Soyeon Kim, Junho Choi, Yeji Choi, Subeen Lee, Artyom Stitsyuk, Minkyoung Park, Seongyeop Jeong, Youhyun Baek, Jaesik Choi

This research paper, "Explainable AI-Based Interface System for Weather Forecasting Model," presents a significant contribution to the burgeoning field of Explainable Artificial Intelligence (XAI) within the context of operational meteorology. The authors, a collaborative team from various Korean institutions including KAIST and NIMS, address the critical need for user-centered XAI in weather forecasting, a domain characterized by high stakes and the reliance on timely, trustworthy predictions. This summary will dissect the paper's contributions, methodology, findings, and implications across multiple sections.

- **Establishing User-Centric Explanatory Requirements:** Through extensive user studies involving sixteen online meetings and three in-person advisories with experts from the Korea Meteorological Agency (KMA) and the National Institute of Meteorological Sciences (NIMS), the researchers identified three key user requirements for explanations: (1) understanding model performance across different rainfall types to detect potential biases; (2) gaining insight into the model's reasoning process to understand how it arrives at its predictions; and (3) assessing the confidence or uncertainty associated with the model's outputs.
- **Mapping XAI Methods to User Needs:** The researchers strategically selected and integrated various XAI methods to fulfill each of the identified user requirements.
- **Developing a User-Friendly XAI Interface:** Based on user feedback gathered throughout the design process, the researchers created a prototype XAI interface system.
- **Demonstrating Increased Decision Utility and User Trust:** The user study involving four KMA forecasters showed that the XAI system significantly increased user trust and decision utility compared to a system providing only predictions.

The methodological architecture of this paper is a strength, showcasing a rigorous and iterative approach to XAI development that prioritizes user needs. The process can be broken down into several key stages:

- User Requirement Elicitation
- XAI Method Selection and Evaluation
- Interface Design and Iteration
- Quantitative and Qualitative Evaluation
- Data Preprocessing and Model Training

The paper's findings are organized hierarchically, with the overarching finding being the successful development and validation of a user-centered XAI system for weather forecasting. This overarching finding is supported by several key sub-findings:

- **Increased User Trust and Decision Utility:** The user study demonstrated a significant increase in user trust and decision utility when explanations were provided alongside the model's predictions.
- **Preference for Intuitive Explanations:** The study revealed a preference for intuitive explanations over those directly derived from XAI algorithms, even for relatively simple predictions.
- **Effective Probability Calibration:** The application of local temperature scaling (LTS) significantly improved the calibration of the model's confidence estimates, as measured by the expected calibration error (ECE).
- **Receptive Field Analysis:** The analysis of the model's receptive field using feature attribution revealed a west bias, consistent with the prevailing westerlies in Korea.
- **Rainfall Type Classifier Performance:** The rainfall type classifier achieved an accuracy of 93.07%, demonstrating its ability to effectively categorize different rainfall scenarios.
- **Qualitative Feedback on Explanations:** The qualitative feedback from forecasters revealed that while the model performance

and confidence explanations were generally well-received, the output reasoning explanations were less intuitive and less likely to be used in practice.

The paper integrates several theoretical frameworks to guide its methodology and interpret its findings:

- User-Centered Design (UCD)
- Explainable AI (XAI)
- Human-Computer Interaction (HCI)
- Cognitive Psychology

The paper acknowledges several limitations that constrain the generalizability of its findings and the scope of its conclusions:

- Data Scarcity for Rainfall Classification
- Interpretability Challenges in Feature Attribution
- Limited User Sample Size
- Contextual Limitations
- Technological Limitations

The paper suggests several promising avenues for future research:

- Expanding the Dataset
- Refining Output Reasoning Explanations
- Enhancing User Interaction
- Cross-Model Generalization
- Multi-Modal Data Integration
- Measuring Explanation Complexity

This research has significant implications across multiple disciplines:

- Meteorology
- Artificial Intelligence
- Human-Computer Interaction
- Cognitive Science

This research represents a significant and promising step towards the development of trustworthy and user-centered AI systems in meteorology. The paper's rigorous methodology, user-centric approach, and empirically validated findings demonstrate the potential of XAI to bridge the gap between AI accuracy and human trust. While limitations exist, particularly regarding data scarcity and the complexity of output reasoning explanations, the paper provides a valuable framework for future research and development in this critical area.