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Persistent cohomology and circular coordinates. (English summary)

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The main goal of this paper is to describe a natural procedure for constructing circular coordinates on a nonlinear data set using techniques from algebraic topology and persistent topology. The authors present a strategy for constructing circle-valued functions on a statistical data set. They develop a machinery of persistent cohomology to identify candidates for significant circle-structures in the data. They ask what happens when an implicit assumption fails.

Reviewed by *İsmet Karaca*

References

1. Belkin, M., Niyogi, P.: Laplacian eigenmaps and spectral techniques for embedding and clustering. In: Diettrich, T., Becker, S., Ghahramani, Z. (eds.) *Advances in Neural Information Processing Systems 14*, pp. 585–591. MIT Press, Cambridge (2002)
2. Cox, T.F., Cox, M.A.A.: *Multidimensional Scaling*. Chapman & Hall, London (1994) [MR1335449 \(96g:62118\)](#)
3. de Silva, V., Carlsson, G.: Topological estimation using witness complexes. In: Alexa, M., Rusinkiewicz, S. (eds.) *Eurographics Symposium on Point-Based Graphics*, ETH, Zürich (2004)
4. Dixon, M., Jacobs, N., Pless, R.: Finding minimal parameterizations of cylindrical image manifolds. In: *CVPRW'06: Proc. 2006 Conference on Computer Vision and Pattern Recognition Workshop*, Washington, DC, USA, p. 192. IEEE Computer Society, Los Alamitos (2006)
5. Donoho, D.L., Grimes, C.: Hessian eigenmaps: new locally linear embedding techniques for high-dimensional data. Technical Report TR 2003–08, Department of Statistics, Stanford University (2003)
6. Edelsbrunner, H., Harer, J.: Persistent homology—a survey. In: Goodman, J.E., Pach, J., Pollack, R. (eds.) *Surveys on Discrete and Computational Geometry: Twenty Years Later*. Contemporary Mathematics, vol. 453, pp. 257–282. American Mathematical Society, Providence (2008) [MR2405684 \(2009h:55003\)](#)
7. Edelsbrunner, H., Letscher, D., Zomorodian, A.: Topological persistence and simplification. *Discrete Comput. Geom.* **28**, 511–533 (2002) [MR1949898 \(2003m:52019\)](#)
8. Ghrist, R.: Barcodes: the persistent topology of data. *Bull. Am. Math. Soc.* **45**(1), 61–75 (2008) [MR2358377 \(2008i:55007\)](#)
9. Guibas, L.J., Oudot, S.Y.: Reconstruction using witness complexes. In: *Proc. 18th ACM–SIAM Symposium on Discrete Algorithms*, pp. 1076–1085 (2007) [MR2485259](#)
10. Hatcher, A.: *Algebraic Topology*. Cambridge University Press, Cambridge (2002) [MR1867354 \(2002k:55001\)](#)

11. Lee, J.A., Verleysen, M.: Nonlinear dimensionality reduction of data manifolds with essential loops. *Neurocomputing* **67**, 29–53 (2005)
12. Morozov, D.: Dionysus library for computing persistent homology. <http://www.mrzv.org/software/dionysus/>
13. Paige, C.C., Saunders, M.A.: LSQR: sparse equations and least squares. <http://www.stanford.edu/group/SLI/>
14. Paige, C.C., Saunders, M.A.: LSQR: an algorithm for sparse linear equations and sparse least squares. *ACM Trans. Math. Softw.* **8**(1), 43–71 (1982) [MR0661121 \(83f:65048\)](#)
15. Pless, R., Simon, I.: Embedding images in non-flat spaces. In: *Conference on Imaging Science Systems and Technology*, pp. 182–188 (2002)
16. Roweis, S., Saul, L.: Nonlinear dimensionality reduction by locally linear embedding. *Science* **290**, 2323–2326 (2000)
17. Sexton, H., Vejdemo-Johansson, M.: jPlex simplicial complex library. <http://comptop.stanford.edu/projects/jPlex/>
18. Tenenbaum, J.B., de Silva, V., Langford, J.C.: A global geometric framework for nonlinear dimensionality reduction. *Science* **290**, 2319–2323 (2000)
19. Zomorodian, A., Carlsson, G.: Computing persistent homology. *Discrete Comput. Geom.* **33**(2), 249–274 (2005) [MR2121296 \(2005j:55004\)](#)

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