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Computing Smooth Connectivity with Routing Functions: Implementation and Applications

Routing functions, recently developed by Cummings, Hauenstein, Hong and Smyth, encode the smooth connectivity of real algebraic varieties. Upon fixing such a variety, one can define a routing function on it. The connected components of a graph associated to the critical points of the routing function are in bijection with the smoothly connected components of the variety. This correspondence also yields a membership test, determining whether a point lies on a given component. Furthermore, the Euler characteristic of each smoothly connected component can be computed from the routing function's critical points. Building on this work, we present a Julia package which implements these methods numerically. The critical points are computed with numerical path tracking in HomotopyContinuation.jl. We demonstrate the functionality of our package on several examples, including the computation of α-positive kinematic parameters of a Feynman diagram.