

# Ryan T. Elmore

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## Degrees

Ph.D. in Statistics, The Pennsylvania State University, August 2003

M.S. in Statistics, Miami University, August 1998

B.S. in Mathematics, Morehead State University, December 1995

## Experience

September 2015 – Present	<b>Assistant Professor</b> , Department of Business Information and Analytics Daniels College of Business, University of Denver
May 2010 – June 2015	<b>Senior Scientist</b> National Renewable Energy Lab
November 2011 – August 2015	<b>Faculty Affiliate</b> , Department of Statistics Colorado State University
June 2008 – March 2010	<b>Analytics Researcher</b> Slide, Inc.
August 2009 – December 2009	<b>Distance Course Coordinator</b> , Department of Statistics Colorado State University
August 2005 – June 2008	<b>Assistant Professor</b> , Department of Statistics Colorado State University
October 2003 – April 2005	<b>Postdoctoral Research Associate</b> , Mathematical Sciences Institute The Australian National University
August 1998 – August 2003	<b>Teaching/Research Assistant</b> , Department of Statistics The Pennsylvania State University
May 1999 – August 1999	<b>Internship in Statistics</b> Minitab, Inc.
August 1996 – August 1998	<b>Teaching Assistant</b> , Department of Mathematics. and Statistics Miami University
May 1997(8) – August 1997(8)	<b>Internship in Statistics</b> National Institute for Occupational Safety and Health
May 1996 – August 1996	<b>Internship in Statistics</b> Institute for Defense Analyses
January 1996 – April 1996	<b>Internship in Statistics</b> Oak Ridge National Laboratory

## Journal Articles – Refereed

1. Urbaczewski, A. and Elmore, R. (2018). Big data, efficient markets, and the end of daily fantasy sports as we know it? *Big Data*, 6(4), 239 – 247. <https://doi.org/10.1089/big.2018.0057>
2. Elmore, R. & Urbaczewski, A. (2018). Hot and Cold Hands on the PGA Tour: Do they Exist? *Journal of Sports Analytics*, 4, 275 – 284. <https://doi.org/10.3233/JSA-180214>
3. Phillips, C., Elmore, R. T., Melius, J., Gagnon, P., & Margolis, R. (2018). A Data Mining Approach to Estimating Rooftop Photovoltaic Potential in the U.S. *Journal of Applied Statistics*, 1 – 10. <https://doi.org/10.1080/02664763.2018.1492525>
4. Gagnon, P., Margolis, R., Melius, J., Phillips, C., & Elmore, R. (2018). Estimating rooftop solar technical potential across the US using a combination of GIS-based methods, lidar data, and statistical modeling. *Environmental Research Letters*, 13(2), 024027. <https://doi.org/10.1088/1748-9326/aaa554>
5. South, C., Elmore, R., Clarage, A., Sickorez, R., and Cao, J. (2018) A starting point for navigating the world of daily fantasy basketball. *The American Statistician*, 1 – 7. <https://doi.org/10.1080/00031305.2017.1401559>
6. Elmore, R. (2018). Predicting which teams will make the NBA playoffs. *Italian Journal of Applied Statistics*, 30(2). <https://doi.org/10.26398/IJAS.0030-009>
7. Margolis, R, Gagnon, P., Melius, J., Phillips, C., Elmore, R. (2017). Using GIS-based methods and Lidar data to estimate rooftop solar technical potential in U.S. cities. *Environmental Research Letters*, **12**. <https://doi.org/10.1088/1748-9326/aa7225>
8. Bugbee, B., Phillips, C., Egan, H., Elmore, R., Gruchalla, K., and Purkayastha, A. (2017). Prediction and characterization of application power use in a high-performance computing environment. *Statistical Analysis and Data Mining*, **10**, 155 – 165. <https://doi.org/10.1002/sam.11339>
9. Elmore, R. (2015). A review of *Analytic Methods in Sports: Using Mathematics and Statistics to Understand Data from Baseball, Football, Basketball, and Other Sports*. *The American Statistician*, **69**, 244. <http://dx.doi.org/10.1080/00031305.2015.1068616>
10. Inman, D., Elmore, R., and Bush, B. (2015). A case study to examine the imputation of missing data to improve clustering analysis of building electrical demand. *Building Services Engineering Research and Technology*, **36**, 628 – 637. <http://dx.doi.org/10.1177/0143624415573215>
11. Davidson, C., Drury, E., Lopez, A., Elmore, R.T., Margolis, R. (2014). Modeling photovoltaic diffusion: an analysis of geospatial datasets. *Environmental Research Letters*, **9**. <https://doi.org/10.1088/1748-9326/9/7/074009>
12. Elmore, R.T., Hettmansperger, T.P., and Xuan, F. (2006a). On Spherical Depth and a Multivariate Median, in R. Y. Liu, R. Serfling, and D. L. Souvaine (eds) *Data Depth: Robust Multivariate Analysis, Computational Geometry, and Applications*, DIMACS Series in Discrete Mathematics and Theoretical Computer Science, **72**, pp. 87–101. <http://goo.gl/d5GAvK>
13. Elmore, R.T., Hettmansperger, T.P., and Xuan, F. (2006b). A fully nonparametric test for one-way layouts. *Australian and New Zealand Journal of Statistics*, **48**, 477 – 490. <https://doi.org/10.1111/j.1467-842X.2006.00452.x>

14. Elmore, R.T., Hall, P., and Troynikov, V.S. (2006). Nonparametric density estimation from covariate information. *Journal of the American Statistical Association*, **101**, 701 – 711. <http://dx.doi.org/10.1198/016214505000000916>
15. Hall, P., Neeman, A., Pakyari, R., and Elmore, R.T. (2005). Nonparametric inference in multivariate mixtures. *Biometrika*, **92**, 667 – 678. <https://doi.org/10.1093/biomet/92.3.667>
16. Elmore, R.T., Hall, P., and Neeman, A. (2005). An application of classical invariant theory to identifiability in nonparametric mixtures. *Annales de l'Institut Fourier (Grenoble)*, **55**, 1 – 28. <http://dx.doi.org/10.5802/aif.2087>
17. Elmore, R.T., Hettmansperger, T.P., and Xuan, F. (2004). The sign statistic, one-way layouts, and mixture models. *Statistical Science*, **19**, 579 – 587. <http://projecteuclid.org/euclid.ss/1113832722>
18. Elmore, R.T., Hettmansperger, T.P., and Thomas, H. (2004). Estimating component cumulative distribution functions in finite mixture models. *Communications in Statistics – Theory and Methods*, **33**, 1–12. <http://dx.doi.org/10.1081/STA-200026574>
19. Bailer, A.J., Elmore, R.T., Shumate, B.J., and Oris, J.T. (2000). Simulation study of characteristics of statistical estimators of inhibition concentration. *Environmental Toxicology and Chemistry*, **19**, 3068–3073. <http://dx.doi.org/10.1002/etc.5620191229>

#### Proceedings – Refereed

1. Frank, S., Heaney, M., Jin, X., Robertson, J., Cheung, H., Elmore, R., Henze, G. (2016). Hybrid model-based and data-driven fault detection and diagnostics for commercial buildings. Proceedings of the 2016 ACEEE Conference, Pacific Grove, CA.

#### Other Articles (Technical Reports and Proceedings)

1. Gagnon, P., Margolis, R., Melius, J., Phillips, C., and Elmore, R. (2016). Rooftop Solar Photovoltaic Technical Potential in the United States: A Detailed Assessment. NREL Report No. TP-6A20-65298.
2. Frank, S., Heaney, M., Jin, X., Robertson, J., Cheung, H., Elmore, R., Henze, G. (2016). Hybrid model-based and data-driven fault detection and diagnostics for commercial buildings. NREL Report No. CP-5500-65924.
3. Elmore, R., Gruchalla, K., Phillips, C., Purkayastha, A., and Wunder, N. (2016) An Analysis of Application Power and Schedule Composition in a High-Performance Computing Environment. NREL Report No. TP-2C00-65392.
4. Getman, D., Bush, B., Elmore, R., and Inman, D. (2015). Evaluation of Methods for Comparison of Spatiotemporal and Time Series Datasets. NREL Report No. TP-6A20-62647.
5. Laros III, J.H., Kelly, S.M., Hammond, S., Elmore, R. and Munch, K. (2014). Power/Energy use case project document. Sandia National Laboratories Technical Report SAND2013-10789. [This work lead to Sandia's Power API that won an R&D100 Award in 2018.]
6. Campanelli, M., Emery, K., Elmore, R., Zaharatos, B. (2014). Uncertainty Analysis for Maximum Power at SRC Using Hierarchical Monte Carlo Simulation. *Proceedings of the 40th IEEE Photovoltaic Specialists Conference*.
7. Jones, W., Elmore, R., Lee, J., and Kennedy, C. (2011). Step-Stress Accelerated Degradation Testing for Solar Reflectors: Preprint. 10 pp.; NREL Report No. CP-2C00-52624.

8. Lee, J., Elmore, R., and Jones, W. (2011). Statistical Modeling of Photovoltaic Reliability Using Accelerated Degradation Techniques (Poster). 1 pg.; NREL Report No. PO-2C00-50738.
9. Lee, J., Elmore, R., Kennedy, C., Gray, M., and Jones, W. (2011). Lifetime Prediction for Degradation of Solar Mirrors using Step-Stress Accelerated Testing (Presentation). NREL (National Renewable Energy Laboratory). 22 pp.; NREL Report No. PR-2C00-52658.
10. Lee, J., Elmore, R., Suh, C., and Jones, W. (2010). Step-Stress Accelerated Degradation Testing (SSADT) for Photovoltaic (PV) Devices and Cells (Presentation). 15 pp.; NREL Report No. PR-2C00-49487
11. Elmore, R. T. and Wang, S. (2003). Identifiability and estimation in multinomial mixture models. *Technical Report #03-04*, Department of Statistics, Penn State University.
12. Hettmansperger, T.P. and Elmore, R.T. (2002). Tests for interaction in a two-way layout: Should they be included in a nonparametrics course? *Proceedings of the Sixth International Conference on Teaching Statistics*.

### arXiv Papers

1. Scharf, H., Elmore, R., and Gruchalla, K. (2014). Prioritized data compression using wavelets. arXiv:1407.2954
2. Biagioni, D.J., Elmore, R., and Jones, W. (2012). Keeping greed good: sparse regression under design uncertainty with applications to biomass characterization. arXiv:1207.1888

### R Packages

Ballr: An R API for basketball-reference.com (author)

RDSTK: An R wrapper for the data science toolkit API. (author)

mixtools: Tools for analyzing finite mixture models (contributor)

### Academic and Industry Presentations – Invited

1. “Sports Analytics: a competitive advantage in the sports industry”, University of Denver, Department of Business Information and Analytics Fall Breakfast, September 2018.
2. “Manifestations of Loss Aversion in Professional Golf”, Joint Statistical Meetings, Vancouver, British Columbia, CA, July 2018 (Topic Contributed).
3. “Integer Programming and Daily Fantasy Sports” Great Lakes Analytics in Sports Conference, University of Wisconsin, Stevens Point, July 2017.
4. “An Introduction to R Markdown” City and County of Denver, June 2016.
5. “The ‘Hot Hand’ Effect on the PGA Tour: Does it Exist?” Presented at University of Colorado, Denver, Department of Mathematical and Statistical Sciences, April 2016.
6. “Topics in Power-Aware High Performance Computing” Presented at the University of Denver, Department of Computer Science, October 2015.
7. “Predicting Who Will Make the NBA Playoffs” Presented at the University of Denver, Department of Business Information and Analytics, January 2015.
8. “R and Web Scraping” Presented at Analyze Boulder Meetup, November 2013.

9. "The Future of Programming: Data" Presented at the Davinci Institute, Boulder, CO, September 2013.
10. "Missing Observations in Time Series Data with Applications to Building Systems Monitors" Presented at Colorado State University, October 2012.
11. "Computational Sciences Center at NREL" Presented at MIT Energy Initiative, May 2013.
12. "Data Analysis @ NREL" Presented at the Department of Energy Conference on Data Analysis in Santa Fe, NM, February 2012.
13. "Mining MLB (Sports) Data" Presented at the August 2011 meeting of the Rocky Mountain Chapter of the Society for American Baseball Research (SABR).
14. "The Life of a Computational Statistician at the National Renewable Energy Lab" Presented at the Colorado State University and Brigham Young University in October 2010 and February 2011, respectively.
15. "The Two Sample Problem and Robust Multivariate Methods" Presented at the University of Chicago Department of Statistics on January 8, 2010.
16. "Robust multivariate statistics and data depth" Presented at Colorado College on November 2, 2007 and University of Wyoming on March 7, 2008.
17. "Statistical inference based on elliptical depth" Presented at conference on Current and Future Trends in Nonparametrics, Columbia, South Carolina, October 12, 2007.
18. "Nonparametric estimation of functionals using covariate information" Presented at University of Sydney, Australia on May 21, 2007.
19. "Nonparametric density estimation from covariate information" Presented at the following universities' Department of Statistics colloquium series (2006): Kansas State University (Oct 12), Texas A&M (Oct 19), and the University of Georgia (Nov 9).
20. "A multivariate test for location based on elliptical depth" Presented at the International Conference on Robust Statistics, Jyväskylä, Finland, June 2005.
21. "An affine-invariant data depth based on random hyperellipses" Presented at: (1) Workshop on Nonparametric Statistical Methods hosted by the University of Tampere, Finland, June 2005, and (2) Statistics Seminar, The Australian National University, May 2005.
22. "Elliptical data depth: theoretical properties and applications" Presented at University of Sydney, March 2005.
23. "A fully nonparametric test for one-way layouts" Presented at the following universities' Department of Statistics colloquium series: Colorado State University, North Carolina State University, University of Florida, University of South Carolina, University of British Columbia, February 2005.
24. "A fully nonparametric test for one-way layouts" Presented at Statistical Society of Australia, Inc. – South Australia Branch, November 2004.
25. "The sign statistic, one-way layouts, and mixture models" Presented at Miami University, September 2003.

#### Academic and Industry Presentations – Non-invited

1. Front Range Information Systems Research Symposium, October 2017, "A Little Math and Daily

## Fantasy Sports”

2. Daniels College of Business, University of Denver, research colloquium “Integer Programming and Daily Fantasy Sports A Winning Strategy?”
3. Colorado-Wyoming Chapter of the American Statistical Association Fall Meeting, November 2016 “The ‘Hot Hand’ Effect on the PGA Tour: Does it Exist?”
4. Front Range Information Systems Research Symposium, November 2016 “The ‘Hot Hand’ Effect on the PGA Tour: Does it Exist?”
5. Denver R Users Group, Denver, CO:
  - a. “Introduction to the ballr package”, November 2017
  - b. “Using R to Predict an NBA Team’s Probability of Making the Playoffs”, January 2014
  - c. “Programming with Big Data in R (pbdR)”, September 2013
  - d. “The .RProfile File”, December 2011
  - e. “R and the Data Science ToolKit (RDSTK)”, May 2011
  - f. “Using R to Analyze Sports Data”, October 2010 (inaugural meeting)
6. Colorado-Wyoming Chapter of the American Statistical Association Fall Meeting, November 2012 “Energy Efficient High Performance Computing”.
7. useR! The 8th International R User Conference, Nashville, TN, June 2012 (lightning talk) “Using R for Scraping Data”.
8. Joint Statistical Meetings, Seattle, WA, August 2006, “Nonparametric density estimation from covariate information.” (Note: I was invited to speak in a Topic Contributed session on function estimation.)
9. The Seventh IMS North American New Researchers Conference, Toronto, Canada, August 2004 “Spherical data depth and an application to multivariate medians”.
10. Applied Statistics Seminar, The Australian National University, July 2004, “Spherical data depth and its applications”.
11. International Biometric Conference / Australian Statistical Conference, Cairns, Australia, July 2004, “The sign statistic and one-way layouts.”
12. Applied Statistics Seminar, The Australian National University, May 2004, “Sign statistics and one-way layouts.”
13. Joint Statistical Meetings, New York, NY, August 2002. “A semiparametric approach to analyzing repeated measures from a finite mixture model.”
14. Workshop on Developments and Challenges in Mixture Models, Bump Hunting and Measurement Error Models, Cleveland, OH, June 2002. “Estimating finite mixture cumulative distribution functions using multinomial mixtures.”
15. Joint Statistical Meetings, Atlanta, GA, August 2001. “An almost nonparametric approach to estimation in the multivariate, finite mixture model.”
16. International Conference on Robust Statistics, Vorau, Austria, July 2001. “Almost nonparametric inference for repeated measures in finite mixture models in the presence of intrasubject correlation.”



## External Funding

- NSF – ECCS grant proposal (2017) “Collaborative Research: AC-Constrained Co-Optimization of Flexible Electricity Supply and Demand Resources Under Uncertainty.” Total Budget: \$250,000 (not funded, co-PI)
- Silicon Mechanics, Inc. (2017) “Topics in GPGPU Computing at the University of Denver.” Total Budget: One GPU Research Clusters, ~\$100,000 (not funded)
- NSF – S&CC-IRG grant proposal (2017) “Integrative Multidisciplinary Research on Smart Urban Communities.” Total budget: \$3,000,000 (not funded)
- NSF – DMS grant proposal (2006) “Problems in classical and contemporary nonparametric statistical methods.” Total budget: \$197,104 (not funded)
- NSF – DMS grant proposal (2005) “Nonparametric topics in finite mixture models and one-way layouts.” Total budget: \$188,670 (not funded)
- DOD – National Security Agency (2007) “11th North American Meeting of New Researchers in Statistics and Probability.” Total budget: \$10,000 (funded)
- DOD – Office of Naval Research (2008) “11th North American Meeting of New Researchers in Statistics and Probability.” Total budget: \$8,000 (funded)

## National Laboratory Funding

- Contributor on Laboratory Directed Research and Development (LDRD) grant proposal “Computational Steering and Modeling using the ESIF Insight Center”. Funded for 24 months in FY15 and FY16.
- Contributor on LDRD grant proposal “A Framework for Comparison of Spatiotemporal and Time Series Datasets”. Funded for 24 months in FY14 and FY15.
- PI on LDRD grant proposal “Integrated Energy Management and Analysis for the ESIF’s Computational Systems”. Funded for 21 months in FY13 and FY14.
- Contributor on LDRD grant proposal “Novel Visualization and Analysis for Extreme-Scale Wind Turbine Array Simulations”. Funded for 24 months in FY13 and FY14.
- Co-PI on LDRD grant proposal “Automated Analysis of Renewable Energy Datasets”. Funded for 18 months in FY12 and FY13.
- Contributor on LDRD grant proposal “Towards Building Design Optimization under Uncertainty”. Funded for 24 months in FY12 and FY13.

## Advising and Committee Membership

Travis J. Atkinson	M.S. in Statistics (CSU, advisor)
Dustin White	M.S. in Statistics (CSU, advisor)
Amy Kagey	M.S. in Statistics (CSU, advisor)
Sarah Williams	M.S. in Statistics (CSU, committee)
Megan D. Higgs	Ph.D. in Statistics (CSU, committee)
Todd Iverson	Ph.D. in Statistics (CSU, committee)
Rozhin Eskandarpour	M.S. in Electrical and Computer Engineering (DU, committee)
Ameer Hamza Janjua	M.S. in Business Analytics (DU, advisor)
Qingyan Zhang	M.S. in Business Analytics (DU, advisor)

Sylvia Zarate	M.S. in Business Analytics (DU, advisor)
Madeline Doering	M.S. in Business Analytics (DU, advisor)
Sean Wang	M.S. in Business Analytics (DU, advisor)
Peyton Garnsey	M.S. in Business Analytics (DU, advisor)
Yini Bi	M.S. in Business Analytics (DU, advisor)
Dong Qiu	M.S. in Mechanical and Materials Engineering (DU, committee)
Michael Atkins	M.S. in Business Analytics (DU, advisor)
Emily Sacks	M.S. in Business Analytics (DU, advisor)
Layth Dieyleh	M.S. in Business Analytics (DU, advisor)
Nathan Thompson	M.S. in Business Analytics (DU, advisor)
Cole Rogers	M.S. in Business Analytics (DU, advisor)
Max Mershon	M.S. in Business Analytics (DU, advisor)
Diwanshu Shekhar	M.S. in Computer Science (DU, committee)

## Professional Societies

American Statistical Association  
The Institute for Operations Research and the Management Sciences

## Teaching Experience

Fall 1996	Precalculus (Miami U.)
Spring 1997(8), Fall 1997	Introduction to Statistics (Miami U.)
Fall 1998(9), Spring 1999	Elementary Statistics (Recitation sections at PSU)
Summer 1999	Elementary Statistics (PSU)
Spring 2000(1), Summer 2000	Probability (PSU)
Fall 2000	Experimental Methods I (PSU)
Fall 2001	Computing Environments (PSU)
Fall 2002	Introduction to Biostatistics (PSU)
Spring 2004	Probability and Stochastic Processes (ANU)
Fall 2005 & 2006	Data Analysis and Regression – ST 540 (CSU)
Fall 2005 & 2006	Statistical Science – ST 501 (CSU)
Spring 2006 & Fall 2007	Nonparametric Statistics – ST 570 (CSU)
Spring 2006	Multiple Regression Analysis – ST 304 (CSU)
Spring 2007 & 2008	Multivariate Analysis – ST 460/560 (CSU)
Fall 2007	Advanced Theory of Statistics I – ST 730 (CSU)
Winter 2016(7,8), Spring 2016(7, 8)	Analytics III – Business Modeling, INFO 2020 (DU)
Winter 2018	Advanced Predictive Modeling, INFO 4390 (DU)
Spring 2018	Sports Analytics, INFO 3700 (DU)

## Professional Service

Co-founded the Denver R Users Group – October 2010  
Co-organizer for conference on Nonparametric Statistics and Mixture Models – May 2008  
Co-organizer for IMS New Researchers Conference in Boulder (NCAR/CU) – July 2008  
Conference organizing committee for IMS New Researchers Conference in Salt Lake City – July 2007  
Secretary for CO/WY Chapter of the ASA  
Founded the Student Organized Activities and Research Seminars (SOARS) at CSU  
Co-organizer of CSU colloquium series (August 2005 – August 2007)  
Member of undergraduate committee (August 2006 – June 2008)  
Reviewed book proposal for CRC Press  
Associate Editor for *Journal of Quantitative Analysis in Sports*  
Referee for *Decision Sciences*



Referee for *Journal of Quantitative Analysis in Sports*  
Referee for *Journal of the American Statistical Association* Referee for *Annals of Statistics*  
Referee for *Journal of Multivariate Analysis*  
Referee for *JRSS Series B*  
Referee for *Computational Statistics and Data Analysis* (2) Referee for *Child Development*  
Referee for *Communications in Statistics*  
Co-organizer of Mathematical Sciences Institute (at ANU) colloquium series

## Computing Skills

*Operating Systems:* Macintosh OS X, Linux, Unix, Windows/DOS  
*Programming Languages:* R, Python, SQL, NoSQL  
*High Performance Computing:* MPI, PBD-R

## Awards

2002 PSU Department of Statistics Research Fellowship  
2002 Student award from Workshop on Developments and Challenges in Mixture Models, Bump Hunting and Measurement Error Models  
2002 Summer Travel Grant, PSU Department of Statistics  
2001 Nominated for The PSU Graduate School's Graduate Assistant Award for Outstanding Teaching  
2001 Summer Travel Grant, PSU Department of Statistics  
1998 Graduate Scholars Award, PSU Graduate School  
1998 Statistical Journal Award, MU Department of Mathematics and Statistics  
1996 Science and Engineering Research Semester, US Department of Energy  
1995-6 Thomas E. Fouch Mathematics Award, MSU Department of Mathematical Sciences  
1995-6 Outstanding Graduate in Mathematics, MSU Department of Mathematical Sciences  
1995-6 Outstanding Undergraduate Student in Mathematical Sciences, MSU Department of Mathematical Sciences  
1994-5 Outstanding Statistics Student, MSU Department of Mathematical Sciences

## Hobbies

Hiking, backpacking, ultimate frisbee, soccer, rock climbing, yoga, computing and data analysis

## References

Available upon request