**Uncertainty-Aware Spatio-Temporal Model for Heatwave Prediction**

Heatwaves are becoming increasingly frequent, intense, and prolonged due to global climate change and rapid urbanization. These extreme events pose significant challenges to public health, agriculture, water resources, and the economy. Despite advances in climate science, accurate heatwave prediction remains difficult because climate data is inherently uncertain, non-stationary, and highly variable across regions and time. Traditional models often fail to capture the complex spatio-temporal dependencies and uncertainty present in weather patterns, thereby limiting their reliability for long-term forecasting.

The problem addressed in this project is the difficulty of predicting heatwaves using numerical climate datasets, which are high-dimensional, dynamic, and prone to measurement errors. Reliable forecasting requires the extraction of features such as intensity, duration, onset, and extent, while simultaneously managing spatial and temporal dependencies. Existing approaches often fail to fully capture these dynamics, leading to inaccurate or unreliable predictions.

The primary objectives of this research are to address non-stationarity in multivariate climate data through adaptive decomposition techniques, to effectively capture spatio-temporal dependencies across multiple cities and climate variables, to integrate uncertainty estimation into the prediction process for confidence-aware decision-making, and to ultimately enhance the reliability and accuracy of long-term heatwave forecasting.

The expected outcomes include the development of a robust forecasting framework that integrates **Multivariate Empirical Mode Decomposition** (MEMD) for effective handling of non-stationary data, **Graph Attention Networks** (GAT) with **GRU** for high-accuracy localized predictions, and **Conformalized Quantile Regression** (CQR) for uncertainty-aware forecasting. This integrated approach aims to provide well-calibrated confidence intervals and dynamic adaptability, ensuring reliable predictions that can support proactive strategies for climate resilience, disaster preparedness, and sustainable urban planning.