Enhancing comparison shopping agents through ordering and gradual information disclosure

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Team – Dishonest Agents

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Overview

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- Aim of this Paper
- Existing Model and Market Overview
- Belief-Adjustment Method and Algorithm
- Experimental Setup and Design
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Introduction

- Comparison Shopping Agents (CSAs)
  - Interface for locating, collecting and presenting price related data
  - Compare many online store prices
  - Save time and money
- How CSA earns revenue?
  - Commercial relationship with seller
  - Fixed payment when consumer referred to seller's website
  - Influence buyer to avoid querying other CSA, improve expected revenue
- Challenge of CSA
  - Competition on price information provided by other CSA
  - Collect as many prices to exhaust the potential of finding a more appealing price
  - **Influence buyer's expectation regarding the prices by disclosing subset of prices**
- Shoppingbots.info (2014) – 350 different online CSAs

Related Works

- Work in Behavioral Science explains how positioning different items in different order helps in influencing buyer's mindset
- Buyer's beliefs can be influenced with prices to encounter by disclosing a subset of prices – Selective Price Disclosure
- Influence of CSAs on retailers and consumer's behaviour
- Cost of obtaining information by CSA
- Buyer's decision making process is affected by time
- Specific use of colours in websites can affect buyer's choices
- Interesting – If prices are arranged in descending order, buyer's are willing to pay more for a product than when they are arranged in ascending order

Aim of this Paper

- Influence buyer's tendency to query additional CSAs
- Cognitive biases - Psychological based
- Two aspects –
  1. Gradual representation of data
     - non-negligible constant time interval or delay **(timing)**
     - versus presenting all the prices at once after the query
     - Kayak.com, momondo.com – real time querying setup, non intentional
  2. Intelligent sequencing of prices in buyer's display
- No extra resources needed – communication or complex computation
- Evaluated each component individually
- Encouraging results

Existing Model and Market Overview

- Assumptions –
  - Numerous sellers
  - Buyers use several available CSAs
  - Sellers set price exogenously, operate in parallel markets
  - CSA's are middle agents
  - CSA's are self interested fully rational agents
  - Maximise T**ermination Probability (buyer make immediate purchase)**

- What does the buyer decide?
  - Terminate price search process and purchase
  - Spend more time querying other CSAs or sellers

Belief-Adjustment Method

- Existing model
  - Prices sorted in ascending order (bulk)
  - PriceGrabber.com, Bizrate.com, Shopper.com
- Use cognitive biases to increase overall Termination Probability (TP)
- Gradual disclosure with dynamic sequencing
  - Aim to guide the buyer to believe no point in further querying additional CSAs
- Result kept with CSA is sorted according to price
- Order in which price is displayed – **Presentation Order**
  - Anchor
  - Effort
  - Despair

Belief-Adjustment Method

- Anchor –

  - Present initial set of price
  - Create reference point
  - Influence buyer belief concerning price range of product
  - Based on anchoring-and-conservative-adjustment estimation method
  - Acceptability of other price depend on anchor - adjust away from anchor to get final answer
  - Best price not included in anchor – increases its attractiveness

- Effort –

  - Affect buyer's expectation of intricacies in finding best price
  - Impression that improvement would require extensive seller search
  - Even an extensive search outputs higher prices than reference point prices

Belief-Adjustment Method

- Despair –
  - Create impression
    - Querying other CSAs is worthless
    - Querying prices from other set of sellers does not yield better price
    - Set of low prices in Anchor and Effort is rare and unique
  - Belief regarding non attractiveness of further querying

Belief-Adjustment Method – Algorithm

Algorithm 1: Belief-Adjustment Method

Input: *sampledPrices* - Set of known prices, sorted in an ascending order
Output: *order* - An ordered vector of the prices

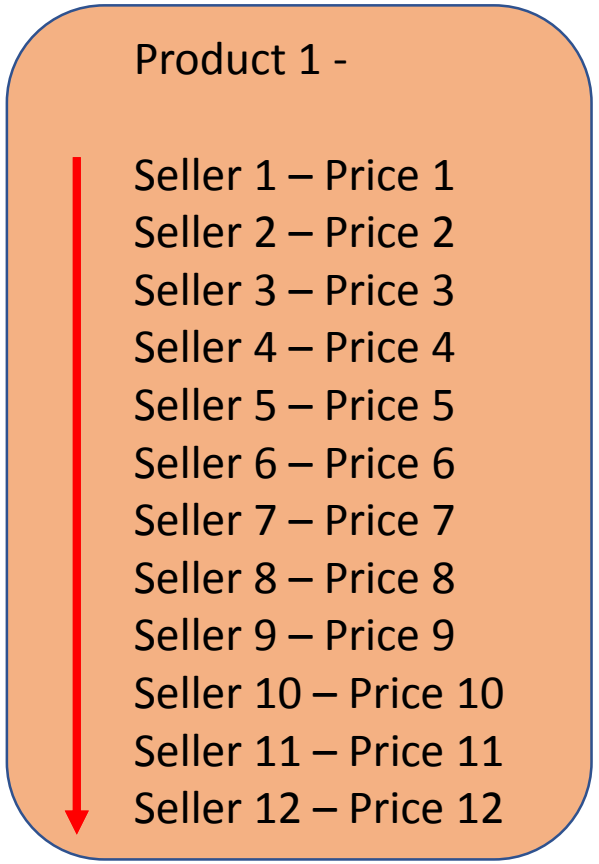
Divide *sampledPrices* into 12 equal subsets $\{sp_1, \ldots, sp_{12}\}$
$anchor \leftarrow \{sp_2, sp_3, sp_4\}$
$effortMin \leftarrow sp_1$
$effortMid \leftarrow \{sp_5, sp_6\}$
$despair \leftarrow \{sp_7, sp_8, sp_9, sp_{10}, sp_{11}, sp_{12}\}$
Phase I : Anchor
for $i \leftarrow 1$ *to* $|anchor|$ **do**
    Iterate between moving the minimal and the maximal price from *anchor* to the end of *order*.
Phase II : Effort
for $i \leftarrow 1$ *to* $|effortMin|$ **do**
    move two random prices from *effortMid* to the end of *order*.
    move a random price from *effortMin* to the end of *order*.
Phase III : Despair
move a random permutation of *despair* to the end of *order*
return *order*

Experimental Setup and Design

- AMT
- Difficulty of using real CSAs –
  - Reluctant to adopt new design and risk reputation
  - No incentive to disclose effectiveness and lose competitive edge
- Web based application of online CSA
- Use price of 5 products
- PriceGrabber.com, Nextag.com, Bizrate.com, Amazon.com

Experimental Setup and Design

Bulk Method



Belief-Adjustment Method

Experimental Setup and Design

- 266 participant – 76 (Bulk) + 104 (Belief-Adjustment) + 86 (Random-Sequential)
- Show up fee and Bonus
- Give up Bonus if new CSA has better best price

$$(\text{i.e. bonus} = \frac{60.9+\tilde{n}}{3600} * 4.8$$

- Alternative Bonus – Difference (Saving due to better price)
- Determine Termination Probability
- Bonus for random CSA = average between Bulk and Sequential

$$0.5 * (\frac{60.9}{3600} * 4.8 + \frac{60.9+10}{3600} * 4.8) = 9 \text{ cents}).$$

Results and Achieved Improvements

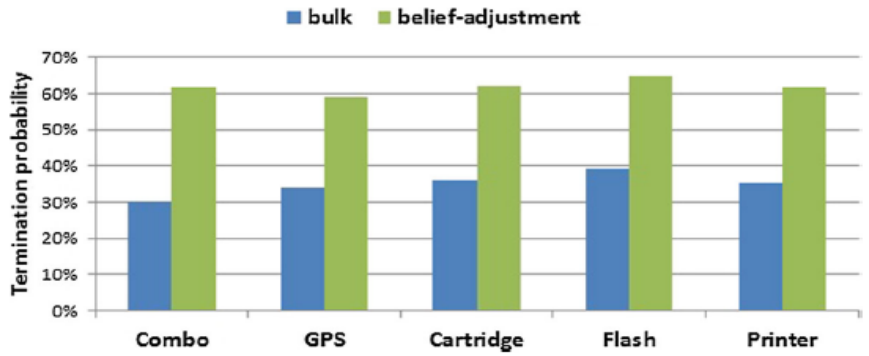


Fig. 2 Comparison of the termination probability with bulk versus belief-adjustment (Color figure online)

Belief-Adjustment >TP Bulk

Maximum Improvement - 97%

Average Improvement - 78.32% on 5 products

Presentation Type (PT) and Presentation Ordering (PO)

Bulk vs. Sequential (PT) & Random vs. Belief-Adjustment (PO)

Belief-Adjustment >TP Random-Sequential

Maximum Improvement – 37.8%

Average Improvement - 33.52% on 5 products

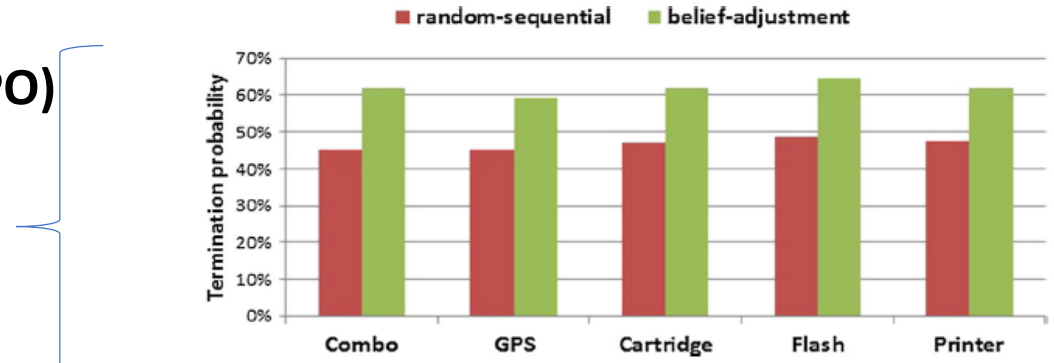


Fig. 3 Comparison of the termination probability with random–sequential versus belief-adjustment (Color figure online)

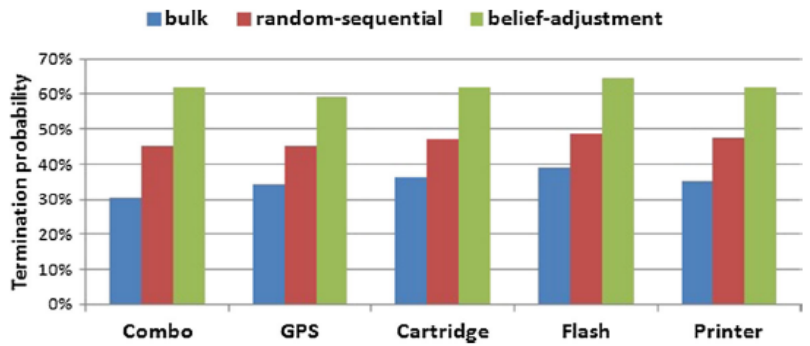


Fig. 4 Comparison of the termination probability, bulk versus random–sequential versus belief-adjustment (Color figure online)

Belief-Adjustment >TP Random-Sequential >TP Bulk

Sequential presentation is of some value

Intelligent ordering of prices account for most of achieved improvement

Results and Achieved Improvements

- Evaluate performance of phases separately (price of other phases presented randomly)
- 158 participants (85 for anchor, 73 for effort)

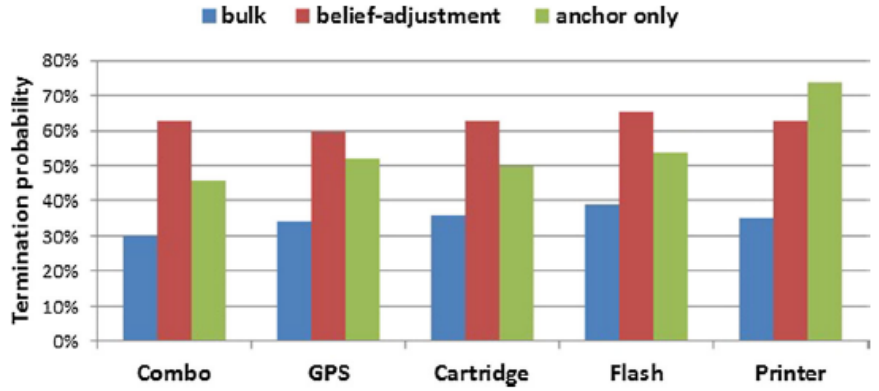


Fig. 5 Comparison of the termination probability, anchor versus belief-adjustment (Color figure online)

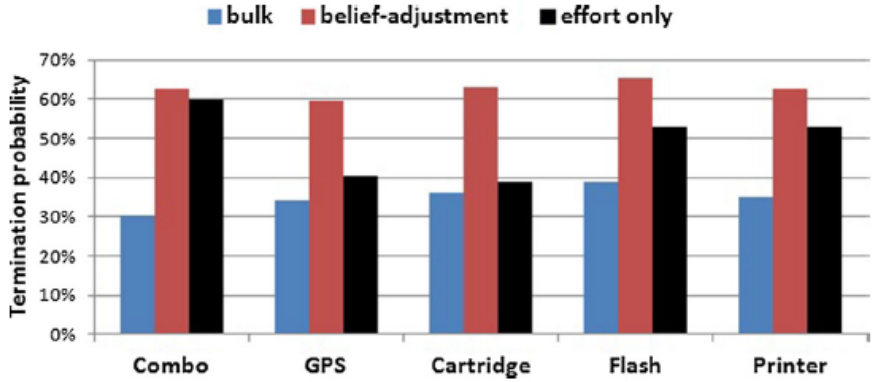


Fig. 6 Comparison of the termination probability, effort versus belief-adjustment (Color figure online)

Anchor (Algorithm 1), Effort, Despair (Random)

Anchor (Random), Effort (Algorithm 1), Despair (Random)

- Belief-Adjustment method is efficient when all 3 phases included

Controlling the Timing

- 2 experiments – Random timing and heuristics timing
- Overall duration *n* seconds, n = number of prices of given product

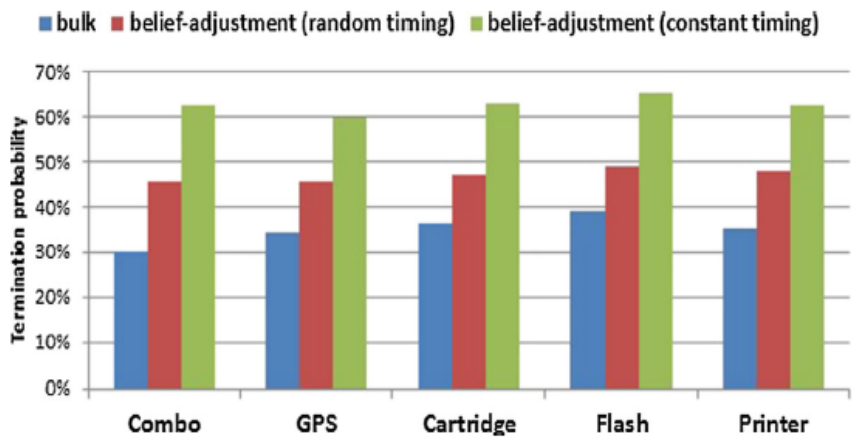


Fig. 7 Comparison of the termination probability, no delay versus belief-adjustment (random timing) versus belief-adjustment (constant timing) (Color figure online)

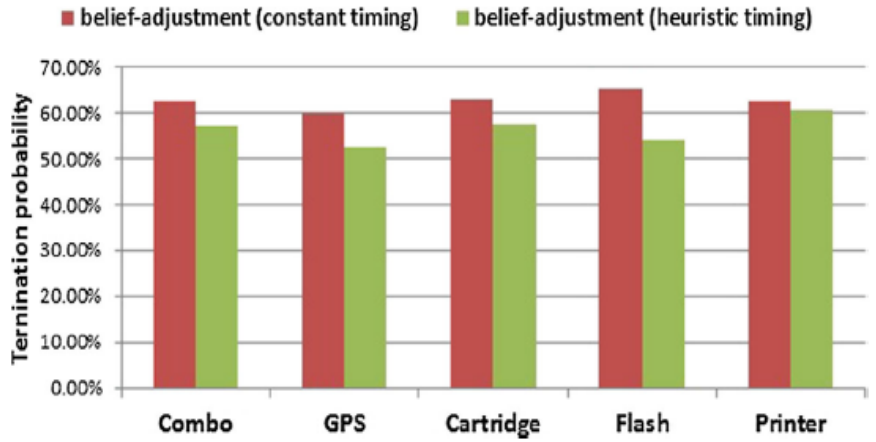


Fig. 8 Comparison of the termination probability, belief-adjustment (heuristic timing) versus belief-adjustment (constant timing) (Color figure online)

- Random value delay between 0.5 sec and 1.5 sec
- 60 participants
- Constant delay of 1 sec

- Constant timing $>_{TP}$ Random timing $>_{TP}$ Bulk

Intelligent variable timing method

Different constant timing for different phases

Anchor - 1 sec, Low Effort - 1.75 sec,
High Effort - 1 sec, Despair - 0.75 sec

Good initial impression, Concentrate on lower, Strengthen the effect of despair

Discussions

- Do not keep the buyer waiting
- Technological challenges to mine in-depth insights about ways prices are displayed
  - 100s of prices added in a tick
  - Spread over 10s of webpages
- Even if they are applying some method, it is very different from what has been proposed and tested in this paper

Table 2 The time at which the minimal price for different flight segments was found

From	To	Kayak			Momondo		
		Query time	T_lowest	Percentile (%)	Query time	T_lowest	Percentile (%)
London	NY	20	17	85	39	22	56
	Paris	15	14	93	55	7	13
	LA	18	12	67	30	5	17
	TLV	12	12	100	61	17	28
	Moscow	15	14	93	36	16	44
NY	Paris	15	12	80	54	24	44
	LA	17	3	18	44	27	61
	TLV	11	10	91	44	22	50
	Moscow	21	7	33	48	24	50
Paris	LA	19	11	58	26	19	73
	TLV	10	9	90	30	10	33
	Moscow	21	15	71	26	16	62
LA	TLV	19	12	63	60	17	28
	Moscow	19	18	95	46	18	39
TLV	Moscow	11	8	73	17	12	71

Percentile (%) From	To	Kayak Time	Momondo Time
0	10	0	0
10	20	1	2
20	30	0	2
30	40	1	2
40	50	0	2
50	60	1	3
60	70	2	2
70	80	2	2
80	90	2	0
90	100	6	0

Kayak.com presents best prices towards the **last stages of search**

Momondo.com present the best price **uniformly distributed over 10-80 percentile**

Conclusions

- Evaluate each method individually, emphasize importance of combining them
- Constant and heuristic timing more effective than random variable timing

- Various other implementation
  - Search based situation in physical domain
    - Example - Searcher looking for a car
  - Search based situation in virtual domain
    - Example - Looking for a partner in online dating site

- Extensions of the work
  - Present more than 1 price at each time step. How many?
  - Divide prices into groups on a ratio (# of prices CSA, specific buyer properties)
  - Options provided to the user by self interested entities

Our Conclusions

- Buyers buy well defined products by spending as little as possible
- Buyers do not make optimal decisions, affected by psychological properties
- Bulk method has TP around 30% - 40% for all products
- Belief-Adjustment method has TP around 60% for all products
- Random-Sequential method has better TP than Bulk method for all products
- Anchor only method and Effort only method individually has better TP than Bulk for all products
- Observation anomaly - Anchor only $>_{TP}$ Belief-Adjustment (for printer)
- Constant Timing of 1 second can be changed to see effect on TP
- Heuristic Timing is intuitive, we can change it to observe effects

Thank you

Questions?