QE2012 AC-3 ECE580 - Rhea

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ECE Ph.D. Qualifying Exam

Automatic Control (AC)

Question 3: Optimization

August 2012

Student answers and discussions for Part 1,2,3,4,5

1.(20 pts)

(i)(10 pts) Find the factor by which the uncertainty range is reduced when using the Fibonacci method. Assume that the last step has the form $1-\rho_{N-1}=\frac{F_2}{F_3}=\frac{2}{3}$,

where *N* − 1 is the number of steps performed in the uncertainty range reduction process.

(ii)(10 pts) It is known that the minimizer of a certain function f(x) is located in the interval[-5, 15]. What is the minimal number of iterations of the Fibonacci method required to box in the minimizer within the range 1.0? Assume that the last useful value of the factor reducing the uncertainty range is 2/3, that is

$$1-\rho_{N-1}=\frac{F_2}{F_3}=\frac{2}{3},$$

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Problem 2. (20pts) Employ the DFP method to construct a set of Q-conjugate directions using the function

$$\begin{aligned} f &= \tfrac{1}{2}x^TQx - x^Tb + c \\ &= \tfrac{1}{2}x^T\begin{bmatrix}1 & 1\\ 1 & 2\end{bmatrix}x - x^T\begin{bmatrix}2\\ 1\end{bmatrix} + 3. \end{aligned}$$

Where $x^{(0)}$ is arbitrary.

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Problem 3. (20pts) For the system of linear equations, $Ax=b$ **where**

$$A=\begin{bmatrix}1 & 0 & -1\\ 0 & 1 & 0\\ 0 & -1 & 0\end{bmatrix}, b=\begin{bmatrix}0\\ 2\\ 1\end{bmatrix}$$

Find the minimum length vector $x^{(*)}$ **that minimizes** $||Ax-b||_2^2$

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Problem 4. (20pts) Use any simplex method to solve the following linear program.

$$\begin{aligned} &\textit{Maximize} && x_1 + 2x_2 \\ &\textit{S'ubject to} && -2x_1 + x_2 \le 2 \\ &&& x_1 - x_2 \ge -3 \\ &&& x_1 \le -3 \\ &&& x_1 \ge 0, x_2 \ge 0. \end{aligned}$$

wers and discussions

Problem 5.(20pts) Solve the following problem:

$$\begin{aligned} \textit{Minimize} \quad & -x_1^2 + 2x_2 \\ \textit{Subject to} \quad & x_1^2 + x_2^2 \leq 1 \\ & x_1 \geq 0 \\ & x_2 \geq 0 \end{aligned}$$

(i)(10pts) Find the points that satisfy the KKT condition.

(ii)(10pts)Apply the SONC and SOSC to determine the nature of the critical points from the previous part.

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Back to ECE QE page

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