Skysong Innovations
Advancing the Arizona State University Knowledge Enterprise

1475 N. Scottsdale Road, Suite 200
Scottsdale, AZ 85287-3538
Phone: 480 884 1996 Fax: 480 884 1984

Case ID:M18-237P
Published: 4/26/2019

Inventors

Ruocheng Guo
Jundong Li
Huan Liu

Contact

skytech_licensing_contacts
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Sequential Event Prediction with Noise-Contrastive Estimation for Marked Temporal Point Process

Background

Tremendous volumes of sequential event data continue to be generated across diverse technological domains. Whether they be "retweets" sprouting across the social media network Twitter, stock trades, or ride-share vehicle usage patterns, effective data processing of past occurrences can improve near-term predictability of future occurrences. Integrating these results into company procedures can drastically improve resource allocation and service quality.

Modeling sequential data often involves training a Marked Temporal Point Process (MTPP). This process evaluates a Conditional Intensity Function (CIF), in which data on both the event timestamp and event type (also called "mark") are used jointly to estimate the likelihood of a near-future occurrence. Most MTPP models are trained by Maximum Likelihood Estimation (MLE) or focus heavily on the design on the CIF. In doing so however, event prediction remains limited by the computational disadvantages inherent to the MLE approach and specific CIF formulations.

Invention Description

Researchers at Arizona State University have developed a new process for training the MTPP that bypasses bottlenecks associated with the MLE approach. Specifically, the MTPP calculates the CIF through a parameterized learning process based on Noise-Contrastive Estimation (NCE). Since CIF computation is circumvented, the system is freed from the intractability, constraints, and assumptions related to conventional handling of the CIF. In turn, this new method reframes the MTPP process entirely, opening new areas for CIF exploration and optimization that have until now been considered unexploitable.

While this method retains strong theoretical ties to MLE, experiments on three real-world sequential datasets (from Citi Bike, Twitter, and stock trading activity in the New York Stock Exchange) have shown clear improvements over MLE techniques and other variants, in terms of both time and mark predictions.

Potential Applications

- Financial quantitative analysis
- Social media
- Ride-sharing
- Logistical management

Benefits and Advantages

- Versatile – Offers valuable and actionable information to an extremely wide range of applications
- Simple – Learning-based approach avoids computational complexities
- Effective – Outperforms similar methods with real-world data
- Paradigm-shifting – Reopens avenues of exploration by bypassing conventionally accepted technical hurdles

Homepage of Professor Huan Liu