



## Budget Pacing for Targeted Online Advertisements at LinkedIn

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# Advertising at LinkedIn

The screenshot shows a LinkedIn profile page for Raymond James Financial Inc. The page layout includes a header with the LinkedIn logo, a search bar, and navigation icons. The main content area features a sponsored post from Raymond James Financial Inc. and a post from Justice Seekers. The right sidebar contains sections for 'People You May Know' and 'Ads You May Be Interested In'. Two red boxes highlight specific areas: one around the sponsored post and another around the 'Ads You May Be Interested In' section.

**Raymond James Financial Inc.** • Sponsored

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#1: Now Vs. Later  
#2: Concrete Vs. Abstract  
#3: Emotional Vs. Non-Emotional

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Connect

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Connect

**Stephen Guo**, CS PhD Candidate at Stanford University  
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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

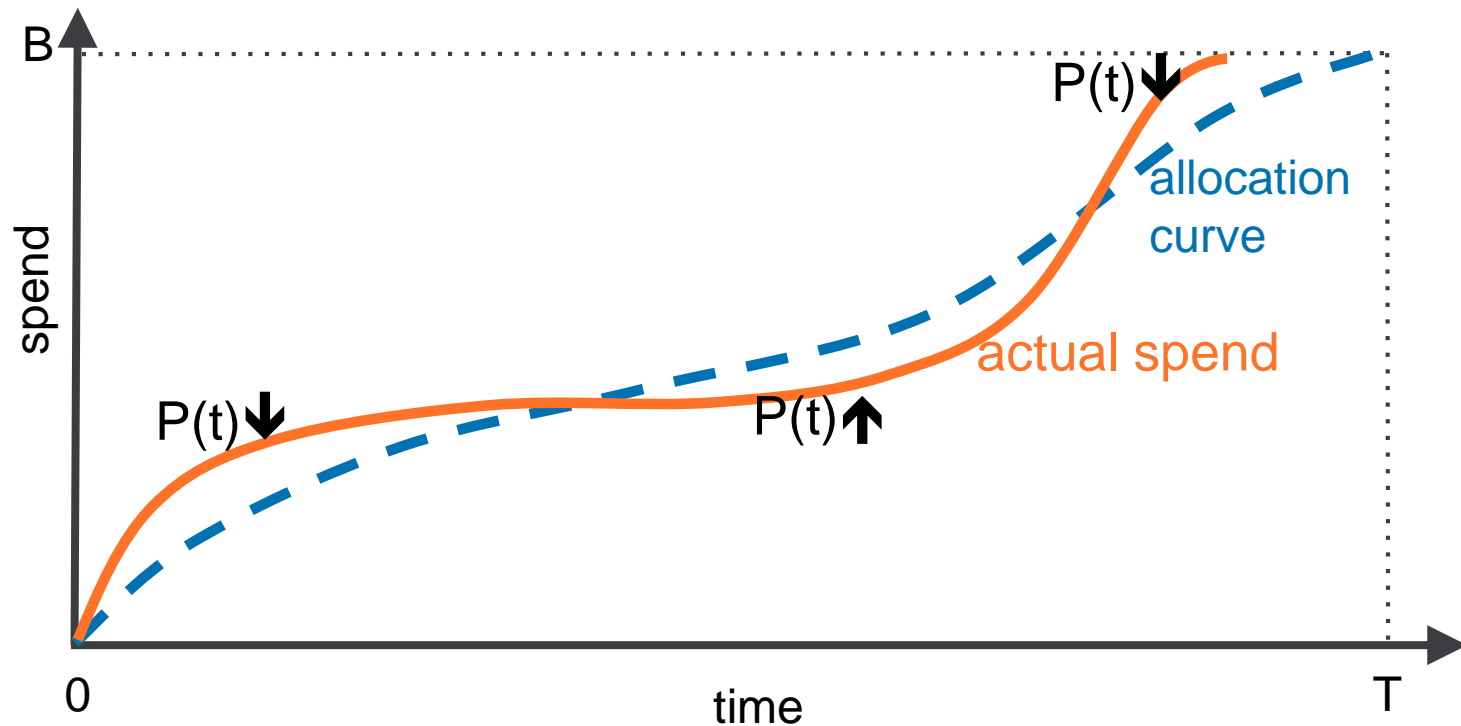
- Greedy algorithm
  - not necessarily optimal for revenue or advertiser experience
- Potential drawbacks for advertisers
  - Short campaign lifetime
  - Narrow audience reach
- Suboptimal revenue for the publisher
  - Inefficient matching of users and advertisers
  - Diminishing market competition over 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)
  - $P(t) = P(t - 1) * (1 - R)$  if budget spent > allocation
  - $P(t) = P(t - 1) * (1 + R)$  if budget spent < allocation

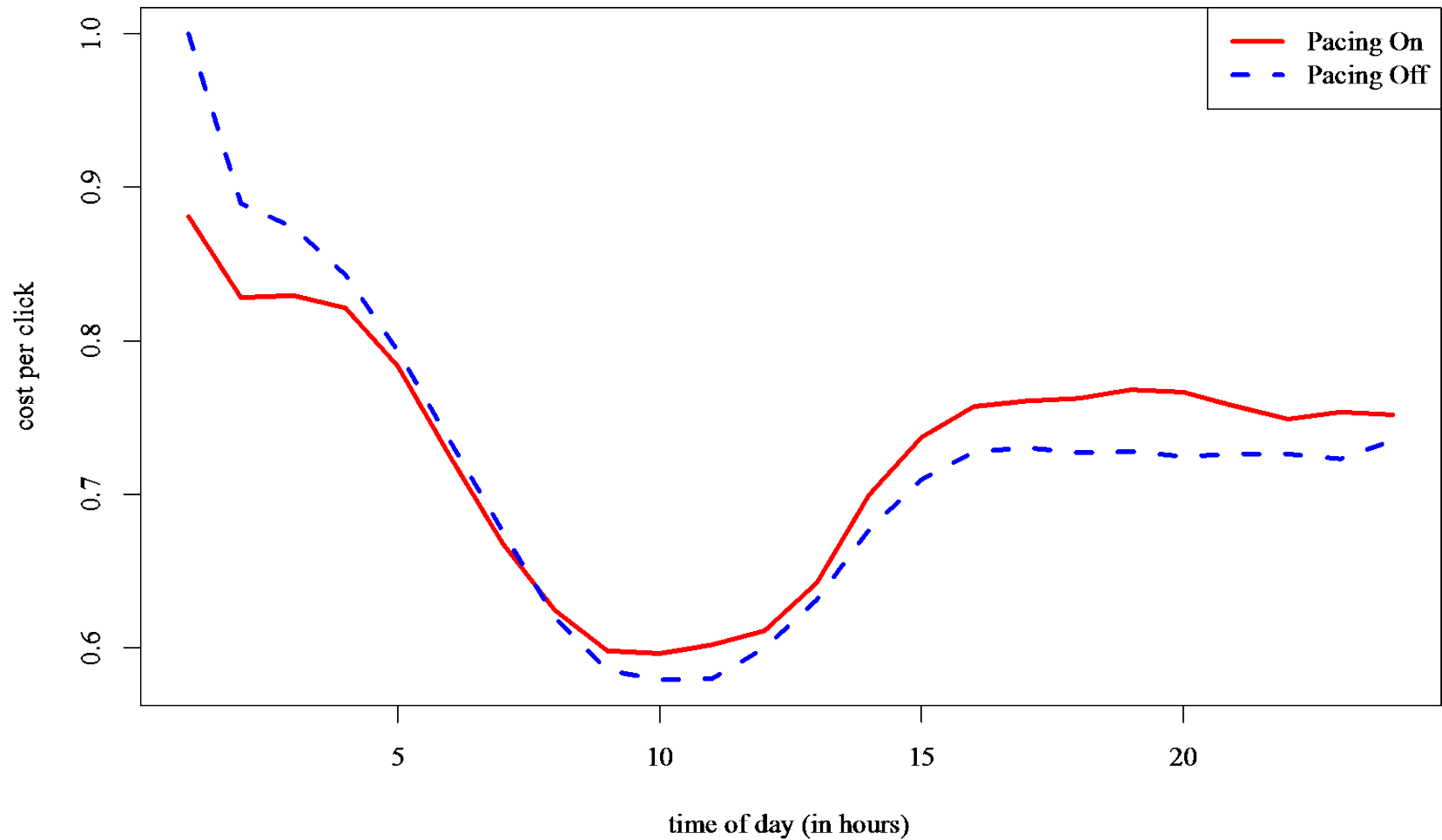


# Results From Experiments

- 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

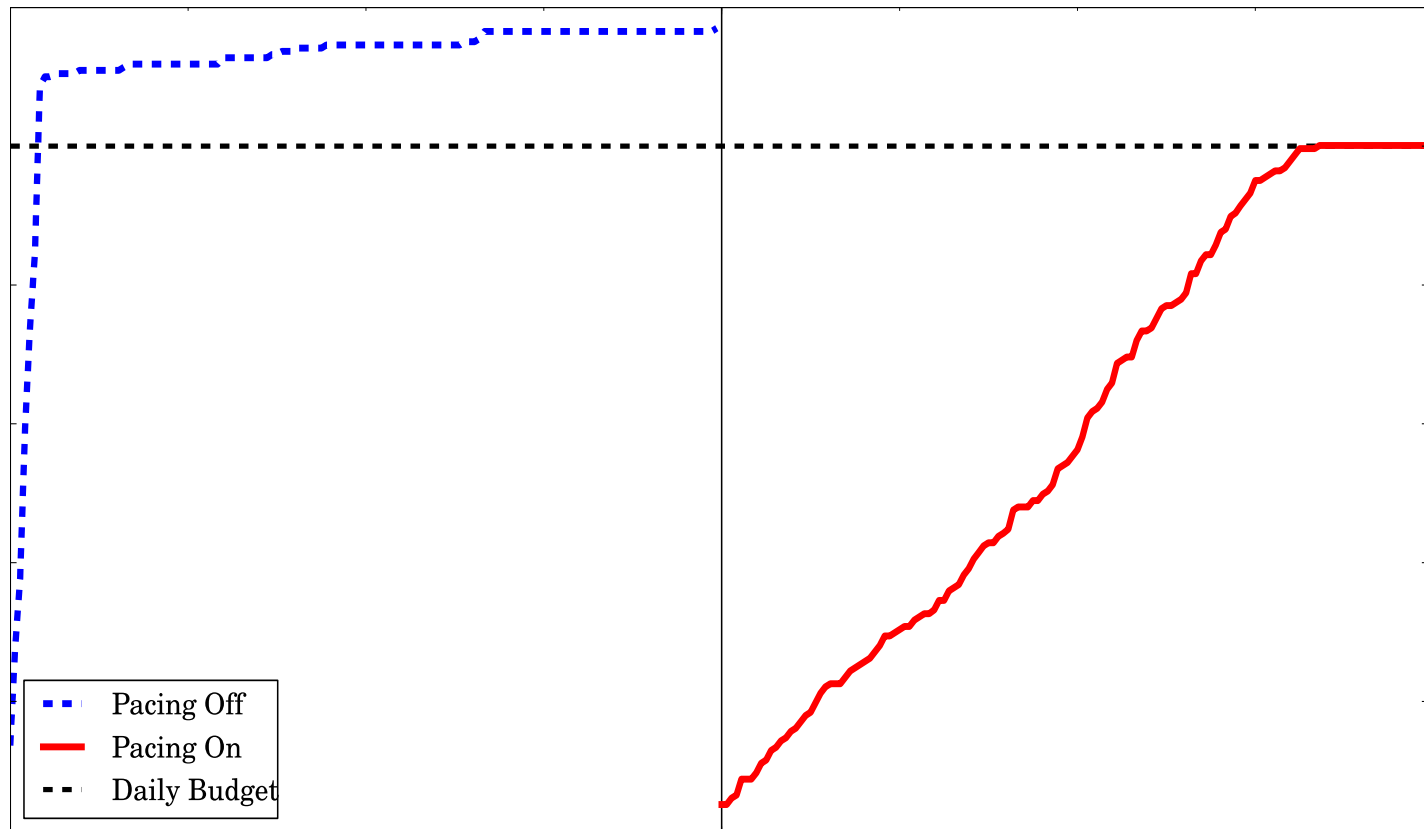
	Sponsored Updates		LinkedIn Ads	
	Off	On	Off	On
Campaign life time (in hours)	6.9	17.2	13.5	19.5
Unique impressions per spend	-	+10.5%	-	+7.7%
Number of campaigns served	-	0.2%	-	+4.7%
Revenue per request	-	+1.0%	-	+5.7%
Over delivery	4.1%	2.4%	3.8%	3.4%

# Why Does Pacing Increase Revenue?

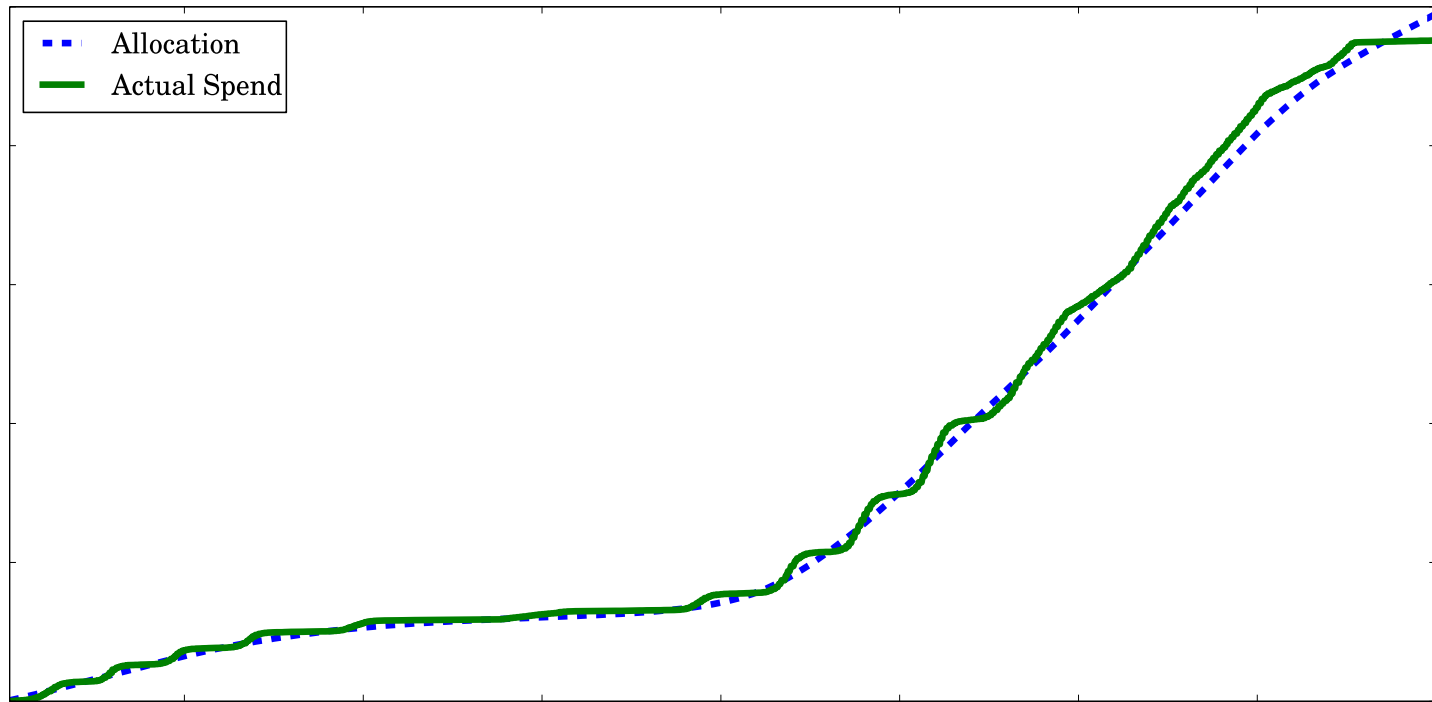




# Over Delivery (Exmample)



# Paced Campaign (Exmample)



# 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

