Time Series Leanings

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I. INTRODUCTION

II. PENCHANT DERIVATION

III. MEAN OBSERVED LEANING

A. Algorithm

IV. SIMPLE EXAMPLE SYSTEMS

A. Impulse with Noisy Response Linear Example

Consider the linear example dynamical system of

$$X_t = \{0, 2, 0, 0, 2, 0, 0, 2, 0, 0\} \tag{1}$$
$$Y_t = X_{t-1} + B\eta_t, \tag{2}$$

with $B \in \mathbb{R} \geq 0$ and $\eta_t \sim \mathcal{N}(0, 1)$. Specifically, consider $B \in [0, 2]$ in increments of 0.02. The response system Y is just a lagged version of the driving signal with varying levels of standard Gaussian noise applied at each time step.

B. Cyclic Linear Example

Consider the linear example dynamical system of

$$X_t = \sin(t) \tag{3}$$
$$Y_t = X_{t-1} + B\eta_t, \tag{4}$$

with $B \in \mathbb{R} \geq 0$ and $\eta_t \sim \mathcal{N}(0, 1)$. Specifically, consider $B \in [0, 2]$ in increments of 0.02. The response system Y is just a lagged version of the driving signal with varying levels of standard Gaussian noise applied at each time step.

C. Non-Linear Example

Consider the non-linear dynamical system of

$$X_t = \sin(t) \tag{5}$$
$$Y_t = AX_{t-1}(1 - BX_{t-1}) + C\eta_t, \tag{6}$$

with $A, B, C \in \mathbb{R} \geq 0$ and $\eta_t \sim \mathcal{N}(0, 1)$. Specifically, consider $A, B, C \in [0, 5]$ in increments of 0.5.

D. RL Circuit Example

Both of the previous examples included a noise term, η_t. Consider a series circuit containing a resistor, inductor, and time varying voltage source related by

$$\frac{dI}{dt} = \frac{V(t)}{L} - \frac{R}{L}I, \tag{7}$$

where I is the current at time t, $V(t) = \sin(\Omega t)$ is the voltage at time t, R is the resistance, and L is the inductance. Eqn. 7 was solved using the *ode45* integration function in MATLAB. The time series $V(t)$ is created by defining values at fixed points and using linear interpolation to find the time steps required by the ODE solver.

Consider the situation where $L = 10$ Henries and $R = 5$ Ohms are constant. Physical intuition is that V drives I, and so we expect to find that V CCM causes I (i.e., $C_{VI} > C_{IV}$ or $\Delta = C_{VI} - C_{IV} > 0$).

V. EMPIRICAL DATA

VI. CONCLUSION

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