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Dipartimento di Ingegneria Industriale

Dipartimento di Eccellenza 2023 - 2027

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Book of Abstracts

ISSPM 2025

8th International Symposium on Statistical Process Monitoring (ISSPM 2025)
7th-11th July 2025, Naples, Italy

ISSPM 2025 PROGRAM AND ABSTRACTS

Program and abstracts of the ISSPM 2025 Conference. 7-11 July 2025
ISSPM (https://www.isspm2025.cesma.unina.it/)

Edited by: Sotiris Bersimis, Christian Capezza, Giovanna Capizzi, Philippe Castagliola, Giovanni Celano, Subha Chakraborti, Davide Forcina, Sven Knoth, Massimiliano Giorgio, Antonio Lepore, Biagio Palumbo, Amalia Vanacore.

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13:30–17:30: **Pre-Conference Tour: Archeological Park of Pompeii**
View details: https://www.isspm2025.cesma.unina.it/program/pre-conference-tour

19:00–19:30: **Registration at the Conference Center**

19:30: **Welcome Cocktail at the Conference Center**

Tuesday July 8, 2025

9:15–9:30: **Technical Opening**
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9:30–10:00: **Opening Ceremony**
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- N. Bianco, Director of the Department of Industrial Engineering
- A. Lanzotti, South delegate of the Extended Partnership MICS (Made in Italy - Circular and Sustainable)
- Representative of the Scientific Committee
- Chairs of the Local Organizing Committee

10:00–10:45: **Session #1 – Ross Spark's Memory and Honor**
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- Sotiris Bersimis (recording)

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- Kamran Paynabar (Georgia Tech)
- Fugee Tsung (Hong Kong University of Science and Technology)
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9:30–11:00: **Session #4 – Nonparametric, Bayesian and Modified SPM Schemes**

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17:00–17:40: **Session #7 – Industrial**
Session chair: Biagio Palumbo (University of Naples Federico II)
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17:40–18:00 **Organizational Notes**

19:30: **Gala Dinner**

Thursday July 10, 2025

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9:30–11:00: **Session #8 – Functional and Multivariate SPM in Modern Applications**
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11:00–11:30: **Coffee Break**

11:30–13:00: **Session #9 – Machine Learning for Process Monitoring: Methods, Challenges, and Applications**

Session chair: Sotiris Bersimis (University of Piraeus)
Room: Plenary

13:00–13:15: **Organizational Notes**

13:15–15:00: **Lunch Break**

15:00–15:30: **Session #10 – Young Session**

Session chair: Antonio Lepore (University of Naples Federico II)
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16:00–16:30: **Coffee Break**

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- Recognize to present and past Local Organizers
- Next ISSPM 2027 location

17:00: **Organizational Notes**

Friday July 11, 2025

10:00–17:00: **Post-Conference Tour: Tour of the Historic Center of Naples**

View details: https://www.isspm2025.cesma.unina.it/program/post-conference-tour[0.4cm]

List of Abstracts

Statistical Process Monitoring with Interval Data

W. Woodall[1], ***S. Steiner***[2]

[1]Department of Statistics, Virginia Tech, United States
[2]Department of Statistics and Actuarial Science, University of Waterloo, Canada

Several methods have been proposed for process monitoring with interval data. We examine these methods and propose a simulation-based approach that is much easier to implement and has a much clearer interpretation.

In particular, neutrosophic statistical analysis is based on interval data. The use of the neutrosophic monitoring methods was considered by [2] and [3]. Neutrosophic methods for analyzing regression data and data from designed experiments was studied by [1] and [4]. Generally, these authors have identified serious flaws in the neutrosophic approaches.

Keywords: Neutrosophic statistics, Control chart, Statistical process control.

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[3] Woodall, W. H., Driscoll, A. R., and Montgomery, D. C. (2022). "A Review and Perspective on Neutrosophic Statistical Process Monitoring Methods". IEEE Access 10, 100456 – 100462.
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EWMA control charts for exponential data — workbench for considering transformations and numerical methods

S. Knoth[1]

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The inherent simplicity of the exponential distribution allows explicit solutions of the average run length (ARL) integral equation for various control charts (here EWMA charts), cf. to some handy methods in [3]; [4]; [1]. On the other hand, the omnipresent Markov chain approximation method works feebly (an example will be given, for illustration). Nonetheless, it was used, for example, in [2]; [7] and elsewhere. Deploying the link between the exponential and the chi-square distribution with two degrees of freedom allows the usage of results (collocation applied to the ARL integral equation) for EWMA S^2 charts in [6], where an R package is available. Finally, Monte Carlo studies can be utilized. Thus, one goal of the talk is comparing all these numerical algorithms and promoting efficient ones.

Having all these methods, we can judge whether transformations of the exponential like in [9]; [5]; [8]; [7], in particular $X^{1/3.6}$ for achieving a bell-shape density function, which mimics the normal case, or other ones like e^{-X} and $\Phi^{-1}(e^{-X})$ to get (exact) beta (uniform in the in-control case) and normal distribution, respectively, are appropriate convenience wrappers or simply diminish the detection performance. Eventually, some recommendations regarding the usage of these transformations will be given.

Keywords: EWMA charts, Exponential data, ARL calculation, Transformations

References

[1] AREEPONG (2009) An integral equation approach for analysis of control charts. PhD thesis, U Technology Sydney
[2] BORROR, MONTGOMERY, RUNGER (1999) Robustness of the EWMA control chart to non-normality. JQT 31(3), 309–316
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[5] KITTLITZ (1999) Transforming the Exponential for SPC Applications. JQT 31(3), 301–308.
[6] KNOTH (2005) Accurate ARL Computation for EWMA-S2 Control Charts. Stat. Comp. 15(4), 341–352
[7] LIU, XIE, GOH, HAN (2007) A study of EWMA chart with transformed exponential data. IJPR 45(3), 743–763
[8] MCCOOL, JOYNER-MOTLEY (1998) Control Charts Applicable When the Fraction Nonconforming is Small. JQT 30(3), 240–247
[9] NELSON (1994) A Control Chart for Parts-per-Million Nonconforming Items. JQT 26(3), 239–240

Active Learning in Process Monitoring Using Streaming Data

C. Capezza[1], ***A. Lepore***[1], ***K. Paynabar***[2]

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[2]School of Industrial and Systems Engineering, Georgia Tech, Georgia, United States

Industrial systems increasingly rely on continuous data streams to monitor process conditions and ensure quality control. While supervised statistical process monitoring techniques can detect deviations from normal operating conditions, their effectiveness depends on labeled data, which are often costly or infeasible to acquire in real time. This work introduces a novel active learning framework for sequential decision-making in labeling under budget constraints. Leveraging partially hidden Markov models, the method captures temporal dependencies and integrates partially labeled data to support dynamic classification of process states. A dual-objective strategy is developed to guide real-time labeling decisions, balancing exploitation, i.e., improving discrimination between known states, and exploration, i.e., discovering previously unobserved out-of-control modes. Validation through simulations and an industrial case study on resistance spot welding in automotive manufacturing demonstrates improved classification accuracy and efficient label usage compared to traditional monitoring approaches.

Keywords: Statistical Process Monitoring, Hidden Markov Model, Sequential Data Analysis, Imbalanced Classification

Acknowledgements
The research activity of C. Capezza and A. Lepore was supported by Piano Nazionale di Ripresa e Resilienza (PNRR) - Missione 5 Componente 2, Investimento 1.3-D.D. 1551.11-10-2022, PE00000004 within the Extended Partnership MICS (Made in Italy - Circular and Sustainable). This manuscript reflects only the authors' views and opinions, neither the European Union nor the European Commission can be considered responsible for them.

Adapting OpenAI's CLIP Model for Few-Shot Image Inspection in Manufacturing Quality Control: An Expository Case Study with Multiple Application Examples

F. M. Megahed[1], ***Y. Chen***[2], ***B. M. Colosimo***[3], ***M. L. Grasso***[3], ***L. Jones-Farmer***[4], ***S. Knoth***[5], ***H. Sun***[6], ***I. Zwetsloot***[7]

[1]Department of Farmer School of Business, Miami University, USA
[2]University of Dayton, USA
[3]Politecnico di Milano, Italy
[4]Miami University, USA
[5]Helmut Schmidt University, Germany
[6]University of Georgia, USA
[7]University of Amsterdam, Netherlands

This expository paper introduces a simplified approach to image-based quality inspection in manufacturing using OpenAI's CLIP (Contrastive Language-Image Pretraining) model adapted for few-shot learning. While CLIP has demonstrated impressive capabilities in general computer vision tasks, its direct application to manufacturing inspection presents challenges due to the domain gap between its training data and industrial applications. We evaluate CLIP's effectiveness through five case studies: metallic pan surface inspection, 3D printing extrusion profile analysis, stochastic textured surface evaluation, automotive assembly inspection, and microstructure image classification. Our results show that CLIP can achieve high classification accuracy with relatively small learning sets (50-100 examples per class) for single-component and texture-based applications. However, the performance degrades with complex multi-component scenes. We provide a practical implementation framework that enables quality engineers to quickly assess CLIP's suitability for their specific applications before pursuing more complex solutions. This work establishes CLIP-based few-shot learning as an effective baseline approach that balances implementation simplicity with robust performance, demonstrated in several manufacturing quality control applications.

Keywords: Computer vision, Industry 4.0, Supervised fault detection, Vision transformer, And visual inspection

Acknowledgements
The work is partially supported by the NSF Grant No. FM-2134409 and CMMI-2412678.

An Adaptive Multivariate Functional Control Chart

F. Centofanti[1], ***A. Lepore***[2], ***B. Palumbo***[2]

[1]Section of Statistics and Data Science, Department of Mathematics, KU Leuven, Belgium
[2]Department of Industrial Engineering, University of Naples Federico II, Italy

New data acquisition technologies allow one to gather amounts of data that are best represented as functional data. In this setting, profile monitoring assesses the stability over time of both univariate and multivariate functional quality characteristics. The detection power of profile monitoring methods could heavily depend on parameter selection criteria, which usually do not take into account any information from the out-of-control (OC) state. This work proposes a new framework, referred to as adaptive multivariate functional control chart (AMFCC), capable of adapting the monitoring of a multivariate functional quality characteristic to the unknown OC distribution by combining p-values of partial tests corresponding to Hotelling T^2-type statistics calculated at different parameter combinations. Through an extensive Monte Carlo simulation study, the performance of AMFCC is compared with methods that have already appeared in the literature. Finally, a case study is presented in which the proposed framework is used to monitor a resistance spot welding process in the automotive industry. AMFCC is implemented in the R package funcharts, available on CRAN.

Keywords: Functional Data Analysis, Profile Monitoring, Statistical Process Control, Adaptive Testing, Nonparametric Combination

Nonparametric Control Charts for Detecting Shifts in Location and Scale based on new Lepage-type Statistics

A. Rakitzis[1]**, *S. R. Shinde***[2]**, *S. B. Mahadik***[2]**, *D. G. Godase***[3]

[1]Department of Statistics and Insurance Science, University of Piraeus, Greece
[2]Department of Statistics, Shivaji University, Kolhapur, India
[3]Department of Statistics, The New College, Kolhapur, India

In this work we investigate the performance of Phase II nonparametric Shewhart- and CUSUM-type control charts based on two new Lepage-type statistics. Specifically, the first is based on van der Waerden and Ansari-Bradely tests while the second uses the Mood test instead of the Ansari-Bradley test. Using Monte Carlo simulation, we evaluate the performance of the considered charts in terms of their average run length and compare them with existing competitive nonparametric charts for joint monitoring, under different distributional models. In addition, we provide empirical rules for the statistical design of the proposed charts. The numerical results show that the proposed charts, especially those based on the van der Waerden and Mood tests, are viable alternatives to the existing monitoring schemes. Finally, we illustrate the implementation of the proposed charts in practice through a real-data example.

Keywords: Ansari-Bradley statistic, Average run length, Mood statistic, Nonparametric control charts, Van der waerden statistic

Acknowledgements
This work has been partly supported by the University of Piraeus Research Center.

Self-Starting Shiryaev (3S): A Bayesian Change Point Model for Online Monitoring of Short Runs

P. Tsiamyrtzis[1], ***K. Bourazas***[2]

[1]Department of Mechanical Engineering, Politecnico di Milano, Italy
[2]Department of Economics, Athens University of Economics and Business, Greece

The Shiryaev's change point methodology is a powerful Bayesian tool in detecting persistent parameter shifts. It has certain optimality properties when we have pre/post-change known parameter setups. In this work we will introduce a self-starting version of the Shiryaev's framework that could be employed in performing online change point detection in short production runs. Our proposal will utilize available prior information regarding the unknown parameters, breaking free from the phase I requirement and will introduce a more flexible prior for change-point parameter, compared to what standard Shiryaev employs. Apart from the on-line monitoring, our proposal will provide posterior inference for all the unknown parameters, including the change point. The modeling will be provided for Normal data, and we will guard for persistent shifts in both the mean and variance. A real data set will illustrate its use, while a simulation study will evaluate its performance against standard competitors.

Keywords: Bayesian Statistical Process Control and Monitoring, At Most Once Change (AMOC), Persistent Shifts, Phase I

Practical Significance and the Modified Control Chart with Estimated Parameters

F. Schoemer Jardim[1], ***B. Ker Simão***[2], ***P. C. Oprime***[2], ***S. Chakraborti***[3], ***M. A. Guerreiro Machado***[4]

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[3]Department of Information Systems, Statistics and Management Science, The University of Alabama (UA), United States
[4]Department of Production Engineering, São Paulo State University (UNESP), Brazil

This presentation addresses the practical limitations of traditional Shewhart X-bar control charts when applied to highly capable processes. While a point outside the control limits typically triggers an out-of-control signal, such a signal may lack practical relevance when the process continues to produce an acceptably low fraction of nonconforming items. The Modified X-bar Control Chart (MCC) was developed for such situations, but under the assumption of a known standard deviation. In this study, we extend the MCC to the more realistic case where the standard deviation is estimated from Phase I data. We show that this estimation introduces additional variability, inflating both the false alarm rate and the fraction nonconforming. To address these effects, we derive adjustments to both the acceptable region and the control limits, ensuring that the chart meets pre-specified in-control performance criteria.
A practical example highlights the importance of these adjustments, particularly for small sample sizes, and demonstrates the benefits of using our proposed modified chart.

Keywords: Modified Control Chart, Practical Significance, Parameter Estimation, Fraction Nonconforming, False Alarm Rate

The expressions to obtain the probability with which the sample Cpk values exceed a threshold

A. F. Costa[1]

[1]Department of IEPG, UNIFEI, Brazil

The index Cpk was created to quantify the ability of the process to produce products within specified limits, but in recent studies the sample estimator C of the capability index Cpk has also been used to control processes and to decide whether a lot should be accepted or not. In this article, we discuss the different expressions that are used to obtain the probability Pr [C < k], where k is the threshold that decides the lot acceptance, or the upper control limit of the Cpk chart.

Keywords: Control chart, Sampling plan, Sampling distribution of the cpk values

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CNPq

Design of EWMA control charts for monitoring the zero-inflated negative binomial distribution using conditional false alarm rate

B. Aytaçoğlu[1]

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Zero-inflated models are commonly used to handle count data that exhibit over-dispersion and a high frequency of zeros. One of these models is the zero-inflated negative binomial (ZINB) model. This study proposes the implementation of dynamic probability control limits (DPCLs) in exponentially weighted moving average (EWMA) control charts for monitoring processes with ZINB-distributed data. The use of DPCLs in designing the control charts has proven to be very useful to overcome the undesirable performance of the control charts due to change in the sample size, risk scores, or covariate values over time. This study considers the case in which the sample size distribution is not known beforehand or may vary over time. The results demonstrate that this method maintains a consistent conditional false alarm rate for the ZINB-EWMA chart, even when the sample size changes over time. Our findings emphasize the chart's capability to dynamically adjust its control limits in response to fluctuations in sample size. The effect of the ZINB distribution's dispersion parameter on monitoring performance is also examined.

Keywords: Dynamic probability control limits, Exponentially weighted moving average (EWMA) chart, Statistical process control, Statistical process monitoring.

Preliminary results on new control charts for inflated binomial processes *(part I)*

***A. Arques-Colomina*[1], *M. C. Belmonte-Bueso*[1], *V. Giner-Bosch*[2], *P. Castagliola*[3]**

[1]Department of Applied Statistics, Operational Research and Quality, Universitat Politècnica de València, Spain
[2]Centre for Quality and Change Management, Universitat Politècnica de València, Spain
[3]Nantes Université & LS2N UMR CNRS 6004, France

In this talk, we present some new monitoring schemes for inflated binomial processes. More precisely, a control chart for a quality characteristic following a zero-inflated binomial (ZIB) distribution is developed based on a discrete version of the EWMA strategy called CEWMA (for count EWMA; Rakitzis et al., 2015 [1]). A procedure for optimally determining the chart parameters is devised and implemented, the performance of the chart being evaluated through an exact calculation of the ARL via Markov chain methods.

Additionally, we present an extension of the ZIB model called the geometrically-inflated binomial (GIB) distribution, which is defined similarly to its Poisson counterpart (Rakitzis et al., 2016 [2]), and we explore some control charts for a process following this distribution. Specifically, a traditional Shewhart-like scheme and some run-rule strategies are developed and studied, focusing on optimal performance.

Preliminary results on the performance of these new charts are presented, as well as a study on how they compare against their competitors.

Keywords: Zero-inflated binomial distributions, High-yield processes, discrete EWMA, Run rules, Markov chains

References

[1] Rakitzis AC, Castagliola P, Maravelakis PE (2015). A New Memory-Type Monitoring Technique for Count Data. Computers and Industrial Engineering, 85:235–247. [doi:10.1016/j.cie.2015.03.021]
[2] Rakitzis AC, Castagliola P, Maravelakis PE (2016). On the Modelling and Monitoring of General Inflated Poisson Processes. Quality and Reliability Engineering International, 32(5):1837–1851. [doi:10.1002/qre.1917]

Preliminary results on new control charts for inflated binomial processes *(part II)*

A. Arques-Colomina[1], **M. C. Belmonte-Bueso**[1], ***V. Giner-Bosch***[2], ***P. Castagliola***[3]

[1]Department of Applied Statistics, Operational Research and Quality, Universitat Politècnica de València, Spain
[2]Centre for Quality and Change Management, Universitat Politècnica de València, Spain
[3]Nantes Université & LS2N UMR CNRS 6004, France

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[2] Rakitzis AC, Castagliola P, Maravelakis PE (2016). On the Modelling and Monitoring of General Inflated Poisson Processes. Quality and Reliability Engineering International, 32(5):1837–1851. [doi:10.1002/qre.1917]

Old Tool, New Purpose: Statistically Equivalent Blocks in Multivariate SPC

C. L. Holcombe[1]

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Multivariate statistical process control (MSPC) charts are particularly useful when there is a need to simultaneously monitor several quality characteristics of a process. Most control charts in MSPC assume that the quality characteristics follow some parametric multivariate distribution, such as the normal. This assumption is often very difficult to justify in practice. Distribution-free MSPC charts are attractive, as they can overcome this hurdle by guaranteeing a stable (or in-control) performance of the control chart without the assumption of a parametric multivariate process distribution. Several distribution-free MSPC charts based on nonparametric hypothesis testing methods have been proposed, utilizing the natural connection between control charts and sequential testing. Recent work in the two-sample hypothesis testing literature has explored the connection between many classical nonparametric tests and statistically equivalent blocks (se-blocks). Using the se-block formulation for many classic rank, placement, and sign-type tests allows for the easy extension to the multivariate setting. These multivariate tests are computationally inexpensive, interpretable, and exactly distribution-free. The goal of this talk is to explore the potential impact of this literature on the development of MSPC charts in the unknown parameters setting. In addition to reviewing an existing control chart based on se-blocks, areas for future work are explored.

Keywords: Nonparametric, Distribution-Free, Statistically Equivalent Blocks, Multivariate, Case U

Detecting Covariance Shifts in Multichannel Profiles

***C. Capezza*[1], <u>*D. Forcina*</u>[1], *A. Lepore*[1], *B. Palumbo*[1]**

[1]Department of Industrial Engineering, University of Naples Federico II, Italy

Modern industrial systems generate multichannel profile data continuously, requiring effective real-time monitoring and fault diagnosis. While many existing methods prioritize detecting shifts in the process mean, changes in the covariance structure are just as important, as they reflect the dynamic interdependencies among multiple variables. This study introduces a functional graphical modeling framework to represent conditional dependencies in multichannel profile data, addressing challenges posed by high dimensionality and sparsity. The method leverages penalized likelihood ratio tests with adaptive penalty terms to detect a wide range of covariance structure changes. To enhance interpretability, a diagnostic procedure based on change-point detection is used to pinpoint the specific relationships that have changed. Simulation studies and a case study on multichannel temperature profile monitoring demonstrate the superior performance of the proposed approach compared to existing methods.

Keywords: Profile Monitoring, Statistical Process Control, Functional Graphical Models, Multichannel Profiles

Acknowledgements
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Efficient Monitoring of Highly Dimensional Data Streams

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The creation of big data is driven by the increasing digitization of information and the proliferation of devices that collect data. As technology advances, the volume, variety, and velocity of data generation continue to grow, leading to the emergence of big data analytics, which aims to extract valuable insights from these extensive datasets. The increasing volume of data presents several opportunities and challenges. In the context of Statistical Process Monitoring (SPM), analyzing high-dimensional data can lead to the "curse of dimensionality," where the data becomes sparse, making it difficult to detect patterns and anomalies. Moreover, another challenge is related to modeling and monitoring complex relationships between multiple variables. Furthermore, implementing Multivariate SPM (MSPM) in real-time settings is difficult due to the need for rapid computation and decision-making, especially when dealing with large volumes of streaming data. A possible solution is to combine MSPM approaches with Machine Learning (ML) methods, however, more challenges arise related to model interpretability, feature selection, and integration of results. In this paper, we propose a robust method which is based on a strategy coming from cluster analysis context. The proposed method is compared to established multivariate control charts based on Hotelling T-Square statistic as well as to other statistics coming from cluster analysis framework, i.e. Dunn's Index. An extensive simulation study showed that the proposed method outperforms in terms of performance its competitors under different scenarios, when data streams consists of a large number of correlated features.

Keywords: Process monitoring, Separability index, Data streams, Machine learning, Cluster Analysis

Long-term profile monitoring with multivariate functional data for application in structural health monitoring

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Structural Health Monitoring (SHM) is crucial in modern civil engineering, enabling the assessment of infrastructure integrity and health. However, environmental influences and measurement errors often obscure structural changes, making it challenging to detect anomalies. This paper presents a novel multivariate monitoring approach for SHM based on functional data analysis (FDA), extending a recently introduced framework of Wittenberg et al. (2025). By integrating supervised and unsupervised methods within a unified function-on-function regression framework, our approach effectively mitigates covariate-induced variations, enhancing the detection of structural changes in multivariate sensor data streams. This results in a comprehensive and robust method for SHM applications, capable of handling large, complex, and/or sparse sensor data.

Keywords: Functional Data Analysis, Multivariate Exponentially Moving Average control chart, Principal Component Analysis

Acknowledgements
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From classical SQC to Quality 5.0 with qcr package

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This presentation explores the powerful capabilities of the qcr package for tackling quality control challenges in the evolving landscape of Industry 5.0. As sensor-generated data becomes increasingly prevalent in modern manufacturing environments, the need for advanced tools to monitor and analyze complex processes is more critical than ever. We will demonstrate how qcr enables effective statistical process monitoring, particularly when dealing with functional data, and discuss its potential to enhance decision-making and operational efficiency in smart, interconnected industrial systems. The qcr package provides a complete set of computational free tools to implement Statistical Process Control (SPC) from complex data, in Industry 5.0 domain. Indeed, it includes a comprehensive set of control charts that allow practitioner to detect anomalies from univariate, multivariate, and even functional data, using authors' own.

Keywords: Functional Data, Industry 5.0, Statistical Process Control.

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One-Class Classification in Neural Networks

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The performance of Artificial Neural Networks (ANNs) can decline when the neural network parameters shift over time. To maintain reliable predictions, it is crucial to monitor the neural network architecture and update or retrain the model when necessary to adapt to new data patterns.

To address this issue, we propose utilizing one-class classification techniques to monitor the latent feature representations, or "embeddings," produced by the ANN. One-class classification methods can detect changes in the data stream. If new data points begin to fall outside these boundaries, it indicates a potential change in the underlying data distribution or the parameters of the neural network, which may impact model accuracy and highlight the need for retraining.

Keywords: Embedding layer, One-class classification, Anomaly detection, LS-SVDD

Practical Considerations for Implementing the Isolation Forest EWMA Control Chart in Phase II Process Monitoring

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Statistical monitoring methodologies are constantly evolving to cope with various data complexities, non-standard situations and related questions that often arise in modern day applications. These questions, for example, relate to the speed of data collection, multi-dimensionality and distributional assumptions. In this context, researchers in the Statistical Process Monitoring (SPM) literature have recently considered Statistical Learning (SL) techniques as viable means to define models under more practical assumptions, and thus to allow setting up control charts for monitoring process stability in a variety of situations. However, a rigorous investigation of some of the key issues related to the implementation of the SL based control charts, supporting on-line (Phase II) SPM, has been lacking and is much needed. As a first step in this direction, here we consider a control chart based on the Isolation Forest (IF), an unsupervised SL technique running an ensemble of decision trees, which has recently been extended to the SPM area. We examine key implementation issues related to the selection of a proper Phase I reference sample, as it strongly influences the model trained to construct the control chart and its statistical performance properties. Our results show that correctly running an IF control chart is a challenging task, needing careful attention by the practitioners. In particular, a huge Phase I sample size and a careful check of the reference sample stability are required to maintain the in-control performance of the control chart at the anticipated target level, and to prevent a significant deterioration of the chart's shift detection capability.

Keywords: Statistical Learning, Multivariate processes, Isolation Forest, Statistical Performance

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Image-Based Process Control: A CNN Approach for Joint Detection and Localization in Spatiotemporal Fault Analysis

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Convolutional Neural Networks (CNNs) have emerged as one of the most effective tools for image analysis. In this study, we propose a custom-designed CNN architecture to construct a process control scheme based on image data. The product image is partitioned into equal-sized grids, each comprising three channels. To train the model, we generate synthetic datasets representing both in-control and out-of-control conditions, tailored to reflect the specific nature of the monitoring task. The proposed method offers dual capabilities: it not only detects multiple simultaneous faults in different regions of the image but also localizes the positions of these faults; both in a single step. Performance evaluation is conducted using run length metrics for detection effectiveness and the Dice score for fault localization accuracy. Extensive simulation studies are carried out to assess the scheme's performance under various shift magnitudes and spatial configurations. Comparative analysis with recently developed control schemes demonstrates the superior performance of our approach in detection, localization, or both across numerous scenarios. Finally, we provide a practical case study to illustrate the implementation of the proposed method in a real practice.

Keywords: Convolutional Neural Networks, Process Control, Image analysis, Spatiotemporal, Monte Carlo Simulation

Online Monitoring of Unstructured Varying-size Point Cloud Data: A Registration-free Approach

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Advances in additive manufacturing now allow the fabrication of complex shapes that are gaining widespread use across various domains. Non-destructive inspection of such innovative shapes is performed by non-contact sensors, collecting large, noisy, and unstructured point clouds of varying size. Surface reconstruction and registration (i.e., alignment of the nominal and real point clouds) are typically applied as a preprocessing step prior to monitoring. However, surface reconstruction techniques may introduce artifacts and spurious connections, thereby affecting monitoring outcomes. In addition, registration is computationally expensive, sensitive to initialization, noise, and partial overlaps. Nevertheless, registration can be avoided by leveraging intrinsic geometric properties of the shape [3]-[4]. To avoid both registration and surface reconstruction, we operate directly on point cloud data and propose a novel monitoring approach. Our proposal combines two alternative feature extraction techniques and a unified monitoring scheme. In particular, the intrinsic properties of printed parts are captured via robust Laplacian [2] and geodesic distances, computed using the heat method [1]. The proposed monitoring scheme exploits thresholding techniques to select features most indicative of potential out-of-control conditions. Numerical experiments highlight the potential of the proposed approach in identifying various defect types across different shapes.

Keywords: Point Cloud Data, Laplace Operator, Discrete Differential Geometry, Online Monitoring

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Calibration of a joint monitoring scheme with cautious parameter learning for guaranteed in-control performance

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Joint monitoring of the mean and variance of a normal process is crucial in quality engineering for assessing homoscedasticity, determining process capability, and recognizing that changes in scale often accompany changes in location. A joint scheme for monitoring both mean and variance must ensure overall performance, even with estimated parameters. Approaches guaranteeing minimum in-control performance are standard, but they lose power with small Phase I samples. Learning approaches allow parameter re-estimation with new data, while cautious schemes define update rules to minimize sample contamination from out-of-control observations [1,2,3].

The challenge in setting up a joint monitoring scheme with cautious parameter learning for guaranteed in-control performance lies in the determination of the individual control limits, in particular the determination of the constants that govern the guaranteed in-control performance. This presentation outlines the problem, discusses the solution recently put forward in [4], and highlights potential for additional research.

Keywords: Cautious parameter learning, Estimated parameters, Joint monitoring, Statistical process monitoring

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Useful Information

THE VENUE ISSPM 2025 will be held at the Federico II Conference Center (Aula Magna, 1st floor), located at Via Partenope 36, 80126, Naples, Italy.

CONFERENCE REGISTRATION The registration desk is located at the Federico II Conference Center (1st floor).

BADGES Participants are required to wear their name badges (issued at the time of registration) during all professional and social activities related to ISSPM 2025.

ASSISTANCE TO THE CONFERENCE PARTICIPANTS Conference assistants are ready to help conference participants. You may recognize them by the yellow badges.

WIRELESS NETWORK Free Wi-Fi is available at the conference venue through the `guestpartenope` wireless network with password `xs4070923`.

UPLOADING YOUR PRESENTATION Presentations (PDF or PowerPoint format) should be uploaded to the conference room during breaks or when no sessions are in progress. Alternatively, presenters can submit their presentation—in PDF or PowerPoint format and no larger than 25 MB— as an email attachment to `isspm2025@unina.it` by 5 July.
To ensure smooth transitions between talks, we kindly ask all presenters to arrive in the session room **10 minutes before the session start time** to meet the chair, check and transfer their presentation, and familiarize themselves with the technical equipment. Each session room is equipped with a laptop with the Windows 11 operating system.

SMOKING The Conference Center is a non-smoking facility. We kindly ask that you respect this.

PARKING Parking around the Conference Venue is extremely limited and expensive. Most of the delegates are expected to travel to the Conference Venue from their accommodations by public transport, taxi, or on foot. Participants with reduced mobility are kindly asked to contact local organizers well in advance about parking and social events.

HOW TO GET THE CONFERENCE LOCATION The conference venue is located at the Federico II Conference Center, located on Via Partenope 36, 80121 Napoli, and can be reached by any of the following methods. For further details, we recommend visiting the conference website (`https://www.isspm2025.cesma.unina.it/venue/the-conference-venue`).

From Napoli Capodichino Airport:

- **By taxi** (recommended): approximately 20 minutes. See the 'Taxi' section below for more details.

- **By ALIBUS airport shuttle**: departures every 15–20 minutes; tickets are available at the airport or on board. The travel time is about 1 hour, depending on the traffic. The ALIBUS stops at Corso Novara/Piazza Garibaldi (Napoli Centrale Railway Station) and Molo Angioino/Beverello (near the harbor). From the Beverello stop, take bus 151 to the Conference Center (get off at "V. Morelli" stop and walk 10 minutes) or walk 20–25 minutes (ask for directions toward Castel dell'Ovo).

From Napoli Centrale Train Station:

- **By taxi** (recommended): around 15 minutes in normal traffic.

- **By Metro Line 1**: direction Piscinola, get off at *Municipio* station. Then, either take bus 151 from the Acton (Beverello) stop to "V. Morelli", or walk 20–25 minutes to Castel dell'Ovo.

Public Transportation: Several bus lines stop within a few hundred meters of the Conference Center, including 151, 154, and 140. Tickets can be purchased at metro stations, newsagents, or tobacco stores. For more information, including maps and schedules, visit: `https://www.comune.napoli.it` (switch to English and see /Getting Around Naples).

TAXI For the local taxi service, please dial +39 0818888 or ask to the Conference assistants at the Registration desk. Instead of the taxi metered fare, passengers may want to opt for the predetermined/fixed rate tariff (recommended) and must advise the driver in advance on entering the cab. Refer to the Conference Center zone as "Via Partenope - Via Caracciolo". Users can request the receipt of the payment, which has no taxable value. Taxi drivers are not allowed to release receipts different from those authorized by the City Council. The receipt is mandatory for fixed tariff, in this case the receipt must be released before the ride. It should be useful to remember the taxi ID (4 numbers) displayed on/in the car in order to more easily claim for any lost item. Tariffs and other useful information are available at www.comune.napoli.it (see /Aree tematiche /Trasporti e mobilità/Trasporto pubblico non di linea/Taxi/Tariffe Taxi and switch to English language).

GENERAL TOURIST INFORMATION Naples is one of the most beautiful cities in the world: a popular Italian destination for those who love art, folklore, and nature. "Centro Storico" is listed by UNESCO as a World Heritage Site. You can visit about 450 churches, encompassing seventeen centuries of history. Naples is also a city where you can taste excellent food, with a large number of starred restaurants featured by the Michelin Guide. We will be happy to assist you in enjoying your stay in Naples. For any questions, ask the Conference Assistants at the Registration desk.

Information are available at `https://www.italia.it/en/naples` and `www.comune.napoli.it`.

EMERGENCY AND MEDICAL SERVICES In case of emergency, calling the following numbers from a fixed line is free of charge: Ambulance 118, Fire Brigade 115, Polizia (Police) 113, Carabinieri (Military Police) 115, Finance Guard 117.

TIME ZONE Similarly to most countries in Europe, Summer (Daylight-Saving) Time is observed in Italy, where the time is shifted forward by 1 hour; 2 hours ahead of Greenwich Mean Time (GMT+2).

WEATHER AND CLIMATE July in Naples is generally hot and dry. Expect daytime temperatures averaging around 28–29 °C (mid-80s °F), with nighttime lows around 20–21 °C (68–70 °F). Rain is rare—typically only 2 days per month—with total precipitation of about 14–26 mm and daily rain chances around 8 %. Recent forecasts suggest July 2025 may be warmer than usual, with occasional peaks above 35 °C.

FOREIGN EXCHANGE AND BANKING The official currency in Italy is the Euro. All major international credit cards are accepted in shops, hotels and restaurants. Travelex, the world leader in foreign currency exchange, is present at the Naples International Airport. Most banks are open on weekdays, from 8.30 AM to 2 PM and from 2:45 PM to 3:45 PM, and closed on Saturdays. ATMs (Automatic Teller Machines) are available 24/7 and located outside banks throughout the city.

VAT Value-added tax is nearly always included in quoted prices. If you are a non-EU resident, you are eligible to take advantage of tax-free shopping in Italy. More details on how to claim a refund are available at `www.agenziadoganemonopoli.gov.it`.

ELECTRICITY Electricity in Italy is a 220-240 volt, 50 Hz system. The power sockets are of type F and L. Bring an appropriate adapter.

DISABLED ACCESS Within the Conference Center, wheelchair access is guaranteed in all lecture theaters, ensuring that wheelchair users can access the full range of conference sessions.

SOCIAL EVENTS

- **Pre-conference tour**: July 7, afternoon – Archaeological Park of Pompeii (`https://www.isspm2025.cesma.unina.it/program/pre-conference-tour`)
- **Welcome reception**: July 7, 19:30 at the Conference Center.

- **Gala dinner**: July 9, 20:00 at the Royal Continental Hotel (1st floor), which is located along the seafront in Via Partenope 38/44.

- **Post-conference tour**: July 11 – Historic center of Naples (`https://www.isspm2025.cesma.unina.it/program/post-conference-tour`).

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