

國立中央大學數學系

專題演講

主 講 人：蔡尚融先生 (國立中央大學數學系)

演講題目：A hybrid-line-and-curve search globalization technique for
inexact Newton methods with applications in semiconductor
device simulations

演講時間：2020年12月31日(星期四) 3:00 p.m. ~ 4:00 p.m.

演講地點：中央大學鴻經館M107

Abstract：

The backtracking line search (LS) is one of the most commonly used techniques for enhancing the robustness of Newton-type methods. The Newton method consists of two key steps: search and update. LS tries to find a decreasing-most updated point along Newton's search direction with an appropriate damping factor from the current approximation. The determination of Newton's search direction relies only on current information. When Newton's search direction is a weakly descent direction, the damping factor determined by LS will be unacceptably small, which often happens for the numerical solution of large, sparse systems of equations with strong local nonlinearity. As a result, the solution process fails into the vicious cycle between no update and the same search. The intermediate solution is trapped within the same region without any progress. This work's main contribution is to propose a new globalization strategy, namely the hybrid line and curve search (HLCS) technique for Newton-type methods to resolve their potential failure problems when line-search is used. If the classical line search fails, we activate the curve search phase. In that case, we first decompose the solution space into two orthogonal subspaces based on the predicted value obtained from Newton's search direction, referred to good and bad subspaces. The bad one responds to the components causing the violation of the sufficient decrease condition. Next, we project the original predicted value on the good subspace and then perform the nonlinear elimination process to obtain a new updated solution that satisfies the sufficient decrease condition globally. In this talk, we use a simple problem with unbalanced nonlinearity to illustrate how our proposed globalization strategy works. Next, we will generalize the idea and implement it for the general system of large, sparse, nonlinear equations, and then describe its application to drift-diffusion semiconductor device simulation. It is known in the literature that solving numerically drift-diffusion equations imposes many challenges due to the strong nonlinearity, the drift-dominated nature, and the presence of internal and boundary layers. We focus on investigating how these issues affect the convergence of an inexact Newton line-search method. As proof of concept, we present four one-dimensional numerical examples to illustrate our proposed approach's effectiveness.

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