Estimating the singular support of the limited-angle tomographic reconstruction using persistent homology

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Abstract

In some applications, we can only use limited-angle X-ray tomography, which results in a much harder reconstruction problem than a full-angle case. Despite an algorithm, the singularities, i.e., the boundaries of the target object, cannot be detected stably. This means parts of the boundaries are missing. If we suppose that the target object has disjoint regions, the boundaries of those regions form cycles. Thus we can try to find missing parts of these cycles (boundaries) with help of homology.

The complex wavelets provide a computational method for finding stable singularities and dividing them into six sets based on their directions. Using prior information about singularities' directions, it is possible to estimate unknown singularities based on known singularities. Persistent homology can identify when known singularities and estimated singularities occur together and form cycles. This way singular support estimation can be reduced. Simultaneously one can get information about the number of regions.