"Large-Scale Optimization Algorithms for Inverse Problems in Atmospheric Imaging"

Abstract:

The physical problem of interest is to estimate both the phase (or wave-front aberration) and the object (or true image) from atmospheric image data modeled by

\[ d = s \ast f + \text{noise}, \]  

where \( \ast \) denotes 2-D convolution product and \( s[\phi] = |F^{-1}\{pe^{i\phi}\}|^2 \). The obvious nonuniqueness issues arising in (1) can be dealt with by taking new image data generated by a technique known as phase diversity.

The phase/object estimation problem presents some interesting mathematical and computational challenges. The problem is ill-posed, so regularization must be incorporated to obtain stable, accurate parameter estimates. We employ a penalty approach known as Tikhonov regularization, which requires the minimization of a function of the form

\[ J[\phi, f] = J_{\text{data}}[\phi, f; d] + \gamma \| f \|^2 + \alpha \phi^T L \phi, \]  

where \( J_{\text{data}} \) is a nonquadratic fit-to-data function, \( L \) is a symmetric positive definite matrix, and \( \gamma \) and \( \alpha \) are small parameters. After discretization, the number of unknowns is quite large (> 10^5).

We apply a pair of algorithms, (i) the limited memory BFGS method (l-BFGS) with line search globalization; and (ii) the Newton/CG algorithm with trust region globalization due to Steihaug. We will present numerical results and point out some interesting parallels between preconditioners for Newton/CG and the initial Hessian for l-BFGS.

Friday, April 6, 2001
3:00 PM in 335 Jabara Hall

Please come join us for refreshments before the lecture at 2:30 p.m. in room 353 Jabara Hall.