A Probabilistic Computational Framework for Learning Persistence in Heatwave Prediction

Zhu, Sofia (School: Baton Rouge Magnet High School)

As the effects of climate change intensify, heatwaves become a pressing issue, underscoring the need for risk mitigation and preparedness. Nationally, the U.S. Centers for Disease Control and Prevention (CDC) reported a significant increase in heat-related illness emergency department visits. For the purposes of this research, heatwaves in Baton Rouge, Louisiana, are defined as a period of high heat (32.2 °C) for three consecutive days. Traditional transformers (TT) have implicit persistence. Explicit persistence ensures a model stores and updates its state across steps, whereas implicit persistence has no memory beyond the input. By developing a model that learns through explicit persistence, the architecture could potentially address how heatwave data should be represented. Three models were built: the encoder-only Time Transformer (TT), the static explicit Markov persistence TT (MarkovTT), and the online explicit Markov persistence TT (MarkovTT-Online). Using a difference in Brier score for probabilistic prediction, a paired bootstrap hypothesis test was created. The results of the 95% confidence interval showed that the MarkovTT performed statistically, significantly worse than the TT and the MarkovTT-Online performed significantly more accurately than the MarkovTT. The static MarkovTT was most likely unable to adapt to non-stationary heatwave patterns whereas the MarkovTT-Online could.

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