Overview

Course:	CS 20 – Discrete Mathematics for Computer Science
Course Level:	Introductory
Course Description:	CS20 is a fun, collaborative introduction to discrete mathematics for computer science. The course is designed to welcome students to the field of computer science. During our class meetings students work in small groups to collaboratively solve problems with the help of a teaching fellow. Classes are active. Participation counts. We use this teaching methodology not so much because it has been proven to be most effective for learning (though it has!) but because it helps us ensure that during this class you will form collegial relationships with a wide range of peers in computer science and applied math with whom you'll be studying and collaborating throughout college. A principal objective of CS20 is to not just to teach a set of mathematical topics, but to develop mathematical maturity. Much of what CS20 prepares you to do is to think mathematically and read and write mathematics. By the end of CS20 you should feel comfortable reading mathematical notation and writing formal proofs. CS20 teaches all the math not taught in the traditional calculus/linear algebra sequence that is needed to take more advanced courses in theory of computation and/or algorithms. That is, CS20 teaches discrete mathematics, logic, and basic probability, but does not teach calculus or linear algebra. Many of the topics in CS20 are not part of the typical secondary school math curriculum. Prospective students may find it helpful to take our "placement test download" to gauge whether the course material is appropriate for you.[1]
Module Topic:	Core-Periphery Structures in Social Networks
Module Author:	Zachary Gabor
Semesters Taught:	Spring 2021
Tags:	Networks [CS], Epistemic Injustice [Phil], Marginalization [Phil]
Module Overview:	The module introduces students to core-periphery structures in social networks. After defining core-periphery structures, we look at some examples in the social world and employ tools from social epistemology and feminist philosophy to articulate ways in which these structures may be harmful. We then discuss research which suggests, in abstract mathematical terms, what kinds of dynamics lead to the emergence of core-periphery structures. Students apply this research to evaluate real-life cases.
Connection to Course Material:	One core topic in discrete mathematics is the study of graphs, mathematical structures which may be represented by networks of dots connected by lines. These mathematical structures can be used (and indeed are used by social scientists) to represent groups of people and social relations between them. One of the goals of CS 20 is to serve as an on-ramp into the discipline. In service of this goal, the course aims to build community and help students develop social resources which will better equip them to thrive as they continue with the subject. The module topic was chosen

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		with this broader course purpose in mind. It both applies conceptual tools of discrete mathematics to ethically important issues and provides students with philosophical and mathematical tools to understand and navigate potentially unjust situations in the core-periphery structured social environments they inhabit.

Goals		
Module Goals:	1. Introduce the graph-theoretical notion of a core-periphery structure. 2. Give students an opportunity to see how this graph-theoretical concept can be used to fruitfully characterize real world phenomena. 3. Introduce hermeneutical injustice as an example of a harm which can occur because a social structure is organized into a core and a periphery 4. Help students look for other kinds of harms which can occur due to core-periphery structures.	
Key Philosophical Questions:	1. What kinds of harms can core-periphery social structures bring about? 2. What is hermeneutical injustice and how does it relate to core-periphery social structures? 3. What are social affordances and how are they distributed among members of the core-periphery social structure?	Many of the key non-mathematical ideas of the module are from the social sciences, not philosophy. The principal philosophical questions are about the ways in which the persistence of these structures may be bad. Thus, students learn philosophical tools to articulate what makes such structures objectionable.

Materials		
Key Philosophical Concepts:	● Social affordances ● Hermeneutical Injustice ● Harms and Benefits	One of the particular ways in which peripherality can harm group members is that with fewer interconnections, they are less likely to be prioritized in the process of generating concepts with which to interpret and articulate experiences, and concepts which they may generate on their own may have fewer channels through which to proliferate into the group at large. Thus, we can expect that core-periphery structures present an environment which can generate hermeneutical injustice. The

		concept of a social affordance is a more general concept which enables students to identify whether certain benefits are distributed fairly in a core-periphery structure.
Assigned Readings:	● Jennifer Saul and Esa Diaz Leon: "Hermeneutical Injustice" (Section 2.4 of the *Stanford Encyclopedia of Philosophy* entry for "feminist philosophy of language). ● (Optional) Asikainen et al: "Cumulative Effects of Triadic Closure and Homophily in Social Networks," *Science Advances* (2020)	The Saul and Leon reading provides an introductory overview of hermeneutical injustice, which will serve as the chief example of a kind of harm that can arise from core-periphery structures in this module. The Asikainen paper offers a technical overview of how core-periphery structures are formed. More specifically, they show how graphs that evolve over time have the tendency to form new connections according to two principles: (1)"triadic closure" (the tendency for "vees" – three vertices (points) connected with two edges (lines) and one missing edge – to form triangles by supplying the missing edge); and (2) "choice homophily" (the tendency for connections to form between vertices representing people with things in common).

Implementation

Class Agenda:	1. Introduce core-periphery structures and the related concept of eccentricity 2. Examples of core-periphery structures 3. Introduce hermeneutical injustice and its connection to core-periphery structures. 4. Discuss other kinds of harms which core-periphery structures can cause or perpetuate. 5. Present Asikainen research: how are core-periphery structures formed? 6. Exercise: core-periphery structures in college departments	
Sample Class Activity:	Students are presented with a graph which represents the relationships between CS majors in a university department. In groups, they are asked to compute the eccentricities of each vertex, and then to divide the vertices into core and periphery. They then discuss how a student might be affected by	The course for which this module is designed is an introduction to the mathematics involved in computer science for students who have less math background than is typical for most CS students. One of the goals

	being in a peripheral position and what features might most likely contribute to choice homophily. Groups convene to compare responses.	of the course was to help students who might be marginalized or find barriers to entry build community within the CS department and find an on-ramp into the discipline. The choice of exercise is meant to encourage students to use the tools introduced by the module to reflect on the challenges and opportunities relating to building a more inclusive community within their discipline.
Module Assignment:	The module assignment consists of the following (two-part) problem-set question: The town of Leafton has a private country club, all of whose members are among the town's highest earners. This association among people with a shared characteristic is an example of homophily. a. How might the homogeneity of the club's class composition have come about as a result of choice homophily? How might it have come about as a result of induced homophily? b. The Leafton town council has become concerned about the social divisions in town that the country club embodies. They are considering requiring the club (and any similar club) to offer free memberships to lower income residents of the community. Does the likelihood that this proposal would be effective at reducing the social divide along class lines in town depend on whether the class homogeneity of the club is a result of induced or choice homophily? Why or why not?	Social scientists distinguish between two kinds of homophily i.e. likeness among groups of people: choice homophily (the tendency of people with traits in common to associate) and induced homophily (the tendency of associated people to become more alike). The follow-up assignment prompts students to think about the differences between the way in which these kinds of homophily enforce social divisions, and what difference in strategy might be called for when aiming to ameliorate the social stratification caused by choice vs. induced homophily. For example, choice homophily may be counteracted simply by arranging for people from different social strata to associate with one another, whereas with induced homophily, doing this alone will not be effective because the same patterns of stratification will be induced.
Lessons Learned:	Students wanted more time to discuss hermeneutical injustice and other ways in which core-periphery structures can potentially be harmful. Though some follow-up discussion or activity relating to the dynamics by which core-periphery structures are formed is important to accomplishing the learning goals of the module, it may make sense to give pride of place to discussion of the potential harms associated with core-periphery structures.	