Analysis of Gneiting and Matérn functions for topology preservation of landmark-based image registration

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Topology preservation is a necessary requirement for elastic image registration. Here, we deal with this topic for landmark-based image registration focusing on two families of functions, i.e. Gneiting and Matérn functions. The former have compact support, which is a benefit property for local transformations [1], whereas the latter have global support and the deformation of each landmark can affect the whole image. But generally, globally supported Radial Basis Functions (RBFs) can make small bending energy. In this talk we evaluate the topology preservation of two Gneiting functions and three Matérn functions in one, two and four landmarks matching. In the first two cases, we analytically compare locality parameters and the positivity of Jacobian matrix determinant of such functions with Wendland functions, whose results were presented in [2]. In the four landmarks case, we instead consider topology preservation analyzing image deformation globally. All theoretical results are supported by extensive numerical experiments.

References

[1] R. Cavoretto, A. De Rossi, Analysis of compactly supported transformations for landmark-based image registration, Applied Mathematics and Information Sciences, 7, 2113-2121 (2013)

[2] X. Yang, Z. Xue, X. Liu, D. Xiong, Topology preservation evaluation of compact-support radial basis functions for image registration, Pattern Recognition Letters, 32, 1162-1177 (2011)