

Institut für Geometrie

Geometrisches Seminar

24.04.2024, 13:45

Seminarraum 2, Kopernikusgasse 24/IV.

Cup Product Persistence and Its Efficient Computation

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It is well-known that the cohomology ring has a richer structure than homology groups. However, until recently, the use of cohomology in the persistence setting has been limited to speeding up barcode computations. Some of the recently introduced invariants, namely, persistent cup-length, persistent cup modules and persistent Steenrod modules, to some extent, fill this gap. When added to the standard persistence barcode, they lead to invariants that are more discriminative than the standard persistence barcode. In this work, we devise an $O(dn^4)$ algorithm for computing the persistent k -cup modules for all $k \in \{2, \dots, d\}$, where d denotes the dimension of the filtered complex, and n denotes its size. Moreover, we note that since the persistent cup length can be obtained as a byproduct of our computations, this leads to a faster algorithm for computing it for $d \geq 3$. Finally, we introduce a new stable invariant called partition modules of cup product that is more discriminative than persistent k -cup modules and devise an $O(c(d)n^4)$ algorithm for computing it, where $c(d)$ is subexponential in d .

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