Graduate Program in Computational Science

Wayne Hayes, UCI Director
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http://www.cs.uci.edu/

Overview
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.

Admission
Students are admitted into the joint program via a Joint Admissions Committee. Applicants should first apply using SDSU’s graduate application. Select students are then invited to apply using UCI’s 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, letters of recommendation, GRE scores, and a Statement of Purpose.

Program Requirements
The normative time to completion is five 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 1-2 day summer seminar series featuring participating faculty members describing their current research and possible projects.

Course Requirements
Core Courses at SDSU
MATH 636 - Mathematical Modeling
COMP 605 - Scientific Computing
COMP 670 - Problems in Computational Science

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

COMP 607 - Computational Database Fundamentals
COMP 589 - Computational Imaging
MATH 693A - Advanced Numerical Analysis I
MATH 693B - Advanced Numerical Analysis II
COMP 526 - Computational Methods for Scientists
COMP 531 - Intro Computational Science
COMP 536 - Computational Modeling
BIO 549 - Microbial Genetics and Physiology
BIO 567L - Biochem Cell Mol Lab
BIO 562 - Ecological Genomics
MB 610A-B - Advanced Topics in Molecular Biology
STATS 700 - Data Analysis
STATS 701 - Monte Carlo Methods
STATS 702 - Data Mining
CS 600 - Bioinformatics  
CS 610 - Computational Genomics  
CS 696 - Programming Problems in Bioinformatics  
STATS 676 - Bayesian Statistics  
STATS 678 - Survival Analysis

**Core Courses at UCI (16 units)**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>MATH 225A</td>
<td>Introduction to Numerical Analysis and Scientific Computing</td>
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<tr>
<td>or MATH 226A</td>
<td>Computational Differential Equations</td>
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<tr>
<td>COMPSCI 206</td>
<td>Principles of Scientific Computing</td>
</tr>
<tr>
<td>ENGRMAE 207</td>
<td>Methods of Computer Modeling in Engineering and the Sciences</td>
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<tr>
<td>STATS 201</td>
<td>Statistical Methods for Data Analysis I</td>
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**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.

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>COMPSCI 284C</td>
<td>Computational Systems Biology</td>
</tr>
<tr>
<td>COMPSCI 274A</td>
<td>Probabilistic Learning: Theory and Algorithms</td>
</tr>
<tr>
<td>COMPSCI 211A</td>
<td>Visual Computing</td>
</tr>
<tr>
<td>COMPSCI 284A</td>
<td>Representations and Algorithms for Molecular Biology</td>
</tr>
<tr>
<td>ENGRCEE 290</td>
<td>Merging Models and Data</td>
</tr>
<tr>
<td>MATH 225A-</td>
<td>Introduction to Numerical Analysis and Scientific Computing</td>
</tr>
<tr>
<td>225B- 225C</td>
<td>and Introduction to Numerical Analysis and Scientific Computing</td>
</tr>
<tr>
<td>MATH 226A-</td>
<td>Computational Differential Equations</td>
</tr>
<tr>
<td>226B- 226C</td>
<td>and Computational Differential Equations</td>
</tr>
<tr>
<td>MATH 225A</td>
<td>Elements of Scientific Writing</td>
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</tbody>
</table>

1 MATH 225A and MATH 226A may not be counted as electives if taken as core courses.

**Research Units at SDSU**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>COMP 897</td>
<td>Doctoral Research</td>
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<tr>
<td>COMP 898</td>
<td>Practicum</td>
</tr>
<tr>
<td>COMP 899</td>
<td>Dissertation</td>
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**Research Units at UCI**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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<tbody>
<tr>
<td>COMPSCI 298</td>
<td>Thesis Supervision</td>
</tr>
<tr>
<td>ENGR 297</td>
<td>Doctor of Philosophy Dissertation Research</td>
</tr>
<tr>
<td>COMPSCI 299</td>
<td>Individual Study</td>
</tr>
<tr>
<td>ENGR 299</td>
<td>Individual Research</td>
</tr>
</tbody>
</table>

**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.

**Qualifying Exam**

The student is expected to pass the Qualifying Exam 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 qualifying exam report before giving the oral presentation to the Doctoral Committee. Should a student fail the qualifying exam, one retake is allowed.

If a Master’s degree will be awarded en route to the Ph.D., students must advance to master’s candidacy at least one quarter prior to conferral of the master’s degree.

**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. 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.

**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 qualifying exam 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)
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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 Supeieure, 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)
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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 Kuznetsova, 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)