TYRUS BERRY

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POSITIONS

Sept 2017- *Assistant Professor*, Department of Mathematical Sciences, George Mason University

Sept 2015-Aug 2017 *Post Doctoral Research Fellow*, Department of Mathematical Sciences, George Mason University

Aug 2013-July 2015 *Research Associate*, Department of Mathematics, Pennsylvania State University

EDUCATION

2013 PhD in Mathematics from George Mason University. GPA: 4.0

- **Thesis:** *Model-Free Techniques for High Dimensional Dynamics*
- **Advisor:** Timothy Sauer

2008 MS in Mathematics from Ohio State University. GPA: 3.5

- **Thesis:** *An Overview of Optimal Stopping Times for Various Discrete Time Games*

2006 BS in Applied Mathematics and
BA in Physics from the University of Virginia. GPA: 3.9

- Highest Distinction, School of Engineering and Applied Sciences

EXTERNAL FUNDING

1. **Role:** Principal Investigator, *Semiparametric methods for data assimilation and uncertainty quantification*. Funded by NSF DMS Applied Mathematics. Total award: $233,747 for 2020-2023.

   This research rigorously integrates model-free methods with established parametric modeling in order to overcome model error while side-stepping the curse-of-dimensionality. Funding will cover 3 years of graduate student support, summer support, travel, and equipment.

2. **Role:** Principal Investigator, *FRG: Collaborative Research: Non-smooth Geometry, Spectral Theory, and Data: Learning and Representing Projections of Complex Systems*. Funded by NSF DMS Computational Mathematics, joint proposal with John Harlim at Penn State and Dimitris Giannakis at Courant Institute. Total award: $1,275,270, GMU portion: $395,425 for 2019-2022.

   This research will establish a model-free, data-driven framework for prediction that can be deployed in widespread real-world applications across many disciplines. Funding will cover 2 years of postdoc support, 2 years of graduate student support, summer support, travel, and equipment.

3. **Role:** Faculty Investigator (PI Steve Schiff at PSU), *Predictive Personalized Public Health (P3H): A Novel Paradigm to Treat Infection Disease*. Funded for 1 summer month by NIH, 2018-2021, and 1 course buyout in Fall 2020.

4. **Role:** Faculty Investigator (PI is Timothy Sauer), *Computational Methods for Hierarchical Manifold Learning*. Funded for 1 summer month by NSF DMS, 2017-2020.

RESEARCH INTERESTS

Geometry of data: diffusion maps, nonlinear dimensionality reduction and decomposition.
Statistical Operator Theory: kernel operator estimation, nonparametric/semiparametric modeling.
Dynamical systems: data assimilation, prediction/control, and uncertainty quantification.
Harmonic analysis: sampling theory and Paley-Weiner spaces on manifolds/metric-measure spaces

PUBLICATIONS

Articles in Refereed Journals (Items 1-12 published as Assistant Professor at GMU)

1. T. Berry, D. Giannakis, J. Harlim, *Bridging data science and dynamical systems theory.*
   Notices of the American Mathematical Society, Volume 67, Issue 9, pp. 1336-1348, 2020.
   https://www.ams.org/journals/notices/202009/rnoti-p1336.pdf

2. T. Berry, D. Giannakis *Spectral Exterior Calculus.*
   Communications on Pure and Applied Mathematics, Volume 73, Issue 4, pp. 689-770, 2020.
   https://doi.org/10.1002/cpa.21885

   This paper develops an entirely novel approach to the classical exterior calculus on smooth manifolds based on building frames (overcomplete spanning sets) for Hilbert and Sobolev spaces of differential forms. This is the first method of global differential analysis for nonlinear spaces such as manifolds. All of the classical elements of the exterior calculus are reformulated, and the new framework is a natural generalization of the exterior calculus to a large class of mathematical objects ranging from non-smooth spaces to discrete spaces such as graphs.

3. D. Easley, T. Berry, *A Higher Order Unscented Transform.*
   To Appear in SIAM Journal on Uncertainty Quantification, 40 pages, 2021.
   http://math.gmu.edu/~berry/Publications/HOUT.pdf

4. H. Antil, T. Berry, J. Harlim, *Fractional Diffusion Maps.*
   Applied and Computational Harmonic Analysis, Volume 54, pp. 145-175, To Appear, Sept. 2021.
   https://doi.org/10.1016/j.acha.2021.03.005

5. D. Ebeigbe, T. Berry, S. Schiff, T. Sauer, *Poisson Kalman filter for disease surveillance.*
   Physical Review Research, Volume 2, Issue 4, 043028, 2020.
   https://doi.org/10.1103/PhysRevResearch.2.043028

6. T. Berry, T. Sauer, *Consistent Manifold Representation for Topological Data Analysis.*
   Foundations of Data Science, Volume 1, Issue 1, pp. 1-38, 2019.
   https://www.aimsciences.org/article/doi/10.3934/fods.2019001

7. F. Hamilton, T. Berry, T. Sauer, *Correcting observation model error in data assimilation*
   Chaos, Volume 29, p. 053102, 10 pages, 2019. https://doi.org/10.1063/1.5087151

8. J. Guan, T. Berry, T. Sauer, *Limits on reconstruction of dynamics in networks.*
   Physical Review E, Volume 98, Issue 2, p. 022318, 6 pages, 2018.
   https://link.aps.org/doi/10.1103/PhysRevE.98.022318

9. T. Berry, T. Sauer, *Correlation between System and Observation Errors in Data Assimilation.*
   Monthly Weather Review, Volume 146, Issue 9, pp. 2913-2931, 2018.
   https://doi.org/10.1175/MWR-D-17-0331.1

10. F. Hamilton, T. Berry, T. Sauer, *Tracking intracellular dynamics through extracellular measurements.* PLOS ONE Volume 13, Issue 10, pp. 1-13, 2018.
    https://doi.org/10.1371/journal.pone.0205031

11. T. Berry, J. Harlim, *Iterated Diffusion Maps for Feature Identification.* Journal of Applied and Computational Harmonic Analysis, Volume 45, Issue 1, pp. 84-119, 2018. http://dx.doi.org/10.1016/j.acha.2016.08.005

12. F. Hamilton, T. Berry, T. Sauer, *Kalman-Takens filtering in the presence of dynamical noise.* European Physics Journal: Special Topics, Volume 226, Issue 15, pp. 3239–3250, 2017. https://doi.org/10.1140/epjst/e2016-60363-2

13. J. Harlim, T. Berry, *Correcting biased observation model error in data assimilation.* Monthly Weather Review, Volume 145, Issue 7, pp. 2833-2853, 2017. https://doi.org/10.1175/MWR-D-16-0428.1

14. T. Berry, T. Sauer, *Density estimation on manifolds with boundary.* Computational Statistics and Data Analysis, Volume 107, pp. 1-17, 2017. http://dx.doi.org/10.1016/j.csda.2016.09.011

15. T. Berry, J. Harlim, *Semiparametric forecasting and filtering: correcting low-dimensional model error in parametric models.* Journal of Computational Physics, Volume 308, pp. 305-321, 2016. http://www.sciencedirect.com/science/article/pii/S0021999115008621

16. F. Hamilton, T. Berry, T. Sauer, *Ensemble Kalman filtering without a model.* Physical Review X, 6, 011021, 2016. http://dx.doi.org/10.1103/PhysRevX.6.011021

17. T. Berry, J. Harlim, *Forecasting Turbulent Modes with Nonparametric Diffusion Models.* Physica D, Volume 320, pp. 57-76, 2016. http://dx.doi.org/10.1016/j.physd.2016.01.012

18. T. Berry, D. Giannakis, J. Harlim, *Nonparametric forecasting of low-dimensional dynamical systems.* Physical Review E, 91, 032915, 2015. http://dx.doi.org/10.1103/PhysRevE.91.032915

19. T. Berry, T. Sauer, *Local Kernels and the Geometric Structure of Data.* Journal of Applied and Computational Harmonic Analysis, Volume 40, Issue 3, pp. 439-469, 2015. http://dx.doi.org/10.1016/j.acha.2015.03.002

20. T. Berry, J. Harlim, *Variable Bandwidth Diffusion Kernels.* Journal of Applied and Computational Harmonic Analysis, Volume 40, Issue 1, pp. 68-96, 2015. http://dx.doi.org/10.1016/j.acha.2015.01.001

21. T. Berry, J. Harlim, *Nonparametric Uncertainty Quantification for Stochastic Gradient Flows.* SIAM/ASA Journal on Uncertainty Quantification, 2015, Vol. 3, No. 1, pp. 484-508. http://dx.doi.org/10.1137/14097940X

22. F. Hamilton, T. Berry, T. Sauer, *Predicting chaotic time series with a partial model.* Physical Review E, 92, 010902 2015. http://dx.doi.org/10.1103/PhysRevE.92.010902

23. T. Berry, J. Harlim *Linear theory for filtering nonlinear multi scale systems with model error.* Proceedings of the Royal Society A 470, 2014. http://dx.doi.org/10.1098/rspa.2014.0168

24. T. Berry, R. Cressman, Z. Greguric-Ferencek, T. Sauer, *Time-scale separation from diffusion-mapped delay coordinates.* SIAM Journal on Applied Dynamical Systems, 12, pp. 618-649, 2013. http://dx.doi.org/10.1137/12088183X Videos: http://math.gmu.edu/~tsauer/dmdc.html

25. T. Berry, T. Sauer, *Adaptive ensemble Kalman filtering of nonlinear systems.* Tellus A, 65, 20331, 2013. http://dx.doi.org/10.3402/tellusa.v65i0.20331

26. F. Hamilton, T. Berry, N. Peixoto, and T. Sauer, *Real-time tracking of neuronal network structure using data assimilation.* Physical Review E, 88, 052715, 2013. http://dx.doi.org/10.1103/PhysRevE.88.052715

27. T. Berry, F. Hamilton, T. Sauer, N. Peixoto, *Detecting connectivity changes in neuronal networks.* Journal of Neuroscience Methods 209, pp. 388-397, 2012. http://dx.doi.org/10.1016/j.jneumeth.2012.06.021

28. T. Berry, T. Sauer, *Convergence of periodically-forced rank-type equations.* Journal of Difference Equations and Applications 17, 2011. http://math.gmu.edu/~berry/Publications/forcedranktype.pdf

29. T. Berry, S. Heilman, R. Strichartz, *Outer approximation of the spectrum of a fractal laplacian.* Experimental Mathematics 18 no. 4 pp. 449-480, 2009. http://math.gmu.edu/~berry/Publications/OuterApproximationV6.pdf

Articles Submitted for Publication

- M. Panagoda, T. Berry, H. Antil, *Convergence Analysis of the Rank-Restricted Soft SVD Algorithm.* Submitted to SIAM Journal on Matrix Analysis and Applications, 15 pages, 2021. https://arxiv.org/abs/2104.01473
- T. Sauer, T. Berry, D. Ebeigbe, M. Norton, A. Whalen, S. Schiff, *Identifiability of infection model parameters early in an epidemic.* Submitted to SIAM Journal on Control and Optimization, 22 pages, 2020. http://math.gmu.edu/~berry/Publications/Identifiability.pdf
- D. Ebeigbe, T. Berry, M. Norton, A. Whalen, D. Simon, T. Sauer, S. Schiff, *A Generalized Unscented Transformation for Probability Distributions.* Submitted to IEEE Transactions on Automatic Control, 15 pages, 2021. https://arxiv.org/abs/2104.01958
- T. Berry, S. Schluchter, *Applications of topological graph theory to 2-manifold learning.* Submitted to Discrete Applied Mathematics, 17 pages, 2019. http://math.gmu.edu/~berry/Publications/TGTandManifolds.pdf

Articles in Preparation

- S. Das, R. Vaughn, T. Berry, D. Giannakis, *Spectral Convergence of Kernel-based Manifold Learning.* In Preparation, 25 pages, 2021.
- S. Das and T. Berry *Scaling Up Manifold Learning with Consistent Landmark Sets.* In Preparation, 14 pages, 2021.
- S. Das and T. Berry, *Learning Theory for Dynamical Systems.* In Preparation, 18 pages, 2021.
- R. Vaughn, T. Berry, H. Antil, *Diffusion Maps for Embedded Manifolds with Boundary with Applications to PDEs.* In Preparation, 35 pages, 2021.
- O. Babb, A. Malhotra, R. Vaughn, Y. Ayub, T. Berry, *Minimum Curvature Embeddings for Dimensionality Reduction.* In Preparation, 17 pages, 2021.
- J. Westhoven, Y. Ayub, T. Berry, *Supervised Dimensionality Reduction Methods for Eliminating Nuisance Variables.* In Preparation, 13 pages, 2021.

TEACHING

- *Assistant Professor*, George Mason University, 2017-present
  - **New Courses:** Developed two new courses, *Linear Algebra with Data Applications* and *Mathematics of Manifold Learning.*

- **Mathematical Data Science Concentration:** Above course development was part of an initiative to create new courses that would form the core of a newly created concentration to advance data science from a rigorous mathematical perspective.
- **Spring 2016-present:** Served on the Numerical Analysis prelim exam committee.
- **Spring 2021**
  - *MATH697, IS*, 6 credits, 1 students.
  - *MATH799, MS Thesis*, 3 credits, 1 students.
  - *MATH999, Doctoral Dissertation*, 6 credit, 1 student.
- **Fall 2020**
  - **New Course:** *MATH689, Linear Algebra with Data Applications*, 11 students.
  - *MATH697, IS*, 2 credits, 1 students.
  - *MATH799, MS Thesis*, 3 credits, 1 students.
  - *MATH998, Dissertation Proposal*, 6 credits, 1 student.
  - *MATH999, Doctoral Dissertation*, 1 credit, 1 student.
- **Spring 2020**
  - *MATH446, Numerical Analysis I*, 47 students, cap of 52.
  - *MATH447/CDS410, Numerical Analysis II*, 9 students, cap of 30.
  - *MATH998, Dissertation Proposal*, 6 credits, 1 student.
- **Fall 2019**
  - *MATH685/OR689, Numerical Methods*, 9 students, cap of 12.
  - *MATH315, Advanced Calculus*, 41 students, cap of 44.
  - *MATH697, IS: Tensor Decomposition and UQ*, 5 credits, 1 student.
  - *MATH998, Dissertation Proposal*, 5 credits, 1 student.
- **Spring 2019**
  - *MATH316, Advanced Calculus II*, 18 students, cap of 30. **Teaching rating: 4.75/5**
  - **New Course:** *MATH689, Mathematics of Manifold Learning*, 11 students. **Teaching rating: 4.92/5**
  - *MATH491, MEGL: Exploring Geometric Flows*, 3 credits, 1 student.
  - *MATH697, IS: Topics in Data Analytics II* , 1 credit, 1 student.
- **Fall 2018**
  - *MATH685/OR689, Numerical Methods*, 8 students, cap of 22. **Teaching rating: 5.00/5**.
  - *MATH315, Advanced Calculus*, 33 students, cap of 38. **Teaching rating: 4.92/5**.
  - LA Mentor for Julian Benali, MATH315.
  - *MATH495, EXTREEMS Seminar*, 1 credit, 4 students.
  - *MATH491, MEGL: Exploring Geometric Flows*, 3 credits, 2 students.
  - *MATH697, IS: Topics in Numerical Analysis*, 2 credits, 1 student.
  - *MATH697, IS: Topics in Data Analytics* , 1 credit, 1 student.
- **Spring 2018**
  - *MATH446/OR481, Numerical Methods*, 56 students, cap 60. **Teaching rating: 4.89/5**
  - LA Mentor for Aneesh Malhotra, MATH446.
  - *MATH491, MEGL: Exploring Geometric Flows*, 1 credit hour, 2 students.
- **Fall 2017**
  - *MATH315, Advanced Calculus*, 37 students, cap of 35. **Teaching rating: 4.72/5**
  - *MATH697, IS: Nonlinear Dynamical Systems*, 3 credit hours, 1 student.

- *MATH491, MEGL: Exploring Geometric Flows*, 1 credit hour, 2 students.

- *Instructor*, George Mason University, 2013-2016.
  - Fall 2016, *MATH685/OR682, Numerical Methods.* **Teaching rating: 4.88/5**
  - Fall 2016, *Reading Course in Riemannian Geometry* (co-instructed w/ Timothy Sauer).
  - Fall 2015, *MATH685/OR682, Numerical Methods.* **Teaching rating: 4.67/5**
  - Fall 2015, *Organizer, Nonlinear Data Analysis Seminar (informal, not a registered course).*
    - Organized and made weekly presentations on manifold learning methods in data science, including foundations, current research, and future directions. Attended weekly by 6-10 graduate students and 1-2 undergraduate students, as well as 3-4 faculty members.
  - Summer 2013, *MATH446/OR481, Numerical Methods.* **Teaching rating: 4.36/5**

- *Teaching Assistant/Summer Instructor*, Ohio State University, 2006-2008 for Pre-Calculus, Calculus I, and Calculus II

EXTREEMS Organizer, Summer 2018

The 2018 EXTREEMS undergraduate research program had 9 undergraduate students paired with 9 faculty mentors working together on individual research projects for 10 weeks over the summer. Students continued their research in the school year as well as continuing to improve the presentations and posters at a seminar class that I taught.

- Organized two weeks of tutorials given by graduate students on topics including: LaTeX, Matlab, Linear Algebra, Real Analysis, Differential Equations, and Numerical Analysis. Tutorials included lectures, group work, and projects where the students would present their work the next day.
- Organized 7 weekly tutorials on advanced topics in applied mathematics given by faculty.
- Mentored 9 undergraduate students on presentation skills with 8 weekly group meetings including practice presentations and group feedback and discussion.
- Organized and ran seminar class in Fall 2018 to improve presentation and presentation skills and develop a poster while continuing research with their faculty advisor.
- All students presented at SUMS undergraduate research conference at JMU in Fall 2018.
- Some students participated at the poster session at the Joint Math Meetings in Spring 2019, one student received an Outstanding Poster Award.

OSCAR Summer Impact Grant in Summer 2020

An intensive interdiscplinary summer project co-managed by three faculty and involving 14 undergraduate students from the CS, Biology, Math, and Design departments. The team developed an interactive web tool for analyzing genetic data integrating mathematical and statistical analysis backend with a Python frontend using an SQL database and Django integrated web interface with user interface developed by the design students.

MENTORING POST-DOCTORAL RESEARCH (2017-present)

1. *Postdoc Mentor* for Suddhasattwa "Shuddho" Das (GMU Postdoc funded by NSF FRG Grant)
   - Fully funded postdoc Fall 2020 - Spring 2022.
   - Paper in preparation with Ryan Vaughn and Dimitris Giannakis: *Spectral Convergence of Kernel-based Manifold Learning.*

- Paper in preparation: *Scaling Up Manifold Learning with Consistent Landmark Sets.*
- Paper in preparation: *Learning Theory for Dynamical Systems.*

2. *Postdoc Co-Mentor* for Donald Ebeigbe (PSU Postdoc funded by Steven Schiff's NIH Grant which GMU subcontracts)

   - Co-authored paper with Timothy Sauer and Steven Schiff, published in Physical Review Research: *Poisson Kalman filter for disease surveillance.*
   - Co-authored paper with T. Sauer, S. Schiff, M. Norton, and A. Whalen, in review: *Identifiability of infection model parameters early in an epidemic.*
   - Paper in preparation with above co-authors: *A Generalized Unscented Transformation for Probability Distributions.*

3. *Postdoc Co-Mentor* for Ryan Vaughn (NYU Postdoc funded by NSF FRG Grant)

   - Paper in preparation with H. Antil: *Diffusion Maps for Embedded Manifolds with Boundary with Applications to PDEs.*
   - Paper in preparation with S. Das and D. Giannakis: *Spectral Convergence of Kernel-based Manifold Learning.*

MENTORING GRADUATE RESEARCH (2017-present)

1. *PhD Advisor* for Deanna Easley (GRA funded by NSF Grant)

   - Advanced to candidacy Spring 2020, expected graduation in Spring 2022.
   - Co-authored paper to appear in SIAM UQ: *A Higher Order Unscented Transform*
   - Proposed Thesis: *Higher Order Kalman Filtering for Nonlinear Systems.*
   - MS Paper Presentation in Spring 2017.

2. *PhD Advisor* for Yemeen Ayub (GRA funded by NSF FRG grant)

   - Passed all prelims, preparing to advance to candidacy in Summer 2021.
   - Paper in preparation: *Minimum Curvature Embeddings for Dimensionality Reduction.*
   - Paper in preparation: *Model-Free Forecasting with Supervised Dimensionality Reduction.*

3. *PhD Co-Advisor (w/ Harbir Antil)* for Mahendra Panagoda

   - Advanced to candidacy Fall 2020.
   - Paper submitted (with Harbir Antil): *Convergence Analysis of the Rank-Restricted Soft SVD Algorithm.*
   - Proposed Thesis: *Matrix Methods and Bi-Level Optimization in Data Analytics and Machine Learning.*

4. *MS Thesis Advisor* for Andrew Draganov

   - Proposed Thesis: *A Unified Framework for Nonlinear Dimensionality Reduction.*

5. *PhD Co-advisor (w/ Timothy Sauer)* for Ryan Vaughn, graduated Spring 2020.

   - Thesis: *Diffusion Maps for Manifolds with Boundary and Regularity Results*
   - Paper in preparation with Harbir Antil based on Ryan's thesis work.
   - Postdoctoral position at Courant Institute, NYU, Fall 2020.

6. *PhD Co-advisor (w/ Timothy Sauer)* for Marilyn Vasquez, graduated Spring 2018

- Thesis: *Consistency of Density Based Clustering and its Application to Image Segmentation.*
- Postdoctoral position at ICERM, Brown University, Fall 2018.

7. *Thesis Committee Member* for Justin Peel advised by John Cressman in Physics
8. *Thesis Committee Member* for David Niemi advised by John Cressman in Physics
9. Co-mentored Franz Hamilton with Tim Sauer while Franz was a postdoc at NCSU (Franz is a former GMU PhD Student, graduated in May 2015), we co-authored 7 papers with Franz.

MENTORING UNDERGRADUATE RESEARCH (2017-present)

1. Jenny Smiley, Spring 2021 - current
   - Continuing a senior capstone research project on COVID-19 modeling that started with a class project in MATH 447 Numerical Analysis II in Spring 2020.
2. Aneesh Malhotra, Fall 2017 - Spring 2019
   - MEGL Project: Applications of Diffusion Maps.
   - JMM 2019 Outstanding Poster Award.
   - Paper in preparation: *Minimum Curvature Embeddings for Dimensionality Reduction.*
3. Orton Babb, Fall 2017 - Fall 2018
   - MEGL Project: Applications of Diffusion Maps.
   - JMM 2019 Outstanding Poster Award.
   - Paper in preparation: *Minimum Curvature Embeddings for Dimensionality Reduction.*
4. Josh Westhoven, Summer 2018 - Fall 2020
   - EXTREEMS-QED Summer 2018: *Generalizing Linear Discriminant Analysis to Regression.*
   - OSCAR Project Spring 2019, continuing EXTREEMS research.
   - Paper in preparation: *Supervised Dimensionality Reduction Methods for Feature Identification.*
   - Presented at SUMS Conference at JMU.
5. Andrew Kim, Spring 2020 - current (High school student)
   - Co-mentoring with Deanna Easley
   - Paper in preparation: *Tensor Eigenvalue Inequalities and Approximate Rank-1 Decomposition.*
6. Ruben Ascoli, Summer 2018 - Spring 2019 (High school student at the time)
   - Published in SIURO: *Limitations of Richardson Extrapolation for Kernel Density Estimation.*
   - Presented at SUMS Conference at JMU
7. Co-mentored Jiajing Guan with Tim Sauer, led to publication in PRE: *Limits on reconstruction of dynamics in networks* with J. Guan as first author.
8. Co-mentored Chris R Carlson with John Cressman (physics), "Pattern Steering for Multistability".
9. Co-mentored Wonjun Lee with Tim Sauer, Wonjun became a graduate student at UCLA.

INVITED TALKS (2017-present. Items 1-20 given while Assistant Professor at GMU)

1. SIAM Dynamical Systems Minisymposium (Virtual). *Optimal Bases and Frames for Data-Driven Forecasting,* May 25, 2021. http://math.gmu.edu/~berry/Presentations/SIAMDS2021.pdf

2. Non-linear Analysis Seminar (NC State, Virtual). *A Manifold Learning Approach to Boundary Value Problems,* April 7, 2021. http://math.gmu.edu/~berry/Presentations/NCSU2021.pdf

3. Applied and Computational Mathematics Division (ACMD) Seminar Series (NIST, Virtual). *Model-free forecasting with applications to multi-sensor arrays,* March 16, 2021. http://math.gmu.edu/~berry/Presentations/NIST2021.pdf

4. Workshop on Mathematical Machine Learning and Applications (PSU, Virtual). *Optimal bases for data-driven estimation of forecast operators,* Dec. 15, 2020. http://math.gmu.edu/~berry/Presentations/PSU2020.pdf

5. BioMath Seminar (VCU), *Overcoming Model Uncertainty in Data Assimilation,* Nov. 1, 2019. http://math.gmu.edu/~berry/Presentations/BioTalkVCU.pdf

6. Statistics Seminar, UW-Madison. *The Mathematics and Statistics of Manifold Learning,* Oct. 9, 2019. http://math.gmu.edu/~berry/Presentations/madison.pdf

7. Clarkson Center for Complex Systems Science Colloquium. *Data-driven representation of dynamical systems,* Clarkson, Sept. 20, 2019. http://math.gmu.edu/~berry/Presentations/TyrusBerryClarkson.pdf

8. Dynamics Days 2020 Conference, Virtual. *Optimal bases for data-driven estimation of forecast operators,* Aug. 26, 2020. http://math.gmu.edu/~berry/Presentations/DDD2020.pdf

9. ICIAM 2019 Conference, Valencia, Spain. *Data-driven forecasting for projections of complex systems,* July 16, 2019. http://math.gmu.edu/~berry/Presentations/TyrusBerryICIAM.pdf

10. SIAM DS19 Conference, Snowbird, UT. *Spectral Exterior Calculus for Dynamics,* May 21, 2019. http://math.gmu.edu/~berry/Presentations/SEC.pdf

11. Math Awareness Conference, ODU. *The Mathematics of Manifold Learning,* April 6, 2019. http://math.gmu.edu/~berry/Presentations/2019ODU.pdf

12. Norbert Wiener Center Seminar, UMD. *Spectral Exterior Calculus,* March 5, 2019. http://math.gmu.edu/~berry/Presentations/SECnotes.pdf

13. Bioengineering Seminar, GMU. *Overcoming Model Uncertainty: Integrating machine learning tools into parametric models,* February 21, 2019. http://math.gmu.edu/~berry/Presentations/BioTalk.pdf

14. Applied Math Colloquium, UMBC. *The interplay of mathematics and statistics in manifold learning,* February 15, 2019. http://math.gmu.edu/~berry/Presentations/UMBC.pdf

15. Joint Math Meetings 2019, Baltimore, MD. *Overcoming model and observation error in data assimilation using manifold learning,* January 17, 2019. http://math.gmu.edu/~berry/Presentations/JMM.pdf

16. RTG Parameter Estimation Workshop, NCSU. *Introduction to Data Assimilation and Kalman Filtering,* July 28, 2018. http://math.gmu.edu/~berry/Presentations/KalmanTutorial.pdf

17. SIAM Uncertainty Quantification Conference, Garden Grove, CA, *Data-driven Correction of Model and Representation Error in Data Assimilation,* April 18, 2018. http://math.gmu.edu/~berry/Presentations/RKHStalk2.pdf

18. Physics Colloquium, GMU. *Forecasting without a model and with an imperfect model,* March 23, 2018. http://math.gmu.edu/~berry/Presentations/GMUphysics.pdf

19. Topology, Arithmetic and Dynamics Seminar, GMU. *Spectral Exterior Calculus,* Feb 9, 2018. http://math.gmu.edu/~berry/Presentations/TADs2018.pdf

20. Applied Math Seminar, JHU. *What geometries can we learn from data?* Nov. 15, 2017. http://math.gmu.edu/~berry/Presentations/JHU2017.pdf

21. PSU-UMD Data Assimilation Workshop. *Correcting biased observation model error in data assimilation,* June 27, 2017. http://math.gmu.edu/~berry/Presentations/RKHS.pdf

22. Extreems Seminar, GMU. *The Quest for Variance : PCA, MDS and ISOMAP,* June 26, 2017. http://math.gmu.edu/~berry/Presentations/PCAMDS.pdf

23. SIAM DS17 Conference, Snowbird, UT. *Data-Driven Correction of Model Error for Forecasting,* May 24, 2017. http://math.gmu.edu/~berry/Presentations/FilteringSnowbird.pdf

24. Idea Testing Session, GMU. *Model Based and Model Free Approaches to Data.* April 7, 2017. http://math.gmu.edu/~berry/Presentations/SmallTalk.pdf

25. Topology, Arithmetic and Dynamics Seminar, GMU. *Accessing geometry via function spaces,* March 10, 2017. http://math.gmu.edu/~berry/Presentations/TADs.pdf

26. Mathematical Biology Seminar, NJIT. *Data assimilation with and without a model.* Feb. 28, 2017. http://math.gmu.edu/~berry/Presentations/njit.pdf

27. Mathematical Sciences Colloquium, GMU, *Learning manifolds from data.* Feb. 24, 2017. http://math.gmu.edu/~berry/Presentations/BerryGMU.pdf

28. Statistics Seminar, GMU. *The crucial role of statistics in manifold learning,* Feb. 10, 2017. http://math.gmu.edu/~berry/Presentations/stats.pdf

SOFTWARE PACKAGES DEVELOPED

Matlab code available at http://math.gmu.edu/~berry/Software.html or by request for DMDC also at https://github.com/tyrusberry?tab=repositories

1. **Spectral Exterior Calculus** - Constructs the Laplacian on differential 1-forms and computes tranformations between frames and bases for Hilbert/Sobolev spaces of 1-forms developed in the *Spectral Exterior Calculus* manuscript in press at CPAM.

2. **Continuous k-Nearest Neighbors (CkNN) Clustering** - Fast multi-scale clustering algorithm based on the CkNN graph Laplacian developed with T. Sauer in *Consistent Manifold Representation for Topological Data Analysis* and the thesis work of M. Vasquez.

3. **Diffusion Forecast** - Model free probabilistic forecast for time-series data, used to obtain state-of-the-art prediction skill on the El-Nino index. Developed with J. Harlim and D. Giannakis in *Nonparametric forecasting of low-dimensional dynamical systems.*

4. **Kalman-Takens Filter** - Model free state estimation and time-series denoising by combining Takens reconstruction and the Ensemble Kalman Filter (EnKF) developed with T. Sauer and F. Hamilton in *Ensemble Kalman filtering without a model.*

5. **Kernel Density Estimator for Manifolds with Boundary** - Estimates the distance-to-boundary function for a data set without any prior knowledge of the boundary location. Returns an unbiased density estimator that is consistent in the interior and at the boundary.

6. **Higher Order Unscented Transform** (joint work with primary author Deanna Easley) - Given the mean, variance, skewness, and kurtosis tensors of any distribution, produces a small set of quadrature points and weights that exactly match these four moments and are ideal for estimating expectations of regular functions.

7. **SIRH Model and Poisson Kalman Filter** (joint work with Donald Ebeigbe) - A Kalman filter optimized for Poisson observations along with example code based on the novel SIRH compartmental disease model for tracking neonatal sepsis and infant hydrocephalus.

8. **Diffusion Mapped Delay Coordinates (DMDC)** - Finds intrinsic coordinates and separates time scales for very high dimensional time series such as video data. Developed with R. Cressman, Z. Greguric-Ferencek, T. Sauer in *Time-scale separation from diffusion-mapped delay coordinates.*