DIGITAL AND COMPUTATIONAL STUDIES

Overview & Learning Goals

Overview

Digital and computational studies (DCS) is "computation in context"— a focus on digital objects (e.g., a computer program) that exist in digital environments. Analysis includes:

- Artifacts: objects of study, which are shared with many fields in the liberal arts. The questions explored include asking how digital objects are interpreted in physical, social, historical, and cultural contexts.
- Architectures: the infrastructures that give rise to the objects, their use, or their study, which are also shared with other fields. The questions explored include consideration of the consequences of these associated infrastructures, data, technology, and labor for understanding the object.
- Actions: the models built and theories tested through those models. The questions explored include asking what different models reveal about objects and what common ground exists between different fields that use those models.
- Agency: interpretation and decision-making. The questions explored include examination of how computation or the existence of a digital object shape who can make decisions, how results are interpreted, or how empowerment to act or express knowledge are influenced under the above conditions.

Objects are not merely analyzed—they are also created. A significant part of the student experience in DCS is collaborative and creative across fields of expertise. This creation can connect with virtually any discipline on campus.

Learning Goals

1. Ability to apply digital and computational techniques to at least one other discipline and work on at least one large project that does this directly
2. Ability to recognize, identify, and analyze the social and ethical issues that arise from the use and creation of digital artifacts in society
3. Ability to think critically about digital artifacts—interpreting them as image, code, and/or narrative
4. Ability to examine the relationship between digital artifacts and the physical, emotional, social, civic, ethical, political, and economic aspects of the people who interact with them
5. Ability to examine the histories of and consequences for using digital artifacts with regard to its associated infrastructure, data, technology, and labor
6. Ability to examine the actions and reactions involving digital artifacts, as well as the artifacts and architecture they engender
    - To critically assess data, including how it was gathered and the practical (social and ethical) implications of its use
    - To assess whether a given method of inquiry is appropriate to address a research question
    - To engage with questions drawn from different disciplines across the liberal arts through digital and computational methods
    - To engage each of the following areas, but to get a deeper experience with at least one:
        - To understand the basic structures and limitations of computer programs
        - To understand the basic techniques and limitations of computational text analysis
        - To understand the basic techniques and limitations of network analysis
        - To understand the basic techniques and limitations of digital mapping
    - To work collaboratively and communicate across disciplines
    - To research, write, and present within multiple disciplines using a combination of traditional and digital techniques and artifacts

Faculty

Crystal Hall, *Program Director*
Martha R. Janeway, *Program Coordinator*

Professor: Eric L. Chown‡
Associate Professor: Crystal Hall
Assistant Professors: Mohammad Irfan, Fernando Nascimento
Visiting Faculty: Erin Johnson (Visual Arts)

Requirements

Requirements for the Coordinate Major

To receive a major in digital and computational studies (DCS) at Bowdoin, students must complete the eight courses detailed below and also have a disciplinary major either in an academic department or an academic program.

Code	Title	Credits
Select one of the following:		1
DCS 1100	Introduction to Digital and Computational Studies	
DCS 1200	Data Driven Societies	
Select one of the following:		1
DCS 2335	GIS and Remote Sensing: Understanding Place	
DCS 2350	Social and Economic Networks	
DCS 2500	Digital Text Analysis	
DCS 2450	Technology and the Common Good	1
A senior capstone course [a]		2
Select three more DCS courses of your choice. [b]		3

a This is a yearlong culminating course providing an opportunity for a research project that combines the student's coordinate major with DCS.

b These three DCS courses should intentionally connect to the coursework in the student's coordinated major discipline to foster exploration of their complimentary nature and must be selected in consultation with a faculty advisor in the Digital and Computational Studies Program. With prior approval from the program director, courses offered outside of DCS may be used to fulfill this requirement.

Requirements for the Minor in Digital and Computational Studies

The minor consists of five courses.

Code	Title	Credits
Select one of the following:		1
DCS 1100	Introduction to Digital and Computational Studies	
DCS 1200	Data Driven Societies	
Four other courses in DCS, at least three of which should be at the 2000-level or above		4

Additional Information

- Courses count toward the major or minor if grades of C- or better are earned.
- One course taken with the Credit/D/Fail grading option may count toward the major or minor as long as a CR (credit) grade is earned.
- One first-year writing seminar may count toward the major or minor.
- A maximum of two independent studies can count toward the major at either the intermediate or advanced level. Independent studies do not count toward the minor.
- The director of digital and computational studies works with students to discuss double-counting cross-listed courses with other departments or programs.
- With prior approval, two courses from a one-semester study-away program may be counted toward the major; three courses may be counted toward the major from a yearlong program. One course from a one-semester study-away program may be counted toward the minor.

Courses

DCS 1020 (c) How to Read a Million Books
Crystal Hall.
Every Other Fall. Fall 2020. Enrollment limit: 16.

Confronts the challenges of having too many things to read and limited attention spans to persuade someone that a written interpretation is valid. Explores different methods of reading (i.e. close, surface, text mining, thematic) at different scales, from 1 book to millions of data points from Bowdoin's library collections. Activities evaluate both the process and rationale for different reading and writing methods. Assumes no knowledge of programming.

Previous terms offered: Fall 2019, Fall 2018.

DCS 1024 (c, FYS) Serious Games: Critical Play for History
Non-Standard Rotation. Enrollment limit: 16.

Did you know that Monopoly began life a game that criticized modern capitalism? Have you ever wondered what sense it makes that in Sid Meier's Civilization, Abraham Lincoln can found the American tribe in 4,000 BCE? This course explores how commercial video and board games can help us understand the past. In return, understanding something about how the discipline of history works will help us think about games as representations of the past. Games to be studied and played may include: Catan, Diplomacy, Monopoly, Sid Meier's Civilization V, Spirit Island, and Twilight Struggle. Students should expect to complete four structured writing assignments and several shorter writing assignments. The course includes a weekly evening game lab. Note: This course is part of the following field(s) of study: US. (Same as: HIST 1024)

Previous terms offered: Fall 2019.

DCS 1100 (c, MCSR) Introduction to Digital and Computational Studies
Crystal Hall; Fernando Nasc.
Every Fall. Fall 2020. Enrollment limit: 35.

Examines the impact of digital artifacts, networked interaction, and computational analysis on the ways in which we establish new knowledge, engage in creative and social practices, and understand the self. Studies how the combination of large-scale digital data and computational modeling methods shape our agency as decision-makers. Emphasis on how the Liberal Arts shape and are shaped by these processes. Coursework includes quantitative analysis, machine learning, text and network analysis, critical readings in the field, and short, exploratory projects. Assumes no knowledge of programming or any software that will be used.

Previous terms offered: Fall 2019, Fall 2018, Fall 2017, Fall 2016.

DCS 1200 (MCSR) Data Driven Societies
Every Spring. Enrollment limit: 35.

What sorts of questions can and should be answered using digital and computational methods? How can such methods in conjunction with data can reveal new insights and questions about the world? How do we construct models to help us better understand social phenomena? Covers topics such as data gathering, validation, analysis, and presentation, as well as statistics and programming. Provides substantive experience in digital and computational methods, and a critical lens for understanding and evaluating what computers can (and cannot) bring to the study of our world.

Previous terms offered: Spring 2020, Spring 2019, Spring 2018, Spring 2017.

DCS 1300 (a, MCSR) Programming with Data
Allen Harper.
Every Fall. Fall 2020. Enrollment limit: 30.

Intended for students with some programming experience, but not enough to move directly into Data Structures. An accelerated introduction to the art of problem solving using the computer and the Python programming language. Weekly labs and programming assignments focus on 'big data' and its impact on the world. (Same as: CSCI 1103)

Prerequisites: CSCI 1055 or DCS 1100 or DCS 1200 or Placement in above CSCI 1101.

Previous terms offered: Fall 2019, Fall 2018, Fall 2017.

DCS 2020 (b) Forecasting and Predictions
Non-Standard Rotation. Enrollment limit: 30.

Computers and the Internet have enabled an explosion in the prediction market where everyone from political consultants to large corporations rely on an ever-increasing amount of data to make predictions that drive their decision making. Examines the topic of predictions through the lens of how it is currently impacting our world. Students learn and apply predictive analytic techniques including traditional time-series analysis, elementary Bayesian statistics, and the design of cutting-edge models through data mining and machine learning. Applications and examples focus on the methods that data analysts use to forecast future events. Readings and discussions model how to assess the quality of those predictions and interrogate the ethics of using forecasts to shape strategy and policy that have real-world implications. Instructor selects thematic content and when pertinent, applies these techniques to the case study of presidential and congressional elections.

Prerequisites: MATH 1600 or Placement in MATH 1700 (M) or Placement in MATH 1750 (M) or Placement in MATH 1800 (M) or Placement in 2000, 2020, 2206 (M).

Previous terms offered: Fall 2016.

DCS 2331 (b, MCSR) The Nature of Data: Introduction to Environmental Analysis
Eileen Sylvan Johnson.
Every Spring. Fall 2020. Enrollment limit: 20.

Examines emerging digital techniques in environmental management and analysis within government, academic, and media sectors. Provides an overview of social science methods including analysis of qualitative data, text analysis, spatial analysis, survey design and analysis, and social network analysis. Topics include collaborative resource management, leveraging the power of social networks, spatial analysis, social-ecological system management, the role of volunteered information and citizen science, and expanding capacities for adaptation and resilience. Labs as part of class time provide students exposure to standard software programs used in social science research, including NVivo, ArcGIS, and Gephi and introduce the basics of R as a programming language for text analysis, and spatial analysis. (Same as: ENVS 2331)

Prerequisites: ENVS 1101 or DCS 1000 - 2969.

Previous terms offered: Spring 2020, Spring 2018, Spring 2017.

DCS 2335 (a, MCSR) GIS and Remote Sensing: Understanding Place
Every Year. Enrollment limit: 20.

Geographical information systems (GIS) organize and store spatial information for geographical presentation and analysis. They allow rapid development of high-quality maps and enable powerful and sophisticated investigation of spatial patterns and interrelationships. Introduces concepts of cartography, database management, remote sensing, and spatial analysis. Examines GIS and remote sensing applications for natural resource management, environmental health, and monitoring and preparing for the impacts of climate change from the Arctic to local-level systems. Emphasizes both natural and social science applications through a variety of applied exercises and problems culminating in a semester project that addresses a specific environmental application. Students have the option of completing a community-based project. (Same as: ENVS 2004)

Previous terms offered: Spring 2020, Spring 2019, Spring 2018, Spring 2017.

DCS 2340 (b, MCSR) Building Resilient Communities
Eileen Sylvan Johnson.
Every Year. Fall 2020. Enrollment limit: 20.

Explores approaches by communities and regions to build resilience in the face of changing environmental and social conditions. Examines the ways communities establish policies and collaborate with state, federal, private and nonprofit sectors towards strengthening local economies, safeguarding environmental values, protecting public health, addressing issues of economic and social justice, and implementing mitigation and adaptation strategies. Provides students with firsthand understanding of how digital and computational technologies including Geographic Information Systems (GIS) are playing an increasingly important role in understanding and informing effective approaches for expanding resilience at a community level to inform policy decision. Students gain proficiency with GIS as part of the course. (Same as: ENVS 2301)

Previous terms offered: Fall 2016.

DCS 2350 (a) Social and Economic Networks
Mohammad Irfan.
Non-Standard Rotation. Fall 2020. Enrollment limit: 22.

Examines the social and economic aspects of today's connected world from a multitude of perspectives; namely, network science, computer science, sociology, and economics. The fundamental questions to be addressed are: What are the properties of real-world networks? What are the effects of networks on our behavioral choices like quitting smoking or eating healthy? How do cascades in networks lead to outcomes like videos going viral? How does Google search the Internet and make money doing so? Debates issues around centrality in networks. Uses game theory to study strategic interactions in networks and markets. (Same as: CSCI 2350)

Prerequisites: DCS 1100 or CSCI 1101 or CSCI 1103 (same as DCS 1300).

Previous terms offered: Fall 2019, Spring 2018.

DCS 2450 (c) Technology and the Common Good
Non-Standard Rotation. Enrollment limit: 35.

As the pace of technological change continues to accelerate, it raises questions about the impacts, positive and negative, on society. Will technology make our lives more comfortable and pleasant or will it destroy human society and lead us to a catastrophic ending? The answers largely depend on our ability to consider new technology advancements in light of desires to live good lives within just institutions. Students engage with topics of current relevance such as artificial intelligence, gene editing, virtual reality, robotics, and the internet of things. Discusses the underlying technological aspects of each and the possible implications for society. Students apply philosophical and ethical concepts and frameworks to consider how technology can become a positive force for the common good and debate possible ways to evaluate and avoid undesirable effects of current and future technologies. No prior programming experience required.

Previous terms offered: Spring 2020.

DCS 2460 (c, MCSR) Smart Phones, Mobile Selves
Fernando Nasc.
Every Fall. Fall 2020. Enrollment limit: 35.

Mobile Devices are increasingly present in our lives. More and more 'smart,' they transform how we communicate, access information, experience our physical spaces, create and maintain friendships, monitor our health, and have fun. In this course, we will critically consider the consequences of these technological artifacts for how we define our personal identities, our interpersonal relationships, and the organization of our societies. In order to deepen our discussions, within the experiential context of DCS, we will learn how the software of mobile devices is structured, how they communicate with each other, with local sensors and other wearable devices. We will also study the physical and social architectures that connect our mobile experiences, including how they are likely to change in the coming years and their possible implications. This course does not require any prior knowledge in computer science or mobile communications.

Prerequisites: DCS 1100 or DCS 1200.

DCS 2470 Artificial Intelligence in the World
Every Spring. Enrollment limit: 35.

Artificial Intelligence (AI) is changing the world. It is being widely deployed by governments, police forces, and businesses. AI algorithms are touted as being without bias, and claims are made that AI regularly outperforms humans on a wide variety of tasks. The truth is far more complex. In this class, we will examine the systems being deployed in the world, the algorithms behind them, and their impact on the world. In particular, we will focus on the relationship between the data used by AI systems and their performance. Special attention will be paid to machine learning systems and students will engage in project-based machine learning activities.

Prerequisites: DCS 1100 or DCS 1200.

Previous terms offered: Spring 2020.

DCS 2500 (MCSR) Digital Text Analysis
Every Year. Enrollment limit: 35.

Explores how digital techniques can enhance our understanding of text. Investigates how to make sense of the burgeoning number of textual sources in a timely manner and what new questions can be raised and answered by computer-based text analysis. Students learn to apply tools for analyzing large texts to problems drawn from areas throughout the liberal arts, such as psychology, philosophy, and literature. In addition, students address questions ranging from authorship of Supreme Court opinions, to using thirty years of newspapers to reexamine historical questions, to interpreting Raphael's masterpiece "School of Athens" through an analysis of Aristotle's and Plato's works. While doing so they also study the strengths and weaknesses of these approaches. No previous computer programming experience is required.

Previous terms offered: Spring 2020, Spring 2019, Spring 2018.

DCS 2550 (b, MCSR) Mapping American History using Geographic Information Systems (GIS)
Patrick Rael; Aaron Gilbreath.
Non-Standard Rotation. Fall 2020. Enrollment limit: 16.

In this intermediate seminar we will use Geographic Information Systems to explore historical problems in 19th-century US history. We will introduce and practice basic statistical techniques, and use the class GIS database to investigate problems, construct our own historical datasets, and make our own maps. Class projects will challenge students to develop critical thinking skills in historical and computational methods, and practice effective data presentation. We will work with a wide array of history data, including information on race, ethnicity, gender, religion, agriculture, slavery, and voting behavior in the period in question. Throughout, we will probe the possibilities and limitations of GIS as a digital technology and methodological approach to historical analysis. (Same as: HIST 2625)

Prerequisites: HIST 1000 - 2969 or HIST 3000 or higher.

DCS 2640 (c, VPA) Interactivity, Computation, and Media Architecture
Non-Standard Rotation. Enrollment limit: 18.

The use of media architecture has become an increasingly common way to engage with our surroundings. Explores how embedded computation affects the way the built environment is experienced. Students consider how digital media is changing notions of place and how we interact with and learn about it. Through short- and long-term projects, students explore how to design and prototype computationally driven experiences, which are embedded into architectural spaces. Reading and writing assignments enhance skills in questioning new media and guide consideration of issues surrounding privacy, surveillance, the digital city, geography of cyberspace, representation and identity, technology in the new global economy, space, and audience. Using the graphical programming language Max, students work with data to alter environments using light, sound, and projection and create digital installations. No previous experience with programming is required.

Prerequisites: DCS 1000 - 2969 or DCS 3000 or higher or CSCI 1000 - 2969 or CSCI 3000 or higher.

Previous terms offered: Fall 2019, Fall 2018.

DCS 2645 (VPA) Filmmaking and Born-Digital Storytelling
Non-Standard Rotation. Enrollment limit: 18.

Considers filmmaking in a networked world, as well as the cultural implications of new technologies. Students will create innovative, internet-based films that engage in the changing digital landscape of ubiquitous computing. Students will learn the basics of film production, including digital camera operation, sound recording, lighting, nonlinear editing, basic compositing, and green screen—tools needed to create compelling films, interactive videos, VR and AR experiences, and innovative transmedia projects. Additionally, students will study the history and proliferation of cinema engaged with digital technologies and the internet. (Same as: CINE 2645)

Prerequisites: DCS 1000 - 2969 or DCS 3000 or higher or CINE 1000 - 2969 or CINE 3000 or higher.

Previous terms offered: Fall 2019.

DCS 2650 (VPA) Art, Technology, and Design for Social Change
Every Other Spring. Enrollment limit: 18.

Both individually and collaboratively, students create public art projects and tools that engage in cultural critique utilizing digital tools, computational methods, and design thinking. Students explore firsthand the intersection of design, technological innovation, and art across multiple disciplines. Discussions, projects, and readings examine various aspects of social change including queer and feminist activist practices, new media theory, data as material, emerging data visualization forms, art for and from networks, critical design for community engagement, and artistic interventions in public spaces.

Previous terms offered: Spring 2019, Spring 2018.

DCS 3030 (c) Site-Specifics: Production of Socially Engaged Media
Non-Standard Rotation. Enrollment limit: 18.

Guided Independent Studio Practice. Students gain an understanding of how digital media technologies can serve as tools for creative cultural practice through the production of site-specific, socially engaged video, sound, and new media artworks. Site visits and meetings with community organizations will contribute to the development of works distributed and displayed through mobile devices, projection, installation and online platforms. Lectures, readings, and discussions provide a historical overview of the intersection of site-specificity and community-based sound and video works. Students develop technical skills in camerawork, lighting, audio recording, and editing, and are introduced to video and sound artists who consider race, class, gender, sexuality, labor and environmental politics. (Same as: VART 3030)

Prerequisites: VART 1000 - 1999.

Previous terms offered: Spring 2019.

DCS 3031 (c) Raised by the Internet: Data, Networks, and Time-Based Media
Non-Standard Rotation. Enrollment limit: 18.

Guided Independent Studio Practice. Explores how the Internet and screen-centric lives change the way we relate to the world and each another. Students create time-based media works that consider the emotional, social, political, and physical effects of new technologies, while addressing questions regarding privacy, artificial intelligence, and digital communities. Additionally, students use information collected by mobile apps, GPS trackers, and more to challenge data culture through creative interventions that include animation, video, interaction design, sound, and other forms of digital expression. (Same as: VART 3031)

Prerequisites: VART 1100 - 2969.

Previous terms offered: Spring 2017.

DCS 3040 (b, MCSR) Building Resilient Communities
Non-Standard Rotation. Enrollment limit: 16.

Explores approaches by communities and regions to build resilience in the face of changing environmental and social conditions. Examines the ways communities establish policies and collaborate with state, federal, private and nonprofit sectors towards strengthening local economies, safeguarding environmental values, protecting public health, addressing issues of economic and social justice, and implementing mitigation and adaptation strategies. Examines the role of big data in informing goal setting and measuring outcomes. Provides students with firsthand understanding of how digital and computational technologies including Geographic Information Systems (GIS) are playing an increasingly important role in understanding and informing effective approaches for expanding resilience at a community level to inform policy decision. Students learn GIS as part of the course. (Same as: ENVS 3909)

Prerequisites: ENVS 1101.

Previous terms offered: Spring 2019.

DCS 3050 Computation in Context
Non-Standard Rotation. Enrollment limit: 20.

An in-depth investigation of an aspect of the relationship of digital technologies with human development, history, education, ethics, the environment, or social practices. Draws on topics including text analysis, network analysis, and image analysis. In turn, these topics are used as a lens to examine real-world issues, such as identity and privacy, both to expand the understanding of such issues as well as to better understand the power and also the limitations of the methodologies. Students apply the models offered by readings and the methodologies of digital and computational studies to a semester-long project that investigates an aspect of computation in the context of their major or minor field of study.

Prerequisites: Two of: either DCS 1100 or DCS 1200 and either DCS 2000 - 2969 or DCS 3000 or higher.

Previous terms offered: Fall 2017.

DCS 3350 (a, MCSR) Contagion
Every Spring. Enrollment limit: 12.

Project-based advanced networks course. Investigates how the historic perspective of contagion has inspired its expansive contemporary view, ranging from interventions in epidemics to diffusion in social networks to network effects on behavioral aspects like smoking, obesity, and happiness. Studies various network models and their properties. Programming projects involve implementation of network models and applying these models to large-scale, real-world networks with millions of agents, with a particular focus on critically assessing the models and algorithms using computational thinking. Projects also involve creating computer simulations to study models of residential segregation by race. Takes a critical view of the implications of various predictive algorithms, including techniques for disease prediction.

Prerequisites: DCS 1100 or CSCI 1101 or CSCI 1103 (same as DCS 1300).

Previous terms offered: Spring 2020.

DCS 3400 (a) Cognitive Architecture
Non-Standard Rotation. Enrollment limit: 16.

Advances in computer science, psychology, and neuroscience have shown that humans process information in ways that are very different from those used by computers. Explores the architecture and mechanisms that the human brain uses to process information. In many cases, these mechanisms are contrasted with their counterparts in traditional computer design. A central focus is to discern when the human cognitive architecture works well, when it performs poorly, and why. Conceptually oriented, drawing ideas from computer science, psychology, and neuroscience. No programming experience necessary. (Same as: CSCI 3400)

Prerequisites: CSCI 2101 or BIOL 2135 or PSYC 2040 or PSYC 2740.

Previous terms offered: Spring 2019, Spring 2018.

DCS 3450 Cognition in Analog and Digital Environments
Every Fall. Enrollment limit: 16.

Human cognition was shaped by an environment unlike the one we live in today. The human capacity for perception and thought are not neutral; rather, they are attuned to the physical world in which the mind evolved. The digital world presents the mind with a very different environment, one in which the human capacity to effectively process information is often stretched to its limit. Meanwhile, large corporations are using psychology, AI, and machine learning in order to more effectively capture and keep our attention. This course examines the relationship of cognition to the environment, whether it be analog or digital, and focuses on the unusual challenges to cognition that come from operating in today's digital world.

Prerequisites: DCS 1100 or DCS 1200.

Previous terms offered: Fall 2019.