Game Theory and Auction Design in Online Advertising:
Past, present, and conjectures about the future

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The first online ad (October 27, 1994)

- Not directly relevant to the user's current activity/request/search
- Similar to newspaper ads, TV ads, billboards, etc.
- "Display ad"

Sponsored listings – GoTo.com (1997)

Sponsored listings before the Internet: Yellow Pages

Sponsored listings before the Internet: Slotting Fees/Endcaps

Sponsored Search

Automated system introduced by GoTo in 1997:

- Advertisers bid on specific keywords

- Bids remain in the system, can be changed at any time

- When a user searches for a particular term, ads for that keyword are shown to him/her next to "organic" results

GoTo/Overture/Yahoo! auction design (until ~2003)

"Generalized First-Price Auction":

- Ads are shown in the descending order of the bids

- Pay-per-click: if an ad is clicked, the advertiser pays his or her bid

- Current bids are publicly observable

Problem

In the Generalized First-Price Auction, a pure strategy equilibrium generally does not exist.

Example

- Two bidders, each has value $10 per click.

- Two positions. Top position gets 20 clicks per hour, bottom one gets 10

- Best response (for bidder 1):
  - If $b_2 < \$5.00$, $BR(b_2) = b_2 + \$0.01$
  - If $b_2 \geq \$5.00$, $BR(b_2) = \$0.01$
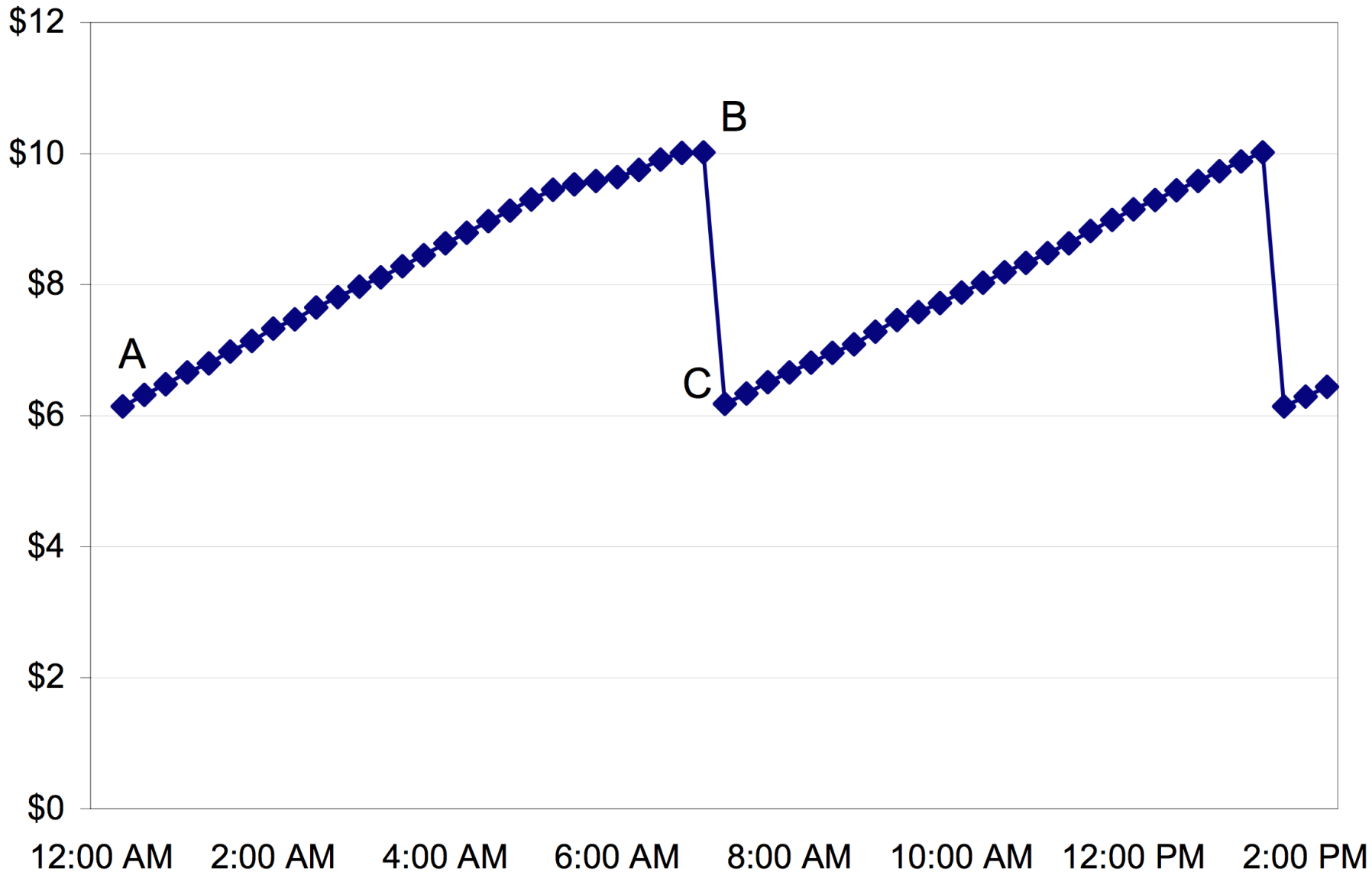
Generalized Second-Price Auction

Introduced by Google in 2002, later adopted widely, currently most common format

- Per-click bids are multiplied by the estimated probability of a click (pCTR), ranked accordingly

- Pay the smallest amount needed to win the slot (e.g., if all advertisers' pCTRs are the same, pay the bid of the *next* highest bidder)

Generalized Second-Price Auction – intuition

Suppose there is only one advertising slot on the page, and it receives 10 clicks per hour.

Suppose you are an advertiser, and you value each click at $7.00. How much should you bid in this auction?

Answer: the optimal bid is $7.00, regardless of what others are bidding.

(With one slot, GSP is truthful, aka incentive compatible)

Generalized Second-Price Auction with multiple slots

Example

- Two positions. Top position gets 20 clicks per hour, bottom one gets 10
- Three bidders. Their values per click are $10, $8, and $1.

Question: Is it an equilibrium for each bidder to bid his or her true value?

Answer: No! For bidders 2 and 3, it is indeed optimal to bid truthfully (given the bids of others). However, that is not the case for bidder 1:

- If he bids truthfully, his profit is 20*($10 – $8) = $40 per hour.

- If instead he bids, say, $5, his profit will be 10*($10 – $1) = $90 per hour

Generalized Second-Price Auction with multiple slots

Example

- Two positions. Top position gets 20 clicks per hour, bottom one gets 10
- Three bidders. Their values per click are $10, $8, and $1.

Question: Is there a stable equilibrium?

Answer: Yes! E.g., the following profile of bids is an equilibrium:

- Bidder 3 bids $1

- Bidder 2 bids $4.50

- Bidder 1 bids anything greater than $4.50

Sponsored Search with Generalized Second-Price Auction

- Wildly successful, often substantially outperforming initial expectations.

- Initially, Google reserved the most valuable real estate (top of the results) to "Google Premium Sponsorships," with auction-based AdWords relegated to the much less desirable right side of the page.

- Message to Premium advertisers just a few months after AdWords launched: "In 2002 we introduced our cost-per-click (CPC) ad program, Google AdWords. Because of market response, we believe this CPC model is the one that yields the best results for advertisers. […] You can expect to make this transition to Google AdWords with informed and responsive customer service."

- Adopted by search engines worldwide

Beyond sponsored search: promoted listings in E-Commerce

- Amazon started experimenting with advertising in 2003.
- Struck gold after about a decade and many experiments and detours.
- Digital "slotting fees" and "endcaps"!

Amazon 'Advertising & other' revenue ($bn)
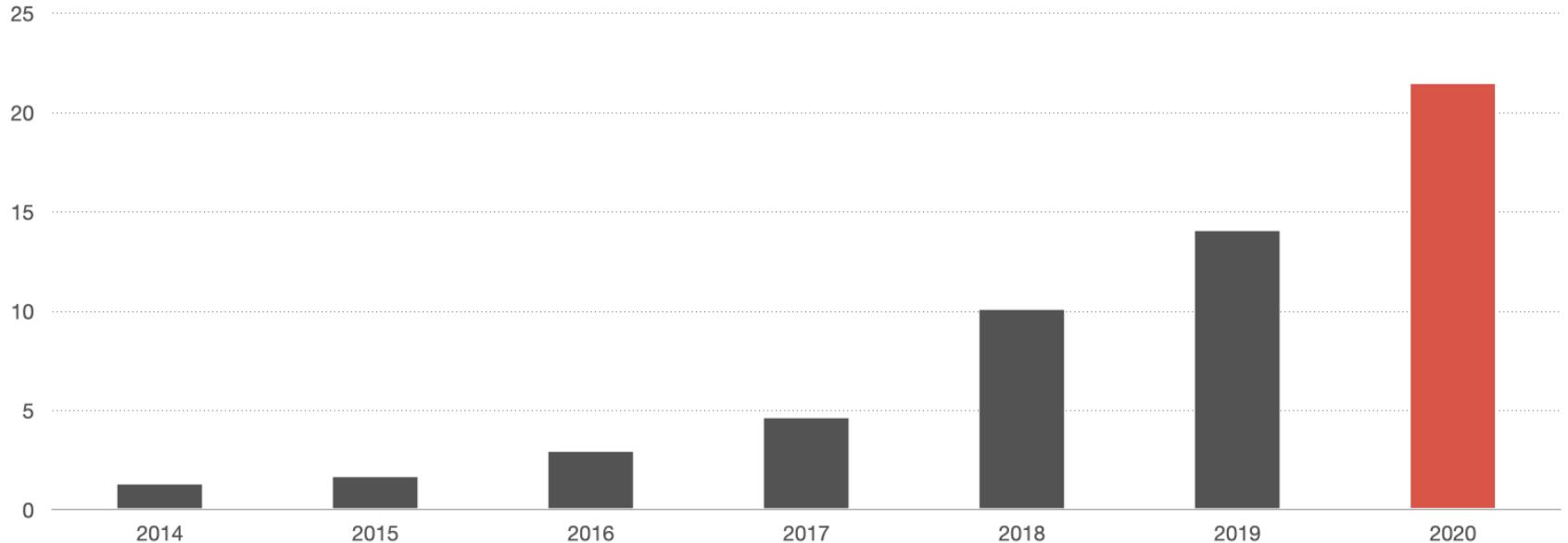
Beyond sponsored search: promoted listings in E-Commerce

- "Many investors likely recognize **Alibaba** as the largest e-commerce and cloud company in China. However, it also leads China's digital advertising market with a 33% share of revenue in the first half of 2019. A large percentage of Alimama's ad revenue comes from Taobao and Tmall, which let merchants promote their product listings via CPC (cost-per-click) bidding platforms."

- "On [Jan 3, 2020], **Walmart** Media Group (WMG), the retail giant's advertising arm, released a self-serve portal so advertisers can directly buy on-site search and sponsored product ads on walmart.com."

- Feb 4, 2019: "Online furniture retailer Wayfair is opening up sponsored products to all […] Brands can bid to promote certain SKUs within certain categories. The pay-for-performance set up means they pay for clicks. The tool is self-service."

Beyond sponsored search: promoted listings in E-Commerce

- **Target**

- **Kroger**

- **Albertson's/Safeway**

- May 27, 2020: "Online grocery company **Instacart** launched a self-serve advertising platform that lets marketers promote products in search results. Brands can choose the products they want to promote, set a budget and pay when users engage with those products."

- Aug 31, 2020: "**Uber Eats** today announced its first in-app advertising format, giving restaurants a way to promote their menu offerings. [...] With Uber Eats' cost-per-click pricing model, restaurants only pay when an app user clicks on the sponsored listing. The self-serve ad platform lets restaurants target their ads based on the location, order history and dietary preferences of Uber Eats customers."

# Observation: strategic considerations (more game theory!)

- Making substantial profits from a sponsored listings platform allows a retailer a greater flexibility in dealing with suppliers, and also allows them to charge lower prices to customers (either uniformly across all products, or for strategically chosen products and verticals).

- In particular, if retailer A has a successful sponsored listings platform, while retailer B does not, retailer A can undercut retailer B's prices - and retailer B cannot respond unless they have their own sponsored listings platform.

- Which means …

Applicability

- Sponsored search (Google, Bing, etc.) ≈ Yellow Pages

- Sponsored products (E-commerce) ≈ Endcaps and slotting fees

- ……….

- The idea of sponsored listings is applicable to *any website or app* with a *search box* (or *search through categories, taxonomy, or navigation*; or another type of *ordered list*) and "results" of that search that are interested in being shown to the end user and are thus willing to pay to be shown more prominently.

App Stores
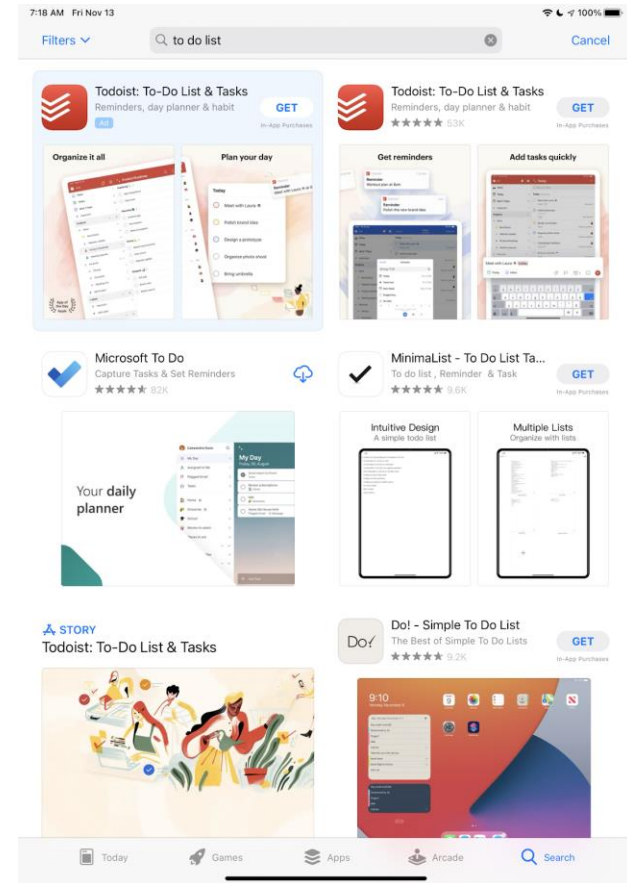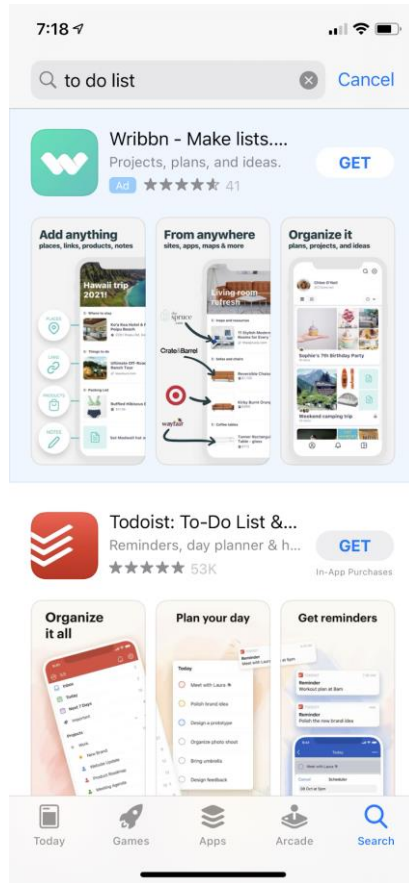
Job search sites

- **Indeed.com** Sponsored Jobs

- **ZipRecruiter** TrafficBoost

- ……….

- **Works in both directions!** -> **Fiverr** Promoted Gigs
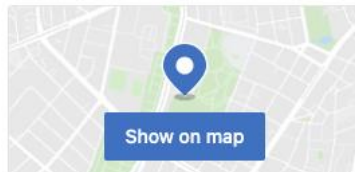
Travel

Search

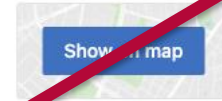Destination/property name:

🔍 San Diego

Check-in date

📅 Saturday, May 8, 2021 ⌄

Check-out date

📅 Saturday, May 15, 2021 ⌄

1-week stay

2 adults ⌵

No children ⌵ | 1 room ⌵

☐ I'm traveling for work ⑦

Search

Stay flexible with free cancellation. Read more. ✕

Only show properties with free cancellation
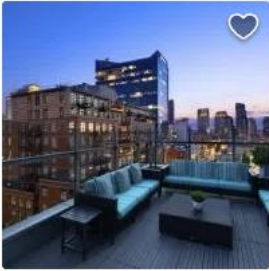
Show on map

San Diego: 296 properties found

Show on map

| Top picks for long stays | Entire homes & apartments | Price (lowest first) | Review Score & Price | **Genius** | ⋯ |

Prices shown are for your 7-night stay ✕

Hotel Indigo San Diego Gaslamp Quarter, an IHG Hotel 👍 Promoted
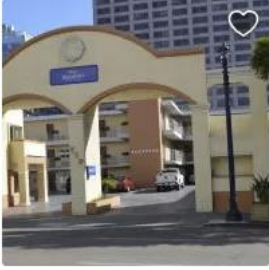
Very Good **8.5**
1,323 reviews

Comfort 8.9

Downtown San Diego, San Diego · Show on map · 1,650 feet from center

Booked 2 times for your dates in the last 6 hours

King Room – 👥

1 king bed

FREE cancellation · No prepayment needed
You can cancel later, so lock in this great price today!

1 week, 2 adults

$1,028

See availability ›

Baymont by Wyndham San Diego Downtown

👍 Genius

Good **7.6**
2,246 reviews

Downtown San Diego, San Diego · Show on map · 2,950 feet from center

Booked 2 times for your dates in the last 24 hours

Queen Room with Two Queen Beds - Non-Smoking – 👥

2 queen beds

FREE cancellation · No prepayment needed
You can cancel later, so lock in this great price today!

1 week, 2 adults

~~$718~~ $640

See availability ›

Many other examples

- Yelp, OpenTable, TripAdvisor

- Gartner Digital Markets (Capterra, GetApp, SoftwareAdvice)

- eBay Promoted Listings

- Etsy (arts and crafts)

- Shopify App Store Ads (launched in 2020)

- Zocdoc

- ……. and this is just in the US!

What makes sponsored listings so successful?

Main reason:

In Sponsored Listings, ads are for items that a user is actively looking for, so relevance is greatly improved and the performance of ads is high.

Benefits to all three groups of constituents:

- The marketplace running sponsored listings

- Vendors

- Customers

Benefits to the marketplace

Flexible, profitable, self-equilibrating monetization lever

Gives freedom to adjust other monetization levers – lower prices (sometimes to zero), eliminate or reduce listing fees, commissions, etc.

Strategic benefit

Attracting more vendors

Users remain on the platform after clicking on the ad (in many cases)

Benefits to the vendors

Allows to drive demand in a controlled manner

Allows new providers to increase the speed of growth on the platform via "costly signaling"

Allows existing providers to quickly ramp up demand for new products

Benefits to the customers

Crucially, fundamentally different from mostly irrelevant display ads

Research shows that customers are *more* likely to click on top listings when they are marked as sponsored, promoted, etc.

- Milgrom and Roberts (JPE 1986), "Price and Advertising Signals of Product Quality"

- Sahni and Nair (REStud 2020), "Does Advertising Serve as a Signal? Evidence from Field Experiments in Mobile Search"

Benefits to the marketplace and vendors translate into better experience for the customers (lower commissions and prices, better variety)

So, what about the future?

Privacy considerations

Sponsored listings are *much* better adapted to the upcoming privacy-first world than display ads, because so much information is contained in user intent.

So advertising budgets may shift from the latter to the former.

Auction format

Increasing adoption of *autobidding*: an advertiser specifies the overall budget and high-level goals, and the platform takes care of the rest.

Ideal for many advertisers, especially *small ones*.

Fascinating use case: Etsy – "How We Built A Context-Specific Bidding System for Etsy Ads" (2021), https://codeascraft.com/2021/03/23/how-we-built-a-context-specific-bidding-system-for-etsy-ads/

Auction format – alternatives to GSP?

- Incentive-compatible alternative to GSP – the Vickrey-Clarke-Groves mechanism:

yandex.com/support/direct/technologies-and-services/vcg-auction.html

https://www.wired.com/2015/09/facebook-doesnt-make-much-money-couldon-purpose/

- *Whole page optimization*: the best combination (and layout) of ads vs. organic results, taking various tradeoffs into account.

Ad listing format

Video ads

Interactive ads

?

Conclusion

Sponsored listings are a really powerful tool – profitable, relevant to users, not irritating or distracting, and giving voice to good vendors.

Origins go to times well before the Internet.

Took off on search engines, spread to ecommerce and beyond, exploding now in more and more domains, not clear where the limit is – anything with a search box or categories or list of items is a potential application.

Exciting developments going forward.

Thank you!

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