Pseudo-spectral method

Motivation: applied in many different fields, such as

Galactic dynamics → Boltzmann equation

Quantum theory → Schrödinger equation

Fluid dynamics → Navier-Stokes equation

and wave propagation

In this class, we look at numerical methods

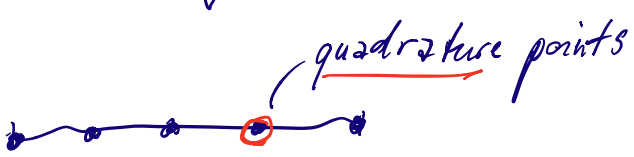
finite-difference method
pseudo-spectral method
} uses discretization of the differential operator ($\nabla \cdot$) strong form

finite-element method
spectral-element method
} uses discretization of the integral operator ($\int \nabla \cdot$) weak form

Pseudo-spectral vs. spectral methods:

Fourier transform example

$$F(k) = \int f(x) e^{-ikx} dx$$



"pseudo": evaluate integral using quadrature points

$$F(k_\ell) = \Delta x \sum_{n=0}^{N-1} f(n\Delta x) e^{-i2\pi n\ell/N}$$

$$\approx \int \ldots$$

spectral: evaluate integral of basis functions analytically