



INDIAN INSTITUTE OF TECHNOLOGY TIRUPATI
DEPARTMENT OF MATHEMATICS AND STATISTICS
MA5191 - PROGRAMMING LABORATORY

Lab Project - I - 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.

Steps to be followed: 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.

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. Explicit Method

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

$$T_{i,j}^{k+1} = T_{i,j}^k + \Delta t \frac{k_T}{\rho C_p} \left[\left(\frac{T_{i-1,j}^k - 2T_{i,j}^k + T_{i+1,j}^k}{\Delta x^2} \right) + \left(\frac{T_{i,j-1}^k - 2T_{i,j}^k + T_{i,j+1}^k}{\Delta y^2} \right) \right] \quad (3)$$

7. Solve for T^{k+1} and plot the values using matplotlib

Gaming Project

Write a Number Slide Game using Python language

1. Generate a random matrix of size 4×4 in the range [1 and 16]
2. Check all entries of the matrix are distinct
3. Remove the entry which is 16
4. Display the option of Play and Solution
5. When the user's choice is Play, display the list of navigation commands
6. A or a for Left, S or s for Down, D or d for right, W or w for up, Q or q for quit
7. When user presses Q or q, confirm again to quit and then quit
8. When the user plays the game, for each of his key press show the matrix (nicely formatted)
9. When the user's choice is solution, display the movement and show the final output
10. For more details about the game, have a look at
<http://www.artbylogic.com/puzzles/numSlider/numberShuffle.htm>