Orthogonal least squares fitting by conic sections and other algebraic curves and surfaces with a special two-step descent method

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When fitting parametric curves and surfaces to m given data points it is quite natural to minimize the sum of squared *orthogonal* distances. Thus both the corresponding values of the parameters and the shape parameters have to be determined. Some general two-step minimization algorithm turns out to become a descent method if (i) the shape parameters appear *linearly* and if (ii) it is possible to calculate *all* possible perpendiculars from some data point onto the curve or onto the surface for fixed parameters values. These requirements are especially fulfilled for circles, ellipses, hyperbolas, parabolas and general parametric polynomials, but also for spheres, ellipsoids, etc.. In those cases the first step consists of solving a few very small systems of linear equations and the second step requires the solution of m polynomial equations of low degree. Thus the algorithm does not need any Jacobian and can easily be programmed. Numerical examples for several implementations are given.