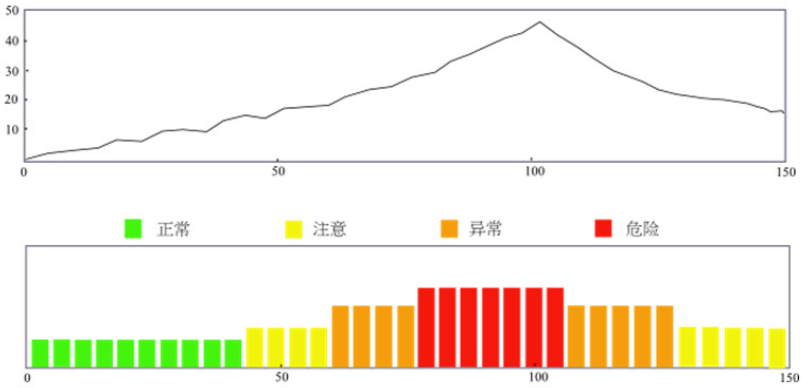

Fig.9 Test 1: Transaction response time and system output of forecast

图 9 测试 1:事务响应时间和模型预测输出

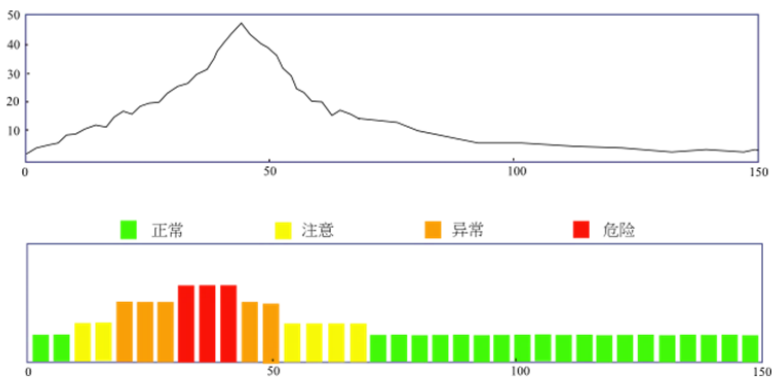

Fig.10 Test 2: Transaction response time and system output of forecast

图 10 测试 2:事务响应时间和模型预测输出

- 第 3 个测试场景为混合业务场景压力测试.

同时测试文件的修改与删除操作.每 10s 加载 10 个虚拟用户直到 50s 后,释放 30 个虚拟用户,然后在 10 秒后重新每秒加载 20 个用户.用户思考时间设置为实际值的 2%~5%.

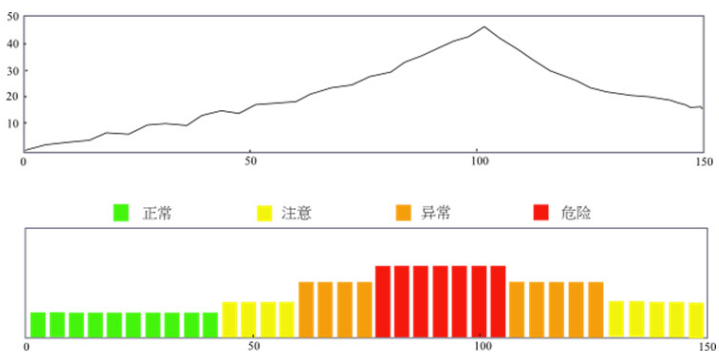

Fig.11 Test 3: Transaction response time and system output of forecast

图 11 测试 3:事务响应时间和模型预测输出

从实验数据分析我们看到:操作的平均事务响应时间在 10s 以内时,模型预测系统状态属于正常范围;10s~20s范围模型预测系统状态为注意;20s~30s范围模型预测系统状态为异常状态;30s以上为模型预测系统危险状态.另外,我们选取了系统状态预测为异常状态时的 CPU 使用率和 JVM 空间占用率数据分析,在该时间段,CPU 占用率超过了 75%,JVM 空间占用率超过 85%,系统处于严重状态.因此,模型评估和预测结果与我们的常识一致.上述实验结果表明:模型有效地评估了对系统的状态,特别是对危险状态进行了预测,因而可以较好地实时监控软件系统.

5 结束语

软件系统的状态评估机制是保障软件系统稳定运行的重要手段,然而随着软件系统规模不断增大,系统复杂性不断的提升,许多传统的评估方法的预测效果越来越不尽人意.这些方法主要的研究思路过于注重对软件系统的各个子系统的外在特征参数进行分析,建立简单模型对系统内部状态进行评估预测,这样往往不能充分挖掘大量数据中隐含的信息.本文则提出了一种基于隐马尔可夫模型的软件系统状态评估预测方法,该方法利用隐马尔可夫模型建立起系统外在状态(观测状态)和内部状态(隐藏状态)之间联系,从整体的角度对系统状态进行预测,而不拘泥于局部的特征,从而提高软件状态预测方法的准确性,便于软件系统管理和维护工作的开展.在今后工作中,我们将考虑进一步开发动态负载均衡算法以及相关程序包,并且结合软件系统的特征和本质对本算法进行优化,使其具有一定的普遍性和适用性.

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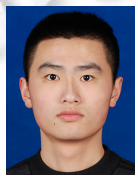
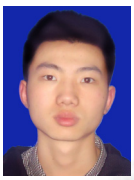
吴佳(1980－),女,四川荣昌人,博士,副教授,CCF 专业会员,主要研究领域为机器智能,数据挖掘.



陈瀚霖(1995－),男,CCF 学生会员,主要研究领域为数据挖掘,机器学习.



曾惟如(1995－),男,主要研究领域为神经网络,机器智能,数据分析.

唐雪飞(1964－),男,博士,副教授,主要研究领域为云计算,数据处理与数据可视化,代码自动化.