Math 485-001, Spring 2020

Meetings: MoWeFr 1:25PM - 2:15PM, Roop 327.

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Course Pre-Requisites: Math 245 and 300 OR serious students from statistics, computer science, sociology, psychology, economics or political science are welcome but need instructor’s consent.

Description: Imagine that our large group must choose two snacks out of ten possibilities for our party. We could begin by asking everyone to rank their preferences and.... then what? Should it be those snacks which are ranked first most often? What if the two snacks with the most first ranks are also those that are ranked last the most, namely if the most desired are also the least desired?! Conversely, what if, say, popcorn, comes in third place but, in a head to head with every other snack it is always the preferred choice? What’s fair?

This course is about how mathematics can help us frame (not necessarily solve) what is fair and how this can lead to some strange paradoxes, not just with snacks but in any electoral context in which groups make decisions collectively. While voting theory dates from the 18th century it is only since the 1950’s that its axiomatics have been studied in depth, starting with Arrow’s impossibility theorem which (roughly) states that there is no electoral system that can simultaneously satisfy some reasonable fairness criteria. Starting in the late 1980’s, Saari’s work on the geometry of voting theory enables us to examine fairness criteria in a coherent spectral fashion. Our goal in this class will be to study the paradoxes and geometry of voting theory with an emphasis on how mathematics can help frame group decision making. There will be a large research project understanding the likelihood of paradoxes like Arrow’s theorem occurring. There will also be forays into apportionment and gerrymandering.

Some introductory reading (second and third require JMU login):