AAE550 11/15/17 HW#3 Thomas Sattely

1. Nelder-Mead Simplex

1) Minimize : $f(x) = 10d + \sum_{i=1}^{d} (x_i^2 - 10\cos(2\pi x_i))$, $-5.12 \le x_i \le 5.12$

For this problem, $x = [x_1 \ x_2]^T$

The constraints are as follows:

$x_1 \ge -5.12 \Rightarrow -5.12 - x_1 \le 0 \Rightarrow \frac{x_1}{-5.12} - 1 \le 0 \Rightarrow g_1(x) = \frac{x_1}{-5.12} - 1$

$x_1 \le 5.12 \Rightarrow x_1 - 5.12 \le 0 \Rightarrow \frac{x_1}{5.12} - 1 \le 0 \Rightarrow g_2(x) = \frac{x_1}{5.12} - 1$

$x_2 \ge -5.12 \Rightarrow g_3(x) = \frac{x_2}{-5.12} - 1$

$x_2 \le 5.12 \Rightarrow g_4(x) = \frac{x_2}{5.12} - 1$

For this problem, use a linear exterior penalty method

$P(x) = \sum_{i=1}^{n} \max(0, g_i(x))$

$\phi(x) = f(x) + r_p P(x)$

$f(x) = 20 + [(x_1^2 - 10\cos(2\pi x_1)) + (x_2^2 - 10\cos(2\pi x_2))]$

$P(x) = \sum_{i=1}^{n} \max[0, g_i(x)]$

$g_1(x) = \frac{x_1}{-5.12} - 1$

$g_2(x) = \frac{x_1}{5.12} - 1$

$g_3(x) = \frac{x_2}{-5.12} - 1$

$g_4(x) = \frac{x_2}{-5.12} - 1$

$\phi = f(x) + r_p P(x)$ (Choose r_p)

Minimize ϕ

IV. Combinatorial Problem with GA

2.

Goal is to minimize the mass of the beam, given by:

$$m = f(x) = \rho_1 A_1 L_1 + \rho_2 A_2 L_2 + \rho_3 A_3 L_3$$

$x = [M_1 \ A_1 \ M_2 \ A_2 \ M_3 \ A_3]$, L_i's are fixed

M_i = Material selection (1, 2, 3, or 4), such that:

$$\rho_i = \rho(M_i), \ E_i = E(M_i), \ \sigma_{y_i} = \sigma_y(M_i)$$

Constraints: $-\sigma_{y_i} \le \sigma_i \le \sigma_{y_i}$

$\sigma_1 \ge -\sigma_{y_1} \Rightarrow g_1(x) = \frac{\sigma_1}{-\sigma_{y_1}} - 1$

$\sigma_1 \le \sigma_{y_1} \Rightarrow g_2(x) = \frac{\sigma_1}{\sigma_{y_1}} - 1$

$\sigma_2 \ge -\sigma_{y_2} \Rightarrow g_3(x) = \frac{\sigma_2}{-\sigma_{y_2}} - 1$

$\sigma_2 \le \sigma_{y_2} \Rightarrow g_4(x) = \frac{\sigma_2}{\sigma_{y_2}} - 1$

$\sigma_3 \ge -\sigma_{y_3} \Rightarrow g_5(x) = \frac{\sigma_3}{-\sigma_{y_3}} - 1$

$\sigma_3 \le \sigma_{y_3} \Rightarrow g_6(x) = \frac{\sigma_3}{\sigma_{y_3}} - 1$

For this problem, use the linear exterior penalty method

$$P(x) = \sum_{i=1}^{n} \max[0, g_i(x)]$$

Minimize: $\phi(x) = f(x) + r_p P(x)$

$f(x) = \rho_1 A_1 L_1 + \rho_2 A_2 L_2 + \rho_3 A_3 L_3$

$g_1(x) = \frac{\sigma_1}{-\sigma_{y_1}} - 1$

$g_2(x) = \frac{\sigma_1}{\sigma_{y_1}} - 1$

$g_3(x) = \frac{\sigma_2}{-\sigma_{y_2}} - 1$

$g_4(x) = \frac{\sigma_2}{\sigma_{y_2}} - 1$

$g_5(x) = \frac{\sigma_3}{-\sigma_{y_3}} - 1$

$g_6(x) = \frac{\sigma_3}{\sigma_{y_3}} - 1$