

# **CMSC 474, Introduction to Game Theory**

## **27. Online Advertisement Auctions**

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# AdWord Auction

- Internet search companies such as Google, Yahoo, and MSN make billions of dollars out of it
- They decide what ads to display with each query to maximize revenue
- Users typing in query keywords, called **AdWords**
- Business place bids for individual AdWords together with a daily budget limit
- Search engines earn money from business when they show their ads in response to queries and charge them the second highest bid

# Google AdWords

https://www.google.com/accounts/ServiceLogin?service=adwords&hl=en\_US&ltmpl=regionalc&passive=false&ifr=false&alwf=true&continue=

Google AdWords

Change Language: English

## Advertise your business on Google

No matter what your budget, you can display your ads on Google and our advertising network. Pay only if people click your ads.



Romi, Owner — Romi Boutique

Start now

Want help creating a new account?

**Call 1-877-721-1738**

(9am - 9pm ET, Mon - Fri). [More](#)

Sign in with your  
**Google Account**

Email:

ex: pat@example.com

Password:

Stay signed in

[Can't access your account?](#)

### Benefits

[How it works](#)

[Reach more customers](#)

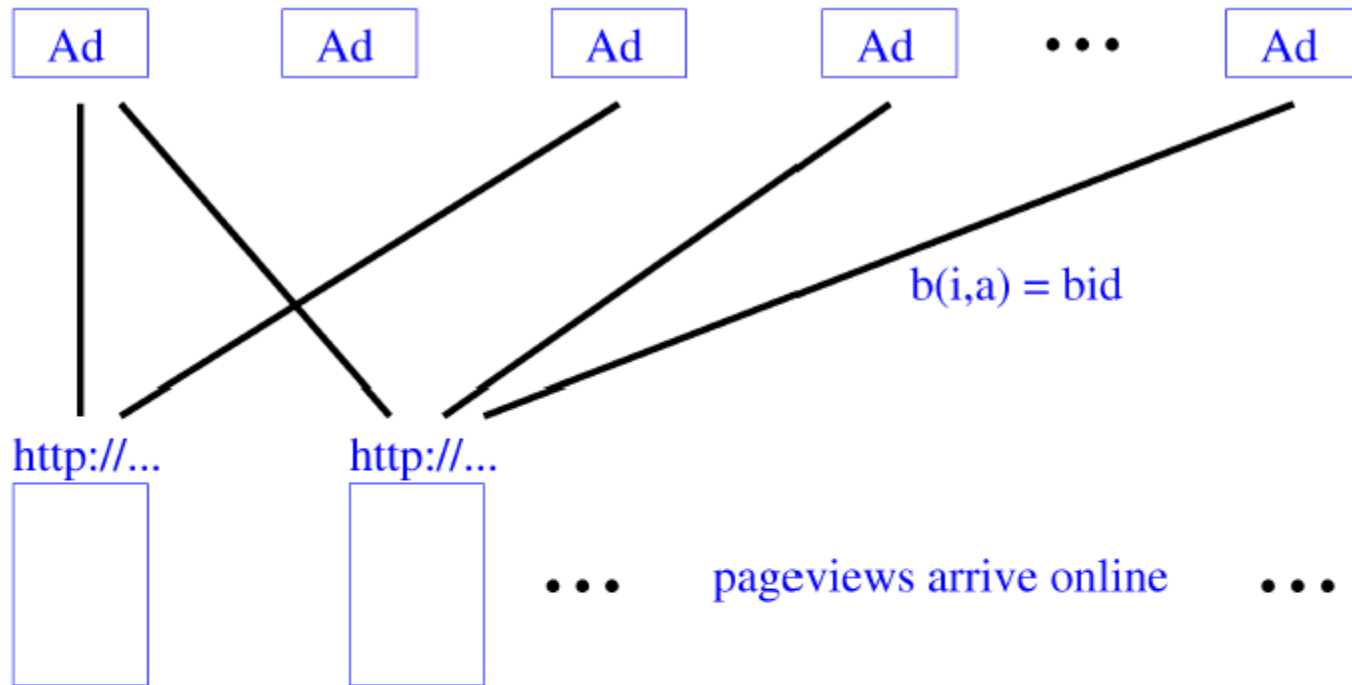
[Costs and payment](#)

[For local businesses](#)

### Benefits of AdWords

- ✓ **Effective:** Advertise on the most-used search engine worldwide.
- ✓ **Local:** Choose to show your ads in your region only.
- ✓ **Quick:** Set up your ad yourself or call us for free first-time set-up service.
- ✓ **Easy:** No expertise required.
- ✓ **Measurable:** Reports show you what you get for your money.
- ✓ **No risk:** You only pay when your advertising works.
- ✓ **Flexible:** Change, pause or end your campaign at any time.

# Online AdWord Auction



- ▶ When page arrives, assign an eligible ad.
  - ▶ revenue from assigning page  $i$  to ad  $a$ :  $b_{ia}$
- ▶ “AdWords” (AW) problem:
  - ▶ **Maximize revenue** of ads served:  $\max \sum_{i,a} b_{ia} x_{ia}$
  - ▶ **Budget** of ad  $a$ :  $\sum_{i \in A(a)} b_{ia} x_{ia} \leq B_a$

# Display Ad Auction

The screenshot shows the CNN website homepage. At the top, there is a navigation bar with the CNN logo, a search bar, and links for 'Sign up' and 'Log in'. Below the navigation bar, there are several news articles and advertisements. The main article on the left is titled 'Witnesses: Huge protests in Yemen over deal for president'. The middle article is 'Reticent believer 'gets the Holy Ghost''. To the right of the main article is a large advertisement for American Airlines with the text 'NOT ON ORBITZ. ALWAYS ON AA.COM.' and a 'Book Now' button. Below the main article is a 'Featured' section with three small images and captions: 'Gallery: Easter around the world', 'Ex-cons assist with WH Easter Egg Roll', and 'Rio's reimagined 'Passion Play''. At the bottom right, there is a 'Most popular stories right now' section with several headlines and progress bars.

EDITION: U.S. | INTERNATIONAL | MÉXICO  
Set edition preference

Sign up | Log in

SEARCH

POWERED BY Google

Home | Video | NewsPulse | U.S. | World | Politics | Justice | Entertainment | Tech | Health | Living | Travel | Opinion | iReport | Money | Sports

updated 10:51 a.m EDT, Sun April 24, 2011

Make CNN Your Homepage

### Witnesses: Huge protests in Yemen over deal for president

Witnesses report hundreds of thousands of demonstrators in Sanaa, Yemen, to protest a deal that would give the country's leader immunity from prosecution. [FULL STORY](#)

- Deal calls for president to step down

### Latest news

- China blocks Easter service in Beijing
- Libya rebels denounce 'dirty games'
- Flights arrive in St. Louis after twister
- Camera captures storm at airport
- New Yorkers hail cab for 3,000-mile trip
- Where did Easter Bunny come from?
- 'Bed Intruder' Internet star arrested
- Wife charged with stabbing NFL player
- Man killed near West Bank holy site

### Reticent believer 'gets the Holy Ghost'

CNN's John Blake had his first brush with the "Holy Ghost" when he was 9 years old, and he's still trying to digest what it meant more than 30 years later. This is his Easter story of love, faith and redemption. [FULL STORY](#)

### Featured

- Gallery: Easter around the world
- Ex-cons assist with WH Easter Egg Roll
- Rio's reimagined 'Passion Play'

### NOT ON ORBITZ. ALWAYS ON AA.COM.

Book Now

AmericanAirlines | AA.com

ADVERTISEMENT

Hi! Log in or sign up to personalize!

POPULAR ON FACEBOOK

NEWSPULSE

Most popular stories right now

- Viral video star arrested in Alabama
- New Yorkers take cross-country taxi ride
- Church: Police block Beijing Easter service
- My Faith: A reluctant churchgoer 'gets the Holy

# Display Ad Auction

- **Impression:** Display/Banner Ads, Video Ads, Text Links
- Cost-Per-Impression (CMI/CPM)
- Done through offline negotiations+ Online allocations
- Q1, 2010: One Trillion Display Ads in US, \$2.7 Billion
- Top publisher: Facebook, Yahoo and Microsoft sites
- Top Advertisers: AT&T, Verizon, Scottrade
- Ad Serving Systems e.g., Facebook, Google DoubleClick, Ad Planner

# DoubleClick Ad Planner

https://www.google.com/accounts/ServiceLogin?service=branding&ltmpl=adplanner&continue=https%3A//www.google.com/adplanner/



Change Language:

[For publishers - Help](#)

## Which websites attract your target customers?

View a site listing:

[Ad Planner top 1,000 sites](#)

Refine your online advertising with DoubleClick Ad Planner, a free media planning tool that can help you:

### Identify websites your target customers are likely to visit

- Define audiences by demographics and interests.
- Search for websites relevant to your target audience.
- Access unique users, page views, and other data for millions of websites from over 40 countries.

### Easily build media plans for yourself or your clients

- Create lists of websites where you'd like to advertise.
- Generate aggregated website statistics for your media plan.

Sign in with your  
**Google Account**

Email: **hajiaghayi@gmail.com**

Password:

[Can't access your account?](#)

[Sign in as a different user](#)

Don't have a Google account?

### Are you a publisher?

Showcase your site with the [DoubleClick Ad Planner Publisher Center](#).

## Learn more about DoubleClick Ad Planner

How it works

[Tutorials](#)

[Features](#)

Define your audience



Find relevant sites for your ads

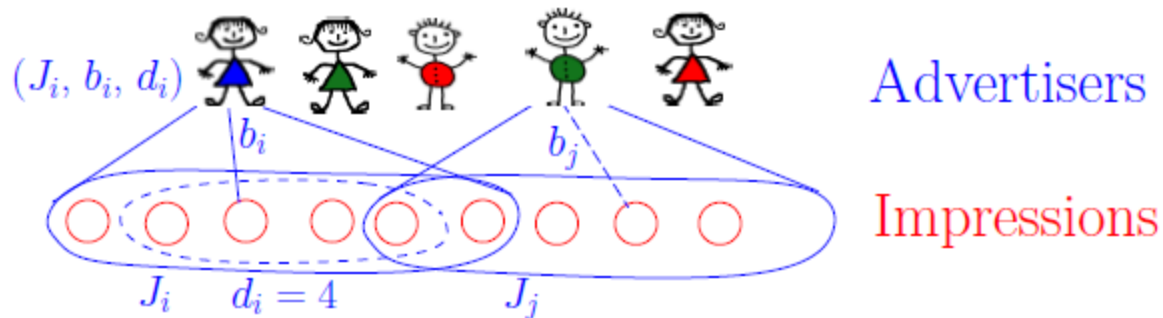


Build and analyze your media plan



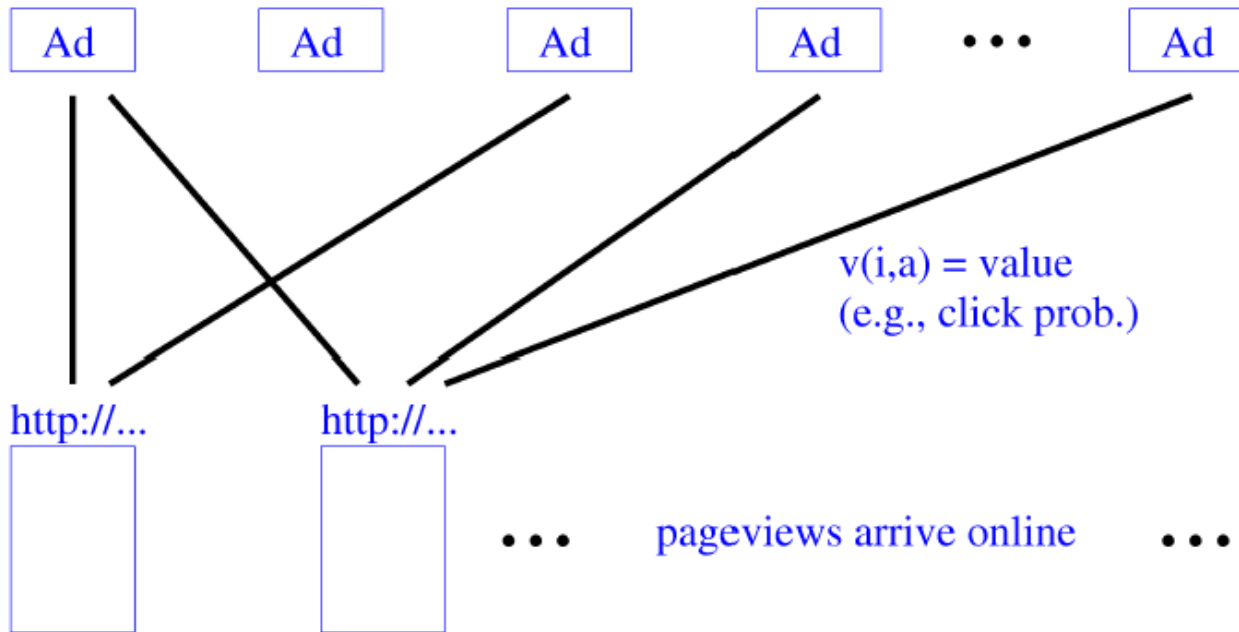
# Google Ad Planning

- ▶  $n$  advertisers, and set  $Y$  of impressions (items).
- ▶ Each advertiser  $i$ 
  - ▶ Interested in a set  $J_i$  of impressions, (e.g, young women in Seattle),
  - ▶ Needs  $d_i$  impressions (Demand),
  - ▶ Value  $v_{it}$  (or Bid  $b_i$ ) for each impression  $t$ ,



Efficiency (or Revenue) Maximization: Find an assignment with the maximum value.

# Online Display Ad



- ▶ When page arrives, assign an eligible ad.
  - ▶ value of assigning page  $i$  to ad  $a$ :  $v_{ia}$
- ▶ Display Ads (DA) problem:
  - ▶ **Maximize value** of ads served:  $\max \sum_{i,a} v_{ia} x_{ia}$
  - ▶ **Capacity** of ad  $a$ :  $\sum_{i \in A(a)} x_{ia} \leq C_a$

# AdCell Auction

shopalerts.att.com/sho/att/index.html?ref=portal



EXPLORE SHOP SUPPORT MY ACCOUNT Log In | Register

Wireless ▾ Internet Home Phone Digital TV Bundles Additional Services Special Offers

## ShopAlerts by AT&T

### Know What's Hot

Get text alerts about new products, special offers, and events from your favorite brands when you are nearby stores. It all comes included with America's best wireless service.

#### Get Started

\* Required Fields

Phone Number \*

Age Range\* (choose one)

E-mail

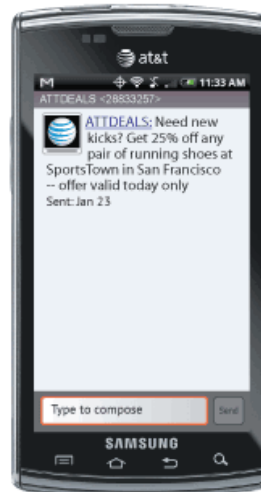
Zip Code

Gender (choose one)

I accept the [Terms and Conditions](#) and have read the [Privacy Policy](#)

Join Now

ShopAlerts is currently available in Chicago, Los Angeles, New York City, and San Francisco.



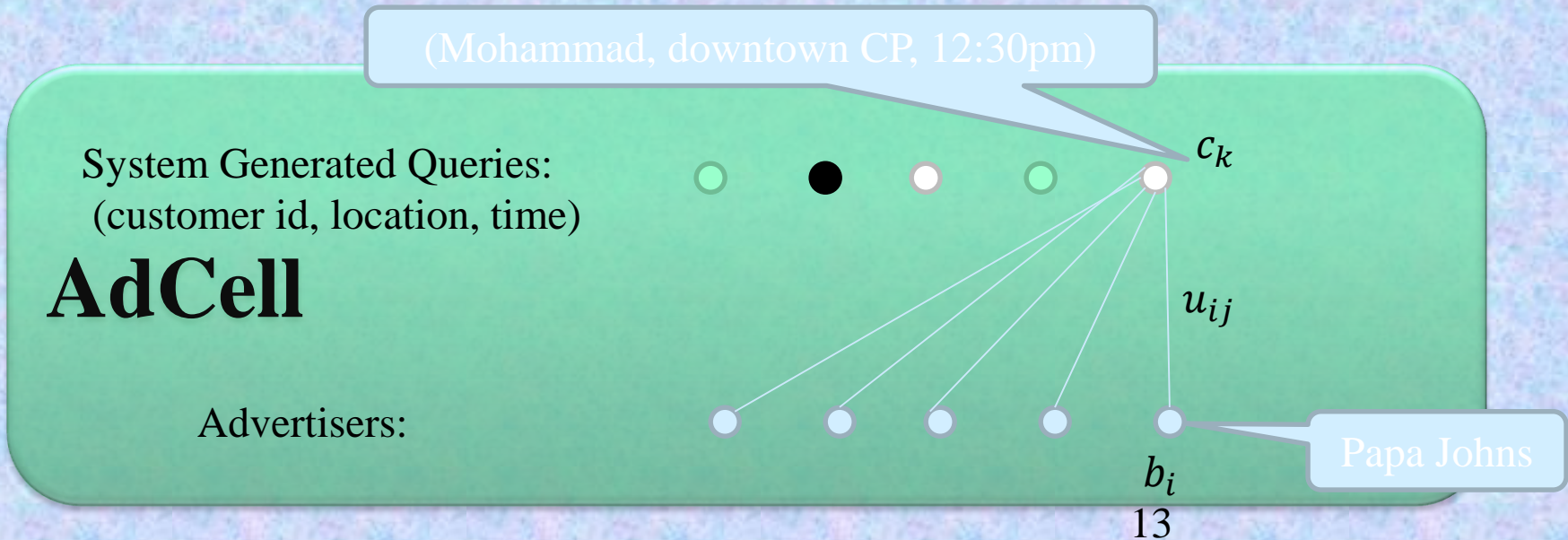
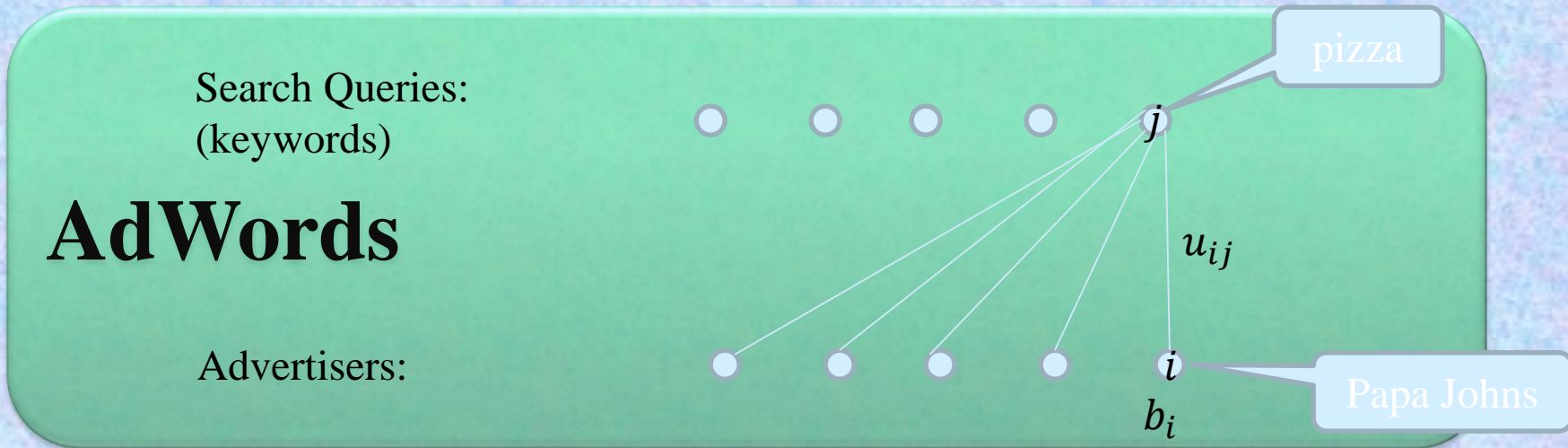
Deals From Your Favorite Brands

and more!

# AdCell Auction

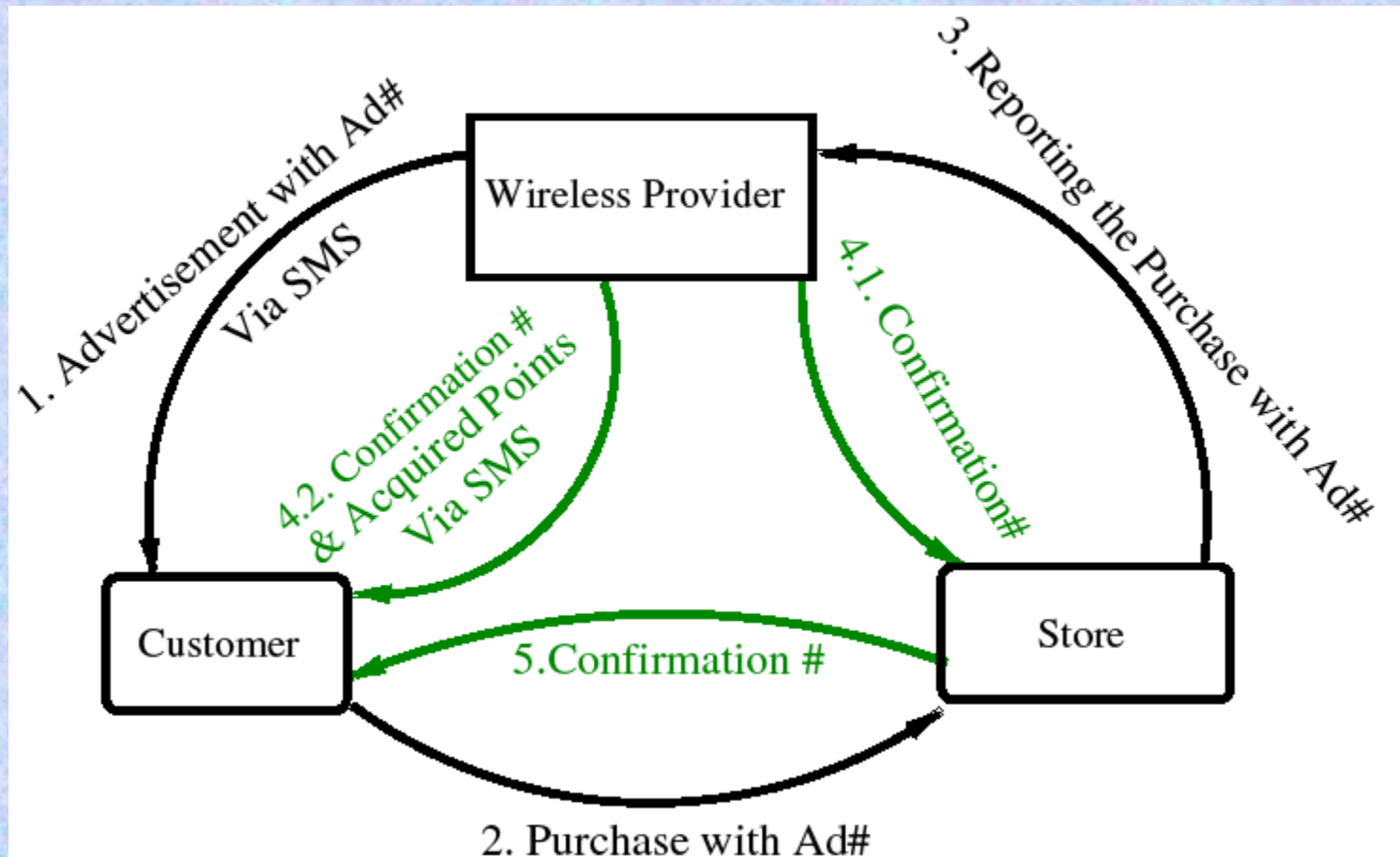
- Online Advertising
  - Major source of revenue
- AdCell vs AdWords
  - Intrusive delivery (SMS,MMS, etc)
  - Limited number of Ads per customer
  - System generated queries
- ShopAlerts by AT&T

# AdWords vs AdCell



# Customer Policy

- AdCell is intrusive
- Incentivizing customers
  - Discount on service plan if they opt in
  - Limited number of ads per month



# Online Bipartite Matching

- All these three problems are generalizations of Online Bipartite Matching:
- The input to the problem is:
  - bipartite graph  $G = (V_1 \cup V_2, E)$
  - $V_1$  is the set of advertisers and  $V_2$  is the set of keywords
  - the vertices in  $V_2$  (keywords) arrive in an on-line fashion
  - the edges incident to each vertex  $u$  in  $V_2$  are revealed when  $u$  arrives and determine the advertisers who want keyword  $u$ .
- When  $u$  arrives, the algorithm may match  $u$  to a previously unmatched adjacent vertex in  $V_1$ , if there is one.
- Such a decision, once made, is irrevocable.
- The objective is to maximize the size of the resulting matching.

# Online Bipartite Matching: Greedy

- Any **greedy** algorithm that always matches a vertex in  $V_2$  if a match is possible constructs a maximal matching, and therefore such an algorithm has a *competitive ratio* of  $\frac{1}{2}=\mathbf{0.50}$  (by a double counting argument).
- *Competitive ratio*: The ratio of our algorithm to the *best (optimum)* offline algorithm.
- On the other hand, given any deterministic algorithm, it is easy to construct an instance that forces that algorithm to find a matching of size no greater than half of the optimum.

# Online Bipartite Matching: Randomized

- Any **randomized** algorithm that chooses a single random ranking on the vertices in  $V_1$
- When a vertex  $u$  in  $V_2$  arrives among its unmatched neighbors assign  $u$  to the one that has the highest ranking
- This produces a competitive ratio  $1-1/e \approx \mathbf{0.63}$
- This is the best that we can do in the online world.
- However, if we know stochastic information like distributions of the keywords (the probability that a node  $u$  in  $V_2$  arrives) and also the budget to the bid ratio is very large, we can obtain a competitive ratio very close to **1**.

# Summary

- Online Advertisement Auctions
  - AdWord Auctions
  - Display Ad Auctions
  - AdCell Auctions