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Ph.D. DISSERTATION DEFENSE

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Title:	Human-Centered Clinical AI: From Passive Sensing to Explainable, Emotion-Adaptive Decision Support
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ABSTRACT

Artificial intelligence (AI) has growing potential to support clinical decision-making by detecting health risks, interpreting predictive patterns, and enabling timely personalized interventions. However, many clinical AI systems remain limited by black-box predictions, static explanations, and limited adaptation to users' emotional and cognitive states. These limitations are especially critical in behavioral health, where risk states fluctuate in daily life and effective support requires transparent, emotionally appropriate, and shared understanding between patients and clinicians.

This dissertation proposes a human-centered clinical AI framework that advances from multimodal passive sensing to explainable and emotion-adaptive shared decision support. Using cannabis-related behavioral health care as the primary application domain, this dissertation integrates smartphone and wearable sensing, explainable artificial intelligence (XAI), affective computing, large language models (LLMs), and shared decision-making principles across five studies. Study 1 develops MobiFit, a multimodal model that combines smartphone and Fitbit data to detect acute intoxication states in natural environments. Study 2 applies XAI methods, including SHapley Additive exPlanations (SHAP), SkopeRules, decision trees, and counterfactual explanations, to generate individualized clinical insights. Studies 3 and 4 develop and evaluate AXAI-CDSS and Empathic-CDSS, emotion-aware clinical decision support systems (CDSS) that integrate model explanations, facial emotion recognition, text sentiment analysis, and LLM-generated

explanations to adapt communication based on users' affective states. Study 5 extends the framework to AI-assisted shared decision support by integrating patient questions, clinician input, XAI summaries, emotional context, knowledge graph evidence, and Multi-Perspective Chain-of-Thought (Multi-CoT) reasoning.

The results demonstrate the feasibility and value of this staged framework. MobiFit outperformed mobile-only and Fitbit-only models in detecting moderate-to-intensive intoxication states. XAI analyses revealed meaningful behavioral and physiological patterns and translated model outputs into individualized explanations. Empathic-CDSS improved perceived usability, clarity, personalization, trust, reliability, and satisfaction compared with a baseline CDSS. Multi-CoT reasoning received the strongest overall expert preference in shared decision-support evaluation.

This dissertation contributes a systematic framework for moving clinical AI beyond black-box prediction toward trustworthy, personalized, emotionally aware, and human-centered decision support.