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Stochastic Simulations
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Universität Ulm
Dr. Kirsten Schorning
Dr. Vitalii Makogin

Reading Course — till July 22, 2017

(a) Read chapter 1, 2, 3 of Clerc, M.(2010). Particle Swarm optimization. ISTE, London. There is an online version of this book for the members of the University of Ulm:
`https://ulm.ibs-bw.de/aDISWeb/app?service=direct/0/Home/$DirectLink&sp=S127.0.0.1:23002&sp=SAKSWB-IdNr484977822`

(b) Write an R program for the "standard" Particle Swarm Optimization algorithm which solves the following optimization problem:
Find $x^* = (x_1^*, x_2^*, x_3^*)^T$ in $[0,1]^3$ which maximizes the function $\Phi : [0,1]^3 \to \mathbb{R}$

$$\Phi(x_1, x_2, x_3) = \det(X^T X)$$

where

$$X = \begin{pmatrix} f^T(x_1) \\ f^T(x_2) \\ f^T(x_3) \end{pmatrix} = \begin{pmatrix} 1 & x_1 & x_1^2 \\ 1 & x_2 & x_2^2 \\ 1 & x_3 & x_3^2 \end{pmatrix}.$$

The program should depend on the parameters **NumIt** (number of iterations) and **NumPart** (number of particles) such that you can change these values quickly.
The program should both return x^* and the maximum value $\Phi(x^*)$.
Hint: The solution is $x^* = (0, 0.5, 1)^T$.

(c) Generalize the program of part (b) to the case where $\Phi : [a,b]^3 \to \mathbb{R}$ with $a, b \in \mathbb{R}$, $a < b$.

(d) Generalize the program of part (b) for arbitrary but fixed $k \in \mathbb{N}$ with $\Phi : [0,1]^k \to \mathbb{R}$

$$\Phi(x_1, x_2, \ldots, x_k) = \det(X^T X)$$

and

$$X = \begin{pmatrix} f^T(x_1) \\ f^T(x_2) \\ \vdots \\ f^T(x_k) \end{pmatrix} = \begin{pmatrix} 1 & x_1 & \ldots & x_1^{(k-1)} \\ 1 & x_2 & \ldots & x_2^{(k-1)} \\ 1 & x_k & \ldots & x_k^{(k-1)} \end{pmatrix}.$$

Additional information

Please send your R-solution to kirsten.schorning@uni-ulm.de by the end of the lecture time (i.e. till July 22, 2017).