Fluctuations in biological tissues

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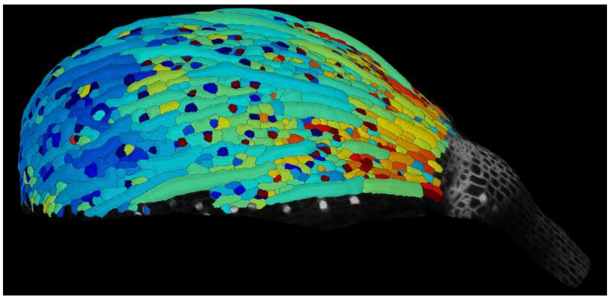

Figure 1: Cell growth is heterogeneous in space and time. Example of a sepal (green organ that protects a flower before it opens) from the model plant Arabidopsis thaliana. The colour scale corresponds to growth rates (high in red, low in blue).

The two hands of most humans almost superimpose. Similarly, flowers of an individual plant have similar shapes and sizes. This is in striking contrast with growth and deformation of cells during organ morphogenesis, which feature considerable variations in space and in time, raising the question of how organs and organisms reach well-defined size and shape. In order to link cell and organ scales, I built a theoretical model of growing tissue with fibre-like structural elements that may account for for the plant cell wall or animal cytoskeleton or extracellular matrix [1]. The model gave two important predictions. First, fluctuations occurring at cellular scale exhibit long-range correlations. Second, the response of fibres to growth-induced mechanical stress may enhance or buffer cellular variability of growth, making it possible to modulate the robustness of morphogenesis.
I will present in more details these results as well as a mathematical tool I defined to analyze signal in tissues: the Cellular Fourier Transform (CFT) [2]. It is suited to these signals which can only be defined at a cellular scale or which are smoothed out of their sub-cellular variations and it allows to overcome the many constrains met when studying geometrically disordered materials such as biological tissue, foams, granular materials... I plan to introduce this method and discuss its application to growth fluctuations in floral organs.

References

[1] Antoine Fruleux and Arezki Boudaoud. Modulation of tissue growth heterogeneity by responses to mechanical stress. *Proceedings of the National Academy of Sciences*, 116(6):1940–1945, 2019.

[2] Antoine Fruleux and Arezki Boudaoud. Cellular fourier analysis for geometrically disordered materials. *arXiv preprint arXiv:2010.09799*, 2020.