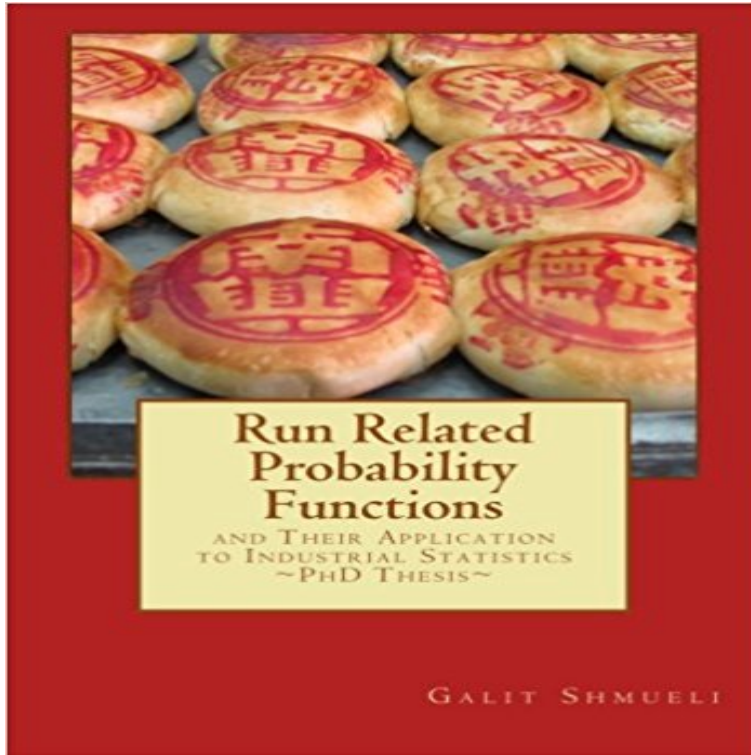


# Run Related Probability Functions and their Application to Industrial Statistics: Ph.D. Thesis



Various procedures that are used in the field of industrial statistics, include switching/stopping rules between different levels of inspection. These rules are usually based on a sequence of previous inspections, and involve the concept of runs. A run is a sequence of identical events, such as a sequence of successes in a slot machine. However, waiting for a run to occur is not merely a superstitious act. In quality control, as in many other fields (e.g. reliability of engineering systems, DNA sequencing, psychology, ecology, and radar astronomy), the concept of runs is widely applied as the underlying basis for many rules. Rules that are based on the concept of runs, or run-rules, are very intuitive and simple to apply (for example: use reduced inspection following a run of 5 acceptable batches). In fact, in many cases they are designed according to empirical rather than probabilistic considerations. Therefore, there is a need to investigate their theoretical properties and to assess their performance in light of practical requirements. In order to investigate the properties of such systems their complete probabilistic structure should be revealed. Various authors addressed the occurrence of runs from a theoretical point of view, with no regard to the field of industrial statistics or quality control. The main problem has been to specify the exact probability functions of variables which are related to runs. This problem was tackled by different methods (especially for the family of order  $k$  distributions), some of them leading to expressions for the probability function. In this work we present a method for computing the exact probability functions of variables which originate in systems with switching or stopping rules that are based on runs (including  $k$ -order variables as a special case). We use Fellers (1968) methods for obtaining the probability generating functions of run related variables, as well

as for deriving the closed form of the probability function from its generating function by means of partial fraction expansion. We generalize Fellers method for other types of distributions that are based on runs, and that are encountered in the field of industrial statistics. We overcome the computational complexity encountered by Feller for computing the exact probability function, using efficient numerical methods for finding the roots of polynomials, simple recursive formulas, and popular mathematical software packages (e.g. Matlab and Mathematica). We then assess properties of some systems with switching/stopping run rules, and propose modifications to such rules.

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