



INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI
DEPARTMENT OF MATHEMATICS AND STATISTICS

MA5191 - PROGRAMMING LABORATORY

Lab Project - IV - Finite Difference Explicit Libraries

I MSc (Mathematics and Statistics)
SEMESTER II

Max. MARKS: 500
Submission Date: 21 March 2021

Scientific Project

Write a Python program to implement the finite difference method.

Consider the following two dimensional heat equation

$$\rho C_p \frac{\partial T}{\partial t} = k_T \left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} \right) \text{ on } (0, H) \times (0, W) \times (0, \infty) \quad (1)$$

$$T(x, 0, t) = f_1(x, t), t \geq 0$$

$$T(x, H, t) = f_2(x, t), t \geq 0$$

$$T(0, y, t) = f_3(y, t), t \geq 0$$

$$T(W, y, t) = f_4(y, t), t \geq 0$$

$$T(x, y, 0) = f_5(x, y), x \in [0, H], y \in [0, W]$$

k_T -Thermal conductivity, ρ -density, C_p -heat capacity.

Steps to be followed:

1. Discretize the space domain
2. Discretize the time domain
3. $T_{i,j}^k$ -Temperature at the (i, j) th location at k th time step.
4. $\Delta x, \Delta y$ - node spacing in the x - and y - direction
5. Obtain the number points in x - and y - directions, let us say N_x and N_y
6. Implicit Method

$$\frac{T_{i,j}^{k+1} - T_{i,j}^k}{\Delta t} = \frac{k_T}{\rho C_p} \left[\left(\frac{T_{i-1,j}^{k+1} - 2T_{i,j}^{k+1} + T_{i+1,j}^{k+1}}{\Delta x^2} \right) + \left(\frac{T_{i,j-1}^{k+1} - 2T_{i,j}^{k+1} + T_{i,j+1}^{k+1}}{\Delta y^2} \right) \right] \quad (2)$$

7. Re-arrange the equation so that you get a matrix $AT^{k+1} = b$.
8. Solve it using numpy and scipy libraries.
9. Solve for T^{k+1} and plot the values using matplotlib.

Gaming Project

Write a Magic Square Puzzle Game using Python Language

1. Get the number of rows required in the magic square (preferably less than 10).
2. Get the total sum required from the user.
3. Get the starting and ending values from the user for the magic square.
4. Check the possibility to generate the magic square for the above conditions.
5. If it is possible to generate the magic square, generate and display the magic square.
6. Further, display the possible combinations of the magic square.
7. For more details: https://en.wikipedia.org/wiki/Magic_square