

Department of Computer Science

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Degrees offered: Bachelor of Science (BS), Bachelor of Arts (BA), Master of Science (MS), and Doctor of Philosophy (PhD) in Computer Science; Master of Computer Science (MCS)

Undergraduate emphases: BS, BA—Science, Digital Systems, Information Systems, Bioinformatics, Information Technology

Graduate specializations: MS—Artificial Intelligence, Information Systems, Parallel Systems, Software Engineering

Accreditation: The Computer Science undergraduate program (Science, Digital Systems, Bioinformatics, and Information Systems emphases) is accredited by the Computing Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD 21202-4012; telephone (410) 347-7700.

Undergraduate Programs

Objectives

The core objective of the department is to fulfill its mission, as defined in its mission statement. A detailed description of all department objectives is given under the department's website:

<http://www.cs.usu.edu/>. The outcome objectives for undergraduates are as follows.

Learning Objectives: Undergraduate Outcomes

All students graduating with a bachelor's degree in Computer Science from Utah State University will be expected to show mastery in the following.

1. Graduates will be proficient in programming in at least two programming languages that have significance in industry.
2. Graduates will master the core curriculum in:
 - a. Data Structures and Algorithms
 - b. Computer Architecture and Organization
 - c. Programming Languages
 - d. Operating Systems
 - e. Software Engineering
3. Graduates will understand the practices and dynamics required to develop software, whether it be a single program or a major software product developed in a team environment.
4. Graduates will gain proficiency in the use of mathematical tools, including calculus, elementary statistics, and probability.
5. Graduates will have sufficient mastery of fundamental knowledge to be lifelong learners in computer science.

6. Graduates will understand the social and ethical issues that face computer scientists, and thus be able to contribute in a positive and productive manner to society.
7. Graduates will be able to communicate information effectively, both in writing and orally.

The course of study offered by the Department of Computer Science is directed primarily toward developing the problem solving skills of its students. This, in conjunction with the understanding of computers and computer systems provided by coursework, will enable a graduate of the program to apply his or her knowledge to finding solutions to problems that arise in the science, business, industry, government, and education sectors.

Students who have the ability to think analytically and creatively will find a challenging and exciting future in computer science.

Opportunities for practical applications of computer science skills are available with members of the computer science faculty who are engaged in research and consultation work both on and off campus.

Assessment

The Computer Science Department has an ongoing assessment process that it highly values. Faculty members devote much of their time and resources to frequent assessment of the level or degree to which stated objectives are being met, the objectives themselves, and the departmental mission statement. The department then uses these results to establish priorities and guide the program. For further information, go to <http://www.cs.usu.edu/>, and click on **assessment**.

Computer Science

Computer Science deals with information structures and processes as they are represented and implemented in modern high-speed digital computers, and with information processing systems designed to implement useful applications of computing.

The program in computer science attempts to provide a solid foundation of knowledge about computers and to teach a mode of thinking that will permit continuing growth on the part of graduates. Prospective students should have an aptitude for mathematics and logic and an interest in analysis and deduction.

Computer science is one of the fastest growing fields of study in our society. Excellent employment opportunities are available to computer science graduates. All of the major corporations hire computer science graduates. Graduates in Computer Science work for numerous Utah-based corporations, as well as Microsoft, IBM, Hewlett-Packard, etc.

The Computer Science bachelor's degree is a four-year degree with areas of emphasis in Science, Digital Systems, Information Systems, Bioinformatics, and Information Technology. In addition, by working with a departmental advisor, students may develop a plan of study tailored to their own unique career objectives.

Science Emphasis

The Science Emphasis is designed for those who plan to pursue scientific or technical careers, research, or graduate education in computer science. Students choosing the science emphasis will take courses in programming languages, advanced algorithms, and math courses in calculus, linear analysis, and multi-variable calculus. Additional courses include a variety of upper-division computer science courses, chosen in consultation with an advisor. This emphasis might be termed the "typical" computer science degree.

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Digital Systems Emphasis

The Digital Systems Emphasis is available for those interested in both the hardware and software aspects of computer systems. In addition to computer science and mathematics courses, students in this emphasis will take electrical engineering courses in electronics, circuits, digital fundamentals, microcomputer systems, and digital system design. The curriculum for students in this emphasis is similar to that for students in the computer engineering major in the Electrical and Computer Engineering Department.

Bioinformatics Emphasis

The Bioinformatics Emphasis is designed for students who wish to pursue careers in the computer science aspects of bioinformatics. Students in this emphasis gain a strong background in core computer science areas, such as programming, theory of computing, and software development. In addition, they follow a course of study in biology, chemistry, and statistics. Through this background and course of study, students are provided with the computational skills and the scientific understanding necessary for work in bioinformatics.

Information Technology Emphasis

The Information Technology Emphasis trains students in all phases of analysis, design, and implementation of information technology. It also gives students expertise in the theory and application of information technology. At the same time, this emphasis provides students with a strong background in business principles, including accounting, finance, marketing, and human resource management. Students in the Information Technology emphasis are prepared for careers that straddle information technology and business, in both the private and public sectors.

Information Systems Emphasis

The Information Systems Emphasis (IS) is designed for students interested in careers as computer scientists specializing in information systems. Majors in this option are trained in all phases of the analysis, design, and implementation of information systems. They also gain an understanding of business fundamentals. Students are, thus, prepared to apply their computing expertise in a business environment.

The Information Systems program at Utah State University offers a common core of courses through two department majors: (1) **Computer Science** and (2) **Management Information Systems**. The curricula of the individual departments differ substantially in emphasis.

The Computer Science major with an Information Technology emphasis is designed for students interested in a career as a Computer Scientist with a background in Information Systems and Technology. Majors in this emphasis are trained in all phases of the analysis, design, and implementation of information systems. They also gain an understanding of business fundamentals. Thus, students are prepared to apply their computing expertise in a business environment. This program of study, offered within the College of Science, leads to a Bachelor of Science, Bachelor of Arts, or Master of Science degree in Computer Science.

The Management Information Systems major, Managerial emphasis, is offered in the Management Information Systems Department, College of Business (see page 391). The Bachelor of Science or Bachelor of Arts program is designed for students interested in business careers as information specialists, systems analysts, network managers, application programmers, and information systems managers in business and industry. MIS majors take required courses in analysis and design, Internet management, telecommunications, decision support systems, spreadsheet and database applications, and information systems projects. All graduates are required to complete a common core of business subjects. The

College of Business is accredited by the American Assembly of Collegiate Schools of Business. The department also offers a Master of Science in Management Information Systems with a specialization in Management Information Systems. See page 392 for additional details.

Undergraduate Research

The Computer Science Department provides opportunities for undergraduates to participate in research projects. Additionally, a student may register for CS 4950 (Undergraduate Research, 1-4 credits) to receive credit for their research. To learn about research opportunities, students should contact Computer Science faculty members. Students may work on a project of their own under faculty supervision, or they may do research as part of a faculty member's research team. For further information, contact Dan Watson, the department's coordinator of undergraduate research, at (435) 797-2440 or dan.watson@usu.edu.

Department and General College of Science Requirements

To fulfill the University Studies requirements, majors in computer science must complete a total of at least 30 semester credits in writing, languages, humanities, arts, and/or social sciences. Courses taken to meet the University Studies requirements, if applicable, may also be counted to meet this departmental requirement. Students must work closely with their advisor to meet both these requirements.

Bachelor of Science Core Requirements

Students working toward the Bachelor of Science degree in Computer Science must complete the following:

1. One year of calculus, including MATH 1210 and 1220. *Students in the Information Technology Emphasis may substitute MATH 1100.*
2. MATH 3310 (Discrete Mathematics). *Not required for students in the Information Technology Emphasis.*
3. One of the following year-long science sequences: (1) BIOL 1610, 1620 (required for Bioinformatics Emphasis); (2) CHEM 1210, 1215, 1220, 1225; (3) PHYS 2210, 2220 (required for Digital Systems Emphasis); (4) PHYS 2110, 2120 (available for Information Technology Emphasis only); or (5) GEO 1110, 3200. The sequence chosen must be outside the student's department.

Except for students enrolled in the Information Technology Emphasis, all Computer Science majors must complete at least 12 science credits.

Requirements

Summary of Departmental Admission and Retention Requirements

Admission requirements of the Department of Computer Science for freshmen are the same as those described for the University on pages 16-20. Transfer students with a 2.5 GPA may apply for admission to the department.

Before a student can register for a Computer Science course, he or she must earn a grade of C- or better in all prerequisite courses. All required classes for the major must be completed with a grade of C- or better. Required courses, regardless of department, may not be taken pass-fail, and a Computer Science major must have advanced

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standing or written permission to register for Computer Science courses or Electrical and Computer Engineering courses at the 3000-level or above.

In addition to completing the required courses listed below, students must comply with the following regulations, in order to graduate with a bachelor's degree in Computer Science.

1. Students must maintain a minimum cumulative GPA of 2.5. The cumulative GPA will be computed using all USU credits, as well as transfer credits (if those transfer credits are applied to any USU requirements, including major requirements).
2. Students must attain a minimum grade of C- in all courses fulfilling Computer Science major requirements.
3. Students may have *no more than six* repeats among courses fulfilling Computer Science major requirements. A grade of *WF* is considered as a repeat. If a course is repeated, the final grade achieved will be used in determining a student's advanced standing GPA.
4. Students may have *no more than one* 5000-level Computer Science course with a grade less than C- on their transcript.

Courses Required for Advanced Standing

Students must achieve a minimum cumulative GPA of 2.5, a minimum GPA of 2.5 (or grade of C- or better) among courses in one of the following core emphasis course sequences, or their equivalent, as determined by the Computer Science Department:

Science Emphasis

CS 1400 Introduction to Computer Science—CS 1 (F,Sp,Su)	3
CS 1405 Introduction to Computer Science—CS 1 Lab (F,Sp,Su)	1
CS 1410 (QI) Introduction to Computer Science—CS 2 (F,Sp,Su)	3
CS 2420 (QI) Algorithms and Data Structures—CS 3 (F,Sp,Su)	3
CS 2450 (CI) Software Engineering (F,Sp)	3
CS 2550 Computer Organization (F,Sp)	3
CS 3000 Undergraduate Seminar (F,Sp)	1
MATH 1210 (QL) Calculus I (F,Sp,Su)	4
MATH 1220 (QL) Calculus II (F,Sp,Su)	4
MATH 3310 Discrete Mathematics (F,Sp,Su)	3

Digital Systems Emphasis

CS 1400 Introduction to Computer Science—CS 1 (F,Sp,Su)	3
CS 1405 Introduction to Computer Science—CS 1 Lab (F,Sp,Su)	1
CS 1410 (QI) Introduction to Computer Science—CS 2 (F,Sp,Su)	3
CS 2420 (QI) Algorithms and Data Structures—CS 3 (F,Sp,Su)	3
CS 2450 (CI) Software Engineering (F,Sp)	3
CS 3000 Undergraduate Seminar (F,Sp)	1
ECE 2700 Digital Circuits (F,Sp)	4
MATH 1210 (QL) Calculus I (F,Sp,Su)	4
MATH 1220 (QL) Calculus II (F,Sp,Su)	4
MATH 3310 Discrete Mathematics (F,Sp,Su)	3

Information Systems Emphasis

CS 1400 Introduction to Computer Science—CS 1 (F,Sp,Su)	3
CS 1405 Introduction to Computer Science—CS 1 Lab (F,Sp,Su)	1
CS 1410 (QI) Introduction to Computer Science—CS 2 (F,Sp,Su)	3
CS 2420 (QI) Algorithms and Data Structures—CS 3 (F,Sp,Su)	3
CS 2450 (CI) Software Engineering (F,Sp)	3
CS 2550 Computer Organization (F,Sp)	3
CS 3000 Undergraduate Seminar (F,Sp)	1
MATH 1210 (QL) Calculus I (F,Sp,Su)	4
MATH 1220 (QL) Calculus II (F,Sp,Su)	4
MATH 3310 Discrete Mathematics (F,Sp,Su)	3

Bioinformatics Emphasis

CS 1400 Introduction to Computer Science—CS 1 (F,Sp,Su)	3
CS 1405 Introduction to Computer Science—CS 1 Lab (F,Sp,Su)	1
CS 1410 (QI) Introduction to Computer Science—CS 2 (F,Sp,Su)	3
CS 2420 (QI) Algorithms and Data Structures—CS 3 (F,Sp,Su)	3
CS 2450 (CI) Software Engineering (F,Sp)	3
CS 2550 Computer Organization (F,Sp)	3
CS 3000 Undergraduate Seminar (F,Sp)	1
MATH 1210 (QL) Calculus I (F,Sp,Su)	4
MATH 1220 (QL) Calculus II (F,Sp,Su)	4
MATH 3310 Discrete Mathematics (F,Sp,Su)	3

Information Technology Emphasis

CS 1030 (BPS) Foundations of Computer Science (F,Sp,Su)	3
CS 1400 Introduction to Computer Science—CS 1 (F,Sp,Su)	3
CS 1405 Introduction to Computer Science—CS 1 Lab (F,Sp,Su)	1
CS 1410 (QI) Introduction to Computer Science—CS 2 (F,Sp,Su)	3
CS 2420 (QI) Algorithms and Data Structures—CS 3 (F,Sp,Su)	3
CS 2450 (CI) Software Engineering (F,Sp)	3
CS 2550 Computer Organization (F,Sp)	3
CS 3000 Undergraduate Seminar (F,Sp)	1
MATH 1100 (QL) Calculus Techniques (F,Sp,Su)	3

For a more complete statement of requirements, please contact the department directly. Requirements may change from time to time.

Bachelor of Science Degree

The department offers a degree program with emphases in Science, Digital Systems, Information Systems, Bioinformatics, and Information Technology. The objectives are to train computer scientists who can relate to science, computer design, or information-based business disciplines. Other areas of emphasis will be considered on an individual basis.

First Semester Schedule (15 credits)

Depending upon emphasis, a new student's first semester schedule is configured from the following:

CS 1400 Introduction to Computer Science—CS 1	3
CS 1405 Introduction to Computer Science—CS 1 Lab	1
MATH 1210 (QL) Calculus I (<i>for Science, IS, DS, or BI Emphasis</i>) (4 cr) or	
MATH 1100 (QL) Calculus Techniques (<i>for IT Emphasis</i>) (3 cr)	3 or 4
University Studies courses	7-8

COMPUTER SCIENCE REQUIRED COURSES

Science Emphasis

CS 1400 Introduction to Computer Science—CS 1 (F,Sp,Su)	3
CS 1405 Introduction to Computer Science—CS 1 Lab (F,Sp,Su)	1
CS 1410 (QI) Introduction to Computer Science—CS 2 (F,Sp,Su)	3
CS 2420 (QI) Algorithms and Data Structures—CS 3 (F,Sp,Su)	3
CS 2450 (CI) Software Engineering (F,Sp)	3
CS 2550 Computer Organization (F,Sp)	3
CS 3000 Undergraduate Seminar (F,Sp)	1
CS 3100 Operating Systems and Concurrency (F,Sp)	3
CS 4700 Programming Languages (F,Sp)	3
CS 5050 Advanced Algorithms (F,Sp)	3
CS 5070 Computer Science Capstone (F,Sp,Su)	1
MATH 1210 (QL) Calculus I (F,Sp,Su)	4
MATH 1220 (QL) Calculus II (F,Sp,Su)	4
MATH 2210 (QI) Multivariable Calculus (F,Sp,Su)	3
MATH 2250 (QI) Linear Algebra and Differential Equations (F,Sp,Su) ..	4
MATH 3310 Discrete Mathematics (F,Sp,Su)	3

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MATH 5610 Computational Linear Algebra and Solution of Systems of Equations (F).....	3
PHIL 1120 (BHU) Social Ethics (F) (3 cr) or	
PHIL 2400 (BHU) Ethics (Sp) (3 cr) or	
PHIL 3520 (DHA) Business Ethics (Sp) (3 cr) or	
PHIL 4530 (DSC) Ethics and Biotechnology (Sp) (3 cr) or	
PHIL 4540 (DHA) Human Values and Information Technology (Sp) (3 cr).....	3
SPCH 1020 (CI) Public Speaking (F,Sp).....	3
STAT 3000 (QI) Statistics for Scientists (F,Sp,Su) (3 cr) or	
MATH 5710 Introduction to Probability (F,Sp) (3 cr).....	3
Advisor-approved computer science classes numbered 5000 or above.....	13

In addition, students must complete 6 credits at the 3000 level or higher, appropriate to the degree.

Digital Systems Emphasis

CS 1400 Introduction to Computer Science—CS 1 (F,Sp,Su).....	3
CS 1405 Introduction to Computer Science—CS 1 Lab (F,Sp,Su).....	1
CS 1410 (QI) Introduction to Computer Science—CS 2 (F,Sp,Su).....	3
CS 2420 (QI) Algorithms and Data Structures—CS 3 (F,Sp,Su).....	3
CS 2450 (CI) Software Engineering (F,Sp).....	3
CS 3000 Undergraduate Seminar (F,Sp).....	1
CS 3100 Operating Systems and Concurrency (F,Sp).....	3
CS 4700 Programming Languages (F,Sp).....	3
CS 5050 Advanced Algorithms (F,Sp).....	3
CS 5070 Computer Science Capstone (F,Sp,Su).....	1
ECE 2270 Electrical Circuits (F,Sp).....	4
ECE 2700 Digital Circuits (F,Sp).....	4
ECE 3710 Microcomputer Hardware and Software (F,Sp).....	4
ECE 3720 Microcomputer Systems Programming (Sp).....	3
MATH 1210 (QL) Calculus I (F,Sp,Su).....	4
MATH 1220 (QL) Calculus II (F,Sp,Su).....	4
MATH 2250 (QI) Linear Algebra and Differential Equations (F,Sp,Su).....	4
MATH 3310 Discrete Mathematics (F,Sp,Su).....	3
PHIL 1120 (BHU) Social Ethics (F) (3 cr) or	
PHIL 2400 (BHU) Ethics (Sp) (3 cr) or	
PHIL 3520 (DHA) Business Ethics (Sp) (3 cr) or	
PHIL 4530 (DSC) Ethics and Biotechnology (Sp) (3 cr) or	
PHIL 4540 (DHA) Human Values and Information Technology (Sp) (3 cr).....	3
SPCH 1020 (CI) Public Speaking (F,Sp).....	3
STAT 3000 (QI) Statistics for Scientists (F,Sp,Su).....	3
Advisor-approved computer science classes numbered 5000 or above.....	13

In addition, students must complete 6 credits at the 3000 level or higher, appropriate to the degree.

Information Systems Emphasis

ACCT 2010 Survey of Accounting I (F,Sp,Su).....	3
ACCT 2020 Survey of Accounting II (F,Sp,Su).....	3
BA 3080 (QI) Operations Research (F).....	3
CS 1400 Introduction to Computer Science—CS 1 (F,Sp,Su).....	3
CS 1405 Introduction to Computer Science—CS 1 Lab (F,Sp,Su).....	1
CS 1410 (QI) Introduction to Computer Science—CS 2 (F,Sp,Su).....	3
CS 2420 (QI) Algorithms and Data Structures—CS 3 (F,Sp,Su).....	3
CS 2450 (CI) Software Engineering (F,Sp).....	3
CS 2550 Computer Organization (F,Sp).....	3
CS 2810 Computer Organization and Architecture (F,Sp).....	3
CS 3000 Undergraduate Seminar (F,Sp).....	1
CS 3100 Operating Systems and Concurrency (F,Sp).....	3
CS 4700 Programming Languages (F,Sp).....	3
CS 5050 Advanced Algorithms (F,Sp).....	3
CS 5070 Computer Science Capstone (F,Sp,Su).....	1
ECON 1500 (BAI) ¹ Introduction to Economic Institutions, History, and Principles (F,Sp).....	3

MATH 1210 (QL) Calculus I (F,Sp,Su).....	4
MATH 1220 (QL) Calculus II (F,Sp,Su).....	4
MATH 3310 Discrete Mathematics (F,Sp,Su).....	3
MHR 3110 (DSS) ² Managing Organizations and People (F,Sp,Su).....	3
PHIL 1120 (BHU) Social Ethics (F) (3 cr) or	
PHIL 2400 (BHU) Ethics (Sp) (3 cr) or	
PHIL 3520 (DHA) Business Ethics (Sp) (3 cr) or	
PHIL 4530 (DSC) Ethics and Biotechnology (Sp) (3 cr) or	
PHIL 4540 (DHA) Human Values and Information Technology (Sp) (3 cr).....	3
SPCH 1020 (CI) Public Speaking (F,Sp).....	3
STAT 2300 (QL) Business Statistics (F,Sp,Su).....	4
Advisor-approved computer science classes numbered 5000 or above.....	13

In addition, the IS Emphasis requires CS 5800 and one course selected from the following list. These courses will be counted among the CS 5000 or above elective courses.

CS 5370 Advanced Software Engineering (F).....	3
CS 5700 Object-Oriented Software Development (F).....	3
CS 5850 Systems Analysis (Sp).....	3

¹ ECON 1500 fulfills the University Studies Breadth American Institutions (BAI) requirement.
² MHR 3110 fulfills the University Studies Depth Social Science (DSS) requirement.

Bioinformatics Emphasis

CS 1400 Introduction to Computer Science—CS 1 (F,Sp,Su).....	3
CS 1405 Introduction to Computer Science—CS 1 Lab (F,Sp,Su).....	1
CS 1410 (QI) Introduction to Computer Science—CS 2 (F,Sp,Su).....	3
CS 2420 (QI) Algorithms and Data Structures—CS 3 (F,Sp,Su).....	3
CS 2450 (CI) Software Engineering (F,Sp).....	3
CS 2550 Computer Organization (F,Sp).....	3
CS 2810 Computer Organization and Architecture (F,Sp).....	3
CS 3000 Undergraduate Seminar (F,Sp).....	1
CS 3100 Operating Systems and Concurrency (F,Sp).....	3
CS 4700 Programming Languages (F,Sp).....	3
CS 5050 Advanced Algorithms (F,Sp).....	3
CS 5070 Computer Science Capstone (F,Sp,Su).....	1
CS 5660 Bioinformatics I (F).....	3
CS 5670 Bioinformatics II (Sp).....	3
CS 5800 Introduction to Database Systems (F).....	3
STAT 3000 (QI) Statistics for Scientists (F,Sp,Su).....	3
MATH 1210 (QL) Calculus I (F,Sp,Su).....	4
MATH 1220 (QL) Calculus II (F,Sp,Su).....	4
MATH 2250 (QI) Linear Algebra and Differential Equations (F,Sp,Su) (4 cr) or	
MATH 2270 (QI) Linear Algebra (F) (3 cr).....	3 or 4
MATH 3310 Discrete Mathematics (F,Sp,Su).....	3
BIOL 3100 (CI) Bioethics (Sp).....	3
BIOL 3060 (QI) Principles of Genetics (F,Sp,Su).....	4
CHEM 1110 (BPS) General Chemistry I (F,Sp) (4 cr) or	
CHEM 1210 Principles of Chemistry (F,Sp) (4 cr).....	4
SPCH 1020 (CI) Public Speaking (F,Sp).....	3
Statistical Methods in Bioinformatics course (currently being developed)	
Advisor-approved computer science classes numbered 5000 or above.....	3
Advisor-approved electives.....	12-13

Students are strongly encouraged to take BIOL 5730 and its prerequisites to fill this elective requirement.

Information Technology Emphasis

ACCT 2010 Survey of Accounting I (F,Sp,Su).....	3
ACCT 2020 Survey of Accounting II (F,Sp,Su).....	3
BA 3080 (QI) Operations Research (F).....	3

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BA 3400 (QI) Corporate Finance (F,Sp,Su)	3
BA 3500 Fundamentals of Marketing (F,Sp,Su)	3
CS 1030 (BPS) Foundations of Computer Science (F,Sp,Su)	3
CS 1400 Introduction to Computer Science—CS 1 (F,Sp,Su)	3
CS 1405 Introduction to Computer Science—CS 1 Lab (F,Sp,Su)	1
CS 1410 (QI) Introduction to Computer Science—CS 2 (F,Sp,Su)	3
CS 2420 (QI) Algorithms and Data Structures—CS 3 (F,Sp,Su)	3
CS 2450 (CI) Software Engineering (F,Sp)	3
CS 2550 Computer Organization (F,Sp)	3
CS 2810 Computer Organization and Architecture (F,Sp)	3
CS 3000 Undergraduate Seminar (F,Sp)	1
CS 3010 (DSC/CI/QI) Information Acquisition, Analysis, and Presentation (F,Sp,Su)	3
CS 3100 Operating Systems and Concurrency (F,Sp)	3
CS 4700 Programming Languages (F,Sp)	3
CS 4720 Computer Networking I (F)	3
CS 5050 Advanced Algorithms (F,Sp)	3
CS 5070 Computer Science Capstone (F,Sp,Su)	1
CS 5800 Introduction to Database Systems (F)	3
CS 5850 Systems Analysis (Sp)	3
ECON 1500 (BAI) Introduction to Economic Institutions, History, and Principles (F,Sp)	3
MATH 1100 (QL) Calculus Techniques (F,Sp,Su)	3
MHR 3110 (DSS) Managing Organizations and People (F,Sp,Su)	3
MHR 3710 Developing Team and Interpersonal Skills (F,Sp)	3
PHIL 1120 (BHU) Social Ethics (F) (3 cr) or	
PHIL 2400 (BHU) Ethics (Sp) (3 cr) or	
PHIL 3520 (DHA) Business Ethics (Sp) (3 cr) or	
PHIL 4530 (DSC) Ethics and Biotechnology (Sp) (3 cr) or	
PHIL 4540 (DHA) Human Values and Information Technology (Sp) (3 cr)	3
STAT 2300 (QL) Business Statistics (F,Sp,Su)	4
Advisor-approved computer science classes numbered 5000 or above	10
Advisor-approved electives	1-2

Suggested Four-year Plan for Science Emphasis

Freshman Year (32 credits)

Fall Semester (16 credits)

CS 1400 Introduction to Computer Science—CS 1	3
CS 1405 Introduction to Computer Science—CS 1 Lab	1
MATH 1210 (QL) Calculus I	4
USU 1010 University Connections	2
Two University Studies breadth courses	6

Spring Semester (16 credits)

CS 1410 Introduction to Computer Science—CS 2	3
MATH 1220 (QL) Calculus II	4
SPCH 1020 (CI) Public Speaking	3
ENGL 1010 (CL1) Introduction to Writing: Academic Prose	3
One University Studies breadth course	3

Sophomore Year (29-31 credits)

Fall Semester (16-17 credits)

CS 2420 (QI) Algorithms and Data Structures—CS 3	3
CS 2550 Computer Organization	3
MATH 2210 (QI) Multivariable Calculus	3
Science Sequence I course	4-5
One University Studies breadth course	3

Spring Semester (13-14 credits)

CS 2450 (CI) Software Engineering	3
CS 2810 Computer Organization and Architecture	3
CS 3000 Undergraduate Seminar	1
MATH 3310 Discrete Mathematics	3
Science Sequence II course, having BLS or BPS designation	3-4

Junior Year (30-32 credits)

Fall Semester (16 credits)

CS 3100 Operating Systems and Concurrency	3
CS 4700 Programming Languages	3
MATH 2250 (QI) Linear Algebra and Differential Equations	4
ENGL 2010 (CL2) Intermediate Writing: Research Writing in a Persuasive Mode	3
One University Studies breadth course	3

Spring Semester (14-16 credits)

CS 5050 Advanced Algorithms	3
CS 5000-level elective course	3-4
Upper-division MATH or STAT course	3
One University Studies depth course	3
One extra science course	2-3

Senior Year (28-31 credits)

Fall Semester (13-15 credits)

CS 5070 Computer Science Capstone	1
CS 5000-level elective courses	9-11
One University Studies depth course	3

Spring Semester (15-16 credits)

CS 3000-level elective course	3
CS 5000-level elective course	3-4
Upper-division MATH or STAT course	3
Extra University Studies course	3
Advisor-approved elective course	3

Suggested Four-year Plan for Digital Systems Emphasis

Freshman Year (32 credits)

Fall Semester (16 credits)

CS 1400 Introduction to Computer Science—CS 1	3
CS 1405 Introduction to Computer Science—CS 1 Lab	1
MATH 1210 (QL) Calculus I	4
USU 1010 University Connections	2
Two University Studies breadth courses	6

Spring Semester (16 credits)

CS 1410 Introduction to Computer Science—CS 2	3
MATH 1220 (QL) Calculus II	4
SPCH 1020 (CI) Public Speaking	3
ENGL 1010 (CL1) Introduction to Writing: Academic Prose	3
One University Studies breadth course	3

Sophomore Year (31 credits)

Fall Semester (17 credits)

CS 2420 (QI) Algorithms and Data Structures—CS 3	3
ECE 2700 Digital Circuits	4
MATH 3310 Discrete Mathematics	3
PHYS 2210 (QI) General Physics—Science and Engineering I	4
One University Studies breadth course	3

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Spring Semester (14 credits)

CS 2450 (CI) Software Engineering	3
CS 3000 Undergraduate Seminar	1
PHYS 2220 (QI/BPS) General Physics—Science and Engineering II ..	4
CS 3100 Operating Systems and Concurrency	3
One University Studies breadth course	3

Junior Year (31-34 credits)

Fall Semester (15-17 credits)

CS 4700 Programming Languages	3
ENGL 2010 (CL2) Intermediate Writing: Research Writing in a Persuasive Mode	3
MATH 2250 (QI) Linear Algebra and Differential Equations	4
One extra science course	2-3
CS 5000-level elective course	3-4

Spring Semester (16-17 credits)

CS 5050 Advanced Algorithms	3
ECE 2270 Electrical Circuits	4
CS 5000-level elective course	3-4
One University Studies depth course	3
CS 3000-level elective course	3

Senior Year (26-28 credits)

Fall Semester (14-15 credits)

ECE 3710 Microcomputer Hardware and Software	4
CS 5070 Computer Science Capstone	1
STAT 3000 (QI) Statistics for Scientists	3
CS 5000-level elective course	3-4
Extra University Studies course	3

Spring Semester (12-13 credits)

ECE 3720 Microcomputer Systems Programming	3
CS 5000-level elective course	3-4
One University Studies depth course	3
Advisor-approved elective course	3

Suggested Four-year Plan for Information Systems Emphasis

Freshman Year (32 credits)

Fall Semester (16 credits)

CS 1400 Introduction to Computer Science—CS 1	3
CS 1405 Introduction to Computer Science—CS 1 Lab	1
MATH 1210 (QL) Calculus I	4
USU 1010 University Connections	2
ECON 1500 (BAI) Introduction to Economic Institutions, History, and Principles	3
One University Studies breadth course	3

Spring Semester (16 credits)

CS 1410 Introduction to Computer Science—CS 2	3
MATH 1220 (QL) Calculus II	4
SPCH 1020 (CI) Public Speaking	3
ENGL 1010 (CL1) Introduction to Writing: Academic Prose	3
One University Studies breadth course	3

Sophomore Year (29-31 credits)

Fall Semester (16-17 credits)

CS 2420 (QI) Algorithms and Data Structures—CS 3	3
CS 2550 Computer Organization	3
MATH 3310 Discrete Mathematics	3
Science Sequence I course	4-5
One University Studies breadth course	3

Spring Semester (13-14 credits)

CS 2450 (CI) Software Engineering	3
CS 2810 Computer Organization and Architecture	3
CS 3000 Undergraduate Seminar	1
ENGL 2010 (CL2) Intermediate Writing: Research Writing in a Persuasive Mode	3
Science Sequence II course, having BLS or BPS designation	3-4

Junior Year (30-31 credits)

Fall Semester (15 credits)

CS 4700 Programming Languages	3
CS 5800 Introduction to Database Systems	3
ACCT 2010 Survey of Accounting I	3
MHR 3110 (DSS) Managing Organizations and People	3
One University Studies breadth course	3

Spring Semester (15-16 credits)

CS 5050 Advanced Algorithms	3
CS 3100 Operating Systems and Concurrency	3
ACCT 2020 Survey of Accounting II	3
STAT 2300 (QL) Business Statistics	4
One extra science course	2-3

Senior Year (28-31 credits)

Fall Semester (13-15 credits)

CS 5070 Computer Science Capstone	1
CS 3000-level elective course	3
CS 5000-level elective courses	6-8
One Depth Humanities and Creative Arts (DHA) course	3

Spring Semester (15-16 credits)

BA 3080 (QI) Operations Research	3
CS 3000-level elective course	3
CS 5000-level elective course	3-4
Extra University Studies course	3
Advisor-approved elective course	3

Suggested Four-year Plan for Bioinformatics Emphasis

Freshman Year (34 credits)

Fall Semester (17 credits)

CS 1400 Introduction to Computer Science—CS 1	3
CS 1405 Introduction to Computer Science—CS 1 Lab	1
MATH 1210 (QL) Calculus I	4
BIOL 1610 Biology I	4
USU 1010 University Connections	2
One University Studies breadth course	3

Spring Semester (17 credits)

CS 1410 Introduction to Computer Science—CS 2	3
MATH 1220 (QL) Calculus II	4
BIOL 1620 (BLS) Biology II	4
ENGL 1010 (CL1) Introduction to Writing: Academic Prose	3
One University Studies breadth course	3

Sophomore Year (29 credits)

Fall Semester (14 credits)

CS 2420 (QI) Algorithms and Data Structures—CS 3	3
CS 2550 Computer Organization	3
MATH 3310 Discrete Mathematics	3
CHEM 1210 Principles of Chemistry I	4
CHEM 1215 Chemical Principles Laboratory I	1

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Spring Semester (15 credits)

CS 2450 (CI) Software Engineering	3
CS 3000 Undergraduate Seminar	1
CHEM 1220 (BPS) Principles of Chemistry II	4
CHEM 1225 Chemical Principles Laboratory II	1
STAT 3000 (QI) Statistics for Scientists	3
One University Studies breadth course	3

Junior Year (31-32 credits)

Fall Semester (16 credits)

CS 3100 Operating Systems and Concurrency	3
CS 5800 Introduction to Database Systems	3
BIOL 3060 Principles of Genetics	4
CHEM 2300 Principles of Organic Chemistry	3
ENGL 2010 (CL2) Intermediate Writing: Research Writing in a Persuasive Mode	3

Spring Semester (15-16 credits)

CS 2810 Computer Organization and Architecture	3
CS 4700 Programming Languages	3
CHEM 3700 Introductory Biochemistry	3
CS 5000-level elective course	3-4
One University Studies breadth course	3

Senior Year (32-33 credits)

Fall Semester (16-17 credits)

CS 5050 Advanced Algorithms	3
CS 5070 Computer Science Capstone	1
CS 5660 Bioinformatics I	3
MATH 2250 (QI) Linear Algebra and Differential Equations (4 cr) or	
MATH 2270 (QI) Linear Algebra (3 cr)	3 or 4
SPCH 1020 (CI) Public Speaking	3
One University Studies depth course	3

Spring Semester (16 credits)

CS 5670 Bioinformatics II	3
CHEM 5730 Genomic Technologies	4
BIOL 3100 (CI) Bioethics	3
One University Studies Depth course	3
Extra University Studies course	3

Suggested Four-year Plan for Information Technology Emphasis

Freshman Year (30 credits)

Fall Semester (15 credits)

CS 1400 Introduction to Computer Science—CS 1	3
CS 1405 Introduction to Computer Science—CS 1 Lab	1
MATH 1100 (QL) Calculus Techniques	3
ENGL 1010 (CL1) Introduction to Writing: Academic Prose	3
ECON 1500 (BAI) Introduction to Economic Institutions, History, and Principles	3
USU 1010 University Connections	2

Spring Semester (15 credits)

CS 1410 Introduction to Computer Science—CS 2	3
SPCH 1020 (CI) Public Speaking	3
Three University Studies breadth courses	9

Sophomore Year (29-31 credits)

Fall Semester (16-17 credits)

CS 2420 (QI) Algorithms and Data Structures—CS 3	3
CS 2550 Computer Organization	3
ACCT 2010 Survey of Accounting I	3
Science Sequence I course	4-5
One University Studies breadth course	3

Spring Semester (13-14 credits)

CS 2450 (CI) Software Engineering	3
CS 2810 Computer Organization and Architecture	3
CS 3000 Undergraduate Seminar	1
ACCT 2020 Survey of Accounting II	3
Science Sequence II course, having BLS or BPS designation	3-4

Junior Year (31 credits)

Fall Semester (16 credits)

CS 4700 Programming Languages	3
CS 5800 Introduction to Database Systems	3
MHR 3110 (DSS) Managing Organizations and People	3
ENGL 2010 (CL2) Intermediate Writing: Research Writing in a Persuasive Mode	3
STAT 2300 (QL) Business Statistics	4

Spring Semester (15 credits)

CS 3100 Operating Systems and Concurrency	3
CS 4720 Computer Networking I	3
CS 5850 Systems Analysis	3
BA 3080 Operations Research	3
MHR 3710 Developing Team and Interpersonal Skills	3

Senior Year (28-31 credits)

Fall Semester (13-15 credits)

CS 5070 Computer Science Capstone	1
BA 3500 Fundamentals of Marketing	3
CS 5000-level elective courses	6-8
One Depth Humanities and Creative Arts (DHA) course	3

Spring Semester (15-16 credits)

CS 5050 Advanced Algorithms	3
BA 3400 (QI) Corporate Finance	3
CS 5000-level elective course	3-4
Extra University Studies course	3
Advisor-approved elective course	3

Minor

Requirements for a minor in computer science are listed below. Before beginning any minor, a student must meet with a departmental advisor and file an approved minor application form with the Computer Science Department.

Computer Science Minor (16-18 credits)

A. Required Courses (10 credits)

CS 1400 Introduction to Computer Science—CS 1 (F,Sp,Su)	3
CS 1405 Introduction to Computer Science—CS 1 Lab (F,Sp,Su)	1
CS 1410 (QI) Introduction to Computer Science—CS 2 (F,Sp,Su)	3
CS 2420 (QI) Algorithms and Data Structures—CS 3 (F,Sp,Su)	3

B. Computer Science Electives (6-8 credits)

Two additional CS classes must be selected from the following:

CS 2450 (CI) Software Engineering (F,Sp)	3
CS 2550 Computer Organization (F,Sp)	3
CS 2810 Computer Organization and Architecture (F,Sp)	3
CS 3100 Operating Systems and Concurrency (F,Sp)	3
CS 4700 Programming Languages (F,Sp)	3

Any CS class numbered 5000 or above

3 or 4
At least one of these two electives must be numbered at the 3000 level or above.

Departmental Honors

Students who would like to experience greater academic depth within their major are encouraged to enroll in departmental honors. Through

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original, independent work, Honors students enjoy the benefits of close supervision and mentoring, as they work one-on-one with faculty in select upper-division departmental courses. Honors students also complete a senior project, which provides another opportunity to collaborate with faculty on a problem that is significant, both personally and in the student's discipline. Participating in departmental honors enhances students' chances for obtaining fellowships and admission to graduate school. Minimum GPA requirements for participation in departmental honors vary by department, but usually fall within the range of 3.30-3.50. Students may enter the Honors Program at almost any stage in their academic career, including at the junior (and sometimes senior) level. The campus-wide Honors Program, which is open to all qualified students regardless of major, offers a rich array of cultural and social activities, special classes, and the benefit of Honors early registration. Interested students should contact the Honors Program, Main 15, (435) 797-2715, honors@cc.usu.edu. Additional information can be found online at: <http://www.usu.edu/honors/>

Additional Information

For more information about requirements for the Computer Science major and minor, see the major requirement sheet, available from the Computer Science Department, or online at: <http://www.usu.edu/majorsheets/>

Graduate Programs

Computer science deals with the programming, use, management, and organization of computers. Graduate students specialize in many different areas, several of which have strong ties to other disciplines such as mathematics, computer engineering, statistics, accounting, and business administration.

Admission Requirements

Applicants for admission to the graduate program should have a bachelor's degree in computer science **or** extensive experience in computing. Normally, a score of at least 640 on the quantitative test of the general GRE is required for admission to the MS, and a score of at least 700 is required for admission to the PhD or MCS. For scores less than these, applicants must show other strengths in their backgrounds to be considered for admission. The GRE computer science subject exam is not required for admission. Those who do take the GRE computer science subject exam will have preference in consideration for the award of financial aid. Decisions on financial aid are made on or near March 15 for the following fall semester.

Course Requirements

In addition to the specific departmental admission and degree requirements described in this section, students are advised that they must also meet all Graduate School requirements as described in the Graduate School section of this catalog. Please note that departmental requirements change from time to time, so students should work closely with their advisor in designing their graduate program. Graduate-level courses outside the department *may* be acceptable for the graduate degree. In all cases, approval of the candidate's graduate committee should be obtained *before* registering for such courses.

Graduate students in the master's degree programs who have not taken or passed at the 50th percentile the computer science GRE subject exam are required to meet departmental placement requirements before completion of their first year. Students who have

not met this requirement after the first year, as a minimum, will not be eligible for department-funded financial aid and cannot submit their program of study. In some circumstances, students will be terminated in the program. The department placement requirement is met in one or a combination of the following three ways:

1. Pass the placement exam in Algorithms and Data Structures, as well as two of the following five placement exams: Computer Architecture and Organization, Operating Systems, Automata, Programming Languages/Compilers, and Software Engineering.
2. Complete CS 2420 (algorithms and data structures) and CS 5050 (advanced algorithms) with a grade of at least *B-*. Also complete with a grade of at least *B-* two of the following courses: CS 2810 or ECE 5750 (architecture); CS 3100 (operating systems); CS 4700 or 5300 (programming languages); and CS 2450, 5370, or 6370 (software engineering).
3. Show on an official transcript from an accredited college or university the completion of three courses deemed by the department to be equivalent to its placement courses. These must be semester-based courses of at least 3 credits, and the corresponding grade must be at least a *B-*.

Master of Science (MS)

Whether Plan A, Plan B, or Plan C (see School of Graduate Studies general requirements), all MS/CS students must meet the following general requirements:

1. Complete four Computer Science courses numbered 6000 and above. CS 6250 and 6900 are *not accepted* for these four courses. CS 6950 can count as *only one* of these four courses, and in that case must be taken for at least 3 credits in a single semester.
2. Complete 1 credit of CS 6900.

No more than 3 total credits in CS 5950, 6950, and 7950 and 1 credit of CS 6900 may be used to satisfy the MS degree requirements. CS 6250 cannot be used to meet MS coursework requirements. A maximum of 15 credits of committee-approved coursework below the 6000-level may be used for the MS degree.

Students completing a **Plan A MS degree** must fulfill the following requirements:

1. Complete at least 24 credits of graduate coursework. The total GPA must be at least 3.0, and no more than two class grades below *B-* and none below *C* may be included.
2. Successfully meet the departmental placement requirement.
3. Successfully complete and submit a graduate thesis proposal.
4. Successfully complete and defend a graduate thesis, based on original work (CS 6970, 6 credits).

Students completing a **Plan B MS degree** must fulfill the following requirements:

1. Complete at least 32 credits of graduate coursework. The total GPA must be at least 3.0, and no more than two class grades below *B-* and none below *C* may be included.
2. Successfully meet the departmental placement requirement.

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3. Successfully complete and submit a graduate report proposal.
4. Successfully complete and defend a graduate report (CS 6970, 2 credits).

Students completing a **Plan C MS degree** must fulfill the following requirements:

1. Complete at least 37 credits of graduate coursework. The total GPA must be at least 3.0, and no more than two class grades below *B-* and none below *C* may be included. CS 6970 *cannot* be included
2. Successfully meet the departmental placement requirement.
3. Successfully complete *one pair of courses* representing a sequence offered by the department. The sequences include: CS 5050 and 6050; CS 5200 and 6200; CS 5300 and 6300; CS 5600 and 6600; CS 5650 and 6650; CS 5700 and 6700; CS 5800 and 7670; CS 6100 and 7100; CS 6450 and 7450; *two* of CS 5370 or 6370, CS 7350, and 7380; *two* of CS 5500, 6500, 6550, and 7550; *two* of CS 5650, 6630, 6650, 7650, and 7680; and *two* of CS 5660, 5670, and 6670.

Master of Computer Science (MCS)

The Master of Computer Science (MCS) is a terminal degree with coursework requirements similar to the PhD, but lacking the PhD's requirement for original research. Students completing an MCS degree must fulfill the following requirements:

1. Complete at least 60 credits of graduate coursework beyond the BS/CS or 30 credits of graduate coursework beyond the MS/CS with a minimum class grade of *B-* and a minimum cumulative GPA of 3.2.
2. No more than 15 credits of coursework numbered below 6000 may be used for the MCS.
3. Complete at least 12 credits of 7000-level computer science coursework.
4. Successfully meet the departmental placement requirement.
5. Successfully complete and submit a research report proposal.
6. Successfully complete and defend a research report, based on original work (CS 7970, 6 credits).
7. Complete 1 credit of CS 6900.

Doctor of Philosophy (PhD)

The Doctor of Philosophy in Computer Science is, above all else, a degree of quality. Simply completing a number of graduate courses or years of study is not sufficient to receive the degree. The successful candidate must demonstrate a breadth of understanding in computer science, as well as a depth of understanding in his or her chosen area(s) of emphasis. Also, students must show an ability to do creative research. This research should be carried out over a significant period of time (i.e., at least one year or three semesters). Thus, each successful PhD candidate will produce a significant piece of original research, presented in a written dissertation and defended in an oral examination. This work should be of such quality that one or more journal or conference articles can be derived from it.

Students completing a PhD/CS must fulfill the following requirements:

1. Complete at least 90 credits of graduate coursework (including at least 27 credits of dissertation/research) beyond a BS/CS or at least 60 credits (including at least 27 credits of dissertation research) beyond an MS/CS with a minimum class grade of *B* and a minimum cumulative GPA of 3.5.
2. If an MS/CS is completed first, then no more than 15 credits of the 60 credits required for the PhD may be taken in coursework numbered below the 6000 level. If an MS/CS is not completed first, then no more than 21 credits of the 90 credits required for the PhD may be taken in coursework numbered below the 6000 level.
3. Complete at least 12 credits of 7000-level computer science coursework.
4. Complete 2 credits of PhD Seminar (CS 7900).
5. Complete 9 credits of department-approved courses outside the department.
6. Pass a set of comprehensive written examinations and an oral examination showing depth and breadth of knowledge in computer science and the student's area(s) of emphasis.
7. Successfully complete and defend a research proposal.
8. Successfully complete and defend a dissertation (CS 7970, for at least 27 credits).

Financial Assistance

Applicants for admission will automatically be considered for financial aid, with no need for additional application procedures. Continuing students will be requested to apply for aid during the spring semester. Acceptance into the program does not guarantee financial assistance.

Computer Science Faculty

Professors

Scott R. Cannon, parallel processing, real-time systems, biomedical applications

Heng-Da Cheng, image processing, artificial intelligence, parallel processing, computer vision, fuzzy logic, VLSI algorithms and architectures, neural networks

Donald H. Cooley, fuzzy logic, evolutionary algorithms, neural networks, multimedia systems

Professor Emeritus

Wendell L. Pope, data structures, automatic software generation, programming languages

Associate Professors

Stephen J. Allan, parallel processing, parallel programming, recognition of parallelism, program optimization

Vicki H. Allan, instruction-level parallelism, register allocation, software pipelining, program optimization

Stephen W. Clyde, software engineering, object orientation, distributed systems, database theory, multimedia systems

Nicholas S. Flann, machine learning, artificial intelligence

Daniel W. Watson, parallel and heterogeneous computing, interconnection networks

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Associate Professors Emeritus

Nelson T. Dinerstein, analysis and construction of information systems, database management systems, applications of small computers
Larre N. Egbert, scientific computing, computer graphics
Gregory W. Jones, theory of computing, software engineering

Assistant Professors

Robert F. Erbacher, computer graphics, visualization, computer security, bioinformatics, GUIs, systems
Jerry James, concurrency, formal methods, distributed systems, operating systems
Minghui Jiang, bioinformatics and computer biology, design and analysis of algorithms, computational geometry
Vladimir Kulyukin, assistive technology, robotics

Seungjin Lim, data mining, semi-structured databases, bioinformatics
Chad D. Mano, computer security
Supratik Mukhopadhyay, software engineering
Xiaojun Qi, image processing, data mining
Changhui Yan, bioinformatics, data mining, machine learning, computational biology

Lecturers

Linda Duhadway, computer science education
Dean Mathias, computer graphics

Course Descriptions

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