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Personalized Monitoring: Applying Classical Tools to New Data

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Industrial statisticians played an important role in the success of the Industrial Revolution. The analytical methods developed in our field have been used to leverage data from machines and workers to improve processes, safety, and products for nearly 100 years. We are now in the midst of the Information Age, and the data revolution brings the challenges and opportunities of our time. Our success in the data revolution rests in our ability to leverage the new scale, scope, and type of data to improve processes, safety, products, health, and services. We have tremendous opportunities and tremendous challenges. An important opportunity for our field is to leverage data that emerges from sensors. Many low-cost, multifunction, wearable devices have been developed. The data from these devices have been used, for example, in recreational, health, productivity, and safety monitoring. This type of data is high frequency, noisy, and follows specific periodic patterns that depend on what is being monitored and the context of the monitoring. In this talk, we will explore the challenges associated with monitoring gait patterns using data from low-cost wearable Inertial Measurement Units (IMUs). The goal of the analysis is to understand how changes in gait patterns relate to fatigue with the end goal of automatically detecting fatigue in an industrial setting. Although many have used sensor data for gait analysis, most treat this as a classification problem, using either statistical or machine learning methods for binary classification. The classification approaches are generally supervised and require a large number of participants with labeled cases of non-fatigued and fatigued periods. Our research team approached this differently by developing personalized monitoring schemes for each individual. Several univariate, multivariate and profile statistical process monitoring methods were explored. The team developed personalized monitoring frameworks based on modifications of classical univariate and multivariate control chart methods and supplemented these frameworks with straightforward diagnostic information. Although it is intuitively appealing, using the classical methods on this new data brings new and unexpected challenges. With these challenges come many opportunities for improved methodology and research in process monitoring related to sensor data. This talk is based on joint work with Saeb Ragani Lamooki, Fadel M. Megahed, Jiyeon Kang, and Lora A. Cavuoto.

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