

Numerical Solution of Partial Differential Equations

In these notes we develop a method for generating, numerically, approximate solutions to the vibrating string problem



$$u_{tt}(x, t) = c^2 u_{xx}(x, t) \quad 0 \leq x \leq \ell \quad t \geq 0 \quad (\text{wave equation}) \quad (1)$$

$$u(x, 0) = f(x) \quad 0 \leq x \leq \ell \quad (\text{initial position}) \quad (2a)$$

$$u_t(x, 0) = g(x) \quad 0 \leq x \leq \ell \quad (\text{initial speed}) \quad (2b)$$

$$u(0, t) = L(t) \quad t \geq 0 \quad (\text{left boundary}) \quad (3a)$$

$$u(\ell, t) = R(t) \quad t \geq 0 \quad (\text{right boundary}) \quad (3b)$$

The function $u(x, t)$ gives the amplitude of the string at position x and time t . Equation (1) is the wave equation. It is the equation of motion for the vibrating string and is a consequence of Newton's law, $F = ma$. Equations (2a,b) specify the initial position and speed of the string and equations (3a,b) specify the position of the two ends of the string for all time.

The method will be an extension of those (like Euler's method, for example) used for generating, numerically, approximate solutions to the initial value problem

$$y'(t) = f(t, y(t)) \quad t \geq 0 \quad (\text{ode}) \quad (4)$$

$$y(0) = y_0$$

Recall that under Euler's method, rather than generating approximate values for $y(t)$ for all values of $t \geq 0$, we pick a step size Δt and consider only $t = 0, \Delta t, 2\Delta t, \dots, t_n = n\Delta t, \dots$. We approximate the ordinary differential equation (4) by an equation, that does not contain any derivatives and that involves only the times t_n , by approximating

$$y'(t_n) = \lim_{h \rightarrow 0} \frac{y(t_n + h) - y(t_n)}{h} \approx \frac{y(t_n + \Delta t) - y(t_n)}{\Delta t} = \frac{y(t_{n+1}) - y(t_n)}{\Delta t}$$

Denoting $y(t_n) = y_n$, this gives

$$\frac{y_{n+1} - y_n}{\Delta t} \approx y'(t_n) = f(t_n, y(t_n)) = f(t_n, y_n)$$

Numerical Solution Partial Differential Equations

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Numerical Solution Partial Differential Equations:

Decoding **Numerical Solution Partial Differential Equations**: Revealing the Captivating Potential of Verbal Expression

In a period characterized by interconnectedness and an insatiable thirst for knowledge, the captivating potential of verbal expression has emerged as a formidable force. Its power to evoke sentiments, stimulate introspection, and incite profound transformations is genuinely awe-inspiring. Within the pages of "**Numerical Solution Partial Differential Equations**," a mesmerizing literary creation penned by a celebrated wordsmith, readers set about an enlightening odyssey, unraveling the intricate significance of language and its enduring affect our lives. In this appraisal, we shall explore the book is central themes, evaluate its distinctive writing style, and gauge its pervasive influence on the hearts and minds of its readership.

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