

DCS303: Discrete Structures and Modeling

TR 9:30 - 10:50 AM, Room Carnegie 339

Office Hrs: By appt/announcement

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Course Description:

This course introduces students to the discrete structures and the methodologies used in discrete approaches to modeling socio-ecological phenomena. In developing our toolkit for systems modeling, we will explore questions about the nature of events, change, uncertainty, and interconnectedness in natural, physical, and social systems. In and out of the classroom, we will engage actively with terminology, theoretical foundations, strategies for developing and testing mathematical and computational models. That learning will then be communicated through symbolic, numeric, visual, and verbal means against the backdrop of the complex, interconnected world we experience.

Community Inspiration and Application Areas:

Population modeling, socioeconomic structures, conservation genetics, NYT social capital, search and seizure, food webs, invasive species propagation, and social networks.

Course Rhythm

Each week we will explore a new theme. Please do the assigned readings prior to Tuesday class for the week. During class each Tuesday, we will typically answer reading questions, review targeted exercises or example areas, and then start a lab exploration in class (sometimes referred to as check-in), left to you to complete by before the next class. Thursdays, we will again answer targeted questions about the lab, work on the second half of the lab, introducing new concepts as necessary, and finish off with a glance ahead at the next week. The full lab will be due Sunday.

DCS Values Statement (under active construction):

The primary purpose of Digital and Computational Studies is to bridge the liberal arts education to computing and the digital world. In this, we are committed to actively creating spaces digital and computational spaces that are radically inclusive. Our core commitment is to integrating equity and social justice throughout our curriculum, and engaging students in metacognition to support this work. Digital and Computational Studies experiences also include

- Community engagement - inspiration in our local, cultural, and/or disciplinary communities, process engagement, meaningful work, and communication;
- “DCS design” - design, modeling, and application with intentional compassion;
- Play - providing a welcoming community that encourages, creativity, imagination, growth mindset, revision, and experimentation;
- Leadership - inviting collaborators to share strengths, build weaknesses, and contribute to a broader shared understanding.

Learning Objectives:

At the end of this course, we expect students will be able to:

1. Metacognitively *engage* in contemporary issues in equity and social justice related to their

digital world, community, and identity.

2. **Play** with computational ideas creatively, using a growth mindset which values revision and experimentation and **demonstrate** community leadership skills as a collaborator that shares strengths, builds weaknesses, and contributes to a broader shared understanding.
3. **Recognize** and **translate between** algebraically, numerically/computationally, visually, and verbally representations of discrete structures difference equations, discrete probability, and networks experientially.
4. **Design models** of **computationally investigate** and ideas in practical and professional spaces through either difference equations, stochastic difference equations, and networks and **communicate** the process and meaning to others.

Text and Technology Requirements:

The course will rely primarily on open educational resources, selected text readings, and other freely available courses. All readings will be provided by me on Lyceum and/or in the syllabus. The exception are “Individualized Explorations” in which you may chose some of your own readings.

Because this course encourages active engagement with the material, come prepared with a laptop each day that has your programming language accessible. If you do not have access to a laptop, you may borrow a Chromebook from the library ([web-based software](#)).

Most coursework and my technological troubleshooting support will be offered in MATLAB with the option to use the open source version, Octave. Occasionally, I will also use Google Spreadsheets/Excel or Program R/R Studio. As an [array-based language](#), MATLAB and Octave, are constructed in a way that naturally supports the discrete modeling in this class. However, you may use a programming language and GUI of your choice for assignments (R and NumPy with Python should also work well).

Earning Grades:

Category	Points offered
In-class Participation and Collaboration	80 points
Project Explorations	180 points (20 points each)
Personalized Explorations	140 points
Grade earned scale	
A+ 388 A 372 A- 360 B+ 348 B 332 B- 320 C+ 308 C 392 C- 280 D+ 268 D 252 D- 240 F	

Course Engagement:

Attendance and full participation in this course is mandatory. Participation points can be earned through consistent attendance and participating fully in class discussions, working out reading exercises to regularly check understanding, coming to class prepared, and in-class group explorations work.

Help each other learn. During group collaborations, you should never be bored. If you know what's going on, help others in your group learn. Explaining concepts to someone else increases your

understanding tenfold. If you are having trouble, ask your teammates and engage the group in conversation. The more effort you put into the course, the more you will get out of it.

Be responsible for your actions. Follow classroom etiquette and the suggestions for success in this class. Attend class regularly, do the readings, check your understanding as you go along by trying problems and code, and seek help with any difficulty with the material before it is a problem. I don't give you a grade, you earn your grade.

Project Explorations:

We will engage in a variety of project explorations throughout the semester, of varying time commitments and depth, that will be collected via Lyceum or on paper) and graded. Keeping up on these assignments (working on them consistently and handing in on time) is crucial for both of us. Each check-in assignment is worth 5 points, and each lab assignment is worth 15, for a total of 20 points on most project explorations.

Personalized Explorations:

While the course is designed to expose you to a number of application areas for the tools we will discuss, I have also made space for you to think about your own identity as a [digital] community member, computational practitioner, disciplinarian, and more. These points of reflection and sharing will occur through reflectionary writing, discussions, [popular book reading and presentation](#), and an individual end of term presentation. For the popular book reading, you may choose your own book or participate in our department bookclub (Tuesdays 4 pm on 9/18, 10/16, and 11/13 in the DCS Community Playspace). This semester, DCS is reading *Weapons of Math Destruction* by Cathy O'Neil - ISBN 9780553418835, list price is \$16.00 ([Book website](#)).

Communication & Class Cancellation:

Check this and your e-mail accounts regularly (at least 1x/day) for all class announcements. If you email me, please allow one business day for a response. If I do not respond, please feel free to email again.

In the event of a snow day, cancellation notice from the school will be available via the official Bates communication channels. If the college is not closed, but I need to cancel class for personal or weather-related reason, I will send out a class course announcement e-mail as soon as I know, but typically no later than 1 hour before class start time. If class is cancelled, expect that I will also post an assignment in lieu of class and the course syllabus may change to reflect the adjustment.

Academic Integrity:

Your academic work is governed by The Bates College Statement on Academic Integrity ([link](#)). Collaboration in this course is encouraged, but the result must be in your own words and or voice, and collaborators should be acknowledged openly. If an assignment product is submitted as a group, I expect that each of you has participated equally in the creation of the final product. I expect honesty and communication from you, so that you may get the most benefit from your investment of time in this course.

Resources:

It is my goal to create a learning experience that is as accessible as possible. If you anticipate any issues related to the format, materials, or requirements of this course, please meet with me outside of class so we can explore potential options. Also, if you have already been approved for accommodations through the Office of Accessible Education ([link](#)), please meet with me so we can develop an implementation plan together.

If you do need need to see me, please stop by during office hours or e-mail me for an appointment. Office hours will rotate between DCS student space in Pettingill, the Office of Intercultural Education, and my office. I am also a very pleasant resource when fed and am happy to join students for lunch if you'd like to talk a little more about topics from class or the DCS program. Academic support resources are also available through Academic Resource Commons (Writing), Math and Stats Workshop (Matlab/Octave & LaTeX), the Library (R), and Curricular Resources and Computing ([link](#)). DCS is also working to provide coordinated peer support, and we welcome your feedback and collaboration on these efforts.

Contract:

This syllabus serves as a contract between student and teacher. I reserve the right to change the syllabus schedule as needed due to class cancellations, adjustments in course pace, etc. If you have any concerns about its content, please talk to me as soon as possible.

Homework and Resource list:

Date	Assignments	Resources & Related Reads
Part I: Recursions, Chaos and Set Theory	Bodine Text Projects: Bluefin Harvesting, Coding Hamlet and Genes, Chaos with May	Octave resource Matlab (Pt 1) and Chaos (pt II)
Week 0: Introduction	Make account on QUBES Pre-semester questionnaire	Data science structures
Week 1: Linear discrete models Project: Bluefin harvesting	Bodine Text (pg 1-13) CS Intro to Recursion Week 1 submission template	Best practices in writing code Recursion and efficiency Sum square error Why SSE and not abs value? 2? kinds of modelers
Week 2: Probability, decision trees, sets, combinations, permutations, logic Project: Hamlet and Genes	(Math is fun - C&P, RV, BD OR ADS Chapter 2) AND ADS Chapter 3 Troubleshooting tips Computational thinking	Infinite Keystroke Theorem Ranked-choice voting C&P for inequity Codon usage bias

Date	Assignments	Resources & Related Reads
DCS Book Club Meeting #1 9/18 Pettingill G04, 4-5 pm	Weapons of Math Destruction Introduction to Ch 3	Book share assignment
Week 3: Chaos, Purpose of modeling and models Project: Uses and Abuses of Computation and Modeling	Bodine Text (pg 14-23) Uses and abuses of models in biology (in Lyceum) Just look at your data first Economics, Data, and an Excel error Data Fitting Abuse	Robert May 1976 article Chaos and Economics Cryptography and random number generators Matlab (Pt 1) and Chaos (pt II) Model purpose Design a Program Approaches
Invited Sampson Lecture , Sept 27 7 PM, Pett G52 Keck	Presidential Medal Awardee Dr. Carlos Castillo Chavez, ASU	Example of scholarship related to this class Co-curricular explorations
Part II: Matrices/Arrays, Stochastic and N-dim difference equations	Projects: Adding Stochasticity, Economic Mobility, Succession	
Week 4: Stochastic 1-D linear difference equations Projects: Beverton Holt	Revisit Bodine Text (pg 14-23) Data scientists crib sheet	Deterministic vs Stochastic
Week 5-6: Linear N-dimensional matrix models Projects: Income Mobility	Course mid-term check-in due Matrix models Income Mobility 1915 US workforce	
October 17-21, Fall Break		
Week 7: Computational thinking & stochastic N-dim models & Book share	Book share assignment Alt book list Definition of an Algorithm Computational thinking	Matrices and covariance Covariance in politics
DCS Book Club Meeting #2 10/23 Pettingill G04, 4-5 pm	Weapons of Math Destruction Ch 4 to Ch 7	Book share assignment
Week 8: Non-linear N-D models Project: Humans vs Zombies	HvZ assumptions HvZ rules website Difference Eq reference	Professional practices in modeling and computation
Part III: Networks and Graphs Project: Social Network Analysis (R)		

Week 9 & 10: Networks Project: Social Networks and Star Wars	Reading on SNA Data gopher and clean commands Intro to SNA with StaRwaRs	Original analysis in python Descriptive analysis Names function
Part IV: Synthesis Project: Your choice		
Week 9 & 10: Project proposals	Project description	
DCS Book Club Meeting #3 11/13 Pettingill G04, 4-5 pm	Weapons of Math Destruction Ch 8 to end	Book share assignment
Nov 17 - Nov 25, November break		
Week 11-12: Final project work-sessions and feedback sessions		
Final exam time: Final project presentations	End of semester reflection due	