Part II: Calculus II Final Project

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Mathematical models explain our perceptions of how the world works. We translate those ideas into the mathematical language in mathematical modeling (Lawson and Marion, 2008). There are multiple advantages to this. The language of mathematics is rather accurate which is helpful in the formation of concepts and the identification of fundamental beliefs. The language of mathematics is compact and has clear manipulation rules. We have gained access to any conclusion that mathematicians have established over hundreds of years (Lawson and Marion, 2008).

1. Algebraic Models

An algebraic model is a representation of a real-life situation using algebraic expressions or equations (variables, constants, operations) to describe relationships between quantities (Model, 2023).

Example: In physics, the equation for motion under constant acceleration:

$$s = ut + \frac{1}{2}at^2$$

s = displacement
u = initial velocity
a = constant acceleration
t = time

This is an algebraic model of how displacement depends on time and acceleration.

2. Graphical Models

A graphical model is a probabilistic model represented by a graph whose nodes correspond to random variables, and whose edges encode conditional dependence (or independence) relationships among them (González-Jiménez et al., 2010).

Example: A graphical model can show how studying, sleep, and exam results are related. “Studying” and “sleep” would be connected to “exam results,” showing that both can affect performance.

3. Statistical Models

A statistical model uses data and equations to describe how one quantity depends on another, helping to make predictions (Coursera, 2023).

Example: A simple statistical model could show how the number of hours studied (X) affects test scores (Y) using the equation: $Y = 50 + 5X$

This means that for every extra hour of study, the test score increases by 5 points on average.

Mathematical modeling is very complicated and unpredictable and requires testing to determine the sales and costs associated with the product of a business. Governments use it to preview policy outcomes, and scientists use it to study systems safely. As the Society for Industrial and Applied Mathematics explains, modeling "bridges mathematics and the real world by translating real problems into a language that can be studied and solved" (SIAM, n.d.). Models make decision-making more reliable by turning guesses into measurable outcomes. The System Dynamics Group at MIT shows that simulation models help test different choices before acting (MIT Sloan, n.d.). Modeling also supports fairness. The United Nations Department of Economic and Social Affairs notes that quantitative models guide countries toward smarter and more equal resource planning (UN DESA, 2020).

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