PIMS Distinguished Lecture Series

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Feasibility of Methods for the Solution of Systems of Linear Interval and Parametric Equations

Many problems in applied mathematics and the engineering sciences involve uncertainties. Often such uncertainties are not known but can be bounded. If for each uncertain value one has an upper and a lower bound then one has an interval uncertainty. A well-established tool for treating problems involving interval uncertainties are interval computations, where one performs computations with intervals instead of real numbers. Appropriate rounding ascertains that the result of a computation can be guaranteed also in the presence of rounding errors.

In our talk we consider systems of linear equations where the coefficients of the matrix and the right hand side vary independently from each other in intervals (interval linear systems) or depend on parameters taken from given intervals (parametric linear systems). The solution set of the former systems can be enclosed by an extension of Gaussian elimination. However, it may break down due to an interval pivot containing zero. We identify some classes of interval matrices for which the breakdown can be avoided by replacing the interval pivot by the range of the pivot over the interval matrix. In the case of symmetric interval matrices, we consider an interval variant of the Cholesky decomposition. We show how the breakdown of this interval method can be prevented for positive definite matrices in many cases. Special attention is paid to positive definite Toeplitz matrices.

In the last part of our talk, we give an outlook on parametric linear systems and an algorithm for the enclosure of the solution set of such a system. We present its application to some problems from structural mechanics involving uncertainties in the material parameters and applied loadings.

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