

## Statistics and Data Science Seminar

### *Taking Mobile Consumer's Pulse—An Integrated Analysis of Mobile Application Usage and In-App Advertising Response*

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**Abstract:** Consumers have increasingly spent more time on mobile applications, and companies have also allocated more resources to advertisement in mobile applications and are actively seeking ways to improve the click-through rate of in-app ads. However, there is a lack of research leveraging consumers' mobile application usage to understand in-app advertisement. In this study, we develop an integrated model of mobile application usage and in-app advertising response. We use a hidden-Markov model (HMM), which allows consumer involvement in mobile activities to drive temporal changes in both consumer mobile application usage and in-app advertising response. Our framework captures three components that are understudied in previous research on in-app advertising responses: 1) contextual mobile app in which consumers are targeted; 2) long-range correlation in preceding periods and 3) multitasking across mobile apps. To address the challenge of long-range correlation in traditional HMM, we further extend HMM by incorporating a long short-term memory (LSTM) autoencoder into the state transition. Using a unique panel dataset, we find salient temporal patterns and persistence of consumers' underlying involvement that govern both application usage and advertisement response. Interestingly, consumers' responses to advertisements follow an inverted-U shape where consumers are most likely to respond to advertisements in a medium state of involvement. Consumers' advertisement responses are also subject to a contextual effect. For example, consumers

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are more likely to respond to advertisements when they use Entertainment apps compared with other apps. Our simulation indicates that incorporating mobile usage information, such as a temporal state of involvement and contextual effects at the individual level (viewing history), can significantly improve the effectiveness of targeting strategies. For instance, incorporating contextual effect and multitasking can increase performance by as much as 21.2%. This improvement can be further enhanced with the help of the LSTM autoencoder to address the long-range correlations in HMM. We are the first to connect consumers' mobile application usage with their in-app ad response.

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