Title:

Bayesian Networks as Systems Integrators for Interpretable and Extensible Multi-Sensor Fusion

Abstract:

In response to the broad range of emerging and legacy threats experienced across the battlespace, modern defense systems have trended toward high levels of interconnectedness on the assumption that information from systems spanning numerous domains will be fused at the speed of relevance. One regime emblematic of these types of challenges which presents ample opportunities for the application of algorithmically driven information fusion and decision support is that of modern air defense. Highlighted by a myriad of threats, sensing systems stratified by domain, and legacy systems coexisting with next generation sensors, ongoing success in this regime hinges on the ability to cohesively integrate information from a variety of sources. Recent neural network-based approaches have received substantial attention, yet their impact continues to be hindered by high computational costs and the lack of explainable outputs. Often overlooked are more traditional and intuitive machine learning techniques such as Bayesian networks.

The attributes of Bayesian networks such flexibility, ease of use, lightweight computational needs, and innate explainability and reasoning capabilities has already led to their successful application in the air defense regime, namely in the performance of tasks up and down the target tracking, identification, and intent classification stack of self-contained systems. These same attributes also make Bayesian networks suitable for use as high level systems integrators to perform multi-sensor fusion. In this work we showcase the feasibility of using Bayesian networks as an extensible and dynamic multi-sensor fusion system to perform last-mile reasoning over any number of disparate black-box approaches, as well as their utility in producing more reliable, trustable, and interpretable results than any individual sensor system operating independently. Through this, we demonstrate the ability of Bayesian networks to produce futuristic results without incurring the computational overhead and cryptic challenges associated with interpreting the results of large neural network-based approaches.