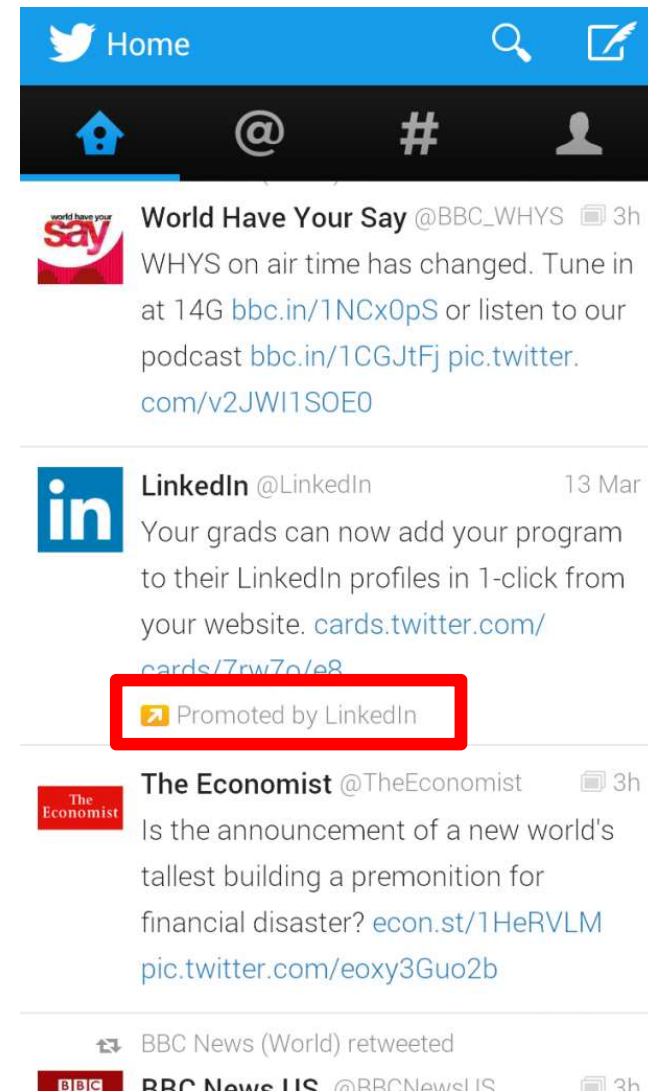




# Sponsored Search Market

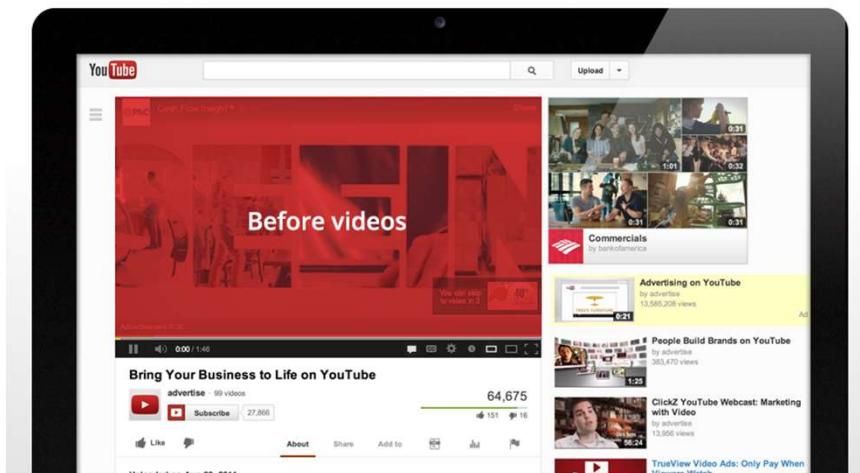


- Traditional advertising
  - newspapers, magazines, TV
  - Negotiate a rate with advertiser, agreeing on a price for showing the ad a fixed number of times.
- Internet advertising (web advertising, online advertising or computational advertising)
  - Web search engines, online content providers and publishers.
    - Sponsored stories, promoted posts/tweets, “like” invitations
    - keyword-based advertising
      - for search engines : show the ad to any user who enters some related queries
      - e.g. "calligraphy pens"





# Advertising : youtube



- Skippable in-stream ads
  - Before, during, or after other videos on YouTube
- Non-skippable in-stream ads
  - 15 seconds (or shorter)
- Bumper ads
  - 6 seconds (or shorter) and play before, during, or after another video. Viewers don't have the option to skip the ad.



How to Make Bread from Scratch- NO BREADMAKER NEEDED

2,596,589 views

32K 1K SHARE



HALO 5.4K Game Movie (Xbox One X Enhanced) All Cutscenes Ultra HD 60FPS

6,751 views

32K 1K SHARE





# 11

Made from the good stuff in chocolate.

CocoaVia

LEARN MORE

## 11 Scariest Things Caught By Drones

32,023,819 views

140K 99K SHARE

12+

Up next

5 People With Superpowers Caught On Tape

8:51

16 Mysterious Creatures Caught on LIVE TV

15:04

UNBELIEVABLE Items! After Tsunamis!

10:13

20 Creepiest Google Earth Images

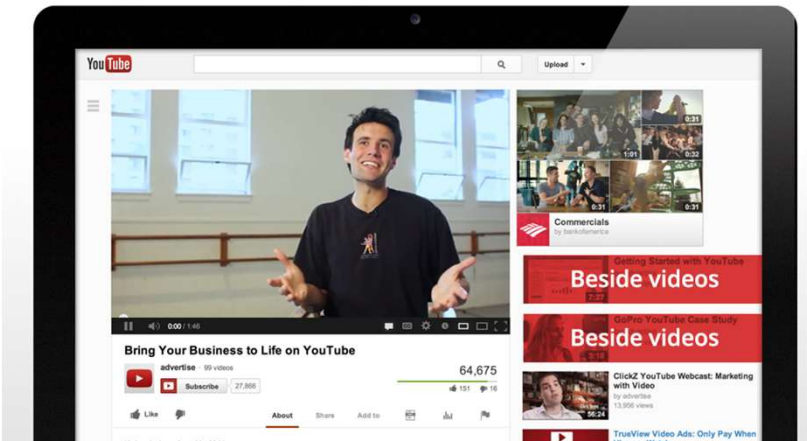
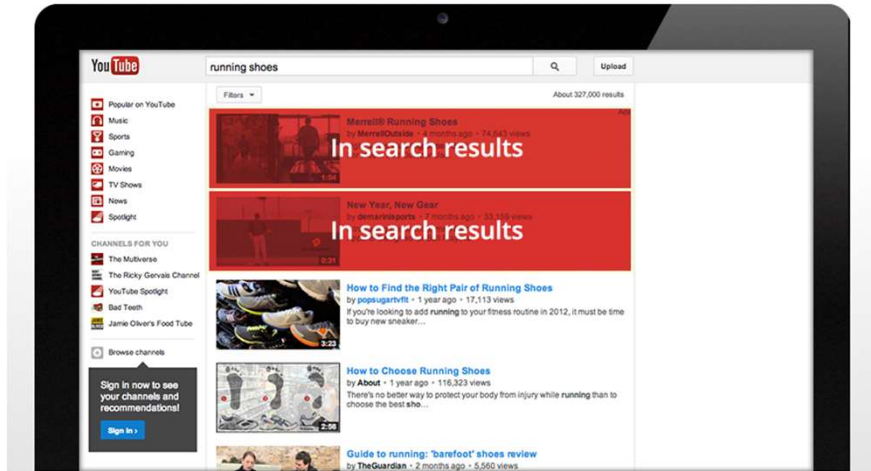
7:48

10 CREEPY Ghost Signs Caught on Tape

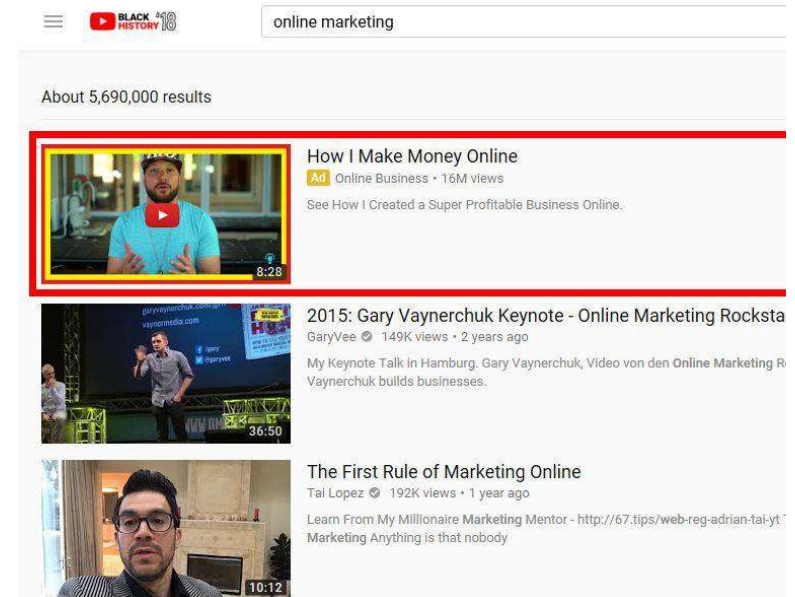
13:40



# As part of a YouTube search result



2019/20 Term 2



CSCI4190 by Laiwan Chan

6

[Advanced Search](#)  
[Preferences](#)Customized based on recent search activity. [More details](#)[Web](#) [Books](#)

Results 1 - 10 of about 381,000 for keuka lake [definition]. (0.19 seconds)

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Find your dream home; Lakefront, Lakeview, Cottage, Land or Farm!  
[www.winetrailproperties.com](http://www.winetrailproperties.com)  
New York





keuka lake lodging



All Maps Images News Videos More Search tools

### Keuka Lake Vacation Rentals & Short Term - Airbnb.com

[www.airbnb.com/](http://www.airbnb.com/)

Short Term Rentals From \$48/Night. 800,000+ Unique Listings Worldwide.  
15,000,000+ Guests Booked · Paris, LA, London, Tokyo · Room, Apartment, Villa.

[Signup Now](#)

[Invite friends to Airbnb](#)

[What is Airbnb™?](#)

[Earn Travel Credit](#)

### Hotels near Keuka Lake State - Hotels.com

[www.hotels.com/](http://www.hotels.com/)

Search & Book Cheap Hotels online. Save with our Best Price Guarantee.  
Photos & Reviews · Guest Reviews · Last Minute Hotel Deals · Travel Guides  
Types: Boutique Hotels, Luxury Hotels, Motels, Hostels, Inns, Country Houses, Apart-Hot...  
[Hong Kong Hotels](#) · [Today's Deals](#) · [Hotels.com Rewards](#) · [Last Minute Deals](#)

### Keuka Lake Rental Home - keukalakerentalhome.com

[www.keukalakerentalhome.com/](http://www.keukalakerentalhome.com/)

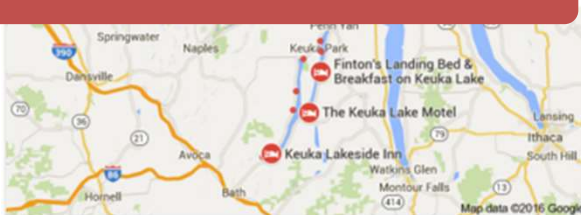
For Rent by Owner - Cabin on Keuka Lake-Loaded-Affordable-Convenient

### Lake Cabin Vacations - frostvalley.org

[www.frostvalley.org/cabin-vacations](http://www.frostvalley.org/cabin-vacations)

Enjoy the comforts of a cabin vacation. Book a cabin now!

[Getaways](#) · [Contact Us](#)



Sun, 17 Apr

Mon, 18 Apr

Price -

**The Keuka Lake Motel**  
Homey base with private baths & TVs  
14720 NY-54

[Visit website](#)



**Finton's Landing Bed & Breakfast on Keuka Lake**  
Lakeside hideaway with a private beach  
881 E Lake Rd  
Free Wi-Fi Free breakfast

[Visit website](#)



**Keuka Lakeside Inn**  
4.5 ★★★★★  
Relaxed waterfront lodging with a dock  
24 Water St  
Free Wi-Fi

[Visit website](#)



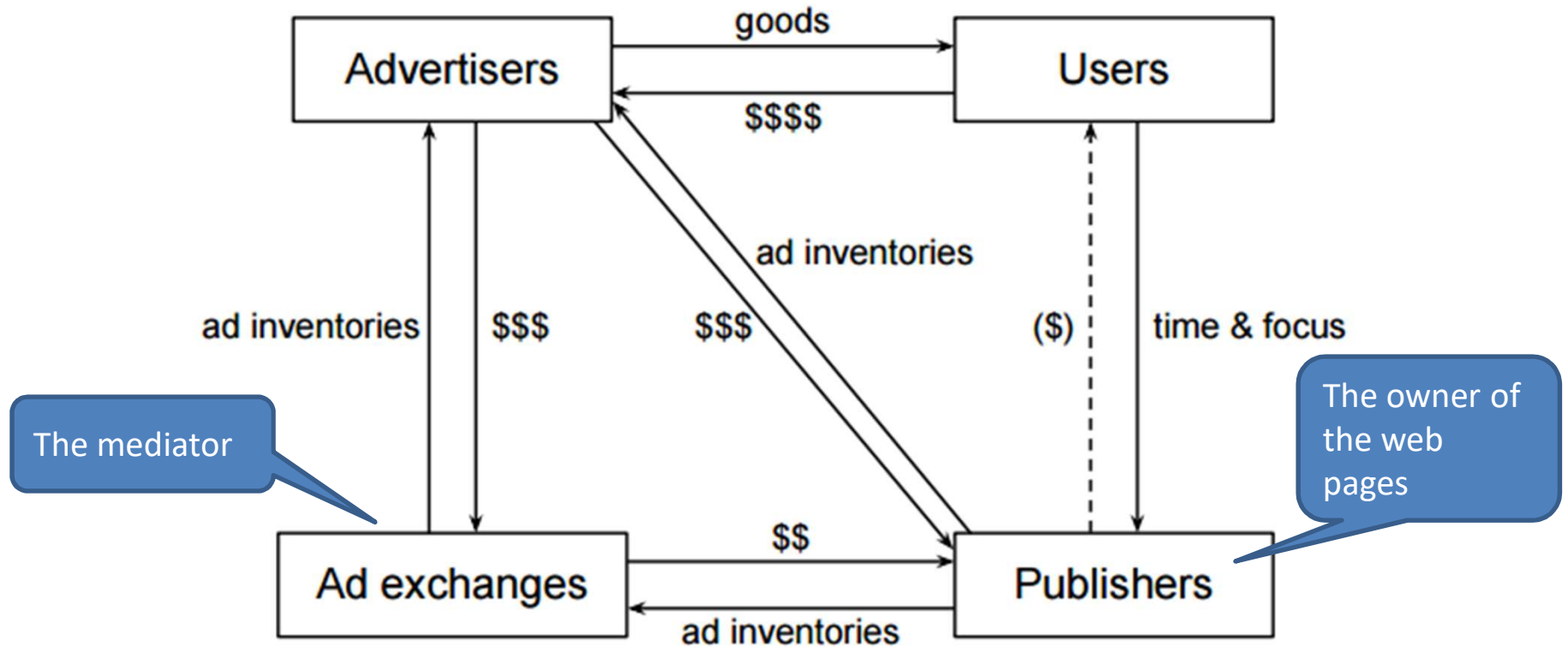
[More hotels](#)

[About pricing](#)





# Ecosystem of Internet Advertising



Source : Yuan, Abidin,  
Sloan and Wang, 2012



# Different types of ads

- Sponsored search ad
  - Advertisers buy keywords that exactly or broadly match with queries submitted by visitors.
- Contextual ad
  - Different ads are shown to visitors based on their geography, language, device and other characteristics.



# Internet Advertising

- Best revenue
  - The search engine finds and displays the best ads from advertisers which suit the user's interest.
- Advertising cost
  - Pricing model
    - Cost per click (CPC), Pay per click (PPC)
    - Cost per view (CPV), Cost per mille (CPM) (Cost per thousand estimated views), Cost per impression (CPI)
    - Cost per action (CPA), Cost per order, (CPO), Cost per purchase
    - Cost per complete view
  - Through bidding



- What is the price for showing the ad ?
- How do we charge if we use keyword-based advertising ?





# Advertising : Google

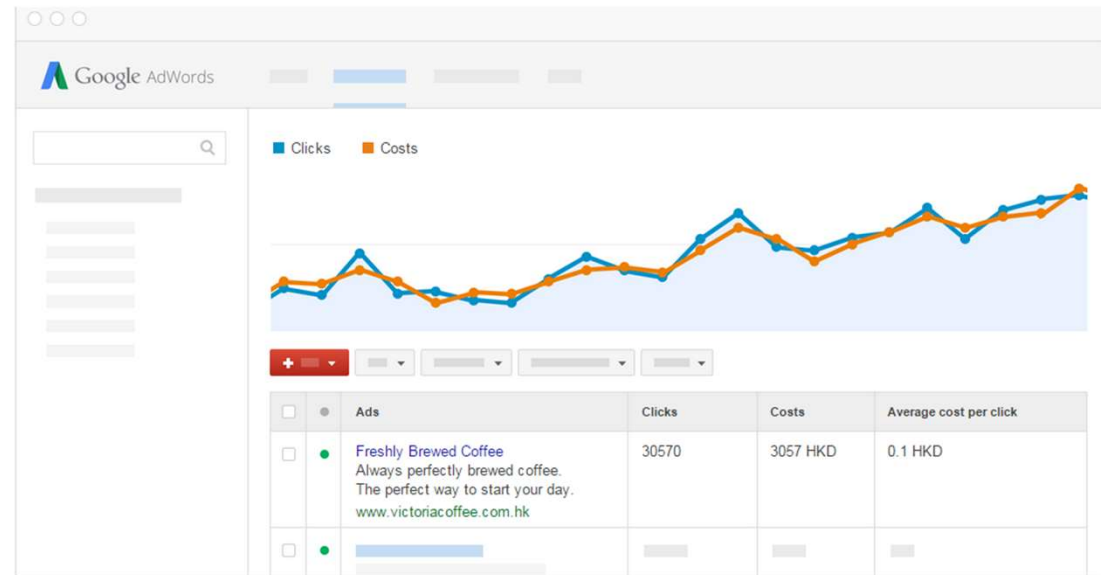
fresh coffee in tsim sha tsui

Freshly Brewed Coffee

**Ad** [www.victoriacoffee.com.hk](http://www.victoriacoffee.com.hk)

Always perfectly brewed coffee.

The perfect way to start your day.



Easy-to-read reports and graphs show how your ads are doing in Google AdWords

Google AdWords			
Clicks	Click-through rate	Average cost per click	Cost
30570	0.18%	0.1 HKD	3057 HKD



# Paying per click



- Cost-per-click (CPC) model, also called pay per click (PPC)
  - You only pay when a user actually clicks on the ad
  - occupying the top spot for “Keuka Lake” costs about \$1.50 per click.
  - “calligraphy pens” costs about \$1.70 per click on Google
  - For the misspelling “calligaphy pens,” the cost is still about \$0.60 per click (potential customers)
  - Queries like “loan consolidation,” “mortgage refinancing,” and “mesothelioma” often reach \$50 per click or more.
  - An advertiser’s estimate that it stands to gain an expected value of \$50 for every user who clicks through such an ad to its site.





# How should a search engine set the prices per click for different queries ?

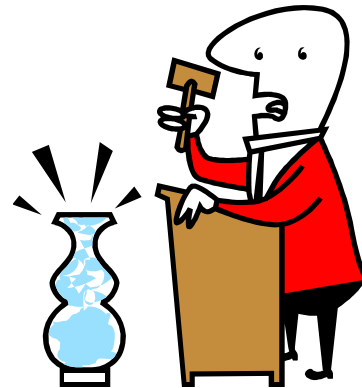
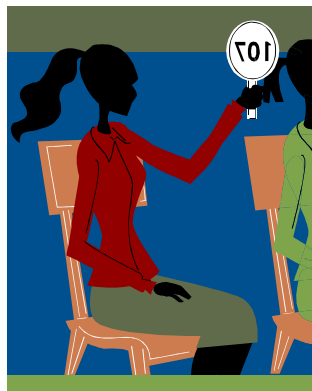


- post prices
  - the way that products in a store are sold
  - so many possible keywords and combinations of keywords !!
  - hopeless for the search engine to maintain reasonable prices for each query in the face of changing demand from advertisers



# How should a search engine set the prices per click for different queries ?

- search engines determine prices using an **auction procedure**, in which they solicit bids from the advertisers.

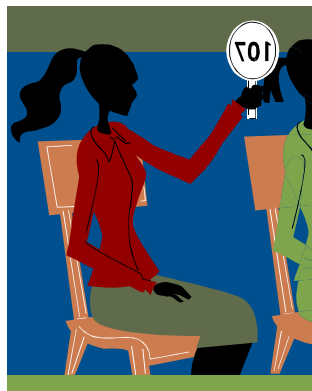






# How should a search engine set the prices per click for different queries ?

- auction procedure
  - a single slot in which an ad could be displayed → a **single-item auction**
  - multiple slots for displaying ads → matching



[Advanced Search](#)  
[Preferences](#)Customized based on recent search activity. [More details](#)[Web](#) [Books](#)Results 1 - 10 of about 381,000 for keuka lake [[definition](#)]. (0.19 seconds)

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[www.winetrailproperties.com](http://www.winetrailproperties.com)  
New York



# The auction process and the price setting

- **Matching Market**
  - if the search engine knew all the advertisers' valuations for clicks
- **Vickrey-Clarke-Groves (VCG) mechanism**
  - the advertisers' valuations are not known
  - encouraging truthful bidding, or to deal with the consequences of untruthful bidding
  - the design of a price-setting procedure for matching markets
- **Generalized Second-Price Auction (GSP)**
  - the procedure that the search industry adopted



# Advertising as a matching market



Slots



Sellers

Advertisers



Buyers





clickthrough  
rates

Slots

Advertisers

10



5



2



The number of  
clicks per hour it  
will receive



# Assumptions

- Advertisers know the **clickthrough rates**.
- The clickthrough rate depends only on the slot itself and not on the ad that is placed there.
  - a relevant, high-quality ad in a high slot will receive more clicks than an off-topic ad → to deal with ad **relevance and ad quality**.
- The clickthrough rate of a slot doesn't depend on the ads that are in other slots.
  - **interaction** among the different ads being shown
  - a more complex issue, not well understood



clickthrough  
rates

Slots

10



5



2



The number of  
clicks per hour it  
will receive

Revenues per  
click

Advertisers



3

intrinsic to  
the  
advertiser



2

does not  
depend on  
what is  
shown



1

The amount of  
money it expects  
to receive per click



- $r_i$  = the **clickthrough rate** of slot  $i$   
(the number of clicks per hour it will receive)
- $v_j$  = **revenue per click** of advertiser  $j$ , the amount of money it expects to receive, on average, each time a user clicks on one of its ads.
- $r_i v_j$  = the **benefit** that advertiser  $j$  receives from being shown in slot  $i$





# Matching Market



$v_{ij}$  =  
valuation  
for item  $i$   
by buyer  $j$



# Market-clearing

clickthrough  
rates

Sellers

Buyers

Revenues per  
click

Valuation

10



3

30, 15, 6

5



2

20, 10, 4

2



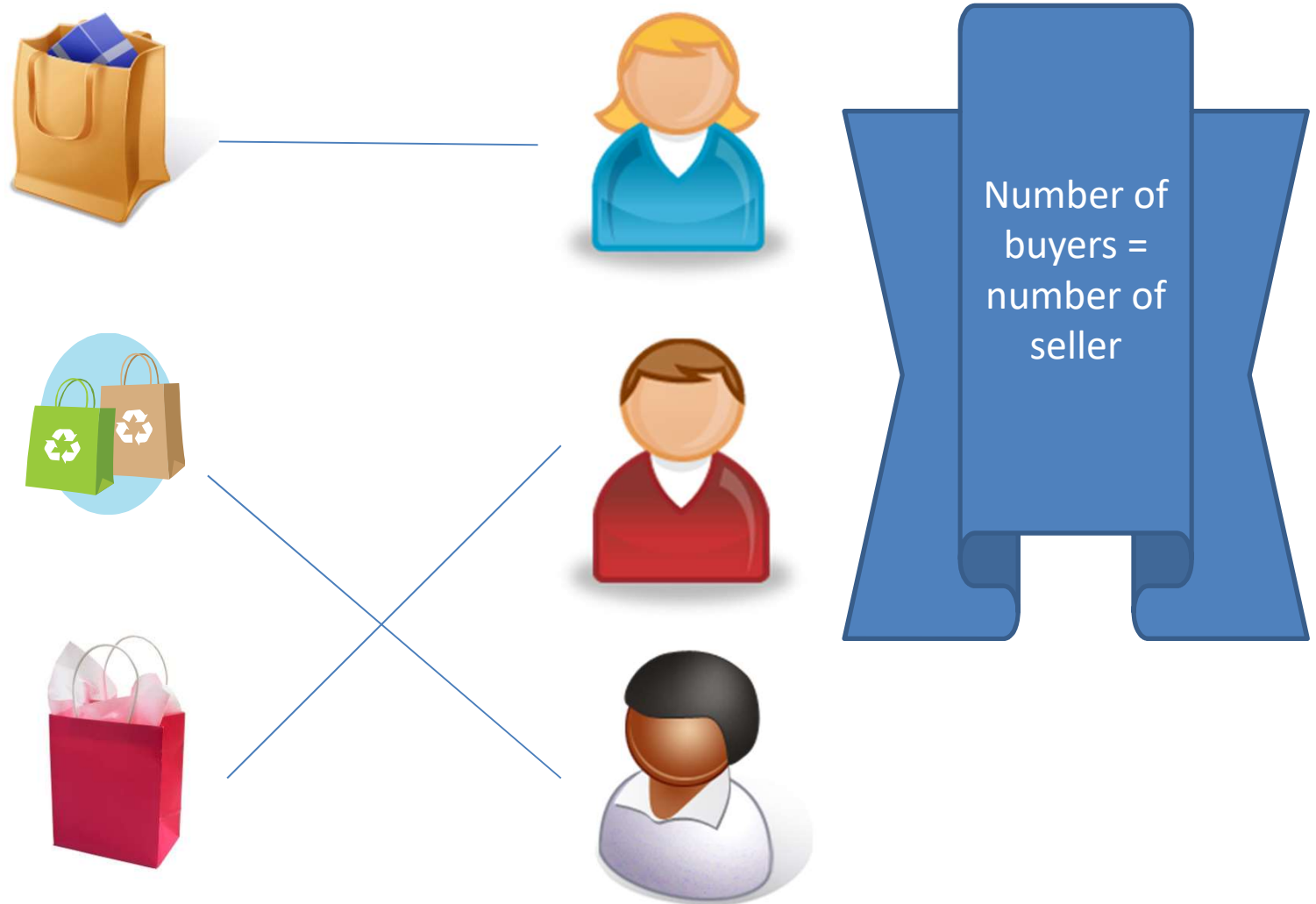
1

10, 5, 2

valuation for  
items 1, 2, 3  
respectively



# Matching Market

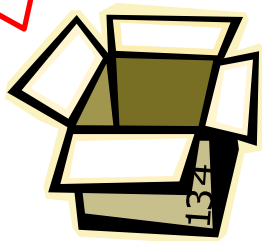




# More advertisers than slots

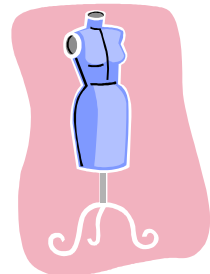


Fictitious  
slots of  
clickthrough  
rate 0





# More slots than advertisers



Fictitious  
advertisers  
who have a  
valuation of 0  
for all slots



# Matching Market



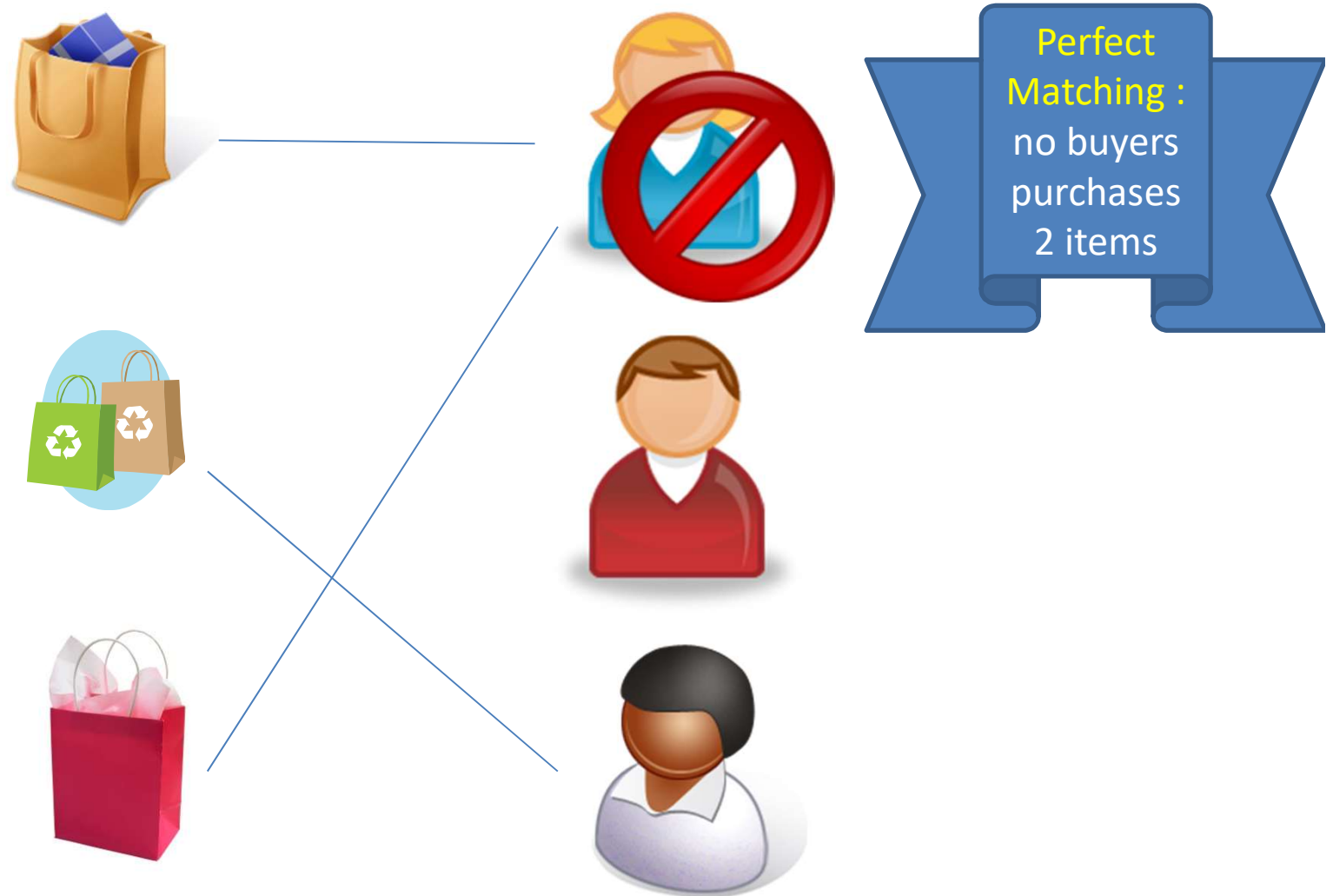
**Goal :**  
Match up  
buyers  
with sellers





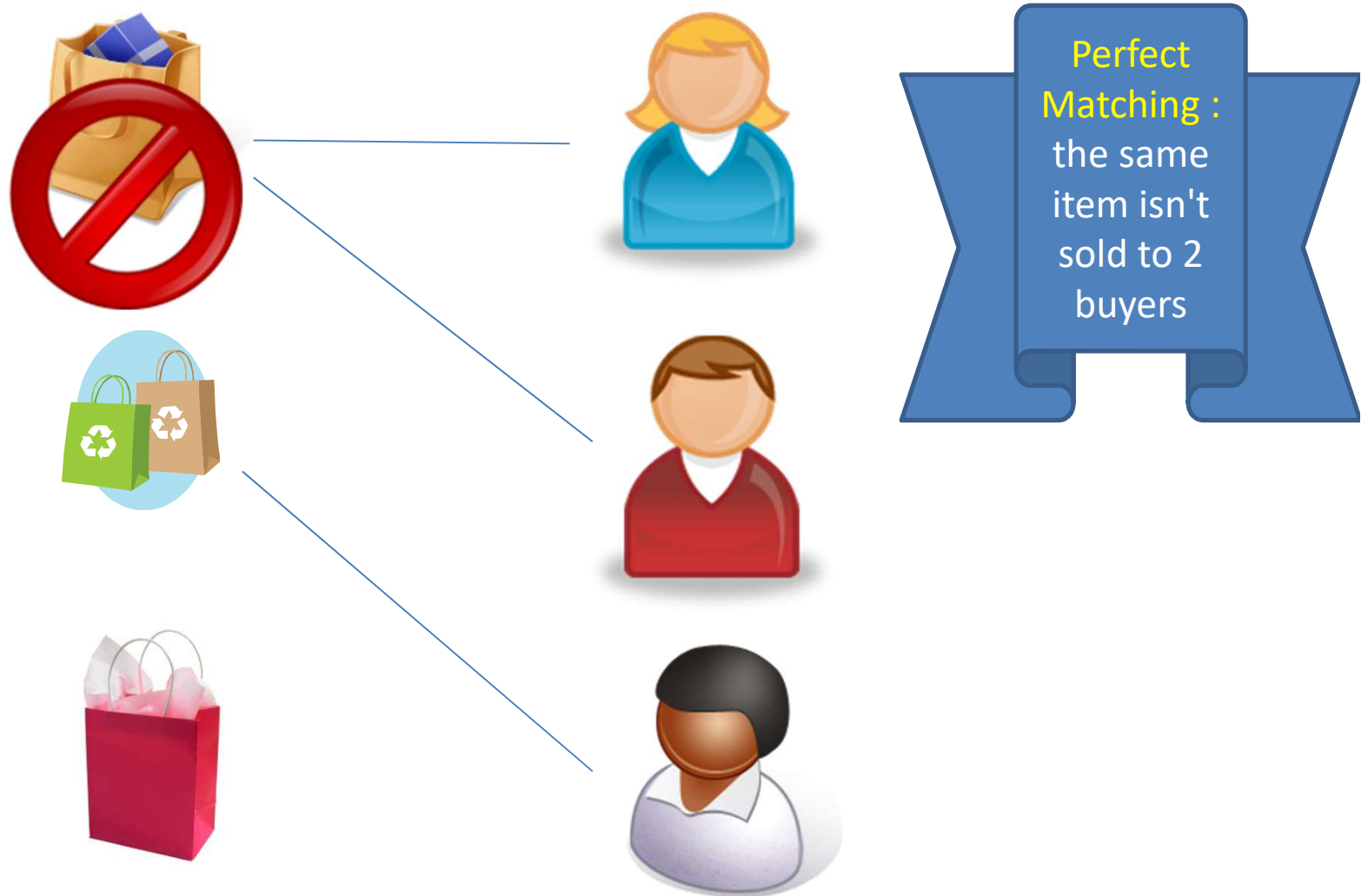


# Matching Market





# Matching Market





Google

keuka lake

[Advanced Search](#)  
[Preferences](#)

Customized based on recent search activity. [More details](#)  
about 381,000 for keuka lake [[definition](#)]. (0.19 seconds)

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[en.wikipedia.org/wiki/Keuka\\_Lake](https://en.wikipedia.org/wiki/Keuka_Lake) - 2k - [Cached](#) - [Note this](#)

[Seneca Lake \(New York\)](#)

The two main inlets are Catharine and Seneca Lake Outlet.

Slot i goes to  
Advertiser j

Valuation ( $v_{ij}$ ) =  
clickthrough rate ( $r_i$ ) x  
revenue per click ( $v_j$ )

Sponsored Links

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New York



# Market-clearing prices



$p_i$  = price  
announced  
by the  
seller



$v_{ij}$  =  
valuation  
for item  $i$   
by buyer  $j$

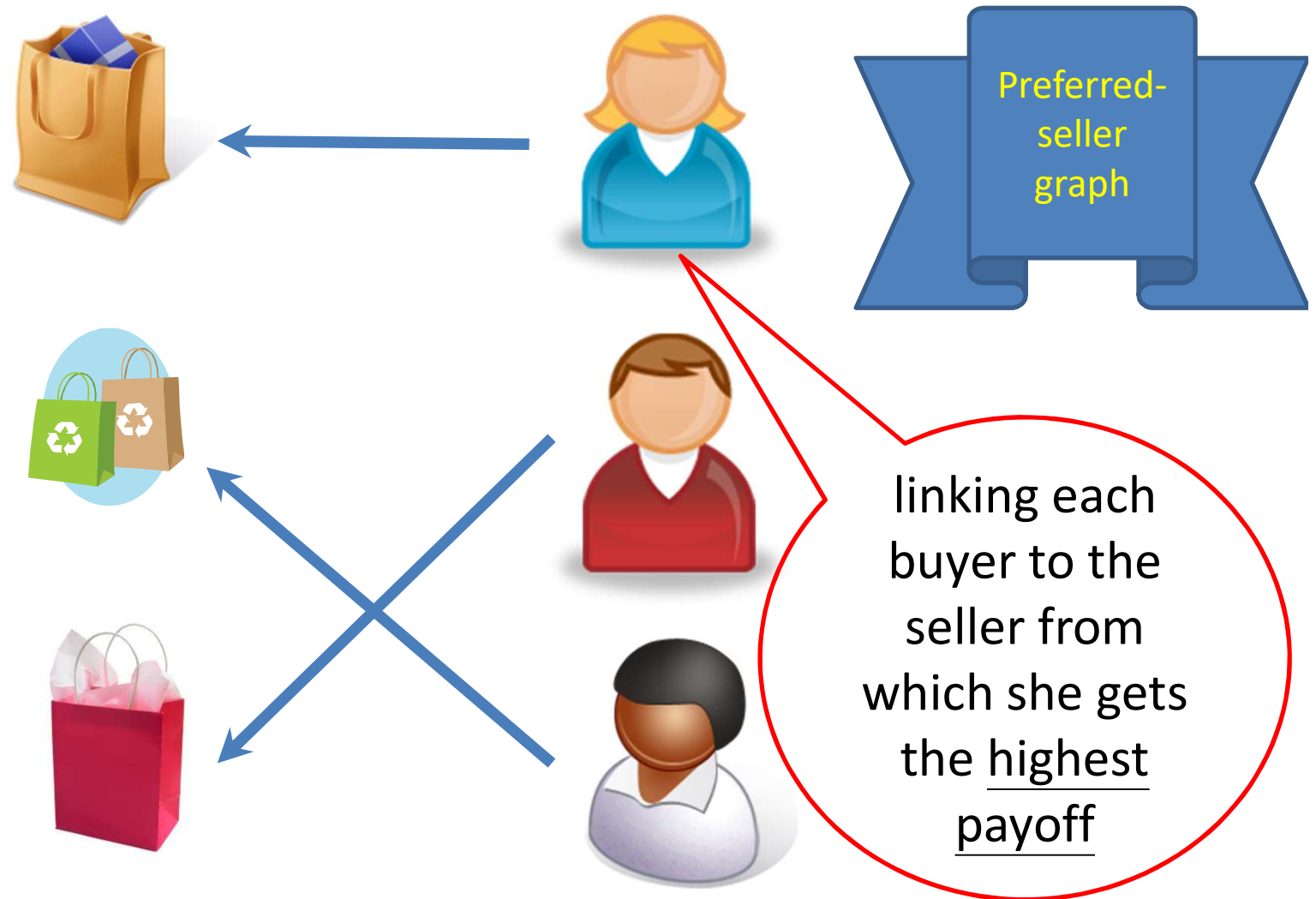


$v_{ij} - p_i$  =  
**payoff** of  
item  $i$  by  
buyer  $j$



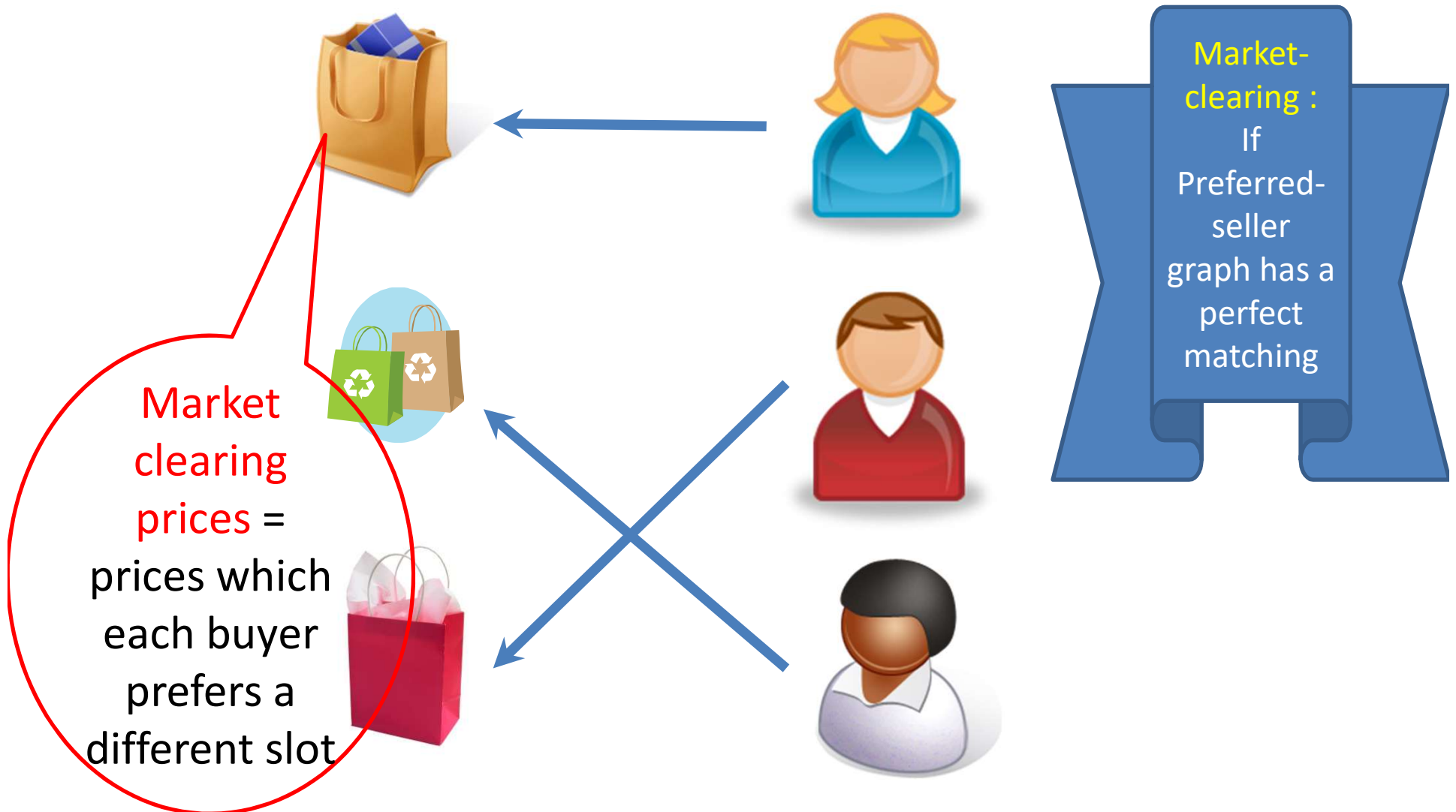


# Market-clearing prices





# Market-clearing prices






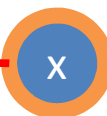


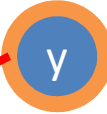

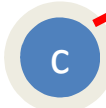
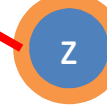



# Market-clearing

Prices	Sellers	Buyers	Valuation	Payoffs = Valuation - Prices
5	a	x	12, 4, 2	7, 2, 2
2	b	y	8, 7, 6	3, 5, 6
0	c	z	7, 5, 2	2, 3, 2



# Market-clearing

Prices	Sellers	Buyers	Valuation	Payoffs = Valuation - Prices
5			12, 4, 2	 7, 2, 2
2			8, 7, 6	3, 5, 
0			7, 5, 2	2,  , 2

Perfect Matching :  
Market Clearing

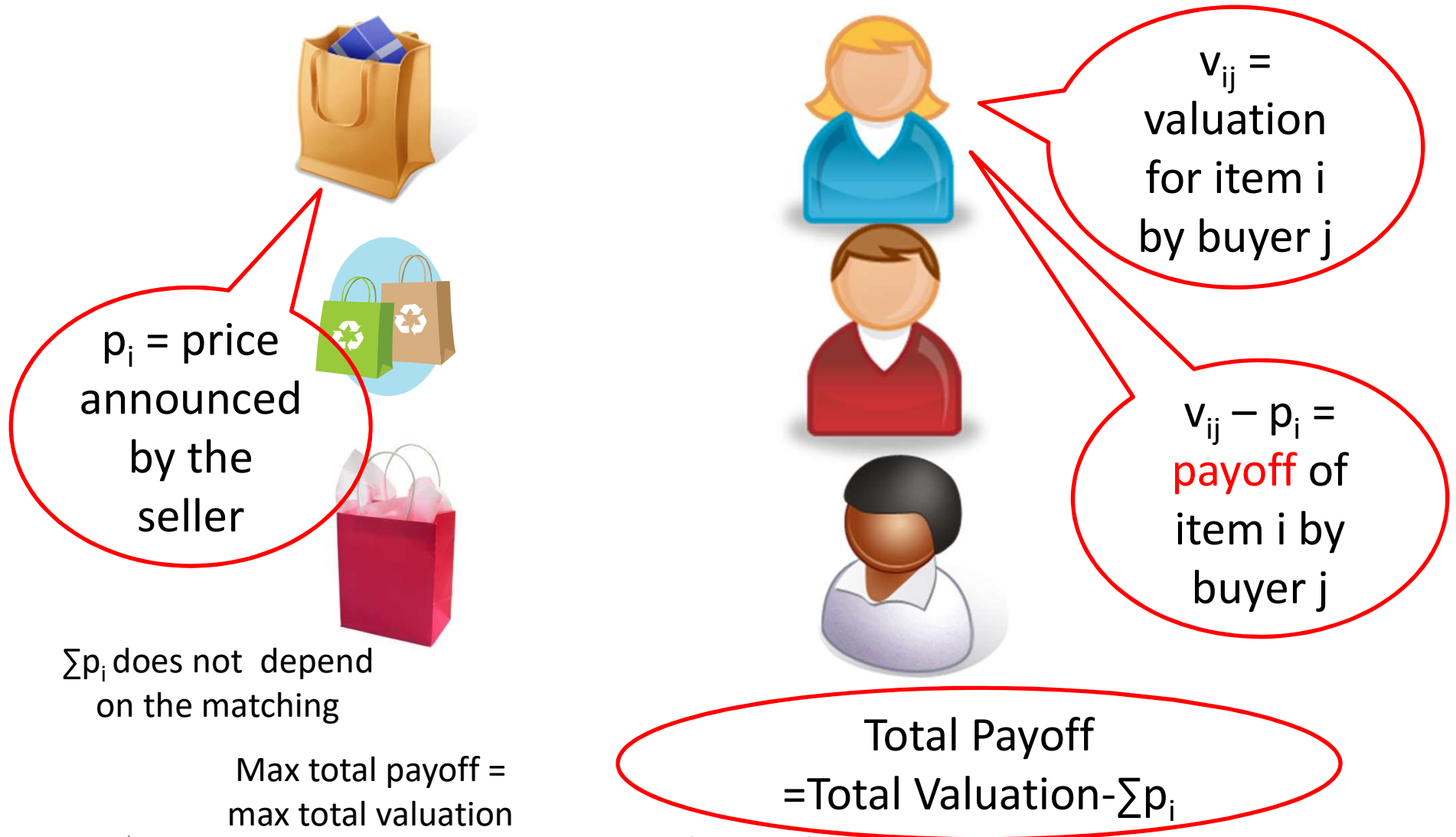


## What would happen if no perfect matching is found ?

- **Existence of Market-Clearing Prices :**
  - For any set of buyer valuations, there exists a set of market clearing prices



# Market-clearing prices






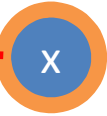

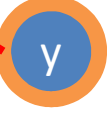

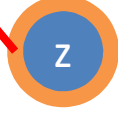
# Constructing the set of market clearing prices

- Initially, all selling prices are 0
- Find the set of sellers that the constricted buyers (buyers competing for some items) and raise the prices by 1 unit.
- Reduce the prices so that the smallest price is 0.





# Market-clearing

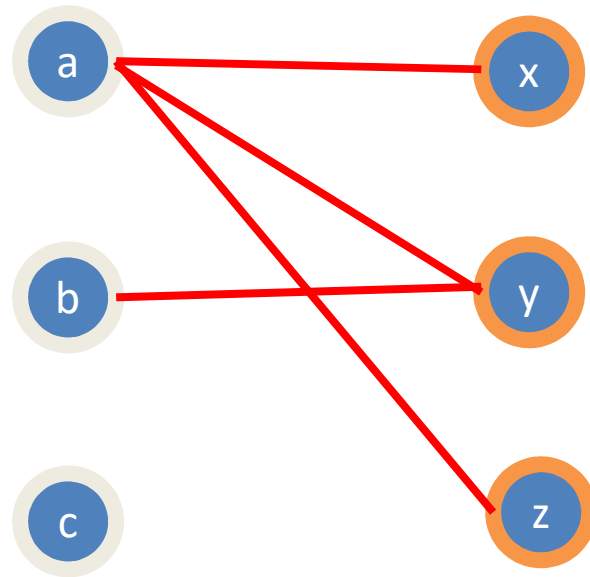
Prices	Sellers	Buyers	Valuation	Payoffs = Valuation - Prices
0			12, 4, 2	12, 4, 2
0			8, 7, 6	8, 7, 6
0			7, 5, 2	7, 5, 2






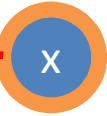



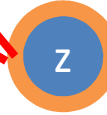
# Market-clearing

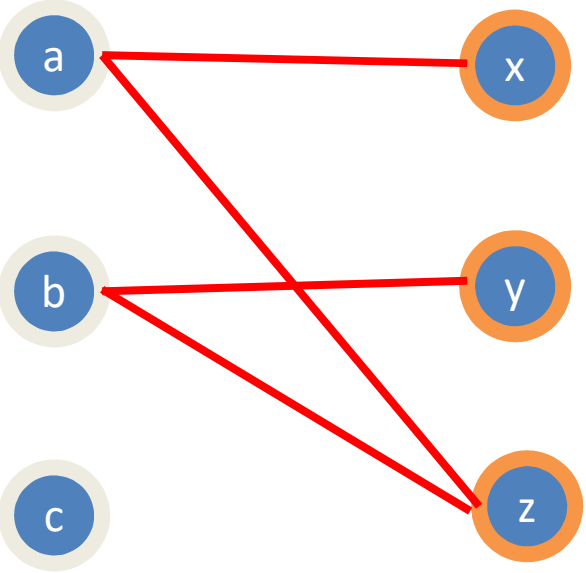
Prices	Sellers	Buyers	Valuation	Payoffs = Valuation - Prices
10	a	x	12, 4, 2	11, 4, 2
0	b	y	8, 7, 6	7, 7, 6
0	c	z	7, 5, 2	6, 5, 2





# Market-clearing

Prices	Sellers	Buyers	Valuation	Payoffs = Valuation - Prices
2, 1			12, 4, 2	10, 4, 2
0			8, 7, 6	6, 7, 6
0			7, 5, 2	5, 5, 2





# Market-clearing





clickthrough

rates

Slots

10

a

5

b

2

c

Given the  
clickthrough  
rates

Revenues per  
click

Advertisers

x

3

y

2

z

1

Given the  
revenues



clickthrough rates	Slots	Advertisers	Revenues per click	valuation
10			3	$3 \times (10, 5, 2) = 30, 15, 6$
5			2	$2 \times (10, 5, 2) = 20, 10, 4$
2			1	$1 \times (10, 5, 2) = 10, 5, 2$

Find the valuation



# Evaluation of payoff $v_{ij} - p_i$

Prices	Slots	Advertisers	valuation	payoff
13	a	x	30,15,6	17,12,6
3	b	y	20,10,4	7,7,4
0	c	z	10,5,2	-3,2,2

Prices set by  
the publisher

Find the  
payoff



# Linking buyer to the seller(s) from which gets the highest payoff

Prices	Slots	Advertisers	payoff
13	a	x	17, 12, 6
3	b	y	7, 7, 4
0	c	z	-3, 2, 2

Use the payoff to do the matching





- Search engine does not know the advertiser's valuation !!