# Math 581.05: Computational Tools for Complex Systems
# Fall 2020

## Instructor Information


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| Instructor: | Daryl DeFord |
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| Classroom: | Zoom (https://wsu.zoom.us/j/95947855932) |
| Class Time: | Wednesday 3:10-4:00pm |
| Office Hours: | Friday 12-1pm |
| Remote Office: | https://wsu.zoom.us/j/2175488966 |


## Course Description

This course will introduce tools and methodology for analyzing complex social systems with network models. The first half of the course will cover standard network constructions and associated centrality metrics, clustering algorithms, dynamical models, and null models through classic papers and examples. The second half of the course will focus on the discrete formulation of political redistricting problems and related applications of sampling connected graph partitions. Beyond the theoretical components, this course will provide resources and experiences for relevant software packages including networkx and gerrychain.

## Remote Logistics

Due to the circumstances surrounding the coronavirus outbreak, our course meetings will be held entirely online, through Zoom. Python scripts and notebooks will be uploaded to the course github page and will also be available in a CoCalc project. This will allow you to follow along as we experiment with the computational tools during our meetings. Further details will be discussed during our first meeting.

## Course Materials

The main material we cover will be presented in lecture notes prepared by me and posted on the course webpage. For each topic, I will also suggest several relevant 'classic'[1] research papers for additional context. Some textbooks that cover the material from a broader perspective include:

- Networks (Newman)
- Network Analysis and Modeling (Clauset)
- Networks, Crowds, and Markets (Easely and Kleinberg)
- Dynamical Processes on Complex Networks (Barrat, Barthelemy, and Vespignani)
- A First Course in Network Science (Menczer, Fortunato, Davis)

[1] this means something different in applied math than pure math ☺

## Learning Outcomes

The main purpose of the course is to introduce basic tools and concepts from social network analysis and computational redistricting. Specific learning outcomes include:

- Writing python programs incorporating the networkx package
- Understanding how network models arise from empirical data
- Facility with the standard concepts in networks analysis including centrality, clustering, and dynamics
- Understanding application of MCMC ensembles to political redistricting
- Using the gerrychain software to run Markov chains for graph partitions

## Assignments and Assessment

Throughout the course there will be several suggested computational exercises. Students who want to work on projects related to this material will have opportunities to explore their interests.

## Grading Policy

The course is being graded S/F. Active participation in lecture and discussion is encouraged but as one of my favorite professors from graduate school used to say: "you can't pass if you don't sign up!"

## Weekly Topics

1. Introduction to NetworkX and Overview
2. Measures and Metrics
3. Null Models
4. Dynamics 1 (Diffusion)
5. Dynamics 2 (Compartment Models)
6. Clustering Methods 1 (Spectral Methods)
7. Clustering Methods 2 (Kitchen Sink)
8. Multiplex Networks
9. Applied Examples (Social Networks)
10. Introduction to Computational Redistricting
11. Geospatial Data
12. MCMC and Ensembles
13. Graph Partitioning
14. Applied Examples (Gerrymandering)
15. Applied Examples (Reform)

## University Policy Statements

### COVID-19 Statement

Students are expected to abide by all current COVID-19 related university policies and public health directives, which could include wearing a cloth face covering, physically distancing, self-attestations, and sanitizing common use spaces. All current COVID-19 related university policies and public health directives are located at https://wsu.edu/covid-19/. Students who do not comply with these directives may be required to leave the classroom; in egregious or repetitive cases, students may be referred to the Center for Community Standards for university disciplinary action.

### Academic Integrity Statement

Academic integrity is the cornerstone of higher education. As such, all members of the university community share responsibility for maintaining and promoting the principles of integrity in all activities, including academic integrity and honest scholarship. Academic integrity will be strongly enforced in this course. Students who violate WSU's Academic Integrity Policy (identified in Washington Administrative Code (WAC) 504-26-010(4) will receive [insert academic sanction (e.g., fail the course, fail the assignment, etc.)], will not have the option to withdraw from the course pending an appeal, and will be reported to the Center for Community Standards.

Cheating includes, but is not limited to, plagiarism and unauthorized collaboration as defined in the Standards of Conduct for Students, WAC 504-26-010(3). You need to read and understand all of the definitions of cheating. If you have any questions about what is and is not allowed in this course, you should ask course instructors before proceeding.

If you wish to appeal a faculty member's decision relating to academic integrity, please use the form available at communitystandards.wsu.edu. Make sure you submit your appeal within 21 calendar days of the faculty member's decision.

### WSU Reasonable Accommodation Statement

Reasonable accommodations are available for students with documented disabilities or chronic medical or psychological conditions. If you have a disability and need accommodations to fully participate in this class, please visit your campus' Access Center/Services website to follow published procedures to request accommodations. Students may also contact their campus offices to schedule an appointment with a Disability Specialist. All disability related accommodations are to be approved through the Access Center/Services on your campus. It is a university expectation that students visit with instructors (via email, Zoom, or in person) to discuss logistics within two weeks after they have officially requested their accommodations. For more information contact a Disability Specialist on your home campus:

- Pullman, WSU Global Campus, Everett, Bremerton, and Puyallup: 509-335-3417 Access Center (https://www.accesscenter.wsu.edu) or email at access.center@wsu.edu.

### Religious Accommodation Statement

Washington State University reasonably accommodates absences allowing for students to take holidays for reasons of faith or conscience or organized activities conducted under the auspices of a religious denomination, church, or religious organization. Reasonable accommodation requires the student to coordinate with the instructor on scheduling examinations or other activities necessary for course completion. Students requesting accommodation must provide written notification within the first two weeks of the beginning of the course and include specific dates for absences. Approved accommodations for absences will not adversely impact student grades. Absence from classes or examinations for religious reasons does not relieve students from responsibility for any part of the course work required during the period of absence. Students who feel they have been treated unfairly in terms of this accommodation may refer to Academic Regulation 104 – Academic Complaint Procedures.

### Attendance Policy

Due to the pace of the course and the range of topics that we will cover this term, daily attendance will be essential for your success. Although it is not officially a part of the course grade, missing class could adversely affect your grade by impacting your understanding of the material. Our class meetings will frequently incorporate activities and discussions that extend the material beyond the presentation in the textbook. In particular, taking good notes of our classroom discussions will be especially important.

## Expectations for Student Effort

Students should expect to spend a minimum of 9 hours per week, engaged in the following types of activities: reading, listening to/viewing media, discussion, or conversation in the LMS or other academic technology, conducting research, completing assignments and reviewing instructor feedback, studying for and completing assessments, etc

### Safety and Emergency Notification

Classroom and campus safety are of paramount importance at Washington State University, and are the shared responsibility of the entire campus population. WSU urges students to follow the "Alert, Assess, Act," protocol for all types of emergencies and the "Run, Hide, Fight" response for an active shooter incident. Remain ALERT (through direct observation or emergency notification), ASSESS your specific situation, and ACT in the most appropriate way to assure your own safety (and the safety of others if you are able).

Please sign up for emergency alerts on your account at MyWSU. For more information on this subject, campus safety, and related topics, please view the FBI's Run, Hide, Fight video and visit the WSU safety portal.

Full details can be found at `https://provost.wsu.edu/classroom-safety/`

### Discrimination and Harassment Policy Statement

Discrimination, including discriminatory harassment, sexual harassment, and sexual misconduct (including stalking, intimate partner violence, and sexual violence) is prohibited at WSU (See WSU Policy Prohibiting Discrimination and Harassment (Executive Policy 15) and WSU Standards of Conduct for Students).

If you feel you have experienced or have witnessed discriminatory conduct, you can contact the WSU Compliance & Civil Rights (CCR) and/or the WSU Title IX Coordinator at 509-335-8288 to discuss resources, including confidential resources, and reporting options. (Visit `ccr.wsu.edu` for more information).

Most WSU employees, including faculty, who have information regarding sexual harassment or sexual misconduct are required to report the information to CCR or a designated Title IX Coordinator or Liaison. (Visit `ccr.wsu.edu/reporting-requirements` for more info).