Advanced multivariate methods for the analysis and monitoring of chemical processes

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In modern manufacturing industrial plants, huge quantities of data are routinely collected by automated sensors. Classical statistical approaches are not able to deal with such kind of data, since they often show high correlation, low signal-noise ratio and missing values. However, there exist different methods, based on the so-called latent variables, which exploit this correlation in order to model the structure of the process space and describe the tipically few independent changes, which occur during its evolution. This Ph.D. project is devoted to the research into the field of multivariate latent variable-based analysis for the monitoring of chemical continuous and batch processes, with special focus on the improvement of real-time technologies and diagnostics and interpretation tools.

Doc, I think beer from fermentator #3 has some problems… HIC!

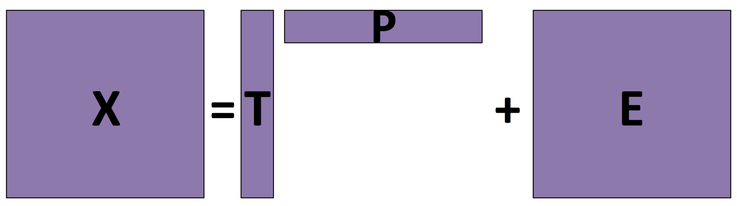
Well, let's have a look at the process data

Mmm…

37849894736239494027494859987653738393284927673290485428392898594090385023983279505904409437850400498503859878978993222341283928985940903850239832795059049044094385040049850385987897899893222341

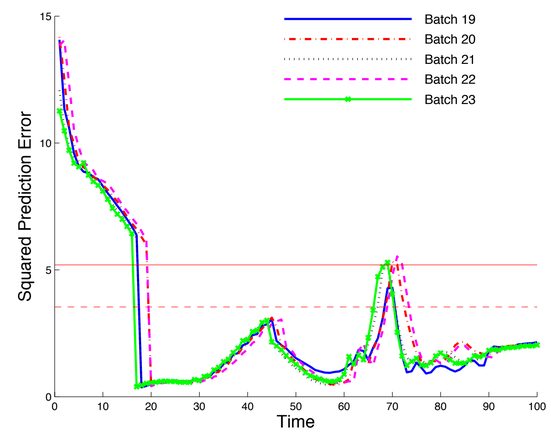
Why not go on with beer, Doc?

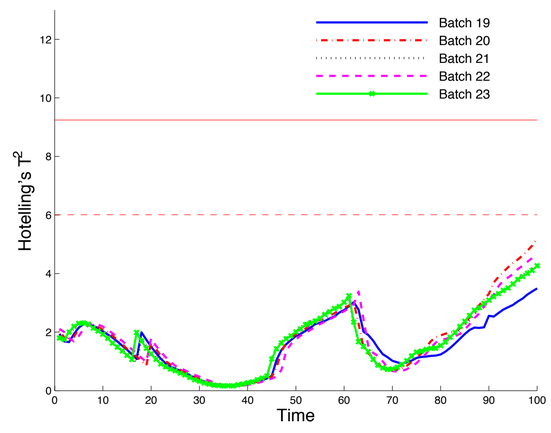
Don't worry, bro! There exist many multivariate analysis techniques which permit to extract the maximum exploitable information from complex data like these and visualize it in a really simple way



Principal Component Analysis (PCA) is one of these methods. It reduces the dimensionality of the dataset under study greatly simplifying industrial process analysis, monitoring, control and optimization.

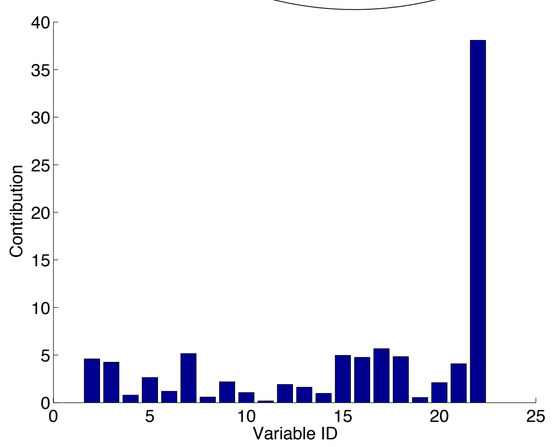
At the end, having a look at only two control charts, you can detect the problems occuring during the evolution of your process





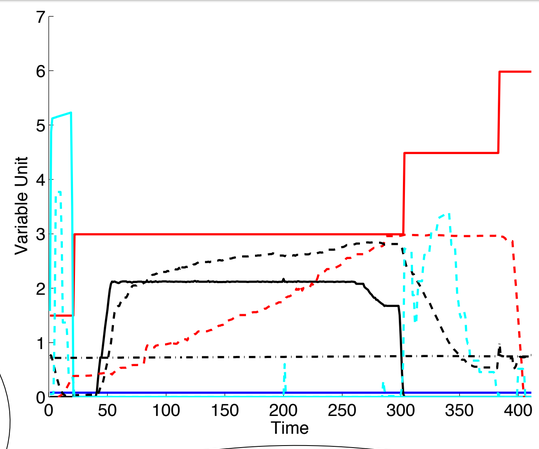
Ok, I got your point. But what about the identification of the problem? Where should our technician focus for repairing the plant?

A graphical tool called contribution plot permits to get an idea about which of the originally measured variables evolved differently with respect to an *in-control* situation. Could you recognize what's the problem in this case?

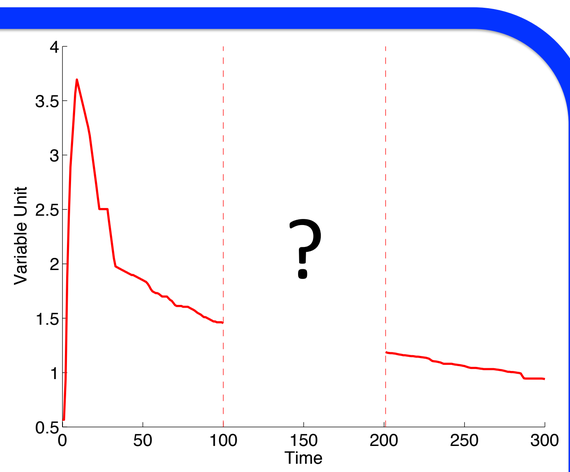


WOW! But if it's so easy, Doc, why do we need this strange guy from the university?

Well, real industrial process data analysis may represent a not so easy problem to deal with because of specific issues such as…



…rather complex relationships affecting the datasets under study…



…or missing values.

We decided to start a joint work with academia aimed at developing novel methodologies for improving real process analysis and manufacturing operations, reducing costs and the environmental impact. As an old wise man used to say: "To solve your problems, you need only three things…"

TALK, TALK and TALK