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Identifying parameter values for oscillations in reaction networks

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In this work we present a method for identifying Hopf bifurcation points in parametric ordinary differential equations (ODE) models of reaction networks with n species. The method is based on a Hopf bifurcation theorem for parametric systems, algebraic geometry, majorization theory and convex analysis. The main difficulty related to identifying Hopf bifurcation points, lies with selecting parameter values such that the next to last Hurwitz determinant $\det H_{n-1}$ is zero. We show that a vertex of the Newton polytope of $\det H_{n-1}$ exists among the exponents of the product of diagonal entries of H_{n-1} which significantly reduces the computational effort. If such a vertex is associated with a negative monomial, then finding candidates for Hopf bifurcation points becomes an easy enough problem. We apply our method to several examples of biochemical networks such as a glycolytic reaction, Ca^{++} ions reaction and a simplified MAPK network.

Keywords: reaction networks, ODE models with parameters, Hopf bifurcation