Multilevel process monitoring: A case study to predict student success or failure

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Abstract:

The paper that will be presented considers three research questions concerning high school students' performance. We worked together with a Dutch high school in attempting the following questions (1) What determines student performance? (2) How can statistical process monitoring be used for predictive monitoring of student progress? (3) What method can be used for predictive monitoring of student results?
One-level linear regression models did not provide satisfactory results and univariate statistical process monitoring techniques proved insufficient. We discuss a three-level model and propose residual control charting at the three levels as the multilevel statistical process monitoring method for online process monitoring of process output. However this method is insufficient for identifying students who need either support or more challenging coursework. Therefore a predictive monitoring method has been developed to enable an early warning system. This method monitors the probability of an event, rather than a process output. The three-level model was used to continuously predict end-of-year grades. Using a Bayesian hierarchical model, probability distributions for the student outcomes are obtained. These can be used to monitor unwanted results in the form of under- and overperforming students using a single predictive control chart setup.

Keywords:
Hierarchical Bayesian; multilevel; predictive monitoring; statistical process monitoring; student performance