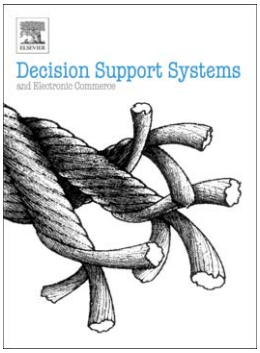

Test sequencing for sequential system diagnosis with precedence constraints and imperfect tests

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PII: S0167-9236(17)30177-X
DOI: doi:10.1016/j.dss.2017.09.009
Reference: DECSUP 12880

To appear in: *Decision Support Systems*

Received date: 19 February 2017
Revised date: 18 July 2017
Accepted date: 28 September 2017

Please cite this article as: Wenchao Wei, Hongbo Li, Roel Leus, Test sequencing for sequential system diagnosis with precedence constraints and imperfect tests, *Decision Support Systems* (2017), doi:10.1016/j.dss.2017.09.009

Test sequencing for sequential system diagnosis with precedence constraints and imperfect tests

Wenchao Wei*, Hongbo Li†, Roel Leus‡

Abstract. We study sequential system testing with the objective of minimizing the total expected testing costs. The goal is to discover the state of a system that consists of a set of independent components. The state of the system depends on the states of the individual components and is classified as working if at least a pre-specified number of components are working, otherwise it is said to be down. During the diagnostic testing procedure, components are tested one by one, in a pre-specified order. The resulting test sequencing problem is NP-hard with general precedence constraints even when the tests are perfect, in which case a component test always reports the correct state of the component. In this work, we will also consider the additional complication that tests can be imperfect, meaning that a test can report a component to be working when it is actually down, and vice versa. We develop a tabu search algorithm together with a simulation-based evaluation technique that incorporates importance sampling to find high-quality solutions within limited runtimes.

Keywords: system testing, sequencing and scheduling, precedence constraints, imperfect tests, tabu search, Monte Carlo simulation, importance sampling.

1. Introduction

System health monitoring for complex systems, such as a space shuttle, aircraft or integrated circuits, is crucial for reducing the likelihood of accidents due to sudden failures, and for improving system availability. It is also imperative that systems be tested before being put into operation, in order to ascertain their functionality. The problem of testing (diagnosing) a multi-component system through a series of tests of its components arises in many practical situations (Ünlüyurt, 2004): telecommunication (testing the connectivity of a network), manufacturing (quality control of newly manufactured products), electrical engineering (test whether a chip is functional or not), etc.

The k-out-of-n configuration is a special case of a complex system that requires that, for the overall system to be functional, at least k out of the total of n components must be working. This

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