Empowering Safety Production and Quality Control with Industrial Large Models

CALL FOR PAPERS

The integration of Industrial Large Models (ILMs) into chemical engineering presents a transformative paradigm for advancing safety production and quality control, motivated by the need to transcend the limitations of conventional methods in managing complex, nonlinear processes and volatile operating conditions. These models leverage vast, multi-modal datasets to enable predictive risk assessment, real-time anomaly detection, and cognitive process optimization. However, significant challenges impede their deployment, including data heterogeneity from disparate sources like Distributed Control Systems (DCS) and online analyzers, the critical need to embed physicochemical laws to ensure reliable and plausible model outputs, stringent real-time inference requirements for safety-critical decisions, and inherent vulnerabilities to adversarial attacks and a lack of interpretability in high-stakes environments. To overcome these barriers, this topic will systematically explore the potential techniques, such as physics-informed neural networks (PINNs) that harmonize data-driven learning with fundamental engineering principles, causal inference frameworks for robust root-cause analysis, federated learning architectures to preserve data privacy across production units, and high-fidelity dynamic digital twins for safe model training and validation. Future research should prioritize the development of domain-adapted fine-tuning strategies specifically for chemical processes, novel prompt-engineering frameworks that incorporate operational expertise, advanced explainable

AI (XAI) for trustworthy decision-making in scenarios like emergency shutdowns, and the establishment of comprehensive regulatory standards for the safe and ethical application of ILMs in the chemical industry. This concerted effort is essential to unlock the full potential of industrial large models in creating more resilient, efficient, and inherently safer chemical processes.

The solicitation scope of this topic includes but is not limited to the following topics:

* Application of Industrial Large Models in Dynamic Risk Assessment for Chemical Processes;

* Integration of Physics-Informed Neural Networks for Optimization in Chemical Processes;

* Root Cause Analysis of Abnormalities in Chemical Processes Based on Causal Inference;

* Federated Learning for Cross-Plant Data Privacy Protection and Application;

* Design and Application of Safety Models Driven by High-Fidelity Dynamic Digital Twins;

* Optimization Research on Domain-Adaptive Fine-Tuning Strategies for Chemical Processes;

* Design of an Operation Experience-Driven Prompt Engineering Framework;

* Trustworthy Decision-Making Application of Explainable AI in Emergency Shutdown Scenarios;

* Research on Defense Mechanisms Against Adversarial Attacks on Industrial Large Models;

* Design and Application of Safety Assessment Methods for Chemical Systems;

* Real-Time Monitoring and Distributed Fault Diagnosis for Chemical Systems;

* Construction of a Regulatory Standards Framework for the Safety and Ethics of Industrial Large Models

If you want to know more about the topic, please contact Professor Cuimei Bo via email: **lj_bcm@163.com**