Simulation and Analysis of 1D Wave Propagation under Various Physical Models

Dario Liotta
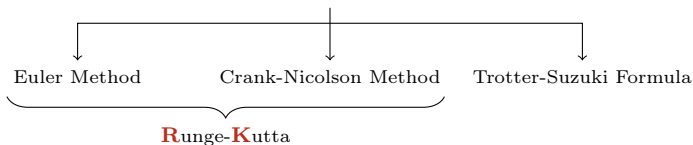
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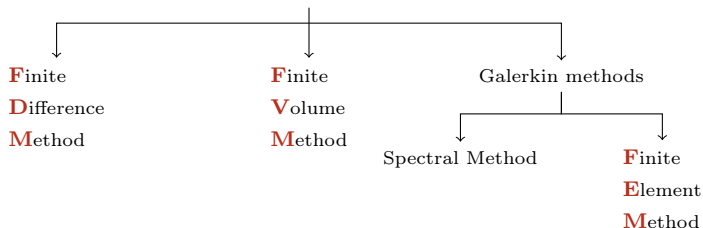Academic Year 2024/2025

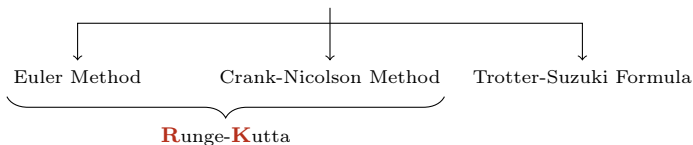# Numerical methods for differential equations

Ordinary **D**ifferential **E**quations

Euler Method   Crank-Nicolson Method   Trotter-Suzuki Formula

Runge-**K**utta

Partial **D**ifferential **E**quations

Finite **D**ifference **M**ethod

Finite **V**olume **M**ethod

Galerkin methods

Spectral Method   **F**inite **E**lement **M**ethod

Numerical methods for differential equations
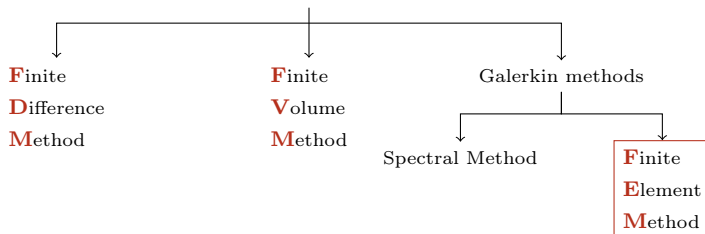
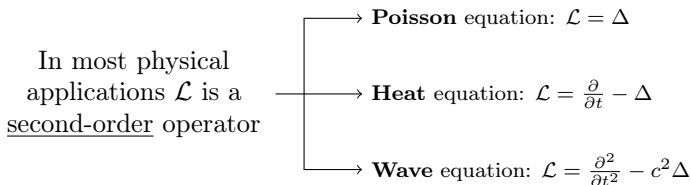## Introduction to the problem

Solving a **PDE** means to find a function u such that

$$\mathcal{L}u = f$$

where $\mathcal{L}$ is a differential operator and f is a source term.

The equation holds in a domain Ω and is completed by prescribing **boundary conditions** on $\partial\Omega$.

In most physical applications $\mathcal{L}$ is a second-order operator

→ **Poisson** equation: $\mathcal{L} = \Delta$

→ **Heat** equation: $\mathcal{L} = \frac{\partial}{\partial t} - \Delta$

→ **Wave** equation: $\mathcal{L} = \frac{\partial^2}{\partial t^2} - c^2\Delta$

Weak formulation

Galerkin methods rely on a **weak formulation**