Measuring the Effectiveness of Display Advertising: A Time Series Approach

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Online display advertising is an area of rapid growth and consequently of great interest as a marketing channel. Recent studies show that display advertising often triggers online conversion activities. However, it is often difficult to determine whether these conversions are the result of the advertising campaign or due to other factors. We measure the effectiveness of campaigns by comparing sales during the days of the campaign flight to a baseline.

We test statistical significance of the trend component against the baseline and examine the effect of advertising on sales via a controlled experiment on Yahoo!, which is performed in [4].

Our main goal is to measure the effectiveness of display advertising campaigns. We address this question using a time series forecasting approach.

Methodology

We follow a time-series approach to decompose the daily number of sales of a given product into a weekly seasonal component and a trend component using Dynamic Linear Models based on Kalman filtering and smoothing ideas [5].

By fixing \( G \) and \( F \), we model the series evolution as a linear combination of a seasonal and a trend component [5].

Our goal is to de-seasonalize the series to associate the trend with a set of marketing campaigns.

\[
G_t = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}, \quad G_t = \begin{bmatrix} \cos(2\pi T / T) & \sin(2\pi T / T) \\ -\sin(2\pi T / T) & \cos(2\pi T / T) \end{bmatrix}
\]

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T = \begin{bmatrix} T_1 & T_2 & T_3 \end{bmatrix}
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\[
F = \begin{bmatrix} 1, 0, 1, 0, 1, 0 \end{bmatrix}, \quad G = \text{blockdiag}(G_1, G_1, G_1)
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Our goal is to measure the effectiveness of display advertising when users are exposed to multiple advertising channels.

If a user performs a commercial action, how should the advertiser attribute credit for the conversion across these multiple channels and media impressions?

This is particularly important for the Cost Per Action (CPA) business model when determining how to allocate resources across advertising channels.

Related Work

- CPA performance on a monthly level [3].
- Aggregate study based just on the observed average performance.
- A study about user features and performance on commercial actions is performed in [4]. However, the study was done with a small set of users and advertisers to have well-defined control and test groups.
- Our main goal is to measure the effectiveness of campaigns on a daily level. This is important for short campaigns and to provide dynamic online performance estimates.

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Discussion

Main goal: Measure the impact of advertising on sales near and long term.

Difficulties:
- Advertisers typically use all available channels (TV, radio, print, online) and there are many vendors within each channel.
- Data is typically not integrated across channels or even within channels and thus the idea of following the online click-stream behavior of web users is generally not possible.
- Achievements and Gaps:
  - High level study across several thousands of campaigns
  - We do not have a detailed understanding of the exact goals of each campaign
  - Comparing sales against the sales generated during some period prior to the campaign might not always be appropriate (the campaign may focus on driving offline sales for instance or launched off-season).
  - Negative sales changes as measured in this study do not necessarily mean that the campaign failed.

Ongoing and Future Work

- Incorporate the number of impressions served as advertising actions in a marketing campaign.
- Does the number of impressions have an impact to predict the number of sales?

References