Budget Pacing for Targeted Online Advertisements at LinkedIn

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Advertising at LinkedIn

- Advertisers must create ‘Campaigns’
- A campaign is defined by
  - a target member segment, e.g., CxO’s in financial industry living in the San Francisco Bay Area
  - a daily budget, e.g., $500
  - a bid value, e.g., $5

- Ranking schemes- auctions
  - The highest payoff campaign always win until it has exhausted its budget
  - Second price auction- the winner pays the bid of the second highest bidder
World of Ad Auctions

- **Greedy algorithm**
  - not necessarily optimal for revenue or advertiser experience

- **Potential drawbacks for advertisers**
  - Short campaign lifetime
  - Narrow audience reach

- **Suboptimal revenue for the publisher**
  - Inefficient matching of users and advertisers
  - Diminishing market competition over the duration of the day
Solution

- **A 30,000 ft view**
  - Monitor campaign budget spend
  - If a campaign is spending “too fast”
  - ... and we know that there will be traffic later in the day
  - Throttle- do not allow the campaign to participate in some auctions

- **Forecasting**
  - We forecast number of eligible impressions for each campaign during the day

- **Allocation Plan**
  - We allocate a budget over time proportional to forecasted number of impressions

- **Tracking**
  - We track budget spend for each campaign
Budget Pacing

- For each eligible ad-auction we allow a campaign to participate with probability $P(t)$ – Pass Through Rate (PTR)
  - $P(t) = P(t - 1) \times (1 - R)$ if budget spent > allocation
  - $P(t) = P(t - 1) \times (1 + R)$ if budget spent < allocation
Results From Experiments

- Alternate day tests for 2 weeks on 2 different advertising products
- LinkedIn Ads
  - Old product that is very competitive
- Sponsored Status Updates
  - New product and is growing fast

<table>
<thead>
<tr>
<th></th>
<th>Sponsored Updates</th>
<th>LinkedIn Ads</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>Campaign life time (in hours)</td>
<td>6.9</td>
<td>17.2</td>
</tr>
<tr>
<td>Unique impressions per spend</td>
<td>-</td>
<td>+10.5%</td>
</tr>
<tr>
<td>Number of campaigns served</td>
<td>-</td>
<td>0.2%</td>
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<tr>
<td>Revenue per request</td>
<td>-</td>
<td>+1.0%</td>
</tr>
<tr>
<td>Over delivery</td>
<td>4.1%</td>
<td>2.4%</td>
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Why Does Pacing Increase Revenue?
Over Delivery (Example)
Paced Campaign (Example)
Our Contributions

- We developed and implemented an algorithm that distributes spend of campaigns evenly in a day

- This algorithm benefits both the advertiser and the publisher

- There is a huge literature on the theoretical aspects of algorithms for serving ads starting from Mehta et. al. 2007

- Real life large scale experiments
  - Some of the well known algorithms with good theoretical properties did not perform well in practice
Thank You