Computational Science

In the College of Sciences

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Robert A. Edwards, Ph.D., Professor of Biology
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Admission to Graduate Study

Students applying for admission should electronically submit the university application available at http://www.calstate.edu/apply along with the $55 application fee.

All applicants must submit admissions materials separately to SDSU Graduate Admissions and to Computational Science.

Graduate Admissions

The following materials should be submitted as a complete package directly to:

Graduate Admissions
Enrollment Services
San Diego State University
San Diego, CA 92182-7416

1. Official transcripts (in sealed envelopes) from all post-secondary institutions attended;
   - Students who attended SDSU need only submit transcripts for work completed since last attendance.
   - Students with international coursework must submit both the official transcript and proof of degree. If documents are in a language other than English, they must be accompanied by a certified English translation.
2. GRE scores (http://www.ets.org SDSU institution code 4682);
3. English language score, if medium of instruction was in a language other than English (http://www.ets.org SDSU institution code 4682).

Master of Science Degree in Computational Science

The following materials should be submitted electronically to the Computational Science Research Center at San Diego State University. Refer to the Graduate Admissions website (http://arweb.sdsu.edu/es/admissions/grad/programs/index.html) for application instructions. Consult the department website (http://www.csrc.sdsu.edu/masters_checklist.html) for details concerning required materials.

1. Three letters of recommendation from persons in a position to judge academic ability;
2. Personal statement of motivating interest for the program and briefly describe research interests and educational goals.
3. Copies of unofficial transcripts from all postsecondary institutions attended.

Ph.D. Degree in Computational Science

Students must apply and be admitted to University of California, Irvine (UCI) and SDSU; however, prospective students must apply to UCI first. Qualified applicants will then be given application instructions to SDSU. Admission will be granted to a limited number of qualified students. Completed applications are due by December 15 for the fall term, although later applications may be allowed at the discretion of the admissions committee. The admissions review process may include personal interviews of applicants.

The following materials should be submitted electronically to the Computational Science Research Center at San Diego State University. Refer to the Graduate Admissions website (http://arweb.sdsu.edu/es/admissions/grad/programs/index.html) for application instructions. Consult the department website (http://www.csrc.sdsu.edu/doctoral_checklist.html) for details concerning required materials.

1. Three letters of recommendation from former or current professors, supervisors, or other appropriate persons;
2. Applicant's statement of purpose, explaining their interest in the program;
3. Current resume;
4. Joint doctoral program in computational science application form;
5. Copies of unofficial transcripts from all post-secondary institutions attended.

Section I. Master's Degree Programs

General Information

The computational science program offers a Master of Science degree. It is offered in collaboration with the Departments of Biology, Chemistry and Biochemistry, Computer Science, Geological Sciences, Mathematics and Statistics, and Physics, in the College of Sciences.

The requirements for entering this program consists of one year of computer programming such as C or Fortran, competence in linear algebra and calculus, with background equivalent to a bachelor's degree in the area of interest. Graduates of this program will have a solid foundation in a field of science and the additional training and experience required of computational science professionals. Fundamental science, in one of the specializations, dominates the program. This is supplemented with additional courses in computational science. Real scientific problem-solving is emphasized, through a thesis that could be done in conjunction with a carefully managed extramural research program. A significant proportion of the students in this program will be employed in positions related to their area of studies, thereby providing opportunities for extramural support. Graduates will be prepared for positions in scientific research, scientific programming, and software engineering.

Associateships

Graduate teaching associateships and graduate nonteaching associateships may be available from the individual departments. See the appropriate department of this bulletin for more information.

Admission to the Degree Curriculum

All students must satisfy the general requirements for admission to the university with classified graduate standing, as described in Part Two of this bulletin. If the undergraduate preparation of the students in the desired specialization is deficient, they will be required to take courses for the removal of the deficiency. These courses, taken by students as a classified graduate student, are in addition to the minimum 30 units required for the master's degree. A complete student program must be approved by the computational science program director. The requirements for entering this program consist of one year of computer programming (e.g., C or Fortran), competence in linear algebra and calculus, and a background equivalent to a bachelor's degree in the area of interest.

Advancement to Candidacy

All students must satisfy the general requirements for advancement to candidacy as described in Part Four of this bulletin.

Specific Requirements for the Master of Science Degree

(Major Code: 07992) (SIMS Code: 773001)

In addition to meeting the requirements for classified graduate standing, the student must satisfy the basic requirements for the master's degree as described in Part Four of this bulletin. The student must also complete a graduate program of 30 units, of which at least 15 units must be in 600- and 700-level courses excluding 799A to include:

Required core courses (15 units):

CS 503	Scientific Database Techniques	3
OR		
CS 514	Database Theory and Implementation	3
OR		
COMP 607	Computational Database Fundamentals	3
COMP 526	Computational Methods for Scientists	3
COMP 536	Computational Modeling for Scientists	3

OR		
MATH 636	Mathematical Modeling	3
COMP 605/		
CS 605	Scientific Computing	3
COMP 670	Seminar: Problems in Computational Science	3

Elective courses (9 units selected from):

COMP 521	Computational Science	3
OR		
MATH 542	Introduction to Computational Ordinary of Differential Equations	3
CS 559	Computer Vision	3
OR		
E E 657	Digital Image Processing	3
COMP 626	Applied Mathematics for Computational Scientists	3
OR		
MATH 693B	Advanced Numerical Methods: Computational Partial Differential Equations	3
COMP 604	Computational and Applied Statistics	3
OR		
STAT 670A	Advanced Mathematical Statistics	3

Research (3 units):

COMP 797	Research	3 (Cr/NC/RP)

Thesis (3 units):

COMP 799A	Thesis	3 (Cr/NC/RP)

Substitution of core courses is permitted based on disciplines related to student's specialization with prior consent of program director. With prior consent of the director, 600-level courses from other departments may be used as electives, based on the student's background and research interest.

A complete student program must be approved by the computational science program director.

Concentration in Data Science

(Major Code: 07992) (SIMS Code: 773011)

The concentration focuses on data science. Students entering the program should have background in modeling, programming, simulation, or statistics. The student must complete a graduate program of 30 units to include the following:

Required core courses (15 units):

CS 503	Scientific Database Techniques	3
OR		
CS 514	Database Theory and Implementation	3
OR		
COMP 607	Computational Database Fundamentals	3
COMP 526	Computational Methods for Scientists	3
COMP 536	Computational Modeling for Scientists	3
OR		
MATH 636	Mathematical Modeling	3
COMP 605/		
CS 605	Scientific Computing	3
COMP 670	Seminar: Problems in Computational Science	3

Elective courses (9 units selected from):

CS 553	Neural Networks	3
OR		
CS 559	Computer Vision	3
OR		

E E 657	Digital Image Processing	3
CS 653	Data Mining and Knowledge Discovery	3
STAT 670A	Advanced Mathematical Statistics	3
STAT 670B	Advanced Mathematical Statistics	3
STAT 672	Nonparametric Statistics	3
STAT 673	Time Series Analysis	3
STAT 700	Data Analysis Methods	3
STAT 702	Data Mining Statistical Methods	3

Research (3 units):

| COMP 797 | Research | 3 (Cr/NC/RP) |

Project (3 units):

| COMP 798 | Special Study | 3 |
| | (and comprehensive examination) | |

Substitution of core courses is permitted based on disciplines related to student's specialization with prior consent of program director. With prior consent of the director, 600-level courses from other departments may be used as electives, based on the student's background and research interest. A complete student program must be approved by the computational science program director.

Concentration in Professional Applications

(Offered through the College of Extended Studies)

(Major Code: 07992) (SIMS Code: 773010)

> No students admitted to program at this time.

The concentration focuses on professional applications of computational science. To enter the program, students must possess a bachelors degree with a strong mathematical background. The student must complete a graduate program of 40 units to include the following:

Required core courses (24 units):

CS 503	Scientific Database Techniques	3
OR		
CS 514	Database Theory and Implementation	3
OR		
COMP 607	Computational Database Fundamentals	3
COMP 526	Computational Methods for Scientists	3
COMP 536	Computational Modeling for Scientists	3
OR		
MATH 636	Mathematical Modeling	3
COMP 605/		
CS 605	Scientific Computing	3
COMP 670	Seminar: Problems in Computational Science	3

Additional required core courses for the concentration (11 units):

COMP 589	Computational Imaging	3
COMP 602	Organizational Development	2
COMP 626	Applied Mathematics for Computational Scientists	3
COMP 671	Problem Solving Techniques	3

Electives (8 units with consent of program director)

Research (3 units):

| COMP 797 | Research | 3 (Cr/NC/RP) |

Project (3 units):

| COMP 798 | Special Study | 3 |
| | *and comprehensive examination* | |

Substitution of core courses is permitted based on disciplines related to student's specialization with prior consent of program director. With prior consent of the director, 600-level courses from other departments may be used as electives, based on the student's background and research interest. A complete student program must be approved by the computational science program director.

Section II. Doctoral Program

http://www.csrc.sdsu.edu/doctoral.html

General Information

San Diego State University and University of California, Irvine (UCI), offer jointly a doctoral program in computational science. The participating faculties are from the College of Engineering and College of Sciences at SDSU and the Donald Bren School of Information and Computer Science and Samueli School of Engineering at UCI.

Admission to the Degree Curriculum

In order to be considered for admission into the program, applicants must fulfill the general requirements for admission with graduate standing to both institutions. Applicants must have received a bachelor's or master's degree in a science, technology, engineering, or mathematics discipline from an accredited institution with standards equivalent to SDSU's and UCI's. Applicants with degrees in other areas may be admitted conditionally and may be advised to take additional courses. Applicants must have an undergraduate or master's grade point average of 3.0. Successful applicants must demonstrate they are well qualified to pursue, with distinction, advanced study and research.

Faculty Advisers and Doctoral Committee: Upon admission to the program, the student will be assigned a faculty mentor from either institution. After completing the first year of study and receiving a progress evaluation, the student will select a doctoral adviser. The doctoral adviser will aide in the development of a suitable course of study for the student, administer the student's qualifying examination, monitor progress of student research and administer the defense of the doctoral dissertation.

Specific Requirements for the Doctor of Philosophy Degree

(Major Code: 07992) (SIMS Code: 773006)

The program consists of a minimum of 62 units of coursework, independent study, and research (including transfer credit) distributed as follows. Any deviation from the program of studies must be done with the approval of the program director.

- Minimum 18 units of graduate level coursework at SDSU (computational science program);
- Minimum 20 units of graduate level coursework at UCI;
- Minimum 24 units of research, practicum, dissertation, and graduate seminar at either institution;
- Required participation in the Summer Research Survey.

Additional units of research, practicum, dissertation, and graduate seminar (COMP 800 at SDSU) may be taken at either institution. A student entering the program with a Bachelor of Science degree will satisfy the initial 18 unit requirement by completing a Master of Science degree in computational science at SDSU, then take 20 units of coursework at UCI. Students with an advanced degree other than computational science will complete appropriate courses and a research project to obtain the equivalent of an M.S. degree in computational science.

San Diego State University Courses. Students are required to take 18 units at San Diego State University. There is a core course requirement that must be satisfied with students taking the following courses (9 units):

MATH 636	Mathematical Modeling	3
COMP 605/		
CS 605	Scientific Computing	3
COMP 670	Seminar: Problems in Computational Science	3

The additional units taken to make up the 18 unit requirement at SDSU are electives to be selected with the approval of the program director at SDSU and UCI.

University of California, Irvine Courses. Students are required to take 20 units at UCI. There is a core course requirement that must be satisfied with students selecting 12 units at UCI. Refer to the program's website for a detailed listing of UCI courses at http://ou-csrc.sdsu.edu/programs/phd.

The additional units taken to make up the 20 unit requirement at UCI are electives to be selected with approval of the program director at SDSU and UCI.

Research Units at SDSU. Computational Science 897, 898, 899.

Qualifying Examination. The qualifying examination shall consist of a term research project supervised by a faculty mentor. The topic of the project will be approved by the program directors in consultation with the faculty mentor. The student will be required to prepare a written account of the research work performed and of its results, and offer an oral presentation before the members of the advisory committee. This level of evaluation will be equivalent and coincide with the computational science Master of Science degree final examination.

Practicum and Doctoral Research. Dissertation research will be carried out here at one of the two institutions, at an industry, or at a national laboratory. In the latter two cases, its denomination is practicum.

Dissertation Proposal. The dissertation proposal shall be submitted by the student to the advisory committee no later than upon completion of the student's third academic year in the program. The dissertation proposal will take the form of a scientific grant proposal to a major funding agency. The proposal will describe the research project that the student intends to carry out, on which the doctoral dissertation will be based. The student will also be required to deliver an oral presentation before the computational science advisory committee. Upon successful completion of the presentation, the student will be recommended for advancement to candidacy for the doctoral degree.

Doctoral Dissertation. Upon completion of the dissertation research, the candidate will submit the dissertation to the advisory committee. The candidate will also present a public oral defense of the dissertation. Before the presentation, an account of the work performed will be submitted for publication to a peer-reviewed, international research journal. Upon successful completion of the presentation, the candidate's advisory committee will make a recommendation to the graduate deans.

Faculty

The following faculty members of the cooperating institutions participate in the joint doctoral program and are available for direction of research and as members of joint doctoral committees.

San Diego State University:

Program Director: José E. Castillo

Committee Members: Ashrafi, Bailey, Baljon, Bhalla, Blomgren, Camacho, Carretero, Castillo, Chen, Cooksy, Curtis, Edwards, Fan, George, Gilles, Hong, Huang, Jacobs, Johnson, Katira, Kumar, Kuznetsova, Levine, Liu, Luque, Müller, Navarro, Nguyen, Nollett, Paolini, Ren, Rohwer, Segall, Sharma, Shen, Shikuma, Sinha, Sukumaran, Tambasco, Vaidya, Venkataraman, Wang, Weber, Xie, Zeller

University of California, Irvine:

Program Director: Wayne Hayes

Committee Members: Allard, Baldi, Burke, Cinquin, Dabdub, Furche, Hayes, Kruggel, Lander, Liu, Lowengrub, Luo, Mjolsness, Mobley, Mortazavi, Mukamel, Nicolau, Nguyen, Rangel, Read, Rignot, Rupert, Stern, Sun, Swindlehurst, Thornton, Tobias, Vrugt, Wang, Whiteson

Associateships

Graduate teaching associateships are available at SDSU and UCI and are awarded on a competitive basis.

Advanced Certificate in Professional Computational Science

(Offered through the College of Extended Studies)
(SIMS Code: 773005)

The Advanced Certificate in Professional Computational Science is designed for private and public industry professionals as well as graduate students who wish to learn professional and technical computational skills in their fields to include tools available for scientific application development (particularly those targeted as parallel and distributed systems), scientific visualization and database query applications, simulation and modeling packages, computational templates such as Matlab and Maple, and the choice of appropriate hardware resources for different classes of computational problems. Credit earned through the Advanced Certificate in Professional Computational Science can be applied toward the units required to obtain the Master of Science degree in Computational Science with a Concentration in Professional Applications.

The advanced certificate requires 12 units to include Computational Science 526, 589, and six additional units with consent of the program director. Each course must be completed with a grade of B (3.0) or better.

Courses Acceptable for Master's and Doctoral Degree Programs in Computational Science (COMP)

Refer to Courses and Curricula and Regulations of the Division of Graduate Affairs sections of this bulletin for explanation of the course numbering system, unit or credit hour, prerequisites, and related information.

UPPER DIVISION COURSES

COMP 521. Computational Science (3)
Prerequisite: Mathematics 151.
Matrices and linear equations, solving ordinary differential equations (ODEs), vector spaces, closed form solutions, qualitative theory, Eigenvalues, linear maps, linear differential equations, other techniques, nonlinear systems, higher dimensional systems.

COMP 526. Computational Methods for Scientists (3)
Prerequisites: Mathematics 252 and 254.
Translating mathematical problem descriptions to computer programs. Introduction to Unix system.

COMP 536. Computational Modeling for Scientists (3)
Prerequisite: Mathematics 151.
Models, computational tools, errors, system dynamics, growth, stability, multicompartment, Euler's, Runge-Kutta methods, system dynamics, infectious disease, enzyme kinetics, environmental cycles, cardiovascular system, metabolism, global warming, empirical models, HIV, population distributions, diffusion, HPC.

COMP 596. Advanced Topics in Computational Science (1-4)
Prerequisite: Consent of instructor.
Selected topics in computational science. May be repeated with the approval of the instructor. See *Class Schedule* for specific content. Limit of nine units of any combination of 296, 496, 596 courses applicable to a bachelor's degree. Maximum credit of six units of 596 applicable to a bachelor's degree. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

Computational Science

GRADUATE COURSES

COMP 602. Organizational Development (2)

Prerequisite: Graduate standing.

Contemporary organizational and leadership theory and practice through personal reflection, team assessment and feedback, and case analysis. Nature of change, forces for change, and impact of change in organizations and individuals. Organizational processes, structures and cultures, and effect on organization's performance.

COMP 605. Scientific Computing (3)
(Same course as Computer Science 605)

Prerequisites: Graduate standing and knowledge of the C programming language or FORTRAN or Computational Science 526.

Parallel programming using message passing to include high performance computing and MPI language extensions.

COMP 607. Computational Database Fundamentals (3)

Prerequisite: Graduate standing.

Data-processing techniques, software, database design, implementation, and manipulation.

COMP 626. Applied Mathematics for Computational Scientists (3)

Prerequisites: Mathematics 252 and 254.

Linear algebra, differential equations and stability theory, and analytical methods for partial differential equations within the context of computational science.

COMP 670. Seminar: Problems in Computational Science (3)

Prerequisite: Graduate standing.

Applications of computational science in solving problems using a variety of methods. Problems selected from biology, chemistry, physics, and other fields.

COMP 671. Problem Solving Techniques (3)

Prerequisite: Graduate standing.

Data abstraction and problem solving skills.

COMP 696. Selected Topics in Computational Science (3)

Prerequisite: Graduate standing.

Intensive study in specific areas of computational science. May be repeated with new content. See *Class Schedule* for specific content. Credit for 596 and 696 applicable to a master's degree with approval of the graduate adviser.

COMP 705. Advanced Parallel Computing (3)
(Same course as Computer Science 705)

Prerequisite: Computational Science 605 [or Computer Science 605].

Libraries, numerical methodology, optimization tools, visualization of results, MPI and GPU computing models. Applications conducted on CSRC student cluster and NSF XSEDE computing resources.

COMP 797. Research (1-3) Cr/NC/RP

Prerequisite: Six units of graduate level computational science courses.

Research in computational science. Maximum credit six units applicable to a master's degree.

COMP 798. Special Study (1-3) Cr/NC/RP

Prerequisite: Consent of staff; to be arranged with program director and instructor.

Individual study. Maximum credit six units applicable to a master's degree.

COMP 799A. Thesis or Project (3) Cr/NC/RP

Prerequisites: An officially appointed thesis committee and advancement to candidacy.

Preparation of a project or thesis for the master's degree.

COMP 799B. Thesis or Project Extension (0) Cr/NC

Prerequisite: Prior registration in Thesis or Project 799A with an assigned grade symbol of RP.

Registration required in any semester or term following assignment of RP in Course 799A in which the student expects to use the facilities and resources of the university; also student must be registered in the course when the completed thesis or project is granted final approval.

COMP 799C. Comprehensive Examination Extension (0) Cr/NC

Prerequisite: Completion or concurrent enrollment in degree program courses.

Registration required of students whose only requirement is completion of the comprehensive examination for the master's degree. Registration in 799C limited to two semesters.

DOCTORAL COURSES

COMP 800. Seminar (3) Cr/NC/RP

Prerequisite: Admission to the doctoral program.

Topics in different areas of computational science.

COMP 810. Colloquium in Computational Science (1) Cr/NC/RP

Prerequisite: Admission to the doctoral program.

Discussions on advances in computational science research. Course to be taken every semester.

COMP 896. Practicum (1-9) Cr/NC/RP

Prerequisite: Admission to the doctoral program.

Independent investigation in general area of field of dissertation. Conducted in industry or national laboratory under faculty supervision. Maximum credit 36 units.

COMP 897. Doctoral Research (1-9) Cr/NC/RP

Prerequisite: Admission to the doctoral program.

Independent investigation in general field of dissertation. Maximum credit 36 units.

COMP 898. Doctoral Special Study (1-3) Cr/NC/RP

Prerequisite: Advancement to candidacy.

Individual study leading to study and research required for doctoral dissertation.

COMP 899. Doctoral Dissertation (1-15) Cr/NC/RP

Prerequisites: An officially constituted dissertation committee and advancement to candidacy.

Preparation of the dissertation for the doctoral degree. Enrollment is required during the term in which the student plans to graduate.