Chapter 32
An Assessment of Imbalanced Control Chart Pattern Recognition by Artificial Neural Networks

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ABSTRACT

Manual detection of abnormality in control data is an annoying work which requires a specialized person. Automatic detection might be simpler and effective. Various methodologies such as ANN, SVM, Fuzzy Logic, etc. have been implemented into the control chart patterns to detect abnormal patterns in real time. In general, control chart data is imbalanced, meaning the rate of minority class (abnormal pattern) is much lower than the rate of normal class (normal pattern). To take this fact into consideration, authors implemented a weighting strategy in conjunction with ANN and investigated the performance of weighted ANN for several abnormal patterns, then compared its performance with regular ANN. This comparison is also made under different conditions, for example, abnormal and normal patterns are separable, partially separable, inseparable and the length of data is fixed as being 10,20, and 30 for each. Based on numerical results, weighting policy can better predict in some of the cases in terms of classifying samples belonging to minority class to the correct class.

INTRODUCTION

Quality control engineering provides some strategies to ensure a product is satisfied with some predetermined quality standards before market release. It provides the necessary mathematical and statistical tools to improve a process, to assure safety, and to analyze reliability (Montgomery, 2007). Quality control process can also help to detect a failure in the production systems such as machine failure. Sequential production of an item that does not satisfy the quality standards can be a sign of a machine

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failure (Panagiotidou & Tagaras, 2012; Paté-Cornell, Lee, & Tagaras, 1987). Early detection of a machine failure can help to avoid expensive equipment and reducing repair cost. Over the years, various rules are implemented such as zone tests or run tests (Jill A Swift & Mize, 1995). Manual quality control process can be a tedious task and highly relies on human skills and experience. For this reason, automated systems to detect abnormal behavior in a control chart is developed by researchers (Hachicha & Ghorbel, 2012). Automated methods provide sophisticated techniques to distinguish abnormal and normal pattern during the production process. Over the years, various normal and abnormal patterns reported in real production systems. In an early study of Western Electric Company, seven abnormal patterns are identified and formulized which are named as uptrend (UT), downtrend (DT), upshift (US), downshift (DS), cyclic (C), systematic (S), stratification (F) patterns are shown in Figure 1, also the mathematical formulations of all these abnormal patterns are given in APPENDIX-A.

Figure 1. Example of six abnormal patterns vs normal pattern