Texas–Wisconsin Modeling and Control Consortium — Group Highlights

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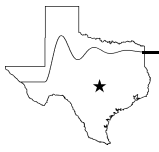
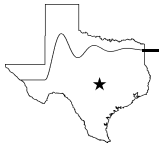
February 19–20, 2001



Current Research Portfolio

- Moving horizon state estimation theory and computation. Eric Haseltine.
- Process monitoring. Brian Odelson.
- Model predictive control (MPC) theory and computation
  - Nonlinear model predictive control. Matt Tenny.
  - Robust model predictive control. Jenny Wang.
  - Designing MPC disturbance models to achieve offset free, robust control. Gabriele Pannocchia
  - Integrated, Large-Scale Model Predictive Control. Ali Elkamel.
- Particulate reactor modeling and control. Daniel Patience.



Recent and Upcoming Graduations

- Chemical vapor deposition modeling and control. Scott Middlebrooks defended. LSI Logic, Portland, Oregon.
- Parameter estimation and experimental design. Sankash Venkatesh is defending his M.S. thesis this month. Siebel Systems Inc. (Software engineer).

Integrated, Large-Scale Model Predictive Control

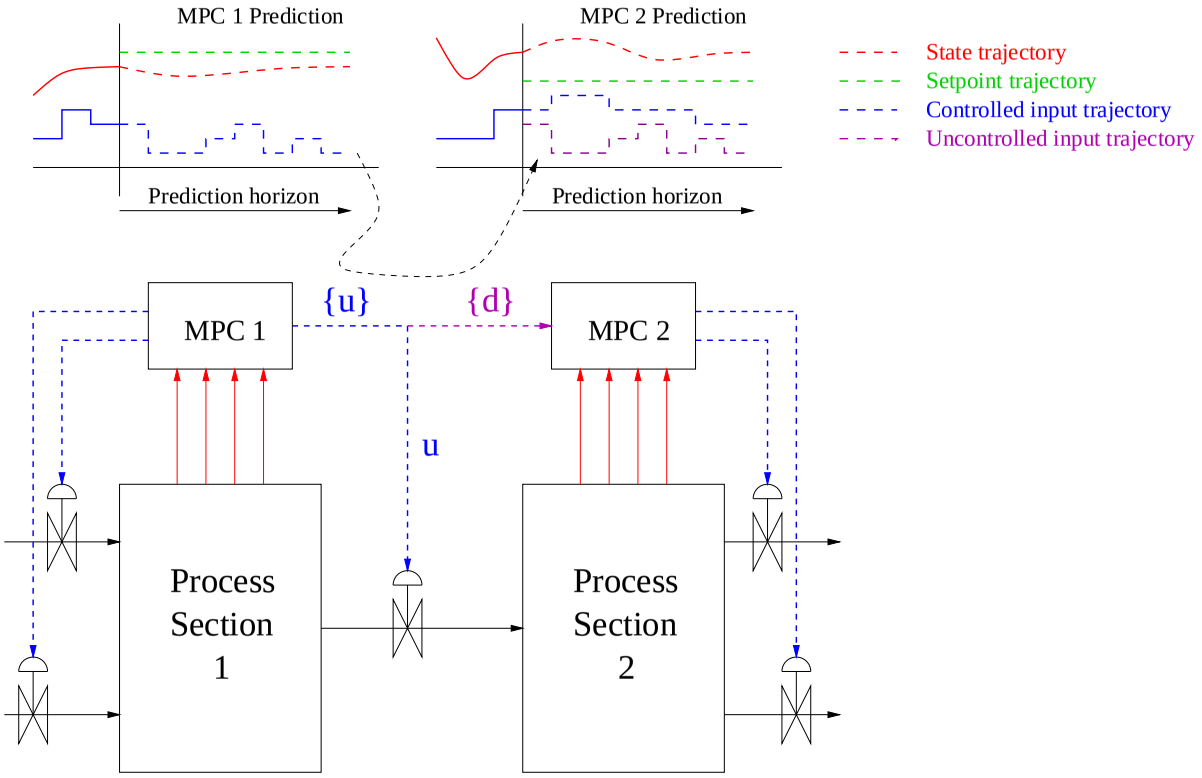
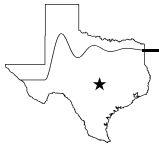


Figure 1: Integration of unit-level MPCs. The forecast of all variables in unit 1 that affect unit 2 are provided as a future disturbance forecast for unit 2.

Integrated, Large-Scale Model Predictive Control

The horizons of the unit MPC controllers contain the **future disturbance forecasts** for all other units.

- Do NOT design a single, monolithic controller.
- Do NOT design a coordination layer for the MPCs.
- Do share each MPC controller's forecast among all MPC controllers.
- Do use **future** tracking and disturbance rejection capability of the unit MPCs.
- On-line implementation is the **same** as unit MPC requirement.
- Main theoretical issue: how to ensure the communicating unit MPCs do not conflict with each other.



State Estimation: Many Molecules to Industrial Scale. Simple Kinetics Example

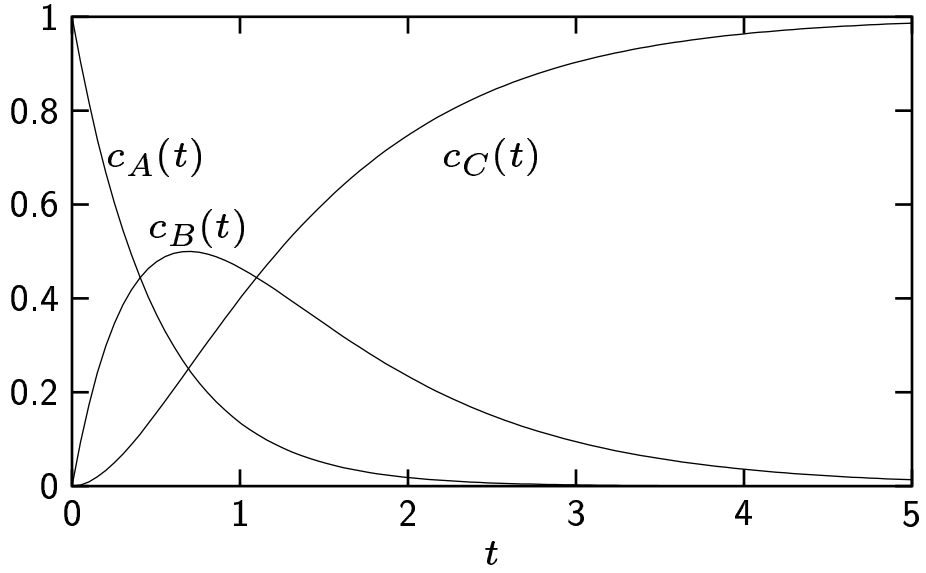
$$\mathrm{A} \xrightarrow{\mathrm{k}_1} \mathrm{B}$$

$$\mathrm{B} \xrightarrow{\mathrm{k}_2} \mathrm{C}$$

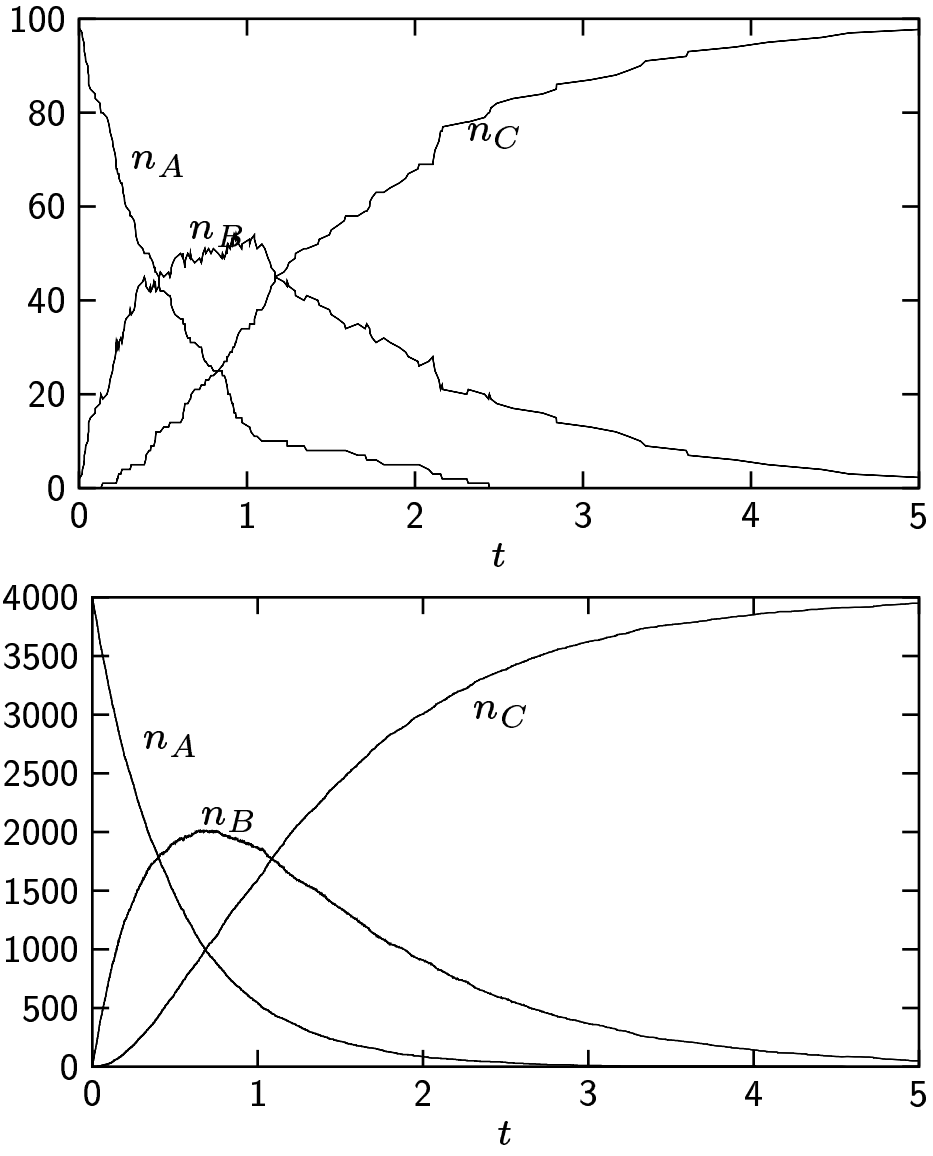
$$\frac{dc_A}{dt} = -r_1, \qquad r_1 = k_1 c_A$$

$$\frac{dc_B}{dt} = r_1 - r_2, \qquad r_2 = k_2 c_B$$

$$\frac{dc_C}{dt} = r_2$$



Kinetics example — Stochastic model



Increasing the abstraction level — The probability density

$$\mathrm{A} + \mathrm{B} \underset{\mathrm{k}_{-1}}{\overset{\mathrm{k}_1}{\rightleftharpoons}} \mathrm{C}$$

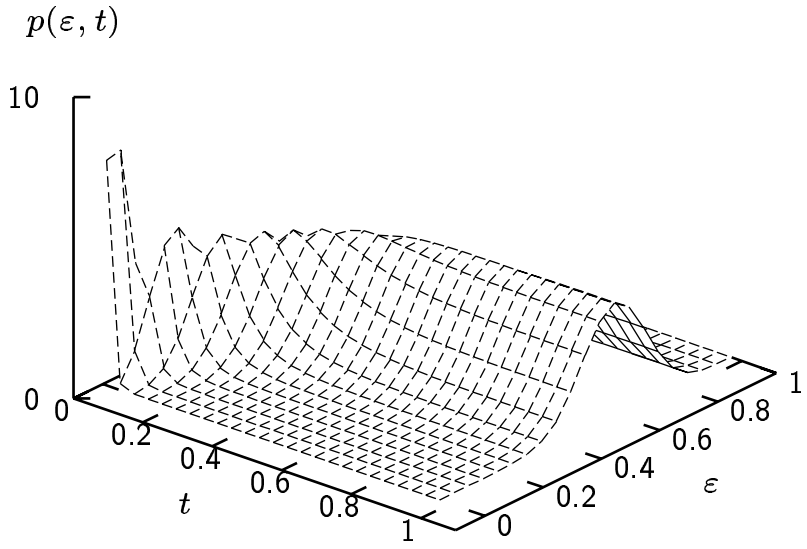


Figure 2: Solution to master equation for A + B $\rightleftharpoons$ C starting with 20 A molecules, 100 B molecules and 0 C molecules, $k_1 = 1/20, k_{-1} = 3$.

The probability density — more molecules

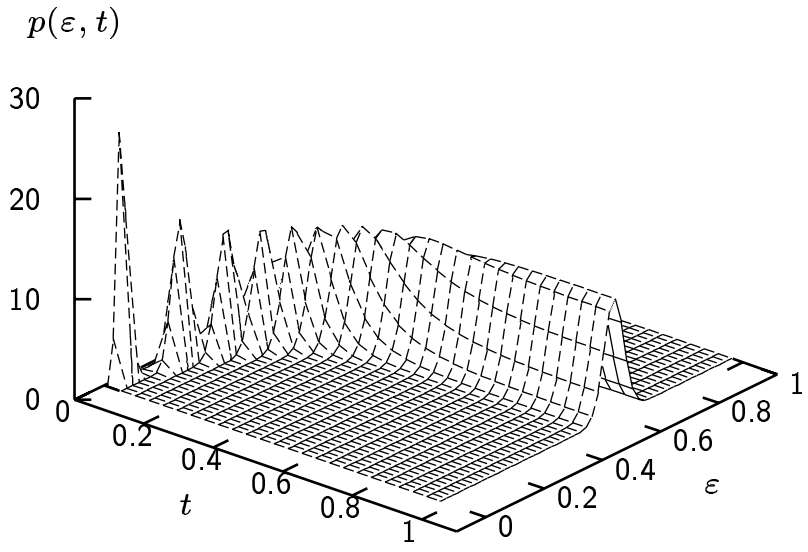


Figure 3: Solution to master equation for A + B $\rightleftharpoons$ C starting with 200 A molecules, 1000 B molecules and 0 C molecules, $k_1 = 1/200, k_{-1} = 3$.

Systems Biology

Drug Interventions will now be studied at a system level.

— Dr. Brian Grinnell, Eli Lilly

Other Activities

- Book writing
- CPC 6 meeting
- Faculty hiring in systems area
- UW ChE Department Chair