Title: Some New Progress in Matrix Computations Abstract: In this talk, we discuss our recent work on computing the singular value decomposition (SVD) and analyzing numerical methods for solving semi-definite programs (SDPs). We start with the special problem of updating the SVD, which is by itself an important problem in signal processing applications. Taking advantage of the rich analytic and algebraic structures in this problem, we develop a version of the well-known fast multipole method (FMM) to update the SVD at a cost about a factor of O(n) less than direct updating. This method is a 1-dimensional version of FMM that is based on judicious use of Chebyshev polynomials and takes full advantage of level-3 BLAS whenever possible. For n = 1000, it can update the SVD with roughly the same amount of accuracy as the direct method but is up to 10 times faster. Better yet, this method is provably stable. Based on this method, we further develop stable methods for solving the symmetric eigenvalue problem and the SVD. Some recent work for solving these problems is considered such a complete resolution that it is referred to as the "Holy Grail". Interestingly, our methods are faster than the Grail and yet provably stable. We also consider issues arising from numerical methods for solving the semi-definite programs (SDPs). The SDPs have a wide range of applications in areas such as control theory and combinatorial optimization. Over the last decade or so, a large number of interior-point methods have been developed to solve the SDPs. However, properly implementing these methods proved to be a surprisingly big challenge. We have systematically analyzed these methods in finite precision. This analysis provides a clear understanding of how SDP methods work in finite precision. It has led to more robust implementations of SDP methods and discovery of more reliable and efficient methods. This is joint work with Dr. Xuebin Chi Ming