

QSS/Mathematics 30.04 - Evolutionary Game Theory

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Homework 1

Prompt/Instructions

For centuries, mathematics has synergistic interactions with problems in the physical sciences and engineering. However, its interaction with the social sciences has yet to be strengthened (an emerging frontier we call “mathematical humanities”), which will be the focus of this quantitative social science class. What big questions in the social sciences will benefit from an evolutionary game theory approach? Please list one or a few and argue why.

Questions in the social sciences that will benefit from an evolutionary game theory approach fall into the following categories.

Public Health

Public health – more specifically the question of how we are to induce people to look after the health of themselves and others – is an issue that has become increasingly more significant with the COVID-19 pandemic and implications of vaccine compliance. While vaccines are an effective means to prevent the spread of disease, anti-vaccine sentiment often results in lack of “herd immunity” (which is the goal to ensure society as a whole is protected). This anti-vaccine sentiment tends to arise in response to concern of side-effects or potential long-term consequences of vaccines. When individuals find that their concern of side-effects outweighs the fear associated with the disease, they often choose not to become vaccinated. This causes issues for society; people think for (and about) themselves, rather than the public good.

This way of thinking, along with the topic of public health vaccination programs, may be modelled using evolutionary game theory to provide greater understanding of the perspectives individuals hold. Further, evolutionary game theory may provide insight as to which strategies to adopt that encourage individuals to continue to become vaccinated in light of declining cases, particularly for the purpose of protecting susceptible individuals. The action of getting vaccinated provides a benefit to society, which explains why we should use evolutionary game theory to investigate the methods in which governments and organization can spread a message to encourage people to become vaccinated, thus increasing public health.

By thinking about public health from an evolutionary game theory point of view, we may further understand why certain actions are taken by members of a population and how we may ensure that public goods are properly maintained, so that we do not fall into the ‘tragedy of the commons’.

Climate Change

In an economy dominated by capitalism, companies (and individuals) often place emphasis on profit maximization without considering the possible negative implications of their actions. This is particularly seen in the case of climate change and global warming; companies aim for profit while

neglecting environmental concerns. While these actions may yield short-term economic benefits, there are long-term consequences that are devastating to the population.

To this end, evolutionary game theory may provide an effective avenue to analyze the ways in which companies can be encouraged to consider climate changes and the implications of their profit-maximizing actions, without slowing the economy or causing significant damage to the economic infrastructure in place. In other words, using evolutionary game theory to study climate change may yield new insights into the ways in which more sustainable development can take place. By looking at games of cooperation and providing incentives to companies (and individuals), we can foster conditions which allow for stable economic growth while considering climate change, which would be an effective solution to the issues surrounding our environment.

Political Polarization

According to [Pew Research Center](#), “Republicans and Democrats are more divided along ideological lines – and partisan antipathy is deeper and more extensive – than at any point in the last two decades.” This issue is due to various causes, one of which is the idea that people are enclosed in environments which reflect and reinforce their own opinions about a given topic: echo chambers.

Echo chambers are often created across partisan lines, resulting in lack of diversity in ways of thinking among members of a group. To this end, opinions of individuals in such groups are not formed entirely on the basis of rationality, but rather by the environment one finds themselves in, which creates issues when attempting to cooperate across partisan lines. By studying political polarization with a lens of evolutionary game theory, we may further understand and consider the interactions between people and the development of polarization across time.

Moreover, evolutionary game theory and graph theory may allow us to perceive how the interactions between conflicting parties (in terms of individuals and as a whole) has changed over time. The issue with echo chambers is likely cyclical; as political polarization becomes more prevalent, people are less likely to talk to others who may not share the same views, which causes further polarization. As many interactions are carried out over the internet, evolutionary game theory may utilize the data collected on who interacts with who in terms of an online sense. Perhaps this investigation would yield potential solutions to resolving the current issues we face as a society.

Internet Ethics

In line with the previous topic, studying the ways in which the internet influences people from the stance of evolutionary game theory may provide insight as to ethical ways to implement certain algorithms that determine what people absorb. In many cases, the internet divides people in society and sends conflicting messages, which detracts from the ‘normal’ functioning of society. In this sense, evolutionary game theory may provide insights as to the interactions people have with others over the internet, along with content in general.

In other words, a question to focus on is as follows: How do we create algorithms with an ethical basis, which do not have the purpose (intended or not) of exploiting individuals and the way they think? Many algorithms currently in place are designed for the purpose of maximizing profit, particularly those implemented into social media platforms. While this has economic benefits for the companies, it comes at a significant cost. In studying human interaction with the internet, evolutionary game theory would provide a basis of understanding for the multifaceted human behavior that occurs when exposed to aggregate information.