

MM2RTB: Bringing Multimedia Metrics to Real-Time Bidding

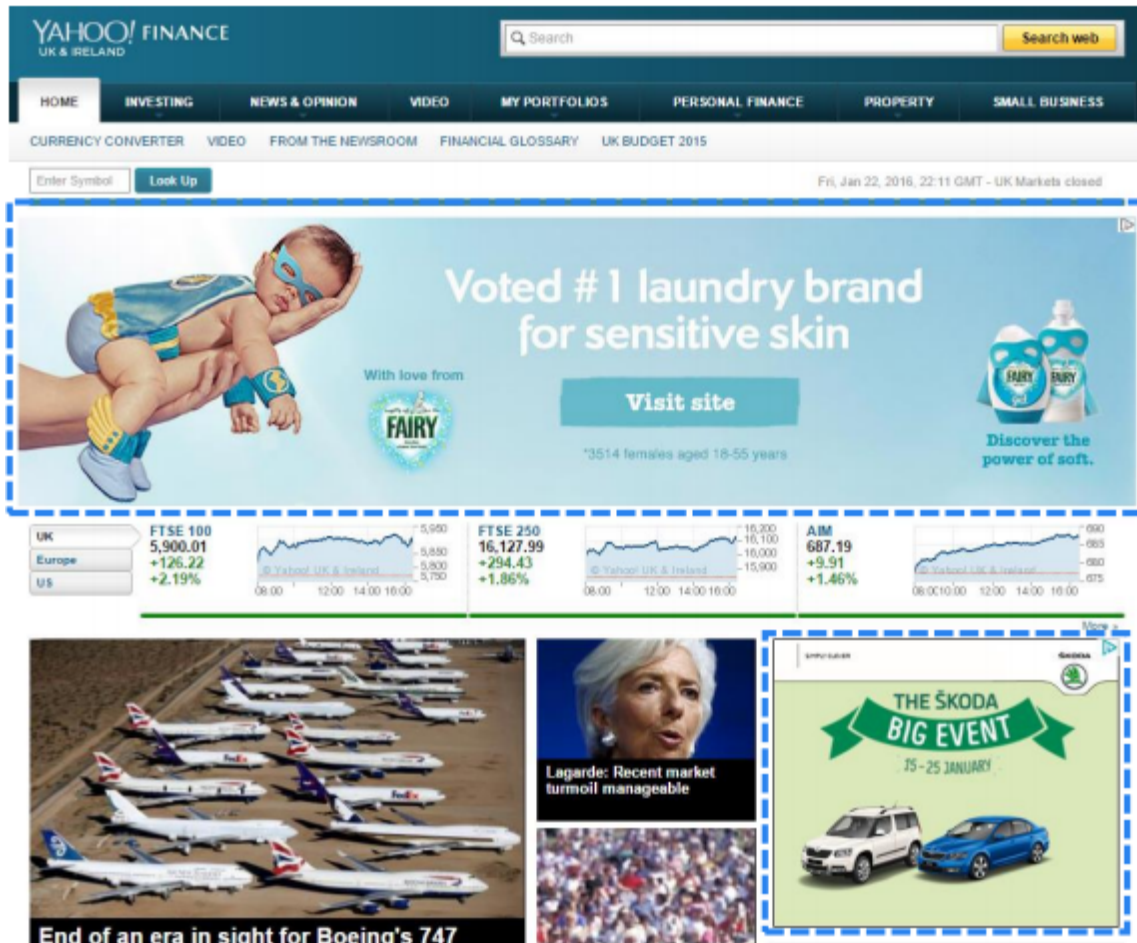
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Problem description

- Single-slot scenario: [SIGIR 2017]
- Multi-slot scenario : [AdKDD & TargetAd 2017]



The screenshot displays the Yahoo! Finance UK & Ireland homepage. At the top, there is a navigation bar with links for HOME, INVESTING, NEWS & OPINION, VIDEO, MY PORTFOLIOS, PERSONAL FINANCE, PROPERTY, and SMALL BUSINESS. Below this is a secondary navigation bar with links for CURRENCY CONVERTER, VIDEO, FROM THE NEWSROOM, FINANCIAL GLOSSARY, and UK BUDGET 2015. A search bar is located in the top right corner.

The main content area features a large banner advertisement for Fairy laundry detergent. The banner includes an image of a baby, the text "Voted #1 laundry brand for sensitive skin", and a "Visit site" button. Below the banner, there are several financial charts and tables, including the FTSE 100, FTSE 250, and AIM indices. A blue dashed box highlights the banner and the charts, with an arrow pointing to the text "Display banner ads".

Below the charts, there are three smaller advertisements: a Boeing 747 aircraft, a portrait of Christine Lagarde with the text "Lagarde: Recent market turmoil manageable", and a Skoda advertisement titled "THE SKODA BIG EVENT" featuring two cars. A blue dashed box highlights the Skoda advertisement, with an arrow pointing to the text "Display banner ads".

What is expected in this paper?

- Why do we need “multimedia metrics”?

To measure the benefits of stakeholders

- What are the “multimedia metrics”?

Contextual relevance

Visual saliency

Image memorability

- How do we integrate the “multimedia metrics”?

Optimize the trade-offs among all stakeholders

How does RTB work?

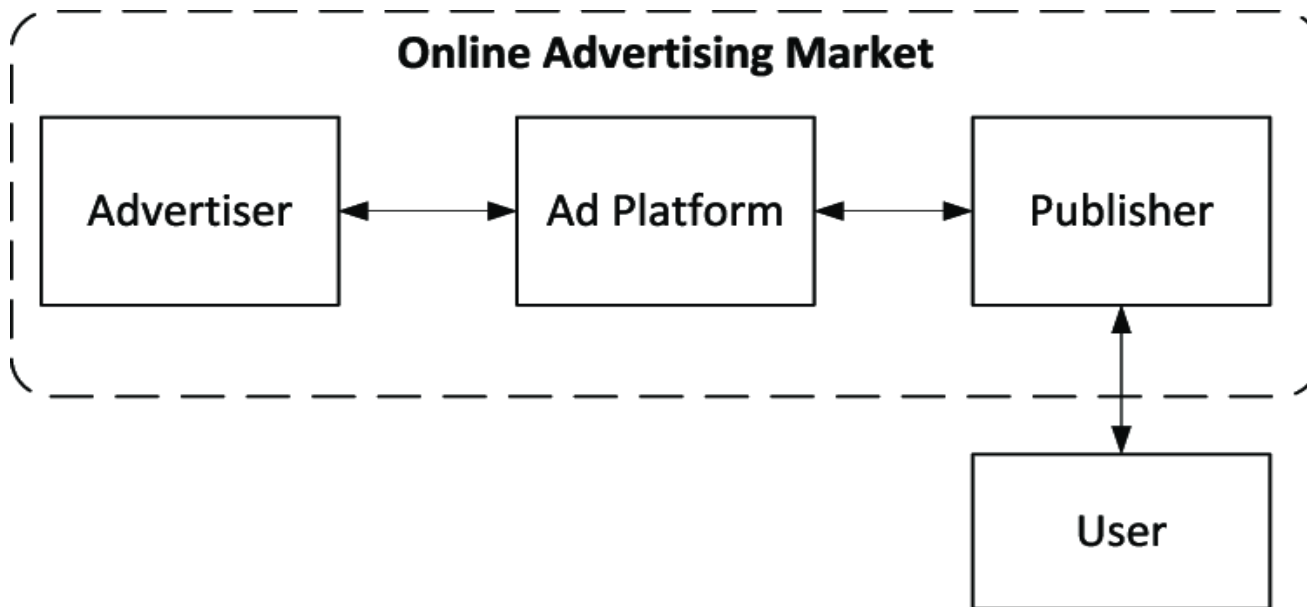


Fig 1: A simplified online advertising serving process [1]

What are the limitations?

- Irrelevant ads

Only 2.8% of participants thought that ads on website were relevant.
(Source: Infolinks and bannerblindness.org)

- Ads overlook

Display ad viewability rates did not budge between 2013 and 2014.
(Source: comScore)

- Competitive ads

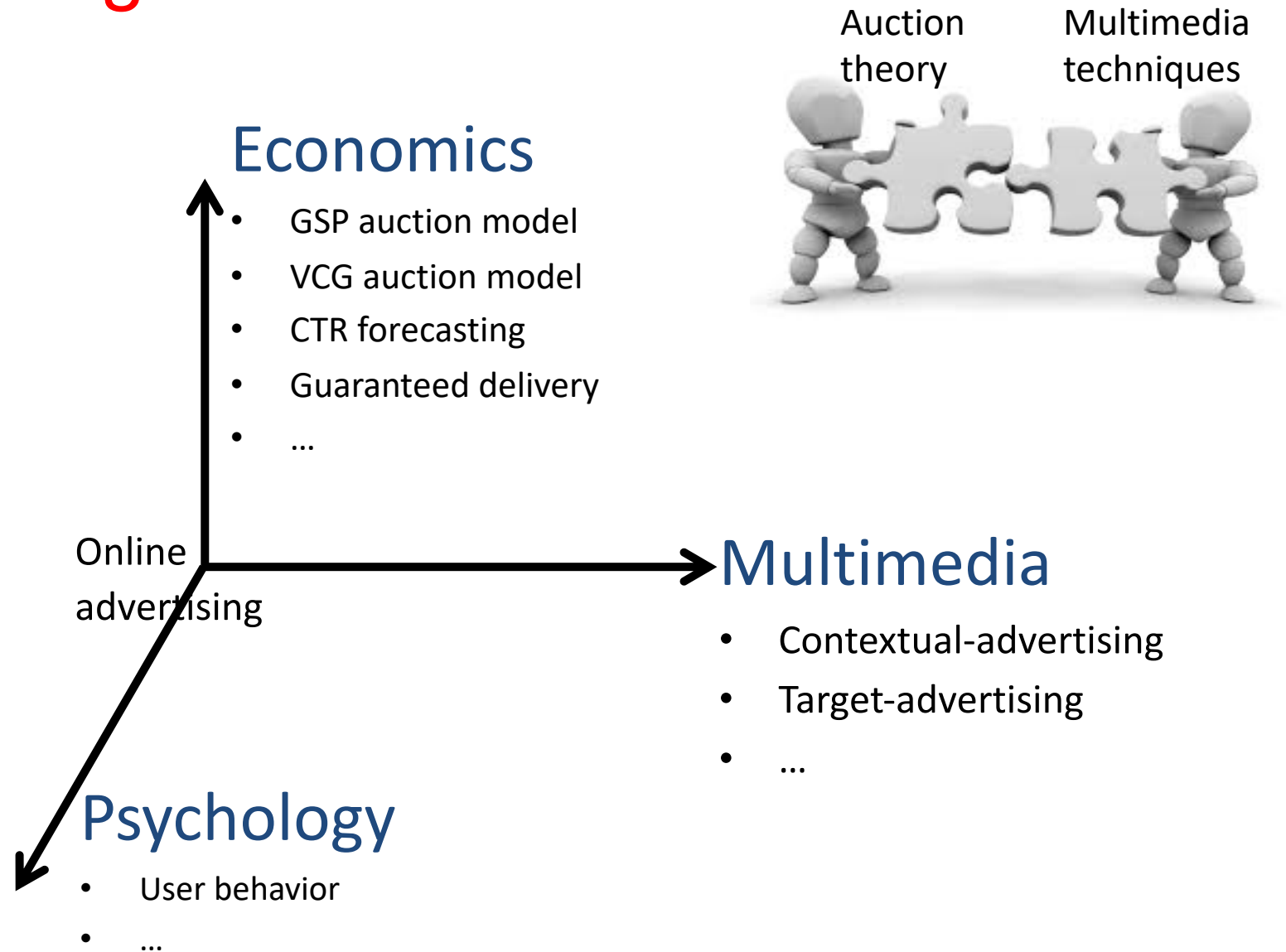
Competitive ads changes the relationship between ad repetition and consumer memory [1].

- Ineffective ad delivery

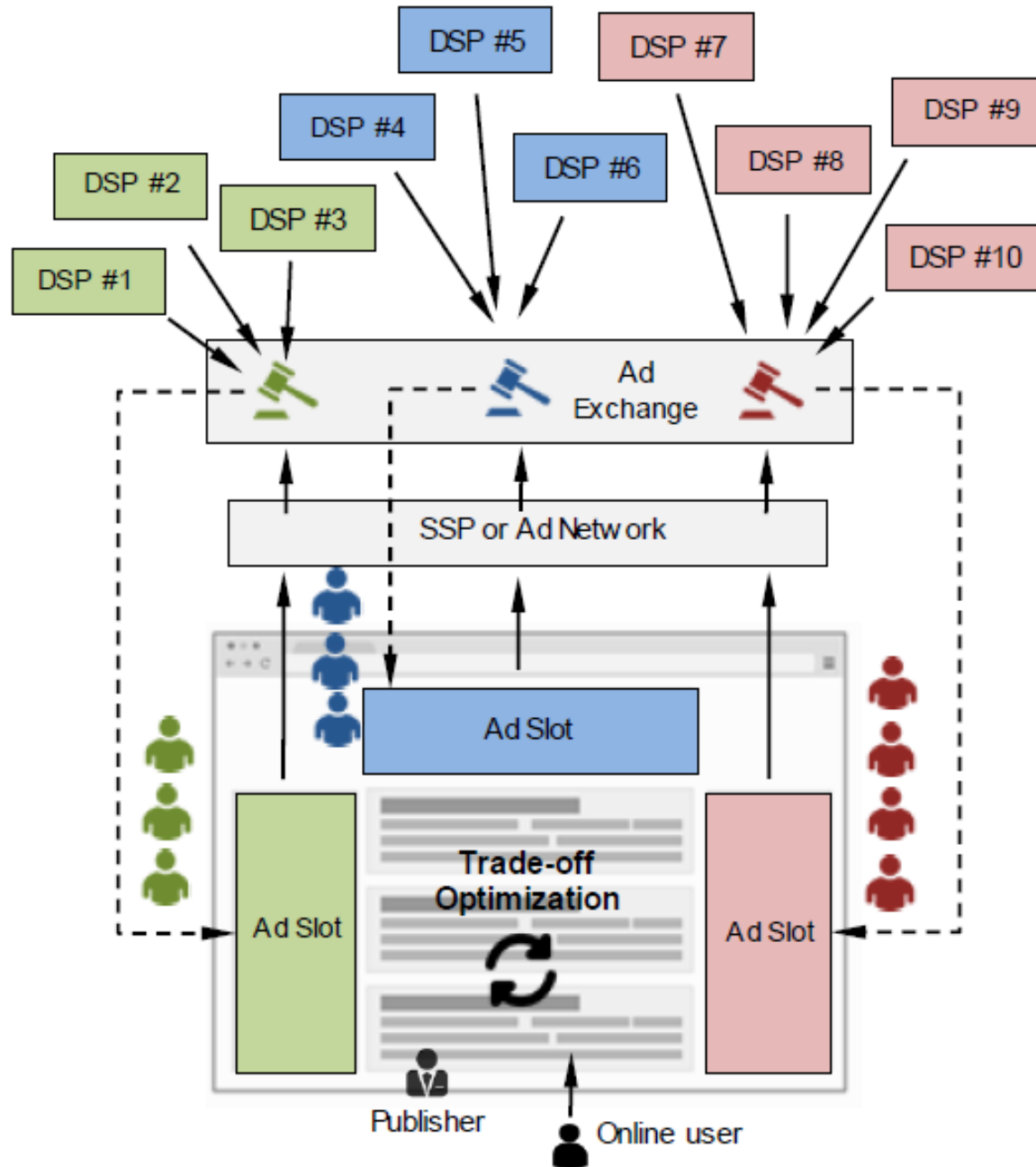
"Half the money I spend on advertising is wasted; the trouble is I don't know which half."
--- John Wanamaker (1838-1922)

[1] Burke, Raymond R., and Thomas K. Srull. "Competitive interference and consumer memory for advertising." *Journal of consumer research* 15.1 (1988): 55-68.

Existing works



Proposed framework



Proposed framework

- Main idea:

Publisher: the best ad should generate the best money;

Advertiser and user: the best ad should fit the context well.

- Objective function:

Maximization of the joint benefits from all ad slots.

- Constraints:

(1) all ad slots have to be occupied by only one ad;

(2) ad slot j must be occupied by the ad who bids for ad slot j ;

(3) no competitive ad-pair occurs;

Calculate benefits: metric variables

- Publisher's revenue
- Advertiser's utility
- Ad Click-through-rate (CTR)
- Ad image memorability (MemNet [1])
- Contextual relevance (TF-IDF[2])
- Visual saliency (MBS [3])

[1] Khosla, Aditya, et al. "Understanding and predicting image memorability at a large scale." *Proceedings of the IEEE International Conference on Computer Vision*. 2015.

[2] MacKay, David JC. *Information theory, inference and learning algorithms*. Cambridge university press, 2003.

[3] Zhang, Jianming, et al. "Minimum barrier salient object detection at 80 fps." *Proceedings of the IEEE International Conference on Computer Vision*. 2015.

Calculate benefits: economics

The input is the bid prices in each auction



Bid price (\$)		Paid Price (\$)		Utility (\$)
8	→	7	→	1
7		6		1
6		5		1
5		4		1
4		ϵ		$4 - \epsilon$

$$\text{Utility} = \text{Value} - \text{Paid price}$$

Calculate benefit

- Variables:

Variables for re-ranking (after normalization)

Ad id	x_1	x_2	x_3	x_4	x_5	x_6
693	0.1999	0.0000	0.7164	0.9387	0.1699	0.7286
1319	0.0400	0.0000	0.8277	0.4077	0.2187	0.1639
1799	0.0160	0.0264	0.5567	0.3353	0.3698	0.8360
1847	0.0000	0.0176	0.8971	0.3698	0.2671	0.1025
2725	0.0000	0.0000	0.9244	0.0712	0.2617	0.8763
3010	0.1999	0.1101	0.9139	0.2596	0.2734	0.1059
3402	0.1441	0.0614	0.8950	0.7269	0.2361	0.7804
4194	0.0400	0.0000	1.0000	0.0720	0.2163	0.2629
5552	0.0400	0.1148	0.5420	0.2836	0.3405	0.8823

- Benefits: linear combination

Determine optimal weights

- Let the Publisher decide the acceptable changes of variables:

$$\mathbf{y}^* = \arg \max_{\mathbf{y}} \sum_{j=1}^n \mathbf{y}^\top \mathbf{x}_{l^*}^{(j)}, \quad (3)$$

$$\text{s.t. } 0 \leq y_k \leq 1, k = 1, \dots, 6, \quad (4)$$

$$\mathbf{y}^\top \mathbf{1} = 1, \quad (5)$$

$$|\xi_1| \leq |\theta_1|, \theta_1 \leq 0, \quad (6)$$

$$\xi_k \geq \theta_k, \theta_k \geq 0, k = 2, \dots, 6, \quad (7)$$

- The change of variable k is defined as:

$$\xi_k = \frac{\sum_{j=1}^n \left(\mathbf{x}_{l^*}^{(j)}(k) - \mathbf{x}_{l^-}^{(j)}(k) \right)}{\sum_{j=1}^n \mathbf{x}_{l^-}^{(j)}(k)}, \quad k = 1, \dots, 6.$$

Datasets

Table 1: Summary of multimedia dataset

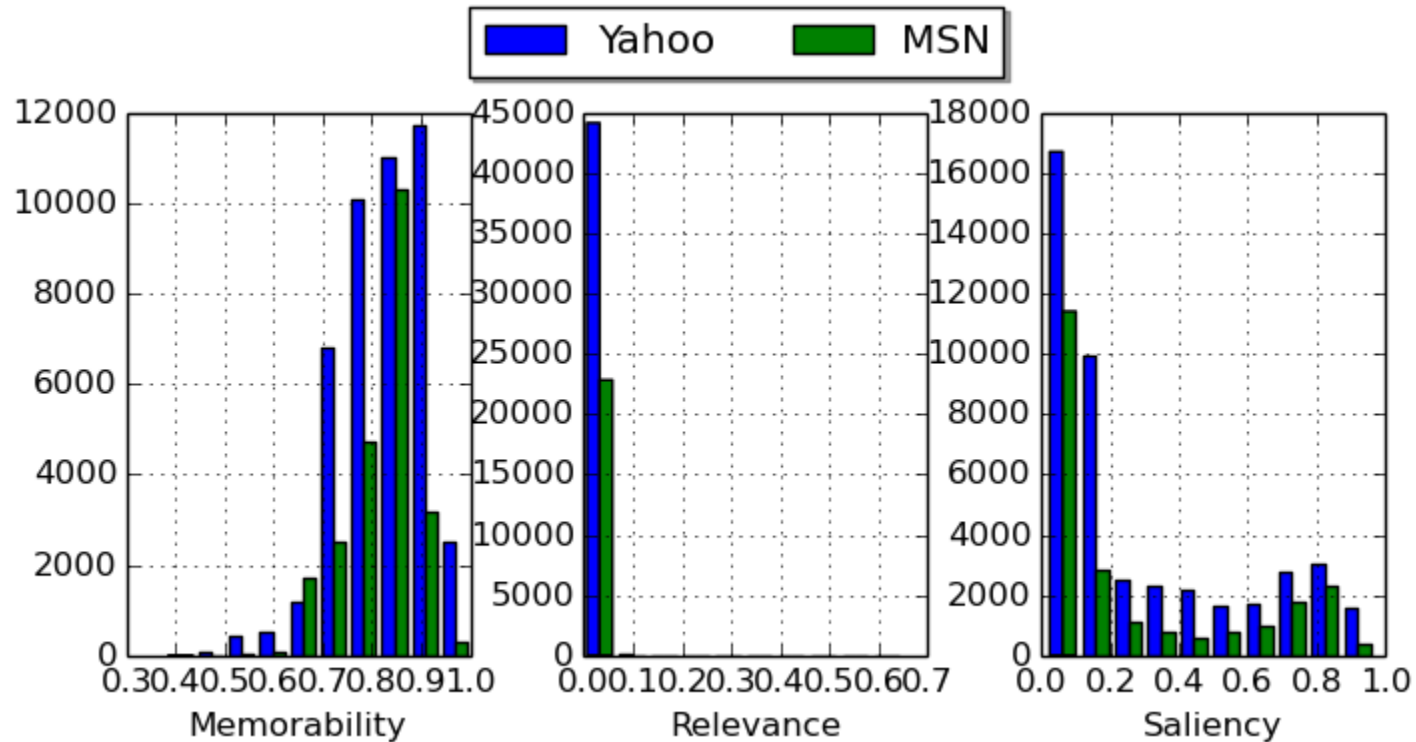
Website	Yahoo	Yahoo	MSN	MSN
Crawler type	I	II	I	II
From	20 Jan 2017	20 Jan 2017	20 Jan 2017	20 Jan 2017
To	30 Jan 2017	30 Jan 2017	30 Jan 2017	30 Jan 2017
Location	Singapore	Singapore	Singapore	Singapore
# of webpages				
with 1 slot	1,481	1,909	798	686
with 2 slots	1,978	3510	1,519	3,689
with 3 slots	1,173	4329	3,633	146
with > 4 slots	1,599	2,468	41	241
# of total impressions	15,836	31,951	14,899	9,466
# of unique advertisers	692	631	160	163
# of total companies	475	431	96	99

Table 2: Summary of auction dataset

Dataset	SSP	Microsoft
Ad type	Display	Search
Ad auction	SP (RTB)	GSP
Market	UK	US
From	08 Jan 2013	26 Dec 2011
To	14 Feb 2013	03 Mar 2012
# of ad slots	31	4,376
# of user tags	NA	NA
# of publishers	NA	1
# of advertisers	374	NA
# of auctions	6,646,643	35,550
# of bids	33,043,127	NA
Bid quote	GBP/CPM	GBP/CPC
Bids of each auction	✓	NA
Winning bid	✓	✓
Winning payment	✓	✓
Estimated CTR	NA	✓

Empirical findings

- Distribution of multimedia variables



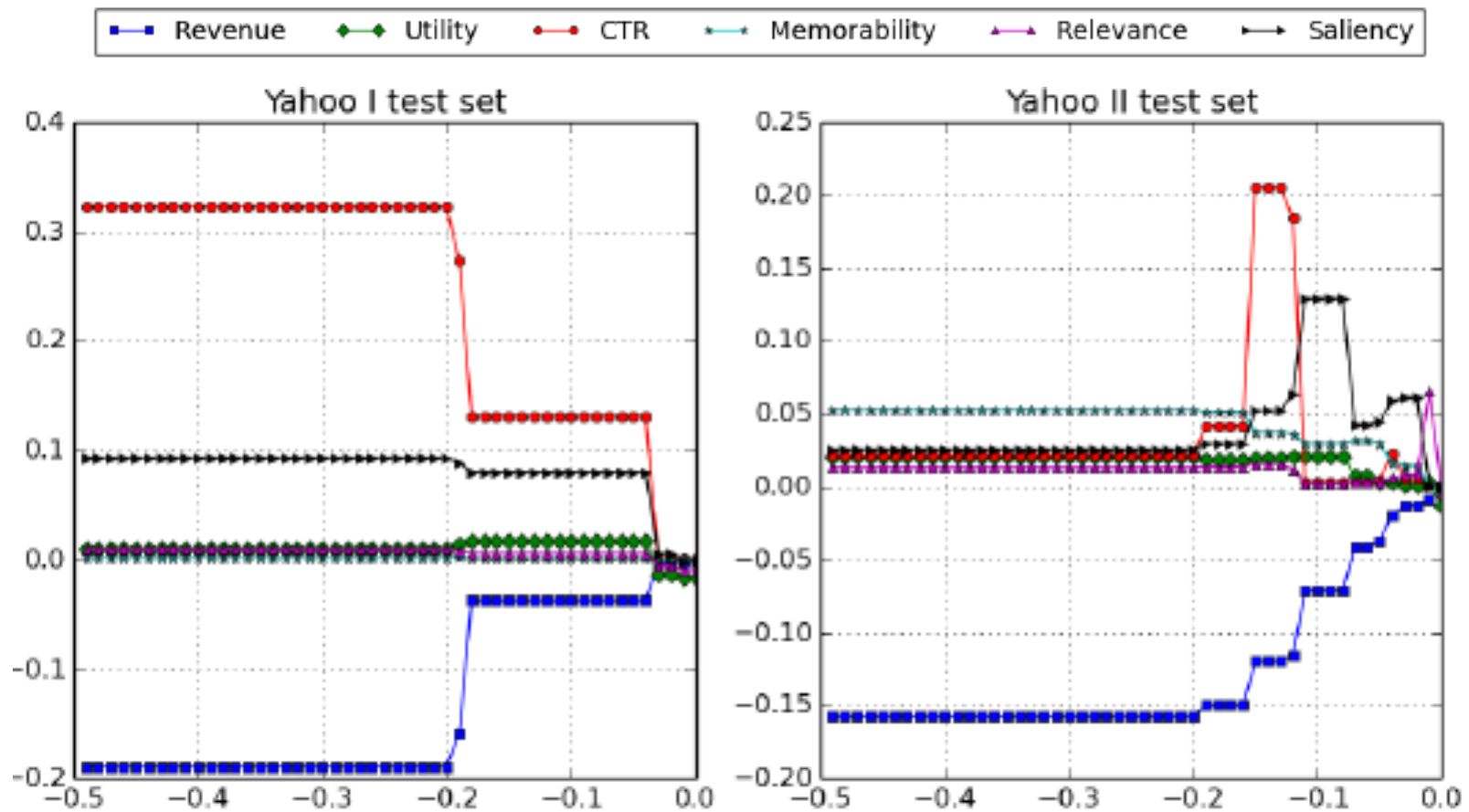
Empirical findings

- Statistic of competitive ad-pair

Ad dataset	Yahoo I	Yahoo II	MSN I	MSN II
# of total webpages	4,750	10,307	5,193	4,076
# of webpages with scenario 1)	786	2,169	3,669	1,480
# of webpages with scenario 2)	155	924	572	238
# of webpages with scenario 3)	412	836	158	82

- Scenario 1: two ads with the same landing webpage;
- Scenario 2: two different ads belongs to the same company;
e.g., Apple iPhone 7 vs. Apple iPhone 6S
- Scenario 3: two competitive ads
e.g., Apple iPhone 7 vs. Samsung Galaxy S7

Changes of variables



Changes of variables

What will happen if publisher (Yahoo) can accept 5% revenue loss?

- Loss of revenue is around 3.6%;
- Increase of CTR is around 13.1%;
- Increase of saliency is around 8.0%;
- Increase of utility is around 1.5%;
- Increase of relevance is around 0.5%;
- Increase of memorability is around 0.0%;

Conclusion and future work

- We proposed a computational framework to optimize trade-offs among all stakeholders. (SIGIR 2017)
- We have extended the framework from single-slot webpage to multi-slot webpage display advertising. (AdKDD & TargetAd, 2017)
- We will investigate how our framework will change and improve the advertising ecosystem in the long run. (future work)