Human-Computer Interaction

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Undergraduate Major in HCI

We are thrilled to announce that Carnegie Mellon is starting a new primary major in Human-Computer Interaction (HCI), one of the first universities worldwide to do so.

Beginning Fall 2020, Carnegie Mellon students within the School of Computer Science (SCS) can declare a primary major in HCI. (Non-SCS students at Carnegie Mellon can continue to couple one of our other highly popular undergraduate options – the Additional Major in Interdisciplinary HCI [https://hci.cmu.edu/academics/hci-undergraduate/major/) or the Minor in Interdisciplinary HCI [https://hci.cmu.edu/academics/hci-undergraduate/minor/) -- with their primary University major.)

About the B.S. in HCI

Our new Bachelor of Science in Human-Computer Interaction will produce HCI specialists who are technically skilled and adept at designing and prototyping interactive solutions with the latest digital technologies. Students graduating from the HCI primary major will have a unique perspective on how digital products and services impact humans, and also how they can be designed to have a positive impact.

Students in this major will have a strong Computer Science core of programming, algorithms, systems and mathematical foundations, just like the other undergraduate majors in SCS. They will specialize by making core elements of human-computer interaction the primary focus of their upper-level classes, and can explore a large range of HCI topics in greater depth through their choices in electives. In the final capstone project course, they will work as part of an interdisciplinary student team to produce innovative digital solutions for a problem presented by a client.

Responding to the Demand for HCI in Tech

Our corporate partners spoke of the need for competitive entry-level professionals who can enter the workforce with a solid understanding of HCI. This technical program will prepare graduates to understand and create innovative services, systems and applications that serve all people. Students will have the opportunity to design for a range of digital technologies, including web, mobile, IoT, VR, AR, sensors, fabrication, gadgets and more.

There is also a need for HCI practitioners with a “T-shaped person” knowledgebase. That is, professionals who exhibit broad knowledge and diverse technical skills, as well as a valuable focus in a specialization area. HCI majors will build a broad foundational knowledge in computing, mathematics and statistics; development skills for digital and interactive technologies; and experience with methods of rapid prototyping, all of which will help them to collaborate with their peers in related fields.

Opportunities for B.S. in HCI Grads

Graduates with this rigorous background as an undergraduate will serve a key role in the tech industry. B.S. in HCI graduates will be poised to take on strategic roles at early stages of their careers, including Front End Engineer, Interaction Designer, Technical Product Manager and UX Engineer positions. For HCI students aiming for research careers or graduate school, they can select a senior thesis option and conduct independent research work under the mentorship of HCI faculty.

Bachelor of Science in HCI Degree Requirements

The primary major in HCI supports students by preparing them with very strong technical knowledge, skills, and understanding. HCI majors must take a minimum of 360 credits (35 courses) distributed as follows:

- CS Core: 5 courses + freshman immigration course
- Computing @ Carnegie Mellon: 3 units
- Mathematics and Statistics: 4 courses
- HCI Core: 6 courses
- HCI Electives: 4 courses
- HCI Capstone Project: 1 course
- Free Electives: 4 courses
- Science and Engineering: 4 courses
- Humanities and Arts (Gen Ed): 7 courses

Total: 35 courses

Computer Science Core (5 courses + immigration course)

Prerequisite Courses
15-112 Fundamentals of Programming and Computer Science 12
07-131 Great Practical Ideas for Computer Scientists 2

Required Courses
07-128 First Year Immigration Course 1
15-122 Principles of Imperative Computation 10
15-150 Principles of Functional Programming 10
15-151 Mathematical Foundations for Computer Science 12
15-210 Parallel and Sequential Data Structures and Algorithms 12
15-213 Introduction to Computer Systems 12

Mathematics and Statistics Core (4 courses)

Prerequisite Course
21-120 Differential and Integral Calculus 10

Required Courses
21-122 Integration and Approximation 10
21-259 Calculus in Three Dimensions 9

Select one of the following courses
15-259 Probability and Computing 12
21-325 Probability 9
36-218 Probability Theory for Computer Scientists 9
36-225 Introduction to Probability Theory 9

Select one of the following courses
15-251 Great Ideas in Theoretical Computer Science 12
21-241 Matrices and Linear Transformations 10
21-242 Matrix Theory 10
36-226 Introduction to Statistical Inference 9
36-326 Mathematical Statistics (Honors) 9
36-401 Modern Regression 9

HCI Core (6 courses)

Research & Evaluation Courses (2)
05-410 User-Centered Research and Evaluation 12
05-317 Design of Artificial Intelligence Products 12

Select one of the following courses
36-202 Methods for Statistics & Data Science 9
36-208 Regression Analysis 9
36-315 Statistical Graphics and Visualization 9

Ideation & Design Courses (3)
05-651 Interaction Design Studio I 12
05-650 Interaction Design Studio II 12
05-452 Service Design 12
05-470 Digital Service Innovation 12
05-317 Design of Artificial Intelligence Products 12
Prototyping Course (1)

05-380 Prototyping Algorithmic Experiences 15

Psychology (1 course)

Select one

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>85-211 Cognitive Psychology</td>
<td>9</td>
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<tr>
<td>85-213 Human Information Processing and Artificial Intelligence</td>
<td>9</td>
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<tr>
<td>85-241 Social Psychology</td>
<td>9</td>
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<tr>
<td>85-251 Personality</td>
<td>9</td>
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<td>85-370 Perception</td>
<td>9</td>
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<td>85-408 Visual Cognition</td>
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<td>85-421 Language and Thought</td>
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<td>88-120 Reason, Passion and Cognition</td>
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HCI Electives (4 courses)

Design Elective (1)

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<thead>
<tr>
<th>Course</th>
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<tbody>
<tr>
<td>05-317 Design of Artificial Intelligence Products</td>
<td>12</td>
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<tr>
<td>05-418 Design Educational Games</td>
<td>12</td>
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<tr>
<td>05-470 Digital Service Innovation</td>
<td>12</td>
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<td>15-465 Animation Art and Technology</td>
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Technical Elective (1)

<table>
<thead>
<tr>
<th>Course</th>
<th>Units</th>
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<tbody>
<tr>
<td>05-434 Machine Learning in Practice</td>
<td>12</td>
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<tr>
<td>05-333 Gadgets, Sensors and Activity Recognition in HCI</td>
<td>12</td>
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<tr>
<td>05-839 Interactive Data Science</td>
<td>12</td>
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<tr>
<td>10-315 Introduction to Machine Learning (SCS Majors)</td>
<td>12</td>
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<tr>
<td>11-411 Natural Language Processing</td>
<td>12</td>
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<tr>
<td>15-281 Artificial Intelligence: Representation and Problem Solving</td>
<td>12</td>
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<tr>
<td>15-365 Experimental Animation</td>
<td>12</td>
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<tr>
<td>15-388 Practical Data Science</td>
<td>9</td>
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<tr>
<td>15-462 Computer Graphics</td>
<td>12</td>
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<tr>
<td>15-464 Technical Animation</td>
<td>12</td>
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<tr>
<td>15-466 Computer Game Programming</td>
<td>12</td>
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<td>15-494 Cognitive Robotics: The Future of Robot Toys</td>
<td>12</td>
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<tr>
<td>16-467 Human Robot Interaction</td>
<td>12</td>
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<tr>
<td>17-428 Machine Learning and Sensing</td>
<td>12</td>
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<tr>
<td>17-437 Web Application Development</td>
<td>12</td>
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<tr>
<td>17-537 Artificial Intelligence Methods for Social Good</td>
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The remaining 2 electives can be chosen from the above lists or from the pre-approved list of HCI electives. Other options will require approval from the program director.

05-499 (Game Design Studio) can count as a design elective. 05-499 (Human-AI Interaction) can count as a technical elective.

HCI Capstone Project (1 course)

05-571 Undergraduate Project in HCI 12

Science & Engineering (4 courses)

Four courses in the domain of science and engineering are required, of which at least one must have a laboratory component and at least two must be from the same department. These courses typically come from the Mellon College of Science and the College of Engineering (CIT). Courses with a primary focus on programming, computation or mathematics are not acceptable for science or engineering courses.

Humanities & Arts (7 courses)

These requirements follow the SCS General Education requirements for Humanities & Arts. See the separate section in this catalog for requirements. NOTE: The Psychology requirement of the HCI core will satisfy the General Education requirement for Category 1: Cognition, Choice & Behavior.

Free Electives (4 courses)

A free elective is any Carnegie Mellon course. However, a maximum of 9 units of Physical Education and/or Military Science (ROTC) and/or Student-Led (StuCo) courses may be used toward fulfilling graduation requirements. These could be used for optional Research Track or an optional HCI minor.

Additional Major in Interdisciplinary HCI

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OVERVIEW

Human-Computer Interaction (HCI) is a fast growing field devoted to the design, implementation, and evaluation of interactive computer-based technology. Examples of HCI products include intelligent computer tutors, wearable computers, social networking sites, and internet-connected personal digital assistants (PDAs). Constructing an HCI product is a cyclic, iterative process that has at least three stages: Design, Implementation, and Evaluation.

The Design stage involves principles of design and human behavior, the Implementation stage principles of computer science, and the Evaluation stage empirical research methods common to several disciplines. There are thus four topical areas to cover in this major: Human Behavior, Design, Implementation, and Evaluation. In slightly more detail, the major involves the following sorts of knowledge and skill:

Design
- Eliciting from the client, formulating, and articulating functional specifications
- Knowing how human factors and cognitive models should inform design
- Knowing the principles of, and having experience with, communication design
- Understanding how implementation constraints should inform design
- Incorporating evaluation results into iterated designs

Implementation Programming Skills
- Standard programming languages - e.g., C++, Java
- Rapid prototyping skill (e.g., Visual Basic, Flash)
- Computational literacy, i.e., knowledge sufficient for effective communication and decision making about:
  - interface construction tools and languages
  - multimedia authoring tools
  - data structures and algorithms
  - Operating systems, platforms, etc.

Evaluation
- Experimental design
- Focus Groups
- Surveys
- Usability Testing (Cognitive walkthroughs, user models, heuristic evaluation, GOMS)
- Statistical Analysis

There are over 45 courses relevant to these areas that are now offered by eight different departments in four different colleges at Carnegie Mellon (School of Computer Science, Dietrich College of Humanities and Social Sciences, College of Fine Arts, and Tepper School of Business).

CURRICULUM

<table>
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Design

Psychology (Choose one)

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The following courses have been approved as electives in the past:

- Design majors do not need to take 05-430 Interaction Design Studio 1 as a prerequisite, since they learn similar material in other courses for their major.

Statistics (Choose one)
- 36-200 Reasoning with Data 9
- 36-207 Probability and Statistics for Business Applications 9
- 36-220 Engineering Statistics and Quality Control 9
- 36-225-36-226 Introduction to Probability Theory - Introduction to Statistical Inference 18
- 36-226 Introduction to Statistical Inference 9
- 36-247 Statistics for Lab Sciences 9
- 70-207 Probability and Statistics for Business Applications 9

Introduction to Programming (Choose one)
- 15-104 Introduction to Computing for Creative Practice 10
- 15-110 Principles of Computing 10
- 15-112 Fundamentals of Programming and Computer Science 12
- 15-121 Introduction to Data Structures 10

Core Courses
- 05-650 Interaction Design Studio II 12
- 05-410 User-Centered Research and Evaluation 12
- 05-430 Programming Usable Interfaces 15

Electives (4 courses)
Electives are intended to provide additional major students with advanced concepts and skills relevant to HCI or breadth of experience not available from their primary major. Given these goals, most electives will be 300-level courses or higher. Courses at the 100-level and 200-level in one’s primary major will not count as electives, although the same course taken by a non-major may count (approval is still required).

Students can take electives in the HCII or courses relevant to HCI from many other departments on campus. All external electives are approved on a case-by-case basis.

The following courses have been approved as electives in the past:

- 05-291 Learning Media Design 12
- 05-320 Social Web 12
- 05-395 Applications of Cognitive Science 9
- 05-413 Human Factors 9
- 05-418 Design Educational Games 12
- 05-432 Personalized Online Learning 12
- 05-434 Machine Learning in Practice 12
- 05-452 Service Design 12
- 05-499 Special Topics in HCI 12
- 05-540 Rapid Prototyping of Computer Systems 12
- 05-589 Independent Study in HCI-UG Var.
- 05-823 E-Learning Design Principles and Methods 12
- 10-601 Introduction to Machine Learning (Master’s) 12
- 15-390 Entrepreneurship for Computer Science 9
- 15-421 Information Security and Privacy 12
- 15-437 Web Application Development 12
- 15-466 Computer Game Programming 12
- 36-309 Experimental Design for Behavioral & Social Sciences 9
- 48-339 IDEATe: Making Things Interactive 12

- 51-241 How People Work 9
- 51-324 Basic 3D Prototyping 4.5
- 51-327 Design Center: Introduction to Web Design 9
- 51-328 Design Center: Design for Digital Systems 9
- 51-385 Design for Service 9
- 51-424 Web Portfolio 4.5
- 51-359 Tools for UX Design 9
- 70-415 Introduction to Entrepreneurship 9

Double Counting
All prerequisites can be double counted with any requirements in your primary major. At most, two non-prerequisite courses can be double counted with core requirements in primary majors.

Accelerated Master’s Programs
The HCII currently offers a three semester (12-month), 15 course Masters in HCI. Undergraduates currently enrolled in the HCI major may apply for the Accelerated Masters program in the fall semester of their senior year. If admitted, student finish the masters degree the following Fall semester.

Admission to the Additional Major
Because space is limited in the major’s required courses, enrollment in the HCI additional major is currently limited to about 50 students in each graduating class. The admissions period occurs in spring semesters. For more details, see the website at hcii.cmu.edu/academics/hci-undergraduate.

Minor in Interdisciplinary HCI
The Minor in Interdisciplinary Human-Computer Interaction will give students core knowledge about techniques for building successful user interfaces, approaches for conceiving, refining, and evaluating interfaces that are useful and useable, and techniques for identifying opportunities for computational technology to improve the quality of people’s lives. The students will be able to effectively collaborate in the design, implementation, and evaluation of easy-to-use, desirable, and thoughtful interactive systems. They will be prepared to contribute to multidisciplinary teams that create new interactive products, services, environments, and systems.

The key concepts, skills and methods that students will learn in the HCI Minor include:

- Fieldwork for understanding people’s needs and the influence of context
- Generative approaches to imagining many possible solutions such as sketching and “bodystorming”
- Iterative refinement of designs
- Basic visual design including typography, grids, color, and the use of images
- Implementation of interactive prototypes
- Evaluation techniques including discount and empirical evaluation methods

The HCI minor is targeted at undergraduates who expect to get jobs where they design and/or implement information technology-based systems for end users, and well as students with an interest in learning more about the design of socio-technical systems. It is appropriate for students with majors in Computer Science and Information Systems, as well as students in less software-focused majors, including Design, Architecture, Art, Business Administration, Psychology, Statistics, Decision Science, Mechanical Engineering, Electrical Engineering, English and many others in the university.

CURRICULUM

Prerequisite (Choose one) Units
- 15-110 Principles of Computing 10
- 15-112 Fundamentals of Programming and Computer Science 12
- 15-121 Introduction to Data Structures 10
- 51-257 Introduction to Computing for Creative Practices 10
- 15-104 Introduction to Computing for Creative Practice 10
The alternative ways of fulfilling the requirements for the HCI minor are designed for students who are in the HCI 2nd major who want to “downgrade” to the minor. These students can use some of the courses completed for the HCI 2nd major as a way of fulfilling the requirements for the minor. Students who are in the HCI minor right from the start are strongly encouraged to follow the regular requirements outlined above and are strongly discouraged from trying these alternative ways of fulfilling the requirements. It can be extremely difficult to get into any of the alternative courses. This is true especially for 05-650, but for other courses as well. The fact that a student in the minor has already taken 05-651 will not give priority for getting into 05-650.

Students will be required to get a grade of “C” or better in each course in order for it to count as part of the Minor. There is no final project or research required for the Minor.

Electives
The HCI minor requires four electives approved by the undergraduate director.

Double Counting
Students may double count up to two (2) of the required courses or electives with any other major or minor.

RELATIONSHIP BETWEEN THE BHCI MAJOR AND MINOR

Admission
- **HCI Additional Major**: Application and admissions required, information on the HCII website (http://www.hcii.cmu.edu/).
- **HCI Minor**: Admissions form available at the HCII website (http://www.hcii.cmu.edu/).

Prerequisites
- **HCI Additional Major**:  
  - Freshman-level programming
  - Statistics
  - Cognitive Psychology
  - Interaction Design Studios
- **HCI Minor**:  
  - Freshman-level programming

Core Courses
- **HCI Additional Major**:  
  - Interaction Design Studio I & II (IxDS)
  - User Centered Research & Evaluation (UCRE)
  - Interface Programming (PUI)
  - BHCI Project
- **BHCI Minor**:  
  - Interaction Design Overview (IxDO)
  - Designing Human-Centered Systems (DHCS)