



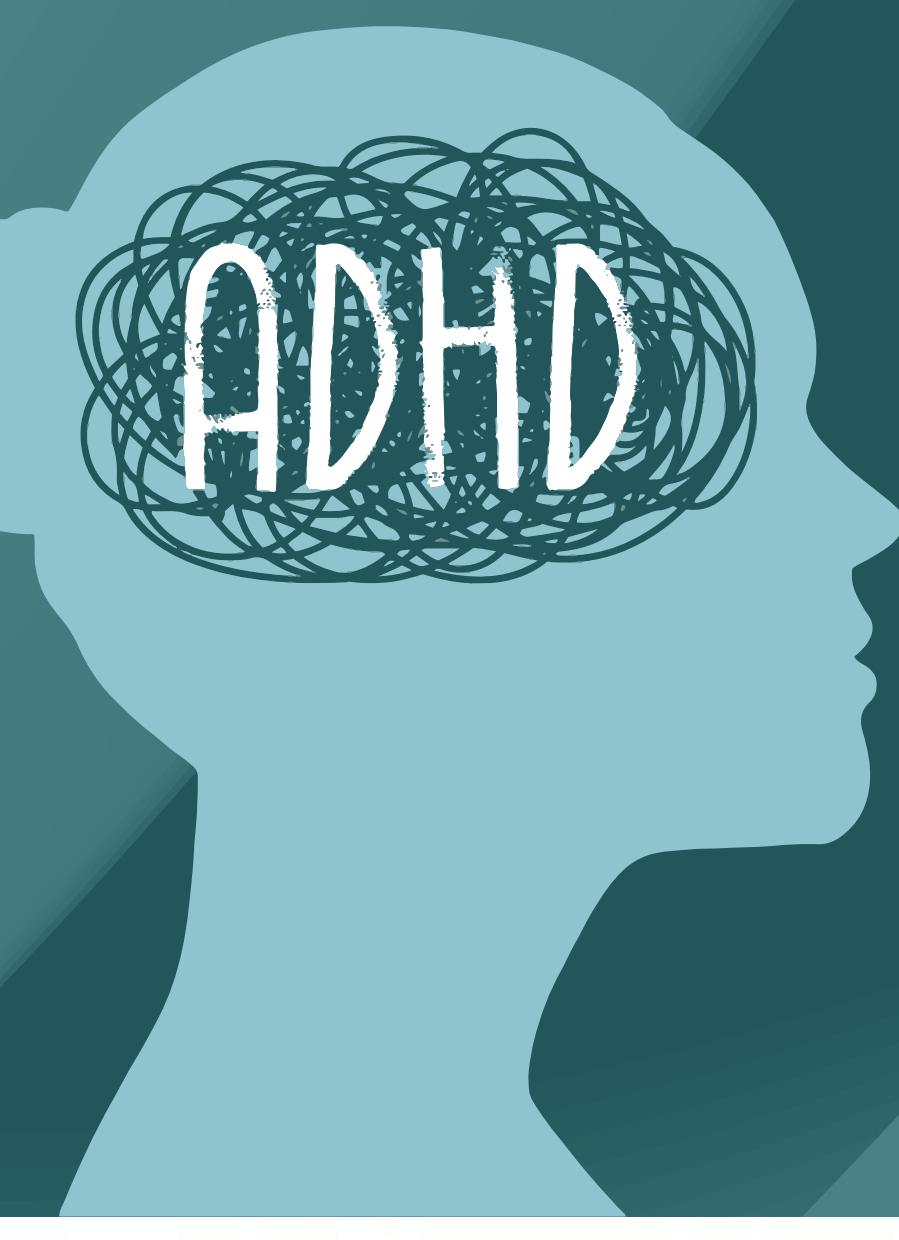
AI-DRIVEN ADHD PREDICTION AND ANALYSIS AT EARLY AGE

A novel approach integrating Machine Learning, Explainable AI, LLMs, and Dialogflow with a virtual therapist chatbot (Comfortchat)

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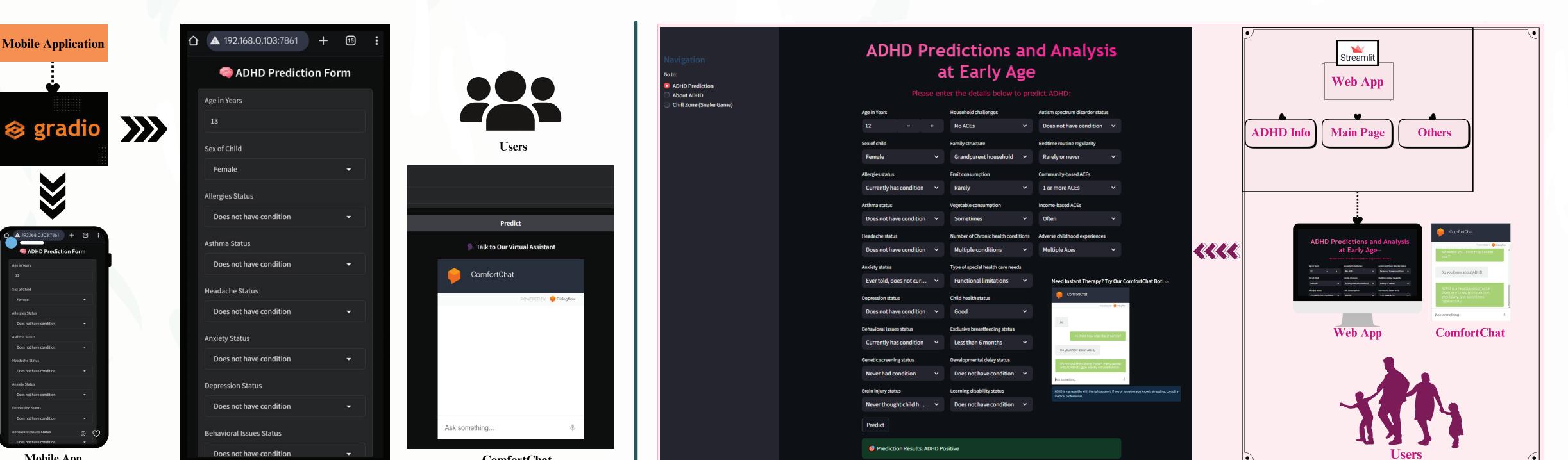
Abstract

ADHD is a common neurological condition that can affect learning, behavior, and self-esteem if not detected early. Early diagnosis leads to better support, improved academic and social outcomes, and reduced long-term costs. This project introduces a smart ADHD detection system using Machine Learning, Explainable AI, LLMs, and a virtual therapy chatbot. Among 14 ML models and 5 BERT-based models tested, our stacked ensemble achieved the best results with 94.27% accuracy. DistilBERT stood out among NLP models. Tools like LIME and SHAP helped explain the system's decisions, and the Dialogflow Chatbot offers basic therapy support. Expert feedback and testing with new data add to the system's strength, aiming to improve early ADHD detection and child mental health.

Novelty

- The proposed system achieves state-of-the-art performance on the CAHMI dataset.
- It is optimized using Machine Learning techniques, Large Language Models (LLMs), and Dialogflow.
- An ablation study has been conducted to analyze the contribution of individual components.
- The model has been tested on unseen datasets to evaluate its generalizability.
- Validation has also been done by domain experts from the National Mental Health Institute and Enam Medical College.
- The system predicts ADHD with high accuracy and provides interactive primary support through an integrated platform, enhancing both early detection and user guidance.

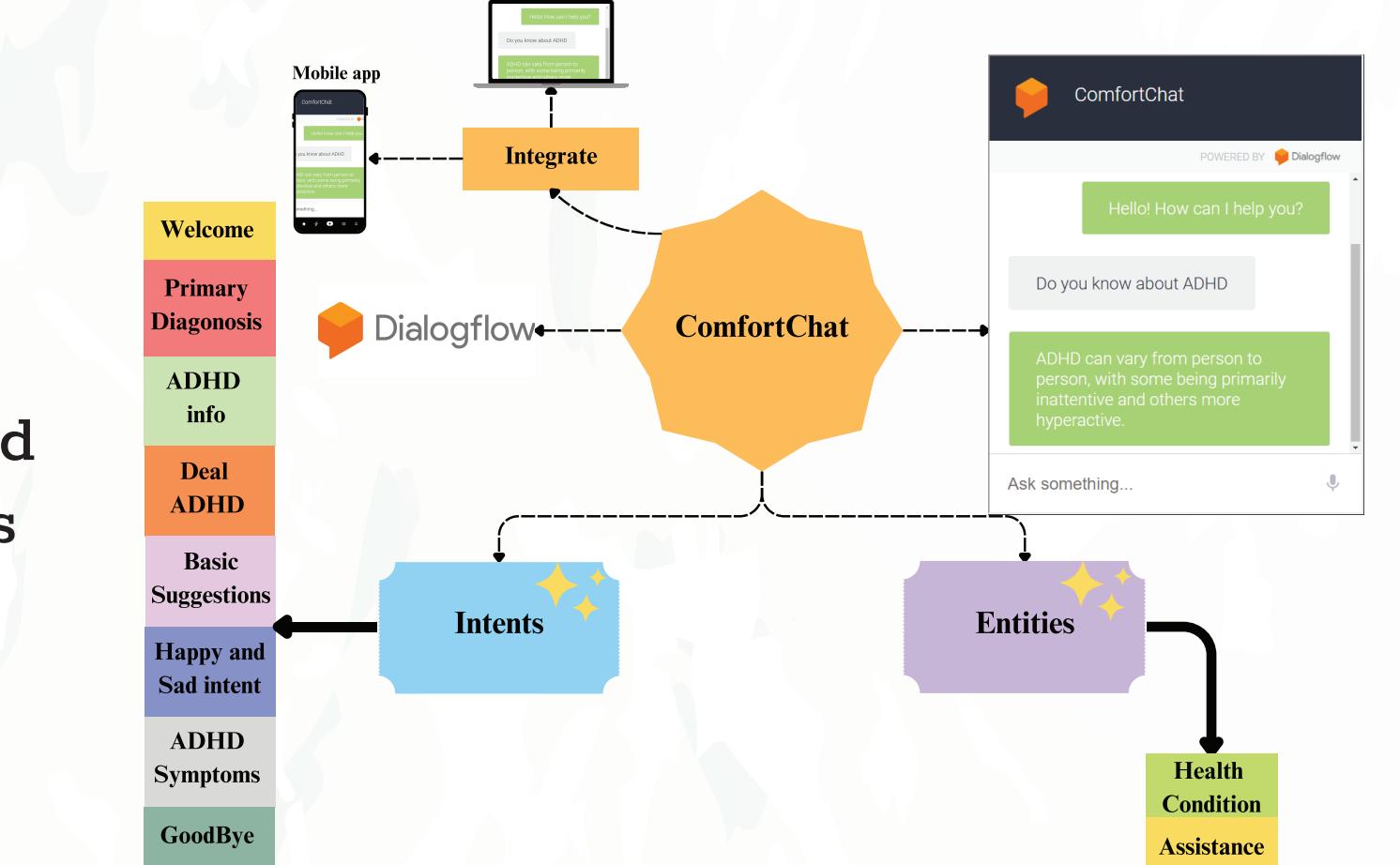
Mobile App and Web App



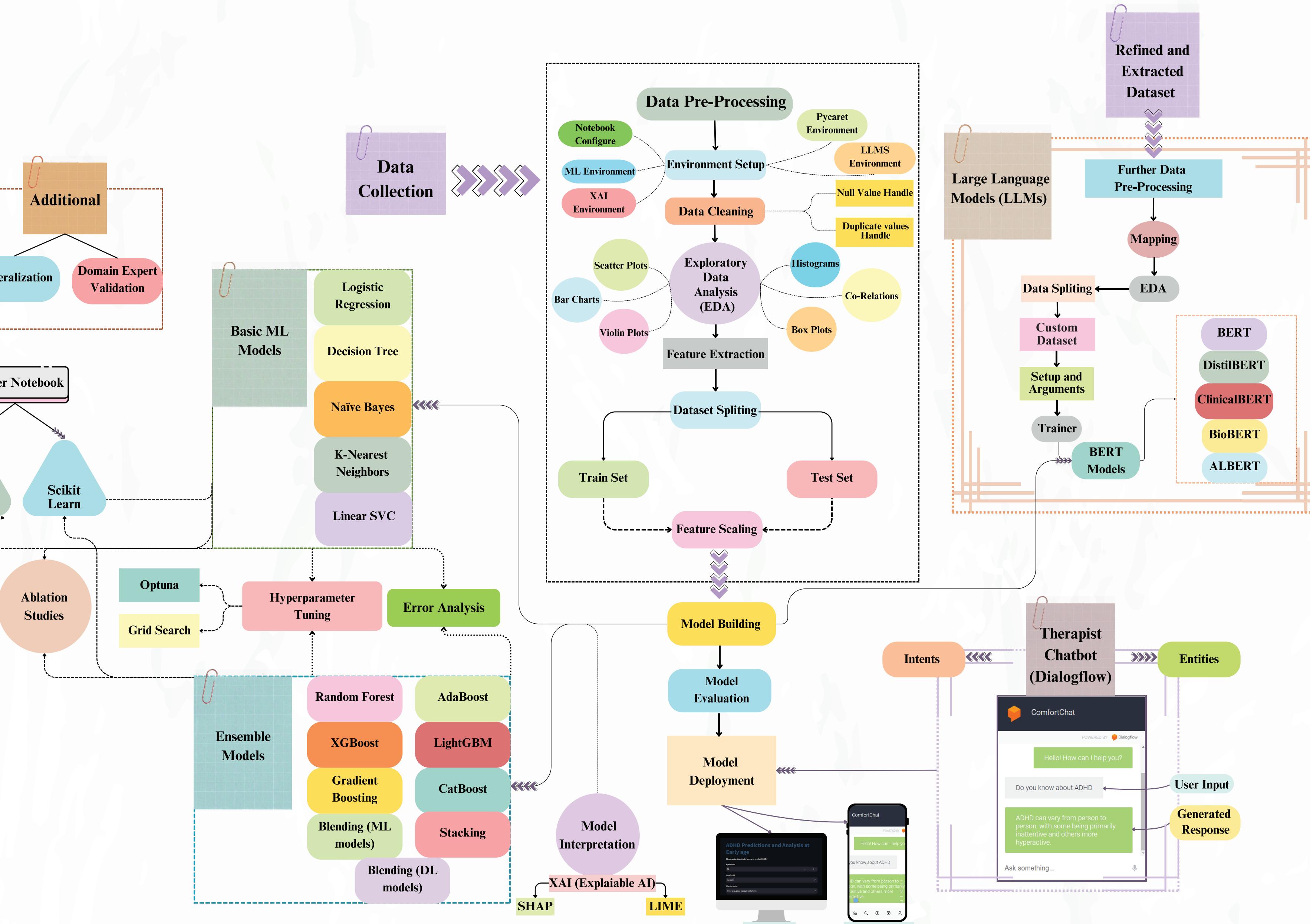
Mobile App: The stacking model was also deployed to a mobile-friendly Gradio interface with integrated ComfortChat for interactive ADHD support.

Chatbot Structure (ComfortChat)

Insight: Enables guided self-assessment, delivers early virtual support, and reduces stigma through accessible AI tools. ComfortChat is built using Dialogflow and integrated with both web and mobile apps for user accessibility. The system is driven by two core components: Intents and Entities.

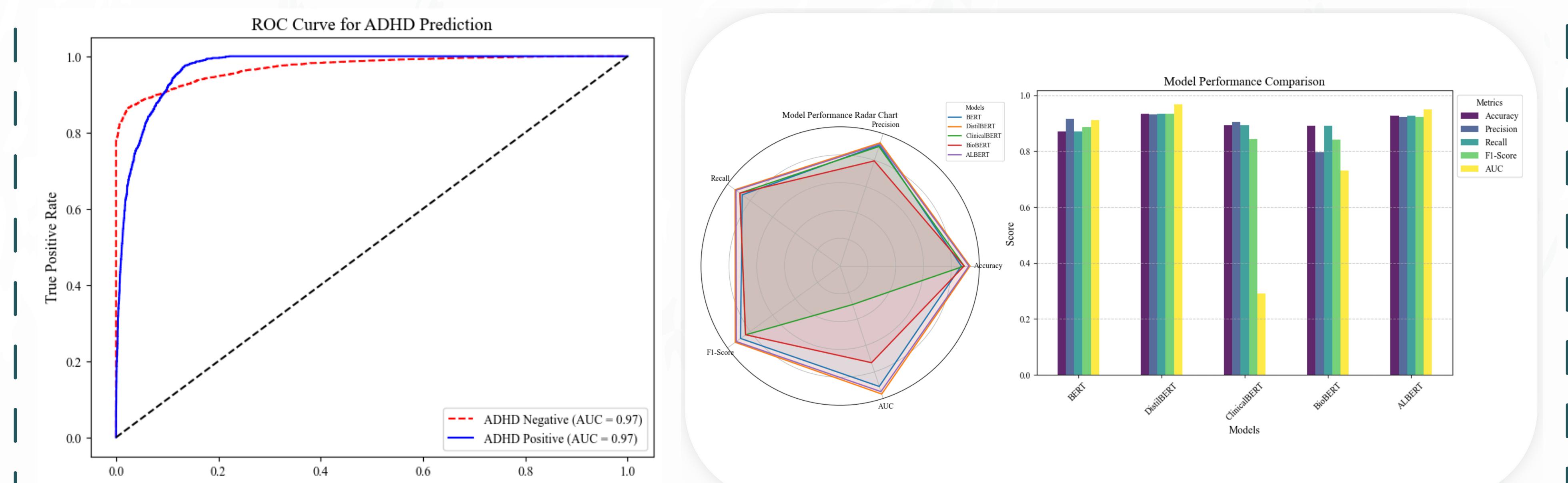


Methodology



Insight: The system combines ML, LLMs, and explainable AI in a seamless pipeline offering accurate ADHD detection, expert validation, and real-time support via mobile and web apps. This end-to-end, modular framework emphasizes scalability, explainability, and real-world applicability in mental health diagnostics.

Result



Insight: The model achieved an AUC of 0.97, indicating excellent accuracy (94% accuracy) in distinguishing ADHD from non-ADHD cases.

Insight: Among the evaluated models, DistilBERT and ALBERT demonstrated top-tier performance across all metrics, with DistilBERT achieving the highest AUC and accuracy.

Key Findings

Health-Related Factors:

- Behavioral issues (63.5%), anxiety (38.8%), depression (43.8%), chronic conditions, developmental delays, premature birth, and low birth weight significantly raise the risk of ADHD.

Social & Environmental Influences:

- Adverse Childhood Experiences (ACEs) like discrimination, household substance abuse, smoking, poor bedtime routines, and grandparent-led families are strongly linked to increased ADHD likelihood—often tripling the risk.

Top Predictors:

- Key indicators identified through SHAP and LIME include behavioral problems, anxiety, chronic illness, and developmental delays—standing out as the most powerful predictors of ADHD.

Explainable AI

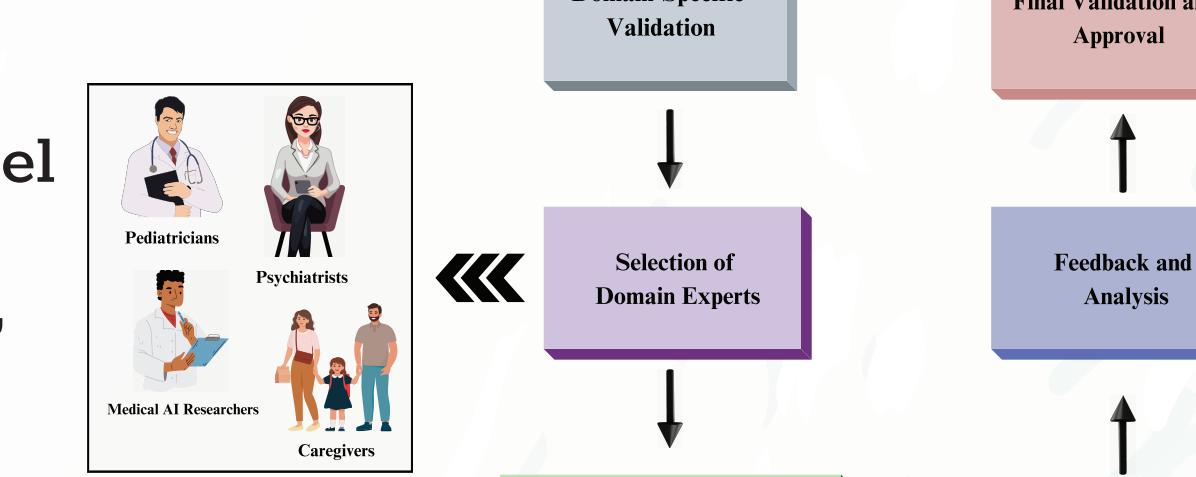


(The presence of multiple conditions and allergies pushes the model toward predicting ADHD, while lower behavioral, anxiety, learning, and developmental delay indicators pull the prediction toward non-ADHD).

Validation

Generalization and Domain Expert Validation

This system was tested on two separate national survey datasets (2018–19 & 2022–23) and showed consistently high performance. The blending model achieved top accuracy (94.98%) and proved the system is robust, reliable, and ready for real-world use. Mental health professionals and caregivers validated this system's usefulness and their feedback helped us refine it for real-life impact.



Conclusion

ADHD affects millions of children worldwide, impacting their daily lives and future. This research shows that AI—especially machine learning, explainable tools like LIME and SHAP, and a virtual therapy chatbot—can help detect ADHD early and provide support. Our system achieved high accuracy and offers clear, trustworthy results. By also considering social and environmental factors, it gives a more complete picture of ADHD. Future work should include larger, diverse datasets and more types of data. This project is a step toward making ADHD diagnosis smarter, earlier, and more accessible for every child.