll and K. Maki. Searching for rare growth factors using multicanonical Monte Carlo methods. *SIAM Review* 49 (2007), p. 673–692.

T. A. Driscoll and A. Heryudono. Adaptive residual subsampling methods for radial basis function interpolation and collocation problems. *Computers Math. Appl.* 53 (2007), p. 927–939. DOI: 10.1016/j.camwa.2006.06.005

R. Platte and T. A. Driscoll. Eigenvalue stability of radial basis function discretizations for time-dependent problems. *Computers Math. Appl.* 51 (2006), 1251–1268. DOI: 10.1016/j.camwa.2006.04.007

T. DeLillo, T. A. Driscoll, A. Elcrat, and J. Pfaltzgraff. Computation of multiply connected Schwarz–Christoffel maps for exterior domains. *Comput. Meth. Function Theory* 6 (2006), 301–315.

J. A. Pelesko and T. A. Driscoll. The effect of the small-aspect-ratio approximation on canonical electrostatic MEMS models. *J. Engng. Math.*, 53 (2005), 239–252. DOI: 10.1007/s10665-005-9013-2

R. Platte and T. A. Driscoll. Polynomials and potential theory for Gaussian radial basis function interpolation. *SIAM J. Num. Analy.* 43 (2005), 750–766. DOI: 10.1137/040610143

T. A. Driscoll. Algorithm 843: Improvements to the MATLAB toolbox for Schwarz–Christoffel mapping. *ACM Trans. Math. Soft.* 31 (2005), 239–251. DOI: 10.1145/1067967.1067971

R. Platte and T. A. Driscoll. Computing eigenmodes of elliptic operators using radial basis functions. *Computers Math. Appl.* 48 (2004), 561–576. DOI: 10.1016/j.camwa.2003.08.007

C. R. Collins, T. A. Driscoll, and K. Stephenson. Curvature flow in conformal mapping. *Comput. Meth. Function Theory* 3 (2003), 325–347.

T. A. Driscoll and H. P. W. Gottlieb. Isospectral shapes with Neumann and alternating boundary conditions. *Phys. Rev. E* 68, 016702 (2003).

T. A. Driscoll. A composite Runge-Kutta method for the spectral solution of semilinear PDE. *J. Comp. Phys.* 182 (2002), 357–367.

T. A. Driscoll and B. Fornberg. Interpolation in the limit of increasingly flat radial basis functions. *Computers Math. Appl.* 43 (2002), 413–422.

B. Fornberg, T. A. Driscoll, G. Wright, and R. Charles. Observations on the behavior of radial basis function approximations near boundaries. *Computers Math. Appl.* 43 (2002), 473–490.

M. Goano, F. Bertazzi, P. Caravelli, G. Ghione, and T. A. Driscoll. A general conformal-mapping approach to the optimum electrode design of coplanar waveguides with arbitrary cross-section. *IEEE Microw. Theory Tech.* 49 (2001), 1573-1580.

T. A. Driscoll and B. Fornberg. A Padé-based algorithm for overcoming the Gibbs phenomenon. *Numerical Algorithms* 26 (2001), 77–92.

T. A. Driscoll and B. Fornberg. Note on nonsymmetric finite differences for Maxwell's equations. *J. Comput. Phys.* 161 (2000), 723–727.

M. Ghrist, T. A. Driscoll, and B. Fornberg. Staggered time integrators for wave equations. *SIAM J. Num. Analy.* 38 (2000), 718–741.

B. Fornberg and T. A. Driscoll. A fast spectral algorithm for nonlinear wave equations with linear dispersion. *J. Comput. Phys.* 155 (1999), 456–467.

T. A. Driscoll and B. Fornberg. Block pseudospectral methods for Maxwell's equations: II. Two-dimensional, discontinuous-coefficient case. *SIAM J. Sci. Comput.* 21 (1999), 1146–1167.

T. A. Driscoll. A nonoverlapping domain decomposition method for Symm's equation for conformal mapping. *SIAM J. Num. Analy.* 36 (1999), 922–934.

T. A. Driscoll and B. Fornberg. A block pseudospectral method for Maxwell's equations: I. One-dimensional case. *J. Comput. Phys.* 140 (1998), 47–65. [Google Scholar search]

T. A. Driscoll, K.-C. Toh, and L. N. Trefethen. From potential theory to matrix iterations in six steps. *SIAM Review* 40 (1998), 547–578. (Google Scholar search)

T. A. Driscoll and S. A. Vavasis. Numerical conformal mapping using cross-ratios and Delaunay triangulation. *SIAM Sci. Comp.* 19 (1998), 1783–1803. (Google Scholar search)

T. A. Driscoll. Eigenmodes of isospectral drums. *SIAM Review* 39 (1997), 1–17. (Google Scholar search)

T. A. Driscoll. A MATLAB Toolbox for Schwarz–Christoffel mapping. *ACM Trans. Math. Soft.* 22 (1996), 168–186. (Google Scholar search)

J. S. Baggett, T. A. Driscoll, and L. N. Trefethen. A mostly linear model of transition to turbulence. *Physics of Fluids A* 7 (1995), 833–838. (Google Scholar search)

T. A. Driscoll and L. N. Trefethen. Pseudospectra for the wave equation with an absorbing boundary. *J. Comp. Appl. Math.* 69 (1996), 125–142. (Google Scholar search)

L. N. Trefethen, A. E. Trefethen, S. C. Reddy, and T. A. Driscoll. Hydrodynamic stability without eigenvalues. *Science* 261 (1993), 578–584. (Google Scholar search)

J. E. Dzielski and T. A. Driscoll. Error bound on the solution of a linear-differential equation in Chebyshev series. *Int. J. Systems Sci.* 24 (1993), 1317–1327.

Software

L. N. Trefethen and others, Chebfun. (Major Driscoll contributions noted for the releases below.)

2011: Version 4.0 (with N. Hale): Rectangular formulations for robust ODE systems
2009: Version 3.0 (with A. Birkisson): Automatic differentiation and solution for nonlinear operators
2008: Version 2.0 (with F. Bornemann): Chebop, for automatic solutions of differential equations (BVP, eigenvalue, PDE)

T. A. Driscoll. Schwarz–Christoffel Toolbox for MATLAB.

2002: Module for solving Laplace's equation with piecewise constant boundary conditions.
2000: Object-oriented interface for polygons and maps.
1996: Inclusion of CRDT algorithm for elongated regions.
1994: Initial release.

Other works

T. A. Driscoll. Review of *Elements of Scientific Computing*, by Tveito, Langtangen, Nielsen, and Cai. *SIAM Review* 53, 807–808 (2011).

M. Hassner, D. V. Leykin, and T. A. Driscoll. An analytic model of MR/GMR head sensitivity function. IBM Research Report RJ 10167, 1999.

T. A. Driscoll. Review of *Computational Conformal Mapping*, by P. K. Kythe. *SIAM Review* 41 (1999), pp. 832–834.

L. N. Trefethen and T. A. Driscoll. Schwarz–Christoffel mapping in the computer era. Proceedings of the International Congress of Mathematicians, Vol. III (Berlin, 1998). *Doc. Math.* 1998, Extra Vol. III, 533–542 (electronic).

G. Wojcik, B. Fornberg, R. Waag, J. Mould, T. A. Driscoll, and L. Nikodym. Pseudospectral methods for large-scale bioacoustic models. Proceedings of the 1997 IEEE Ultrasonics Symposium.

T. A. Driscoll. Uses of the Berenger PML in pseudospectral methods for Maxwell's equations. Proceedings of the 1997 IUTAM Symposium on Computational Methods for Unbounded Domains, T. L. Geers, ed.

T. A. Driscoll. *Domain Decomposition Methods for Conformal Mapping and Eigenvalue Problems.* Ph.D. thesis, Center for Applied Mathematics, Cornell University, 1996.

T. A. Driscoll and B. Land. Vibrations of isospectral drums. Computer animation video produced at the Cornell Theory Center, 1995.

T. A. Driscoll. Schwarz–Christoffel Toolbox user's guide. Cornell Computer Science Technical Report TR 94-1422, 1994.

Recent invited presentations

Optimal splitting in spectral collocation

Seminar, Oxford University, November 2013

Numerical computing with functions

Colloquium, Wichita State University, September 2013

Reflections on flipping a math classroom

Summer Faculty Institute, University of Delaware, June 2013

Optimal splitting in spectral collocation

Seminar, Arizona State, April 2013

Numerical computing with functions

Colloquium, Arizona State, April 2013

Numerical computing with functions

Colloquium, Temple University, December 2012

Chebfun beyond the ordinary (DE)

Chebfun and Beyond, Oxford University, September 2012

Spectral deferred correction for time-dependent PDEs in Chebfun

SIAM Annual Meeting 2012, Minneapolis, July 2012

Chebfun for PDE

Eigenvalues/singular values and fast PDE algorithms: acceleration, conditioning, and stability, Banff International Research Station, June 2012

Optimal splitting in spectral collocation

Del-Mar Numerical Analysis Day, University of Delaware, April 2012

Differential equations in Chebfun

Seventh International Congress on Industrial and Applied Mathematics, Vancouver, July 2011 (minisymposium)

Rectangular projections for reliable spectral collocation

Seventh International Congress on Industrial and Applied Mathematics, Vancouver, July 2011 (minisymposium)

Chebfun: A software system for interacting with functions

NSF-CBMS Conference on Radial Basis Functions, Dartmouth, MA, June 2011

Approximation Theory, Spectral Methods, and Chebfun (with L. N. Trefethen)

Fifth annual Dobbiaco Summer School, Dobbiaco, Italy, June 12-17, 2011

Automatic Fréchet differentiation for the spectral solution of boundary-value problems

SIAM Annual Meeting, July 2010 (minisymposium)

Automatic solution of differential equations in the chebfun system

Canadian Applied and Industrial Mathematics Society, University of Western Ontario, June 2009

SIAM Southeastern-Atlantic Section Conference, University of South Carolina, April 2009

Courant Institute seminar, February 2009

Solving continuous differential equations numerically: chebfun and chebop

SIAM Annual Meeting, San Diego, July 2008
University of Manchester seminar, May 2008
Oxford University seminar, April 2008
University of Dundee seminar, April 2008

Least squares methods for conformal mapping and boundary value problems

SIAM Annual Meeting, San Diego, 2008

Modeling and simulation of human tear film dynamics

SUNY Buffalo colloquium, November 2007

Detection and approximation of jumps using complex-variable techniques

7th International Conference on Spectral and High-Order Methods, Beijing, China, June 2007

Spectral least-squares for conformal mapping and potential theory

Computational and Conformal Geometry Workshop, SUNY Stony Brook, April 2007

Radial basis function methods for meshless PDE computation

New Jersey Institute of Technology seminar, January 2007
Oxford University Computing Laboratory seminar, January 2007

Teaching experience

Undergraduate experience

Calculus A,B,C
Includes special section of Calculus A for life sciences majors
Linear algebra (math and engineering majors)
ODEs (math and engineering majors)
PDEs
Numerical analysis (two-semester sequence)
Complex analysis

Graduate experience

Numerical linear algebra and equation solving
Numerical ODEs/PDEs
Spectral/high-order methods for PDEs
Radial basis functions

Philosophy

While I enjoy lecturing, I no longer believe it should be the only or even primary way of teaching most math classes. The marginal benefits of a live lecture over a recorded one are overshadowed by supervised active learning, which leads to increased sharing of the instructor's expertise directly with students as they wrestle with the material in new problems and situations. I am still experimenting with techniques such as problem-based learning, laboratory exploration, and flipping the classroom for my own teaching. In addition, I believe mathematics needs to embrace teaching computation throughout the curriculum, rather than quarantining it into a few courses or lab sections.

Use of technology

Maple demos, labs, and projects in computer classrooms for calculus, ODEs
MATLAB demos, labs, and projects in computer classrooms for linear algebra, numerical analysis
In-class demos for complex analysis
Student blogs and wikis
Maple TA, Webassign for computer assigned/graded homework in calculus
Lightscribe pencasts (ODEs/linear algebra)
Screen capture on a tablet PC (calculus, numerical analysis)
Use of Sakai and Canvas LMS

Professional activities

Associate Editor of the *SIAM Journal on Scientific Computing*, 2008–present

Associate Editor of *Journal of Engineering Mathematics*, 2010–present

Member, Society for Industrial and Applied Mathematics

Referee for SISC, SINUM, J. Comput. Phys., Proc. Royal Soc. A, J. Comput. Appl. Math., Computers Math. Appl., J. Sci. Comput., Num. Meth. Fluids, J. Phys. A, Phys. Rev. E, SIAM J. on Applied Dynamical Systems, Constr. Approx., Complex Var., Comput. Meth. Func. Theory

Book reviewer for SIAM Review, Wiley, J. Flu. Mech.

Reviewer of grant proposals for NSF and the Swiss National Science Foundation

Organizing committee of Mathematical Problems in Industry, 2004 (Delaware)

Students supervised

Lei Chen (Ph.D. candidate)

Shawn Abernethy (M.S. with thesis expected, 2013)

Quan Deng (Ph.D. expected, 2013)

Alfa Heryudono (Ph.D., 2008)

Rodrigo Platte (Ph.D., 2005)

Academic visits

Institute for Mathematics and Its Applications, University of Minnesota, September–December 2010

Oxford University Computing Laboratory, January–June 2008

Oxford University Computing Laboratory, June 1999

ETH-Zürich (Swiss Federal Institute of Technology) Supercomputing Institute, Summer 1994

Consultations

United Technologies, 2002–2003

Contact: Fabio Bertolotti. Use of spectral methods in investigating thermoacoustic instability ("singing flame") in power-generating turbines.

Weidlinger Associates, 1998–2000

Contact: Greg Wojcik. High-order and spectral methods in space and time for the numerical simulation of acoustic wave propagation in tissue.

IBM Almaden Research Center, 1995–2001

Contact: Martin Hassner. Applications of conformal mapping to inductive and magnetoresistive read heads for hard drives.