

# Sponsored Search Ad Selection by Keyword Structure Analysis

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# Outline

- Introduction
- Data Study
- Proposed Method
- Evaluation and Analysis
- Conclusion and Future Work

# Sponsored Search



17,100,000 RESULTS

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Read actual customer reviews and ratings on **tablets** and **tablet** PCs. Find low prices on a wide selection of **tablets**.

← Query from User

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everbuying.com is rated ★★★★★ on ResellerRatings (1019 reviews)

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↖ Sponsored Search Results

← Organic Search Results

# Sponsored Search System



Query

Making Ad Selection



Advertiser

Bid

Estimate Click Probabilities (Estimated CTR) for Each Ad

Group of Candidate Ads

Get Bid Prize for Each Ad from the Advertisers' Bid



Rank the Ads According to Estimated CTR × Bid Price

**Main Target for Sponsored Search is to Earn Money**

When there is an ad click

Advertiser will pay the search engine money according to the generalized second price auction



# Bid Keyword in Sponsored Search

**Bid Keyword:** Short phrases from advertisers

**Ad:** Ad contains several parts, including ad title, ad copy, display url etc..

Example for Bid Keyword and Ad	
Bid Keyword	used Toyota Camry 2005
Ad Title	2005 Toyota for Sale
Ad Copy	Find a Toyota Near You. Compare 2005 Models Now!
Display url	www.AutoTrader.com/Toyota



**Advertiser**

**A keyword can directly map to a group of ads, therefore our work focuses on the selection of bid keywords.**

# Monetization Ability Should be Optimized

- ❑ Existing works focused on improving relevance
- ❑ High relevance doesn't necessarily leads to high revenue
- ❑ **We should also optimize the monetization ability**

## Existing Works:

- [1] J. Feng et. al. Implementing sponsored search in web search engines: Computational evaluation of alternative mechanisms. IN-FORMS J. on Computing, Jan. 2007.
- [2] A. Fuxman et. al. Using the wisdom of the crowds for keyword generation. WWW '08
- [3] A. Z. Broder et. al. Search advertising using web relevance feedback. CIKM '08
- [4] A. Broder et. al. Online expansion of rare queries for sponsored search. WWW '09
- [5] Y. Choi et. al. Using landing pages for sponsored search ad selection. WWW '10
- [6] D. Hillard, et.al. Improving ad relevance in sponsored search. WSDM '10

# Overview of Our Work

## **Data Study**

**Find that entities and modifiers inside the bid keywords have different impacts on the relevance and monetization ability**

## **Our Ad Selection Methods**

**Make Ad Selection Based on Components: Select and Optimize on Component Basis and then Make Combination**

## **Evaluation**

**Evaluate the Proposed Methods on Both Relevance and Monetization Ability Metrics**

# Data Study: Decompose the Text Streams

**Entity Recognition : well studied in the literatures. Our work's method is similar to [1]:**

- ❑ **A pre-defined over 30K entity list**
- ❑ **Updatable with many specialized methods**
- ❑ **Remaining parts are regarded as modifiers**

Table: Example for Decomposing the Text Streams

	<b>Query</b>	<b>Bid Keyword</b>
<b>Text Stream</b>	Toyota sedan review 2005	used Toyota Camry 2005
<b>Entities</b>	Toyota sedan	Toyota Camry
<b>Modifiers</b>	review, 2005	used, 2005

[1]X. Yin and S. Shah. Building taxonomy of web search intents for name entity queries. In Proceedings of the 19th international conference on World wide web, WWW '10, pages 1001–1010, 2010.



# Data Study: Methods

Our method is to compare the mean value among the entity (modifier) groups. If the entities (modifiers) have impacts on the tested variable (CTR or revenue), there should be significant differences among the group mean values.

- ❑ Extract 0.9 million unique keywords covering two months records
- ❑ Calculate the historical average CTR and historical revenue for each keyword
- ❑ Decompose the keywords and get 7400 unique entities / 2300 unique modifiers
- ❑ Compare the mean value of CTR/revenue of the 7400 entity groups and 2300 modifier groups respectively
  - ✓ ANOVA test: Do all the groups have same mean value of CTR/revenue?
  - ✓ Tukey's HSD test: How many groups have significantly different mean value?

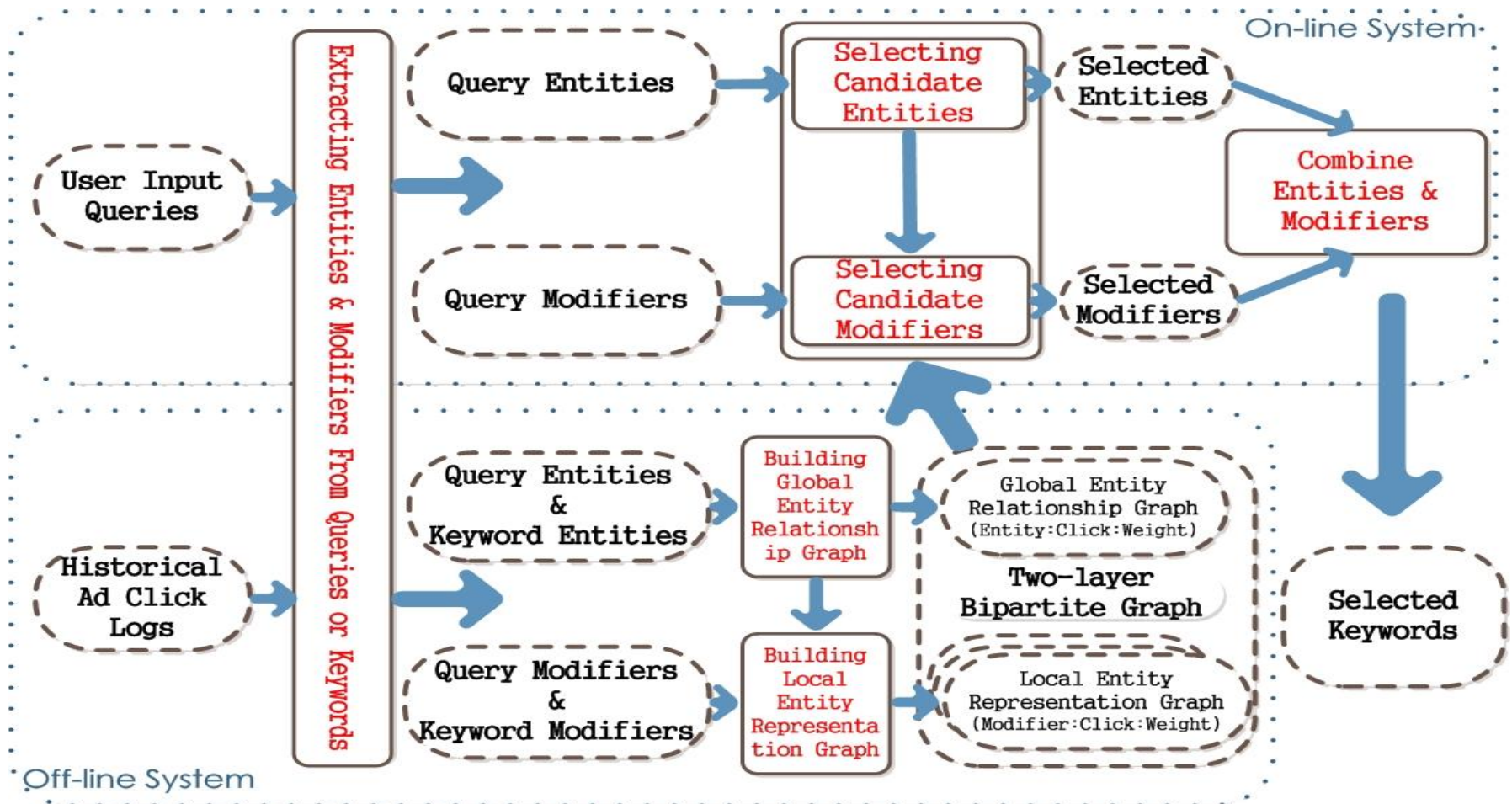
# Data Study: The Impacts on Relevance and Monetization Ability

- ❑ Both entities and modifiers have impacts on sponsored search effectiveness
- ❑ Entities play an important role on both relevance and monetization ability
- ❑ Modifiers only have impacts on relevance

Table: Top 5 Entities and Modifiers with Best Distinguish Ability on CTR and Revenue

Entity	GNum	CTR	Modifier	GNum	CTR	Entity	GNum	Revenue
iTunes	7341	1.69	chase	2262	0.5	online college	7339	43085
HSBC	7341	1.62	speck	2251	0.58	state farm	7326	33018
green dot	7341	1.79	download	1728	0.35	flower dlivery	7324	30910
P&G	7340	1.55	login	615	0.28	auto insurance	7323	26720
Citibank	7339	1.17	pay	477	0.25	home secure	7317	27187

# Proposed Ad Selection Method

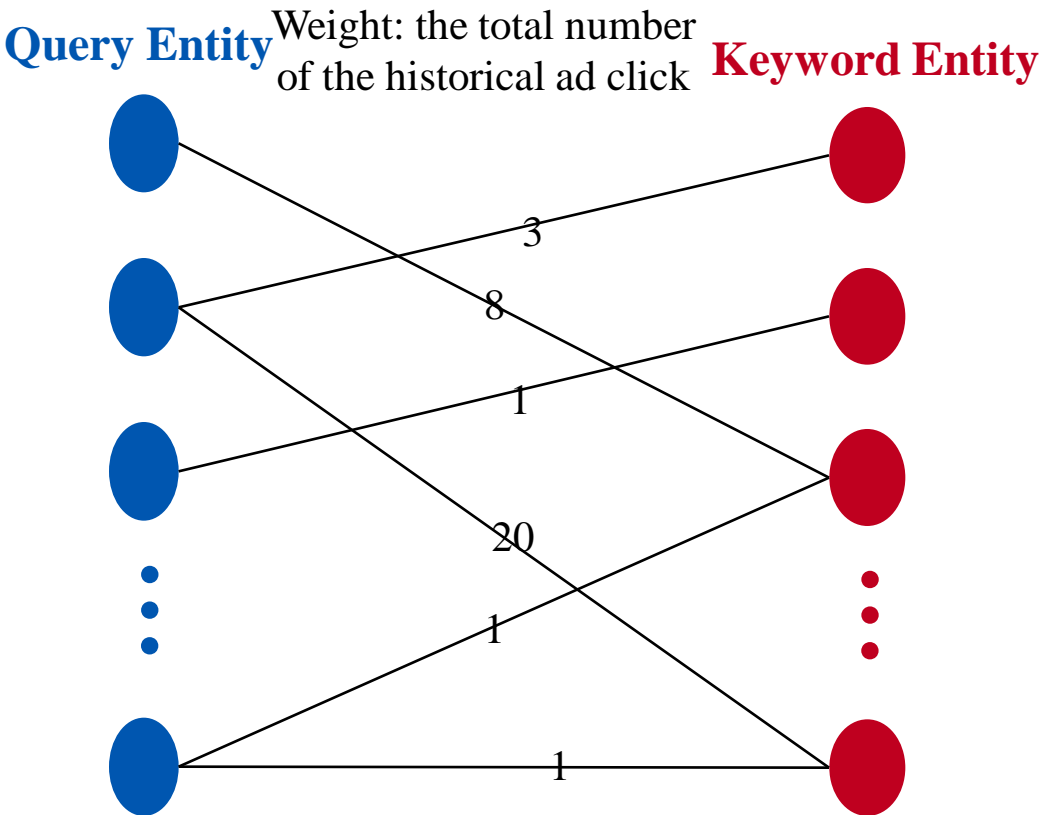


- ❑ Mine entities and modifiers separately and then make combination
- ❑ Optimize relevance and monetization ability separately on component level
- ❑ There are two parts: Off-line knowledge base and on-line selection system

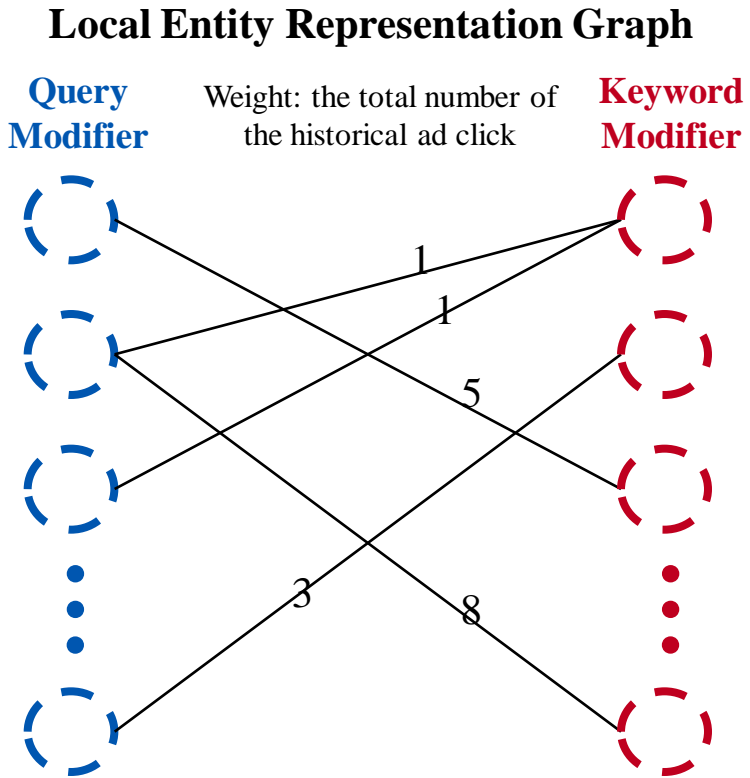
# Off-line Knowledge Base for Entity Relationship

## Two-layer Bipartite Graph

### Global Entity Relationship Graph



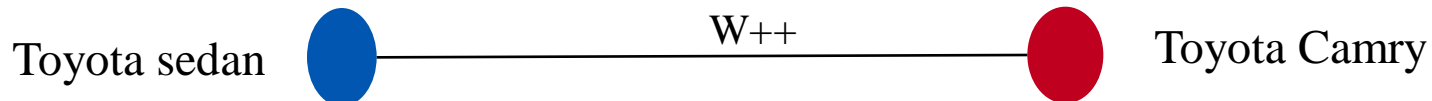
### Beneath Each Entity in the Global Graph:



# Off-line Knowledge Base for Entity Relationship

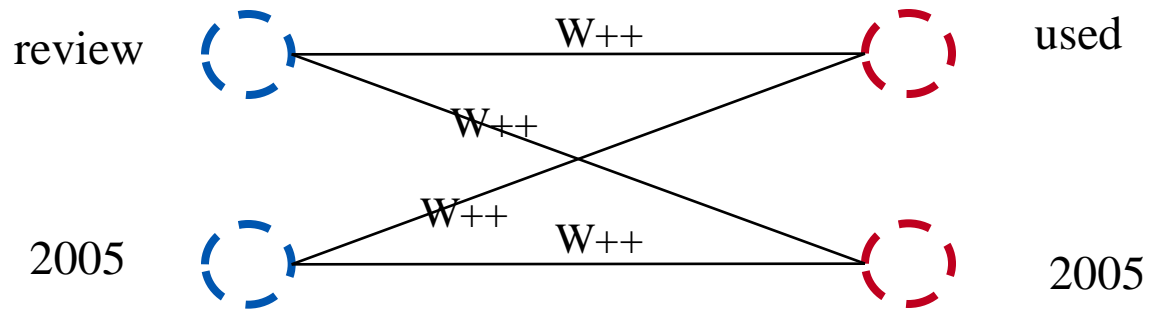
	Query	Bid Keyword
<b>Text Stream</b>	Toyota sedan review 2005	used Toyota Camry 2005
<b>Entities</b>	Toyota sedan	Toyota Camry
<b>Modifiers</b>	review, 2005	used, 2005

## Building Global Entity Relationship Graph



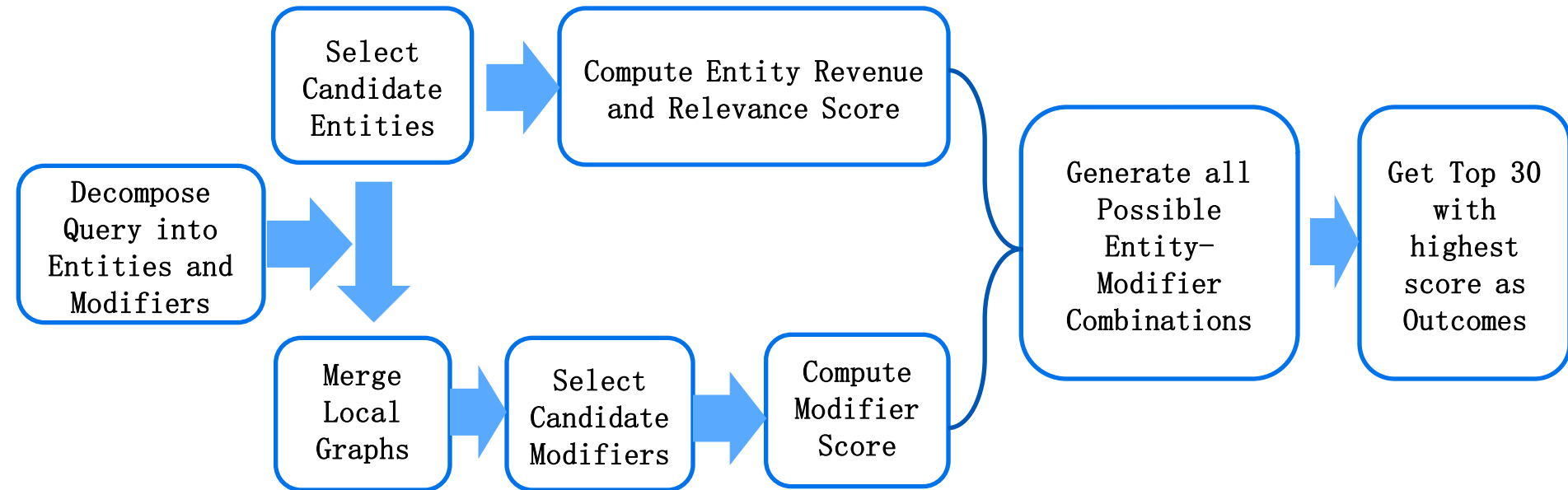
## Building Local Entity Representation Graph

In the representation graphs of entities 'Toyota sedan' and 'Toyota Camry'



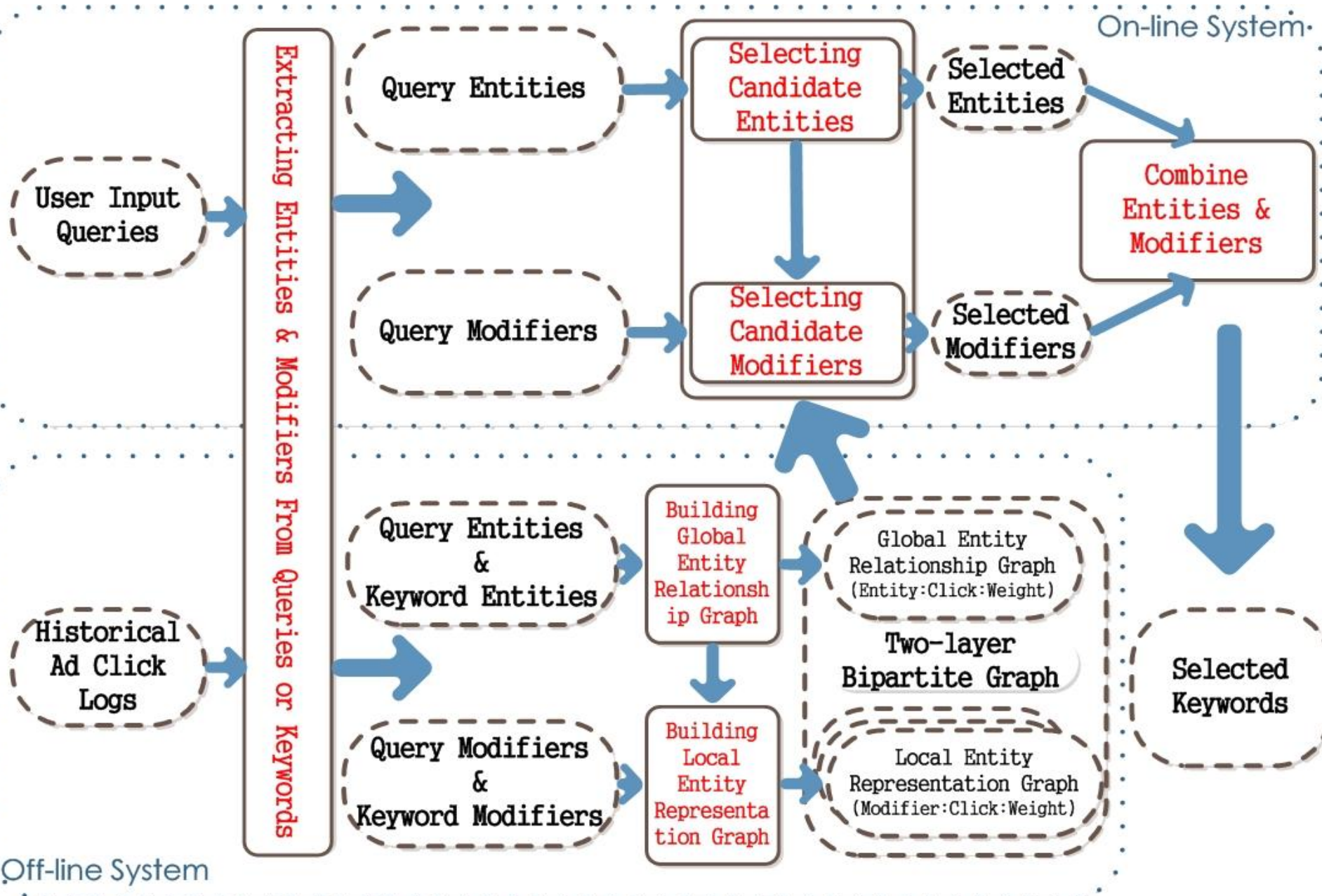
# On-line Ad Selection

- ❑ Decompose the input query into entities and modifiers
- ❑ Select candidate keyword entities
- ❑ Compute entity score = revenue score  $\times$  relevance score
- ❑ Select candidate keyword modifiers and compute the scores
- ❑ Generate all possible entity-modifier combinations
- ❑ Return keywords with highest score (entity score + modifier score)





# Summary for Proposed Ad Selection System



# Experiment Settings

## Dataset and Tested Methods

Dataset	Unique Query	Unique Keyword	Pairs/Records	Duration
Knowledge Base	1.5M	5.1M	3.5M Pairs	2 months
Evaluation	22.5K	12K	400K Records	3 days

Tested Methods	Description
Tf-Idf with Query Expansion	Baseline: Tf-Idf with query expansion using top 10 snippets from the organic search results
Random Walk with Restart	Baseline: Random Walk with Restart[1]
OnlyEntity (abbreviated as OE)	Proposed Method: employ the entity expansion results and match the keywords with only entities
EntityWithModifier (abbreviated as EWM)	Proposed Method: take advantages of the modifiers and match keywords with entity-modifier combinations

[1] I. Antonellis, H. G. Molina, and C. C. Chang. Simrank++: query rewriting through link analysis of the click graph. Proc. VLDB Endow., 1(1):408–421, Aug. 2008.



# Evaluation on Relevance: The Recall Rate

- ❑ Select ‘correct’ keywords, which have triggered ad clicks in the log , within small set size is quite important
- ❑ Without triggered ad clicks in the log does not indicate the selected keywords are ‘incorrect’
- ❑ Recall Rate of OE and EWM are both significantly higher than those of the two baselines on top 30 keywords at 0.01 level

Table: Recall Rate in Different Positions

Position	OE	EWM	Tf-Idf	Random Walk
10	48.44%	<b>59.71%</b>	57.44%	58.94%
15	53.79%	<b>65.13%</b>	62.60%	59.71%
20	57.11%	<b>68.86%</b>	66.33%	60.14%
25	60.13%	<b>72.11%</b>	69.01%	60.49%
30	62.25%	<b>74.24%</b>	71.60%	60.68%

# Evaluation on Relevance: The Precision Rate

- ❑ Evaluate the precision rate with manual judgment of the query-keyword pairs
- ❑ The evaluators give a score for each query-keyword pair from 1-5, means cannot judge, irrelevant, weak relevant, relevant, and strong relevant respectively
- ❑ In total 1600 query-keyword pairs are judged
- ❑ EWM can outperform 2 baselines by 8.4% and 0.9% respectively at a 0.05 significance level

Table: Precision Rate on Manually Labeled Results

Label	OE	EWM	Tf-Idf	Random Walk
Relevant (3-5)	76.87%	<b>79.50%</b>	71.11%	78.59%
Irrelevant (2)	23.13%	<b>20.50%</b>	28.89%	21.41%

# Evaluation on Monetization Ability

- ❑ A simulation system, which can conduct simulating auctions and get the collection of winner ads to be displayed, is employed to evaluate the monetization ability
- ❑ The sum of the cost per click (CPC, the amount of money the search engine would get if the ad was clicked) of the top n returned ads is used as metrics
- ❑ EWM outperforms all the other algorithms by about 5% units at all positions

Table: Simulation Results on Revenue

Position	OE	EWM	Tf-Idf	Random Walk
1	230.76	<b>267.17</b>	255.03	257.23
5	207.69	<b>243.32</b>	237.03	228.24
10	190.23	<b>225.9</b>	219.03	204.87
15	178.15	<b>213.66</b>	202.93	188.06
20	175.43	<b>204.06</b>	193.45	175.43
25	168.94	<b>196.24</b>	185.87	165.34
30	161.46	<b>189.62</b>	179.56	156.93

# Conclusion and Future Work

- We discovered the different impacts of different components inside the bid keywords, accordingly we tried to make ad selection on component level
- A novel ad selection methodology was proposed in which both relevance and monetization ability of keywords are considered
- For the future work, we would like to take the interests of advertisers, like conversion rate, into consideration in our ad selection algorithm

Thank You  
~Any Questions~