Integer Least Squares with a Block Toeplitz Matrices

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We consider the problem of finding the least squares solution to an overdetermined set of linear equations, where the coefficient matrix and the right hand vector are composed of real numbers but the unknown vector is composed of integers. This problem has applications in communications, cryptography, and global positioning system.

Although the problem is known to be NP-hard, effective procedures have been proposed for finding an approximate solution. A polynomial-time algorithm was developed by Lenstra, Lenstra, and Lovasz (LLL). Another well known technique is called Sphere Decoding; this method can compute the exact solution, albeit in exponential time.

We are interested in the case where the coefficient matrix is a block Toeplitz matrix. This application arises in wireless communication with multiple transmit and receive antennas.

We begin our talk by presenting the mathematical setting of the problem. Then we describe the LLL and the Sphere Decoding algorithms. Finally, we show how we may take advantage of the Toeplitz structure to speed up the computational procedures.

This work is joint with Daniel Tracy, a graduate student in computer science at Rensselaer.