Lecture 13. 5 October 2004

- **Review of Lecture #11: Second order optimality conditions** - necessary condition, sufficient condition. If the necessary condition is violated the point cannot be a local minimum point. If the sufficiency condition is not met, the point may not be an isolated minimum point.

- **Review of Lecture #12: Introduction to genetic algorithms and a computer program.**

- **Return Midterm Exam. Comments.**

- **Comments on Use of Optimality Conditions.**
  - Always use the standard form of the NLP problem
  - Make sure to check all the KKT conditions
  - Check regularity of the candidate solution points

- **Duality in Nonlinear Programming.** Duality in Nonlinear Programming: Lagrangian duality, or local duality

- Equality Constrained Problem: $x^*$ is a local min for the equality constrained problem as well as the Lagrangian function at $u^*$. Given optimum $u$, optimum $x$ can be found by minimizing the Lagrangian. Given $u$ in the neighborhood of its optimum, $x$ found by minimizing the Lagrangian is also in the neighborhood of its optimum value. Thus, there is a unique correspondence between $u$ and $x$: $x = x(u)$ and $x(u)$ is differentiable of $u$.

- **Dual function.** Definition of the dual function. Gradient and Hessian of the dual function.

- **Local duality theorem.** Maximize the dual function. Example problem

- **Generalization to inequality constrained problem.** Maximize the dual function subject to non-negativity of the dual variables. Strong duality theorem; weak duality theorem.

- **Saddle points.** Saddle point theorem. Example problem.
Read: Duality in NLP.

HW#8: Solve #5.4 optimality conditions; Check duality assumption; calculate the dual function; maximize the dual function; show \( x^* = x(u^*) \), and \( f(x^*) = \phi(u^*) \). Submit by Thursday, 10/7/04, hard as well as electronic copy.