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Time Series Analysis of Driver Behavior on Curves

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Introduction

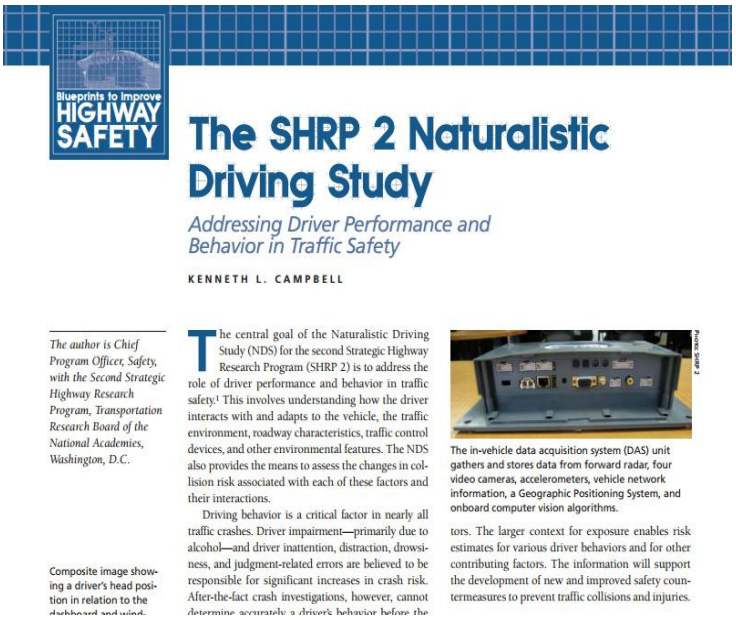
- The number of crashes are disproportionally higher on curves

- Analysis of Driver Behavior on Rural Curves using the SHRP 2 NDS Data (Coming soon!)

- Time Series Analysis (Proof-of-concept)

Description of SHRP 2 NDS Data

- 3000 Drivers
- Six States
- Two Years
- 18 Million Traveled Miles
- 2 Petabytes Data
- Data were collected at 10 HZ



Blueprints to Improve HIGHWAY SAFETY

The SHRP 2 Naturalistic Driving Study

Addressing Driver Performance and Behavior in Traffic Safety

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The central goal of the Naturalistic Driving Study (NDS) for the second Strategic Highway Research Program (SHRP 2) is to address the role of driver performance and behavior in traffic safety.[1] This involves understanding how the driver interacts with and adapts to the vehicle, the traffic environment, roadway characteristics, traffic control devices, and other environmental features. The NDS also provides the means to assess the changes in collision risk associated with each of these factors and their interactions.

Driving behavior is a critical factor in nearly all traffic crashes. Driver impairment—primarily due to alcohol—and driver inattention, distraction, drowsiness, and judgment-related errors are believed to be responsible for significant increases in crash risk. After-the-fact crash investigations, however, cannot

The in-vehicle data acquisition system (DAS) unit gathers and stores data from forward radar, four video cameras, accelerometers, vehicle network information, a Geographic Positioning System, and onboard computer vision algorithms.

tors. The larger context for exposure enables risk estimates for various driver behaviors and for other contributing factors. The information will support the development of new and improved safety countermeasures to prevent traffic collisions and injuries.

Composite image showing a driver's head position in relation to the

http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Pages/The-SHRP-2-Naturalistic-Driving-Study-472.aspx

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State Space Model

- **Explanatory variables** and stochastic time component

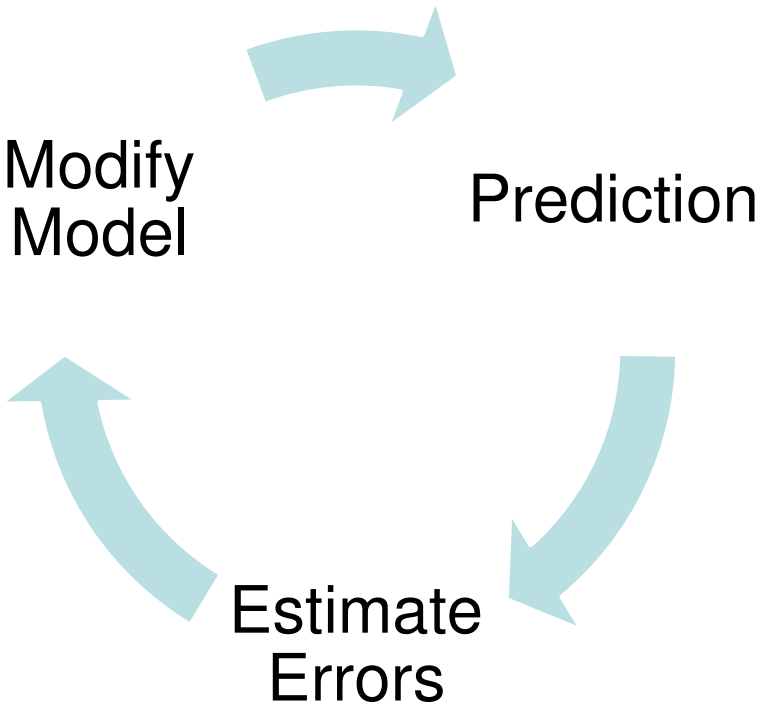
- Explanatory variables can **evolve over time**

- **Intervention effects** is coded as dummy variable

Observation equation: $Y_t = F_t\theta_t + v_t$, with $v_t \sim N_1(0, V_t)$

State evolution equation: $\theta_t = G_t\theta_{t-1} + \omega_t$, with $\omega_t \sim N_p(0, W_t)$

State Space Model



State Space Model

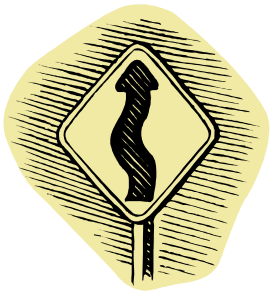
1. Intervention Analysis

- How the driver interacts with traffic and roadway environment?

2. Forecasting Analysis

- Can we forecast future position based on past observations?

INTERVENTION ANALYSIS WITH STATE SPACE MODEL



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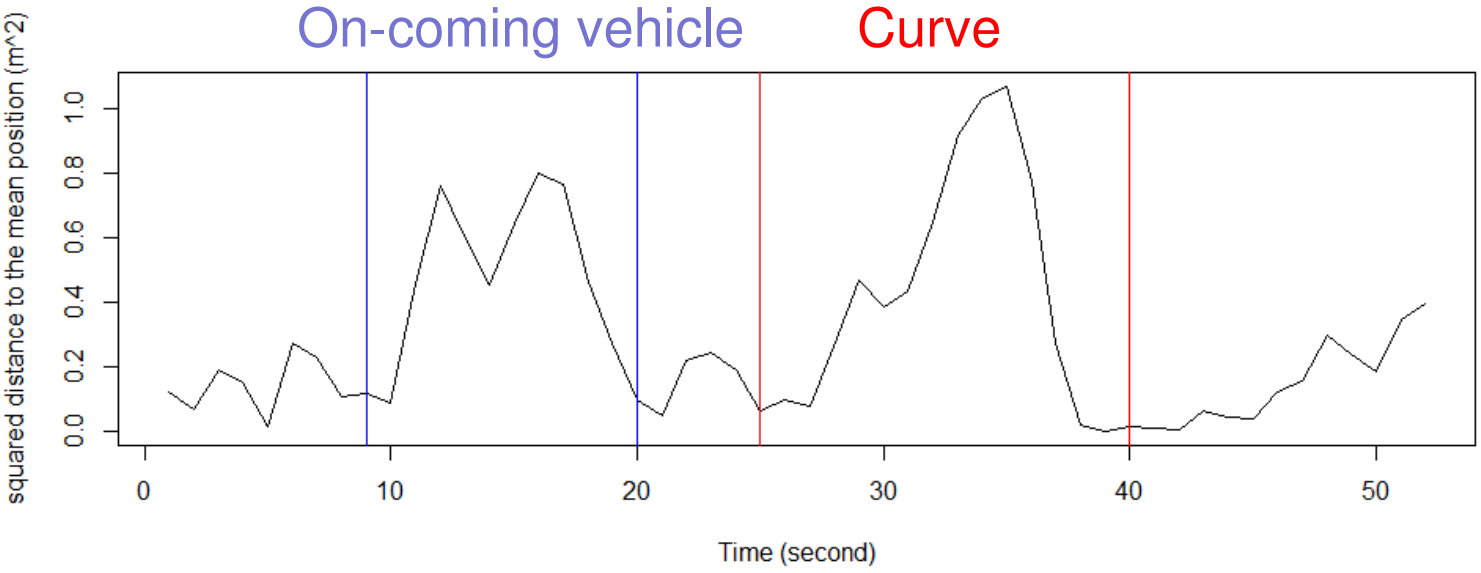
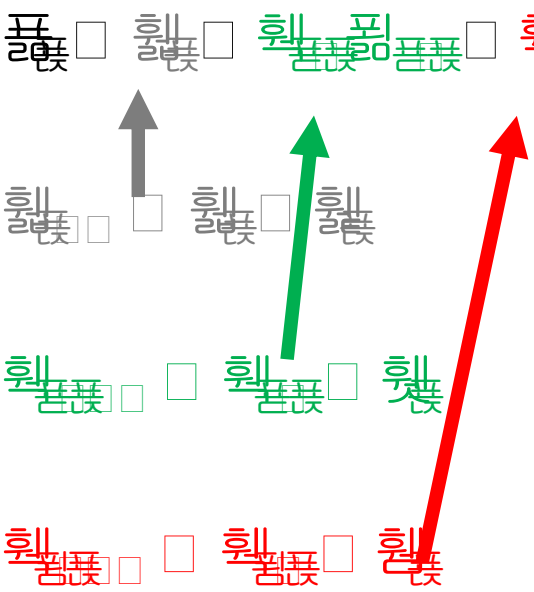
Deviation to the Normal Driving Position



State Space Model – Intervention Analysis

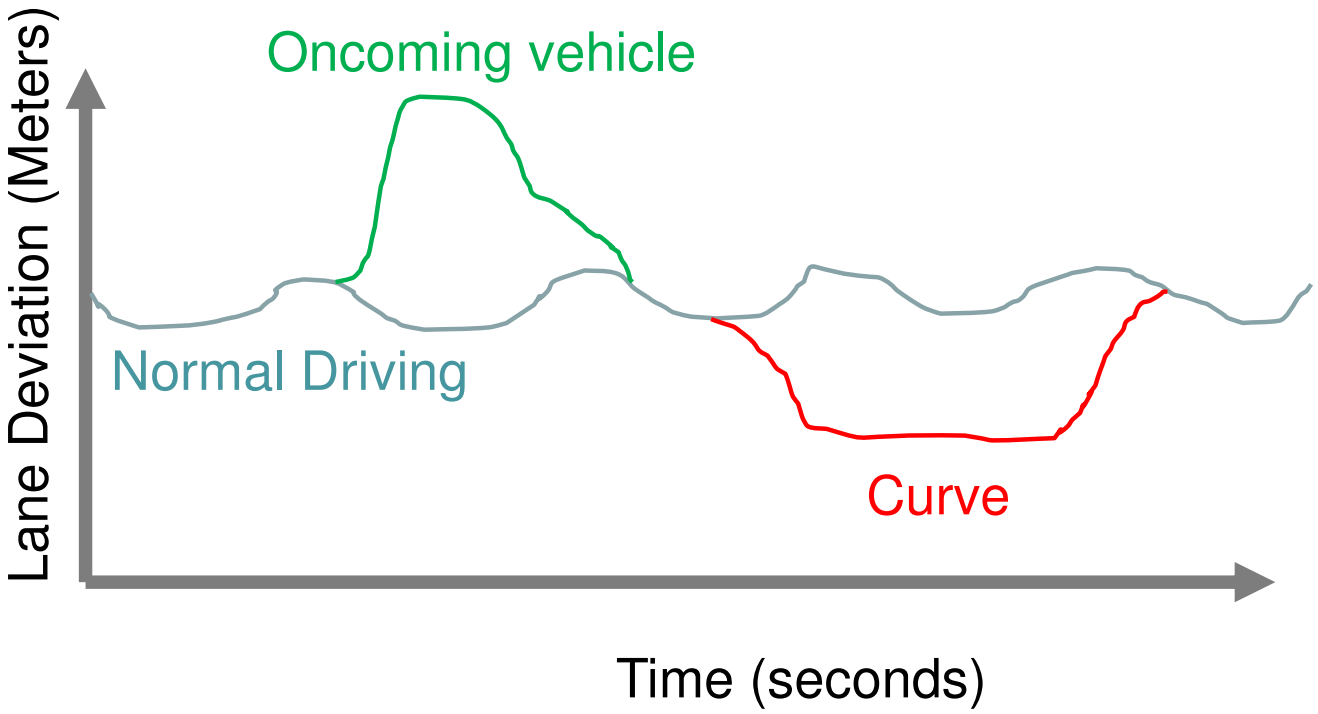


Normal Driving Position

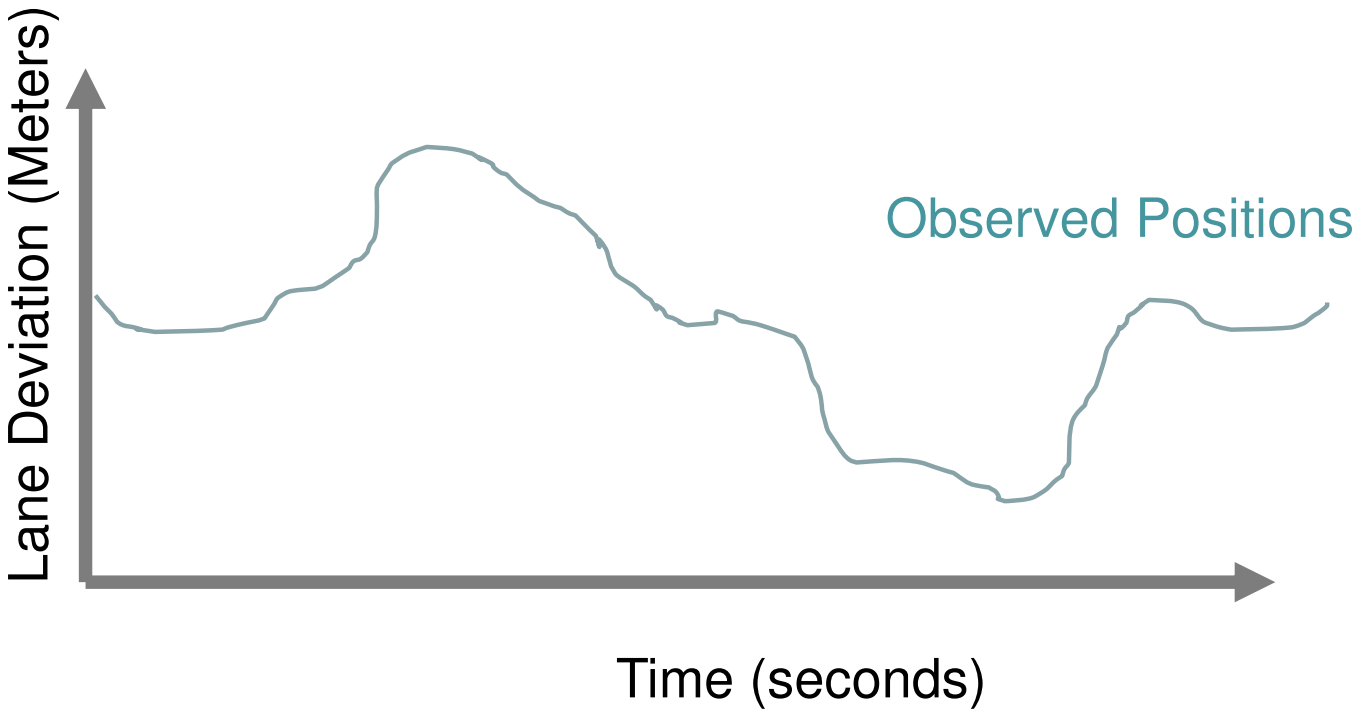
Oncoming vehicle Effect

Curve Effect

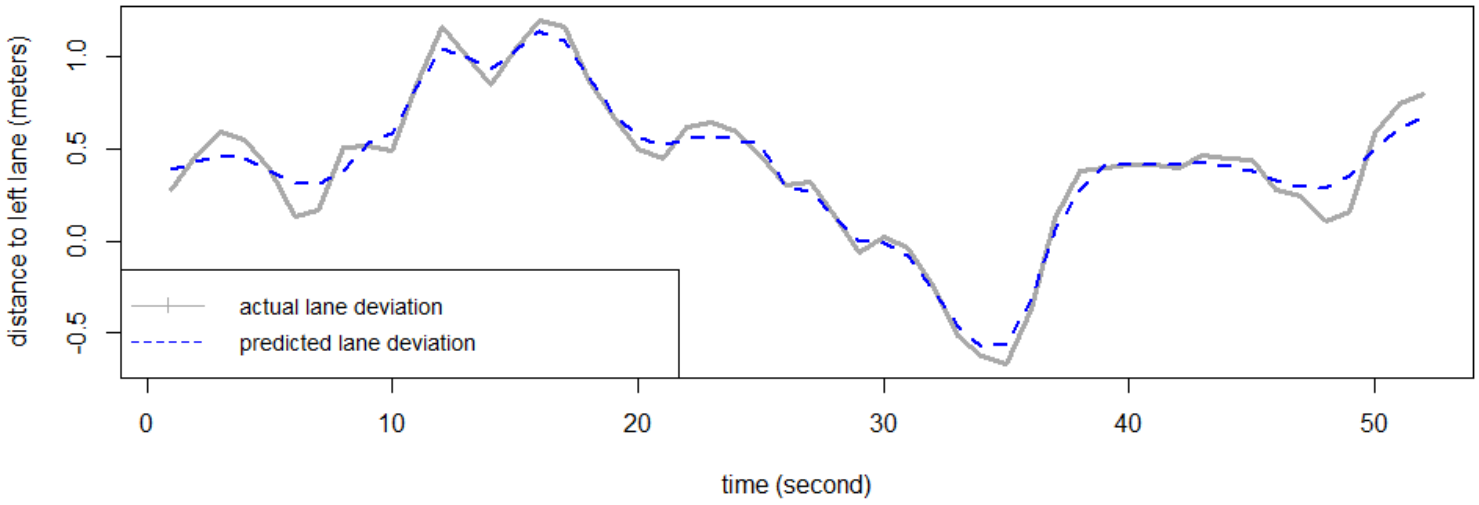
State Space Model – Intervention Analysis



State Space Model – Intervention Analysis



State Space Model– Modeling Results

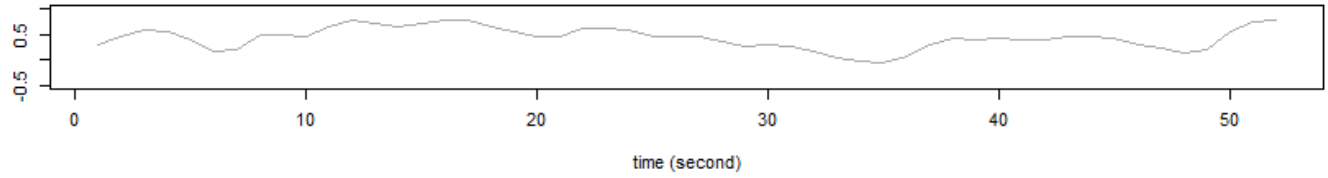


Observed

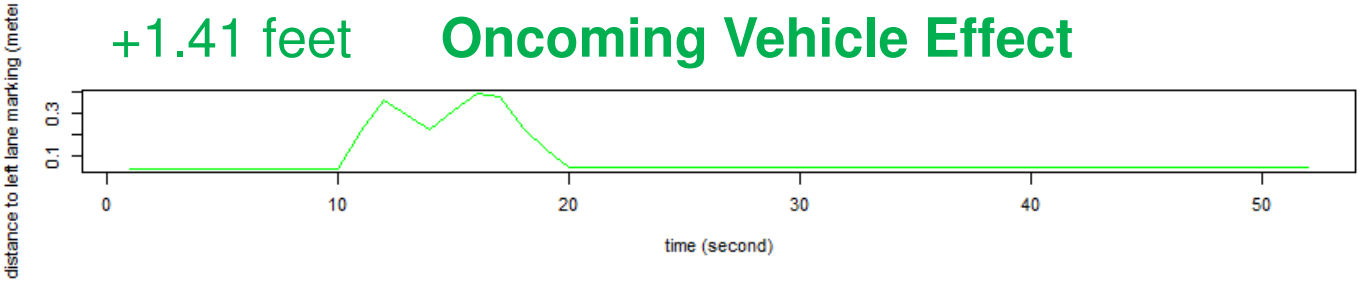
Predicted

Decomposition for Different Effects

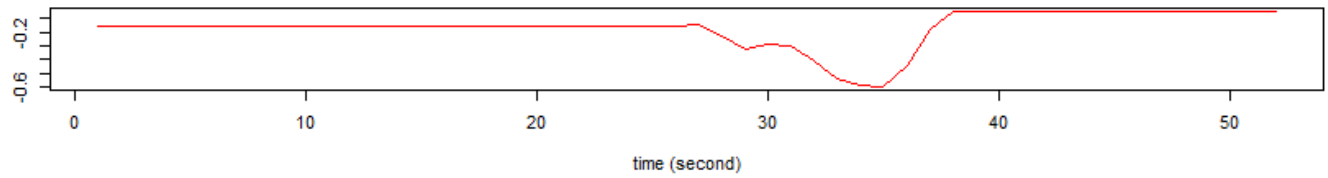
1.44 feet **Normal Driving Variation**



+1.41 feet **Oncoming Vehicle Effect**



- 1.74 feet **Curve Effect** urve



FORECASTING WITH STATE SPACE MODEL

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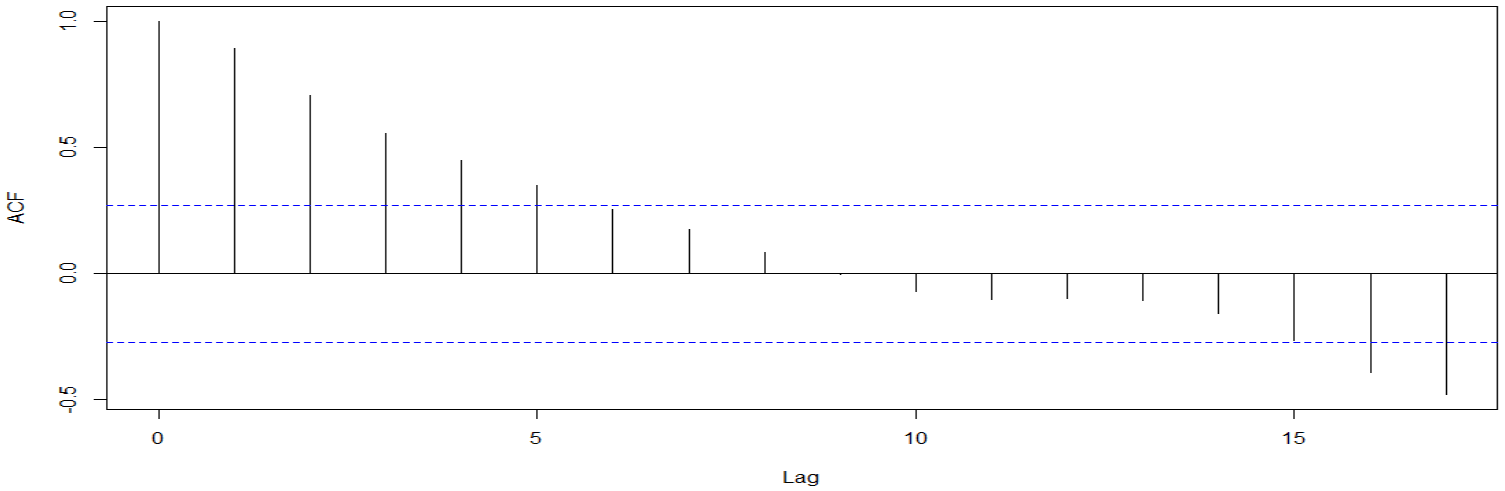
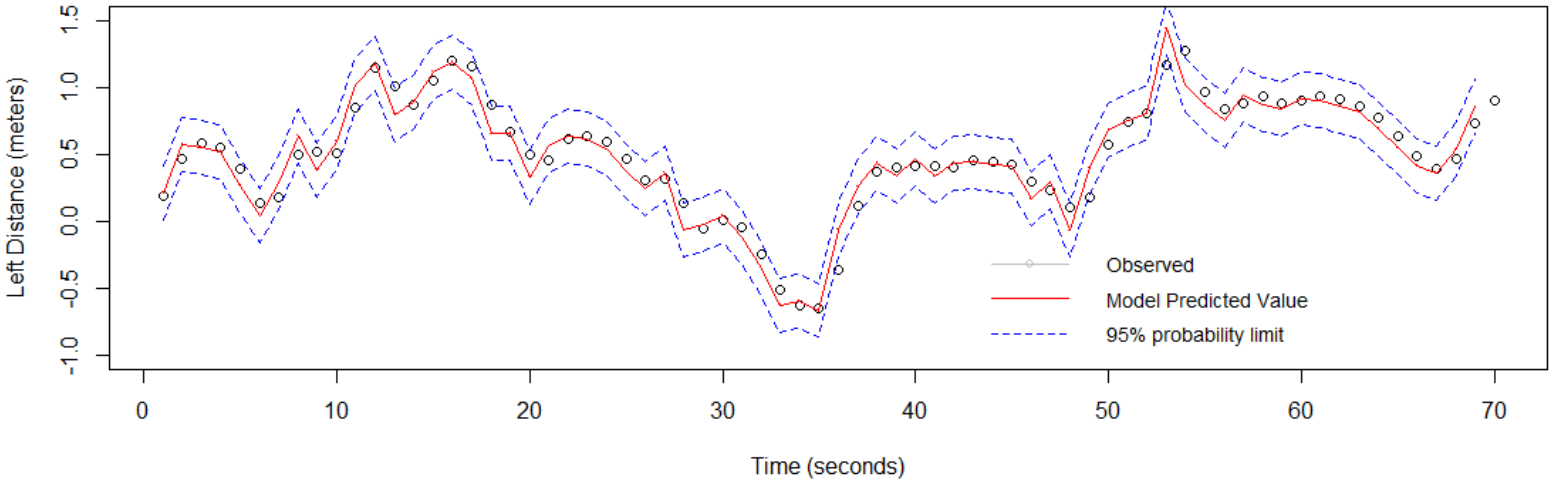
State Space Model - Forecasting

- Predict vehicle's future position based on the past observations.



Autocorrelation Function

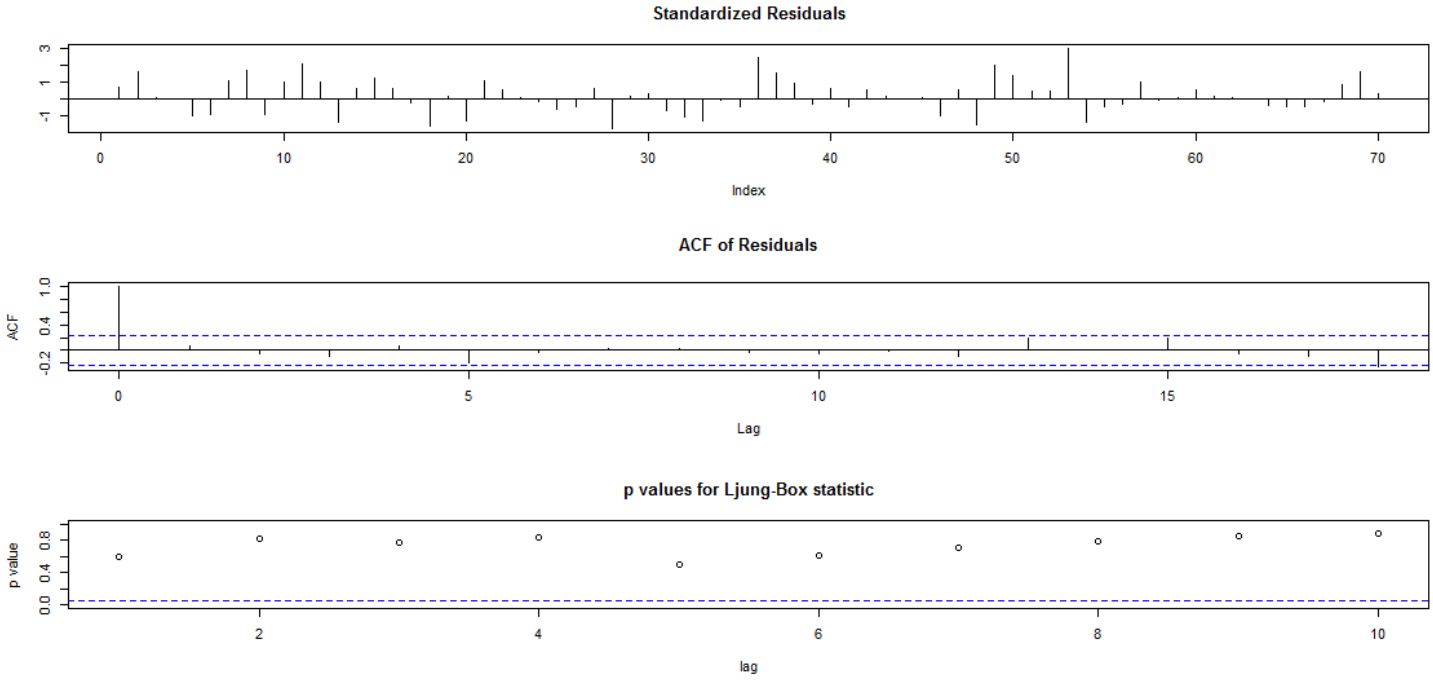
State Space Model - Forecasting



Observed o o o o o o o o

Predicted

Model Diagnostics



Summary

Intervention Analysis evaluated the influence of the oncoming vehicle and the curve on driver behavior

Forecasting Analysis successfully predict the future positions

Limitation is difficulty to draw safety implications with statistical significance

Thanks for your attention!

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