# Solving the 1D thermal heat equation

Implicit vs. explicit difference scheme

# Solving the 2D heat equation using finite difference discretization scheme

**Stationary heat equation (elliptic PDE, Poisson problem)**

The stationary heat equation is defined by

,

where *k* is the thermal conductivity in W/K/m, *T* is the temperature in K, *ρ* is the density in kg m-3, and *H* is the radioactive heat production rate in W/kg and

.

Rearranging equ gives the Poisson equation (assuming a constant *k*)

,

which can be solved directly for the temperature using a finite difference discretization as

.

This yields a system of equations for each nodal grid point





with *a* = 1/Δ*x*2, *b* = 1/Δ*z*2, and c = 2(a + b). For a 2D defined problem, equation describes the temperature for each nodal point within the grid nx\*nz and we can build a system of equations for the entire model domain in the form of A\*T = rhs, where A is the coefficient matrix given by the constants *a*, *b*, and *c*, and rhs is the right hand sight vector defined by the heat source term.

The matrix A is a sparse matrix with non-zero points at the location of the stencil running through the numerical domain.

* Numbering/indexing of the domain
* Assignment of the coefficients to the indices of the matrix
* Boundary conditions
* Time-dependent 2D solution