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for solving partial differential equations. The focuses are the stability and convergence theory. The partial differential equations to be discussed include •parabolic equations, •elliptic equations, •hyperbolic conservation laws. 1.1 Finite Difference Approximation Our goal is to approximate differential operators by finite difference operators.

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In numerical analysis, finite-difference methods are a class of numerical techniques for solving differential equations by approximating derivatives with finite differences. Both the spatial domain and time interval are discretized, or broken into a finite

number of steps, and the value of the solution at these discrete points is approximated by solving algebraic equations containing finite differences and values from nearby points. Finite difference methods convert ordinary differential equations

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$$\left\{ \frac{\partial^2 u(x)}{\partial x^2} = 0, \quad u(0) = a_1, u(T) = a_2 \right\}$$

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