Can Machines Evaluate Scientific Truth? Dual-Stream Bayesian Analysis for Automated Claim Verification Across Multiple Domains

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Evaluating scientific claims requires synthesizing evidence across extensive literature, which is time-consuming for experts and challenging to automate. Existing approaches rely on expensive fine-tuned transformer models requiring domain-specific training, limiting scalability and generalizability. We developed a Bayesian evidence aggregation system evaluating causal scientific claims by integrating dual evidence streams: text-based stance analysis and causal graph pathway reasoning. A pre-trained Sentence Transformer represents each abstract as a point in multidimensional vector space, with stance classification performed through cosine similarity to any given claim, eliminating domain-specific fine-tuning. An adaptive decision tree dynamically weights text and graph evidence based on quality indicators, enabling robust handling of cases where one evidence source is unreliable. Credibility scoring uses citation counts, publication recency, and journal prestige, with bootstrap resampling for confidence interval quantification. Validated across four claims: CO2 and ocean acidification (93%, strongly supported), night shift work and cancer risk (67%, supported), alcohol consumption and cardiovascular benefit (33%, refuted), and air pollution and cognitive decline (90%, strongly supported). All verdicts aligned with consensus from IPCC, IARC, The Lancet, and WHO without domain-specific modifications. Lightweight embedding-based approaches can achieve consensus-aligned verdicts without resource-intensive fine-tuning, offering superior generalizability and interpretability. This framework provides a scalable solution for automated claim verification with applications in research synthesis, policy evaluation, and combating misinformation.

Awards Won:

Association for the Advancement of Artificial Intelligence: AAAI Membership for the School Libraries of All 8 Winners (in-kind award / part of 1st-3rd prize and honorable mentions' prize)