國立臺北大學自然資源與環境管理研究所
101 學年度第二學期『環境系統分析專題』

課程講義(十三)：非線性規劃與演算法
Nonlinear Programming and Algorithms

Nonlinear Programming: Concepts, Algorithms and Applications
  (http://cepac.cheme.cmu.edu/pasilectures/biegler/BieglerLecture.pdf)
Global Optimization Algorithms - Theory and Application (http://www.it-weise.de/projects/book.pdf)
Nonlinear Programming (Chapter 13) in *Applied Mathematical Programming*
  (http://web.mit.edu/15.053/www/AMP-Chapter-13.pdf)

- NONLINEAR PROGRAMMING -- INTRODUCTION
  - □ Formulations of the Models and Complexity
  - □ Local Optima vs. Global Optima
  - □ Convexity and Convex Programming
    - ⇨ Convexity of a Function: Convex, Concave and Un-determinant
    - ⇨ Convex Region vs. Non-convex Region
  - □ Analytical Solutions vs. Numerical Solutions
    - ⇨ Linearization of Nonlinear Objective Function => unnecessary nowadays!
    - ⇨ Software Packages => Lingo, What'sBest, GAMS (NLP) etc.

- UNCONSTRAINED OPTIMIZATION
  - □ Minima, Maxima and Saddle Points
    - ⇨ Necessary Conditions and Sufficient Conditions
  - □ Gradient of a Function (First Derivatives)
  - □ Hessian Matrix (Second Derivatives)
    - ⇨ Positively Definite: All the Eigenvalues are Positive

- LAGRANGE MULTIPLIERS AND OTHER METHODS
  - □ Lagrange Multiplier Method
    - ⇨ Constraints with All Equalities
    - ⇨ Properties of the Lagrange Multipliers
  - □ Kuhn-Tucker Conditions: Constraints with Inequalities
  - □ Gradient Search Procedure (Greedy) => Danger of Being Trapped at Local Optima

- ALGORITHMS FOR NONLINEAR PROGRAMS
  - □ Numerical Methods (Chang, 2002, Chap.5)
    - ⇨ Newton Method, Conjunctive Direction and Conjunctive Gradient Methods
  - □ Top-Ten Algorithms
  - □ Heuristic Algorithms => Soft Computation => Emulation of Natural Phenomena
    - ⇨ Artificial Neural Network; Genetic Algorithms
    - ⇨ Simulated Annealing; Tabu Search
    - ⇨ Ant Search, Ant Colony Algorithm, Swarm Intelligence, etc.