Controlled Perturbation for Certified Geometric Computing with Fixed Precision Arithmetic

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Transforming geometric algorithms into effective computer programs is a difficult task. This transformation is particularly made hard by the basic assumptions of most theoretical geometric algorithms concerning the handling of robustness issues, namely issues related to arithmetic precision and degenerate input. We start with a discussion of the gap between the theory and practice of geometric algorithms, together with a brief review of existing solutions to some of the problems that this dichotomy brings about. We then focus on controlled perturbation, an efficient method for removing degeneracies and certifying correct predicate-evaluation in algorithms for constructing geometric arrangements and related structures, while using fixed-precision arithmetic. We discuss the theory and practice of controlled perturbation, compare it with other techniques, and survey several applications of the method including a very recent one to dynamic maintenance of molecular surfaces.