Exercises: List 0

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OBS: JUSTIFY ALL YOUR ANSWERS AND CLAIMS. CLARIFY THE PARAMETERS AND SETUPS USED.

1 Exercises

1. Consider the temperature field T over a thin rectangular plate represented as a domain $D \subset \mathbb{R}^2$. The temperature is a smooth function $T : D \subset \mathbb{R}^2 \rightarrow \mathbb{R}$, with $T = T(x, y)$, that satisfies the Laplace equation:

$$\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2} = 0, \tag{1}$$

   subject to boundary conditions:

   - $T(0, y) = 75°$, $0 \leq y \leq \overline{y}$,
   - $T(\overline{y}, x) = 100°$, $0 \leq x \leq \overline{x}$,
   - $T(\overline{x}, y) = 50°$, $0 \leq y \leq \overline{y}$,
   - $T(x, 0) = 0°$, $0 \leq x \leq \overline{x}$,

   which are shown in Figure 1.(a).

2. Using a regular and structured grid, like the one pictured in Figure 1.(b), apply the finite difference scheme presented in section 29.2 of [1], in order to get the numerical solution of the boundary value problem above.

3. Considering the isolines of the temperature field defined by:

$$S(k) = \{(x, y) \in D; \quad T(x, y) = k\}. \tag{2}$$

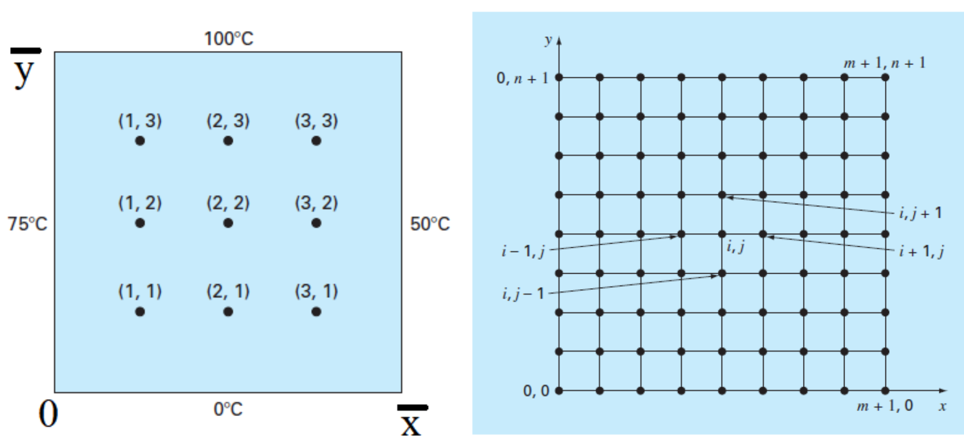
4. Develop a program to extract isolines of the temperature field based more or less on the marching cubes philosophy [2].

5. Buid a program to visualize the isolines generated.

References

[1] C. Chapra and R. P. Canale. *Numerical Methods for Engineers*. McGraw-Hill International Editions, www.turboteamhu.com/wp-content/uploads/2015/10/numerical-analysis.pdf, 1988.

[2] W. E. Lorensen and H. E. Cline. Marching cubes: A high resolution 3d surface construction algorithm. *Computer Graphics*, 21(4):163–169, July 1987.



(a) (b)

Figure 1: (a) Boundary conditions and domain. (b) Grid for finite-difference scheme.