

Simple Mechanisms for Welfare Maximization in Rich Ad Auctions



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Motivation – Rich Ad Auctions

The screenshot shows a Google search for 'soccer ball'. The first ad is from adidas.com, featuring a star rating and delivery time highlighted in an orange box. The second ad is from Modell's Sporting Goods, featuring a site-wide discount highlighted in an orange box.

Google

soccer ball

Ad · www.adidas.com/ ▾

adidas® Soccer Balls - Order From adidas.com Today

Shop adidas **Soccer Balls** Today. Free Shipping For Members On All Orders! Don't miss out on Your Favorites. Order From The Official adidas® Store. Sign Up & Get 15% Off. Earn Points. Free Returns & Exchanges. Game Changing Technology.

★★★★★ Rating for adidas.com: 4.7 - Average delivery time: 1–3 days

adidas® Soccer Cleats · adidas® Sale · adidas® Predator 20 · Tiro Soccer Collection

📍 537 Monmouth Rd Suite 198, Jackson Township, NJ - (732) 833-2901 - Hours

Ad · www.modells.com/ ▾

Soccer Balls | Modell's Sporting Goods

Wide variety of sporting goods, Athletic, active apparel & footwear for the entire family. Discover The Latest Modells Shoes And Clothing. Shop Online Now. Best Price Guarantee.

Shop Sale · Shop Apparel · Shop Footwear · Fan Shop · Shop By Sport

Deal: 10% off Site Wide · Code 100FF

Packing Problem:

- Ads have varying sizes
- Multiple relevant ad formats per advertiser
- Platform has a size constraint

Model – Rich Ads

Publicly
known

Size w_j for all ads $j \in S$

Expected no. clicks α_j for all ads $j \in S$

Set of rich ads A_i

Value per click v_i



Unit-demand advertiser

Utility:

When $j \in A_i$ is allocated at price p
the utility of i is $v_i \alpha_j - p$

Model – Rich Ads

Publicly
known

Size w_j for all ads $j \in S$

Expected no. clicks α_j for all ads $j \in S$

Reported rich ads $S_i \subseteq A_i$

Bid per click b_i



Unit-demand advertiser

Utility:

When $j \in A_i$ is allocated at price p
the utility of i is $v_i \alpha_j - p$

Model – Rich Ad Auction

Feasibility Constraints:

- [UNIT-DEMAND] Allocate (at most) one ad $j(i) \in S_i$ per advertiser i
- [KNAPSACK] Total space allocated is $\sum_i w_{j(i)} \leq W$

Objective:

- Choose a feasible allocation to maximize SOCIAL WELFARE $\sum_i v_i \alpha_{j(i)}$

Algorithm Design

Simpler Approximation Algorithm

Optimal is NP-Hard!

[Sinha-Zoltners'79]

Best of *Incremental-Bang-per-Buck* allocation and **highest value ad** gives a **2-approximation** to the optimal social welfare.

[This Paper]

Lemma. Best of *Bang-per-Buck* allocation and **highest value ad** gives a **3-approximation** to the optimal welfare.

--- *Bang-per-Buck* allocation: Allocate ads greedily in order of $\frac{b_i \alpha_j}{w_j}$ ---

Mechanism Design

Simple & Truthful Auction!

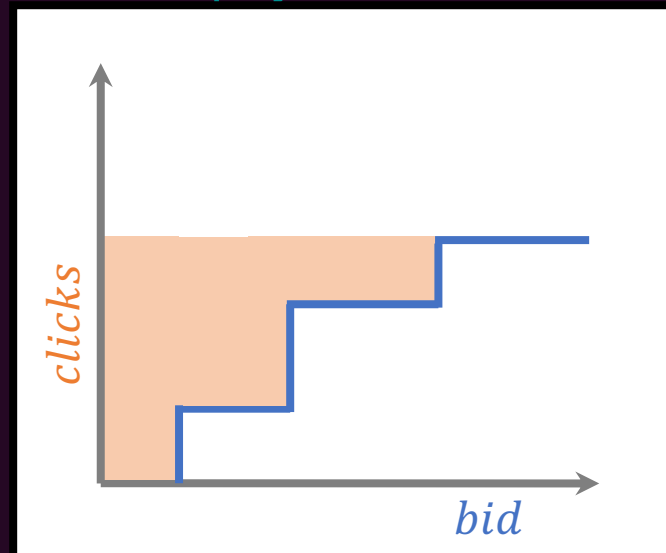
[This paper]

Main Theorem. There is a **simple truthful mechanism** which gets a **3-approximation** to the optimal social welfare.

Monotone allocation rule

- *Bang-per-Buck* Allocation with prob. $2/3$ and **highest value ad** with prob. $1/3$
- Allocation (expected clicks) is **monotone** in both bid-per-click b_i and set of rich ads S_i

Myerson's lemma like payment rule



= **Truthful Auction**

Generalized Second Price Auction

- Our **monotone allocation** can be easily paired with GSP prices!
- **GSP**: The minimum bid b_i^* that won't change i 's allocation
- Very simple payments
- GSP is very widely used in practice in ad auctions
- GSP is **not truthful!**

Q. Welfare guarantee at Equilibrium?

Price of Anarchy of GSP

[This paper]

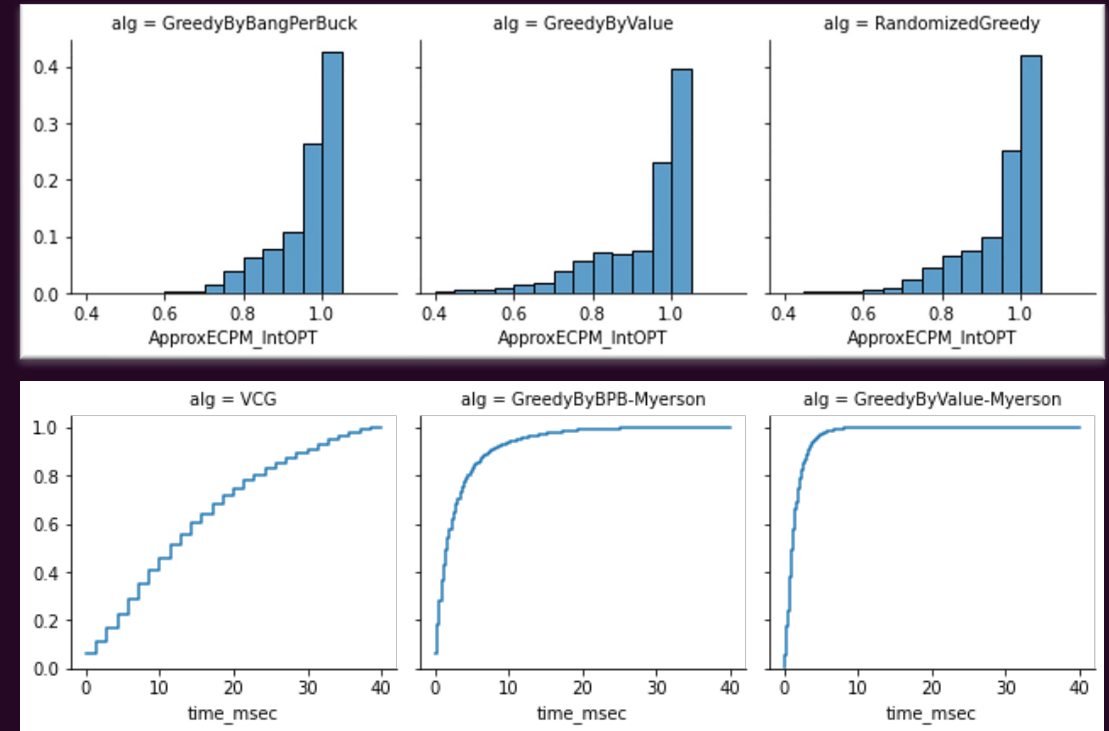
Theorem. Randomizing between the *Bang-per-Buck* allocation and highest value ad has a **pure PoA** of 6 and a **Bayes-Nash**

PoA of $\frac{6}{\left(1 - \frac{1}{e}\right)}$

Empirical Evaluation

Experimental Results

- On average our mechanism obtained **98%** of the optimal welfare
- On average our mechanism was **10 times faster** than VCG



Thank You!

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LINK TO PAPER