COURSE OF THE XVIII SPANISH-FRENCH SCHOOL *Jacques-Louis Lions*
ABOUT NUMERICAL SIMULATION IN PHYSICS AND ENGINEERING
Las Palmas de Gran Canaria, June 25-29, 2018

A Brief Introduction to Mesh Generation

Josep Sarrate*

Keywords: Geometry modeling, mesh generation, mesh optimization, mesh adaption.

Mesh generation is one of the most important steps involved in the numerical simulation of a wide range of problems in applied sciences and engineering. Therefore, the characteristics of the generated meshes have to be in accordance, not only with the physics of the problem we are solving and the geometry of the bodies we are dealing with, but also with the level of accuracy we need to achieve. That makes mesh generation a challenging and also fascinating field because a dual engineering and mathematical approach is required.

In this short course we will analyze the basic ingredients involved in the meshing process. We will begin by reviewing how geometries are described depending on the applications we face, and what kind of actions we might perform in order to adapt the input geometries to a numerical simulation process.

Next, we will describe the basic concepts of the most relevant mesh generation methods that are widely used, both in industry and academia, and discuss their advantages and weaknesses. First, we will focus on methods that generate structured meshes (see picture on the left). These methods are still preferred in a wide range of simulations. For instance in applications where a strict alignment of elements is required by the analysis: boundary layers in computational fluid dynamics or composites in structural dynamics. Afterwards, we will move to unstructured mesh generation algorithms. These methods exhibit a higher flexibility to deal with an arbitrary geometries and with applications that requires anisotropy or/and large gradients in the element size (for instance, shocks). In addition, we will analyze how these methods can be extended to generate curved high-order meshes (see picture on the right).

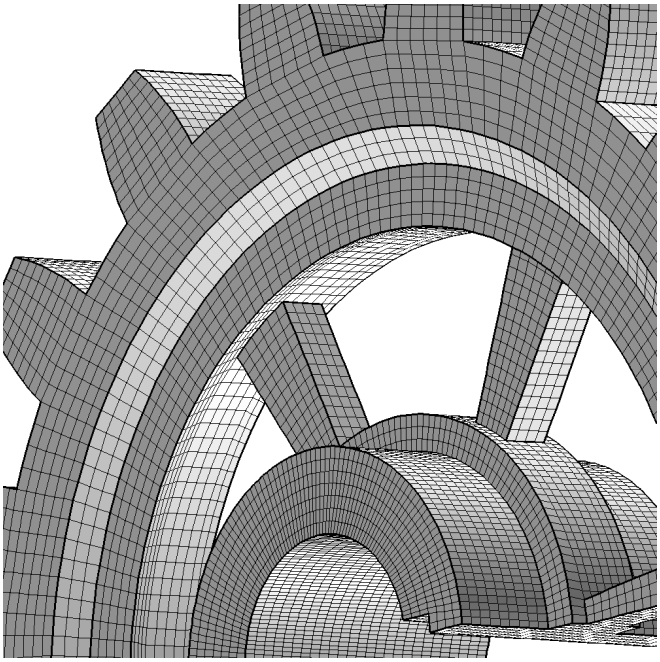
Finally, we will analyze mesh optimization and mesh adaption procedures and how they can be used to improve a mesh in order to increase the accuracy and the computational efficiency of the underlaying simulation.

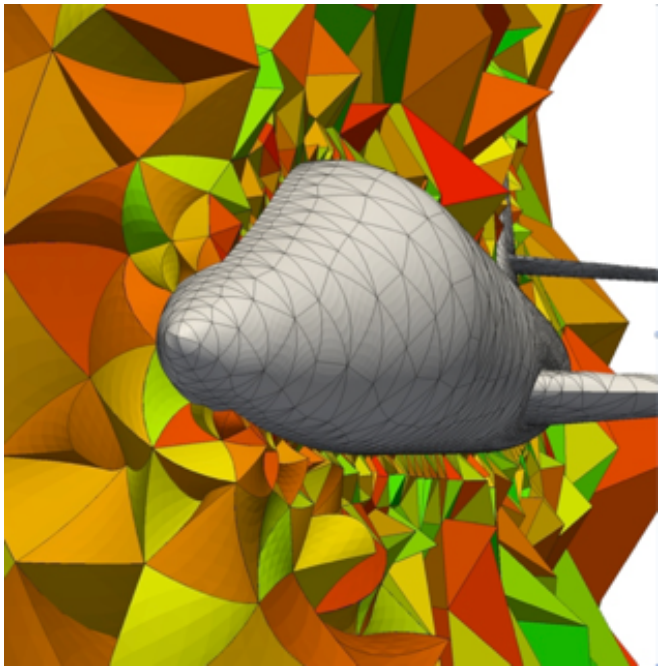
Suggested readings

[1] P.L. George, P. Frey, *Mesh Generation: Application to Finite Elements*. Wiley, 2008.

[2] J.F. Thompson, B.K. Soni, N.P. Weatherill, *Handbook of Grid Generation*. CRC Press, 1999.

[3] S.H. Lo, *Finite Element Mesh Generation*. CRC Press, 2015.





*Laboratori de Càlcul Numèric. Escola Tècnica Superior de Camins, Canals i Ports de Barcelona. Universitat Politècnica de Catalunya, Barcelona (SPAIN). Email: jose.sarrate@upc.edu, Website: http://www.lacan.upc.edu/sarrate