

# Lecture 22: Advertisements and Auctions

Innovation Nation

## Pop-up ad creator: 'I'm sorry'

By James O'Toole @jtotoole August 15, 2014: 10:22 AM ET



The competition *hates it!*

24 Lectures on building Web Systems

You won't *believe* Lecture 22!

# Review: Recommender Systems

- Web Systems often use **recommendation systems** to **predict** items that are relevant to their **users**
  - Loosely, recommendation systems predict “ratings” for items or selections that a user has not considered
    - “You haven’t tried it yet, but we think you’ll really enjoy this toothpaste.”
  - **Collaborative filtering** considers **similarity** based on **nearby users**
    - “Other UM students bought this dank coronavirus mask. You should buy it too.”
  - **Content-based filtering** considers **similarity** based on **individual user history**
    - “You bought toothpaste. Now try floss!”
- **k Nearest Neighbor** is gathers the **k** closest points
  - “close” => Euclidian distance, Pearson’s r, cosine similarity
  - Various normalization and re-weighting schemes are possible

# One-Slide Summary: Ads and Auctions

- **Advertisements** are public announcements or displays that promote a product, service, or event
  - **Ads** are the basis of financial stability for a variety of web services
    - Google, Facebook, YouTube, (some) news sites, etc. are all “free” because they advertise
- Users **trade their time** to enjoy a free service
  - You have to watch the 30 second ad to watch your desired YouTube video
  - You have to look at the banner ad or image before viewing the content
- **Advertisers** pay money to a web service provider with a variety of schemes
  - Pay-per-view: advertiser pays \$ each time an ad is displayed
  - Pay-per-click: advertiser pays \$\$ each time an ad gets clicked on
  - Advertisers are motivated to **minimizing cost** while **maximizing return**:  
Ads can be **targeted** to particular users to increase **click-through rate**
- Advertisers engage in complex, automated **auction systems** to run ad campaigns
  - Users, advertisers, and web systems are all **agents** in this advertisement **economy**

# Diction for today's lecture

- The **advertiser** pays money to the **seller** to display their advertisement in hopes that the **user** consumes the advertisement.
  - Example advertiser: Ford, Sony, Nintendo, Yamaha
- The **seller** displays advertisements to the **user** in exchange for money from the **advertiser**
  - Example seller: Google, Facebook, YouTube, popular site X
- The **user** views the advertisement from the **advertiser** while enjoying “free” access to the **seller**
  - Example user: You

# Why advertise?

- Ads help you **sell more product** or make more money
  - Easier to find your product
  - Brand image above generic
  - Paper: "The economic analysis of advertising"
- Ads are a big **waste of money**?
  - Well... "investment." I need to convince consumers of my product or service.
  - Also, my competitors will advertise too.
- Ads **create value** for consumers?
  - Helps me know what my options are. If I have \$10, how do I want to spend it?
  - Makes content like news free, which is worth more to me than annoyance of seeing ads?

# Banner ads

- Show everyone the same ad
  - Olden days: Just make an agreement with a site
    - “I’ll pay \$50/month if you put this on your site”
  - More recent trend: **pay per click**
    - Pay some amount per 1,000 clicks
    - What can go wrong?

The screenshot shows the Yahoo! homepage interface. At the top, there are navigation icons for Finance, Music, Shopping, Mail, My Yahoo!, and Messenger. The central search bar contains the text "Search for:" and "on the Web" with a dropdown arrow. Below the search bar, there is a link to "Yahoo! Search" and a list of search options: "Advanced", "My Web", and "Answers BETA".

A section titled "Yahoo! Search: 2005 Top Searches - See what the world was searching for." is visible. Below this, there is a "Check your mail status: Sign In" link and a "Free mail: Sign Up" link. A grid of links is displayed, including "360°", "Autos", "Finance", "Games", "GeoCities", "Groups", "Health", "Horoscopes", "HotJobs", "Local", "Kids", "Mail", "Maps", "Mobile", "Movies", "Music", "My Yahoo!", "News", "People Search", "Personals", "Photos", "Real Estate", "Shopping", "Sports", "Travel", "TV", "Yellow Pages", and "All Y! Services...".

A large advertisement for Chevrolet is featured, titled "Chevy: No. 1 selling cars, trucks and SUVs." It includes images of a 2006 Cobalt Coupe LS, a 2006 Silverado 150 Crew Cab, and a 2006 Tahoe 4WD LS. The ad text states: "The price on our tag is the price you pay. Not a penny more." and "Take delivery by 1/3/06".

Below the Chevrolet ad, there are two sections: "Yahoo! Small Business" with links for "Web Hosting", "Domain Names", "Sell Online", and "Search Listings"; and "Yahoo! Featured" with links for "SBC Yahoo! DSL", "Weekend Plans", "Downloads", and "HotJobs".

On the right side, there is a "Red Tag Event" banner for Chevrolet with the text "PRICE YOUR CHEVY NOW" and "Visit Chevy.com". Below this is the "In the News" section, dated "6:24am, Sat Dec 31", listing several news items such as "U.S. death toll in Iraq nears 2004 level" and "Palestinian militants release 3 hostages". There is also a "Year in Review 2005" section with a "Full Coverage - Photo Essay" link.

At the bottom right, there is a "Weather and Traffic" section with a text input field for "Enter City or U.S. Zip Code".

# Contextual ads

- Customize ads to page/user
  - Automatically analyze a page to see what it's about
  - Analyze a user to know what they are likely to click on
- Put a box "ad goes here" and ad network figures out the best ad
- **Intuition:** Higher click-through rate (CTR) if ads are relevant to the user!

## Global trade could plummet by more than 30 percent this year, W.T.O. says.

The World Trade Organization said Wednesday that global trade was set to [fall sharply](#) this year, as the spread of coronavirus locks down factories, suppresses consumer demand and disrupts global shipping markets.

In a video briefing, Roberto Azevedo, the organization's director general, said that global trade volume could shrink by 13 percent to 32 percent or even more, compared with the previous year.

"Trade in 2020 will fall steeply in every region of the world and basically across all sectors," he said.

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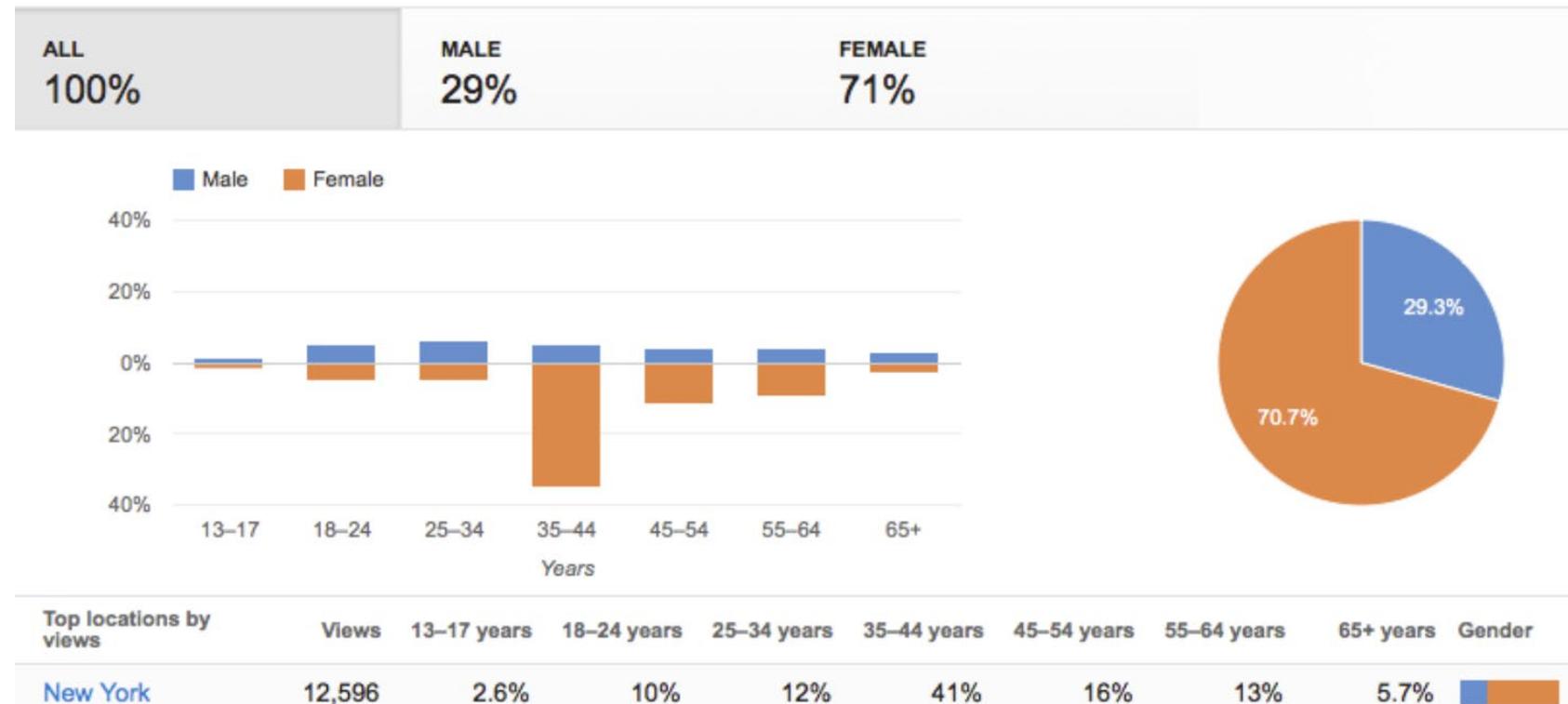
# Aside: MMPI

- The **Minnesota Multiphasic Personality Inventory** is a psychological assessment of adult personalities
  - 567 True/False questions
  - Very well-established psychometric test
- Example questions:
  - “I like mechanics magazines.”
  - “I have a good appetite.”
  - “My hands and feet are usually warm enough.”
- Innocuous datapoints provide profoundly accurate assessments of:

Depression	Anxiety	Propensity for exaggerating
Likelihood to become addicted	Propensity for blaming others	Propensity for lying
<i>Whether you're cheating on the test</i>		

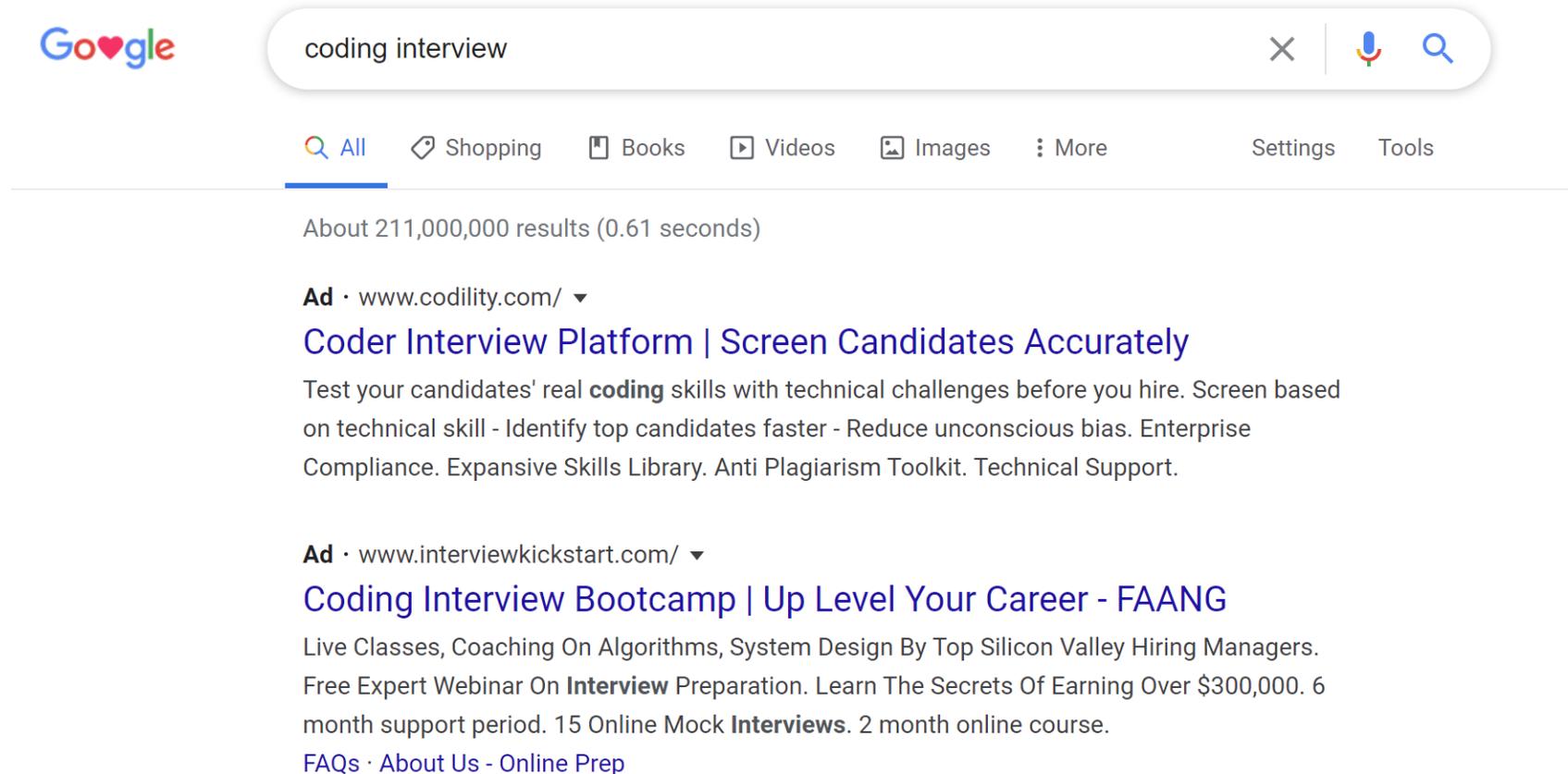
# Aside: Innocuous data and your identity

- Your identity is valuable to advertisers
  - If a company knows *group X* is **more likely** to view a video on *topic Y*, they will **pay more** to advertise on that video than on another topic



# Search ads (AdWords?)

- Secret: people are telling you what they want to find



The screenshot shows a Google search interface. The search bar contains the text "coding interview". Below the search bar, there are navigation links for "All", "Shopping", "Books", "Videos", "Images", and "More". To the right of these links are "Settings" and "Tools". The search results show "About 211,000,000 results (0.61 seconds)". The first result is an advertisement from "www.codility.com/" with the title "Coder Interview Platform | Screen Candidates Accurately". The description for this ad is "Test your candidates' real **coding** skills with technical challenges before you hire. Screen based on technical skill - Identify top candidates faster - Reduce unconscious bias. Enterprise Compliance. Expansive Skills Library. Anti Plagiarism Toolkit. Technical Support." The second result is an advertisement from "www.interviewkickstart.com/" with the title "Coding Interview Bootcamp | Up Level Your Career - FAANG". The description for this ad is "Live Classes, Coaching On Algorithms, System Design By Top Silicon Valley Hiring Managers. Free Expert Webinar On **Interview** Preparation. Learn The Secrets Of Earning Over \$300,000. 6 month support period. 15 Online Mock **Interviews**. 2 month online course." Below the second ad, there are links for "FAQs · About Us - Online Prep".

Google

coding interview

All Shopping Books Videos Images More Settings Tools

About 211,000,000 results (0.61 seconds)

**Ad** · www.codility.com/ ▾  
**Coder Interview Platform | Screen Candidates Accurately**  
Test your candidates' real **coding** skills with technical challenges before you hire. Screen based on technical skill - Identify top candidates faster - Reduce unconscious bias. Enterprise Compliance. Expansive Skills Library. Anti Plagiarism Toolkit. Technical Support.

**Ad** · www.interviewkickstart.com/ ▾  
**Coding Interview Bootcamp | Up Level Your Career - FAANG**  
Live Classes, Coaching On Algorithms, System Design By Top Silicon Valley Hiring Managers. Free Expert Webinar On **Interview** Preparation. Learn The Secrets Of Earning Over \$300,000. 6 month support period. 15 Online Mock **Interviews**. 2 month online course.  
FAQs · About Us - Online Prep

# Where the money's at

- Google revenue: they own the largest contextual ad and search ad business
  - i.e., advertisement brings in \$\$\$\$

	Q4		Fiscal Year		
	2018	2019	2017	2018	2019
Google Search & other	\$23,320	\$27,185	\$69,811	\$85,296	\$98,115
YouTube ads <sup>(1)</sup>	3,605	4,717	8,150	11,155	15,149
Google properties	26,925	31,902	77,961	96,451	113,264
Google Network Members' properties	5,593	6,032	17,616	20,010	21,547
Google advertising	32,518	37,934	95,577	116,461	134,811
Google Cloud	1,709	2,614	4,056	5,838	8,918
Google other <sup>(1)</sup>	4,771	5,264	10,914	14,063	17,014
Google revenues	38,998	45,812	110,547	136,362	160,743
Other Bets revenues	154	172	477	595	659
Hedging gains (losses) <sup>(2)</sup>	124	91	(169)	(138)	455
Total revenues	\$39,276	\$46,075	\$110,855	\$136,819	\$161,857

<sup>(1)</sup> YouTube non-advertising revenues are included in Google other revenues.  
<sup>(2)</sup> Hedging gains (losses) were previously included in Google revenues.



# Thought questions

- You are starting a new web business. You expect to make \$100 from *every new customer* you sign up to your service.
  - What is the **maximum price** you would be willing to pay for an ad that is guaranteed to make you a new customer?
  - What are some *other factors* do you need to consider when deciding how much to pay for a real ad?
- Two common ways of paying for ads:
  - Pay Per Click (PPC)
  - Pay Per View (PPV)
- What are situations where an advertiser might prefer one to the other?
  - What other mechanisms could you use to pay for ads?

# From the Advertiser's Perspective

- Advertiser provides an advertisement to the seller
  - “Here’s some text and a URL”
  - “Here’s an image of size X by Y”
  - “Here’s a video”
- Advertiser wants to *maximize return*
  - Ad views
  - Click through rate (fraction of views that result in a click)
  - Action rate (fraction of views that result in some action, like a purchase)
- Question: What can advertisers do to maximize return?



# What is ad quality?

- Content is **relevant**
  - Not random
- When you click on it, you go somewhere expected
  - This is called the **landing page**
- Ideal world: "I'm glad I saw this ad today"
  - **Landing page experience**



Gut Doctor "I Beg Americans To Throw Out This Vegetable Now"

## SPONSORED CONTENT



**How to Spot a Good Investment in a Changing Neighborhood**

MANSION GLOBAL



**This Game Can Train Your Brain to Think Strategically (No Joke!)**

VIKINGS



**Millions Of People Are Cancelling Their Netflix Account Because Of This One Site**

MYFINANCETODAY.COM



**Learn to speak a new language in just 3 weeks? - Here's how!**

BABEL



**Could This Be The #1 Trick to Reverse Hearing Loss (Do This Tonight)**

HEALTHNEWTIPS.TODAY

# What constitutes a good ad?

- Good ads drive **new leads** and **new purchases**
  - A **good ad** targets the **users** who *would not* have bought your product *without having seen your ad*
    - Example: Pumpkin spice lattes in the autumn
    - Example: Sump pump maintenance service
      - “What is a sump pump?” – me when moving to Michigan
  - Good ads **add value to the user** without being disruptive
- Bad ads get **ignored** and may **harm brand image**
  - A **bad ad** is irrelevant to the user
    - Example: Advertisements for high-density flashmobs (no thx covid)
  - A **bad ad** may be **disruptive** to the user

# From the Seller's Perspective

- The seller wants many advertisers to **compete** for the user's time
  - More advertisers = more \$ per view, click, action, etc.
- The seller *also* wants to keep the experience **positive** for the user
  - Less attractive advertising space if users quit
  - Less data about users, less visibility overall
- Seller must ensure ads are **good** so that they add value to the user
  - i.e., if the seller does a good job matching advertisers to users, then CTR increases, and thus competition from advertisers increases as well

# Seller's interest in good ads

- Sellers will measure **ad quality** *both* for ensuring a positive user experience but also for further competitive edge
  - Advertisers will want a prediction ahead of time: “how many leads will I get from this ad?”
- Google will increase your cost to bid on ads if your ad is bad:  
<https://support.google.com/google-ads/answer/140351?hl=en>
- Other considerations:
  - Ad blocking
    - If you hate ads, you'll block them
    - This is awful for revenue

# From the User's Perspective

- Is a world with no online advertising better than one with it?
  - Would you want to pay for Gmail? Gross.
    - Would you want to use your @comcast.net address? Even worse.
- Least annoying/harmful as possible (i.e., **minimize disruption**)
  - No malware/Bitcoin mining ads
  - Arms race: ads are competing for attention
    - Sponsored content?

This is the last ad you'll ever have to see.



Get **Adblock**

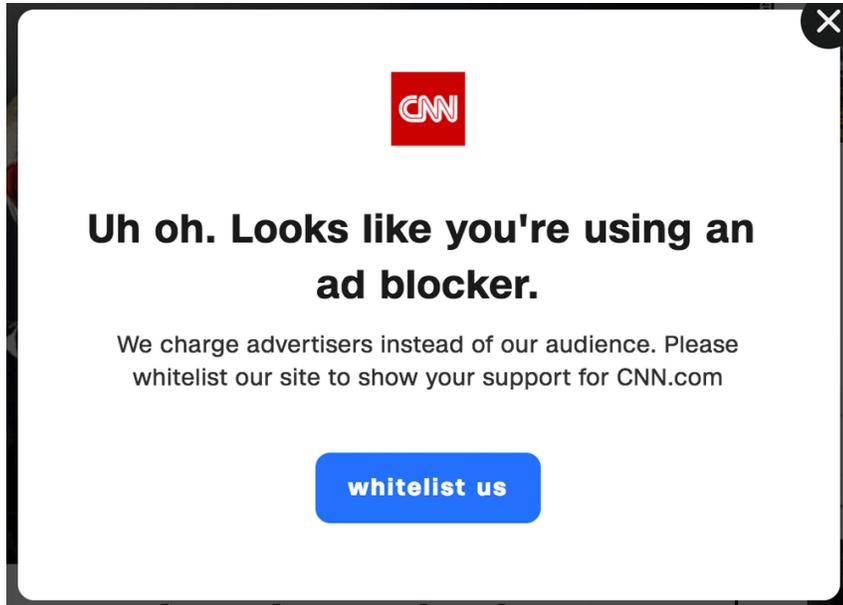
Skip Ad ▶

Advertisement 0:14

0:00:00 / 1:18:54



# Anti-adblock



PublishersDAILY

## U.S. Publishers: \$15.8B Annual Revenue Lost To Ad Blocking

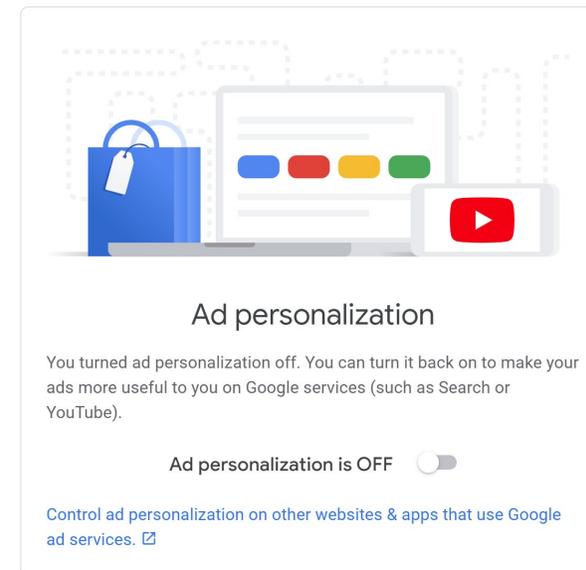
by Laurie Sullivan @lauriesullivan, October 16, 2017

Consumers in Europe are more likely to block ads, but the United States isn't far behind. About 26% of U.S. consumers use some sort of ad-blocking software, according to data released Monday. And soon, Google will give consumers another way to block ads, through its Chrome browser scheduled to launch in 2018.

- Do you visit a site if it makes you turn off AdBlock?
  - Lol no. Also use F12 to remove the modal from the DOM
    - Or use a terminal-based browser

# Thought questions

- If you run a site supported by advertising, over the long term, what are some pros and cons of preventing people with ad blocking from visiting your site? Do you think it is a good long-term strategy?
- Is turning "ad personalization" (ads based on tracking and your identity) worse for you or worse for Google?



# Why auctions and advertising

- How much should I sell an ad on my page for?
  - I don't know
  - But businesses paying for advertising know
- Auction: process to discover a price
  
- Every time an ad is shown, an auction takes place to decide how much the advertiser will pay

# How auctions work

- I say what I have to sell
- Everyone who's interested has a competition where they say how much they're willing to pay to buy it
  - Say a price, and highest gets it
  - Start at a low price, increase until only one person wants it
- Strategy
  - Seller wants most money possible
  - Buyers want to spend least possible

# Auctions for Web Systems

- The **user** types a query on Google (the **seller**)
- The **seller** goes to market and tells the **advertisers**:  
“I just got a sweet query from this user. They searched for X and have demographic properties Y. How much do you want to pay to display your ad for them?”
- **Advertisers** compete based on
  - Amount willing to pay
  - What type of payment they want (i.e., per click? Per view? Per action?)
  - Ad quality
  - Ad relevance to user

# Example of strategic behavior

- Auction format: 3 buyers
  - buyer 1 names a price, then buyer 2, then 3.

	<b>B1</b>	<b>B2</b>	<b>B3</b>
<b>Willing to Pay</b>	\$100	\$500	\$400
<b>Bid</b>	\$100	\$150	\$151
<b>Why?</b>	(must compete with B2, B3)	(thinks B3 will only go for \$125)	(lol rekt)

# Why was this bad?

- **Strategic behavior:** everyone had to do a lot of thinking about the other
- **Missing Information:** The outcome of the auction would change if performed again with the same knowledge
- **Misallocation:** At the end of the auction, the “wrong” person won. Buyer 2 should talk to Buyer 3 to buy it from them.
- **No list price:** The **seller** could have gotten much more money

# Sealed-bid first price auction

- Everyone submits a bid, doesn't tell the others
- The person with the highest bid pays what they bid

	<b>B1</b>	<b>B2</b>	<b>B3</b>
<b>Willing to Pay</b>	\$100	\$500	\$400
<b>Bid</b>	\$100	\$500	\$400
<b>Why?</b>	Incomplete information... bid for what you're willing		

# Sealed-bid first price auction

- What happens if we have the auction many times?

	<b>B1</b>	<b>B2</b>	<b>B3</b>
<b>Willing to Pay</b>	\$100	\$500	\$400
<b>Bid</b>	\$100	\$500	\$400
<b>Bid 2</b>	\$100	\$499	\$400
<b>Bid 3</b>	\$100	\$498	\$400
<b>...</b>			
<b>Bid n</b>	\$100	\$401	\$400

- B2's strategy can be to keep lowering the price until they find the minimum they need to keep beating the others
- **Consequence:** buyers bid less than they are willing to pay

# Sealed-bid second-price

- Get same long-term outcome, but incentive to bid true value and no strategic thinking needed

	<b>B1</b>	<b>B2</b>	<b>B3</b>
<b>Willing to Pay</b>	\$100	\$500	\$400
<b>Bid</b>	\$100	\$401	\$400
<b>Why?</b>	B2 pays \$400 (the “second price”)		

# Google advertising auction

- When a search query comes in, Google finds *relevant* ads, then considers the **bid** and **quality score** of each relevant **advertiser**, ranks the ads, and selects the one that ranks the highest

- Small example (ford pays \$3.01)

	Bid	Quality Score	Ad shown?
<b>Ford</b>	\$5	10	Shown
<b>GM</b>	\$3	10	Not shown
<b>Chevrolet</b>	\$1	10	Not Shown

# Google search advertising auction

- Consider (CPC = cost per click)

- $$\text{CPC} = \frac{\text{ad rank of next ad}}{\text{your ad's quality score}} + \$0.01$$

Ad #	Advertiser	Max bid	Quality Score	Ad Rank	CPC
1	Ford	\$3.00	8	24	$\frac{20}{8} + .01 = \$2.51$
2	GM	\$4.00	5	20	$\frac{15}{5} + .01 = \$3.01$
3	Chevrolet	\$5.00	3	15	$\frac{12}{3} + .01 = \$4.01$
4	Toyota	\$6.00	2	12	N/A

- Higher quality ads are rewarded by paying less

# Thought questions

- Amazon has an "Automate Pricing" feature for sellers where it will set the seller's price for an item to automatically be lower than the next competitor's. Is this more similar to a first-price or second-price auction?
- Do you think it would be more profitable to spend less money on an ad for a rare search term (like LEGO Set 10698) or more money for a common search term (like LEGO)?

LEGO Classic Large Creative Brick Box 10698 Build Your Own Creative Toys, Kids Bui...  
★★★★★ 3,044 ratings

New  
\$43<sup>99</sup> FREE Shipping  
Arrives: Thu, Apr 30  
[See more](#) [Add to Cart](#)

24 other options  
sorted by price + delivery: low to high [Filter](#)

New  
\$56<sup>92</sup> & FREE Shipping  
This item requires special handling ... [More](#) [Add to Cart](#)  
Ships from America \$hops Here  
Sold by America \$hops Here  
★★★★☆ (200 ratings)  
81% positive over the last 12 months

New  
\$56<sup>94</sup> & FREE Shipping  
This item requires special handling ... [More](#) [Add to Cart](#)  
Ships from Unbeatable Bargain Deals  
Sold by Unbeatable Bargain Deals  
★★★★☆ (444 ratings)  
77% positive over the last 12 months

New  
\$56<sup>98</sup> & FREE Shipping  
This item requires special handling ... [More](#) [Add to Cart](#)  
Ships from Shopville USA  
Sold by Shopville USA  
★★★★★ (33,159 ratings)  
93% positive over the last 12 months

# Closing Remarks

- **Advertisers** use **auctions** to *provide their valuation* of the **user's time**
- **Seller** provides infrastructure for pairing **advertisers** and **users**
  - Use combination of **bid price** to *maximize revenue* while tracking **ad quality** to ensure **user** is happy
- Auctions susceptible to collusion
  - Maybe advertisers can work together to minimally outbid others?
- Advertisers vulnerable to fake clicks
  - Can you rig selenium to click ad links automatically?
    - That costs the advertiser money!