FEDERICO FUENTES

Malott Hall, Office 582, 301 Tower Rd
Ithaca, NY 14853, USA
+1 (607) 255-4959
https://federicofuentes.github.io/
federico.fuentes@cornell.edu

EMPLOYMENT

Cornell University, **H.C. Wang Assistant Professor** of Mathematics**,** Ithaca, NY, USA, Jul. 2018-

RESEARCH INTERESTS

Numerical analysis, functional analysis, solid mechanics, fluid mechanics, hydrodynamic stability, finite element methods, computational mechanics, function spaces, polynomial optimization

EDUCATION

The University of Texas at Austin, *Oden Institute* (formerly *ICES*), Austin, TX, USA, May, 2018
    Ph.D. in Computational Science, Engineering and Mathematics (Opt.: Computational and Applied Mathematics)
    Various applications of discontinuous Petrov-Galerkin (DPG) finite element methods
    Supervisor: Leszek Demkowicz
    Committee: Ivo Babuška, Luis A. Caffarelli, Thomas J. R. Hughes, J. Tinsley Oden, Aleta Wilder

Imperial College London, London, UK, 2013
    M.Sc. in Advanced Computational Methods for Aeronautics, Flow Management and Fluid-Structure Interaction
    Global stability of plane Couette flow using sum of squares techniques
    Supervisor: Sergei Chernyshenko
    Honors: Distinction, Best Overall M.Sc. Student, Best M.Sc. Research Project

Universidad de los Andes, Bogotá D.C., Colombia, 2012
    B.Sc. in Mathematics
    B.Sc. in Mechanical Engineering (Minor: Biomedical Engineering)
    Honors: Graduated first in class in both Mathematics and Mechanical Engineering.

RESEARCH GRANTS

National Science Foundation (NSF) grant (as sole PI), *Polynomial Optimization and Finite Element Methods for Nonlinear Mechanics*, $114,000

RESEARCH EXPERIENCE

Cornell University, Ithaca, NY, USA, 2018-
Global stability in fluid mechanics, polynomial optimization in finite element discretizations to study nonlinear mechanics, shape-independent constants in hp estimates of finite element methods

Geophysical Fluid Dynamics Program, WHOI, Woods Hole, MA, USA, Jun.-Aug. 2017
Global stability of 2D plane Couette flow (with David Goluskin)

The University of Texas at Austin, Austin, TX, USA, 2013-2018 (with Leszek Demkowicz)
High-order exact sequence shape functions, DPG and DLS finite element methodologies, PolyDPG: high-order polygonal finite element methods, different variational formulations of linear elasticity, validation of DMA viscoelastic experiments, boundary traces of Sobolev spaces

Imperial College London, London, UK, 2012-2013 (with Sergei Chernyshenko)
Global stability of fluids via sum-of-squares optimization

Universidad de los Andes, Bogotá D.C., Colombia, 2006-2012
Isogeometric analysis in hyperelastic materials (with V. Calo), contour dynamics in bounded domains (with J. R. Toro), second order differential operators (with M. Winklmeier), duct fitting losses (with O. López), wind tunnel experiments of prototype of the *Triplaris americana* seed (with A. Pinilla)

Leibniz Universität Hannover, Hannover, Germany, May-Aug. 2009
Aerodynamics of the *Triplaris americana* seed (with J. Seume and A. Gómez)

TEACHING EXPERIENCE

Cornell University, Ithaca, NY, USA, 2018-

Lecturer:
- Calculus II (2020)
- Finite Mathematics for the Life and Social Sciences (2019)
- Numerical Analysis and Differential Equations (2018, 2019)
- Calculus III (2019)
- Honors Introduction to Analysis I (2018)

The University of Texas at Austin, Austin, TX, USA, 2013-2018

Teaching Assistant:
- Numerical Methods for Applications (T. Arbogast)
- Functional Analysis in Theoretical Mechanics (L. Demkowicz)
- Introduction to Mathematical Modeling in Science and Engineering (R. Moser)

Professional Development:
- College of Natural Sciences Graduate Concentration in Undergraduate Teaching and Mentoring
- Teaching Preparation Certificate for Teaching Assistants
- Inclusive Classrooms Leadership Certificate Seminar
- Student Employee Excellence Certificate

Universidad de los Andes, Bogotá D.C., Colombia, 2006-2012

Teaching Assistant:
- Integral Calculus and Differential Equations (L. J. Corredor)
- Integral Calculus and Differential Equations (M. Winklmeier)

AWARDS AND HONORS

- NSF research grant recipient (sole PI), NSF, 2020
- H.C. Wang Assistant Professorship, Cornell, 2018
- Geophysical Fluid Dynamics Fellowship, WHOI, 2017
- Professional Development Award, The University of Texas at Austin, 2017
- Graduate School Recruitment Fellowship, The University of Texas at Austin, 2013
- Robert Bird Group award for Best M.Sc. Research Project, Aeronautics Dpmt., Imperial College London, 2013
- Best Overall M.Sc. Student, Department of Aeronautics, Imperial College London, 2013
- COLFUTURO Scholarship Recipient for Colombian postgraduates studying overseas, 2012
- Graduated top of the class in B.Sc. in Mathematics, Universidad de los Andes, 2012
- Graduated top of the class in B.Sc. in Mechanical Engineering, Universidad de los Andes, 2012
- Among Best Saber Pro Scores (nationwide exam for all Colombian university graduates), 2011
- Semester Academic Excellence Scholarships, Universidad de los Andes, 2007, 2010, 2011
- Ramón de Zubiría Scholarship, Universidad de los Andes, 2009
- Best International Baccalaureate (IB) score, The English School (Colombia), 2006
- Medal for top 5 in the XXIV Colombian Mathematics Olympics, 2005

TECHNICAL SKILLS AND LANGUAGES

- MATLAB, Fortran, Python, VBA, Java
- ANSYS, SOLIDWORKS, Solid Edge, LaTeX, Sublime, Ipe, Inkscape, ParaView, matplotlib
- Linux, Windows and Mac, bash, makefiles, compilers (intel and GNU), version control systems (Git, SVN)
- Software developer for (see also github.com/federicofuentes):
  - In-house adaptive 2D and 3D high-order finite element codes called *hp2d* and *hp3d*
  - ESEAS high-order shape functions library
  - PolyDPG codes for polygonal finite element methods (www.polydpg.com)
  - In-house fluid stability codes using semidefinite programming
- Fluent in Spanish and English

PROFESSIONAL AFFILIATIONS

- American Mathematical Society (AMS)
- Society for Industrial and Applied Mathematics (SIAM)
- U.S. Association for Computational Mechanics (USACM)
- American Physical Society (APS)

ACADEMIC SERVICE

- Judge in *Cornell Mathematical Contest in Modeling*, 2018-2019
- Host of the ICES Babuška Forum at the University of Texas at Austin, 2017-2018
- Referee for scientific journals: *Computers & Mathematics with Applications*, *Computer Methods in Applied Mechanics and Engineering*

PUBLICATIONS

Journal Articles

- Fuentes, F., Goluskin, D., and Chernyshenko, S. (2019) Global stability of fluid flows despite transient growth of energy. *ArXiv e-prints*, arXiv:1911.09079. Preprint submitted.
- Vaziri Astaneh, A., Fuentes, F., Mora, J., and Demkowicz, L. (2018). High-order polygonal discontinuous Petrov-Galerkin (PolyDPG) methods using ultraweak formulations. *Comput. Methods Appl. Mech. Engrg.*, 332:686-711.
- Keith, B., Petrides, S., Fuentes, F., and Demkowicz, L. (2017). Discrete least-squares finite element methods. *Comput. Methods Appl. Mech. Engrg.*, 327:226-255.
- Fuentes, F., Demkowicz, L., and Wilder, A. (2017). Using a DPG method to validate DMA experimental calibration of viscoelastic materials. *Comput. Methods Appl. Mech. Engrg.*, 325:748-765.
- Fuentes, F., Keith, B., Demkowicz, L., and Le Tallec, P. (2017). Coupled variational formulations of linear elasticity and the DPG methodology. *J. Comput. Phys.*, 348:715-731.
- Keith, B., Fuentes, F., and Demkowicz, L. (2016). The DPG methodology applied to different variational formulations of linear elasticity. *Comput. Methods Appl. Mech. Engrg.*, 309:579-609.
- Huang, D., Chernyshenko, S., Goulart, P., Lasagna, D., Tutty, O., and Fuentes, F. (2015). Sum-of-squares of polynomials approach to nonlinear stability of fluid flows: an example of application. *Proc. R. Soc. A*, 471(2183).
- Fuentes, F., Keith, B., Demkowicz, L., and Nagaraj, S. (2015). Orientation embedded high order shape functions for the exact sequence elements of all shapes. *Comput. Math. Appl.*, 70(4):353-458.

Conference Papers

- Bernal, L. M., Calo, V. M., Collier, N., Espinosa, G. A., Fuentes, F., and Mahecha, J. C. (2013). Isogeometric analysis of hyperelastic materials using PetIGA. *Procedia Computer Science*, 18:1604-1613. 2013 International Conference on Computational Science (ICCS).

In preparation

- Fuentes, F., Demkowicz, L., and Wilder A. Using high-order DPG finite element methods to study form-wound medium-voltage coils.
- Fuentes, F. and Demkowicz, L. Lipschitz boundary trace theorems in fractional H^s(curl) spaces.
- Fuentes, F. and Fantuzzi, G. Global optimization of nonlinear functionals using finite element discretizations and polynomial optimization.

CONFERENCE PRESENTATIONS

Talks

- Global stability of fluid flows despite transient growth of energy. Cornell Dynamics Seminar. Cornell University, Ithaca, NY, USA, March, 2020.
- Using high-order DPG finite element methods to study form-wound medium-voltage coils. 15th U.S. National Congress on Computational Mechanics (USNCCM). Austin, TX, USA, August, 2019.

- Global stability of 2D plane Couette flow beyond the energy stability limit. Workshop: Scientific Computing Across Scales: Extreme Events and Criticality in Fluid Mechanics. The Fields Institute for Research in Mathematical Sciences, University of Toronto, Toronto, ON, Canada, April, 2019.
- Global stability of 2D plane Couette flow beyond the energy stability limit. AMS Sectional Meeting, Special Session on Analytical and Numerical Aspects of Turbulent Transport. University of Michigan, Ann Arbor, Ann Arbor, MI, USA, October, 2018.
- Various applications of discontinuous Petrov-Galerkin (DPG) finite element methods. Scientific Computing and Numerics (SCAN) Seminar. Cornell University, Ithaca, NY, USA, August, 2018.
- Various applications of discontinuous Petrov-Galerkin (DPG) finite element methods. PhD Dissertation Defense. The University of Texas at Austin, Austin, TX, USA, April, 2018.
- Global stability of plane Couette flow beyond the energy stability limit. 70th Annual Meeting of the American Physical Society Division of Fluid Dynamics. Denver, CO, USA, November, 2017.
- Insulation integrity for power-dense, medium voltage, electric machinery (with Aleta Wilder). Office of Naval Research (ONR) Peer Review in Controls, Electromagnetism, and Power Electronics. Naval Postgraduate School, Monterey, CA, USA, November, 2017.
- Discrete least-squares (DLS) and polygonal discontinuous Petrov-Galerkin (PolyDPG) finite element methods. Third Minimum Residual and Least Squares Finite Element Methods Workshop. Portland State University, Portland, OR, USA, October, 2017.
- Global stability of 2D plane Couette flow beyond the energy stability limit. Texas Applied Mathematics and Engineering Symposium (TAMES). The University of Texas at Austin, Austin, TX, USA, September, 2017.
- Global stability of two-dimensional plane Couette flow beyond the energy stability limit. 2017 Geophysical Fluid Dynamics Program. Woods Hole Oceanographic Institute (WHOI), Woods Hole, MA, USA, August, 2017.
- Various applications of the DPG methodology. Oberwolfach Seminar: Discontinuous Petrov-Galerkin Methods. Mathematisches Forschungsinstitut Oberwolfach (MFO, Oberwolfach Research Institute for Mathematics), Oberwolfach, Germany, June, 2017.
- Using discontinuous minimum residual methods to simulate DMA experiments in linear viscoelasticity. 2017 Finite Element Rodeo. University of Houston, Houston, TX, USA, March, 2017.
- Using discontinuous minimum residual methods to validate DMA experimental calibration results in linear viscoelasticity. SIAM Conference on Computational Science and Engineering (CSE) 2017. Atlanta, GA, USA, February-March, 2017.
- Minimum residual methods applied to linear thermoviscoelasticity. The Mathematics of Finite Elements and Applications (MAFELAP) 2016. Brunel University London, London, UK, June, 2016.
- Minimum residual methods in linear thermoviscoelasticity. 2016 Finite Element Rodeo. Texas A&M University, College St., TX, USA, March, 2016.
- The DPG methodology applied to various variational formulations of linear elasticity. Second Minimum Residual and Least Squares Finite Element Methods Workshop. Delft University of Technology, Delft, Netherlands, November, 2015.
- High Order Shape Functions for Exact Sequence Elements of All Shapes. Part II. Pyramid. 13th U.S. National Congress on Computational Mechanics (USNCCM). San Diego, CA, USA, July, 2015.
- High Order Shape Functions for Exact Sequence Elements of All Shapes. Part II. Pyramid. 2015 Finite Element Rodeo. Southern Methodist University, Dallas, TX, USA, February, 2015.

Posters

- Using discontinuous minimum residual methods to validate DMA experiments of viscoelastic materials. Workshop for Advances in Computational Sciences and Engineering (Oden 80 years). The University of Texas at Austin, Austin, TX, USA, March, 2017.
- Minimum residual methods in linear thermoviscoelasticity. Workshop for Advances in Mathematics for Finite Elements (Babuška 90 years). The University of Texas at Austin, Austin, TX, USA, March, 2016.
- Pyramid High Order Exact Sequence Shape Functions. Polytopal Element Methods in Mathematics and Engineering. Georgia Institute of Technology, Atlanta, GA, USA, October, 2015.

- Pyramid High Order Exact Sequence Shape Functions. Advanced Numerical Methods in the Mathematical Sciences. Texas A&M University, College St., TX, USA, May, 2015.
- Orientation Embedded Finite Element (FE) Shape Functions for the Exact Sequence Elements of All Shapes. Sixth International Workshop on High-Order Finite Element and Isogeometric Methods (HOFEIM). Frauenchiemsee Island, Germany, July, 2014.