To what extent do you agree with the claim "all models are wrong, but some are useful" (attributed to George Box)? Discuss with reference to mathematics and one other area of knowledge.

George Box, a British statistician claimed, "all models are wrong, but some are useful," demonstrating that we should focus more on whether a model can be useful in everyday life instead of worrying about its correctness (Clear). Models are a simplified representation of a product, system, or idea. By its very definition, models are "wrong," because their simplification suggests they are never perfect. Models are continuously improving and refined to make the complex realities in the world easier to understand. This is shaped around models' utility: the state of being useful, which is why they are created to be helpful in some way to support individuals with their decisions. Hence, I will explore how mathematics and human sciences justify the extent to which Box's claim is true.

Mathematical models are often shaped around statistical models that cannot exactly replicate a situation, but they could be helpful for many purposes to make sense of our world's findings. In particular, the Gaussian distribution is a bell curve that illustrates how certain values near the average of a data set occur more frequently than outliers that are much higher or lower. The model is not always correct because future expectations are unpredictable, and may not follow this symmetrical curvature. We would often consider mathematics to be the most objective area of knowledge. Having said that, the Gaussian distribution curve demonstrates that, even in mathematics, all knowledge is probabilistic rather than absolute. In the model's case, it processes data and focuses on simplifying complex numbers. This indicates that statistical models are technically wrong in their simplification because they cannot perfectly represent reality. At the same time, they are useful for formulating conclusions based on certain

probabilities, but they may bring uncertainty when using said models. Despite this fact, I agree to a great extent that models are useful with their flaws. Statistical models like the bell curve are useful because they lend a way of knowing future possibilities. Moreover, bell curve samples including intelligence quotient scores are assumed to follow a normal distribution. However, outliers including poverty or educational disparities in some countries may present variations in the data (Mindrila and Baletnyne). These models are useful by simplifying the probability of random outcomes, making it easier for mathematicians to effectively make assumptions about the real world, except when we consider outlying data. This relates to the pragmatic theory of truth: a model does not have to be completely true or accurate to be useful. While the bell curve oversimplifies numbers and real-world situations, it is an essential tool that represents the usefulness of models to make predictions and simplify the interpretation of the common trends of the world.

Conversely, not all mathematical models are useful depending on what they are used for and in what context. While statistical models are useful, I would argue that since they are never perfect and perhaps oversimplified, their usefulness may be limited, especially when it comes to making decisions based on individuals' well-being. For instance, Euclidean geometry assumes that space is flat which is useful in two-dimensional applications, such as basic architecture and city planning. However, it becomes less useful when the curvature of spaces matters in our three-dimensional world. One common example of how Euclidean geometry is not useful is in engineering projects where human safety is at risk. Namely, the construction of long suspension bridges like the Golden Gate Bridge requires non-Euclidean geometry to consider many factors: this may encompass extreme weather, wind forces and material stress applied on structures when vehicles pass by. This causes me to agree with the fact that all models are in some way wrong

because they are assumptions like Euclidean geometry that simplify complex reality. In turn, this limits the extent to which all models are useful, as individuals must be aware of choosing the right model to follow and understand its limitations before applying their knowledge in the correct context. Some models are not useful because they simplify reality extensively, which can make them impractical. Particularly, in said large-scale engineering projects, we have to consider the life-or-death consequences when dealing with real-world problems that thus require a higher degree of precision. This suggests that while multiple models exist, not all models including Euclidean geometry are always applicable. As a result, other models that are less abstract, such as considering physics concepts concern more with the world's complex nature and would be safer and useful to a greater extent compared to Euclidean geometry. Consequently, the extent to which models are useful depends on what it is used for; models may be useful in one domain, but not in another.

Next, the human sciences, specifically economic models, can be useful to analyze and make predictions about the political and economic circumstances of certain countries. This is exemplified in the Rational Choice Theory (RCT), which models how human choices are assumed to maximize utility and self-interests (Paulus). While RCT simplifies human behaviour into common patterns, it does not account for the independent nature of humans as they can sometimes be irrational. For example, RCT-related assumptions by investors and banks failed to predict human behaviours including excessive risk-taking as one factor attributed to the 2008 global financial crisis (Finance and Economics Society, NSIT). Although economics demonstrates how all models are simplified, they are a useful tool to help predict what might happen under certain conditions. However, a model's predictions do not guarantee that the exact outcomes will occur due to the unpredictable nature of human behaviour, reinforcing that models

are deemed to be wrong. Even with the flaws in the RCT where some exceptions and outliers can undermine its accuracy, it can still help policymakers, businesses and governments make decisions for desired objectives based on what would normally happen to the majority of a population. Humans can thus have a clearer understanding and approximate future outcomes of political or economic events. With this knowledge from models, it eliminates the need to deal with difficult concepts such as the code behind computers or the psychological components of human activity. In particular, these simplifications can be useful for making predictions and guiding decisions. Nevertheless, models may lead to misguided policies and incorrect forecasts, limiting the extent to which models are useful for making predictions. This is presented when governments implement policies merely on potential economic forecasts rather than considering factors including social behaviour or political instability that significantly contributed to the 2008 financial crisis. When economic predictions fail, financial losses and even economic crises may occur. This highlights how models are useful to a certain extent. They can inform individuals about potential decisions but do not provide rigid frameworks that guarantee a solution to a problem.

In contrast, not all economic models are useful as their usefulness in one country or period may not manifest the same effectiveness if used elsewhere. Many individuals can be affected when models stimulate large-scale decisions; in matters of ethics including government decisions, a more precise understanding of a model is required to help reinforce a decision that ensures the well-being of a large population. Namely, the Phillips curve demonstrates the inverse relationship between inflation and unemployment. However, this trade-off is not always the same, as it ignores the impact of firms' productivity and government intervention. To illustrate, the 1970s stagflation in the United States presented both high inflation and high unemployment

disproving the inverse trade-off thus revealing the limitations of the Phillips curve (Nielsen). Besides, this model is only useful when predicting short-term circumstances. In the long term, this graph will not be accurate because the world can change easily due to the many political and natural fluctuations that can happen anytime. Furthermore, all models are simplified in a way that tends to disregard other perspectives which may leave out key stakeholders such as the government, producers and consumers, making models incomplete. This aligns with the concept of perspective and how different viewpoints shape knowledge being interpreted and created with bias. This causes me to agree that models are useful to some extent, on the condition that individuals know what information is being neglected from a simplified model that may leave out technological advancements and political factors that can drastically shift economic trends. If individuals blindly use a model without knowing what is being left out, it is not useful, as they do not understand it. This reinforces that knowledge stemming from models is only useful when applied correctly, as models can also provide misleading information. This demonstrates the fallibility of knowledge and how a model is only useful if individuals understand its limitations from bias, which may impede the usefulness and understanding of a model.

Overall, to a great extent, I believe that all models are wrong, but some are useful. Mathematics demonstrates that models are a simplification of reality and never precise; for that reason, they are considered “wrong.” The area of knowledge establishes how models are only useful when applied in the correct scenarios, especially if a model could put someone’s life in danger, it should not be used. In human sciences, specifically economics, models are revealed to be wrong because it is impossible to predict the nature of human behaviour as well as the political and natural circumstances of the world. Yet, some models are still useful if individuals understand the limitations and consider the factors that their simplified model neglects. Instead

of arguing whether an amount of information is accurate, as all models are wrong, we can see the importance of focusing more on using knowledge for practical purposes to advance our world findings, rather than pointing out what is necessarily right or wrong.

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