The Impact of Changes in Resolution on the Persistent Homology of Images

Conference Publishing

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Relevance to the Centre

Hoa Bui utilised her mathematical expertise to assist a team of Engineers to establish theoretical and numerical results that bound the difference between persistence diagrams computed from images of an object taken at different resolutions. Persistent homology is the study of connected components and holes in a sequence of nested shapes. In image analysis, these nested shapes are obtained by thresholding a real-valued function defined on the image domain. For example, to characterise the geometry of a porous material an appropriate function is the signed Euclidean distance transform derived from the binary map of solid and pore. The persistence diagrams computed from such a distance transform then quantify the sizes, shapes, and connectivity of all the individual pores and grains. Capturing both the micro- and macro-scale properties of a material using micro-CT is a trade-off between accuracy at the micro-scale and the computational expense associated with the large image dimensions required to represent a macroscale sample. Persistent homology is very expensive to compute on high resolution imagery, studying large datasets of imagery is nearly impossible; being able to select a coarser resolution can alleviate this issue and allow for more data to be analysed. The main focus of this paper is to establish both theoretical and numerical results that bound the difference between persistence diagrams computed from images of an object taken at different resolutions.

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