A SURVEY ON QUANTUM FUZZY TURNING MACHINE USED TO SOLVE THE DIFFERENTIAL EQUATIONS

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ABSTRACT

The big problem in mathematic differential equation (DE) its how to solve complex DE numerically with low time complexity. This paper a survey on some methods which used to solve ordinary, partial, delay, and fuzzy differential equations. A survey about a quantum fuzzy turning machine is a theoretical concept that combines principles of quantum computing with fuzzy logic. It is based on the idea of using fuzzy logic to model uncertainty in quantum systems. The goal is to use the principles of quantum computing to improve the ability of fuzzy systems of DE to process uncertain or incomplete information. However, this is still an active research area, and there have not been any practical applications of quantum fuzzy turning machines developed yet.

Keywords: *Differential Equations (DE), Quantum Computing, Turing Machine, fuzzy differential equations.*

INTRODUCTION

A differential equation is an equation that relates a function with its derivatives [1]. The function is typically unknown and the goal is to find it. Differential equations are used to model a wide range of physical phenomena such as motion, electrical circuits, and population growth [2]. They are classified into two main categories: ordinary differential equations (ODEs) and partial differential equations (PDEs). ODEs involve derivatives with respect to a single independent variable, while PDEs involve derivatives with respect to multiple independent variables [3]. There are many ways to solve differential equations, including analytical methods (such as separation of variables and integration factors) and numerical methods (such as Euler's method and the Runge-Kutta method). The choice of method depends on the specific equation and the desired level of accuracy [4] [5].

QUANTUM COMPUTING

Quantum computing is a type of computing that uses quantum-mechanical phenomena, such as superposition and entanglement, to perform operations on data [6]. Quantum computers are able to solve certain problems much faster than traditional computers by leveraging the properties of quantum mechanics [7]. Some examples of problems that a quantum computer could potentially solve efficiently include factoring large integers, searching large databases, and simulating quantum systems. However, quantum computing is still a relatively new field, and there are currently no large-scale, practical quantum computers [8].

One way to characterize the time-dependent behavior of a quantum system is to use a differential equation [9]. The Schrödinger equation is the best known quantum differential equation, and it represents the time-dependent evolution of a quantum system's wave function. So can find out all there is to know about a system, including its energy, location, and momentum, by looking at its wave function, also called a state vector [10].

When written formally, the Schrödinger equation looks like this:

iħ ∂Ψ/∂t = HΨ

In this equation, **Ψ** is the wave function, **H** is the Hamiltonian operator, **i** is the imaginary unit, **ħ** is the reduced Planck constant, and **∂Ψ/∂t** is the partial derivative of the wave function with respect to time [11]. Systems with these characteristics are quantum equivalent to quantum dynamics because of an observation known as shifting equivalence: if a real number shifts the coefficient matrix of a homogeneous ODE system, the normalized solution of the system stays unaltered. In order to create an anti-Hermitian matrix, we can shift the coefficient matrix by the real fraction of its eigenvalues. Figure 1 presents a summary of our findings and their consequences[9].

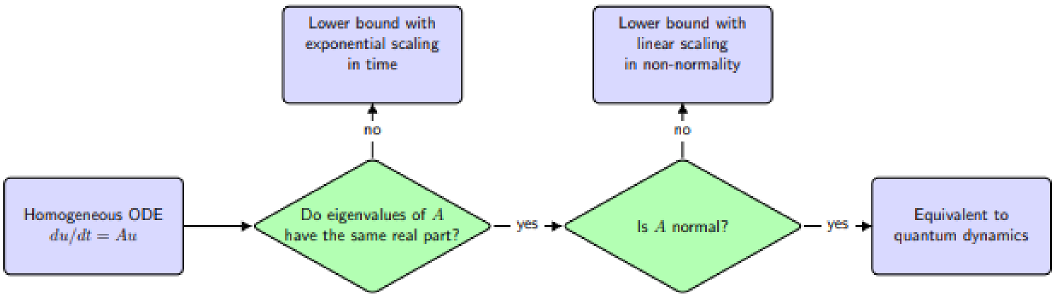

Figure 1: Flowchart of our hardness results for generic quantum ODE solvers and their implications[9].

All of the system's particle energy and interactions are encoded in the Hamiltonian operator, which works on the wave function to determine its time-dependent evolution. The Heisenberg equation, Pauli equation, and Dirac equation are further quantum differential equations employed in the study of quantum systems' dynamics [12].

TURNING MACHINE

In contrast, [13] proposes an alternative method that formalizes arithmetic operations on standard computer hardware in an effort to use the analytical method (for calculations). The method makes it possible to solve nonlinear systems and differential equations. They keep a fixed number of terms to represent numbers in their theoretical computer model. Using a finite-difference method, the answer is presented as a series whose powers are determined by the size of the independent variable's steps. A convergent finite-difference scheme, which is similar to the equation being examined, is produced by this method, as is a schematic depiction of the problem. Probabilistic methods allow for the averaging of repeated computations and the elimination of unnecessary intermediary steps. All stages of formalization for classical computer operations converge on "the method of the computer analogy." The proposed approach provides an explicit analytic representation of the answer. They describe the essential features of the technique and show them off using an example solution set for several nonlinear equations.

In [14], they give an implicit explanation of polynomial time computing in terms of regular differential equations by defining the class P of languages that may be computed in polynomial time in terms of differential equations with polynomial right-hand sides. Using this conclusion, we can characterize P in a clear and elegant way that is both pure and continuous (in both time and space). To their knowledge, this is the first treatment of these classes based entirely on ordinary differential equations. Functions that can be calculated in polynomial time over the reals are part of their description. Their findings may shed fresh light on classical complexity by demonstrating a very easy method for establishing complexity classes like P that does not need the use of the idea of a (discrete) machine. Further, this may provide methods for rephrasing standard questions about computing complexity as ordinary differential equations. Additionally, they gain the insight that Claude Shannon's General Purpose Analog Computer (GPAC) from 1941 is comparably computable and difficult to Turing machines. Analog computers or computational models can also account for their findings. This expanded conclusion lends credence to the Church-Turing Hypothesis, which says that Turing machines are equivalent to any physically possible (macroscopic) computer in terms of both computability and computational complexity.

Turning Machine Differential Equation

A turning machine differential equation is a word that is not commonly used in theoretical computer science or mathematics literature, nor is it a well-understood notion[15]. The formal language theory is more often used while studying Turing machines[16]. The Turing machine is a mathematical model that is used to study the boundaries of computation; it is a theoretical idea and is not intended to be a physical machine. The behaviour of a physical machine that is motivated by the Turing machine notion may be described by a differential equation. However, such a differential equation would need to be specially created and is probably quite complicated[17].

Fuzzy Turning Machine (FTM)

A variant of the Turing machine known as a fuzzy turning machine (FTM) performs calculations using fuzzy logic. A branch of mathematical logic known as fuzzy logic deals with reasoning that is approximate rather than exact. Instead of crisp sets, fuzzy sets are used in an FTM to define the tape alphabet and transition rules. This makes it feasible to describe a variety of potential values with a single transition rule or tape symbol, making computation models more flexible and versatile[18].

Unlike the traditional Turing machine, which employs classical sets to express computations, the fuzzy Turing machine (FTM) is a theoretical idea that cannot be physically implemented. FTM may tackle issues traditional Turing machines cannot, including issues with pattern recognition, control systems, decision-making, and optimization[19].

Although there is little published literature on FTM in theoretical computer science, this topic of study is active in the study of fuzzy logic and its use in computer science[20].

QUANTUM FUZZY TURNING MACHINE DIFFERENTIAL EQUATIONS.

A speculative idea that combines fuzzy logic and quantum computing is known as a quantum fuzzy turning machine (QFTM). It is a variant of the fuzzy turning machine that does calculations using quantum mechanical phenomena like superposition and entanglement.

A QFTM performs calculations using quantum states and quantum operations and represents uncertain or approximation information using fuzzy logic. Quantum fuzzy sets are used to design the transition rules, tape alphabet, and computation process in QFTM.

However, a differential equation would probably be employed to characterize the development of the fuzzy quantum system over time. Regarding the differential equation, it could not locate any particular references for the quantum fuzzy turning machine differential equation. It is crucial to remember that QFTM is a theoretical idea and not a real-world gadget. Research in quantum computing, fuzzy logic, and its applications in computer science is still ongoing in this relatively young discipline. By collecting quantum fuzzy turning machines on Differential equations, complexity time is to be reduced.

CONCLUSION

In physics, chemistry, economics, and other sciences, many problems may be expressed in ordinary differential equations (ODEs) and partial differential equations (PDEs). The public techniques for solving equations (ODEs) and (PDEs) are surveyed in this study and mentioned. Some techniques or technologies include the Turing machine, fuzzy DE, and quantum computing.

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