

Fractals, Algorithms, and Us

Collegiate Scholars Program at the University of Chicago

Summer 2019

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Class Room: Computer Science Instructional Laboratory (CSIL) 3

Class Hour: Monday and Wednesday, from 1-3 pm

Class Website: <https://canvas.uchicago.edu/courses/22450>

Course Description: This course is designed around developing mathematical skills, with a focus in programming, while also taking seriously the cultural and social implications of mathematical work. We will design algorithms to solve equations, create and explore a variety of different fractals, and use neural networks to recognize images and generate art; simultaneously, we will discuss how mathematics combined with various forms of power have shaped the world, consider the ethical implications of artificial intelligence, and embark on a cross-cultural survey to reckon with the richly varied lived experiences of people doing math.

This course will have a considerable component of in-class discussion and writing, as well as homework mostly conducted in [Python](#), and will include a substantial final project.

Grade Distribution: The typical UChicago grading scale will be used. I reserve the right to curve the scale dependent on overall class scores at the end of the semester. Any curve will only ever make it easier to a higher letter grade. Assessments are weighed using the following proportions:

- 25% of your grade will be determined by homework assignments.
- 25% of your grade will be determined by participation during in-class discussions.
- 25% of your grade will be determined by in-class work.
- 25% of your grade will be determined by the final project.

Course Policies

During Class

Computers will be allowed in class, but please respect one another by refraining from using computers for anything but activities related to the work at hand. In general, when notes are taken, paper and pencil is preferred to electronic mediums. Phones are generally prohibited as they are rarely useful for anything in the course, for both students and the instructor. Eating and drinking are allowed in class, except as prohibited by the rules of the spaces we occupy.

Attendance and Homework Policy

Attendance is expected in all sections. Valid excuses for absence will be accepted before class, except in extenuating circumstances. Unexplained and extended absences will affect your performance in the course; keep in mind that half of your grade is determined by in-class participation and work, but more so note that programming is often a difficult thing to learn for first-timers without hands-on experience.

Out of respect for the graders, homework should be neat and stapled; penalizations may be made for illegible or disorganized work. You may work on homework together, but independently written solutions must be submitted. Homework must be turned in at the beginning of class. Late homework is not accepted except with instructor permission. Your worst homework grade (for example, if you are unable to turn an assignment in) is dropped.

Final Project

Because of the breadth of the course, the final projects will have a great deal of flexibility as to their form and content. For example, students could write a report on Eurocentrism in mathematics, could train a neural network to play music or play a game, or turn in a portfolio of fractal art by their own design. Project outlines must be approved by the end of week 4. Projects can be done individually or in groups of 2-3 people, and will be presented to the class at the end of the course; students can also choose to present their projects at the CSP Culminating Event.

Academic Integrity and Honesty

Students are required to comply with the University policy on Academic Integrity found in the Student Manual at <https://studentmanual.uchicago.edu/>. Please do not exploit other students by compelling them to share their labor. If cooperating with others or citing external work, mark clearly who took part in creating the shared result.

Message from Student Disability Services

"If you require any accommodations for this course, as soon as possible please provide your instructor with a copy of your Accommodation Determination Letter (provided to you by the Student Disability Services office) so that you may discuss with him/her how your accommodations may be implemented in this course. The University of Chicago is committed to ensuring the full participation of all students in its programs. If you have a documented disability (or think you may have a disability) and, as a result, need a reasonable accommodation to participate in class, complete course requirements, or benefit from the University's programs or services, you are encouraged to contact Student Disability Services as soon as possible."

To receive accommodation, you must be appropriately registered with Student Disability Services. Contact the office at 773-795-1186, on 5501 S. Ellis Avenue, at disabilities@uchicago.edu, or at their website disabilities.uchicago.edu

Non-Discrimination Policy

Discrimination based on race, color, religion, creed, sex, gender, national origin, age, disability, veteran status, or sexual orientation is a violation of state and federal law and/or University policy and will not be tolerated. Harassment of any person (either in the form of quid pro quo or creation of a hostile environment) based on race, color, religion, creed, sex, gender, national origin, age, disability, veteran status, or sexual orientation also is a violation of state and federal law and/or the University of Chicago policy and will not be tolerated. Retaliation against any person who complains about discrimination is also prohibited. University policies covering discrimination, harassment, and retaliation may be accessed at <https://studentmanual.uchicago.edu/page/policy-harassment-discrimination-and-sexual-misconduct>.

Schedule, readings, and learning objectives

The schedule is tentative and subject to change.

Week 1: *What is math?*

- **Monday, June 24**
 - In-class reading and discussion from *Joy in the Struggle*.
 - Introduction to Python, Turtle, and algorithms.
 - Assigned reading from *African Fractals: Modern Computing and Indigenous Design*, due Monday.
- **Wednesday, June 26**
 - Review of complex numbers and solving polynomials.
 - In-class exercises with logic, loops, iteration, and Newton's method.
 - Introduction to the Newton fractal.
 - Homework assignment #1: exercises with Turtle, due Monday.

Week 2: *How is math part of our lived experiences?*

- **Monday, July 1**
 - In-class discussion on *African Fractals: Modern Computing and Indigenous Design*.
 - In-class exercises with Python and Turtle.
 - Assigned reading from *Pedagogy of the Oppressed* and *Decolonising the University*, due Monday.
 - Homework assignment #2: making fractals with Turtle, due Wednesday.

Week 3: *How do we teach math? Who gets to do math?*

- **Monday, July 8**
 - In-class discussion on *Pedagogy of the Oppressed* and *Decolonising the University*.
 - Introduction to recursion.
 - Assigned reading on "[Western mathematics: the secret weapon of cultural imperialism](#)," due Monday.
- **Wednesday, July 10**
 - Introduction to the Mandelbrot and Julia sets.
 - In-class exercises on recursion.
 - Homework assignment #3: generating more fractals with Turtle and Python, due Wednesday.
 - Final project assignment: outline due Wednesday of week 4, project due Wednesday of week 6.

Week 4: *How does math change the world? (part 1)*

- **Monday, July 15**
 - In-class discussion on “Western mathematics: the secret weapon of cultural imperialism.”
 - Introduction to neural networks.
 - Assigned reading from “Racist in the machine,” due Monday.
- **Wednesday, July 17**
 - Final project outlines due!
 - In-class exercises teaching a neural network to write.
 - Homework assignment #4: design your own neural network.

Week 5: *How does math change the world? (part 2)*

- **Monday, July 22**
 - In-class discussion on “Racist in the machine.”
 - Introduction to buddhabrots and AI-generated art.
 - Assigned reading from *Scientists at War* and “The dual nature of science.”
- **Wednesday, July 24**
 - In-class exercises on buddhabrots and neural networks.
 - Work on finals projects.

Week 6: *What kinds of mathematicians will we be? How will we change the world?*

- **Monday, July 29**
 - In-class discussion on *Scientists at War* and “The dual nature of science.”
 - Work on projects.
- **Wednesday, July 31**
 - Present final projects!
 - Course evaluations.