

电力系统运行与可靠性

大型电力系统可靠性评估中的马尔可夫链蒙特卡洛方法

石文辉 别朝红 王锡凡

西安交通大学电气工程学院 西安交通大学电气工程学院 西安交通大学电气工程学院

摘要: 提出大型电力系统可靠性评估的一种新的蒙特卡洛模拟方法-马尔可夫链蒙特卡洛方法(Markov chain Monte Carlo, MCMC)。MCMC方法是一种特殊的蒙特卡洛方法, 它将随机过程中的马尔可夫过程引入到蒙特卡洛模拟中, 实现动态蒙特卡洛模拟。该方法通过重复抽样, 建立一个平稳分布与系统概率分布相同的马尔可夫链, 从而得到系统的状态样本。由于MCMC方法考虑了系统各个状态间的相互影响, 相比于随机采样的蒙特卡洛方法所得到的独立样本序列, 更准确模拟了电力系统运行实际情况。IEEE-RTS 24节点算例表明, 该算法可快速收敛, 节省计算时间, 提高计算速度。同时, 由于每条马尔可夫链均收敛于同一个分布, 即所谓平稳分布, 所以算法具有良好的稳定性。对西北330 kV电网的可靠性评估再次表明了该方法的正确性和有效性以及该方法用于大型电力系统的可靠性评估的优越性和潜力。

关键词: 大型电力系统 可靠性评估 马尔可夫链蒙特卡洛方法 Gibbs抽样器

Applications of Markov Chain Monte Carlo in Large-scale System Reliability Evaluation

SHI Wen-hui BIE Zhao-hong

Abstract: A new Monte Carlo simulation method for large-scale system reliability evaluation is presented, which is Markov chain Monte Carlo (MCMC). MCMC is a kind of dynamic Monte Carlo simulation method that introduces Markov chain in stochastic process to the Monte Carlo simulation. In this method, the Gibbs sampler utilizes a set of full conditional distributions associated with the target distribution of interest in order to define a Markov chain with an invariant distribution equal to the target distribution. The system states are sampled one by one from this Markov chain to evaluate reliability. Comparing with the classical Monte Carlo simulation method, the relativities between these states are considered, which can reflect the inherence of the system states. The results of the IEEE RTS 24-bus test system show that the proposed method is efficient in system evaluation. The proposed model improves the convergence, stability and computation speed of the reliability evaluation dramatically. Finally, the evaluation results of North-west 330kV power system also indicate the presented method is valid and has great advantage that it applies to large-scale system evaluation.

Keywords: large-scale power system reliability index Markov chain Monte Carlo Gibbs sampler

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通讯作者: 别朝红

作者简介:

作者Email: zhbie@mail.xjtu.edu.cn

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