# Special Issue

# Advances in the Information Bottleneck: Theory, Methods, and Applications

## Message from the Guest Editors

This *Technologies* Special Issue seeks to advance cutting-edge research on the theory, methods, and applications of the Information Bottleneck, with emphasis on the following: (1) Theoretical Frontiers: Scaling laws for model performance, mechanistic interpretations of intelligent emergence, uncertainty quantification in dynamic systems, theoretical bounds of IB-driven representation learning, and so on. (2) Algorithmic Innovations: Efficient mutual information estimation techniques, low-complexity IB optimization frameworks, multi-view learning, integration with neural architectures and reinforcement learning, lightweight inference strategies for LLMs, and so on. (3) Applications: Enhancing model interpretability, multi-modal learning, high-dimensional representation learning, communication protocol optimization via information compression, IB-guided analysis in complex systems, and so on. By bridging theoretical breakthroughs and practical applications, this Special Issue aims to establish robust, efficient, and interpretable information processing paradigms—addressing persistent challenges such as data redundancy, pattern analysis, and opacity of black-box models in AI systems.

## Guest Editors

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### Editor-in-Chief

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