

# GFPOP for ECG data

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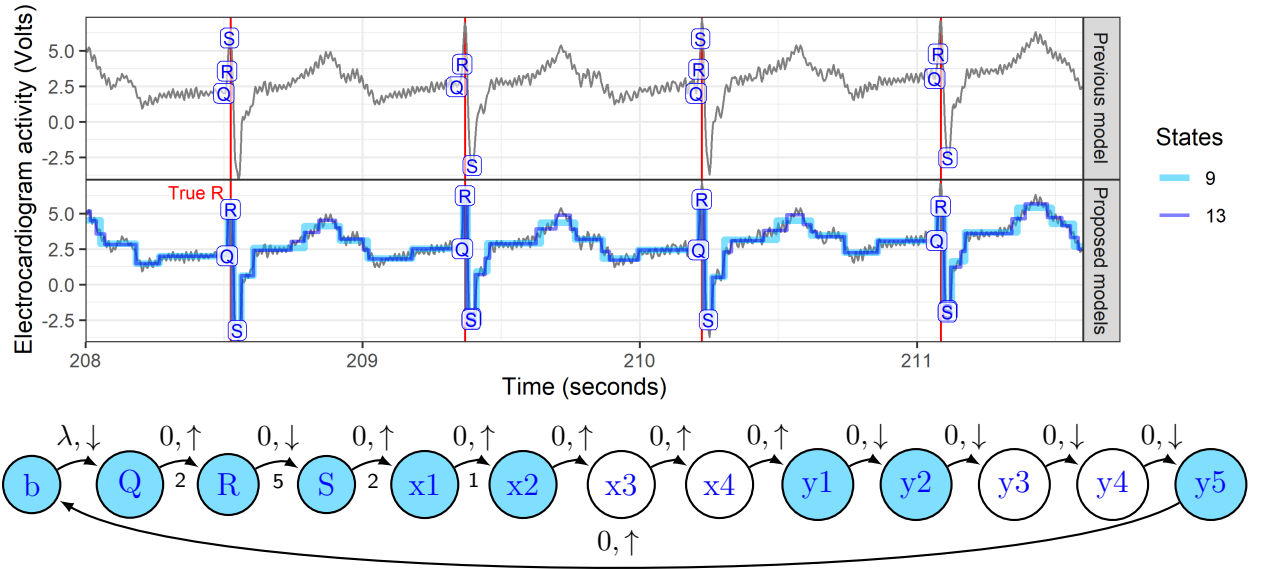


Figure 1: In these electrocardiogram data, it is important for models (blue) to accurately detect the QRS complex (Q is before the peak, R is the peak marked in red, S is the local minimum after the peak). **Top:** Previous model of ? mistakenly predicts S at the peak. **Bottom:** proposed constrained changepoint model using a graph with 9 vertices accurately predicts R at each peak.

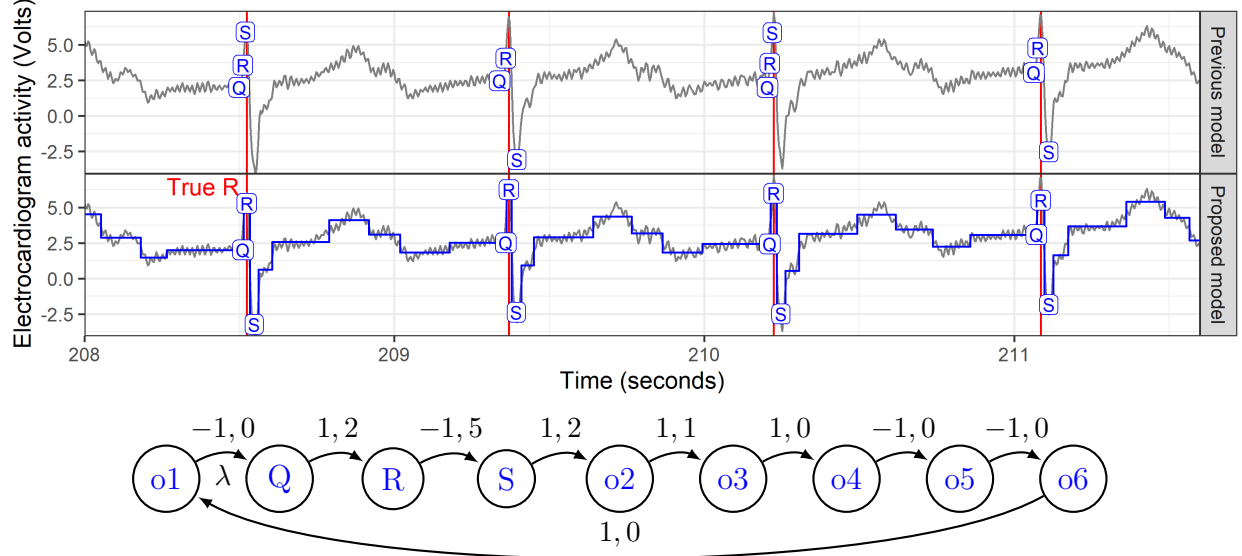


Figure 2: In these electrocardiogram data, it is important for models (blue) to accurately detect the QRS complex (Q is before the peak, R is the peak marked in red, S is the local minimum after the peak, other states/segments o1–6). **Top:** Previous model of ? mistakenly predicts S at the peak. **Middle:** proposed constrained change-point model accurately predicts R at each peak. **Bottom:** graph structure of proposed nine-state constrained change-point model. Below each edge  $e$  we show the penalty  $\lambda_e$ , which is either a constant  $\lambda > 0$  or zero if nothing is shown; above we show the constants  $\delta_e, \gamma_e$  in the constraint function  $g_e(m_i, m_{i+1}) = \delta_e(m_i - m_{i+1}) + \gamma_e \leq 0$  ( $\delta_e = 1$  for a non-decreasing change,  $\delta_e = -1$  for a non-increasing change,  $\gamma_e \geq 0$  is the minimum magnitude of change).