Computer Science

Computer science is now a critical tool for pursuing an ever-broadening range of topics, from outer space to the workings of the human mind. In most areas of science and in many liberal arts fields, cutting-edge work depends increasingly on computational approaches. The undergraduate program at Brown is designed to combine breadth in practical and theoretical computer science with depth in specialized areas. These areas range from traditional topics, such as analysis of algorithms, artificial intelligence, databases, distributed systems, graphics, mobile computing, networks, operating systems, programming languages, robotics and security, to novel areas including games and scientific visualization.

Our requirements are built on a collection of pathways, each representing a well-defined area within computer science. Concentrators interested in particular areas can choose the courses included in particular pathways. Conversely, concentrators who are unsure of their area of interest but who have particularly enjoyed certain courses can choose pathways that include these concentrations. Students may not use more than two CSCI 1970 courses to complete the requirements for the Sc.B. and one CSCI 1970 course for the A.B. requirements.

Requirements for the Standard Track of the Sc.B. degree

Prerequisites (0-3 courses)
Calculation prerequisite: students must complete or place out of second semester calculus.
- MATH 0100 Introductory Calculus, Part II
- or MATH 0170 Advanced Placement Calculus
- or MATH 0190 Advanced Placement Calculus (Physics/Engineering)

Concentration Requirements

Core-Computer Science:
Select one of the following introductory course Series: 2

Series A
- CSCI 0150 & CSCI 0160 Introduction to Object-Oriented Programming and Computer Science and Introduction to Algorithms and Data Structures

Series B
- CSCI 0170 & CSCI 0180 Computer Science: An Integrated Introduction and Computer Science: An Integrated Introduction

Series C
- CSCI 0190 Accelerated Introduction to Computer Science (and an additional CS course not otherwise used to satisfy a concentration requirement; this course may be CSCI 0180, an intermediate-level course, or an advanced course)

Thirteen CS courses numbered 0220 or higher. 13

## Two complete pathways (at least one core course from each)

# Each requires two 1000-level courses as well as one-to-three intermediate courses
# One of the courses used in one pathway must be a capstone course (defined below)
# The core and related courses used in one pathway may not overlap with those used in another

# Additional intermediate courses so that a total of five are taken, with at least one from each of the three categories
# One additional 1000-level course that is neither a core nor a related course for the pathways used above

Intermediate Courses

Students must complete the intermediate courses defined for the pathway they choose. In addition, ScB students must take at least one course from each intermediate course category to ensure they span all areas. Taking additional courses beyond those listed for the pathway may be required.

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### Foundations

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCI 0220</td>
<td>Introduction to Discrete Structures and Probability</td>
</tr>
<tr>
<td>CSCI 1010</td>
<td>Theory of Computation</td>
</tr>
</tbody>
</table>

### Mathematics

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCI 0530</td>
<td>Coding the Matrix: An Introduction to Linear Algebra for Computer Science</td>
</tr>
<tr>
<td>or MATH 0520</td>
<td>Linear Algebra</td>
</tr>
<tr>
<td>or MATH 0540</td>
<td>Honors Linear Algebra</td>
</tr>
</tbody>
</table>

### Concentration Requirements

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCI 1450</td>
<td>Probability for Computing and Data Analysis</td>
</tr>
<tr>
<td>or APMA 1650</td>
<td>Statistical Inference I</td>
</tr>
<tr>
<td>or APMA 1655</td>
<td>Statistical Inference I</td>
</tr>
</tbody>
</table>

### Systems

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>MATH 0180</td>
<td>Intermediate Calculus</td>
</tr>
<tr>
<td>or MATH 0200</td>
<td>Intermediate Calculus (Physics/Engineering)</td>
</tr>
<tr>
<td>or MATH 0350</td>
<td>Honors Calculus</td>
</tr>
</tbody>
</table>

### Pathways

Completing a pathway entails taking two courses in the pathway of which at least one is a course course for the pathway. One must also take the intermediate courses specified as part of the pathway.

**SYSTEMS: studies the design, construction, and analysis of modern, multi-faceted computing systems**

**Core Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>CSCI 1380</td>
<td>Distributed Computer Systems</td>
</tr>
<tr>
<td>or CSCI 1670</td>
<td>Operating Systems</td>
</tr>
<tr>
<td>or CSCI 1680</td>
<td>Computer Networks</td>
</tr>
</tbody>
</table>

**Related Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCI 1270</td>
<td>Database Management Systems</td>
</tr>
<tr>
<td>or CSCI 1320</td>
<td>Creating Modern Web Applications</td>
</tr>
<tr>
<td>or CSCI 1600</td>
<td>Real-Time and Embedded Software</td>
</tr>
<tr>
<td>or CSCI 1650</td>
<td>Software Security and Exploitation</td>
</tr>
<tr>
<td>or CSCI 1660</td>
<td>Introduction to Computer Systems Security</td>
</tr>
<tr>
<td>or CSCI 1730</td>
<td>Design and Implementation of Programming Languages</td>
</tr>
<tr>
<td>or CSCI 1760</td>
<td>Multiprocessor Synchronization</td>
</tr>
<tr>
<td>or CSCI 195Y</td>
<td>Logic for Systems</td>
</tr>
<tr>
<td>or ENGN 1640</td>
<td>Design of Computing Systems</td>
</tr>
</tbody>
</table>

**Intermediate Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCI 0330</td>
<td>Introduction to Computer Systems</td>
</tr>
<tr>
<td>CSCI 0220</td>
<td>Introduction to Discrete Structures and Probability</td>
</tr>
<tr>
<td>or CSCI 0320</td>
<td>Introduction to Software Engineering</td>
</tr>
</tbody>
</table>

**SOFTWARE PRINCIPLES: studies the design, construction, and analysis of modern software systems**

**Core Courses**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSCI 1280</td>
<td>Compilers and Program Analysis</td>
</tr>
<tr>
<td>or CSCI 1320</td>
<td>Creating Modern Web Applications</td>
</tr>
<tr>
<td>or CSCI 1600</td>
<td>Real-Time and Embedded Software</td>
</tr>
<tr>
<td>or CSCI 1730</td>
<td>Design and Implementation of Programming Languages</td>
</tr>
<tr>
<td>or CSCI 195Y</td>
<td>Logic for Systems</td>
</tr>
</tbody>
</table>

**Related Courses**
### Core Courses
- **CSCI 1270**: Database Management Systems
- **or CSCI 1380**: Distributed Computer Systems
- **or CSCI 1650**: Software Security and Exploitation

### Intermediate Courses
- **CSCI 0220**: Introduction to Discrete Structures and Probability
- **CSCI 0320**: Introduction to Software Engineering
- **CSCI 0330**: Introduction to Computer Systems (Data)

### Related Courses
- **CSCI 1550**: Probabilistic Methods in Computer Science
- **or CSCI 1580**: Information Retrieval and Web Search
- **or ECON 1660**: Big Data

### Intermediate Courses
- **CSCI 0320**: Introduction to Software Engineering
- **or CSCI 0330**: Introduction to Computer Systems
- **MATH 0520**: Linear Algebra
- **or MATH 0540**: Honors Linear Algebra
- **or CSCI 0530**: Coding the Matrix: An Introduction to Linear Algebra for Computer Science

### DATA: Studies the management and use of large data collections
- **CSCI 1270**: Database Management Systems
- **or CSCI 1420**: Machine Learning
- **or CSCI 1951A**: Data Science

### Intermediate Courses
- **CSCI 0320**: Introduction to Software Engineering
- **or CSCI 0330**: Introduction to Computer Systems
- **MATH 0520**: Linear Algebra
- **or MATH 0540**: Honors Linear Algebra
- **or CSCI 0530**: Coding the Matrix: An Introduction to Linear Algebra for Computer Science

### ARTIFICIAL INTELLIGENCE / MACHINE LEARNING: studies the theory and application of algorithms for making decisions and inferences from rules and data
- **CSCI 1410**: Artificial Intelligence
- **or CSCI 1420**: Machine Learning
- **or CSCI 1430**: Computer Vision
- **or CSCI 1460**: Computational Linguistics

### Related Courses
- **CSCI 1550**: Probabilistic Methods in Computer Science
- **or CSCI 1580**: Information Retrieval and Web Search
- **or CSCI 1951A**: Data Science
- **or CSCI 1951C**: Designing Humanity Centered Robots
- **or CSCI 1951K**: Algorithmic Game Theory
- **or ENGN 1610**: Image Understanding

### Intermediate Courses
- **CSCI 1450**: Probability for Computing and Data Analysis
- **or MATH 1650**: Statistical Inference I
- **or MATH 1655**: Statistical Inference I

### SECURITY: studies the design, construction, analysis, and defense of techniques to protect systems, data, and communications
- **CSCI 1510**: Introduction to Cryptography and Computer Security
- **or CSCI 1650**: Software Security and Exploitation

### Related Courses
- **CSCI 1320**: Creating Modern Web Applications
- **or CSCI 1380**: Distributed Computer Systems
- **or CSCI 1670**: Operating Systems
- **or CSCI 1730**: Design and Implementation of Programming Languages
- **or CSCI 1800**: Cybersecurity and International Relations
- **or CSCI 1950Y**: Logic for Systems
- **or CSCI 1951B**: Virtual Citizens or Subjects? The Global Battle Over Governing Your Internet

### Intermediate Courses
- **CSCI 0330**: Introduction to Computer Systems
- **CSCI 1010**: Theory of Computation
- **CSCI 0220**: Introduction to Discrete Structures and Probability

### VISUAL COMPUTING: studies the creation, interaction, and analysis of images and visual information, including animation and games
- **CSCI 1230**: Introduction to Computer Graphics
- **or CSCI 1250**: Introduction to Computer Animation
- **or CSCI 1280**: Intermediate 3D Computer Animation
- **or CSCI 1300**: User Interfaces and User Experience
- **or CSCI 1370**: Virtual Reality Design for Science
- **or CSCI 1430**: Computer Vision
- **or CSCI 1950T**: Advanced Animation Production
- **or CSCI 2240**: Interactive Computer Graphics

### Related Courses
- **CSCI 1950N**: 2D Game Engines
- **or CSCI 1950U**: Topics in 3D Game Engine Development
- **or ENGN 1610**: Image Understanding
- **or CLPS 1520**: Computational Vision
Brown programs for designing one's own concentration.

SELF-DESIGNED: This pathway is modeled after the Intermediate Courses Related Courses Core Courses processes at the interface between humans and systems DESIGN: studies the design, construction, and analysis of computer architecture and hardware

Core Courses

ENGN 1630 Digital Electronics Systems Design or ENGN 1640 Design of Computing Systems or ENGN 1650 Embedded Microprocessor Design

Related Courses

CSCI 1600 Real-Time and Embedded Software or CSCI 1760 Multiprocessor Synchronization or ENGN 1660 Design and Implementation of VLSI Systems

Intermediate Course

CSCI 0330 Introduction to Computer Systems

COMPUTATIONAL BIOLOGY: studies the foundations and applications of algorithms for analyzing biological data and processes

Core Courses

CSCI 1810 Computational Molecular Biology or CSCI 1820 Algorithmic Foundations of Computational Biology

Related Courses

CSCI 1420 Machine Learning or CSCI 1951A Data Science or CLPS 1520 Computational Vision

Intermediate Courses

CSCI 0220 Introduction to Discrete Structures and Probability or CSCI 1010 Theory of Computation or CSCI 1450 Probability for Computing and Data Analysis or APMA 1650 Statistical Inference I or APMA 1655 Statistical Inference I

DESIGN: studies the design, construction, and analysis of processes at the interface between humans and systems

Core Courses

CSCI 1300 User Interfaces and User Experience or CSCI 1370 Virtual Reality Design for Science or CSCI 1951C Designing Humanity Centered Robots

Related Courses

CSCI 1230 Introduction to Computer Graphics or CSCI 1320 Creating Modern Web Applications or CSCI 1600 Real-Time and Embedded Software or CSCI 1951A Data Science or CSCI 1900 csciStartup or VISA 1720 Physical Computing

Intermediate Courses

CSCI 0320 Introduction to Software Engineering or CSCI 0330 Introduction to Computer Systems or CSCI 1450 Probability for Computing and Data Analysis or APMA 1650 Statistical Inference I or APMA 1655 Statistical Inference I

SELF-DESIGNED: This pathway is modeled after the Brown programs for designing one's own concentration.

Students electing this pathway must write a proposal for their pathway and have it approved by an advisor and the director of undergraduate studies. The proposal must meet the breadth and overall course requirements. This must be done by the end of shopping period of the student's seventh semester.

1 Capstone: a one-semester course, taken in the student’s last undergraduate year, in which the student (or group of students) use a significant portion of their undergraduate education, broadly interpreted, in studying some current topic in depth, to produce a culminating artifact such as a paper or software project.

2 Certain 1000-level courses may be used to fill the additional 1000-level course requirements for both the AB and ScB. No more than one such course may be used for the AB concentration and no more than three for the ScB concentration. A list of approved non-CS courses is on our web page. Unless explicitly stated on our web page, such non-CS courses may not be used as part of pathways.

Requirements for the Professional Track of the Sc.B. degree.

The requirements for the professional track include all those of the standard track, as well as the following:

Students must complete two-to-four-month full-time professional experiences, doing work that is related to their concentration programs. Such work is normally done within an industrial organization, but may also be at a university under the supervision of a faculty member.

On completion of each professional experience, the student must write and upload to ASK a reflective essay about the experience addressing the following prompts, to be approved by the student's concentration advisor:

- Which courses were put to use in your summer's work? Which topics, in particular, were important?
- In retrospect, which courses should you have taken before embarking on your summer experience? What are the topics from these courses that would have helped you over the summer if you had been more familiar with them?
- Are there topics you should have been familiar with in preparation for your summer experience, but are not taught at Brown? What are these topics?
- What did you learn from the experience that probably could not have been picked up from course work?
- Is the sort of work you did over the summer something you would like to continue doing once you graduate? Explain.
- Would you recommend your summer experience to other Brown students? Explain.

Requirements for the Standard Track of the A.B. degree

Prerequisites (0-3 courses) 0-3

Students must complete or place out of second semester calculus.

MATH 0100 Introductory Calculus, Part I or MATH 0170 Advanced Placement Calculus or MATH 0190 Advanced Placement Calculus (Physics/Engineering)

Concentration Requirements (9 courses) 2

Core Computer Science:

Select one of the following series:

Series A

CSCI 0150 Introduction to Object-Oriented Programming and Computer Science

Series B

CSCI 0160 Introduction to Algorithms and Data Structures
## Requirements for the Professional Track of the A.B. degree.

The requirements for the professional track include all those of the standard track, as well as the following:

Students must complete two two-to-four-month full-time professional experiences, doing work that is related to their concentration programs. Such work is normally done within an industrial organization, but may also be at a university under the supervision of a faculty member.

On completion of each professional experience, the student must write and upload to ASK a reflective essay about the experience addressing the following prompts, to be approved by the student's concentration advisor:

- Which courses were put to use in your summer's work? Which topics, in particular, were important?
- In retrospect, which courses should you have taken before embarking on your summer experience? What are the topics from these courses that would have helped you over the summer if you had been more familiar with them?
- Are there topics you should have been familiar with in preparation for your summer experience, but are not taught at Brown? What are these topics?
- What did you learn from the experience that probably could not have been picked up from course work?
- Is the sort of work you did over the summer something you would like to continue doing once you graduate? Explain.
- Would you recommend your summer experience to other Brown students? Explain.
Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Helvetica was used instead of Arial.

The editor may contact Leepfrog for a draft with the correct fonts in place.