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Uses of Differential Equations in Mathematical Modeling's Function

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Abstract: Converting real-world issues into mathematical language is the process of creating ordinary differential equations. They can facilitate problem solving and make problem processing simpler. They play a crucial role in bridging the gap between theory and practice in mathematics. This paper presents the method steps for creating an ordinary differential equation model based on a brief overview of mathematical modeling. It also integrates the practical investigation of the use of ordinary differential equations in mathematical modeling to offer direction for future research in this area.

Keywords:ODE, Applications, Mathematics

1. Introduction

1.1 Mathematical Modeling

In mathematical modeling, complicated phenomena are primarily analyzed, relationships and laws are described using mathematical language, relevant mathematical linkages are given, and practical issues are solved by applying mathematical techniques. This is a mathematical modeling procedure [1-3]. In contrast to mathematical computations, mathematical modeling necessitates logical reasoning, induction, summarizing, and refining. The ability to translate real-world issues into mathematical relationships is essential to mathematical modeling. The ultimate purpose of mathematical modeling is the process of solving real-world issues. The last step in mathematical modeling is to verify the outcomes. The right answer can only be found when the conditions of the real problem are satisfied.

1.2 Mathematical Modeling's Function

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- Students can experience the relationship between mathematics and other subjects and daily life through mathematical modeling.
- It can help students develop a mathematical consciousness and comprehend the practical applications of mathematics, which will pique their interest in the subject and encourage them to study it.
- Teaching mathematical modeling is a means of developing a variety of skills, including the capacity for mathematical expression, mathematical application, collaboration and communication, mathematical imagination, and creative expression.
- Thirdly, by giving students the time and space to engage in inquiry, mathematical modeling enables them to actively learn how to become self-sufficient in their acquisition of mathematical knowledge, to actively engage in mathematical practice, and ultimately to apply mathematics and social studies to their everyday lives.
- The goal of a high-quality education is to "develop students' imaginative and practical skills." We shouldn't limit the application of mathematics to being the straightforward application of knowledge. Implementing and running the mound process.
- According to the author, the capacity to construct mathematical models is a prerequisite for accurately representing the practical significance of mathematics.

2. Procedure for Creating a Model of Ordinary Differential Equations

2.1 Creating Models of Ordinary Differential Equations Using Known Basic Laws

The known theorems and laws from a variety of disciplines are primarily used in the process of establishing the ordinary differential equation model. Examples of these include the following: Hooke's law in elastic deformation; Terry's law; Aki Mead's law; the law of universal gravitation; Newton's second law of motion; decay rates in radiological problems; biology; economics; and growth rates in population problems.

2.2 Definition of Derivatives

The definition of the derivative is:

$$dy - dx = \lim_{\Delta x \to 0} f(x) + \Delta x - f(x) - \Delta x = \lim_{\Delta x \to 0} \Delta x - \Delta y \ldots\ldots\ldots(1)$$

If the function f(x) is differentiable, then y is roughly equal to the instantaneous rate of change of x at that time, as indicated by Δx/Δy. It is primarily used in relation to the terms "growth" and "rate" that are used in demographic and biological research, "decay" in radiation-related issues, and "margin" in economics [4-8].

2.3 Differential Method to Establish Ordinary Differential Equation Model

This method is mainly to find the relationship between microelements, anddirectly apply the relevant laws to the function to build a model. Suppose that the variable I in a practical problem meets the following conditions: I is a quantity related to the variation interval $[a, b]$ of an independent variable x; I$\Delta I - i \approx f(N_i)\Delta x_i$ is additive to the interval [a, b]; a partial quantity, then We can consider the use of differential equations to establish ordinary differential equation models.

2.4 Establishing Ordinary Differential Equation Models via Differential Method

This approach primarily consists of determining the relationships between microelements and then applying the pertinent rules to the function in order to construct a model. Assume that in a real-world scenario, variable I satisfy the subsequent criteria: When we analyse the usage of differential equations to create ordinary differential equation models, we can consider the following: I is a partial quantity that is related to the variation interval [a,b] of an independent variable x;I$\Delta I - i \approx f(N_i)\Delta x_i$ is additive to the interval [a, b]. The stages for establishment are as follows: choose an independent variable x based on the particulars of the problem and calculate its change interval as [a,b]; A continuous function at x can be expressed as follows: ΔI≈f(xdx,f(x)dx=dI. Here, dI is referred to as the element of the quantity I, and the two sides of the equation can be simultaneously integrated to obtain the required quantity I. Choose any interval in the interval [a,b] and record it as [x,x+dx]. Find the near-sighted value corresponding to the partial quantity ΔI in this interval [9].

2.5 Common Differential Equations Utilised in Mathematical Simulation

2.5.1 Using Ordinary Differential Equations in the Corruption Forecasting Model

Ordinary differential equations can be employed for mathematical modelling in the current search and arrest of numerous corrupt officials participating in the crime. Thus, mathematical modelling and creativity can be achieved through the application of ordinary differential equations. A novel model is built for forecasting the number of corrupt individuals, consisting of three steps, based on the number of individuals involved in predicting the overall number of individuals involved.

- The theoretical phase. Let t be the time, X_O be the total number of members of the corrupt group at time t=0, and r(x) be the participating party. Let x(t) be the function of the total number of members of the corrupt group involved in t. The inherent growth rate, denoted by r, is the growth rate of the total number of individuals involved in the case at time x0. The maximum number of individuals that may be involved in this corruption event is represented by xm. The resistance coefficient generated during the tracing process is indicated by μ. i (t) represents the percentage of the total population involved in this corruption event, λ the percentage of the total population involved at t=0, and λ the average number of confessed members of each corrupted person apprehended within a month.
- The analysis phase. The number of prospective corrupt elements is steadily declining if the number of corrupt elements presently involved is trending upward. The number of persons participating in this corruption event and time t are represented by the functional connection x(t), and the growth rate r(x) corresponding to the number of people is represented by x(t>), which is a continuous function related to t, one of which is xm. Additionally, there is a particular functional connection to x(t). According to the earlier hypothesis, r(x)=r-kx, where k is the slope and k>0, and r(x) is a linear function of x.

When x=xm, the number of persons involved grows at a rate of 0,r(xm)=0, allowing k=r/xm to be calculated. At this point, the growth rate function of the number of people participating can be applied:

$$\mathrm{r(x) = r(1 - x/xm)} \ldots\ldots\ldots\ldots(2)$$

- Phase of calculation. The following differential equations can be established[5] without taking into account the intensity and complexity of the reconnaissance, which could have an impact on the findings of the reconnaissance:

$$\mathrm{dx/dt = r(1 - x/xm)x} \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

$$\mathrm{x(0) = xo} \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

$$\text{The solution is } \mathrm{x(t)} = \frac{xm}{1 + \left(\frac{xm}{x0} - 1\right) e}$$

Given that the investigation's complexity may have an impact on its findings, the coefficient of resistance can be chosen to create the differential equation that follows:

$$\begin{array}{l} \mathrm{di/dt} = \lambda \mathrm{i}(1 - \mathrm{i}) - \mu \mathrm{i} \\ \mathrm{i}(0) = \mathrm{io}(\lambda \neq \mu) \end{array} \ldots\ldots\ldots\ldots\ldots\ldots(5)$$

$$\text{The solution ii (t)} = \frac{1}{\frac{\lambda}{\lambda - \mu} + \left(\mathrm{io} - \frac{\lambda}{\lambda - \mu}\right) e}$$

Anti-corruption departments in China can utilise this mathematical model to forecast the amount of corrupt individuals who will be involved in anti-corruption efforts in the future. It is easy to see that the error ranges between the number of corrupt individuals detected in real work and the number computed theoretically have a lot in common [9-11].

2.6 **Models of Population Prediction Using Ordinary Differential Equations**

Building the model are inherently impossible if all the components are included from the outset. Consequently, it is possible to start by simplifying the issue, create a crude mathematical model, and then make incremental changes to it until a flawless mathematical model is achieved. The maximum population that the artificial environment can support is indicated by the constant Nm, which Weilhurst put into mathematical modelling. Generally speaking, a nation's living space and Nm increase with its level of industrialization and Nm, respectively. According to Weirhurst, the growth rate can be written as r (1-Nt / Nm), and as Nt rises, the net growth rate will progressively fall. As Nt steadily gets closer to Nm, the net growth rate will be will eventually become closer to zero; a population forecast model can be constructed using this supposition [5-9-. As a result, Welhurst's theory can be creatively applied to create a new population prediction model.

$$\mathrm{dN/dt} = \mathrm{r}(1 - \mathrm{N/NO})\mathrm{N} \ldots\ldots\ldots\ldots\ldots\ldots(6)$$

$$\mathrm{N(t0)} = \mathrm{N0} \ldots\ldots\ldots\ldots\ldots\ldots(7)$$

This ordinary differential equation establishes a logical mathematical model that can be solved with separated variables. The answer is:

$$\mathrm{N(t)} = \frac{Nm}{1+\left(\frac{NM}{N0}-1\right)e} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(8)$$

A reasonable population growth projection can be constructed using this population forecasting model in conjunction with Welhurst's related theory.

3. Conclusion

In summary, the essay primarily examines the use of ordinary differential equations in mathematical modeling in detail, enhances several earlier mathematical models, and imaginatively designs some new mathematics using ordinary differential equations. The model is used to various fields of study. More in-depth studies will be conducted in the future to develop other mathematical models to address some challenging social problems.

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