1 FEM

1.1 The problem

Let us consider a domain $\Omega \subset \mathbb{R}^2$, with $\Gamma = \partial\Omega$ its boundary.
This boundary is partitioned into two non-overlapping regions Γ_D and Γ_N where Dirichlet and Neumann boundary conditions, respectively, are applied.
The strong form of the boundary value problem can be stated as:

$$-\frac{\partial^2 u}{\partial x^2} - \frac{\partial^2 u}{\partial y^2} = f \qquad in\ \ \Omega$$

$$u = 0 \qquad on\ \ \Gamma_D$$

1.2 The solution

The purpose of this exercise is to solve the homogeneous boundary value problem with the Finite Element Method (FEM) using triangular elements and linear basis functions.
Given the high level of complexity, this code has to exploit a well-defined structure, with different functions for different tasks.

The steps to solve the problem are the following:

1. Pattern creation for the stiffness matrix
2. Computation of local stifness matrices and their assembly
3. Computation of the right-hand side
4. Boundary conditions enforcement
5. Linear system solution

The three ASCII files are used to represent a computational grid, characterized by different extensions:

- topol: the file containing the triangle topology;
- coord: the file containing the node coordinates;
- bound: the file containing the set of Dirichlet nodes.