(DR5): Mathematical Methods in Morphometry: the mathematical description of complex natural shapes

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Capacity: 1 student

Related modules: Calculus, Linear Algebra, Scientific Computing, Differential equations

Applicable for degrees

- Mathematics
- Mathematics & Physics
- Mathematics & Computer Science
- Mathematics with Philosophy

Abstract: Morphometry is a branch of mathematical biology that deals with the mathematical and statistics description of natural forms. It was pioneered by Sir D'arcy W. Thompson, who published 1917 his famous book *On Growth and form* [1], which built the foundations of the discipline. The field was subsequently developed by several significant contributions by scientists from different disciplines. The measurement, analysis and classification of shapes of animals, plants and human body parts use mathematical tools from various areas of mathematics and statistics.
In this project, the student will explore the mathematics foundation and its applications of some of these tools. The project will focus on using Fourier and principal component analysis methods to model the shape of natural objects. The student will use these approaches to approximate and measure the shape of natural forms with their evolutive or functional significance. The student will also write original computer programs in Python or C++ that implement the shape analysis tools.

Bibliography:

1. Thompson, D'Arcy Wentworth. *On growth and form.* Cambridge University Press, 1961.
2. Nixon, M., & Aguado, A. (2019). *Feature extraction and image processing for computer vision*. Academic press.
3. Lestrel, P. E. (Ed.). (1997). *Fourier descriptors and their applications in biology*. Cambridge University Press
4. Cartwright, Mark. Fourier methods for mathematicians, scientists and engineers. Chichester: Ellis Horwood, 1990.
5. Dryden, I. L., & Mardia, K. V. (2016). *Statistical shape analysis: with applications in R* (Vol. 995). John Wiley & Sons.