Detection of a Random Sequence of Disorders

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A random sequence having segments being the homogeneous Markov processes is registered. Each segment has his own transition probability law and the length of the segment is unknown and random. The transition probabilities of each process are known and *a priori* distribution of the disorder moment is given. The former research on such problem has been devoted to various questions concerning the distribution changes when more than one homogeneous segment is expected. The detection of the disorder rarely is precise. The decision maker accepts some deviation in estimation of the disorder moment. In the models taken into account the aim is to indicate the change point with fixed, bounded error with maximal probability. The case with various precision for over and under estimation of this point is analysed. The case when the disorder does not appears with positive probability is also included. The observed sequence, when the change point is known, has the Markovian properties. The results insignificantly extends range of application, explain the structure of optimal detector in various circumstances and shows new details of the solution construction. The motivation for this investigation is the modelling of the attacks in the node of networks. The objectives is to detect one of the attack immediately or in very short time before or after it appearance with highest probability. The problem is reformulated to optimal stopping of the observed sequences. The detailed analysis of the problem is presented to show the form of optimal decision function.

The detection precision implemented here support investigations of non-homogeneous processes. In the application of the considered model is well known as this sequential methods can be used for non-sequential problems that arise in the analysis of multi-state processes. In a variety of applications, the observed dynamical system switches between different modes. Thus, the observed process is non-stationary, but it consists of homogeneous segments separated by mode switch times, or change-points. Each mode corresponds to a particular distribution, however, the change-points and the modes are usually unknown. The general class of such stochastic processes are referred as multi-state processes. A subclass of multi-state processes with the additional assumption of a Markov chain that governs the mode switching is called hidden Markov chains. The latter are widely used in speech recognition, biological sequences alignment, biochemistry, genetics, and signal processing. The problems can be resolved by a suitable sequential scheme, that can re-sample the data sequentially and handle one homogeneous segment at a time. At each step, a sequential change-point detection tool is applied to detect the occurrence of the next change-point. If detected, the location of the change-point is estimated, and after that, the algorithm is applied to the post-change data.

Key Words: disorder problem, sequential detection, optimal stopping, change point