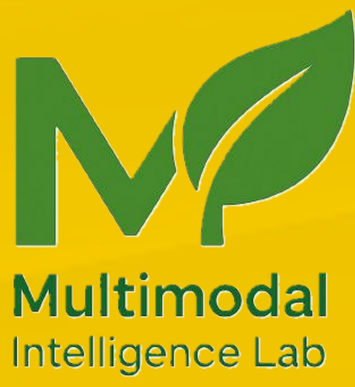




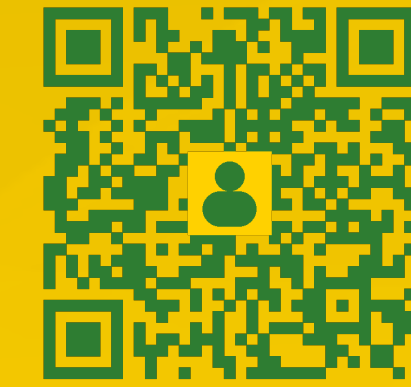
SOUTH DAKOTA
STATE UNIVERSITY



MuSDeT: Multi-Scale Encoding, Gated Fusion, and Temporal Context for Lightweight Wearable Stress Detection

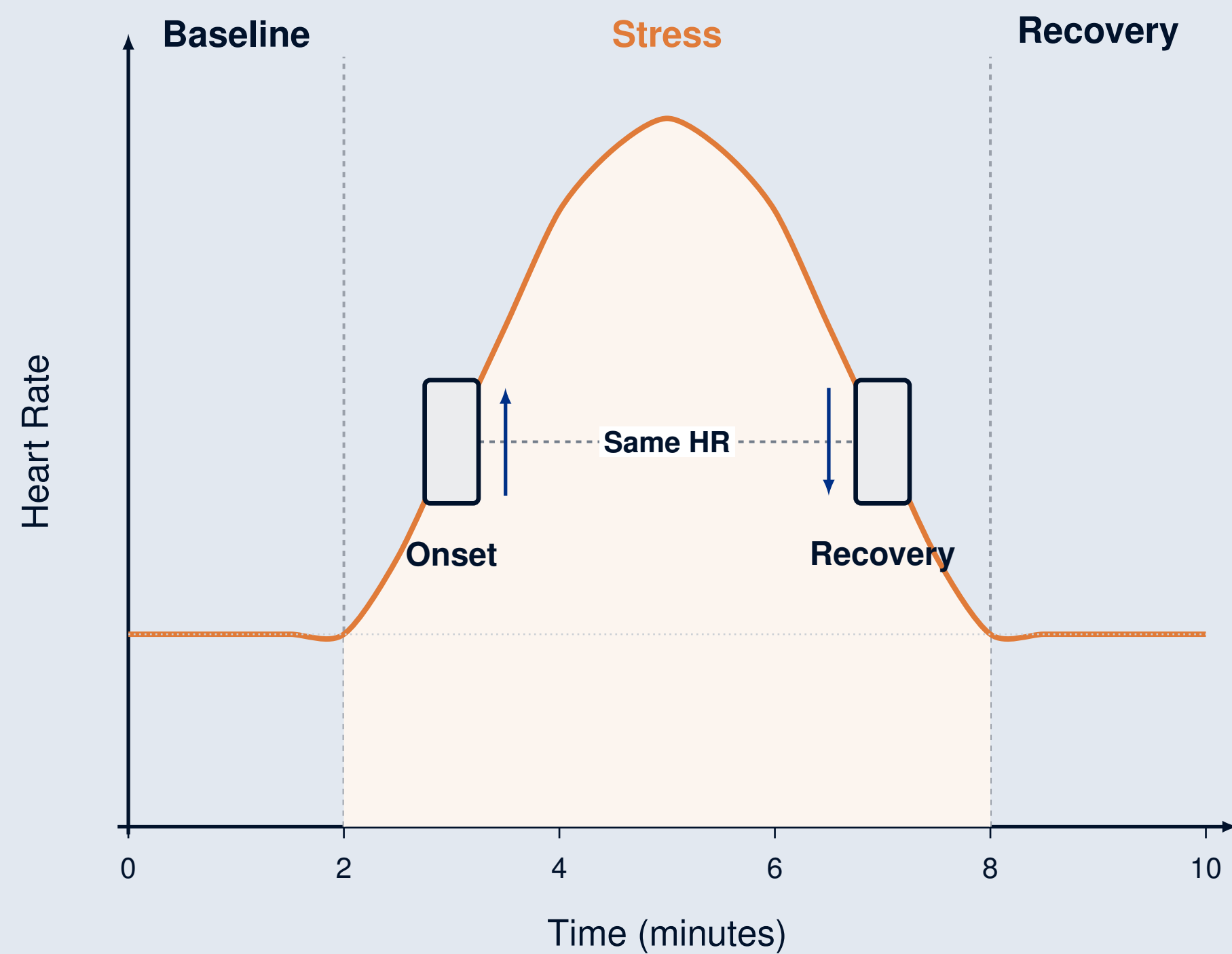
Mukhtiar Ali, Chulwoo Pack

South Dakota State University, Dept. of Electrical Engineering & Computer Science, **Multimodal Intelligence Lab**

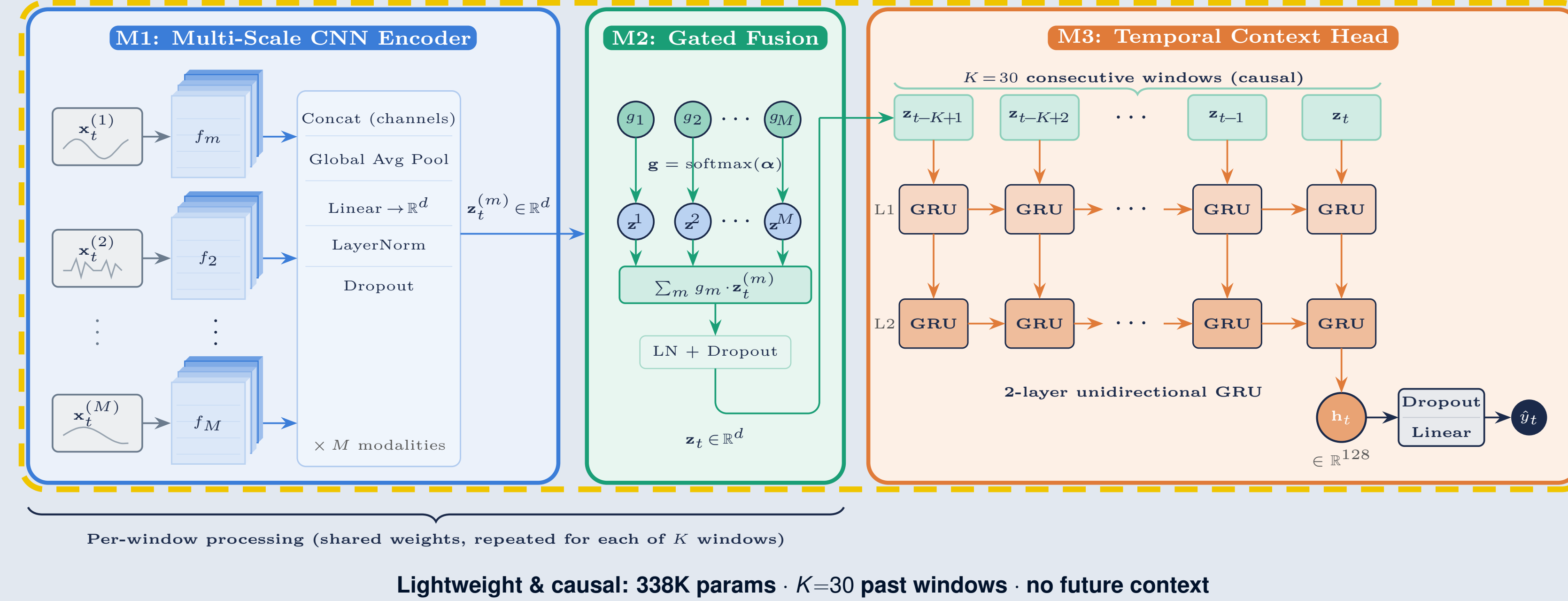


MOTIVATION

- **Physiological patterns span multiple time scales**
Heart rate changes rapidly; EDA and temperature drift slowly. Single-kernel CNNs capture one scale, not both → **M1**: multi-scale CNN encoder
- **Sensors vary in informativeness**
EDA tracks arousal; ECG is sensitive to motion artifacts; sampling rates vary by $175\times$ across sensors. Equal-weight fusion ignores this → **M2**: learned modality gates
- **Stress evolves over time**
Stress develops gradually and persists, but window-level models classify 1-second snapshots in isolation → **M3**: causal temporal context over $K=30$ past windows



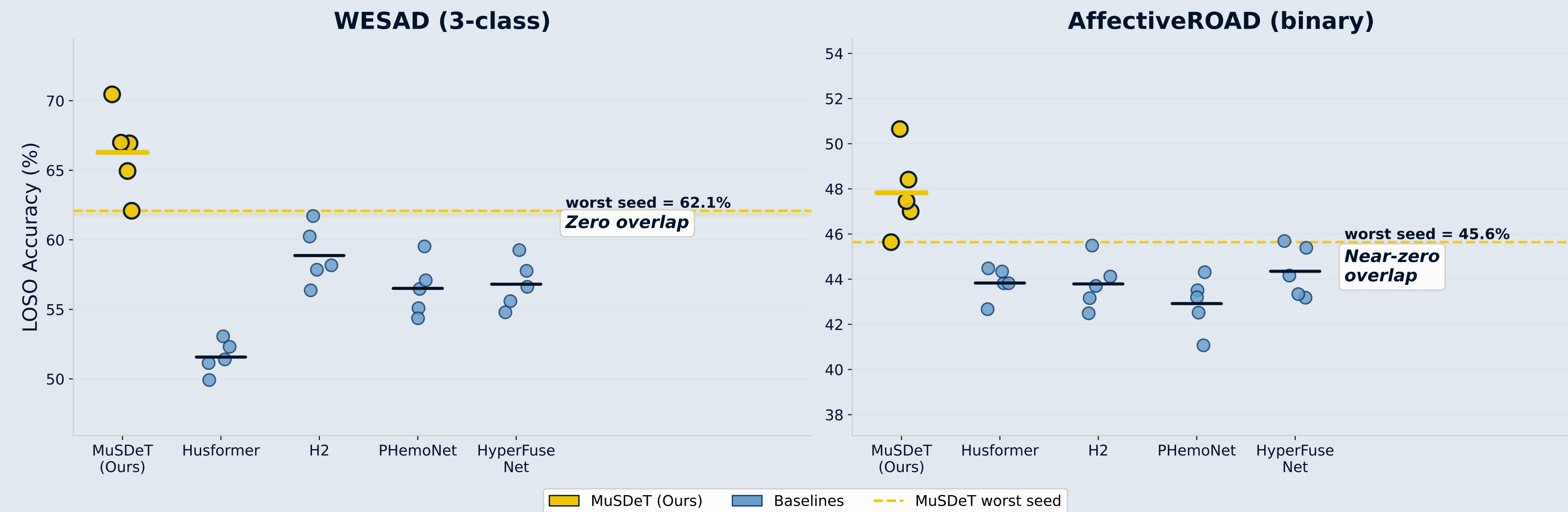
ARCHITECTURE



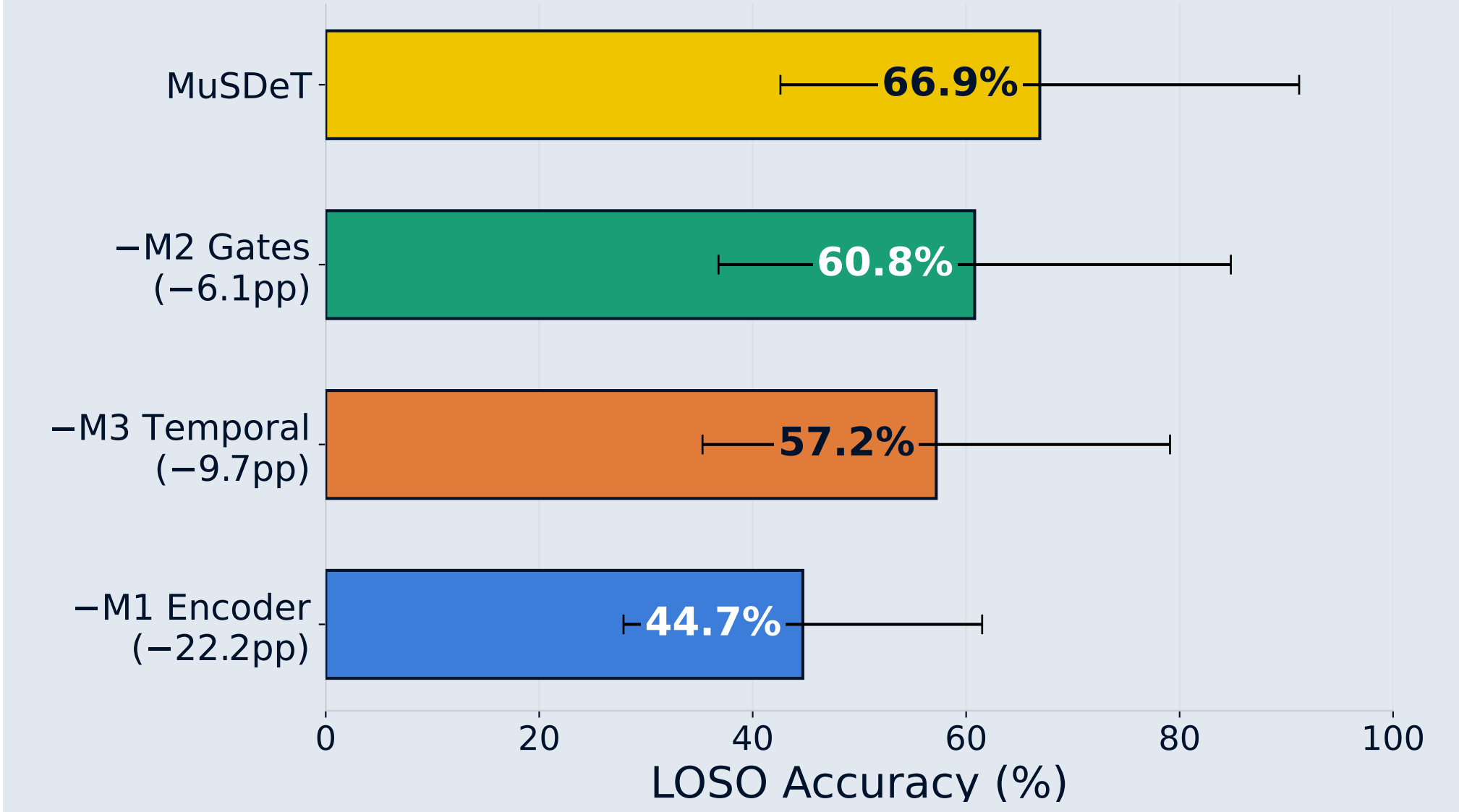
RESULTS

MuSDeT reaches 66.9% LOSO on WESAD — worst seed stays above all baselines.

Protocol: leave-one-subject-out, zero/near-zero window overlap, 5 seeds.



ABLATION & SCALING



–M1 Encoder: single-kernel CNN –M2 Gates: equal weights
–M3 Temporal: $K=1$

