The flexibility and creative freedom present in the field of data science (DS) allows for an infinite set of potential areas of knowledge production. This is most prevalent within agent-based modelling (ABM), as no other field can analyze human behavior and other complex systems as accurately as ABM. On the whole, ABM has allowed anyone with the equivalent of an undergraduate education to perform creative research and produce new knowledge on various systems in our world. This includes uncovering empirical evidence of systematic oppression which is prevalent in the United States. Additionally, advances in ABM like flow management allow for an even closer look into the workings of human behavior and economic systems. The infinite nature of discovery in our field is best exemplified by considering how these tools can be used to promote and to impede welfare.

To answer the overarching question of how the arrival of data science (DS) and ABM might advance our understanding of the world and its various systems, we must first identify what DS has already taught us. Geoff West said, “Data provide the basis for constructing, testing, and refining our theories and models whether they seek to explain the origins of the universe, the nature of evolutionary processes, or the growth of the economy.” This is a good starting point for analysis of the question at hand. Our ability to find and analyze high resolution datasets on human social and economic behavior currently allows us to not only understand the way these systems operate, but also to understand why they are the way they are. For example, even as an undergraduate student, I would be able to prove through ABM that low income de facto communities are highly underserved in terms of education availability and housing opportunities. This is significant as absence of the ability to prove this empirically may have exacerbated these issues. To flesh out my point, I will explain generally how a student like me may be able to conduct this research. For education, I could easily import spatial population data on the city of Richmond and surrounding areas. Then, by mapping every education service in the same area, I could potentially establish that low income communities are on average further away from schools generally and are likely to be attending schools of lower quality (using per student investment or accreditation statistics) than kids in more affluent areas of Henrico County. On the housing side of things, I could map the same de facto low income & high income communities in Richmond and find a lack of affordable housing across the city generally, and specific to areas close to but not within low income areas. This sort of ABM approach would show that high rent housing and suburbs act as devices of gentrification in Richmond, keeping low income communities at a disadvantage in terms of access to education and health care. The comeuppance of DS and ABM in the past has allowed us to understand systems in a way that was previously empirically impossible. The potential for a student in this course to conduct a study like this represents just how significantly DS and ABM have contributed to our ability to describe and understand human systems. But what are current innovations in DS and ABM that will serve to similarly revolutionize knowledge?

One answer to this question is flow management. Essentially a subsection or area of study within ABM, developments in flow management allow the scientist to simulate the movement of agents based on a potentially infinite set of decision factors. The repeatable nature of these simulations allows one to easily test and retest a complex, adaptive system. As it goes with most powerful innovation, this could be used for the betterment of society or for the opposite. Just one way in which this technique could harm is its original application, military technique. Using flow management models, a militaristic power could map the flow of human movement (or even other systems like water/utilities) in an opposing society and use military strength to destroy the welfare of an entire group of people with a small number of precise attacks. Essentially, this highly precise understanding of systems of transportation, water, and utilities allows opposing powers to more effectively identify ways to cause harm to many people. This innovation also has potential to improve the human condition.

Those who organize huge social gatherings (not currently of course), could utilize TRANSIMS to simulate possible evacuation situations like fire, flooding, or an active shooter. Using TRANSIMS, you could optimize the layout of the venue to plan for an emergency and ensure the maximum number of people are able to escape, if need be. This kind of use can translate to any scale, from maximizing the safety of your one bedroom apartment to optimizing the macro level layout of a Disney park to ensure guests can see as much of the park as possible in a finite amount of time. There is clear potential for the future of flow management to improve the human condition in these ways among countless other applications.

Overall, the comeuppance and advancement of ABM in DS has changed the way we understand the world. The nature of DS allows us to critically analyze a system of nearly any form, economic, social, or otherwise. Advancements in the field will only continue to improve this understanding of systems and of human behavior/rationality. By improving our ability to analyze how agents move (flow management) and behave (DS more generally) data science can advance understanding of systems and human decision making in an infinite number of ways as the field allows for much creative freedom.