

# Causal Inference for N-of-1 Observational Study with State-Space Models

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## Abstract

**Background** With advanced mobile phone technologies and accessibility to many kinds of sensors, smart phones and other wearable sensors are able to continuously collect social activity information of patients with schizophrenia (Alina Trifan, Maryse Oliveira, 2019), such as GPS, accelerometer data, call/text frequency, calling duration and survey answer. The measurements of one individual are multivariate time series, which can be seen as N-of-1 time series studies to identify potential causal relationships. In this study, the causal relationship between call activity behavior and perceptual loneliness is of interest. The goal of this study is to examine the properties of state space model and its application in N-of-1 study.

**Methods** Average period treatment effect (APTE) proposed by E. J. Daza (2019) was used to quantify the causal relationship between call activity behavior and mental health score. Preliminary state space model analysis was applied on simulated data which is simulated by state space model, allowing all states to evolve over time. APTE was estimated for each treatment period by applying a state space model while enforcing the stable treatment assumption. Shu Li and Peter Buhlmann (2020) proposed a method Causal Transfer to estimate the causal effect in non-stationary time series. Sample version of Causal Transfer was used to predict APTE.

**Results** Under period stable assumption, state space model can capture the change point between adjacent stable period. Causal transfer has a better performance in APTE estimation and lower variance.

**Discussion** State space model algorithm converges or "stabled" after few iterations which requires that first few estimates should be excluded for calculating the APTE. One can use state space model to detect the change points of APTE so that time series will be separated into different period according to the change points. State space model could be applied in each segmented time period respectively.