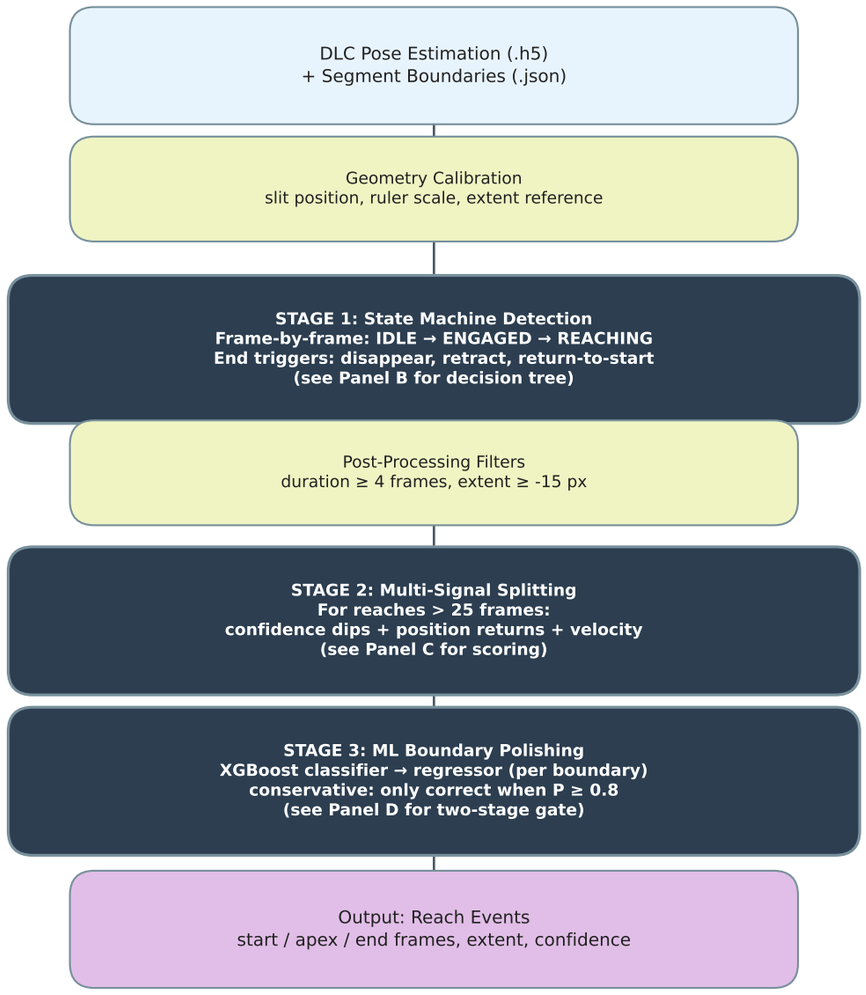
Mouse Reach Detection Algorithm v5.3

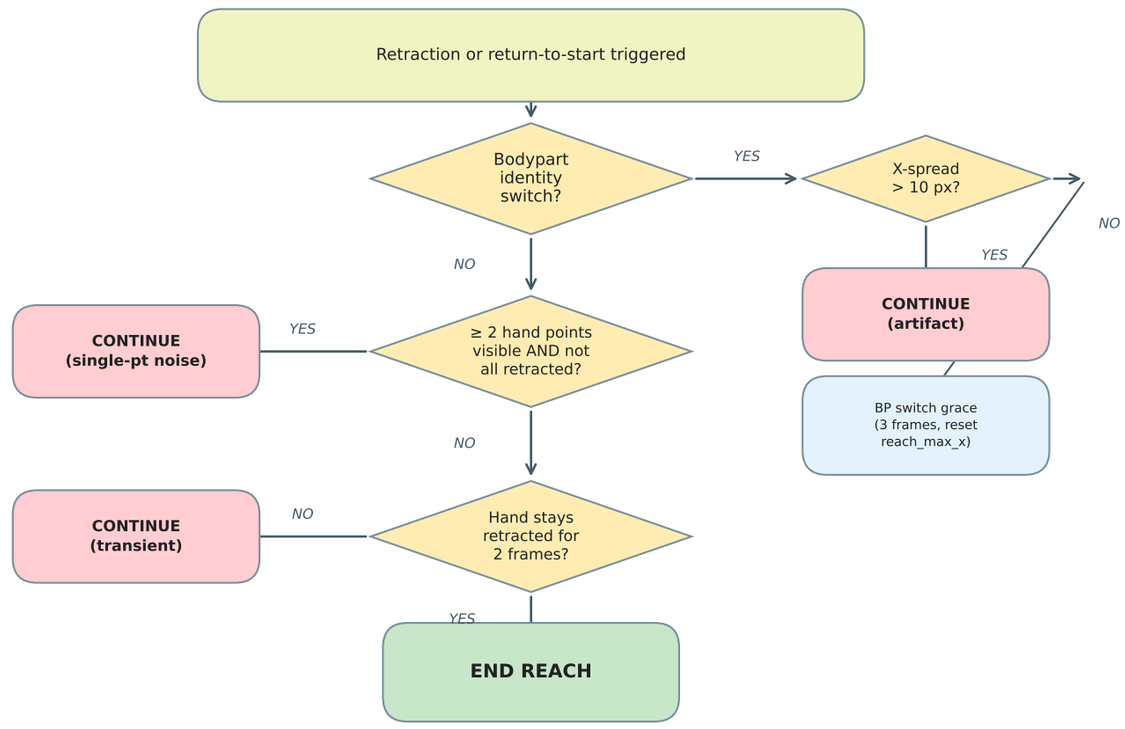
A. Pipeline Architecture



v5.3: 98.8% boundary accuracy (matched), 94.5% overall
Cross-validated generalization: 84.6%

B. Retraction Decision Tree

Called when hand retraction or return-to-start is detected

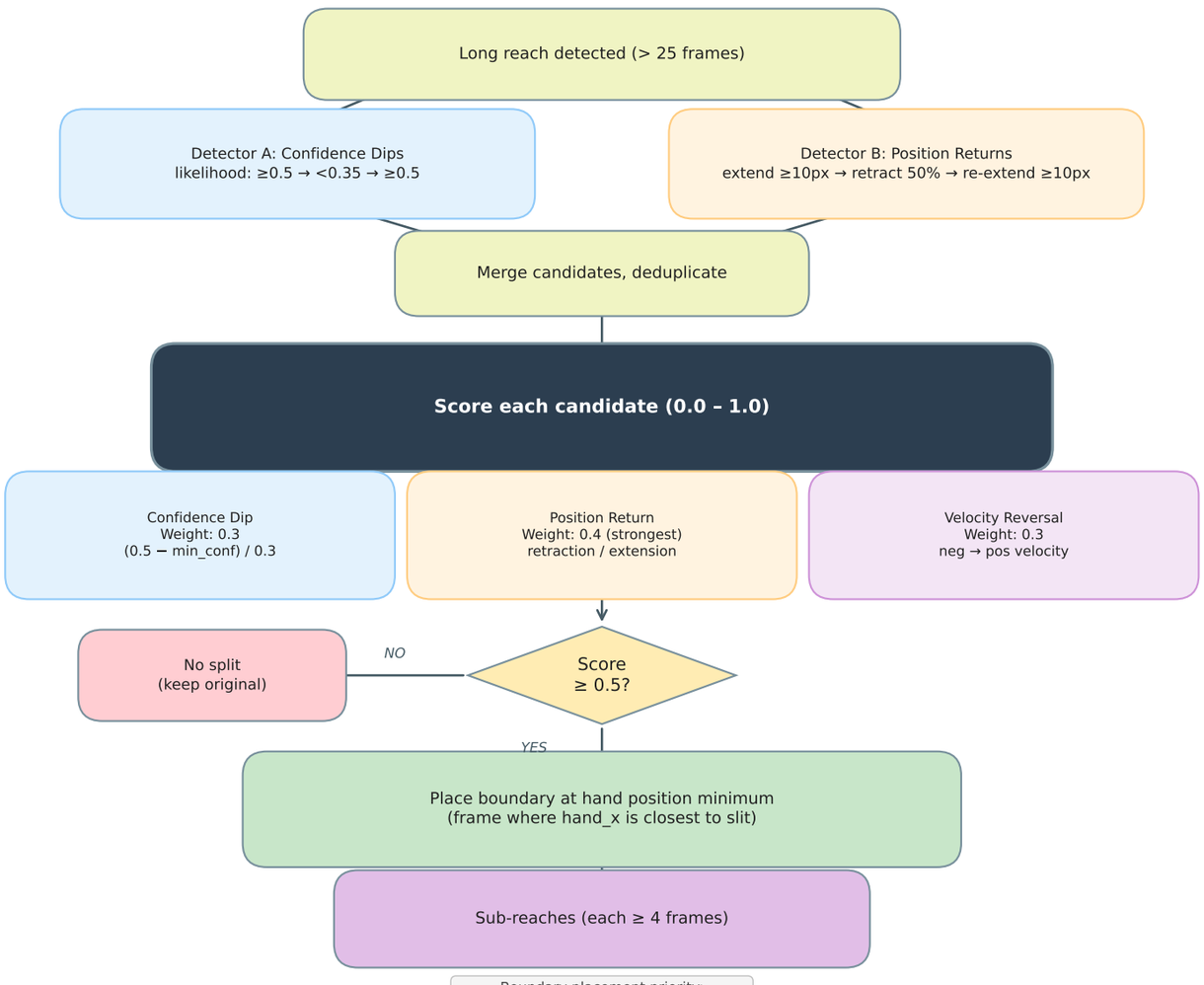


Retraction criteria:
• Hand retracted > 50% of extension AND > 5 px
• OR hand returned within 5 px of slit
• Sustained over 2 consecutive frames

State Machine Summary:
IDLE → nose within 25 px of slit → ENGAGED
ENGAGED → hand visible ≥ 2 frames → REACHING
REACHING → hand gone ≥ 3 frames OR retraction confirmed → IDLE

C. Multi-Signal Split Scoring

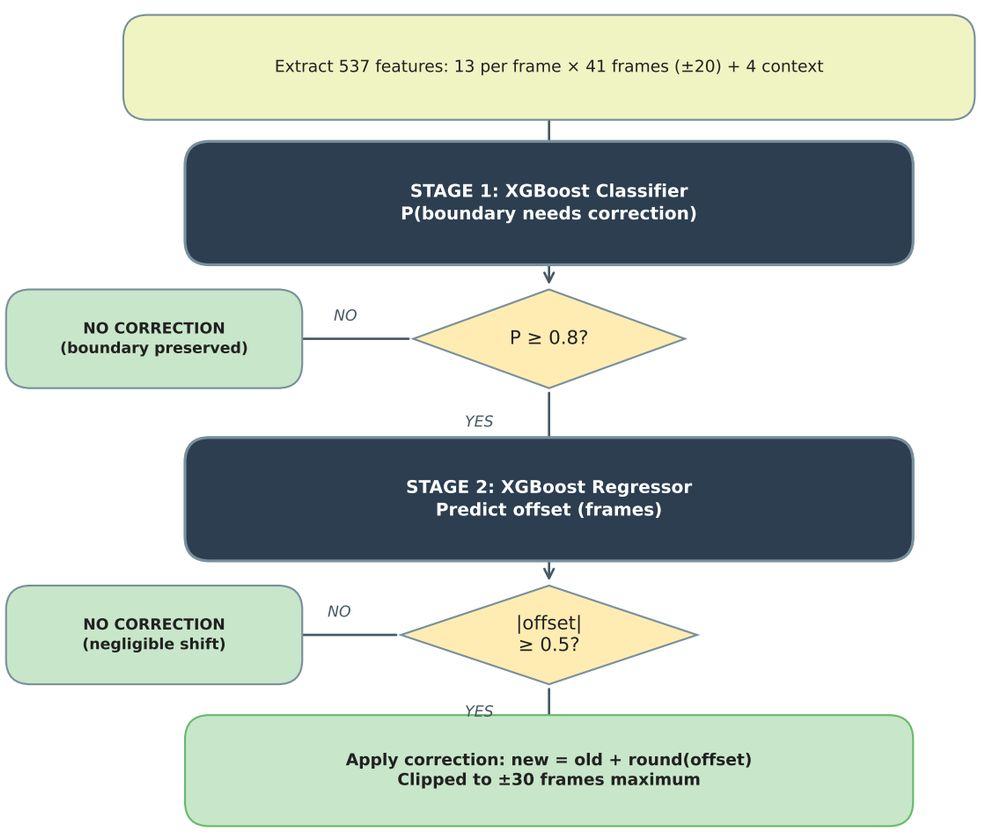
For reaches > 25 frames (95th percentile of GT duration)



Boundary placement priority:
1. Hand position minimum (closest to slit)
2. Last positive velocity frame
3. Confidence dip center (fallback)

D. ML Boundary Polishing

Applied independently to each reach start and end boundary



Training: 2,492 reaches × 23 videos
XGBoost: 300 trees, depth 6, lr 0.06
5-fold GroupKFold CV (grouped by video)
Features: hand positions (×4), likelihoods (×4),
nose pos/likelihood, mean hand, visibility count, velocity

Design principle: ~80% of boundaries are already correct. The classifier gate prevents corrupting correct boundaries with unnecessary regression predictions.