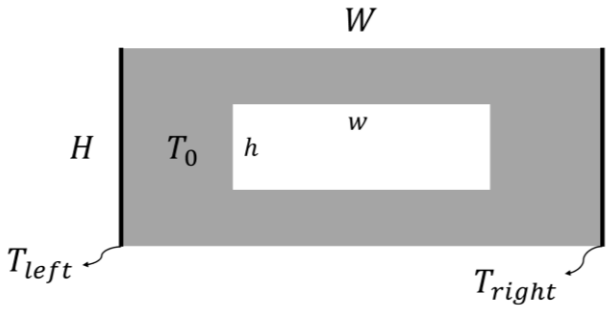
1. INTRODUCTION

In this problem, we will try to visualize what would happen to a metal plate with a hole at the center of it if two temperature sources are connected to its opposing sides. To do so, we will make use of the relaxation method.

2. PROBLEM STATEMENT

A rectangular metal plate with width W and height H has a rectangular hole at its center, which has width w and height h. Initially, the plate is at temperature T_0.

We will connect a source with a constant temperature of T_{left} to its left side, while connecting a source with a constant temperature of T_{right} to the opposing side. Then, we will wait for a long time, so that the plate reaches a steady state.

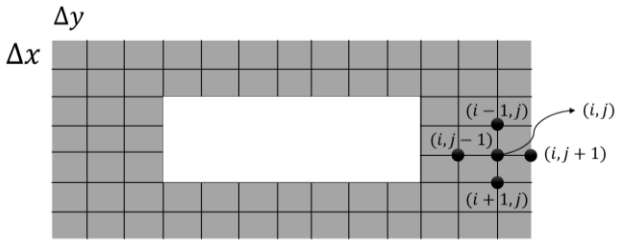


In order to describe how heat evolves with respect to time, we make use of the 2D heat equation:

$$\frac{\partial T}{\partial t} = \alpha\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right) \tag{1}$$

where α is thermal diffusivity.

To treat this equation numerically, we have to discretize the plate and define a grid of nodes in this way:



We will assume that $\Delta x = \Delta y$. After discretizing Eq. 1, we could arrive at:

$$T_{i,j} = \frac{T_{i-1,j} + T_{i+1,j} + T_{i,j-1} + T_{i,j+1}}{4} \tag{2}$$

To see how Eq. 2 was derived, please refer to this link. Basically, the temperature at each node would be the average of its neighboring nodes. Note that the $\Delta x = \Delta y$ condition has to be satisfied in the simulation. Otherwise, Eq. 2 does not hold.

In this problem, you are asked to use Eq. 2 to plot the temperature of the plate at each node **when the plate reaches its steady state**. A great way to visualize the temperature would be to plot the temperature surface as a function of position (x and y on the plate).

3. CHECKING YOUR RESULTS

In order to check your results, you can compare your results with the provided solution files in the GitHub repository.

4. TABLE OF CONSTANTS

W	$0.1\ m$
H	$0.1\ m$
w	$0.04\ m$
h	$0.04\ m$
T_0	$303\ K$
T_{left}	$323\ K$
T_{right}	$283\ K$