

# Computational Science, Ph.D.

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## Lee Swindlehurst, UCI Director

949-824-2818

<http://www.computationalscience.uci.edu/>

## Joint Doctoral Program with UC Irvine and San Diego State University

A joint offering with San Diego State University (SDSU), the Ph.D. program in Computational Science trains professionals capable of developing novel computational approaches to solve complex problems in both fundamental sciences and applied sciences and engineering. A program of study combining applied mathematics, computing, and a solid training in basic science culminates in doctoral research focused on an unsolved scientific problem.

The Ph.D. in Computational Science produces broadly educated, research-capable scientists that are well prepared for diverse careers in academia, industry, business, and government research laboratories.

Students are admitted into the joint program via a Joint Admissions Committee. Applicants apply to UCI directly using the UCI graduate application.

Applicants are expected to hold a Bachelor's degree in one of the science, technology, engineering, and mathematics (STEM) fields.

Applicants are evaluated on the basis of their prior academic record and their potential for creative research and teaching, as demonstrated in submitted materials. These materials include official university transcripts, three letters of recommendation, GRE scores, a Statement of Purpose, and a Personal History statement.

## Program Requirements

The normative time to completion is five years. The maximum time to completion is seven years. A total minimum of 66 units of course work, independent study, and research must be completed. These units must be distributed as follows:

- Minimum of 18 units of graduate-level coursework as SDSU.
- Minimum of 24 units of graduate-level coursework at UCI.
- Minimum of 24 units of combined research, practicum, and dissertation research units at either institution.

## Summer Research Survey

Students are required to attend the annual summer seminar series featuring participating faculty members describing their current research and possible projects.

## Course Requirements

### Core Courses at SDSU

MATH 636 - Mathematical Modeling OR MATH 638 - Continuous Dynamical Systems and Chaos

MATH 693B - Advanced Computational PDEs

COMP 605 - Scientific Computing

### Elective Courses at SDSU

*Students select 9 units from the following list, or appropriate substitutions, with the approval of the program director and their research mentor*

AE 601 - Computational Fluid Mechanics

AE 641 - Structural Optimization

AE 670 - Optimal Control

BIOL 606 - Biological Data

BIOL 668 - Advanced Biological Data Analysis

BIOL 740 - Phylogenetic Systematics

BIOMI 608 - Programming Problems in Bioinformatics

CHEM 711 - Chemical Thermodynamics

CHEM 712 - Chemical Kinetics

CHEM 713 - Quantum Chemistry

CIVE 620 - Traffic Flow and Control

CIVE 697 - Traffic Signals Systems Operations and Control

COMP 526 - Computational Methods for Scientists

COMP 607 - Computational Database Fundamentals

COMP 670 - Seminar: Problems in Computational Science

CS 600 - Bioinformatics

CS 610 - Computational Genomics

CS 653 - Data Mining and Knowledge  
 CS 666 - Advanced Distributed Systems  
 CS 696 - Programming Problems in Bioinformatics  
 EE 645 - Antennas and Wave Propagation  
 EE 657 - Digital Signal Processing  
 EE 658 - Advanced Digital Signal Processing  
 EE 665 - Multimedia Wireless Networks  
 EE 740 - Advanced Topics in Physical Electronics Antenna Design  
 MATH 693A - Advanced Computational Optimization  
 MATH 693B - Advanced Computational PDEs  
 MB 610A-B - Advanced Topics in Molecular Biology  
 ME 610 - Finite Element Methods  
 PHYS 604 - Electricity and Magnetism  
 PHYS 606 - Statistical Mechanics  
 PHYS 608 - Classical Mechanics  
 PHYS 610 - Quantum Mechanics  
 STATS 676 - Bayesian Statistics  
 STATS 678 - Survival Analysis  
 STATS 700 - Data Analysis  
 STATS 701 - Monte Carlo Methods  
 STATS 702 - Data Mining

### Core Courses at UCI (16 units)

COMPSCI 206	Principles of Scientific Computing
COMPSCI 271	Introduction to Artificial Intelligence
ENGRCEE 290	Merging Models and Data
STATS 201	Statistical Methods for Data Analysis I

### Elective Courses at UCI

*Students select 8 units from the following list, or appropriate substitutions, with the approval of the program director and their research mentor*

BME 232	Introduction to Computational Biology
BME 233	Dynamic Systems in Biology and Medicine
BME 238	Spectroscopy and Imaging of Biological Systems
CHEM 230	Classical Mechanics and Electromagnetic Theory
CHEM 231A	Fundamentals of Quantum Mechanics
CHEM 231B	Applications of Quantum Mechanics
CHEM 232A	Thermodynamics and Introduction to Statistical Mechanics
CHEM 232B	Advanced Topics in Statistical Mechanics
CHEM 250	Computational Chemistry
CHEM 250L	Computational Chemistry Laboratory
COMPSCI 211A	Visual Computing
COMPSCI 221	Information Retrieval, Filtering, and Classification
COMPSCI 242	Parallel Computing
COMPSCI 261	Data Structures
COMPSCI 265	Graph Algorithms
COMPSCI 268	Introduction to Optimization
COMPSCI 273A	Machine Learning
COMPSCI 274A	Probabilistic Learning: Theory and Algorithms
COMPSCI 284A	Artificial Intelligence in Biology and Medicine
COMPSCI 284C	Computational Systems Biology
EECS 203A	Digital Image Processing
EECS 215	Design and Analysis of Algorithms
EECS 227	Cyber-Physical System Design
EECS 240	Random Processes
EECS 242	Information Theory
EECS 250	Digital Signal Processing I

EECS 282	Monolithic Microwave Integrated Circuit (MMIC) Analysis and Design II
ENGRCEE 250	Finite Element Method in Structural Engineering
ENGRCEE 270	Flood Risk and Modeling
ENGRCEE 273	Watershed Modeling
ENGRCEE 274	Climate Data Analysis
ENGRCEE 292	Wavelets in Hydrology, Engineering, and Geoscience
ENGRMAE 230A	Inviscid Incompressible Fluid Mechanics I
ENGRMAE 230B	Viscous Incompressible Fluid Mechanics II
ENGRMAE 270A	Linear Systems I
STATS 210B	Statistical Methods II: Categorical Data
STATS 230	Statistical Computing Methods

### Research Units at SDSU

COMP 897 - Doctoral Research  
 COMP 898 - Practicum  
 COMP 899 - Dissertation

### Research Units at UCI

COMPSCI 298	Thesis Supervision
COMPSCI 299	Individual Study
ENGR 297	Doctor of Philosophy Dissertation Research
ENGR 299	Individual Research

## Practicum and Doctoral Research

Dissertation research is carried out at either UCI or SDSU, or at an industry or national laboratory under the supervision of the Doctoral Advisor. While conducting dissertation research, students must enroll in the appropriate research units at the campus of the Doctoral Advisor. If research is done outside of UCI or SDSU, students should register in-absentia if appropriate.

## Research Report Exam

The student is expected to pass the research report within two years of admittance. This examination consists of a term research project supervised by a faculty mentor. The student is required to prepare a written account of research work performed and its results, and offer an oral presentation before the members of the Doctoral Committee. The student must submit a paper based on their research report before giving the oral presentation to the Doctoral Committee. Should a student fail the research report exam, one retake is allowed.

## Dissertation Proposal

Students must submit a dissertation proposal to the doctoral committee by the end of their third year in the program. This proposal should take the form of a scientific grant proposal to a major funding agency. It should describe the research project that the student intends to carry out and upon which their doctoral dissertation will be based. The student must also offer an oral presentation of the proposal before the Computational Science faculty. Upon successful completion of this presentation, the student will be recommended for advancement to candidacy for the doctoral degree.

## Advancement to Doctoral Candidacy

After successful completion of the dissertation proposal and certification that all other requirements are fulfilled, the student is advanced to candidacy at both campuses. Students not registered at UCI will need to formally advance to candidacy in the summer term. Advancement to candidacy for the Ph.D. must occur at least one term prior to dissertation defense.

## Dissertation and Final Oral Examination

On completion of the research, the student prepares the dissertation in accordance with UCI regulations. A final draft of the dissertation is presented to each member of the doctoral committee at least three weeks prior to the final oral examination. The oral defense is held on the campus of the primary faculty advisor. Students must follow UCI filing deadlines. Students are required to be registered for Dissertation Research (3 units) at SDSU and Dissertation Research (4 units) simultaneously at UCI during the semester in which they present their doctoral defense. Alternatively, students can request filing fee status at UCI in the quarter in which they present their doctoral defense.

## Requirements for the M.S.

Requirements for a Master's degree include a satisfactory completion of first- and second-year coursework plus submission of a satisfactory research report.

## University of California, Irvine Faculty

Jun F. Allard, Ph.D. University of British Columbia, *Assistant Professor of Mathematics; Physics and Astronomy* (Mathematical and computational biology)

Pierre F. Baldi, Ph.D. California Institute of Technology, *UCI Chancellor's Professor of Computer Science; Biological Chemistry; Biomedical Engineering; Developmental and Cell Biology* (Bioinformatics, computational biology)

Kieron Burke, Ph.D. University of California, Santa Barbara, *Professor of Chemistry; Physics and Astronomy* (Physical chemistry and chemical physics, polymer, materials, nanoscience, theoretical and computational)

Olivier Cinquin, Ph.D. University College London, *Assistant Professor of Developmental and Cell Biology* (Mathematical modeling of networks, systems biology)

Donald A. Dabdub, Ph.D. California Institute of Technology, *Professor of Mechanical and Aerospace Engineering; Civil and Environmental Engineering* (Mathematical modeling of urban and global air pollution, dynamics of atmospheric aerosols, secondary organic aerosols, impact of energy generation on air quality, chemical reactions at gas-liquid interfaces)

Kristen Davis, Ph.D. Stanford University, *Assistant Professor of Civil and Environmental Engineering; Earth System Science* (Coastal Dynamics)

Filipp Furche, Ph.D. University of Karlsruhe, *Professor of Chemistry* (Physical chemistry and chemical physics, theoretical and computational)

Wayne B. Hayes, Ph.D. University of Toronto, *Associate Professor of Computer Science* (Biomedical Informatics and Computational Biology, Computer Vision Scientific and Numerical Computing)

Frithjof Kruggel, M.D., Ph.D. Ludwig Maximilian University of Munich, *Professor of Biomedical Engineering; Electrical Engineering and Computer Science* (Biomedical signal and image processing, anatomical and functional neuroimaging in humans, structure-function relationship in the human brain)

Arthur D. Lander, Ph.D. University of California, San Francisco, *Donald Bren Professor and Professor of Developmental and Cell Biology; Biomedical Engineering; Logic and Philosophy of Science; Pharmacology* (Systems biology of development, pattern formation, growth control)

Feng Liu, Ph.D. Princeton University, *Professor of Mechanical and Aerospace Engineering* (Computational fluid dynamics and combustion, aerodynamics, aeroelasticity, propulsion, turbomachinery aerodynamics and aeromechanics)

John S. Lowengrub, Ph.D. Courant Institute of Mathematical Sciences, *UCI Chancellor's Professor of Mathematics; Biomedical Engineering; Chemical Engineering and Materials Science* (Applied and computational mathematics, mathematical and computational biology)

Ray Luo, Ph.D. University of Maryland, College Park, *Professor of Molecular Biology and Biochemistry; Biomedical Engineering; Chemical Engineering and Materials Science* (Protein structure, noncovalent associations involving proteins)

Eric D. Mjolsness, Ph.D. California Institute of Technology, *Professor of Computer Science; Mathematics* (Applied mathematics, mathematical biology, modeling languages)

David L. Mobley, Ph.D. University of California, Davis, *Associate Professor of Pharmaceutical Sciences; Chemistry* (Chemical biology, physical chemistry and chemical physics, theoretical and computational)

Seyed Ali Mortazavi, Ph.D. California Institute of Technology, *Assistant Professor of Developmental and Cell Biology* (Functional genomics to study transcriptional regulation in development)

Shaul Mukamel, Ph.D. Tel Aviv University, *UCI Distinguished Professor of Chemistry; Physics and Astronomy* (Physical chemistry and chemical physics, polymer, materials, nanoscience, theoretical and computational)

Hung Nguyen, Ph.D. North Carolina State University, *Assistant Professor of Chemical Engineering and Materials Science* (Computational Nanoscience of Functional Biomaterials & Complex Fluids)

Alexandru Nicolau, Ph.D. Yale University, *Department Chair and Professor of Computer Science; Electrical Engineering and Computer Science* (Architecture, parallel computation, programming languages and compilers)

Roger H. Rangel, Ph.D. University of California, Berkeley, *Professor of Mechanical and Aerospace Engineering* (Fluid dynamics and heat transfer of multiphase systems including spray combustion, atomization and metal spray solidification, applied mathematics and computational methods)

Elizabeth L. Read, Ph.D. University of California, Berkeley, *Assistant Professor of Chemical Engineering and Materials Science; Molecular Biology and Biochemistry* (Dynamics of complex biochemical systems, regulation of immune responses)

Eric Rignot, Ph.D. University of Southern California, *Donald Bren Professor of Earth System Science* (Glaciology, climate change, radar remote sensing, ice sheet modeling, interferometry, radio echo sounding, ice-ocean interactions)

Timothy Rupert, Ph.D. Massachusetts Institute of Technology, *Assistant Professor of Mechanical and Aerospace Engineering; Chemical Engineering and Materials Science* (Mechanical behavior, nanomaterials, structure property relationships, microstructural stability, grain boundaries and interfaces, materials characterization)

Hal S. Stern, Ph.D. Stanford University, *Professor of Statistics; Cognitive Sciences* (Bayesian methods, model diagnostics, forensic statistics, and statistical applications in biology/health, social sciences, and sports)

Lizhi Sun, Ph.D. University of California, Los Angeles, *Professor of Civil and Environmental Engineering; Chemical Engineering and Materials Science* (Micro- and nano-mechanics, composites and nanocomposites, smart materials and structures, multiscale modeling, elastography)

A. Lee Swindlehurst, Ph.D. Stanford University, *Professor of Electrical Engineering and Computer Science* (Signal processing, estimation and detection theory, applications in wireless communications, geo-positioning, radar, sonar, biomedicine)

Kevin Thornton, Ph.D. University of Chicago, *Associate Professor of Ecology and Evolutionary Biology School of Biological Sciences* (Genome evolution, gene duplication, population genetics, adaptation)

Douglas J. Tobias, Ph.D. Carnegie Mellon University, *Professor of Chemistry* (Atmospheric and environmental, chemical biology, physical chemistry and chemical physics, theoretical and computational)

Jasper A. Vrugt, Ph.D. University of Amsterdam, *Associate Professor of Civil and Environmental Engineering; Earth System Science* (Complex systems, modeling, statistics, hydrology, geophysics, ecology, data, optimization, hydropower, data assimilation)

Yun Wang, Ph.D. Pennsylvania State University, *Associate Professor of Mechanical and Aerospace Engineering* (Fuel cells, computational modeling, thermo-fluidics, two-phase flows, electrochemistry, Computational Fluid Dynamics (CFD), turbulent combustion)

Daniel Whiteson, Ph.D. University of California, Berkeley, *Associate Professor of Physics and Astronomy; Logic and Philosophy of Science* (Particle Physics)

## San Diego State University Faculty

Andy Cooksy, Ph.D. University of California, Berkeley, *Professor of Chemistry and Biochemistry* (Laser Spectroscopy, Reaction Dynamics, and Ab Initio Calculation of Free Radicals and Other Transient Molecule)

Chris Curtis, Ph.D., University of Washington, *Assistant Professor of Mathematics* (Fluid Mechanics, Modeling and Simulation, Computational Fluid Dynamics and Numerical Simulation)

Robert Edwards, Ph.D. University of Sussex, Brighton, England, *Professor of Computer Science* (Microbiology, Bioinformatics, and High Performance Computing)

Juanjuan Fan, Ph.D. University of Washington, *Professor of Statistics* (Multivariate Failure Time Data, Tree Based Methods, Genetic Epidemiology)

Jerome Gilles, Ph.D. Ecole Normale Supérieure, France, *Assistant Professor of Mathematics* (Applied Harmonic/Functional Analysis, Signal/Image Processing)

Ke Huang, Ph.D. University of Grenoble, France, *Assistant Professor of Electrical and Computer Engineering* (VLSI Testing, Fault Modeling and Diagnosis. Machine Learning, Data Mining. Trustworthy ICs. Computer-Aided Design)

Gustav Jacobs, Ph.D., University of Illinois at Chicago, *Professor of Aerospace Engineering* (Computational Physics, High-Order Methods, Fluid and Plasma Dynamics)

Calvin Johnson, Ph.D. University of Washington, *Professor of Physics* (Theoretical and Computational Nuclear Structure and Nuclear Astrophysics)

Parag Katira, Ph.D., University of Florida, *Assistant Professor of Mechanical Engineering* (Biomolecular Motors, Cell Mechanics, Mechanosensing, Tissue Dynamics, Soft Matter Interactions, Design of Active Materials)

David Kopriva, Ph.D. University of Arizona, *Research Professor, CSRC at SDSU* (Computational Mathematics, Numerical Analysis)

Sunil Kumar, Ph.D., Birla Institute of Technology and Science, India, *Professor of Electrical and Computer Engineering* (Multimedia Traffic, Compression Techniques, Image Processing Techniques)

Lyuba Kuztnesova, Ph.D. Cornell University, *Assistant Professor of Physics* (Nanophotonics)

Richard Levine, Ph.D. Cornell University, *Professor of Statistics* (Markov Chain Monte Carlo Methods, Environmental Statistics, Biostatistics, Bayesian Decision Theory)

Xiaobai Liu, Ph.D. Huazhong University of Science and Technology, China, *Assistant Professor of Computer Science* (Computer Vision, Machine Learning, Computational Statistics and their applications to clinic diagnosis, sports, transportation, surveillance, video games and others)

Antonio Luque, Ph.D. University of Barcelona, *Assistant Professor of Mathematics* (Applied Mathematics, Biophysics, Physical Virology)

Duy Nguyen, Ph.D. McGill University, Canada, *Assistant Professor of Electrical and Computer Engineering* (Signal Processing, Communications, and Information Theories for Wireless Systems and Networks)

Kenneth Nollett, Ph.D. University of Chicago, *Assistant Professor of Physics* (Astrophysics and Nuclear Physics)

Christopher Paolini, Ph.D. San Diego State University, *Assistant Professor of Electrical and Computer Engineering* (Cyberinfrastructure, Computational Geochemistry)

Shangping Ren, Ph.D. University of Illinois at Urbana-Champaign, *Professor of Computer Science* (Cyber-Physical Systems, Real-Time Scheduling, and Cloud Computing)

Forest Rohwer, Ph.D. San Diego State University, *Professor of Biology* (Genomic Analysis of Phage, Diversity of Coral-associated Bacteria, Opportunistic Infections and Coral Disease)

Anca Segal, Ph.D. University of Utah, *Professor of Biology* (The Mechanism of Site-Specific Recombination; Structure/Function Analysis of Recombination Proteins)

Satish Sharma, Ph.D. Banaras Hindu University, India, *Professor of Electrical and Computer Engineering* (Electromagnetics Antennas)

Samuel Shen, Ph.D. University of Wisconsin, Madison, *Albert W. Johnson Distinguished Professor of Mathematics* (Statistical Climatology & Agroclimatology, Fluid Dynamics & Forced Nonlinear Waves)

Nicholas Shikuma, Ph.D. University of California, Santa Cruz, *Assistant Professor of Biology* (Molecular Mechanisms of Bacteria/Bacteriophage/Animal Interactions)

Patrick Shoemaker, Ph.D. University of California, San Diego, *Research Associate Professor CSRC at SDSU* (Analog Integrated Circuit Design, Neurobiology, Neural Computation)

Usha Sinha, Ph.D. Indian Institute of Science, Bangalore, India, *Professor of Physics* (Medical and Imaging Physics, Magnetic Resonance Imaging (MRI), and Informatics)

Mauro Tambasco, Ph.D. University of Western Ontario, *Associate Professor of Physics* (Medical Physics)

Naveen Vaidya, Ph.D. York University, Canada, *Assistant Professor of Mathematics* (Applied Mathematics, Mathematical Biology, Disease Modeling, Differential Equations)

Satchi Venkataraman, Ph.D. University of Florida, *Professor of Aerospace Engineering* (Structural Mechanics, Design Optimization, Composite Materials, Biomechanics)

Wei Wang, Ph.D. University of Nebraska, Lincoln, *Associate Professor of Computer Science* ( Cyber-Physical Systems, Wireless Multimedia Networking, Breast Cancer Image Processing)

Fridolin Weber, Ph.D. University of Munich, Germany, *Albert W. Johnson Distinguished Professor of Physics* (Superdense Matter, Astrophysics, General Relativity)

Tao Xie, Ph.D. New Mexico Institute of Mining and Technology, *Professor of Computer Science* (High-Performance Computing, Energy-Efficient Storage Systems, Parallel/Distributed Systems, and Security-Aware Scheduling)

Robert W Zeller, Ph.D. California Institute of Technology, *Professor of Biology* (Cell and Molecular Biology)