Rudy Geelen

Postdoctoral Researcher
Oden Institute for Computational Engineering and Sciences
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RESEARCH INTERESTS

- Reduced-order and data-driven modeling of complex systems
- Scientific machine learning
- Computational mechanics
- Modeling and failure in engineering materials
- Multiscale modeling and simulation
- Numerical methods in engineering

PROFESSIONAL EXPERIENCE

Postdoctoral Researcher *Apr. 2020 – present*
Oden Institute for Computational Engineering and Sciences
The University of Texas at Austin, Austin, TX
Advisor: Karen E. Willcox

Doctoral Researcher *Aug. 2015 – March 2020*
Department of Mechanical Engineering & Materials Science
Duke University, Durham, NC
Advisor: John E. Dolbow

Student Employee *Nov. 2014 – July 2015*
Department of Mechanical Engineering
Eindhoven University of Technology, Eindhoven, the Netherlands
Advisor: Joris Remmers

Visiting Student *Aug. 2012 – Jan. 2013*
Computational Mechanics Research Laboratory
Johns Hopkins University, Baltimore, MD
Advisor: Somnath Ghosh

EDUCATION

Ph.D. in Mechanical Engineering *Aug. 2015 – Apr. 2020*
Dissertation: *Towards simulations of pervasive fracture across structural scales*
Department of Mechanical Engineering & Materials Science
Duke University, Durham, NC
Advisor: John E. Dolbow

M.S. in Mechanical Engineering *2011 – Nov. 2014*
Thesis: *The analysis of complex crack growth using the partition of unity method*
Department of Mechanical Engineering
Eindhoven University of Technology, Eindhoven, the Netherlands
Advisors: Joris Remmers & Marc Geers

B.S. in Mechanical Engineering *2008 – 2011*
Department of Mechanical Engineering
Eindhoven University of Technology, Eindhoven, the Netherlands

JOURNAL ARTICLES

9. **R. Geelen**, L. Balzano, S. Wright and K. Willcox. Learning physics-based reduced-order models from data using nonlinear manifolds. *Chaos: An Interdisciplinary Journal of Nonlinear Science*, doi.org/10.48550/arXiv.2308.02802. (**under review**)
8. P. Buchfink, **R. Geelen**, S. Glas, B. Krämer, M. Hongliang and H. Sharma. Hamiltonian model order reduction on symplectic quadratic manifolds. *Computer Methods in Applied Mechanics and Engineering*. doi.org/10.1016/j.cma.2023.116402. (2023)
7. **R. Geelen**, S. Wright and K. Willcox. Operator inference for non-intrusive model reduction with quadratic manifolds. *Computer Methods in Applied Mechanics and Engineering*. Volume 403, Part B, 115717, doi:10.1016/j.cma.2022.115717. (2023)
6. **R. Geelen** and K. Willcox. Localized non-intrusive reduced-order modeling in the operator inference framework. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Science*, 380:20210206, doi:10.1098/rsta.2021.0206. (2022)
5. **R. Geelen**, J. Plews, M. Tupek and J. Dolbow. Scale-bridging with the extended/generalized finite element method for linear elastodynamics. *Computational Mechanics* 68, pp.295-310, doi:10.1007/s00466-021-02032-2. (2020)
4. C. Rhea, J. Hlavacek-Larrondo, R. Kraft, A. Bogdan, **R. Geelen**. A Data-driven Approach to X-Ray Spectral Fitting: Quasi-deconvolution. *Research Notes of the AAS*, 5 (5), 113, doi:10.3847/2515-5172/ac00c2. (2020)
3. **R. Geelen**, J. Plews, M. Tupek and J. Dolbow. An extended/generalized phase–field finite element method for crack growth with global–local enrichment. *International Journal for Numerical Methods in Engineering*, 121(11), pp.2534–2557, doi:10.1002/nme.6318. (2020)
2. **R. Geelen**, Y. Liu, T. Hu, M. Tupek and J. Dolbow. A phase-field formulation for dynamic cohesive fracture. *Computer Methods in Applied Mechanics and Engineering*. Volume 348, pp.680–711, doi:10.1016/j.cma.2019.01.026. (2019)
1. **R. Geelen**, Y. Liu, J. Dolbow and A. Rodríguez-Ferran. An optimization-based phase-field method for continuous-discontinuous crack propagation. *International Journal for Numerical Methods in Engineering*, 116(1), pp.1–20, doi:10.1002/nme.5911. (2018)

REFEREED CONFERENCE PROCEEDINGS

2. A. Kalur, P. Mortimer, J. Sirohi, **R. Geelen**, and K. Willcox. Data-driven closures for the dynamic mode decomposition using quadratic manifolds. *AIAA Aviation 2023 Forum* (p. 4352), doi.org/10.2514/6.2023-4352. (2023)
1. **R. Geelen**, L. Balzano and K. Willcox. Learning latent representations in high-dimensional state spaces using polynomial manifold constructions. *IEEE Conference on Decision and Control*, Dec. 13-15, 2023, Singapore, doi.org/10.48550/arXiv.2306.13748. (**accepted**)

JOURNAL ARTICLES IN PREPARATION

1. **R. Geelen**, I. Farças, and K. Willcox. A variational multiscale perspective on nonlinear model reduction: application to rocket engine combustion problems. (**in preparation**)

TEACHING

- Assisting Professor Dolbow in teaching Nonlinear Finite Element Analysis (ME525/CEE630, ∼10 students), Spring 2019, lecturing on Newton-Raphson based strategies, line-search methods, nonlinear elasticity and multidimensional plasticity.
- Lead Teaching Assistant for Introduction to Finite Element Analysis (ME524, ∼50 students) under Professor Aquino (Fall 2016) and Professor Dolbow (Fall 2017). Responsibilities included giving lectures, have office hours, and grading homework.

MENTORING

- Yujia (Judy) Hao – Oden Institute, 2023–present
- Megan Ogle – Duke, 2018 (Duke Research Experience for Undergraduates)

PROFESSIONAL ACTIVITIES

- **Journal reviewer** (6): Computer Methods in Applied Mechanics and Engineering ∘ Finite Elements in Analysis and Design ∘ Journal of Computational Physics ∘ International Journal for Numerical Methods in Engineering ∘ Advances in Computational Mathematics ∘ Chaos: An Interdisciplinary Journal of Nonlinear Science
- **Memberships** (2): U.S. Association for Computational Mechanics (USACM) ∘ Society for Industrial and Applied Mathematics (SIAM) Early Career Membership

AWARDS & HONORS

- **IOP Early Career Researcher Prize**, Physics Enhancing Machine Learning in Applied Solid Mechanics workshop (12/12/2022, IOP, London), £100 Cash Award.
- **Peter O'Donnel Jr. Postdoctoral Fellowship**, Oden Institute for Computational Engineering and Sciences, the University of Texas at Austin, 2020-2021. Performance-based renewal for granted for 2021–2022.
- **Duke University Outstanding Dissertation Award**, Department of Mechanical Engineering & Materials Science, 2020
- **USACM Travel Fellowship**, 15th US National Congress on Computational Mechanics, 2019
- **Duke Graduate School Travel Award**, 13th World Congress in Computational Mechanics, 2018
- **Graduate Fellowship**, Duke University, 2015
- **Fulbright Belgium Finalist**, 2015
- **Graduated With *Great Appreciation***, Eindhoven University of Technology, 2014

INVITED TALKS & SEMINARS

12. Learning physics-based reduced-order models from data using nonlinear manifolds. *Design++ Seminar Series, ETH Zürich*, Zürich, November 2023.
11. Learning physics-based reduced-order models from data using nonlinear manifolds. *Sandia National Laboratories – Computer Science Research Institute (CSRI) seminar*, Albuquerque, NM, November 2023.
10. Learning physics-based reduced-order models from data using nonlinear manifolds. *Centre for Analysis, Scientific Computing and Applications*, Eindhoven University of Technology, June 2023.
9. Learning physics-based reduced-order models from data using polynomial manifold constructions. *Control Systems & Dynamics Seminar*, University of California San Diego, April 2023.
8. Learning physics-based reduced-order models from data using quadratic manifolds. *Φ-ML Meets Engineering – Seminar Series*, the Alan Turing Institute, virtual seminar, February 2023.
7. Learning physics-based reduced-order models from data using manifold constructions. *TU Delft, Faculty of Civil Engineering and Geosciences*, virtual seminar, 2022.
6. Learning physics-based reduced-order models from data using quadratic manifolds. *IBM Professional Interest Community – Dynamical Systems (IBM Research Brazil)*, virtual seminar, 2022.
5. Operator inference for non-intrusive model reduction with quadratic manifolds. *RWTH Aachen, Faculty of Civil Engineering*, virtual seminar, 2022.
4. Learning physics-based reduced-order models from data using quadratic manifolds. *Babuška Forum Seminar*, Austin, TX, USA, 2022.
3. Recent Advances in the Computational Modeling of Pervasive Fracture. *Duke MEMS Graduate Student Seminar Series*, Durham, NC, USA, 2018.
2. Advances in Gradient Damage Models for Modeling Fracture. *Sandia National Laboratories*, Albuquerque, NM, USA, 2018.
1. An Optimization Based Phase Field Approach for Continuous-Discontinuous Crack Propagation. *Duke MEMS Graduate Student Seminar Series*, Durham, NC, USA, 2017.

CONFERENCE PRESENTATIONS & WORKSHOPS

14. Learning Learning Latent Representations in High-Dimensional State Spaces Using Polynomial Manifold Constructions. *62nd IEEE Conference on Decision and Control (CDC 2023)*, Marina Bay Sands, Singapore, December 2023.
13. Learning Physics-based Reduced-order Models from Data using Quadratic Manifolds. *AIAA SciTech Forum 2023*, virtual seminar, 2023.

12. Learning Physics-Based Reduced-Order Models From Data Using Quadratic Manifolds. *Physics Enhancing Machine Learning in Applied Solid Mechanics workshop*, Institute of Physics Applied Solid Mechanics group, virtual seminar, 2022. (**Early Career Researcher Prize**)
11. Operator inference for non-intrusive model reduction with quadratic manifolds. *The 5th Annual Meeting of the SIAM Texas-Louisiana Section*, Houston, TX, USA, 2022.
10. Operator inference for non-intrusive model reduction with nonlinear manifolds. *RISE of the Machines: Robust, Interpretable, Scalable, Efficient Decision Support – Project Workshop*, Austin, TX, USA, 2022.
9. Operator inference for non-intrusive model reduction with nonlinear manifolds. *The 19th U.S. National Congress on Theoretical and Applied Mechanics*, Austin, TX, USA, 2022.
8. Operator inference for non-intrusive model reduction with nonlinear manifolds. *SIAM Conference on Uncertainty Quantification (UQ22)*, Atlanta, GA, USA, 2022.
7. Localized non-intrusive reduced-order modeling in the operator inference framework. *Institute of High Performance Computing (IHPC), A*STAR virtual workshop*, 2021.
6. Localized non-intrusive reduced-order modeling in the operator inference framework. *EUROMECH colloquium 618 – Uncertainty Quantification in Computational Mechanics*, virtual workshop, 2021.
5. Localized non-intrusive reduced-order modeling in the operator inference framework. *Mechanistic Machine Learning and Digital Twins for Computational Science, Engineering & Technology*, virtual conference, 2021.
4. Localized non-intrusive reduced-order modeling in the operator inference framework. *The 16th U.S. National Congress on Computational Mechanics*, virtual conference, 2021.
3. An Extended/Generalized Phase–field Finite Element Method for Fracture with Global–Local Enrichment. *The 15th U.S. National Congress on Computational Mechanics*, Austin, TX, USA, 2019.
2. A Phase-field Formulation for Dynamic Cohesive Fracture. *The 13th World Congress on Computational Mechanics*, New York, NY, USA, 2018.
1. An Optimization Based Phase Field Model for Continuous-Discontinuous Fracture. *The 14th U.S. National Congress on Computational Mechanics*, Montréal, Canada, 2017.

as of October 2023