CDS 292: Network Analysis

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Syllabus Part 1

Fall 2021

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This syllabus is split into three parts:

1. Part 1: General Course description

2. Part 2: Instructors

3. Part 3: Calendar

Course Introduction.

The purpose of CDS 292 is to introduce the novice data analyst to the basic concepts of networks, as well as the mathematical, statistical, and computational tools that support the application of those concepts. Networks have become an essential tool in the world of data analysis, and thus in disciplines as disparate as sociology, biology, arts, and physics, networks show up now with abundant regularity.

The course uses the programming language `Python`, which is one of the most versatile and extensively used computational tools at present. The versatility of `Python` in data analysis is well-established and currently it is a tool no data scientists can do without.

CDS 292 is a true amalgamated course, with mathematical, computational, statistical, and data analytic material. To have a sense about what the course tries to achieve, by the end of the course the successful student should 1) be able to perform data analysis using networks and its various concepts, 2) understand the fundamental properties of each concept learned to apply them correctly, 3) be able to error check code and libraries constructed by others (lots of shared code on the Internet has errors) and finally, 4) know enough to understand how to build a networks algorithm from scratch, error check it, and use it.

This course is a Quantitative Reasoning Mason Core course, designed to fulfill the relevant learning outcomes. It does this by focusing on the teaching, use, and interpretation of quantitative analysis to study concrete theoretical and real-world problems. **Quantitative reasoning will be expected of students!**

> **Disclaimer: It is common for students to join this class thinking it is about social media and/or the use of packages to study social networks. This is incorrect**.
>
> This class is primarily about an introduction to network concepts and network analysis broadly defined, not focused specifically on social media, or social networks although some do appear. Also, although we do learn how to code routines using `Python` in the network setting, this class is not designed to focus on a computational tool, library, or language; in other words, the is not particularly aimed at learning `R` or `Python` per se.

Advice to succeed in this class

Read the book, slides, notebooks and solutions a few times. There are many little concepts that keep popping up over and over, and they are scattered so unless you read, they will escape you.

Practice a lot of code. Programming is like playing a musical instrument, which can always be done better if you like it, practice, and have some natural talent. I am sure you have all three, but the one you can control is practice. Make variations on the code, try new things, etc.

Dust off your old high-school math. The course does rely on the use of some algebra, matrices, and arithmetic. This goes with the Quantitative Reasoning Core designation. Please, please do not underestimate this. Many students join the class proficient in coding but rusty in math. Data Science relies on people understanding the meaning of quantities and numbers. This class fully embraces that notion and there is an expectation that you will use the class to improve those skills.

Once solutions are provided, study them. It cannot be stressed enough how this is essential prep for exams.

Take full advantage of collaborative work. There are activities designed specifically for you to engage with other students. Make use of them. Peer learning is an important part of learning. But remember your problem set submissions are only your own!

Don't delay in talking to your instructor if there's a problem. If you wait, the problem may get worse and your instructors may have less options/time to help you through it.

Textbook

It is made available to you on Blackboard.

Computer IT Support

If you are having difficulties with your GMU network account, or with software on the GMU network, please contact IT support: support@gmu.edu. The ITS Support Center is in Innovation Hall, Room 226 or can be reached at: 703-993-8870.

Learning Outcomes and Quantitative Reasoning Mason Core

General

1. Students are able to interpret quantitative information (i.e., formulas, graphs, tables, models, and schematics) and draw inferences from them. Students are able to decant information to determine if it has network structure.

2. Given a quantitative problem, students are able to formulate the problem quantitatively and use appropriate arithmetic, algebraic, and/or statistical methods to solve the problem. Matrix algebra is part of the methodology of this course.

3. Students are able to evaluate logical arguments using quantitative network theory reasoning.

4. Students are able to communicate and present quantitative results effectively. This is achieved by a set of continuing in-class activities where students are required to apply network techniques to a data problem, analyze the results, and defend them to the class and instructor.

Specific Learning Lesson Outcomes

Lesson 0 Navigating CDS 292 Online and Lesson 1: `Python` and Colaboratory

Lesson 2 Building Blocks of Networks

Lesson 3 (part 1) Node Degrees, Link Indicators, Network Formulas, and Adjacency Matrix

Lesson 3 (part 2) Node Degrees, Link Indicators, Network Formulas, and Adjacency Matrix

Lesson 3 (part 3) Node Degrees, Link Indicators, Network Formulas, and Adjacency Matrix

Lesson 4 (part 1) Histograms of Node Degrees (concepts)

Lesson 4 (part 2) Histograms of Node Degrees (data analysis)

Lesson 5 (part 1) Paths in Networks (general concepts)

Lesson 5 (part 2) Paths in Networks (network clusters and structural connectivity)

Lesson 6 Shortest Paths in Networks

Lesson 7 (part 1) Triangles, v-shapes, and clustering

Lesson 7 (part 2) Triangles, v-shapes, and clustering

Lesson 7 (part 3) Triangles, v-shapes, and clustering

Lesson assignments

For due dates of assignments, please consult **Syllabus Part 3**.

Course Material Availability

Lesson slides, videos, `Python` notebooks, problem set assignments, colaboratory assignments, solutions, other class materials, and assignments and exam scores will be posted to the class Blackboard site.

Policies and Procedures

Numerical/Letter grade correspondence

Grade scored g	Will equal
$97\% \leq g \leq 100\%$	A+
$94\% \leq g < 97\%$	A
$90\% \leq g < 94\%$	A-
$87\% \leq g < 90\%$	B+
$84\% \leq g < 87\%$	B
$80\% \leq g < 84\%$	A-
$77\% \leq g < 80\%$	C+
$74\% \leq g < 77\%$	C
$70\% \leq g < 74\%$	C-
$60\% \leq g < 70\%$	D
$0\% \leq g < 60\%$	F

Grading

- When grading assignments, while correct answers are important, it is more important how you arrived at those answers, including derivations, logic used, algorithms, and good problem solving strategies. Some (minimal) credit is given for the answer and most credit is given for the correct work leading to the answer.

- Full credit is given for correct answers provided ALL supporting work is shown in an organized manner showing how the answer was arrived at.

- Semester grades will be computed from the following percentages:

    - 45% Assignment Grade:
        * 15% for colaboratory assignments
        * 30% for problem sets
    - 25% for midterm exam
    - 30% for final exam
    - Participation has a value of 10% as extra credit (see below)

Assignments

All `Python` Problem Set submissions MUST ORIGINATE ON PAPER, then be scanned, and then be sent. For scanning, the gold standard is a standalone scanner. You may use phone apps to scan if you do not have access to a standalone scanner. Some options:

- Adobe Scan app

- Microsoft Office Lens

Some recommendations:

- **Do not send problem sets pictures**. They are hard to read. Think: if you have trouble reading it from a picture, we have even more trouble as we have to read many such submissions.

- **Send a SINGLE pdf document** containing your solutions.

- **CORRECT INDENTATION OF** `Python` **CODE IS A CONDITION TO COR-RECTNESS**. If you are not sure about your handwriting, use a symbol to mark an indented block. Just a right pointing arrow will be enough.

- **Time extensions may ONLY be granted by the instructor**, must be in writing from, and will give a specific time. **Late assignments sent directly to your TA will NOT be graded**.

- The total available points in each Problem Set can vary week to week.

- The semester Problem Set grade will consist of the averaged sum of the individual Problem Set grades. Specifically,

$$\text{Problem Set Grade} = \frac{\text{(Sum of points you obtained)}}{\text{(Sum of points over all sets)}}$$

- Problem Sets are generally released a **week before the due date**.

Colaboratory Assignments

- Every week, there will a set of coding problems intended for you to solve with your **programming partner(s)**.

- One of you will import the provided notebook to Colaboratory, invite partner(s), and start working.

- An important part of the assignment is that you organize the way you work. This is to avoid overwriting each other's code. There is a video demonstrating how to do this (see Lesson 0 in Blackboard).

- Once you have finished with the notebook. **MAKE SURE THAT AT THE TOP OF THE NOTEBOOK THERE IS A TEXT CELL WITH YOUR NAMES**. Then, invite your teaching assistant (emails specified in Part 2 of the syllabus) to the notebook and he/she will be able to grade it.

- To submit your work, **one of you should go to the submission page in Blackboard, leave a message and press the submit button**. This is just so we keep track of the date you sent your work.

- All Notebooks have equal weight.

- The semester Notebook grade will consist of the averaged sum of the individual Notebook grades. Specifically,

$$\text{Notebook Grade} = \frac{\text{(Sum of points you obtained)}}{\text{(Sum of points over all Notebooks)}}$$

- Notebooks are generally released **a week before the due date**.

Exams

- The exams will be available on Blackboard with the **Respondus Lockdown Brower**.

- Once you open the exam you will have 2 hours and 45 minutes to complete it unless you open with less than 2 hours and 45 minutes before exam closing. In that case, you will only have the remaining time between when you open the exam and the closing time.

- Dates for the midterm and final are stated in Part 3 of the syllabus.

- NOTE ON RESPONDUS: If you have installed RESPONDUS at NVCC or any other college/school/..., it MUST be UNINSTALLED and REINSTALLED for use at MASON. This is due to the internal handshaking that occurs between MASON's Blackboard and RESPONDUS.

- Students will be REQUIRED to show their GMU ID card PRIOR to beginning either the Midterm or Final exams. (Remember: "No GMU ID - No exam grade - No exception").

Participation

This grade is only extra credit. If a student does not feel the need to tap into the participation extra credit grade, they will still have access to 100% of the points. To receive credit for participation, students must:

- attend office hours with both the instructor and the teaching assistants, and

- contribute to any discussions, or pose questions.

Over time, we have found that students find themselves in trouble by misunderstanding certain basic things about the class. In addition, office hours are grossly underused but students that do participate gain a great deal. Therefore, we have introduced an incentive structure to have students actively participate in this activity.

More comments on Grading

- While correct answers matter, it is more important how you arrived at those answers. Completeness in answers (compete thoughts, complete codes, complete plots) is about $\frac{1}{2}$ credit for the problem.

- Semester grades will be computed as a percentage of points earned divided by total points available in each category. Grades are mathematically determined and will NOT be curved.

- There are no extra credit assignments/projects available for CDS-292.

Technology Needed and GMU netlogin

- Each student will require access to Blackboard from GMU. Make sure you have access to your GMU netlogin.

- Each student will require checking email often and therefore also requires have up to date

- Software access for the class:

    - PDF reader with the capacity to display pages in single page view (for slides), and

– a computer capable of executing `Python` code, and the `networkx` and `matplotlib` libraries,

– a computer with a browser to use Blackboard and Respondus browser (needs to be Mason Installed or it doesn't work) with a webcam or a phone with a webcam (consult Lesson 0 for details).

– Access to a Google account is highly recommended (Colaboratory).

Collaboration and Plagiarism

- All CDS-292 activities are subject to GMU's Honor Code and IT policies.

- Collaboration: Students are encouraged to discuss homework problems with each other. Discussion means each student working the problem may talk with someone else (aka: conversation on the logic or software needed to compete the assignment) but will fully work the problem on their own.

- Plagiarism will not be tolerated at any time. Students will be given a zero for any assignment, quiz, or exam where plagiarism is suspected. If plagiarism is suspected a second time for any student, an automatic grade of "F" will be assigned for the course with a report sent to the Dean for further action.

- Collaboration becomes plagiarism when: **A STUDENT COPIES THE WORK OF SOMEONE ELSE, EITHER FROM STUDENTS CURENTLY TAKING CDS-292, OR WHO HAVE TAKEN CDS-292 IN THE PAST OR BY COPYING THE WORK FROM ANY PUBLISHED OR UNPUBLISHED SOURCE**.

- All problem sets, notebook assignments, and exams, including computer programs and associated outputs, turned in for grading represent the student's own work.

- Students may not discuss exam problems with anyone other than your instructor or the CDS-292 TA.

- COLLABORATION DURING AN EXAM OR QUIZ IS NOT AUTHORIZED AT ANY TIME AND THUS PROHIBITED AND IS CONSIDERED PLAGIARISM!

- All plagiarism violations will be reported in writing to the Dean's office.

Prohibited Equipment use during exams and quizzes

Exams are closed book/closed notes. The only allowed equipment is the blackboard site under respondus, paper and pencil. Therefore, other computer equipment, smart phone, calculator or other electronic device use during an exam is prohibited. Individual instructors may announce modifications to this policy which will be specific to their class section only.

Disabilities

If you have a documented learning disability or other condition that may affect academic performance students MUST:

1. Have the need for accommodation on file with Office of Disability Services (SUB I, Rm. 4205; 703-993-2474; http://ods.gmu.edu);

2. Provide the instructor with a copy of the Office of Disability Services accommodation determination prior to receiving any accommodations. We will protect this information as private and will not share the information with anyone other than the class assistants unless authorized in writing by the student or the Office of Disability Services.

3. In case you need it, we can arrange for an alternate testing location for the Midterm and Final Exams with PRIOR notice, which is needed AT LEAST 1 week in advance although it is better if even more time is allowed.

4. PLEASE NOTE: If you are having ANY difficulties with CDS-292 due to personal limitations, PLEASE let the instructor know. We want to help you succeed in CDS-292 and in your GMU career.

CDS 292: Network Analysis

Syllabus Part 2

Fall 2021

This syllabus is split into three parts:

1. Part 1: General Course description

2. Part 2: Instructors

3. Part 3: Calendar

Section 1: TR 10.30 - 11.45 AM

Instructor Valentin Vergara Hidd

Email vvergara@gmu.edu

Class Meetings This as synchronous class. As such, we will meet twice a week in this zoom meeting room. Note that you don't need a password for the meeting, but you **must be authenticated** using your Mason *netid* to log in to zoom. You will also find a direct link to the class session in Blackboard

Office Hours Every Thursday from 12PM to 1PM I will hold *walk-in* office hours in this zoom meeting room. If you need additional office hours, send me an email and we can schedule it. Please, allow some time for me to schedule our meeting (i.e. email me at least 1 day before the time you want to meet).

Time to respond emails We created this class to minimize the amount of work you should do over weekends. With that in mind, I will respond to emails within a day during the week (Monday to Friday).

Section 2: TR 9.00 - 10.15 AM

Instructor Arie Croitoru

Email acroitor@gmu.edu

Class Meetings This section will be delivered as an online synchronous class. As such, we will meet twice a week in this zoom meeting room. Note that no password is required to join the sessions but you **must be authenticated** using your Mason *netid* to log in to zoom to join our sessions. You will also find a direct link to the class session in Blackboard

Office Hours Every Monday from 3:00PM to 4:00PM I will hold *walk-in* office hours in this zoom meeting room. If you are unable to meet during office hours, please send me an email with your availability and we will coordinate a time that is convenient for both of us. Please, allow some time for me to schedule our meeting (i.e. email me at least 1 work day before the time you want to meet).

Time to respond emails I will respond to email messages within 24 to 48 hrs, Monday through Friday. Emails sent during weekends and holidays will be responded to on the following Monday.

STARs (both sections)

Formally, the STARs for this class are assigned to a section. However, feel free to reach to both of them for office hours or content questions. If you need help with topics such as grading reviews, contact the STAR assigned to your section.

Radhika Laddha: Section 1

1. **Email** TBD

2. **Office Hours** TBD

3. **Time to respond emails** TBD

Jennifer Smiley: Section 2

1. **Email** TBD

2. **Office Hours** TBD

3. **Time to respond emails** TBD

CDS 292: Network Analysis

Syllabus Part 3

Fall 2021

This syllabus is split into three parts:

1. Part 1: General Course description

2. Part 2: Instructors

3. Part 3: Calendar

Definition of a week: This semester, each week is defined from the beginning of Saturday (12:00 AM) to the end of the following Friday (11:59 PM)

Calendar

Calendar week	Lesson	Due dates
Aug 23 - Aug 27	Lesson 0: Navigating CDS 292; Lesson 1: Tools	• FERPA form related to Colaboratory use: Wednesday Aug 25th • Signed Statement that Lesson 0 has been read and understood: Wednesday Aug 25th • Colaboratory notebook: Friday Aug 27th • Problem Set: Friday Aug 27th
Aug 28 - Sep 3	Lesson 2: Building blocks of networks	• Colaboratory notebook: Wednesday Sep 1st, by the end of the day (11:59 pm) • Problem Set: Friday Sep 3rd

Sep 4 - Sep 10	Lesson 3 (part 1): Node Degrees, Link Indicators, Network Formulas, and Adjacency Matrices	• Colaboratory notebook: Wednesday Sep 8th • Problem Set: Friday Sep 10th
Sep 11 - Sep 17	Lesson 3 (part 2): Node Degrees, Link Indicators, Network Formulas, and Adjacency Matrices	• Colaboratory notebook: Wednesday Sep 15th • Problem Set: Friday Sep 17th
Sep 18 - Sep 24	Lesson 3 (part 3): Node Degrees, Link Indicators, Network Formulas, and Adjacency Matrices	• Colaboratory notebook: Wednesday Sep 22nd • Problem Set: Friday Sep 24th
Sep 25 - Oct 1	Lesson 4 (part 1): Histograms of Node Degrees	• Colaboratory notebook: Wednesday Sep 29th • Problem Set: Friday Oct 1st
Oct 2 - Oct 8	Lesson 4 (part 2): Histograms of Node Degrees	• Colaboratory notebook: Wednesday Oct 6th • Problem Set: Friday Oct 8th
Oct 9 - Oct 15	Review and Midterm	
Oct 16 - Oct 22	Lesson 5 (part 1): Paths in networks	• Colaboratory notebook: Wednesday Oct 20th • Problem Set: Friday Oct 22nd
Oct 23 - Oct 29	Lesson 5 (part 2): Paths in networks	• Colaboratory notebook: Wednesday Oct 27th • Problem Set: Friday Oct 29th

Oct 30 - Nov 5	Lesson 6: Shortest paths in networks	
		• Colaboratory notebook: Wednesday Nov 3rd
		• Problem Set: Friday Nov 5th
Nov 6 - Nov 12	Lesson 7 (part 1): Triangles, v-shapes and clustering	
		• Colaboratory notebook: Wednesday Nov 10th
		• Problem Set: Friday Nov 12th
Nov 13 - Nov 19	Lesson 7 (part 2): Triangles, v-shapes and clustering	
		• Colaboratory notebook: Wednesday Nov 17th
		• Problem Set: Friday Nov 19th
Nov 20 - Nov 26	Lesson 7 (part 3): Triangles, v-shapes and clustering	
		• Colaboratory notebook: Wednesday Nov 24th
		• Problem Set: Friday Nov 26th
Nov 27 - Dec 3	Review Sessions	
Dec 14	Final Exam	