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Mathematical modelling and algorithms

Over the course of the Covid-19 Pandemic, the usefulness of mathematical modelling has become more obvious than ever. This evening, we heard from an excellent panel of speakers about the power of this technique. Dr Nira Chamberlain, President of the Institute of Mathematics and its Applications, explained to us what a mathematical model actually is and gave us brief examples of this method being used in different sectors. Dr Kit Yates, Senior Lecturer in the Department of Mathematics at the University of Bath, gave us an overview of how mathematical modelling was used in the beginning of the Covid-19 pandemic and how a poor model led to a lot of people downplaying the danger of the virus. Following from this, Dr Ellen Brooks Pollock, who is an Associate Professor at Bristol University's Veterinary School and also a contributing member of SPI-M, the modelling sub-group of SAGE, gave us an overview of the models her team had created and how these had impacted government policy. Lastly, Dr Hannah Fry, Associate Professor in the Mathematics of Cities at the Centre for Advanced Spatial Analysis at UCL, described to us the limitations of mathematical modelling and how we should take care when considering which questions these models can help us answer.

Dr Chamberlain explained to us that mathematical modelling is a technique of taking real-world issues, transforming these into maths, solving a problem using mathematical techniques, and then using this to guide real-world decisions. These models are used all across society from economics to health. The most useful models follow a pattern of understanding, predicting, and influencing; they allow us to understand the problem we're facing in greater depth, predict how this problem will evolve, and then influence our decision making.

This technique has been used a lot over the course of the Covid-19 pandemic. Dr Brooks Pollock and her team at SPI-M took social contact data from thousands of people across the UK in order to develop models to predict how the R-number will change depending on certain social restrictions. These models contributed to the government's easing of step-by-step approach of lockdown easing, as they were used when making decisions about opening schools and allowing one-person households to join another household. Dr Yates spoke to us about a model based upon some rudimentary calculations in the beginning of the pandemic which gave Covid-19 an infection fatality rate of 0.25%. This turned about to be a major underestimation partly due to the simplicity of the model, but also because of the assumptions made about the nature of this disease. Dr Yates used this case to highlight the fact that the assumptions of a model must be clearly stated so that it can be effectively scrutinised. Without this step there can be major real-world implications.

Despite these models' power, there are limits to what we can ask. Dr Fry explained to us that whenever we consider using these techniques we have to consider carefully what we want with them. We now have algorithms that are better at detecting abnormal tissue than doctors, but using these algorithms on their own will likely result in many people undergoing treatment when they never needed to, as not all abnormal or cancerous tissue actually poses a health threat. This just shows that we must always consider the consequences of using models to solve real issues.

During the Q&A session, the speakers all discussed the importance of the public's understanding of these models as they're use is growing rapidly. Dr Fry emphasised that these models must be seen as being done with the public, not to them.

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