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Imperfect inspection with directional information: A general failure probability model

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ABSTRACT

Suppose that the entire sequence of items produced is divided into a stream of nondefective items, followed by a stream of defective items. We propose a sequential inspection procedure for the production process that has a general failure probability–increasing, constant, or decreasing failure patterns. We also consider the inspector's classification errors as well as the costs of inspection and misclassifications. In numerical analysis, we show that other inspection models are special cases of our general model and analyze the effects of failure patterns on the inspection cost for various combinations of the type I and II errors.

KEYWORDS

dynamic programing; inspection error; quality control; screening; search model

1. Introduction

Consider a mass production of items, such as printing labels, mixing ingredients, or filling containers. We assume that the production process starts in control at the beginning of a production run and produces only nondefective items, but the production process is subject to a random failure at any time. If the process goes out of control, it stays in that state for the rest of the production run and produces only defective items. In such a case, the entire sequence of finished items can be divided into two disjoint sets: a stream of nondefective items, followed by a stream of defective items.

To detect any failure of the production process early, we may conduct an on-line inspection of items. In many cases, the 100 percent inspection of items is not economically justifiable due to a high inspection cost and time. As an alternative, every kth item is inspected during the production process. When we find a defective item, we stop the production process and inspect the k items in the last segment. The production process is then brought back to the in-control state. Thus, a renewal occurs at the end of each circle. Based on the assumption that the production process follows the renewal process, Chun (2010) recently proposed an on-line inspection model that determines how often to inspect items on the production line and how to detect more defective items.

In many practical situations, however, the production speed is relatively fast compared with the inspection time, and it is not feasible to carry out on-line inspections. Suppose that n items produced during a production run are arranged in chronological order, and an off-line inspection will be performed to find any defective items. When we inspect one of the n items in the sequence, we can obtain directional information about the timing of a process failure.

If the inspected item is defective, for example, the process went out of control before the defective item was produced and, thus, all the items produced after the defective item are also defective. If the tested item is nondefective, on the other hand, all the items produced before it in time are also nondefective and should be accepted with no further inspections. In this article, we make use of directional information to develop an off-line inspection model, which is more cost effective than the 100 percent screening of all items (Tang and Tang 1994).

As a concrete example of the off-line inspection procedure with directional information, consider the process of filling plastic cups with cottage cheese drawn from a large container in the pasteurized food industry (Herer and Raz 2000). The concentration of curd in the container must meet a given specification. When the plastic cups are being filled with the ingredient in the container, the concentration of curd could deviate from the specification. In such a case, all the cottage cheese cups filled after this point in time are

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