Artificial Intelligence Program

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www.cs.cmu.edu/bs-in-artificial-intelligence

Overview
Carnegie Mellon University has led the world in artificial intelligence education and innovation since the field was created. It’s only natural, then, that the School of Computer Science would offer the nation’s first bachelor’s degree in Artificial Intelligence, which started in Fall 2018.

The new BSAI program gives students the in-depth knowledge needed to transform large amounts of data into actionable decisions. The program and its curriculum focus on how complex inputs — such as vision, language and huge databases — can be used to make decisions or enhance human capabilities. The curriculum includes coursework in computer science, math, statistics, computational modeling, machine learning and symbolic computation. Because Carnegie Mellon is devoted to AI for social good, students will also take courses in ethics and social responsibility, with the option to participate in independent study projects that change the world for the better — in areas like healthcare, transportation and education.

Just as AI unites disciplines from machine learning to natural language processing, instruction in the BSAI program includes faculty members from the school’s Computer Science Department, Human-Computer Interaction Institute, Institute for Software Research, Language Technologies Institute, Machine Learning Department and Robotics Institute.

Students who graduate with a B.S. in AI from SCS will have the computer science savvy and skills our students are known for, with the added option to participate in independent study projects that change the world for the better — in areas like healthcare, transportation and education.

How to Apply
The BSAI program is reserved for current and future SCS students only. Therefore, students must first be accepted into the School of Computer Science as first year students. Once at Carnegie Mellon and enrolled in SCS, students can declare a BSAI major in the spring of their first year. Initially, the program will accommodate roughly 100 students total, or about 30-35 from each class.

A limited number of current SCS sophomores and juniors may apply to transfer into the program. Consult with the director of the BSAI program for information.

Curriculum
BSAI majors will take core courses in math and statistics, computer science, artificial intelligence and ethics, along with general education courses in science and engineering, and humanities and arts.

Math and Statistics
All of the following: Units
15-151 Mathematical Foundations for Computer Science (if not offered, substitute 21-127) 10
21-122 Integration and Approximation (students without credit or a waiver for 21-120, Differential and Integral Calculus, must take 21-120 before 21-122) 10
21-241 Matrices and Linear Transformations 10
21-259 Calculus in Three Dimensions 9
36-218 Probability Theory for Computer Scientists or: (15-259 or 21-325 or 36-225) and 36-226 9
36-401 Modern Regression 9

Computer Science
All of the following: Units
07-128 Freshman Immigration Course 1
15-122 Principles of Imperative Computation (students without credit or a waiver for 15-112, Fundamentals of Programming and Computer Science, must take 15-112 before 15-122) 10
15-150 Principles of Functional Programming 10
15-210 Parallel and Sequential Data Structures and Algorithms 12
15-213 Introduction to Computer Systems 12
15-251 Great Ideas in Theoretical Computer Science 12

Artificial Intelligence
All of the following three AI core courses: Units
07-180 Concepts in Artificial Intelligence 5
15-281 Artificial Intelligence: Representation and Problem Solving 12
10-315 Introduction to Machine Learning (Undergrad) plus one of the following AI core courses: 12
16-365 Computer Vision
11-411 Natural Language Processing
15-386 Neural Computation 9
15-482 Autonomous Agents 12
15-483 Truth, Justice, and Algorithms 9
15-494 Cognitive Robotics: The Future of Robot Toys 12
16-350 Planning Techniques for Robotics 12
16-362 Mobile Robot Algorithms Laboratory 12
16-384 Robot Kinematics and Dynamics 12
others as designated by the AI Undergraduate Program

One Decision Making and Robotics course (min. 9 units): Units
10-403 Deep Reinforcement Learning & Control 12
10-417 Intermediate Deep Learning 12
10-418 Machine Learning for Structured Data 12
11-441 Machine Learning for Text Mining 9
11-485 Introduction to Deep Learning 9
36-402 Advanced Methods for Data Analysis 9
others as designated by the AI Undergraduate Program

One Machine Learning course from the following (min.9 units): Units
10-403 Deep Reinforcement Learning & Control 12
10-417 Intermediate Deep Learning 12
10-418 Machine Learning for Structured Data 12
11-441 Machine Learning for Text Mining 9
11-485 Introduction to Deep Learning 9
36-402 Advanced Methods for Data Analysis 9
others as designated by the AI Undergraduate Program

One Perception and Language course from the following (min. 9 units): Units
11-442 Search Engines 9
11-492 Speech Processing 12
15-387 Computational Perception 9
15-463 Computational Photography 12
16-421 Vision Sensors 12
others as designated by the AI Undergraduate Program

One Human-AI Interaction course from the following (min. 12 units): Units
05-317 Design of Artificial Intelligence Products 12
05-391 Designing Human Centered Software 12
16-467 Human Robot Interaction 12
others as designated by the AI Undergraduate Program

School of Computer Science electives
Two general computer science electives: Units
These electives can be from any SCS department: 200-level or above, at least 9 units each (see exceptions below):
Computer Science [15-], Computational Biology [02-], Human Computer Interaction [05-], Machine Learning [10-], Language Technologies [11-], Robotics [16-], and Software Engineering [17-]. (NOTE: The following undergraduate courses do NOT count as Computer Science electives: 02-201, 02-223, 02-250, 02-261, 15-351, 16-223, 17-200, 17-333, 17-562. Some IDEATE courses and SCS graduate courses might not be allowed. Consult with a CS undergraduate advisor before registration to determine eligibility for this requirement.)
Ethics Course

One of the following courses: Units
16-161 ROB Freshman Seminar: Artificial Intelligence and Humanity 9
17-200 Ethics and Policy Issues in Computing 9
80-249 AI, Society, and Humanity 9

Humanities and Arts

All candidates for the bachelor's degree in Artificial Intelligence must complete a minimum of 63 units offered by the College of Humanities & Social Sciences and/or the College of Fine Arts. These courses offer students breadth in their education and perspectives and provide students with a better appreciation of social, artistic, cultural, political and economic issues that can influence their effectiveness as computer scientists upon graduation.

Requirements for this component of the degree are listed under the SCS main page under General Education Requirements (http://coursecatalog.web.cmu.edu/schools-colleges/schoolofcomputerscience/#genedtext). SPECIAL NOTE FOR AI STUDENTS: AI majors must satisfy Category 1 of the General Education requirements by taking one of the following Cognitive Studies (Category 1A) courses:

• 85-211 Cognitive Psychology
• 85-213 Human Information Processing and Artificial Intelligence
• 85-370 Perception
• 85-390 Human Memory
• 85-408 Visual Cognition
• 85-421 Language and Thought

Science and Engineering

All candidates for the bachelor's degree in Computer Science must complete a minimum of 36 units offered by the Mellon College of Science and/or the College of Engineering (CIT). These courses offer students an opportunity to explore scientific and engineering domains that can influence their effectiveness as computer scientists upon graduation.

Requirements for this component of the degree are listed under the SCS main page under General Education Requirements (http://coursecatalog.web.cmu.edu/schools-colleges/schoolofcomputerscience/#genedtext). These students should still be able to complete their degree in four years given the light load of their senior year. Students with credit for introductory programming will take 15-112 in their first semester and shift some CS courses to later semesters after consulting with their academic advisor; students with no credit for calculus will take 21-120 in their first semester and shift 21-122 and 21-259 to subsequent semesters.

Computing @ Carnegie Mellon

The following course is required of all students to familiarize them with the campus computing environment:

99-101 Computing @ Carnegie Mellon 3

Free Electives

A free elective is any Carnegie Mellon course. However, a maximum of nine (9) units of Physical Education and/or Military Science (ROTC) and/or Student-Led (StuCo) courses may be used toward fulfilling graduation requirements.

Undergraduate Research Thesis

AI majors may use the SCS Honors Research Thesis as part of their degree. The SCS Honors Undergraduate Research Thesis (07-599) typically starts in the fall semester of the senior year, and spans the entire senior year. Students receive a total of 36 units of academic credit for the thesis work, 18 units per semester. Up to 18 units can be counted toward SCS elective requirements (9 per semester for 2 semesters maximum). Students interested in research may also consider using Research and Innovation in Computer Science (15-300, 9 units) in their junior year since this course will introduce students to various research projects going on in the School of Computer Science that may lead to a senior thesis. This course leads to a subsequent Research Practicum in Computer Science (15-400, 12 units) that allows students to complete a small-scale research study or experiment and present a research poster. Students who use 15-400 to start their senior thesis can use these units toward the required 36 units.

For more information about the SCS Honors Research Thesis, refer to the SCS Honors Research Thesis (http://coursecatalog.web.cmu.edu/schools-colleges/schoolofcomputerscience/#scshonorsresearchthesistext) section for learning objectives, application requirements and expected outcomes.

BSAI Roadmap: Sample Course Sequence

The sample given below is for a student who already has credit for introductory programming and introductory calculus. Students with no credit for introductory programming will take 15-112 in their first semester and shift some CS courses to later semesters after consulting with their academic advisor; students with no credit for calculus will take 21-120 in their first semester and shift 21-122 and 21-259 to subsequent semesters. Students should still be able to complete their degree in four years given the light load of their senior year. Students with credit for 21-120 and 21-122 may start with a more advanced math class (e.g. 21-241) in their first year. It is recommended that students keep their academic load lighter for their Senior Fall semester to account for offsite job interviews or for their Senior Spring semester to account for visits to graduate schools.

FRESHMAN YEAR:

Fall Units
07-128 Freshman Immigration Course 1
15-122 Principles of Imperative Computation 10
15-151 Mathematical Foundations for Computer Science 10
21-122 Integration and Approximation 10
76-101 Interpretation and Argument 9
99-101 Computing @ Carnegie Mellon 3

Spring Units
07-180 Concepts in Artificial Intelligence 5
15-150 Principles of Functional Programming 10
15-213 Introduction to Computer Systems 12
21-241 Matrices and Linear Transformations 10
21-259 Calculus in Three Dimensions 9

SOPHOMORE YEAR:

Fall Units
15-210 Parallel and Sequential Data Structures and Algorithms 12
15-281 Artificial Intelligence: Representation and Problem Solving 12
36-218 Probability Theory for Computer Scientists 9
xx-xxx Science and Engineering Elective 9
xx-xxx Ethics Elective 9

Spring Units
10-315 Introduction to Machine Learning (Undergrad) 12
15-251 Great Ideas in Theoretical Computer Science 12
85-xxx Cognitive Studies Elective 9
xx-xxx Science and Engineering Elective 9
xx-xxx Humanities and Arts Elective 9
### JUNIOR YEAR:

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<th>Fall</th>
<th>Units</th>
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<tr>
<td>11-411 Natural Language Processing or 16-385 Computer Vision</td>
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<td>36-401 Modern Regression</td>
<td>9</td>
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<tr>
<td>xx-xxx AI Elective: Machine Learning</td>
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<td>xx-xxx Humanities and Arts elective</td>
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<td>xx-xxx Free Elective</td>
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<th>Spring</th>
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<td>xx-xxx AI Elective: Human-AI Interaction</td>
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<td>xx-xxx AI Elective: Decision Making and Robotics</td>
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<td>xx-xxx Science and Engineering elective</td>
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<td>xx-xxx Humanities and Arts elective</td>
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<td>xx-xxx Free Elective</td>
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### SENIOR YEAR:

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<tr>
<td>xx-xxx AI Elective: Perception and Language</td>
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<td>xx-xxx SCS Elective</td>
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<td>xx-xxx Science and Engineering Elective</td>
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<th>Spring</th>
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**Minimum number of units required for the degree: 360**

The flexibility in the curriculum allows many different schedules, of which the above is only one possibility. Some elective courses are offered only once per year (Fall or Spring). AI cluster electives (decision making and robotics, machine learning, perception and language, and human-AI interaction) may be taken in any order and in any semester if prerequisites are met and seats are available. Constrained electives are shown in the specific semesters in the schedule above as an example only. Students should consult with their academic advisor to determine the best elective options depending on course availability, their academic interests and their career goals.