

# FELIPE ARRATE

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## EDUCATION

- 2005 - 2008 **Ph.D.**, Applied Mathematics, **Johns Hopkins University** (JHU), Baltimore, MD.  
**Thesis:** *“Study of Geodesics in Groups of Diffeomorphisms and their related equations”*  
*“Application of Riemannian gradient descent equations in groups of diffeomorphisms to shape segmentation”*
- Aug, 2005 **Master of Sciences** in Structural Mechanics, **University of Southern California** (USC), Los Angeles, CA.  
**Thesis:** *“Identification and Response Estimation of Stochastic Nonlinear Dynamical Systems in a Polynomial Chaos Basis”*.
- Jan, 2001 **Mechanical Engineer** Professional Title (**BSc. - M.Sc.** in Mechanical Engineering), Federico Santa Maria Technical University, Chile.  
**Thesis:** *“On the modeling of the complete heat transfer problem (conductive, convective and radiative) that takes place in a copper refining furnace”*. (Awarded a 100/100 grade score).

## RESEARCH INTERESTS

- Analysis of biomedical and other images using the mathematical structure induced on the infinite-dimensional space of shapes under the action of groups of diffeomorphisms. This framework induces a metric in the space of shapes that allows their analytic and statistical study, allowing the classification of subjects under different medical pathologies.
- Study of Hamiltonian systems. In particular, during the PhD research, singular solutions of the geodesic Euler-Poincarè equation on diffeomorphisms (EPDiff) were studied. Using a fluid dynamic point of view in the study of image deformation, the analysis was focused in the evolution of the generalized momentum of diffeomorphic flow of least energy. In particular, the momentum map for singular solutions of the EPDiff yielded a Hamiltonian formulation which provided a complete parametrization of members of deformable object classes by their canonical positions and initial momenta.
- Identification and Analysis of Dynamical Systems under random excitation. As part of the research in Structural Dynamics, the probabilistic behavior of dynamical structures with random parameters under stochastic excitation was studied, opening a full world of problems related with the uncertainty in the design of structures and machines.

## RESEARCH & TECHNICAL EXPERIENCE

- 2006 - 2008 Research Assistant at the Center of Imaging Science (CIS), Johns Hopkins University, Baltimore, MD. In charge of several applications of image deformation to the study of medical correlations between normal and diseased subjects.
- 2003-2005 Research Assistant at the Civil Engineering Department, University of Southern California (USC). Identification and prediction of the structural behavior of stochastic multidimensional dynamical systems.
- 2001-2003 Mechanical Engineer Designer at Electro Aço Altona, Blumenau, Santa Catarina, Brazil. In charge of the structural and dynamical design of alloy steel parts for mining equipments, components for electric energy, coal, chemical and hydro power industry parts.
- 2001 Mechanical Engineer Analyst at Drillco Tools, Santiago, Chile.

## TEACHING EXPERIENCE

- 2003-2005 Teaching Assistant at the University of Southern California: Structural Dynamics, Dynamics, Computer Methods in Engineering, Mechanics of Deformable Bodies and Mechanics of Solids.
- 2002-2003 Lecturer at University of Chile, School of Engineering, Santiago, Chile. Course: Mechanical Design.
- 2002-2003 Lecturer at Federico Santa Maria Technical University, Valparaiso, Chile. Course: Computational Mechanics.
- 1995-2000 Teaching Assistant at the Mathematics Department and Physics Department, Federico Santa Maria Technical University, Valparaiso, Chile. Courses: Advanced Physics I-II, Calculus I-II-III Algebra I-II and Mathematics I-II-III.

## HONORS AND AWARDS

- 2006 - NSF DMS-NIH Graduate Research Assistantship at the Center of Imaging Science (CIS), Johns Hopkins University, Baltimore, MD.
- 2003-2005 CALTRANS Graduate Research Assistantship at the Civil Engineering Department, University of Southern California (USC).
- 2003-2005 Graduate Teaching Assistantship at the Civil Engineering Department, University of Southern California: Structural Dynamics, Dynamics, Computer Methods in Engineering, Mechanics of Deformable Bodies and Mechanics of Solids.
- 1996-2000 Graduate Teaching Assistantship at the Mathematics Department and Physics Department, Federico Santa Maria Technical University, Valparaiso, Chile. Courses: Advanced Physics I-II, Calculus I-II-III Algebra I-II and Mathematics I-II-III.
- 1997-1999 Student Representative in the Academic Council (Elected twice by direct voting of the students), Federico Santa Maria Technical University, Valparaiso, Chile.
- 1991 Top national score in the mathematics section of PAA Test (the Chilean version of the SAT test) (821 out of 821).
- 1991 Top national score (836 out of 836) in Mathematics knowledge and aptitude test (a multiple choice math test taken by students finishing high school and applying for college admission).

## PUBLICATIONS

### Computational Anatomy, Shapes and Diffeomorphisms

1. Felipe Arrate, Laurent Younes, and J.T. Ratnanather, “Numerical methods for solving EPDiff equation in Computational Anatomy”, Geometry and Statistics of Shape Spaces, Statistical and Applied Mathematical Sciences Institute (SAMSI), North Carolina, July 2007.

### Stochastic Non-linear Dynamical Systems, Applied Mathematics

1. F. Arrate, M. R. Hernandez-Garcia, S. F. Masri, R. Ghanem, “Data-Based Stochastic Models of Uncertain Nonlinear Systems”, IUTAM Symposium on Dynamics and Control of Nonlinear Systems with Uncertainty, Nanjing University of Aeronautics and Astronautics, Nanjing, China, XXIV, 394 p., Sept 2007.
2. F. Arrate, S. Masri, “Non Parametric Non-Statistical Identification and Estimation of Stochastic dynamical systems”, March 2006. *Submitted*.
3. S. Masri, R. Ghanem, F. Arrate, J. Caffrey, “Stochastic Nonparametric Models of Uncertain Hysteretic Oscillators”, AIAA Journal, vol. 44, 10, pp. 2319-2330, 2006.
4. S. Masri, R. Ghanem, F. Arrate, J. Caffrey, “Data-Based Probabilistic Models for Predicting the Dynamic Response of Uncertain Nonlinear Systems”, International Journal of Non-Linear Mechanics, 2005.
5. Felipe Arrate, “General properties of Multidimensional Hermite Polynomials”. University of Southern California, August 2005.
6. Felipe Arrate, Alejandro Sáez, Carlos Rosales, “On the modeling of the complete heat transfer problem (conductive, convective and radiative) that takes place in a copper refining furnace”. MS. Thesis work, Federico Santa Maria Technical University, Chile, January 2001.

### Academic Standards, Student participation

1. Felipe Arrate, “A critical analysis of Mathematics Curricula at Santa Maria University”. Report prepared for the academic committee in charge of science teaching at Federico Santa Maria Technical University, Valparaiso, CHILE, July 1998.
2. F. Arrate, F., “Student participation and University” - as part of a study on allocation of government resources in advanced education, report presented to the Chilean Senate as the student’s representative (Federico Santa Maria University), Valparaiso, CHILE, August 1997.

## INVITED TALKS and CONFERENCES

- Poster Session: “*Numerical methods for solving EPDiff equation in Computational Anatomy*”, Felipe Arrate, Laurent Younes, and J.T. Ratnanather, SAMSI, North Carolina, July 2007.
- SAMSI “*Workshop on the Geometry and Statistics of Shape Spaces*”, Durham, North Carolina, July 2007.
- Seminar: “*Non-Statistical Estimation of Stochastic Dynamical Systems*”, Applied Mathematics Department, Johns Hopkins University, December 2006.
- “*Euler-Poincaré Differentials*” Workshop. Santa Fe, NM. July 24 - 28, 2006. (Invited by Darryl Holm and Laurent Younes)
- IMA Annual Program Year Workshop, “*Shape Spaces*”, University of Minnesota, April 3-7, 2006.

- Non-Parametric Non-Statistical Identification and Estimation of Stochastic dynamical systems. University of Southern California. August 2005.
- Identification and prediction of Stochastic Nonlinear Dynamical Systems in a Polynomial Chaos Basis. University of Southern California. August 2004.

## **LANGUAGES**

English (Fluent); French (advanced working knowledge); Portuguese (advanced working knowledge); Spanish (native).