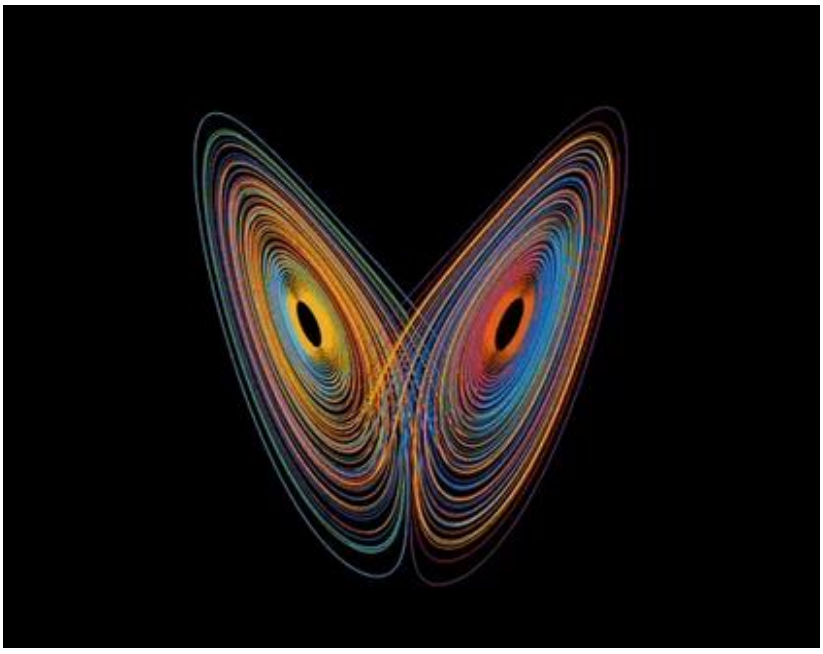

Application of Differential equation in Computer Science

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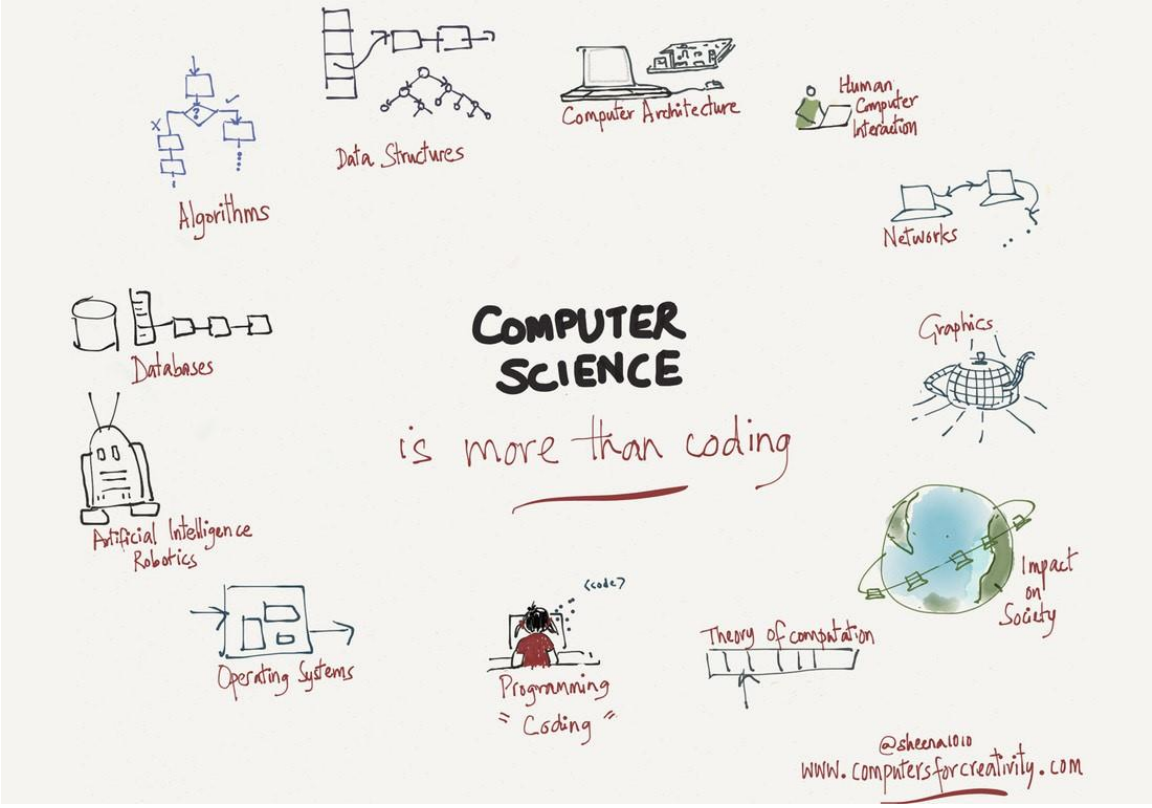
Spring-2023

Introduction

In this lecture we're going to talk about the function of Differential in Computer Science , AI and ML

- First of all we're going to talk about the meaning and nature of Differential and Computer science .
- **Differential equation** is an essential tool for describing the nature of the physical universe and naturally also an essential part of models for computer graphics.
- **Computer Science** is the study of computers and computational systems. Computer scientist deal mostly with software and software systems like design, development and application. They're build the algorithm and analysis them.
- To put it more simply **Computer Science** is the study of how process and data can be digitized and automated.

So now that you know what these two means we will discuss the rest of the article



Importance of Differential equation in CS

- Whenever a continuous process is modeled mathematically, chances are high that Differential equation are used. So it's not surprising that Differential equation also play and important rule in computer algebra and simulation.

Application of Differential equation in CS

- Differential equations have numerous applications in computer science they are used in modeling and simulation of complex systems .

  Now we will examine some examples of applications :

- **Simulation of complex systems :** Weather patterns
- **Game development**
- **Machine learning :** Neural networks
- **Cryptography**
- **Computer visualization**

- Now I would like to expand two topics for you :

a) **Game development** : In a simple video game involving a jumping motion, a differential equation is used to model the velocity of character after a command is given to return them to the ground in a simulated gravitational field.

b) **Machine learning** : Depend on what field were working we need to create an algorithm and plotting our data in some cases we have exponential plot that in some of them we use differential equation . in many cases like economy, bourse , physics simulation ,neural networks and etc we need differential to model the data.

Machine Learning

1- Consider a simple non-linear differential equation of the form :

$$\frac{dy}{dt} = -y^3 + \sin(t)$$

This equation arises in various contexts in machine learning , such as in the study of dynamical systems and control theory. To solve this differential equation , we can use numerical methods such as the
Euler- method or Runge-Kutta method . for example , using the Euler method with a step size of h, we can approximate he value of y at time $t + h$ as :

$$y(t + h) = y(t) + h(-y(t)^3 + \sin(t))$$

We can then repeat this process to obtain the value of at any desired time t.

- Alternatively , we can use machine learning to learn the solution to this differential equation from data . one approach is to generate a dataset of (t,y) pairs by solving the differential equation numerically, and then use a supervised learning algorithm to learn tha mapping between the input t and the output y .

2- A common differential equation used in machine leraning is :

$$\frac{dy}{dt} = -y^2 + t$$

This equation is used in many case of machine learning, such as signal processing , image processing, neural networks , and many other applications .
To solve this equation we can use numerical methods such as Euler method or the Runge –kutta method . for example , using Euler method with a step size of h, we cam calculate the value of a y at time $t + h$ approximately as :

$$y(t + h) = y(t) + h(-y(t)^2 + t)$$

We can repeat this process to obtain the value of y at any desired time t.
For example we can use a neural network to learn the mapping between input t And output y , and then use it to predict y for new values of t.