The Investigation and Application of Tsallis Random Generator

陳信實、鄧志堅

E-mail: 9901393@mail.dyu.edu.tw

ABSTRACT

Tsallis distribution was proposed by C. Tsallis in 1996 to solve the slow convergence problem of simulated annealing. It is shown that Tsallis ’ s generalized simulated annealing is much faster than the classical simulated annealing (“ Boltzmann machine ”) and fast simulated annealing (“ Cauchy machine ”). However, Tsallis distribution is very complicated and its random variable could not be generated by ordinary simulation techniques such as inversion and rejection methods. Tsallis adopts algorithm of R. N. Mantegna (1994) to produce a Tsallis random number generator. This method has many problems, however. First it could generate complex number when the parameter is near by 1.4. Second, when it is generated using Monte Carlo simulation, its histogram is not identical with the corresponding theoretical probability density (PDF). We plan to come out with a better Tsallis random number generator which can match the Tsallis ’ s PDF in most cases of its parameter ’ s ranges.

Keywords : Tsallis distribution ; Simulated Annealing ; Monte Carlo simulation ; random number generator

Table of Contents

REFERENCES

1. 王舜宏, “ 全域最佳化演算法及其應用, ” 台灣大學電機工程研究所碩士論文, 1993。 2. 陳隆熙, “ 一個解決TSP問題最佳解的穩定方法－以TA演算法為例, ” 大葉大學工業工程研究所碩士論文, 2002。 3. 韓復華、楊智凱, “ 門檻接受法在TSP問題上之應用, ” 運輸計劃季刊, 25(2), pp. 163-188, 1996。 4. Ahrens, J. H. and Dieter, U., “ Computer method for sampling from the exponential and normal distribution, ” Commun. ACM 15, pp. 873-882, 1972. 5. Althofer, I. And Koschnick, K. U., “ On the convergence of threshold accepting, ” Applied Mathematics and Optimization, 24, pp. 183-195, 1991. 6. Bain, L. J. and Engelhardt, M., Introduction to Probability and Mathematical Statistics, Duxbury Press, Boston, 1987. 7. Birnbaum, Z. W., “ Numerical tabulation of the distribution of Kolmogorov ’ s statistic for finite sample size, ” Journal of the American Statistical Association, 47, pp. 425-441, 1952. 8. Box, G. E. P., and Muller, M. E., “ A note on the generation of random normal deviates, ” Ann. Math. Stat., 29, pp. 610-611, 1958. 9. Bratley, P., Fox, B. L. and Schrage, L. E., A Guide to Simulation, 2nd ed., Springer-Verlag, New York, 1987. 10. Chambers, J. M., Mallows, C. L., and Stuck, B. W., “ A method for simulating stable random variables, ” JASA, 71, pp. 340-344, 1976. 11. Dekkers, A. and Aarts, E., “ Global optimization and simulated annealing ” , Mathematical Programming, 50, pp. 367-393, 1991. 12. Dueck, G. and Scheuer, T., “ Threshold accepting: a general purpose optimizatiom algorithm appeared superior to simulated annealing, ” Journal of Computational Physics, 90, pp. 161-175, 1990. 13. Feller, W., An Introduction to Probability Theory and Its Application, Volume II, , pp. 165-173, 1966. 14. Franz, A. and Hoffmann, K. H., “ Threshold accepting as limit case for a modified Tsallis

statistics, ” Applied Mathematics Letters, 16, pp. 27-31. 2003. 15. Kirkpatrick, S., “ Optimization by simulated annealing: quantitative studies, ” Journal of Statistical Physics, 34(5/6), pp. 975-986, 1984. 16. Monagan M. B., Geddes K. O., Heal K. M., Labahn G., Vorkoetter S. M., McCarron J., and DeMarco P., Maple 7 Programming Guide, Waterloo Maple Inc., Canada, (2001). 17. Mantegna, R. N., “ Fast, accurate algorithm for numerical simulation of Levy stable stochastic process, ” Physical Review E, 49, pp. 4677-4683, 1994. 18. Marsaglia, G., “ Generating a variate from the tail of the normal distribution, ” Technometrics, 6, pp. 101-102, 1964. 19. Papoulis, A., Probability & Statistics, Prentice Hall, Englewood Cliffs, NJ, pp. 120-121, 1990. 20. Pardalos, P. M., Romeijn, H. E. and Tuy, H., “ Recent devlopment and trends in global optimization, ” Journal of Computational and Applied Mathematics, 124, pp. 209-228, 2000. 21. Penna, T. J. P., “ Traveling salesman problem and Tsallis statistics, ” Physical Review E, 51, pp. R1-R3, 1995. 22. Press, W. H., Teukolsky, S. A., Vetterling, W. T. and Flannery, B. P., “ Numerical receipes in Fortran, ” Cambridge University Press, Cambridge, 1989. 23. Rosenkrantz, D. J., Stearns, R. E. and Lewis, P. N., “ An analysis of Several Heuristics for the Traveling Salesman Problem, ” SIAM Journal on Computing, 6, pp. 563-581, 1977. 24. Schmeiser, B., “ Generation of variates from distribution tails, ” Operations Research, 28, pp. 1012-1017, 1980. 25. Szu, H. and Hartley, R., “ Fast simulated annealing, ” Physics Letters A, 122(3/4), pp. 157-162, 1987. 26. Tsallis, C., “ Possible generalization of Boltzmann-Gibbs statistics, ” Journal of Statistical Physics, 52(1/2), pp. 479-487, 1988. 27. Tasllis, C. and Stariolo, D. A., “ Generalizes simulated annealing, ” Physical A, 233, pp. 395-406, 1996. 28. Tian, P., J. Ma and Zhang, D. M., “ Application of the simulated annealing algorithm to the combinatorial optimization problem with permutation property: an investigation of generation mechanism, ” European Journal of Operational Research, 118, pp. 81-94, 1999.