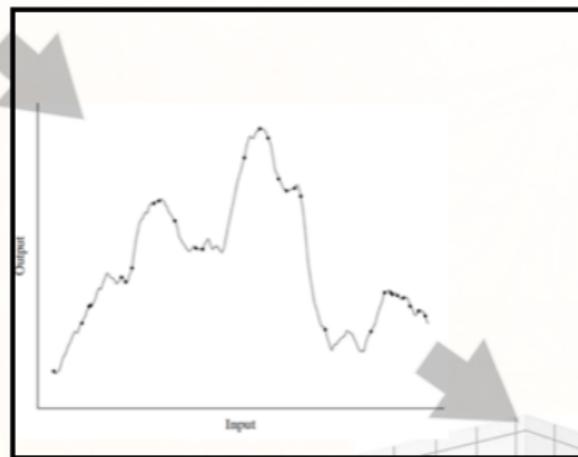
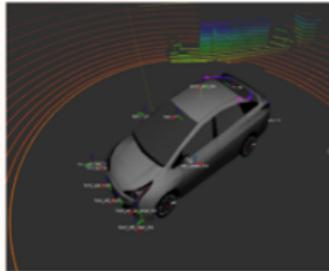
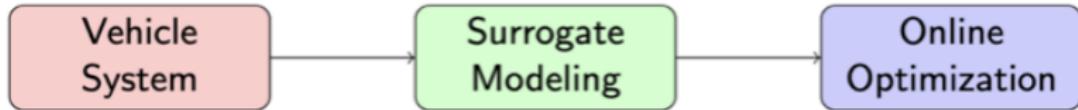


Surrogate Modeling for Online Optimization

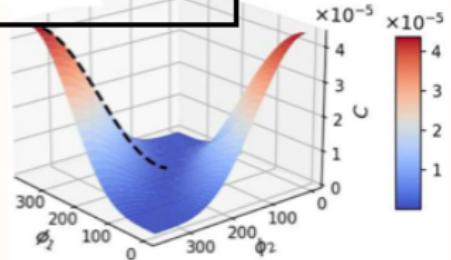
Whitney Huang  School of
MATHEMATICAL AND
STATISTICAL SCIENCES
Clemson University
joint with Katherine Kreuser



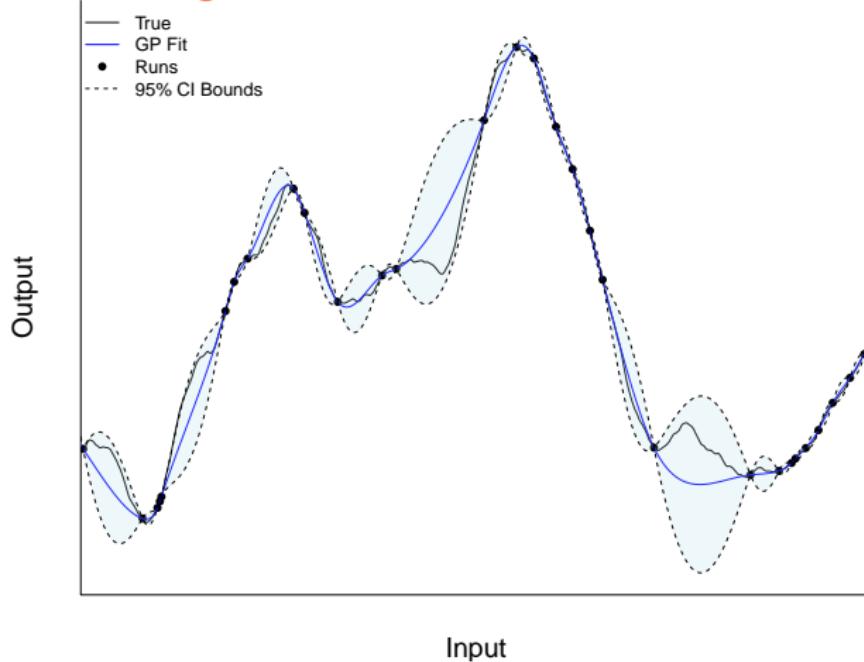
3.23.12 VIPR Meeting, September 18



Goal: To perform **curve fitting** for **time-varying functions** to support downstream online optimization



Curve Fitting: Not Just the Line, But the Confidence



- ▶ Function estimation achieved by **Gaussian process (GP)**:

$$f(\boldsymbol{x}) \sim \text{GP} (m(\boldsymbol{x}), K(\boldsymbol{x}, \boldsymbol{x}')) , \quad \boldsymbol{x} \in \mathcal{X}$$

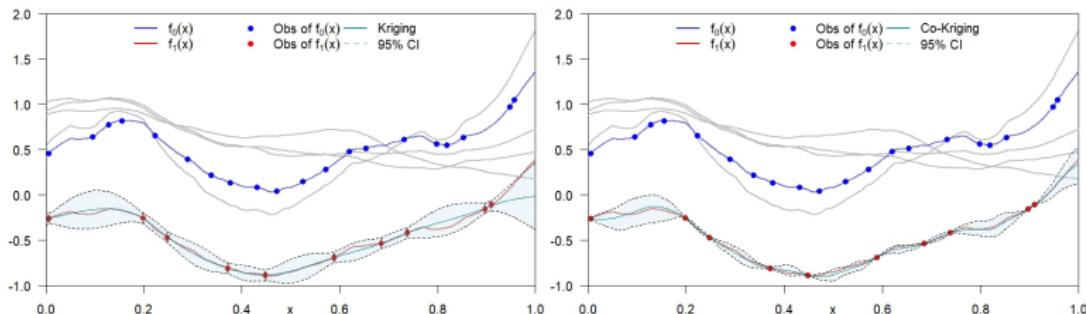
- ▶ **GP** offers an “optimal” estimate $\hat{f}(\boldsymbol{x})$ with “localized” uncertainty (error bars)

Modeling Time-Varying Functions

Autoregressive GP [Kennedy & O'Hagan, 2000]:

$$f_t(x) = \phi_{t-1} f_{t-1}(x) + \epsilon_t(x).$$

At each time point t , GP fits the curve $f_t(\cdot)$. ϕ controls how the function changes from one time step to the next

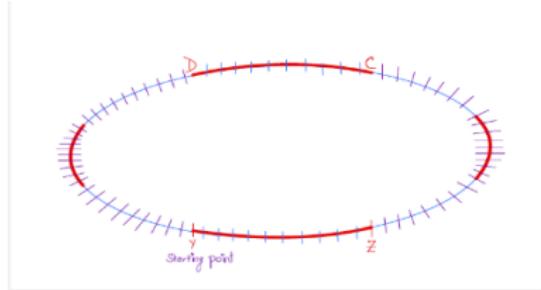


	Static GP	Dynamic GP
Obs	Present only	Past and Present
Mean PI Widths	0.225	0.115
1-NRMSPE	0.764	0.930

Dynamic GP Outperforms Static GP in Predictive Accuracy and Precision

What Have We (Mainly Katherine) Done?

- ▶ Oval Track: Acceleration Choice for Minimum Time

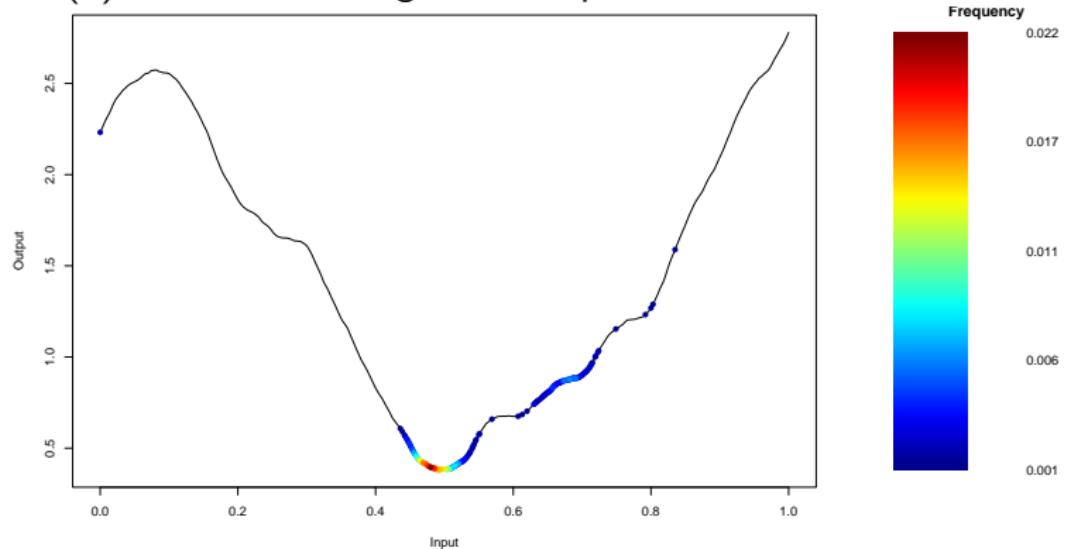


- ▶ Assess the added value of modeling the dynamics using an AR-GP

Oval Track Results

Oval Track Results Cont'd

AR(1)-GP Forecast Arg Min UQ.pdf



Plans for This Semester and Beyond

- ▶ **Modeling:**

- ▶ Refining dynamics models that balance statistical and computational efficiency
- ▶ Developing methods for multiple conflicting function estimations in multi-objective online optimization

- ▶ **Inter-Group Collaboration:**

Stat + Opt ; Stat + Eng ; Opt + Eng + Stat

- ▶ **Broader Connections:** MATH-STAT Foundation of **Digital Twins** and Their Applications