

Convergent Signal Confirmation for Probabilistic Causal Chain Inference in Event Graphs

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Abstract: Convergent Signal Confirmation (CSC) is a framework and formal theorem for event-plausibility inference in information retrieval, wherein causal chain propagation from a hypothesised effect identifies corroborating warrants that aggregate into a probabilistic plausibility score. Plausibility scores are computed as the hop-decay-weighted mean warrant strength across all active hypothesis-targeting causal chain links within their TTL window, without requiring complete chain observation. Unlike classification-based approaches, CSC treats event plausibility as an emergent property of the current active corroborating warrant states, allowing continuous monitoring without explicit query formulation. While static knowledge ingestion and causal warrant construction are performed independently of real-time signal intake, confirmed events continuously re-enter the warrant graph as evidence, creating a self-reinforcing activation loop wherein observed events become warrants for downstream plausibility inference. CSC additionally supports unsupervised event discovery, wherein regions of the warrant graph exceeding an activation density threshold α are surfaced as candidate events without requiring a pre-specified hypothesis, enabling the system to identify plausible events it was not explicitly queried for.

Keywords: causal inference, knowledge graphs, event detection, probabilistic reasoning, temporal reasoning, information retrieval

INTRODUCTION

In the information age, the ability to act and enact power is proportionally tied to information processing capabilities. As Simon observed in 1971, a wealth of information creates a poverty of attention – a tension presently amplified by the emergence of open-access initiatives and the sheer availability of information – spanning research literature, governmental records, journalistic archives, and real-time event streams. The bottleneck has shifted from information access to causal interpretation: extracting structured, traceable causal relationships from an ever-growing corpus of unstructured text. Together, this enables bidirectional causal reasoning: forward inference, wherein active warrant chains surface plausible future events before they occur; and backward inference, wherein an observed signal – such as a social media event stream – is scored as a hypothesis against the warrant graph to identify its plausible causal antecedents. CSC thus operates as a unified framework for both event anticipation and causal explanation of emerging phenomena.