

ISO/IEC JTC 1 SC 42 Artificial Intelligence – Working Group 4

Use Case Submission Form

The quality of use case submissions will be evaluated for inclusion in the Working Group’s Technical Report based the application area, relevant AI technologies, credible reference sources (see References section), and the following characteristics:

- Data Focus & Learning: Use cases for AI system which utilizes Machine Learning, and those that use a fixed *a priori* knowledge base.
- Level of Autonomy: Use cases demonstrating several degrees (dependent, autonomous, human/critic in the loop, etc.) of AI system autonomy.
- Verifiability & Transparency: Use cases demonstrating several types and levels of verifiability and transparency, including approaches for explainable AI, accountability, etc.
- Impact: Use cases demonstrating the impact of AI systems to society, environment, etc.
- Architecture: Use cases demonstrating several architectural paradigms for AI systems (e.g., cloud, distributed AI, crowdsourcing, swarm intelligence, etc.)

1. General

| | | |
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| ID | (leave blank, for internal use) | |
| Use case name | Machine Learning Driven Analysis of Batch Process Operation Data to Identify Causes for Poor Batch Performance | |
| Application domain | Batch Manufacturing | |
| Deployment model | On-premise systems | |
| Status | Prototype | |
| Scope ¹ | Detecting the issues in batch manufacturing process that leads to bad quality products or longer cycle times of batch processing | |
| Objective(s) ² | Provide insight to the operation team to improve the productivity of batch manufacturing through machine learning on historical operation data | |
| Narrative | Short description (not more than 150 words) | An approach was developed that can use machine learning models to identify issues in batch manufacturing. |
| | Complete description | Batch operation is generally quite complex involving dynamics in the operation and interplay of various process variables. Due to this, sometimes, few batches end up running slower than nominal batch time and few batches also yield bad quality end products resulting in significant |

¹ The scope defines the intended area of applicability, limits, and audience.

² The intention of the system; what is to be accomplished?; who/what will benefit?.

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| | <p>production loss. Additionally, often in the industrial context, data size and variety are limited and to develop a robust machine learning model from limited available data sets is a challenging task.</p> <p>Due to transient nature of batch operation data, the traditional PCA algorithm fails in analyzing the batch data and hence MPCA was applied as logical extension of PCA algorithm. As MPCA naturally considers the dynamics in the data and inter-correlations among the process variables, it provides a valuable insight on the batch data.</p> <p>The approach was successfully demonstrated on milk pasteurization process data where only 4 batches were provided for modelling. Using such 4 seed batches, the algorithm synthetically creates 50 batches of data and introduction of anomalies in some batches. Concept of design of experiments and stochastic perturbations are used in synthetic generation of the data set.</p> <p>The work was able to successfully build a robust MPCA model with such data and isolate the bad batches of data from good batches of the data. Additionally, through contribution plots, the algorithm identifies when a certain batch drifted from nominal operation and which variables are the root causes for the bad batch operation.</p> | | | |
| Stakeholders ³ | Batch manufacturer such as milk pasteurization, pharmaceutical, paint manufacturing, etc. | | | |
| Stakeholders' assets, values ⁴ | Improve the productivity and avoid the re-work | | | |
| System's threats & vulnerabilities ⁵ | Incorrect use of AI/ML; New Security Threats | | | |
| Key performance indicators (KPIs) | ID | Name | Description | Reference to mentioned use case objectives |
| | 1 | Closeness to Golden Batch | How close a process is to the best possible batch | Helps in isolation of bad batches from good batches by identifying combination of process variable trajectories that lead to good or bad batch operation. |

³ Stakeholder are those that can affect or be affected by the AI system in the scenario; e.g., organizations, customers, 3rd parties, end users, community, environment, negative influencers, bad actors, etc.

⁴ Stakeholders' assets and values that are at stake with potential risk of being compromised by the AI system deployment – e.g., competitiveness, reputation, trustworthiness, fair treatment, safety, privacy, stability, etc.

⁵ Threats and vulnerabilities can compromise the assets and values above - e.g., different sources of bias, incorrect AI system use, new security threats, challenges to accountability, new privacy threats (hidden patterns), etc.

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| AI features | Task(s) | Classification | | |
| | Method(s) ⁶ | Multiway Principal Component Analysis | | |
| | Hardware ⁷ | 64 GB RAM Windows server | | |
| | Topology ⁸ | NA | | |
| | Terms and concepts used ⁹ | Classification, MPCA, Anomalies | | |
| Standardization opportunities/ requirements | <ul style="list-style-type: none"> • Standard data representation models for AI relevant batch data handling • Standard GUI for AI relevant result presentation. | | | |
| | Challenges and issues | Discovering actionable insight with limited industrial data set, handling dynamics in the process variables | | |
| Societal Concerns ¹⁰ | Description | Consistent batch operation lead to enhanced productivity | | |
| | SDGs ¹¹ to be achieved | Industry, Innovation, and Infrastructure | | |

⁶ AI method(s)/framework(s) used in development.

⁷ Hardware system used in development and deployment.

⁸ Topology of the deployment network architecture.

⁹ Terms and concepts used here should be consistent with those defined by Working Group 1 (AWI 22989 and AWI 23053) or to be recommended for inclusion.

¹⁰ To be inserted.

¹¹ The Sustainable Development Goals (SDGs), also known as the Global Goals, are a collection of 17 global goals set by the United Nations General Assembly. SDGs are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.

URL: <http://www.undp.org/content/undp/en/home/sustainable-development-goals.html>

References

| References | | | | | | |
|------------|----------------|---|-----------|---------------------------------------|--------------------------|--|
| No. | Type | Reference | Status | Impact on use case | Originator/org anization | Link |
| 1 | Confer ence | Jeffy, F., J., Gugaliya, J., K., and Kariwala, V. Application of Multi-Way Principal Component Analysis on Batch Data, 2018 UKACC 12th International Conference on Control | Published | Use case taken from this source | ABB | https://www.rese archgate.net/publi cation/32898976 2_Application_of_ Multi- Way_Principal_Co mponent_Analysis _on_Batch_Data |
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