

Derek DeSantis

TA-3, Bldg 1690, Room 136, Los Alamos, NM
ddesantis@lanl.gov • +1 (805) 509-6579 • <http://www.derekdesantis.com>

EDUCATION

- Postdoc in Mathematical Machine Learning & Climate Science** 2019 – Current
- Los Alamos National Labs - Center for Nonlinear Studies
 - Postdoc Advisors: Phillip Wolfram, Boian Alexandrov
- Ph.D. in Mathematics** 2014 – 2019
- University of Nebraska - Lincoln
 - Thesis Advisor: David Pitts
 - Thesis Title: Operator Algebras Generated by Left Invertibles
- Masters in Mathematics** 2012 – 2014
- University of Nebraska - Lincoln
- B.S. in Mathematics and Applied Physics** 2007 – 2012
- California State University - Channel Islands
 - Graduated with both Mathematics and Physics Program Honors
 - Advanced Math GPA: 4.00 / 4.00, Advanced Physics GPA: 3.9 / 4.00

RESEARCH INTERESTS

- Earth System Science:**
Machine learning approaches to discovering latent climatic processes, developing coupled ESM model diagnostics, performing model initialization.
- Machine Learning/Data Science:**
Interpretability and robustness methods, in particular with regards to (large scale) unsupervised machine learning. I am also interested in connections between single operator theory and machine learning (e.g. Koopman theory and kernel based methods).
- Mathematics:**
Mathematical machine learning, non-self adjoint operator algebras, operator theory, and harmonic analysis.

SELECT AWARDS & SCHOLARSHIPS

- NSF Mathematics Sciences Graduate Internship** 2018
Competitive internship giving graduate students in mathematics the chance to work on problems at a national lab. Worked at Los Alamos designing a large scale unsupervised machine learning model to predict where climate biomes are changing.
- Emeritus Faculty Fellow** 2016 – 2017
Departmental award given to doctoral students in support of research.
- Chancellor's Fellowship** 2012 – 2014
Chancellor's Fellowships are designed to assist departments with the recruitment of superior graduate students by adding fellowship funds to an assistantship.
- Sally Casanova Scholar** 2012 – 2014
Competitive grant that provided funds for summer research at a doctoral granting institution of choice, along with funds for travel and graduate school applications. Worked with Dr. Akemann at UC Santa Barbra on the Kadison-Singer problem.
- NSF-LSAMP Scholar** 2009 – 2010
Grant geared towards STEM students in disadvantaged socioeconomic backgrounds

PUBLICATIONS

- [10] D. Comeau, D. DeSantis, "Interpretable depth-based clustering for analyzing water masses," *In preparation*.
- [9] B. Alexandrov, D. Comeau, D. DeSantis, R. Vangara, "Interpretable latent climate signatures in MPAS-O Southern Ocean via nonnegative tensor factorization," *In preparation*.
- [8] D. DeSantis, "CEC - A cluster ensemble method for detecting consistent signatures," *In preparation*.
- [7] D. DeSantis, E. Skau, B. Alexandrov, "Factorizations of Binary Matrices – Rank Relations and the Uniqueness of Boolean Decompositions," *Submitted for publication*.
- [6] D. DeSantis, P. J. Wolfram, K. Bennett, B. Alexandrov, "Coarse-grain cluster analysis of tensors with application to climate biome identification," *Derek DeSantis et al 2020 Mach. Learn.: Sci. Technol. 1 045020*.
- [5] B. Alexandrov, D. DeSantis, G. Manzini, E. Skau, "Nonnegative Canonical Polyadic Decomposition with Rank Deficient Factors," *Submitted for publication*.
- [4] D. DeSantis, "Operator Algebras Generated by Left Invertibles," *Submitted for publication*.

- [3] D. DeSantis, K. Leonard, “Error Correction for Fire Growth Modeling,” *Proceedings of the International Workshop on Agricultural and Environmental Information and Decision Support Systems (IAEIDSS 2013)*, Springer Lecture Notes in Computer Science, pp. 216–227, 2013.
- [2] D. DeSantis, R. Field, W. Hough, B. Jones, R. Meissen, J. Ziefle, “Permutation Pattern Avoidance and the Catalan Triangle,” *Missouri Journal of Mathematical Sciences*, vol. 25, is. 1, pp. 50–60, 2013.
- [1] L. Contreras, D. DeSantis, K. Leonard, “On the geometric deformations of functions in $L^2(D)$,” *Involve*, vol. 6, no. 2, pp. 233–241, Sep 2013.

SERVICES

- CNLS Graduate Student Seminar Organizer 2021 – Current
A seminar run postdocs within the Center for Nonlinear Studies. Postdocs and visiting graduate students present research talks, alongside informal presentations about conversion and funding opportunities.
- Operator Theory Reading Seminar Founder 2014 – 2019
Co-founder of graduate student organized seminar in operator theory. The focus of the seminar alternates between elementary operator theory and focused topics (such as group C*-algebras, CB maps and operator algebras, quantum computing, etc.)
I have been the organizer or co-organizer each semester up until the start of the Fall 2018 semester.
- Graduate Student Seminar Organizer 2013 – 2014
A seminar run for, and by, mathematics graduate students. Presentation topics include, but are not limited to: introductions to research areas, math history, funding opportunities and summer internships.
- Nebraska Conference for Undergraduate Women in Math 2012 – 2019
Volunteered in various capacity for the annual Nebraska Conference for Undergraduate Women in Math (NCUWM). NCUWM’s overall goal is to arm participants with knowledge, self-confidence and a network of peers to help them become successful mathematicians.
- All Girls/All Math Summer 2014
A week long mathematics summer camp for high school girls. I was a lecturer in the summer school.
- Math Day 2012 – 2018
An event created to stimulate interest in mathematics in Nebraska high school students. Various grants are awarded through mathematics competitions. I often volunteered in administering quiz bowls.

SELECT TALKS

Conference and Seminar Talks:

- Climate, Ocean, and Sea Ice Modeling Seminar Fall 2020
Robust and interpretable unsupervised machine learning techniques for analyzing the climate system - LANL, NM
- Canadian Operator Symposium Spring 2020
Operator Algebras Generated by Left Invertibles - Fields Institute, Toronto, Canada
- American Meteorological Society Winter 2019
Multi-resolution Cluster Analysis - Addressing Trust in Climate Classification - Boston, MA
- American Geophysical Union Winter 2019
Multi-resolution Cluster Analysis - Addressing Trust in Climate Classification - San Fransisco, CA
- Climate, Ocean, and Sea Ice Modeling Seminar Summer 2018
A Wavelet Based Approach to Climate Biome Clustering - Los Alamos National Labs, NM
- Great Plains Operator Theory Symposium Summer 2018
Operator Algebras Generated by Left Invertibles - Oxford, OH
- Joint Mathematics Meetings Winter 2018
Operator Algebras Generated by Left Invertibles - San Diego, CA
- Nebraska-Iowa Functional Analysis Seminar Fall 2017
Operator Algebras Generated by Left Invertibles - Des Moines, IA

General Audience Talks:

- CNLS Postdoc Seminar Lectures 2019 – Current
Presented many lectures. Topics center around importance of robustness, interpretability in ML within climate sciences.
- Creighton Mathematics Conference for Undergraduates Fall 2017
Turning Hard Problems Into (Infinitely Many) Easy Ones - Creighton University, Omaha, NE
- Great Plains Alliance Speaker Fall 2017
Turning Hard Problems Into (Infinitely Many) Easy Ones - Dordt College, Sioux Center, IA
- Graduate Student Seminar Lectures 2014 – 2018
Presented many lectures. Topics included, *Math and Music*, *Introduction to Operator Theory*, *Connections Between Analysis and Algebra*.

PROGRAMING EXPERIENCES

- Custom interpretable MPAS-O clustering - Los Alamos National Labs
 - Developed python package to perform custom interpretable clustering of water masses in MPAS-O data.

- Language: Python - numpy, pandas, scipy, sklearn, xarray
- Robust Consensus clustering - Los Alamos National Labs
 - Designed python package to discover consistent signals within a cluster ensemble.
 - Language: Python - numpy, pandas, scipy, sklearn
- Nonnegative tensor factorizations - Los Alamos National Labs
 - Worked utilizing custom nonnegative tensor factorization toolbox to discover robust signals.
 - Language: Python - numpy, pandas, scipy, sklearn
- Köppen-Geiger Climate Model Package - Los Alamos National Labs
 - Wrote a python package to implement the Köppen-Geiger Climate Model.
 - Language: Python - dask, numpy, pandas, xarray
- Learning changes in climate biomes - Los Alamos National Labs
 - Developed a large scale unsupervised learning model to predict climate biomes.
 - Language: Python - dask, numpy, pandas, pywavelet, scipy, sklearn, xarray
- Wildfire boundary modeling - California State University
 - Modeled the boundary of wildfire using level-set methods.
 - Language: Matlab
- \LaTeX - Various
 - Have written numerous papers, talks, notes and documents in \LaTeX .
 - Language: \LaTeX

ADDITIONAL EDUCATION

- MSRI Summer School: Representations of High Dimensional Data July 2018
Topics included compressed sensing, data mining, compression, classification, topic modeling, and large-scale stochastic optimization.
- Great Plains Operator Theory Symposium 2018
 - Miami University 2017
 - Texas Christen University 2016
 - Urbana-Champaign
- Rocky Mountain Mathematics Consortium June 2015
The focus of the 2015 RMMC Summer school was on the classification program for C^* -algebras.
- Nebraska-Iowa Functional Analysis Seminar 2013-2018
NIFAS is a biannual functional analysis conference.

TEACHING

Instructor of Record:

- College Algebra Three Sections
Freshman course designed to prepare students for applied calculus.
- College Algebra + Trig. Three Sections
Freshman course meeting five days a week that combines college algebra and trigonometry. The course is designed to prepare students for calculus.
Course convener Spring 2016.
- Applied Calculus One Section
Rudiments of differential and integral calculus with applications to problems from business, economics, and social sciences.
- Calculus I One Section
Differential calculus in one variable with basic integration theory.
- Calculus II One Section
Integration theory techniques and applications, infinite series, power series and Taylor series.
- Differential Equations One Section
First and second-order methods for ordinary differential equations including: separable, linear, Laplace transforms, linear systems, and some applications.
- Geometry Matters One Section
Highly interactive upper division math course designed for secondary school teachers. The focus is pedagogy, covering geometry and measurements.
- Math Modeling One Section
Highly interactive upper division math course designed for primary school teachers. Course focus is pedagogy - covering topics seen in elementary and middle school mathematics classes.
- Contemporary Math Three Sections
Course covers quantitative reasoning methods and decision making in the areas of management, statistics, and social choice. Topics include voting theory, probability, and graph theory.
Designed interactive course packet which included outline of notes and small group exercises.

Teaching Assistant:

- Calculus II Recitation Eight Sections

- Calculus III Recitation
- Advanced Matrix Theory Grader

One Section
One Section