CSI-758: Visualization and Modeling of Complex Systems / Spring 2021

Dr. Kent L. Miller

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Basic Information

About the Instructor	
Name	Dr. Kent L. Miller, Ph.D.
Title	Adjunct Professor
Phone	N/A
Mason email	kmille60@gmu.edu
	(Please allow 2 day response M-F)
Website	**Blackboard**
Office hours	By appointment

About the Course	
Course title	Visualization and Modeling of Complex Systems
Course number-sec	CSI-758-001
Credit hours	3
Department	Computational Science & Informatics
Meeting day/time	T 7:20pm-10pm
Classroom	Innovation Hall 222
Prerequisites	none
Required purchase	none
Required text	none
Required freeware	GNU R and TeX Live or Overleaf

Textbook

No textbook is required. The instructor will prepare a workbook that can be used in class or at home, so that the course can be completed on-line, if university authorities so require. The workbook will contain text, computer code, in-class examples, and assignments. The workbook will be posted one chapter per lecture on **Blackboard**.

Software

The student may use either an on-line service, or install the software on the student's platform.

On-line service

GNU R is available as an on-line service. See `https://rdrr.io/snippets/`. To save a plot, right-click on the image, and save as a PNG file.

LaTeX is available as an on-line service. See `https://www.overleaf.com/`.

Installation

GNU R can be installed on your platform. Depending on your platform, try one of:

```
https://cran.r-project.org/bin/linux
https://cran.r-project.org/bin/macosx
https://cran.r-project.org/bin/windows
```

You may also want an Interactive Development Environment (IDE) for GNU R. Try R Studio IDE from `https://www.rstudio.com/products/rstudio/download/`.

LaTeX can be installed on your platform. Try TeX Live which is available from `http://www.tug.org/texlive/acquire-netinstall.html`. Download takes about two and an half hours. Pick a time, such as during the late evening, when the download will not be interrupted.

If you are a non-thesis student, then it will be easiest to install GNU R on your platform, but use `https://www.overleaf.com/` for LaTeX.

If you are a thesis student, then you should install GNU R and TeX Live on your own platform. This is a precaution. Sometimes on-line providers go out of business, or are hacked, and then your thesis and years of work are lost.

If you are a scientist, then you should use a Linux distribution. Linux distributions come with tens of thousands of software packages, including GNU R and LaTeX, and are very easy to maintain.

About the Course

Description of the course

The course will cover four important topics.

1) Complex systems: complex systems are networks of components that interact in a nonsimple way. Real

world examples of complex systems include: climate; economies; ecosystems; gene regulation within a cell; the Internet; markets; and societies. Complex systems often exhibit emergent properties; meaning, properties that appear at the macroscale that are not expected from our knowledge at the microscale. Complex systems often exhibit self-organization; meaning, unexpected structures appear at the macroscale over time.

2) Modeling: a model is a representation of a system, often miniaturized or simplified. A model can be conceptual, graphical, mathematical, or physical. The ability to model and analyze complex systems is a critical skill. For reasons of cost and safety, one first builds a model in software before building prototypes and conducting trials. The student will gain experience building software models of complex systems.

3) Analysis: complex systems can exhibit peculiar behaviors such as chaos, instability, limit cycles, and system collapse. The student will learn how to look for such behaviors.

4) Visualization: behaviors of complex systems are hard to understand from large tables of numerical output. Graphical representations are needed. The student will gain experience with data visualization.

The instruction will be handled in a lecture/lab format. Visualization and Modeling of Complex Systems is more than a traditional knowledge transfer course. It also develops hands-on skills with computational tools to help the student solve problems. Indeed, modeling is best learned through experience. A student with modest software skills should be able to complete the course on-line, which may be necessary if university authorities so order.

GMU course catalog description:

CSI 758: *Visualization and Modeling of Complex Systems.* 3 credits. Covers elements of modeling and analysis for scientific applications. Concentrates on sample projects and student-initiated projects to use visualization, image and graphical analysis as they apply to modeling of complex data sets and systems. Reviews methods of creating and generating analysis and visualization packages. Data sets from multiple sources will be used. Modeling and analysis accompanied by appropriate readings from current literature. Offered by Computational & Data Sciences (`http://catalog.gmu.edu/colleges-schools/science/computational-data-sciences/`). May not be repeated for credit.

Course goals and objectives

By the end of the course, students will have gained experience with: designing, modeling, and analysing complex systems; visualization of system behavior; and typesetting reports as required for masters and PhD theses and for scientific publications.

Grading and Course Requirements

This course is graded on the Graduate Regular scale. See `http://catalog.gmu.edu/policies/academic/grading/`.

Coursework is weighted as follows:

Coursework	Val	Qty	Max
Homework	5	13	65
Project	15	1	15
Midterm exam	10	1	10
Final exam	10	1	10
Total			100

The instructor does **not** grade on a curve. Numerical grades are cumulative and translate to final letter grades as follows:

A+	97.00–100.00	C+	77.00–79.99
A	93.00–96.99	C	73.00–76.99
A-	90.00–92.99	C-	0.00–72.99
B+	87.00–89.00		
B	83.00–86.99		
B-	80.00–82.99		

Due dates

Assignments must be posted on **Blackboard** before 12:00 noon the day of the following class or exam. Late assignments will be reviewed but will **not** be graded (See the section on Late assignments below).

Format

Each assignment states what is deliverable. All deliverables must be prepared in LaTeX (a typesetting software required by many mathematical and scientific journals, and for theses) and submitted in PDF format. How to use LaTeX and how to convert to PDF will be taught in the first week. Students will not need prior knowledge of how to do this. The first homework assignment will be done in class, to be sure that all the software works from end-to-end (GNU R, LaTeX, and **Blackboard**).

Level of research expected

The level of learning expected from each assignment is as follows:

Coursework	Level
Homework	Mid–High
Project	High
Exams	Low

Here we are using Bloom's Taxonomy.

Level	Skill	Description
High	Creating	Designing, constructing, inventing, devising, . . .
	Evaluating	Hypothesizing, judging, checking, critiquing, . . .
	Analyzing	Organizing, structuring, outlining, integrating, . . .
Mid	Applying	Using, implementing, . . .
	Understanding	Summarizing, inferring, interpreting, comparing, . . .
Low	Remembering	Recognizing, listing, naming, identifying, . . .

Criteria for grading

Coursework	Criteria
Homework	Submit deliverables
Project	Components of research paper
Exams	Correct answers

For homework and exams, partial credit for a wrong answer is possible, but only if the student showed the steps in his or her reasoning.

Purpose of each assignment

Coursework	Purpose
Homework	Gain experience with modeling, analysis, and visualization
Project	Put the components together to write a well formatted research paper
Exams	Test knowledge and understanding

The project is a kind of capstone. The student should meet with the instructor to pick a suitable topic. The instructor would like to see the student dig into something that excites him or her. A thesis student may wish to work on the modeling and graphics for his or her thesis topic.

Put another way, the assignments assess the following:

Coursework	Assessment
Exams	Do you remember the material?
Homeworks	Can you apply what you learned?
Project	Can you create with what you learned?

General Course Policies

Attendance and participation

Attendance is optional, because university authorities may require the course to be completed on-line. Visualization and Modeling of Complex Systems is not a traditional knowledge transfer course which can be done by reading a text. Some of the course learning objectives involve skills development (e.g. computer programming). In a sense, this course is more akin to an apprenticeship. One learns by doing, with an instructor nearby. That said, a student with modest computer skills should be able to complete the course on-line.

Late assignments and make up exams

Four grounds for a late assignment or a make up exam will be accepted:

1. the student had a medical emergency, documented with a valid doctor's note;

2. the student is a member of a GMU sports team and was required to participate in an out-of-town game, documented with a valid note from the coach;

3. the student is a member of the armed forces and was called up for service, documented with a valid note; or

4. the student required an academic accommodation (see the section on Disability Accommodations on page 4).

Incompletes

The instructor discourages the use of Incomplete. Three grounds for requesting an Incomplete will be accepted:

1. the student had a medical emergency that prevented the student from completing the semester, documented with a valid doctor's note;

2. the student is a member of the armed forces and was called up for service, documented with a valid note; or

3. the student was arrested, deported, detained, or otherwise physically restrained from completing the semester, documented with a valid lawyer's note.

To convert the Incomplete to a passing grade, any remaining assignments and exams must be submitted soon after the end of the semester. The University calendar states the deadline.

Electronic devices

Some devices not allowed

No cellphones are allowed. Such devices distract both the student and the classmates.

Personal computer allowed

If the student owns a laptop computer, the student may bring it to class. The student may use said laptop in *lieu* of the university's computer. For reasons of health, the student may prefer to use a personal laptop rather than to touch a public computer. Computers are to be used for coursework only.

Exception for emergencies

Safety first. Nothing in this syllabus prevents the student from using electronic devices in response to an emergency (e.g. to make a 911 call).

University Policies

The Stearns Center for Teaching and Learning recommends all syllabi include the following statements.

Academic Integrity

The integrity of the University community is affected by the individual choices made by each of us. Mason has an Honor Code with clear guidelines regarding academic integrity. Three fundamental and rather simple principles to follow at all times are that: (1) all work submitted be you own; (2) when using the work or ideas of others, including fellow students, give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment, ask for clarification. No grade is important enough to justify academic misconduct. Plagiarism means using the exact words, opinions, or factual information from another person without giving the person credit. Writers give credit through accepted documentation styles, such as parenthetical citation, footnotes, or endnotes. Paraphrased material must also be cited, using MLA or APA format. A simple listing of books or articles is not sufficient. Plagiarism is the equivalent of intellectual robbery and cannot be tolerated in the academic setting. If you have any doubts about what constitutes plagiarism, please see me.

Disability Accommodations

Disability Services at George Mason University is committed to providing equitable access to learning opportunities for all students by upholding the laws that ensure equal treatment of people with disabilities. If you are seeking accommodations for this class, please first visit `https://ds.gmu.edu/` for detailed information about the Disability Services registration process. Then please discuss your approved accommodation with me. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email: `ods@gmu.edu`, Phone: (703) 993-2474.

Basic Course Technology Requirement

Activities and assignments in this course will regularly use the Blackboard learning system, available at `https://mymason.gmu.edu`. Students are required to have regular, reliable access to a computer with an updated operating system (recommended: Windows 10 or Mac OSX 10.13 or higher) and a stable broadband Internet connection (cable modem, DSL, satellite broadband, etc., with a consistent 1.5 Mbps [megabits per second] download speed or higher. You can check your speed settings using the speed test on this website.)

Campus Closure

If the campus closes or class is canceled due to weather or other concern, students should check Blackboard for updates on how to continue learning and information about any changes to events or assignments.

Course Materials and Student Privacy

Videorecordings—whether made by instructors or students—of class meetings that include audio, visual, or textual information from other students are private and must not be shared outside the class.

Live video conference meetings (e.g. Collaborate or Zoom) that include audio, textual, or visual information from other students must be viewed privately and not shared with others in your household or recorded and shared outside the class.

Course Recordings

Some of our synchronous meetings in this class will be recorded to provide necessary information for students in this class. Recordings will be stored on Blackboard and will only be accessible to students taking this course during this semester.

Diversity and Inclusion

TBD.

President Washington's Anti-Racism and Inclusive Excellence Task Force continues to work this spring to address his goals for the Mason community; committees continue their work on addressing his call for anti-racism language that faculty can add to their syllabi, as well

as creating resources for faculty to implement anti-racist teaching practices that will align with such policies. Outreach to larger groups of faculty, via townhalls and other events, will be a key part of the work of Spring 2021. In the meantime, Sterns Center encourages faculty to continue to commit to anti-racist and inclusive practices ...

Your instructor welcomes diversity.

Privacy

Students must use their MasonLive email account to receive important University information, including communications related to this class. I will not respond to messages sent from or send message to a non-Mason email address.

Recording and/or sharing class materials

Some kinds of participation in online study sites violate the Mason Honor code; these include accessing exam or quiz questions for this class; accessing exam, quiz, or assignment answers for this class; uploading of any of the instructor's materials or exams; and uploading any of your own answers or finished work. Always consult your syllabus and your professor before using these sites.

Safe Return to Campus Statement

All students taking courses witha a face-to-face component are required to have completed Safe Return to Campus Training prior to visiting campus. Training is available in Blackboard (`https://mymason.gmu.edu`).

Students are required to follow the university's public health and safety precautions and procedures outlined on the university Safe Return to Campus webpage (`www2.gmu.edu/safe-return-plan`). Similarly, all students in face-to-face and hybrid courses must also complete the Mason COVID Health Check daily, seven days a week.

The COVID Health Check system uses a color code system, and students will receive either a Green, Yellow, or Red email response. Only students who receive a "Green" notification are permitted to attend courses with a face-to-face component. If you suspect that you are sick or have been directed to self-isolate, please quarantine or get testing. Faculty are allowed to ask you to show them that you have received a Green email and are thereby permitted to be in class.

Sexual Harrassment, Sexual Misconduct, and Interpersonal Violence

Notice of mandatory reporting of sexual assault, interpersonal violence, and stalking: As a faculty member, I am designated as a "Non-Confidential Employee," and must report all disclosures of sexual assault, sexual harassement, interpersonal violence, stalking, sexual exploitation, complicity, and retaliation to Mason's Title IX Coordinator per University Policy 1202. If you wish to speak with someone confidentially, please contact one of Mason's confidential resources, such as Student Support and Advocacy Center (SSAC) at 703-380-1434 or Counseling and Psychology Services (CAPS) as 703-993-2380. You may also seek assistance or support measures from Mason's Title IX Coordinator by calling 703-993-8730, or emailing `titleix@gmu.edu`.

Student and Faculty Names and Pronouns

Gender identity and pronoun use: If you wish, please share your name and gender pronouns with me and how to address you in class and via email. I use the third-person pronoun "he" for myself and you may address me as "Kent Miller," "Dr. Miller," "Prof. Miller," or "Kent" in email and verbally.

Mason allows students to update their name and pronoun on Mason records.

Tentative Course Schedule

CSI-758 schedule

Wk	Date		Chap	HW Due	Proj	Exam
1	01-26	F	1			
2	02-02	F	2	1		
3	02-09	F	3	2		
4	02-16	F	4	3		
5	02-22	F	5	4		
6	03-02	F	6	5		
7	03-06	F		6		Midterm
8	03-09	F	7			
9	03-16	F	8	7		
10	03-23	F	9	8		
11	03-30	F	10	9	Topic	
12	04-06	F	11	10		
13	04-13	F	12	10	Draft	
14	04-20	F	13	12	Draft	
15	04-27	F		13	Draft	
16	05-04	F			Final	Final exam

Note: F = Face-to-face, O = on-line.

Disclaimer

Information in this syllabus is subject to change. The most frequent cause of change is university closure due to snow. University authorities may require the course to be completed on-line.