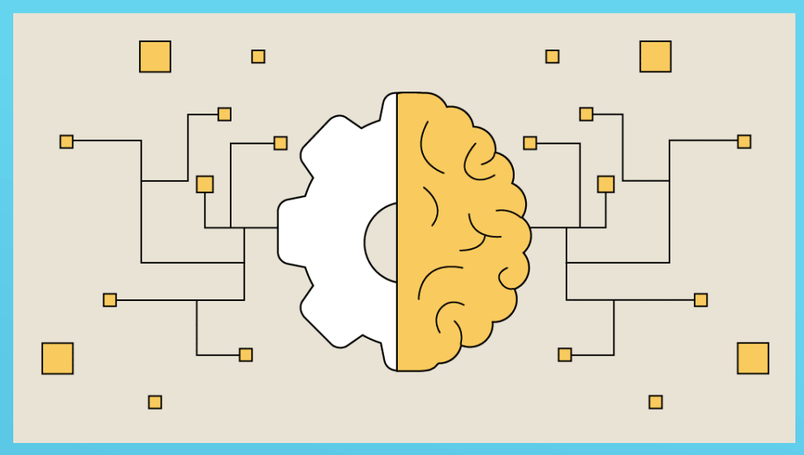
iP2i SEMINAR
LES 2 INFINIS
LYON



# Theory

## « The Eigenvalues of Laplace Operators: From Analytical to Machine Learning Approaches »

Rhameez S. Herbst, University of Johannesburg

In this presentation, eigenvalue problems are investigates. With particular focus on the eigenvalues of Laplace operators, we explore the analytical and numerical approaches to finding eigenfunction-eigenvalue pairs. While considerable detail is devoted to the analytical methods in their relation to how the solution is derived we use this as a means of demonstrating how numerical methods deviate from this practice. Lastly, the effectiveness of Machine Learning techniques, such as PINNS, is discussed and a few test problems are presented.

**Definition**

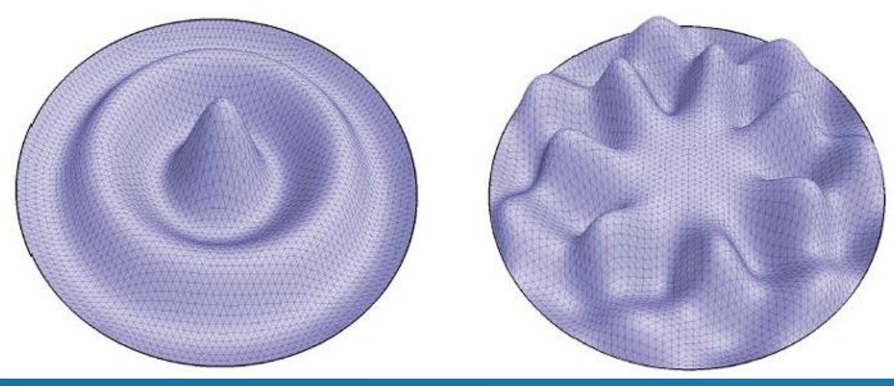
**Helmholtz Equation** (**Laplacian Eigenvalue Problem**):

$$\Delta f = -\lambda f, \qquad f : M \to \mathbb{R}$$

Solution: Eigenfunctions $f_i$ with corresponding family of eigenvalues (**Spectrum**):

$$0 \leq \lambda_1 \leq \lambda_2 \leq \cdots \uparrow +\infty$$

*Here Laplace-Beltrami Operator:* $\Delta f := div(grad\ f)$



November 25, 2024
Croix Rousse, 2 pm