Adaptive Control of Bayesian Network Computation

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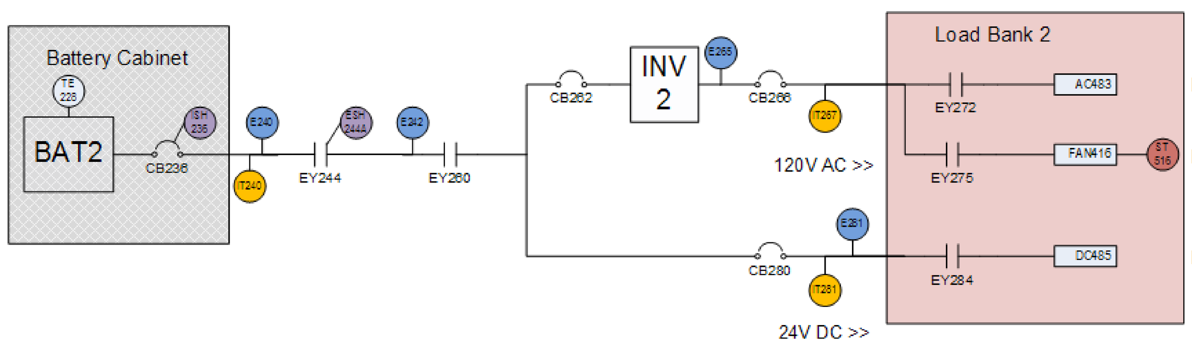
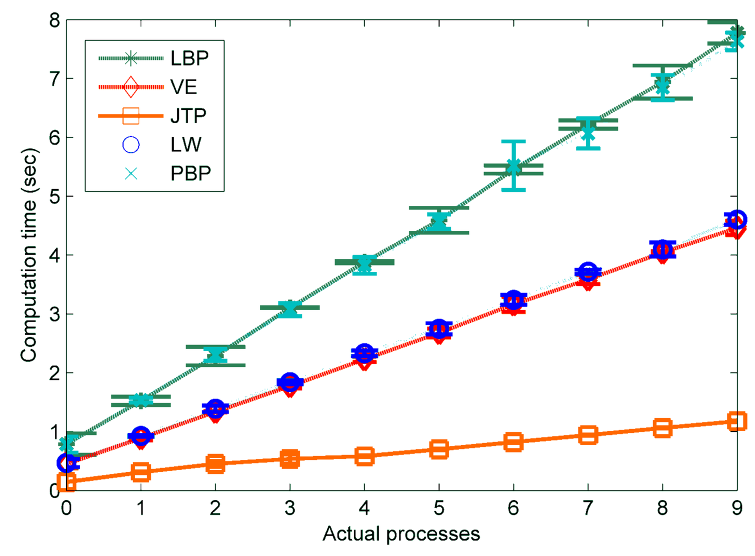
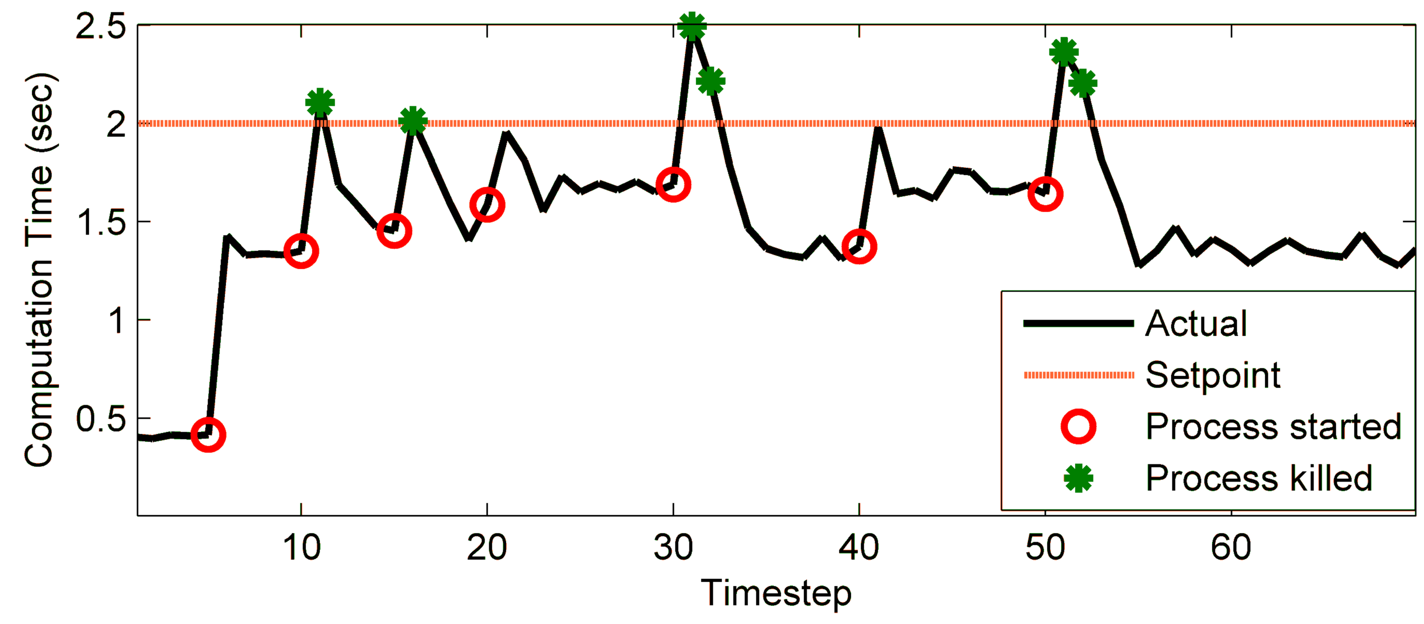
Bayesian Network Computation



• Bayesian Networks (BNs) have been successful in diagnosing faults in aerospace electrical power systems.
• We use data from ADAPT, an electrical testbed at NASA Ames, and a subsection of the full BN.
• During each timestep of a simulation, the states of each node are calculated using sensor evidence.



• Many BN inference algorithms exist, each with varying runtimes and tradeoffs. We compare LW (likelihood weighting) and JTP (junction tree propagation).

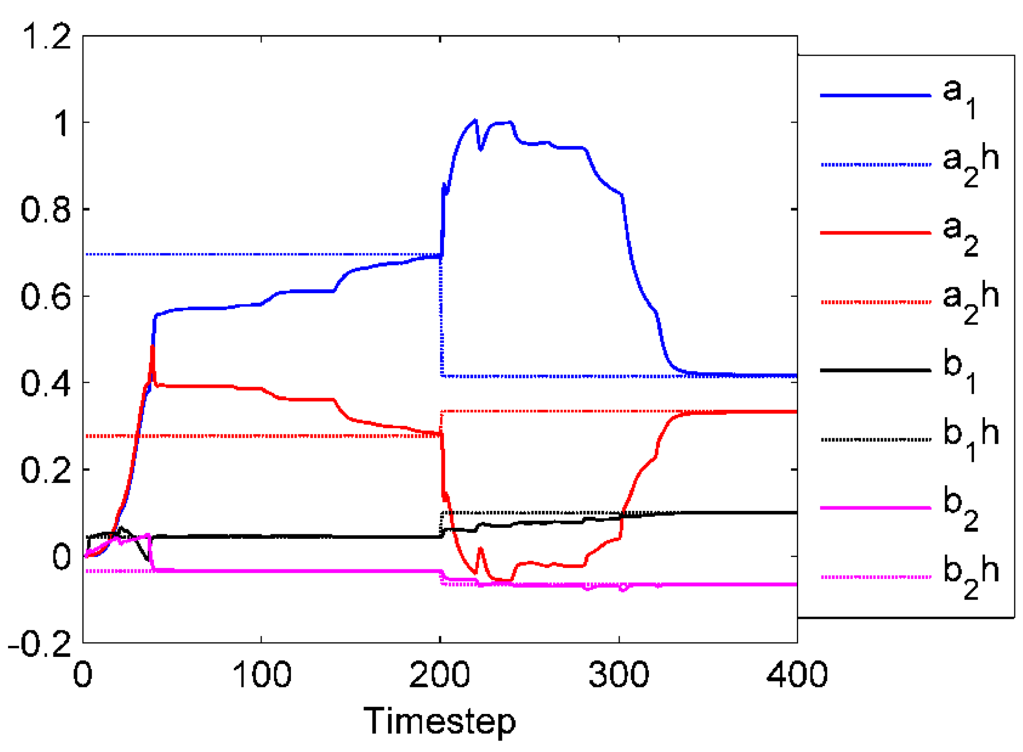


• BN inference is performed in an unpredictable environment with low criticality background processes, which compete for the CPU.
• These processes can be terminated (controlled) to ensure the BN inference completes in a set amount of time.

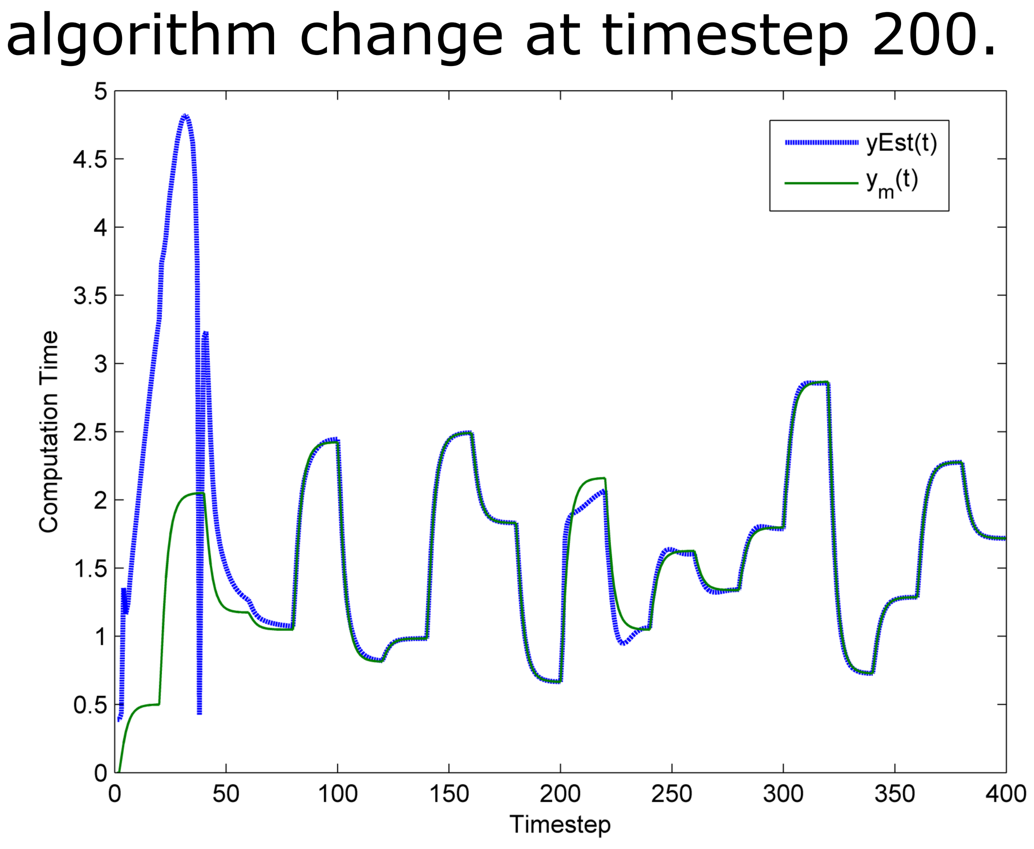
Adaptive Controller

Minimum Degree Pole Placement

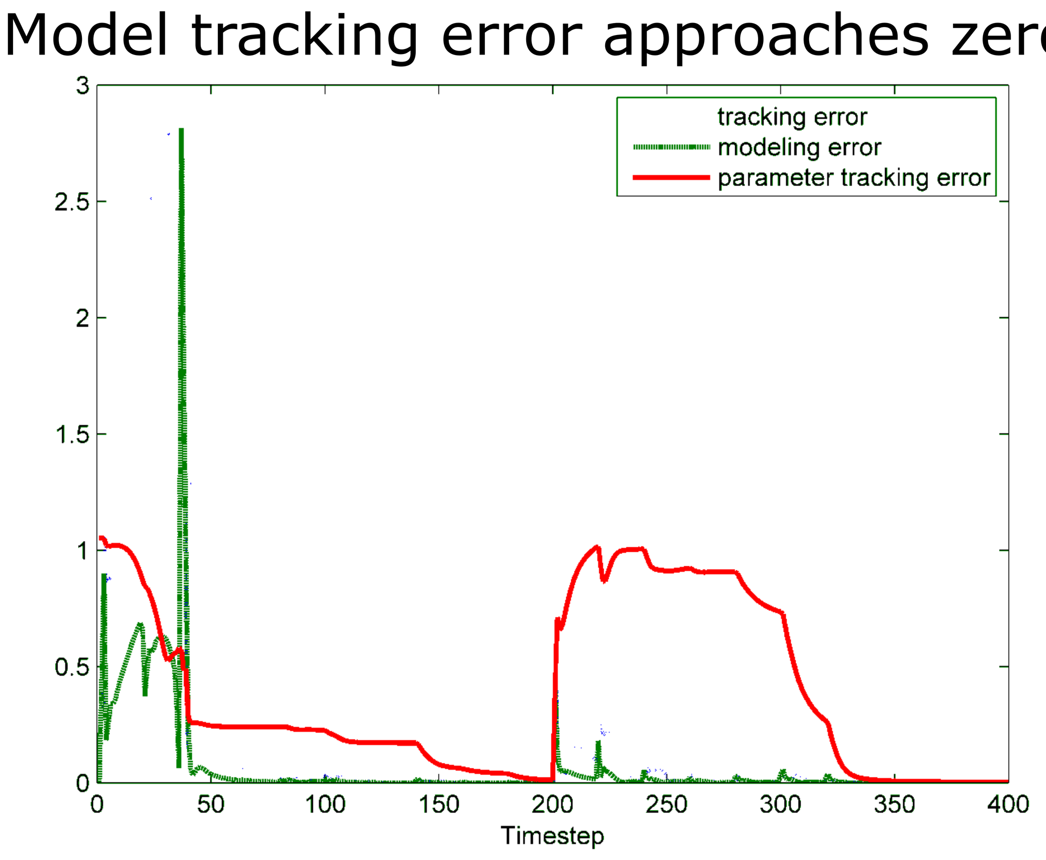
$$u=\underbrace{\frac{T}{R}u_c}_{\text{Feed backward}}-\underbrace{\frac{S}{R}y}_{\text{Feed forward}}$$



Parameter adaptation with LW to JTP algorithm change at timestep 200.

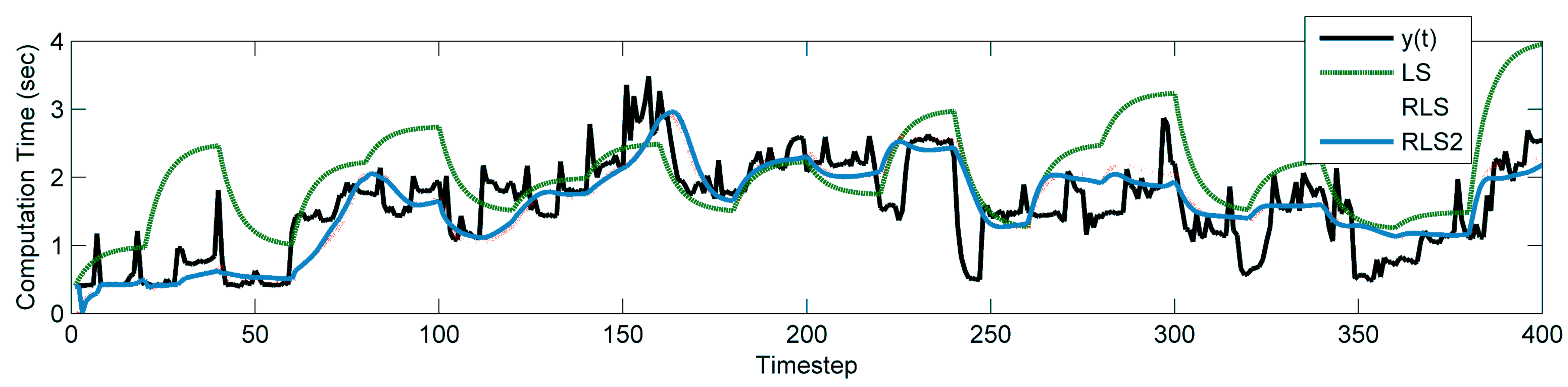


Model tracking error approaches zero.



MDPP controller effectively learned open loop parameters within 200 timesteps and after BN inference algorithm change.

Computation Model



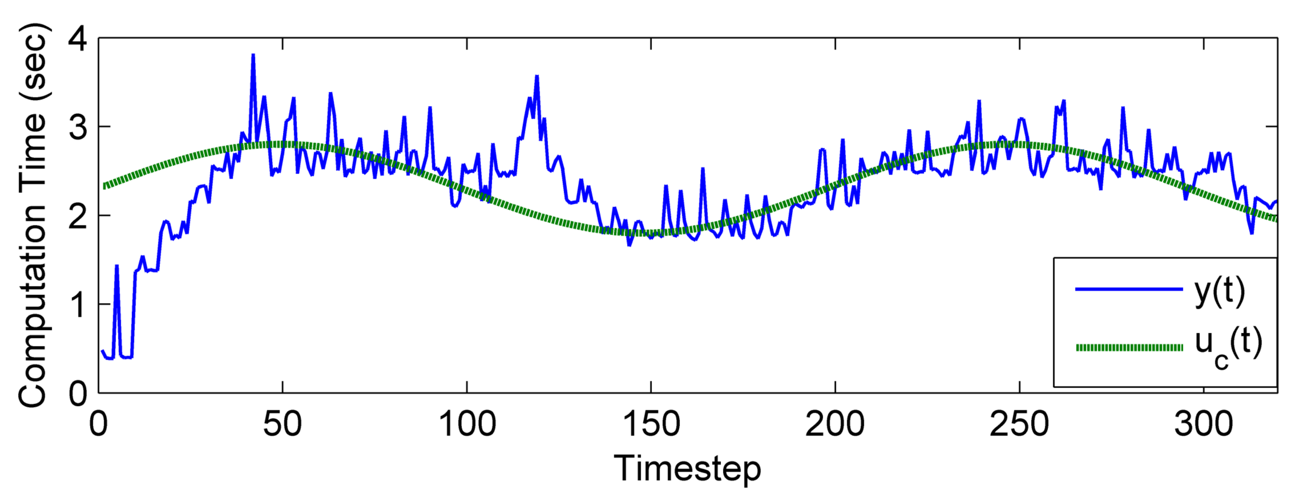
Open loop model fitting with first order least squares (LS), first order recursive least squares (RLS), and second order recursive least squares (RLS).

The parameters $a_{1,2}$ and $b_{1,2}$ are learned. $u(t)$ is the max number of background processed given by a random square-wave.

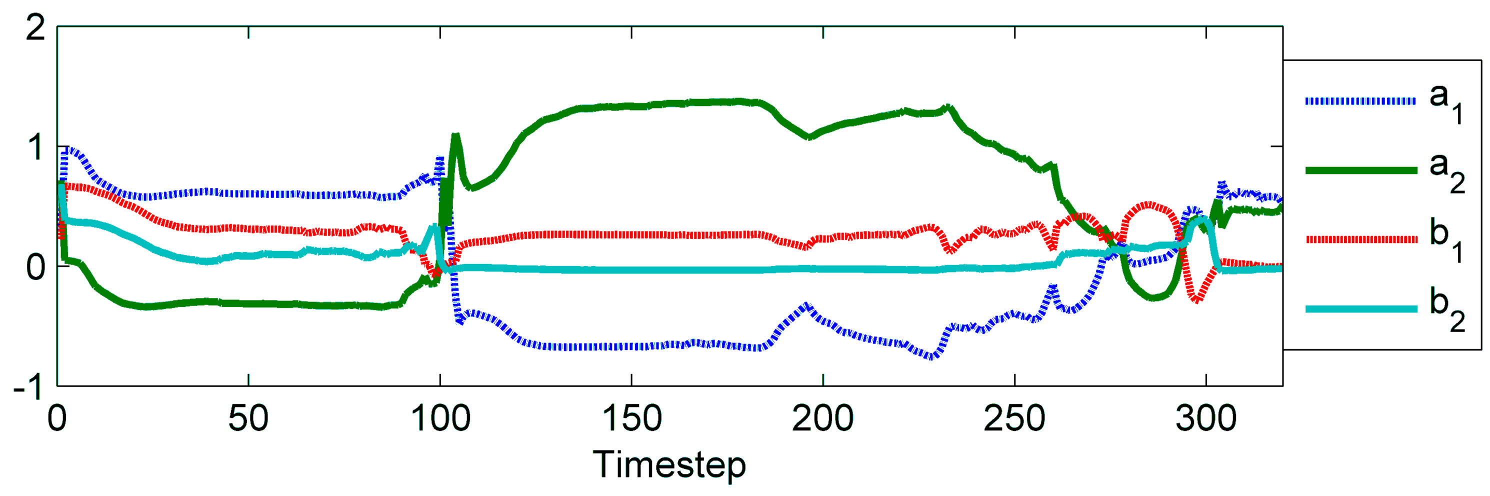
$$\hat{y}(t)=a_1\hat{y}(t-2)+a_2\hat{y}(t-1)+b_1u(t-1)+b_2u(t-2) \quad \textbf{(1)}$$

Adaptive Parameter Tracking

Sinusoidal Set-point

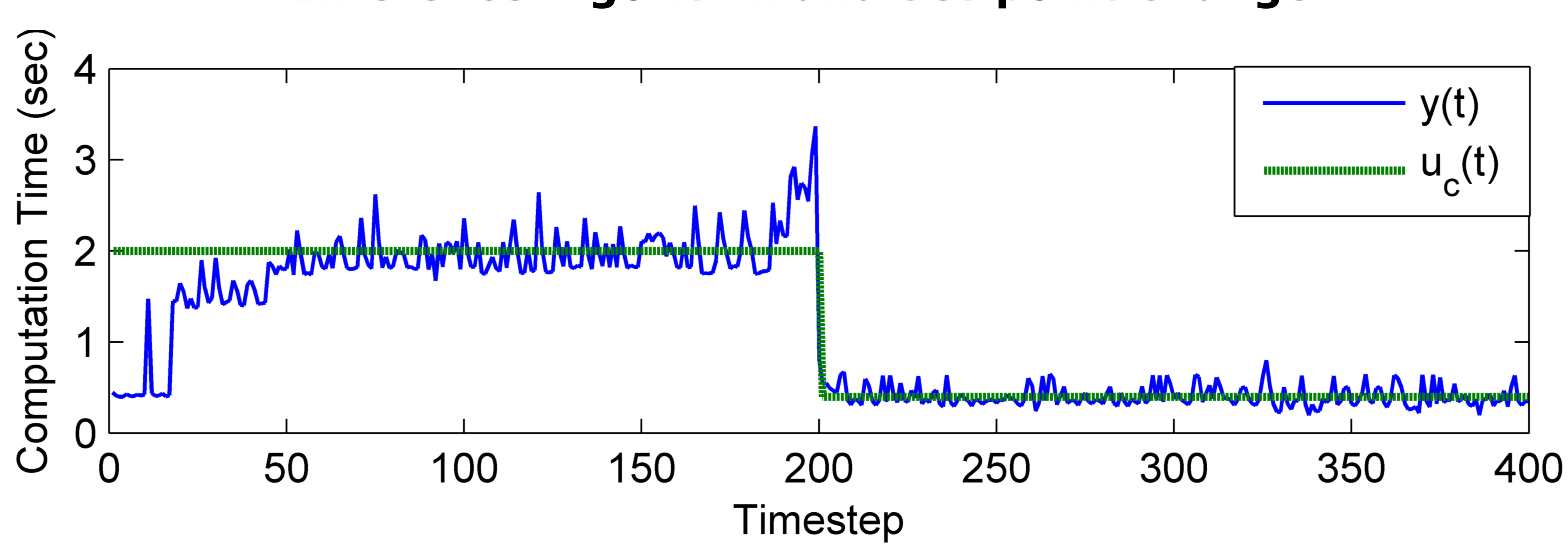


Closed loop simulation with sinusoidal computation time set-point $u_c(t)$. Background processes were created pseudo-randomly with a Poisson function.



Parameter adaptation during the sinusoidal set-point simulation. Parameters are defined in (1).

Inference Algorithm and Set-point Change



Closed loop tracking with simultaneous inference algorithm change (likelihood weighting to junction tree propagation) and set-point change at timestep 200.