COMPUTER SCIENCE

Department website: Computer Science | Gonzaga University (https://www.gonzaga.edu/school-of-engineering-applied-science/degrees-and-programs/computer-science/)

The Bachelor of Science in Computer Science (BSCS) is intended for students whose primary interest is the understanding and development of algorithms and software/apps. It is a technical degree requiring considerable mathematics and science. The Bachelor of Arts in Computer Science (BACS) serves students with an interest in computing who would also like to study broadly in leadership/management and other disciplines (the BACS degree offers students the flexibility to study and/or minor in another discipline outside of Computer Science). The Bachelor of Science in Data Science (BSDS) is an interdisciplinary degree for students interested in knowledge and skills applicable to all aspects of the data science lifecycle: data collection and preprocessing, data visualization, data analysis, statistical inference, machine learning and AI, app/model deployment, and data storytelling/communication. The Bachelor of Science in Cybersecurity (BSCY) is a technical degree intended for students wanting to gain expertise in secure software engineering, networks/internet of things (IoT), cryptography, and digital forensics.

The minors allow students pursuing other degrees to study computer science, app development, data science, and cybersecurity.

Faculty expertise and research interests span a wide range of computer science topics, including software engineering, database systems, data science, machine learning, artificial intelligence, natural language processing, cybersecurity, networks/IoT, robotics, graphics, and AR/VR. Select students can participate in research projects directly with a faculty mentor through independent study courses, a senior thesis, or as a member of a professor's research group. Students are encouraged to pursue summer research or industry-sponsored internships. Many Computer Science, Data Science, and Cybersecurity students secure summer research funding through the National Science Foundation's Research Experience for Undergraduates program. Others intern in the computer industry, some with companies that regularly work with the Department of Computer Science.

The Department of Computer Science, housed in the Bollier Center for Integrated Science and Engineering, runs multiple labs and servers:

- Windows and Linux labs for general computing
- A student projects lab
- A dedicated cybersecurity lab
- A faculty/student collaborative research lab
- A high-performance GPU server for data-intensive research
- Multiple general-purpose Linux servers available for student and faculty work

The department sponsors several student organizations, including the Women in Computing (WiC) club, chapters of Upsilon Pi Epsilon, an honor society, and the Association for Computing Machinery (ACM), a professional association of computer scientists. Computer Science students also participate in programming contests, cybersecurity competitions, and hackathon events. Many Computer Science students are also active in the GU Robotics club.

Computer Science majors can graduate with departmental honors if they have fulfilled all degree requirements, achieved a grade point average of at least 3.50 in their Computer Science courses, and written a senior thesis under the supervision of a Computer Science faculty member while successfully completing CPSC 495 and 496.

Students in the Bachelor of Science in Computer Science, Bachelor of Arts in Computer Science, and Bachelor of Science in Cybersecurity degree programs participate in a large software engineering project during their senior year. Each project is completed under the guidance of a faculty advisor and a project sponsor. Advisors are frequently practicing software developers. Project sponsors are often from the computer industry. Students in the Bachelor of Science in Data Science degree program participate in an intensive capstone experience, researching and building a large, semester-long data/machine learning-related project.

The Bachelor of Science in Computer Science degree program is built on a broad and rigorous foundation of science, mathematics, software engineering, and advanced computer science topics. It is accredited by the Computing Accreditation Commission of ABET, www.abet.org, under the General Program Criteria and the Computer Science and Similarly Named Computing Programs Program Criteria.

Computer Science (BS) Major Program Requirements

120 credits (89 credits in computer science, mathematics, and science)

Code	Title	Hours
Computer Science Requirements		
Lower Division		
CPSC 121	Computer Science I	3
CPSC 122	Computer Science II	3
CPSC 223	Algorithm and Abstract Data Structures	3
CPSC 224	Software Development	3
CPSC 260	Computer Organization	3
Upper Division		
CPSC 321	Database Management Systems	3
CPSC 326	Organization of Program Languages	3
CPSC 328	Computer Networks	3
CPSC 346	Operating Systems	3
CPSC 391	Software Engineering and Ethics	3
CPSC 450	Design and Analysis of Computer Algorithms	3
CPSC 491	Software Engineering	2
CPSC 492	Senior Design Project II	3
Computer Science Technical Electives		
Any 200, 300, or 400 level CPSC course excluding CPSC 497. At most 2 courses from CPSC 2xx, and 435.		21
Mathematics Requirements		
MATH 157	Calculus and Analytic Geometry I	4
MATH 231	Discrete Structures	3
MATH 258	Calculus and Analytic Geometry II	4
Select two of the following:		6
MATH 259	Calculus and Analytic Geometry III	
MATH 260	Ordinary Differential Equation	
MATH 328	Operations Research	
ENSC 371	Advanced Engineering Math	
CPSC 455	Chaos and Dynamical Systems	
any 400 level Mathematics course		

Science Requirements [2]		**4**
BIOL 105 & 105L	Information Flow in Biological Systems and Information Flow in Biological Systems Lab	
BIOL 106	Energy Flow in Biological Systems	
BIOL 205 & 205L	Physiology and Biodiversity and Physiology and Biodiversity Lab	
BIOL 206 & 206L	Ecology and Ecology Lab	
BIOL 207 & 207L	Genetics and Genetics Lab	
CHEM 101 & 101L	General Chemistry I and General Chemistry I Lab	
CHEM 205	Inorganic Chemistry	
CHEM 230 & 230L	Organic Chemistry I and Organic Chemistry Lab I	
CHEM 231 & 231L	Organic Chemistry II and Organic Chemistry Lab II	
CHEM 245 & 245L	Biochemistry and Biochemistry Lab	
CHEM 310 & 310L	Analytical Chemistry and Analytical Chemistry Lab	
PHYS 222	Electronics	
PHYS 224	Modern Physics	
PHYS 325	Computational Physics	
Science and Mathematics Electives		**9**
BIOL 105 & 105L	Information Flow in Biological Systems and Information Flow in Biological Systems Lab	
BIOL 106	Energy Flow in Biological Systems	
BIOL 205 & 205L	Physiology and Biodiversity and Physiology and Biodiversity Lab	
BIOL 206 & 206L	Ecology and Ecology Lab	
BIOL 207 & 207L	Genetics and Genetics Lab	
CHEM 101 & 101L	General Chemistry I and General Chemistry I Lab	
CHEM 205	Inorganic Chemistry	
CHEM 230 & 230L	Organic Chemistry I and Organic Chemistry Lab I	
CHEM 231 & 231L	Organic Chemistry II and Organic Chemistry Lab II	
CHEM 245 & 245L	Biochemistry and Biochemistry Lab	
CHEM 310 & 310L	Analytical Chemistry and Analytical Chemistry Lab	
CPSC 455	Chaos and Dynamical Systems	
ENSC 371	Advanced Engineering Math	
PHYS 121 & 121L	Physics I and Physics I Lab	
PHYS 122 & 122L	Physics II and Physics II Lab	
PHYS 224	Modern Physics	
PHYS 325	Computational Physics	
PHYS 222	Electronics	
MATH 259	Calculus and Analytic Geometry III	
MATH 260	Ordinary Differential Equation	
Any 300 or 400 Mathematics course		
Total Hours		**89**

[1] Excluding CPSC 497 Computer Science Internship. At most 2 courses from CPSC 2xx, CPSC 435 Parallel and Cloud Computing, and CPSC 436 Biomedical Informatics and Computing.

[2] At least six of the elective science and mathematics credits must be chosen from BIOL, CHEM, or PHYS courses.

CS: Concentration in Software Security

Code	Title	Hours
CPSC 353	Applied Cryptography	3
Select one of the following:		3
CPSC 341	Internet of Things	
EENG 410	Information Theory and Coding	
Total Hours		**6**

Software Application Development Concentration

Code	Title	Hours
CPSC 331	UI/UX Design	3
CPSC 332	Web Development	3
CPSC 333	Mobile App Development	3
CPSC 334	Linux and DevOps	3
Total Hours		**12**

CS: Concentration in Data Science

Code	Title	Hours
CPSC 222	Introduction to Data Science	3
CPSC 322	Data Science Algorithms	3
Select one of the following:		3
MATH 121	Introductory Statistics	
MATH 221	Applied Statistics	
MATH 321	Statistics for Experimentalist	
Select two of the following:		6
CPSC 323	Machine Learning and Intelligent Systems	
CPSC 325	Data Science Project Lab	
CPSC 475	Speech and Natural Language Processing	
Total Hours		**15**

Computer Science (BA) Major Program Requirements

Code	Title	Hours
Lower Division		
CPSC 121	Computer Science I	3
CPSC 122	Computer Science II	3
CPSC 223	Algorithm and Abstract Data Structures	3
CPSC 224	Software Development	3
CPSC 260	Computer Organization	3
Select one of the following:		3-4

MATH 148	Survey of Calculus	
MATH 157	Calculus and Analytic Geometry I	
MATH 231	Discrete Structures	3
Upper Division		
CPSC 321	Database Management Systems	3
CPSC 328	Computer Networks	3
CPSC 391	Software Engineering and Ethics	3
CPSC 450	Design and Analysis of Computer Algorithms	3
CPSC 491	Software Engineering	2
CPSC 492	Senior Design Project II	3
CPSC Technical Electives [2]		12
Select one Software Development course:		3
CPSC 331	UI/UX Design	
CPSC 332	Web Development	
CPSC 333	Mobile App Development	
CPSC 334	Linux and DevOps	
Select one Software Systems course:		3
CPSC 326	Organization of Program Languages	
CPSC 341	Internet of Things	
CPSC 346	Operating Systems	
CPSC 482	Data Intensive Systems	
CPSC 483	Data Science Capstone	
Select one Data Science and Machine Learning course		3
CPSC 222	Introduction to Data Science	
CPSC 322	Data Science Algorithms	
CPSC 323	Machine Learning and Intelligent Systems	
CPSC 482	Data Intensive Systems	
CPSC 483	Data Science Capstone	
Select one Leadership-Management course:		3
BENT 490	Creativity, Innovation, and Entrepreneurship	
COMM 401	Communication and Leadership	
ENGM 310	Systems Engineering Management	
ENGM 405	Engineering Project Management	
Total Hours		**62-63**

[1] CPSC 2XX, 3XX, 4XX (except 497), CPEN 442 Introduction to Robotics, CPEN 430 Digital System Design/ CPEN 430L Digital System Design Lab, or EENG 410 Information Theory and Coding.

[2] CPSC 2xx, 3xx, 4xx (except 497), CPEN 442, 430/L, or EENG 410.

Computer Science Minor

For non-Computer Science Majors

Program Requirements

Code	Title	Hours
CPSC 121	Computer Science I	3
CPSC 122	Computer Science II	3
CPSC 223	Algorithm and Abstract Data Structures	3
MATH 231	Discrete Structures	3
CPSC 300-498 [1]		6

[1] One elective course may be a 200-level course.

Software Development Minor

For non-Computer Science Majors

Program Requirements

Code	Title	Hours
CPSC 121	Computer Science I	3
CPSC 122	Computer Science II	3
CPSC 224	Software Development	3
CPSC 332	Web Development	3
CPSC 391	Software Engineering and Ethics	3
Select one of the following:		3
CPSC 328	Computer Networks	
CPSC 331	UI/UX Design	
CPSC 333	Mobile App Development	
CPSC 334	Linux and DevOps	
CPSC 346	Operating Systems	
Total Hours		**18**

Courses

CPSC 110. Special Topics for Non Majors. (1-3 Credits)
May be repeated for credit.
Computer Science topics of special interest to students majoring in other disciplines. Sample topics include principles of programming, web programming, and media computing. May not be counted towards a major in Computer Science. On sufficient demand.
Students cannot enroll who have a major in Comp Sci Computation Think or Computer Science.

CPSC 121. Computer Science I. (3 Credits)
Techniques of problem-solving and algorithmic development. An introduction to programming. Emphasis is on how to design, code, debug, and document programs using good programming style. Fall and Spring.

CPSC 122. Computer Science II. (3 Credits)
A continuation of CPSC 121. An examination of dynamic memory management and recursion; an introduction to basic data structures and algorithmic analysis. Fall and Spring.
Prerequisites: CPSC 121 with a minimum grade of D

CPSC 190. Directed Study. (1-3 Credits)
Topic to be decided by faculty.

CPSC 193. FYS:. (3 Credits)
Topics to be determined by instructor.

CPSC 212. Computational Modeling. (3 Credits)
This course introduces students to the modeling process and computer simulations. It considers two major approaches: system dynamics models and agent-based models. A variety of software tools will be explored. Applications will be chosen from ecology, medicine, chemistry, biology, and others. Spring.
Prerequisites: CPSC 121 with a minimum grade of D
Enrollment limited to students with a semester level of First Year (0-25.99 credits) or Second Year (26-59.99 credits).

CPSC 213. Special Topics. (3 Credits)
May be repeated for credit.
Topic to be determined by instructor.

CPSC 214. Special Topics. (3 Credits)
May be repeated for credit.
Topic to be determined by instructor.

CPSC 215. Special Topics. (3 Credits)

CPSC 222. Introduction to Data Science. (3 Credits)
This course provides an introduction to the underlying ideas, concepts, and techniques used in data science. Students gain skills in statistical and computational thinking, and their practical application to real-world, data-driven problem solving and decision making. The course teaches important concepts and skills in both statistical reasoning and computer programming for the purpose of analyzing real-world data sets. Examples are drawn from diverse areas such as economics, social science, health and wellness, climate science, and education. Students gain experience using the Python programming language, Python's standard libraries for data science applications and computational notebooks (e.g., using Jupyter). The course also raises important social questions concerning privacy, social inequality, and professional ethics related to data science and its applications. Fall & Spring.
Prerequisites: CPSC 121 with a minimum grade of D
Enrollment limited to students with a semester level of First Year (0-25.99 credits) or Second Year (26-59.99 credits).

CPSC 223. Algorithm and Abstract Data Structures. (3 Credits)
Algorithm analysis using Big-O notation, sorting, heaps, balanced binary search trees, and hash tables. Fall and Spring. MATH 231 and CPSC 223 can be taken concurrently.
Prerequisites: CPSC 122 with a minimum grade of D and (MATH 231 (may be taken concurrently) with a minimum grade of D)

CPSC 224. Software Development. (3 Credits)
This course covers topics in object-oriented programming, user-interface design and development, and software construction including program design, development tools, and basic concepts in software engineering. Students work on hands-on development assignments and projects throughout the semester. Fall and Spring.
Prerequisites: CPSC 122 with a minimum grade of D

CPSC 260. Computer Organization. (3 Credits)
This course covers basic topics in the design of modern computer systems. Topics include digital logic, computer system components, machine-level code, memory organization and management, computer arithmetic, assembly-language programming, and basic connections between high-level and low-level languages (C and assembly). This course also serves as a foundation for courses on networking. security, operating systems, and computer architecture, where a deeper understanding of systems-level issues is required. Fall and Spring. **** Students who have taken and received credit for CPEN 231 may not also receive credit for CPSC 260. *****
Prerequisites: CPSC 122 with a minimum grade of D

CPSC 290. Directed Reading. (0-3 Credits)
Individual exploration of a topic not normally covered in the curriculum.

CPSC 310. Special Topics. (3 Credits)
May be repeated for credit.
Topics that reflect the current interests and expertise of the faculty. On sufficient demand.
Prerequisites: CPSC 122 with a minimum grade of D

CPSC 311. Special Topics. (3 Credits)
May be repeated for credit.
Topics that reflect the current interests and expertise of the faculty. On sufficient demand.
Prerequisites: CPSC 122 with a minimum grade of D

CPSC 312. Special Topics. (3 Credits)
May be repeated for credit.
Topics that reflect the current interests and expertise of the faculty. On sufficient demand.
Prerequisites: CPSC 122 with a minimum grade of D

CPSC 313. Special Topics. (3 Credits)
May be repeated for credit.
Topics that reflect the current interests and expertise of the faculty. On sufficient demand.
Prerequisites: CPSC 122 with a minimum grade of D

CPSC 314. Special Topics. (3 Credits)
May be repeated for credit.
Topics that reflect the current interests and expertise of the faculty. On sufficient demand.
Prerequisites: CPSC 122 with a minimum grade of D

CPSC 315. Special Topics. (1-3 Credits)
May be repeated for credit.
Topics that reflect the current interests and expertise of the faculty. On sufficient demand. Prerequisite: CPSC 223
Prerequisites: CPSC 223 with a minimum grade of D

CPSC 321. Database Management Systems. (3 Credits)
Introduction to relational database concepts and techniques. Topics include the relational model, database design, SQL, transactions, file and index organization, and using databases within software applications, Fall. Prerequisite: CPSC 122 or CPSC 222
Prerequisites: Prerequisites exist. Refer to Zagweb.

CPSC 322. Data Science Algorithms. (3 Credits)
This course provides a detailed overview of the processes and techniques used in creating data science applications. Emphasis is placed on popular algorithms for the analysis, classification, and mining of relational data. Students learn to implement data science algorithms and techniques over real-world data sets through assignments and projects in Python. Topics include data preparation and cleaning, summary statistics, basic data visualization techniques, feature selection, discretization, k nearest neighbors, naive bayes, decision trees, ensemble methods, apriori rule mining, and k-means clustering. Fall. Prerequisite: CPSC 122 or CPSC 222
Prerequisites: Prerequisites exist. Refer to Zagweb.

CPSC 323. Machine Learning and Intelligent Systems. (3 Credits)
This course provides a detailed overview of topics in machine learning with an emphasis on algorithms and techniques for unstructured and complex data sets. Students implement and apply machine learning algorithms to examples drawn from time series, image, audio, textual, and numerical data. Topics include regression analysis, support vector machines, genetic algorithms, neural networks and heuristic search. Concepts and issues in building intelligent systems and the role of machine learning are also discussed. Fall.
Prerequisites: CPSC 322 with a minimum grade of D or CPSC 223 with a minimum grade of D

CPSC 325. Data Science Project Lab. (3 Credits)
This course provides an overview of how to design a data science system and deploy the system into a production environment. Students complete a semester-long project that involves researching a data science problem, proposing a solution to the problem, implementing the solution, and deploying the solution as a hosted web application. Emphasis is placed on working with web-based application programming interfaces, gathering and processing data, researching and implementing common machine algorithms for data mining and classification, and securely deploying models in the cloud. Spring, odd years.
Prerequisites: CPSC 322 with a minimum grade of D or CPSC 323 with a minimum grade of D
Equivalent: CPSC 483

CPSC 326. Organization of Program Languages. (3 Credits)
Examination of the structures and concepts of procedural, functional, and logic-based programming languages. Spring.
Prerequisites: CPSC 223 with a minimum grade of D

CPSC 328. Computer Networks. (3 Credits)
Study of main components of computer communications and networks; communication protocols; routing algorithms; machine addressing and network services.
Prerequisites: Prerequisites exist. Refer to Zagweb.

CPSC 331. UI/UX Design. (3 Credits)
Exploration of theories and principles related to human-computer interaction, user experience design, and user interface design. Development of techniques and practices for designing and evaluating software usability. Upon sufficient demand.
Prerequisites: CPSC 122 with a minimum grade of D

CPSC 332. Web Development. (3 Credits)
Techniques of web-based software application development. Introduces programming languages and frameworks for web programming. Emphasis on web programming basics using well-established approaches including the basics of full-stack web development. Fall.
Prerequisites: CPSC 122 with a minimum grade of D

CPSC 333. Mobile App Development. (3 Credits)
This course provides an introduction to mobile application development. The primary aim of this course is to provide students with a thorough introduction to designing and building native and/or cross-platform apps for mobile devices. The platform, frameworks/libraries, and development tools used in this course vary and are dependent on the current demand in industry. Topics include object-oriented programming, design patterns, user interface design and implementation, data storage, working with application programming interfaces, threading, camera and photos, and location and maps. Additional topics are covered based on trending mobile app features. Upon sufficient demand.
Prerequisites: CPSC 122 with a minimum grade of D

CPSC 334. Linux and DevOps. (3 Credits)
This course covers topics of using and managing Linux OSes from the command line, virtual machines, containers, DevOps philosophy, continuous integration, continuous deployment, and Git. Students work on hands-on development assignments and projects throughout the semester. Upon sufficient demand.
Prerequisites: CPSC 328 with a minimum grade of D

CPSC 341. Internet of Things. (3 Credits)
The Internet of things (IoT) is the network of physical devices, buildings (smart building), furniture (smart home), vehicles (smart transportation), and many others. In this class, students will learn key technologies in IoT and obtain hands-on experience by building IoT devices. A substantial part of the material will cover IoT applications, IoT architecture, embedded systems, network protocols, sensor networks, and IoT security. Students will also work on research projects related to IoT applications, design, and security. Spring, odd years.
Prerequisites: CPSC 328 with a minimum grade of D

CPSC 346. Operating Systems. (3 Credits)
Study of operating systems internals. Topics include concurrent programming, memory management, file system management, scheduling algorithms, and security. Fall. Prerequisite(s): CPSC 122 and (CPSC 260 or (CPEN 231 and CPEN 231L))
Prerequisites: Prerequisites exist. Refer to Zagweb.

CPSC 348. Computer Security. (3 Credits)
Study of security and information assurance in stand-alone and distributed computing. Topics include ethics, privacy, access control methods and intrusion detection. Spring.
Prerequisites: CPSC 223 with a minimum grade of D and CPSC 260 with a minimum grade of D or (CPEN 231 with a minimum grade of D and CPEN 231L with a minimum grade of D)

CPSC 351. Theory of Computation. (3 Credits)
Study of automata, languages, and computability theory. Regular grammars, finite state automata, context-free grammars, pushdown automata, Turing machines, decidable and undecidable problems, and problem reduction. Upon sufficient demand. Prerequisite(s): CPSC 122 and (MATH 231 or MATH 301)
Prerequisites: CPSC 223 with a minimum grade of D and (MATH 231 with a minimum grade of D or MATH 301 with a minimum grade of D)

CPSC 353. Applied Cryptography. (3 Credits)
Topics include classical cryptosystems, block ciphers, public key cryptosystems, key exchange protocols, and hash functions. Fall. Prerequisite(s): CPSC 223 and (MATH 231 or MATH 301)
Prerequisites: CPSC 223 with a minimum grade of D and (MATH 231 with a minimum grade of D or MATH 301 with a minimum grade of D)

CPSC 390. Directed Study. (1-3 Credits)
Topic to be decided by faculty.

CPSC 391. Software Engineering and Ethics. (3 Credits)
A survey of approaches used in software engineering focusing on software development processes, requirements engineering, estimation, scheduling, risk analysis, testing, version control, and project management. This course also discusses ethical, societal, security and legal issues in software engineering, including their relationship to professional development.
Prerequisites: CPSC 224 with a minimum grade of D

CPSC 410. Advanced Topics. (3 Credits)
Topics that reflect the current interests and expertise of the faculty. On sufficient demand.
Prerequisites: CPSC 223 with a minimum grade of D

CPSC 411. Advanced Topics. (3 Credits)
Topics that reflect the current interests and expertise of the faculty. On sufficient demand.
Prerequisites: CPSC 223 with a minimum grade of D

CPSC 412. Advanced Topics. (3 Credits)
Topics that reflect the current interests and expertise of the faculty. On sufficient demand.
Prerequisites: CPSC 223 with a minimum grade of D

CPSC 413. Advanced Topics. (3 Credits)
Topics that reflect the current interests and expertise of the faculty. On sufficient demand.
Prerequisites: CPSC 223 with a minimum grade of D

CPSC 414. Advanced Topics. (3 Credits)
Topics that reflect the current interests and expertise of the faculty. On sufficient demand.
Prerequisites: CPSC 223 with a minimum grade of D

CPSC 415. Advanced Topics. (3 Credits)
Topics that reflect the current interests and expertise of the faculty. On sufficient demand.

CPSC 425. Computer Graphics. (3 Credits)
Introduction to the use of graphics primitives within a higher level language to produce two and three-dimensional images; underlying mathematical operations used to implement standard graphics packages; practical experience with current graphics systems. Upon sufficient demand.
Prerequisites: CPSC 223 with a minimum grade of D and MATH 231 with a minimum grade of D

CPSC 431. Computer Hardware Design and Architecture. (3 Credits)
Understanding the design techniques, machine structures, technology factors, and evaluation methods that will determine the form of computers in 21st century. Spring.
Prerequisites: CPSC 260 with a minimum grade of D or CPEN 231 with a minimum grade of D

CPSC 432. CIS:. (3 Credits)

CPSC 433. Responsible Data Science. (3 Credits)
Study of the ethical foundations concerning data science and algorithms in datasets. Topics include: privacy, autonomy, security and informed consent in data gathering; fairness, accuracy and diversity in data (pre)processing; algorithm bias and bias amplification; transparency and explainability in algorithmic decision-making; identifiability and non-discrimination methods in data processing and algorithms; care for users in the design of systems or specific models such as impacts on disadvantaged and marginalized groups; ethical design for accountability and user recourse; public trust and confidence in models; and justice issues concerning the curation of datasets for machine learning and AI systems. Emphasis throughout on guiding principles and responsibilities of the professional founded on ethical frameworks.

CPSC 435. Parallel and Cloud Computing. (3 Credits)
Parallel Programming platforms; principles of parallel algorithm design; basic communication operations; programming using the message-passing paradigm (MPI); programming on shared address space platforms (POSIX Thread and OpenMP); cloud computing; big data analysis; and other advanced topics. On sufficient demand.
Prerequisites: CPSC 260 with a minimum grade of D or (CPEN 231 with a minimum grade of D and CPEN 231L with a minimum grade of D)
Equivalent: CPEN 435

CPSC 436. Biomedical Informatics and Computing. (3 Credits)
Investigation of the role of computers in the provision of medical services; machine learning algorithms for regression, classification, clustering, and anomaly detection; medical decision-making support; genomic medicine and its techniques. On sufficient demand.
Prerequisites: CPSC 260 with a minimum grade of D or (CPEN 231 with a minimum grade of D and CPEN 231L with a minimum grade of D)
Equivalent: CPEN 436

CPSC 439. Digital Forensics. (3 Credits)
Digital forensics covers the three functions of digital forensics performed by organizations: employee abuse investigations, incident response, and electronic discovery. Students will learn to conduct all three. In particular students will learn to gather, analyze and present digital evidence to the sponsoring organization as well as to legal audiences. On sufficient demand. Prerequisite(s):CPSC 223 and (CPSC 260 or (CPEN 231 and CPEN 231L))
Prerequisites: Prerequisites exist. Refer to Zagweb.

CPSC 448. Network and System Security. (3 Credits)
Computer Network and System Security covers cybersecurity in computer operating systems, network infrastructure, and devices like routers and switches, server management for Windows and Linux operating systems, along with managing sensitive data. On sufficient demand. Prerequisite(s): CPSC 223 and (CPSC 260 or (CPEN 231 and CPEN 231L))
Prerequisites: Prerequisites exist. Refer to Zagweb.

CPSC 450. Design and Analysis of Computer Algorithms. (3 Credits)
Advanced study of computer algorithms not covered in CPSC 223 along with principles and techniques of computational complexity. Topics could include dynamic programming, B-trees, minimum spanning trees, Floyd and Warshall algorithms, various string matching algorithms, computational geometry, exponential growth of round-off errors, NP-completeness and reducibility. Fall - even years.
Prerequisites: CPSC 223 with a minimum grade of D and MATH 231 with a minimum grade of D

CPSC 455. Chaos and Dynamical Systems. (3 Credits)
Introduction to the study of discrete nonlinear dynamical systems and their chaotic behavior. The course will focus on investigation s through computer experiments- both numerical and graphical- and the corresponding mathematical analysis of the observed behavior. A significant portion of the course will be devoted to designing graphics programs. In the humanistic tradition of Gonzaga, students will also learn the historical development of the modern science of chaotic dynamical systems. Upon sufficient demand. Prerequisite(s): CPSC 122 and (MATH 231 or MATH 301)
Prerequisites: Prerequisites exist. Refer to Zagweb.

CPSC 475. Speech and Natural Language Processing. (3 Credits)
Natural language processing (NLP) applies computational theory and techniques to human language, whether to investigate language itself or to enhance computers' ability to process speech and writing. NLP researchers and developers work with human language at every level, including phonetics (the sounds of language), morphology (the structure of words), syntax (the ordering of words in writing and speech), and pragmatics (the interactions among word sequences in writing or conversation). CPSC 475 is a quick tour through the basics, which could include text normalization and tokenization, n-grams, sentiment classification, part-of-speech tagging, parsing, semantic analysis, phonetics, and more. Spring, odd years.
Prerequisites: CPSC 122 with a minimum grade of D or CPSC 222 with a minimum grade of D
Enrollment limited to students with a semester level of Fourth Year (96+ credits) or Third Year (60-95.99 credits).

CPSC 481. Data Analytics and Communication. (3 Credits)
In this course, students will learn a variety of techniques and tools for effectively communicating data analysis questions, results, and insights to a range of audiences. The course will cover techniques related to data storytelling, data visualization, interactive dashboarding, digital portfolio design and development, technical report writing, and technical presentation skills for data science. Students will also learn to effectively use modern tools related to data storytelling and visualization. On sufficient demand. Prerequisite: CPSC 222
Prerequisites: Prerequisites exist. Refer to Zagweb.

CPSC 482. Data Intensive Systems. (3 Credits)
This course covers tools and techniques used in applying statistical and machine learning approaches to real-world data sets. Through hands-on assignments and projects, students learn relevant architectures, programming models, and tools related to data modeling and storage, extract-transform-load (ETL) processes, data warehousing, and data pipeline creation and management. The course also explores scalable, distributed, and cloud-based approaches used in data-intensive applications for accessing, filtering, clustering, and classifying data. On sufficient demand.
Prerequisites: (CPSC 223 with a minimum grade of D or CPSC 322 with a minimum grade of D) and CPSC 321 with a minimum grade of D

CPSC 483. Data Science Capstone. (3 Credits)
This course provides an overview of how to design a data science system and deploy the system into a production environment. Students complete a semester-long project that involves researching a data science problem, proposing a solution to the problem, implementing the solution, and deploying the solution as a hosted web application. Emphasis is placed on working with web-based application programming interfaces, gathering and processing data, researching and implementing common machine algorithms for data mining and classification, and securely deploying models in the cloud. On sufficient demand.
Prerequisites: CPSC 322 with a minimum grade of D or CPSC 323 with a minimum grade of D

CPSC 490. Directed Reading. (1-3 Credits)
Individual exploration of a topic not normally covered in the curriculum. Arrangement with an instructor.
Enrollment limited to students with a semester level of Fourth Year (96+ credits).

CPSC 491. Software Engineering. (2 Credits)
First semester of a two semester senior design project in which students work in teams to develop a large software product. Teams meet weekly with their faculty project advisors.
Prerequisites: CPSC 223 with a minimum grade of D and CPSC 224 with a minimum grade of D
Corequisites: CPSC 491L, CPSC 499
Enrollment limited to students with a semester level of Fourth Year (96+ credits).

CPSC 491L. Senior Design Project Lab I. (1 Credit)
First semester of a two semester senior design project in which students work in teams to develop a large software product. Teams meet weekly with their faculty project advisors. Fall.
Prerequisites: CPSC 223 with a minimum grade of D and CPSC 224 with a minimum grade of D
Corequisites: CPSC 491, CPSC 499
Enrollment limited to students with a semester level of Fourth Year (96+ credits).

Enrollment is limited to students with a major in Comp Sci Computation Think or Computer Science.

CPSC 492. Senior Design Project II. (3 Credits)
Second semester of a two semester senior design project in which students work in teams to develop a large software product. Teams meet weekly with their faculty project advisors.
Prerequisites: CPSC 491 with a minimum grade of D
Enrollment limited to students with a semester level of Fourth Year (96+ credits).

CPSC 492L. Senior Design Project Lab II. (3 Credits)
Second semester of a two semester senior design project in which students work in teams to develop a large software product. Teams meet weekly with their faculty project advisors. Spring.
Prerequisites: CPSC 491 with a minimum grade of D and CPSC 491L with a minimum grade of D
Enrollment limited to students with a semester level of Fourth Year (96+ credits).

Enrollment is limited to students with a major in Comp Sci Computation Think or Computer Science.

CPSC 493. Secure Software Engineering. (3 Credits)
Secure Software Engineering covers the principles and practices of secure programming: writing programs in a safe fashion, avoiding vulnerabilities which can be exploited by attackers, and using library security features like authentication and encryption. On sufficient demand.
Prerequisites: CPSC 223 with a minimum grade of D and CPSC 224 with a minimum grade of D

CPSC 495. Thesis I. (1 Credit)
First of a two semester senior thesis project. Requires arrangement with a faculty supervisor.
Enrollment limited to students with a semester level of Fourth Year (96+ credits).

Enrollment is limited to students with a major in Computer Science.

CPSC 496. Thesis II. (1 Credit)
Second of a two semester senior thesis project. Requires arrangement with a faculty supervisor.
Prerequisites: CPSC 495 with a minimum grade of S
Enrollment limited to students with a semester level of Fourth Year (96+ credits).

Enrollment is limited to students with a major in Computer Science.

CPSC 497. Computer Science Internship. (0-3 Credits)
May be repeated for credit.
Computer Industry Internship.

CPSC 499. Computers and Society. (1 Credit)
This course discusses ethical, societal, security and legal issues in computing, including their relationship to professional development. Topics are examined within the context of students' senior design projects. Fall.
Prerequisites: CPSC 223 with a minimum grade of D and CPSC 224 with a minimum grade of D
Corequisites: CPSC 491, CPSC 491L
Enrollment limited to students with a semester level of Fourth Year (96+ credits).

Enrollment is limited to students with a program in Comp Sci Computation Think or Computer Science.