

改进贝叶斯网络在大面积停电事件应急情景动态推演模型中的应用

郝宗良,张韶华

(国网宁夏电力有限公司,银川 750001)

Application of improved Bayesian networks in dynamic inference model of emergency scenarios for large area power outages

HAO Zongliang, ZHANG Shaohua

(State Grid Ningxia Electric Power Co., Ltd., Yinchuan 750001, China)

摘要: 为了有效界定停电事件的影响因素,提高应急情景动态推演模型的准确性,避免电力突发事件的发生,设计基于改进贝叶斯网络的大面积停电事件应急情景动态推演模型。首先,对初始情景、引发情景、爆发情景、恢复情景和消失情景等五个网络层级进行分析,构建大面积停电事件情景网络;其次,考虑应急决策主体、对象、目标、方案以及决策环境,模拟大面积停电事件应急决策过程,利用改进贝叶斯网络计算多层次情景网络之间移动概率,确定事件动态演化规律;最后,通过大面积停电事件数据的输入结果,得出包含大面积停电事件动态推演路径和最优应急方案。实验结果表明:应用设计模型后,停电面积缩小率为48.57%,停电事件的实际停电面积明显缩小。完善了应急情景动态推演过程,事件应急方案与实际停电情况相匹配,可以高效应对大面积停电事件,具有较高的应用价值。

关键词: 改进贝叶斯网络;大面积停电事件;应急情景;动态推演;应急方案

Abstract: In order to effectively define the influencing factors of power outage events, improve the accuracy of emergency scenario dynamic deduction models, and avoid the occurrence of power emergencies, a large-scale power outage emergency scenario dynamic deduction model based on improved Bayesian networks is designed. Firstly, five network levels of initial scenario, triggering scenario, outbreak scenario, recovery scenario, and disappearance scenario are analyzed to construct a large-scale power outage scenario network. Then, emergency decision-making subject, object, target, plan, and decision-making environment are considered, the emergency decision-making process of large-scale power outage events is simulated, improved Bayesian networks is used to calculate the probability of movement between multi-level scenario networks, and the dynamic evolution law of events is determined. Finally, based on the input results of large-scale power outage event data, the dynamic inference path and optimal emergency plan including large-scale power outage events are obtained. The experimental results show that after applying the design model, the reduction rate of power outage area is 48.57%, and the actual power outage area of power outage events is significantly reduced. The dynamic deduction process of emergency scenarios has been improved, and the emergency response plan is matched with the actual power outage situation, which can efficiently respond to large-scale power outage events and has high application value.

Key words: improved Bayesian network; large area power outages; emergency scenarios; dynamic deduction; emergency plan

0 引言

停电事故的原因包括自然因素破坏、电力设备故障、保护设备故障、错峰用电、线路检修等。突然停电不仅会给设备带来损坏,同时也会对居民的日常生活造成直接的影响。大面积停电是指由于电网遭受重大自然灾害或重大事故,造成区域电网、省电网或主要中心城市电网负荷下降而造成的大面积断电^[1-2]。因此,大面积停电具有影响范围广、历时长、危害性

大、突发性强等特点,是一种非常严重的电力突发事件。近年来,大面积停电事件频发,给电力企业带来巨大的经济损失^[3],同时也给用户的日常生活带来较大的负面影响,为了将大面积停电事件带来的负面影响降至最低^[4],同时提高电力系统的安全性,有必要针对大面积停电事件进行应急情景动态推演。

文献[5]基于高效数据降维的配电网停电用户数量预测模型,在利用数据驱动建模的基础上,通过部分依赖图分析和特征降维的方法优化了模型的预测效果和计算效率。但在事故场景分类的过程中,忽略了其他可能影响停电事件的因素,导致无法有效降低大面积事故情景所带来的负面影响。文献[6]针对传

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