Machine learning challenges in the real-world computational advertising

Bartłomiej Romański, PL in ML, 2018

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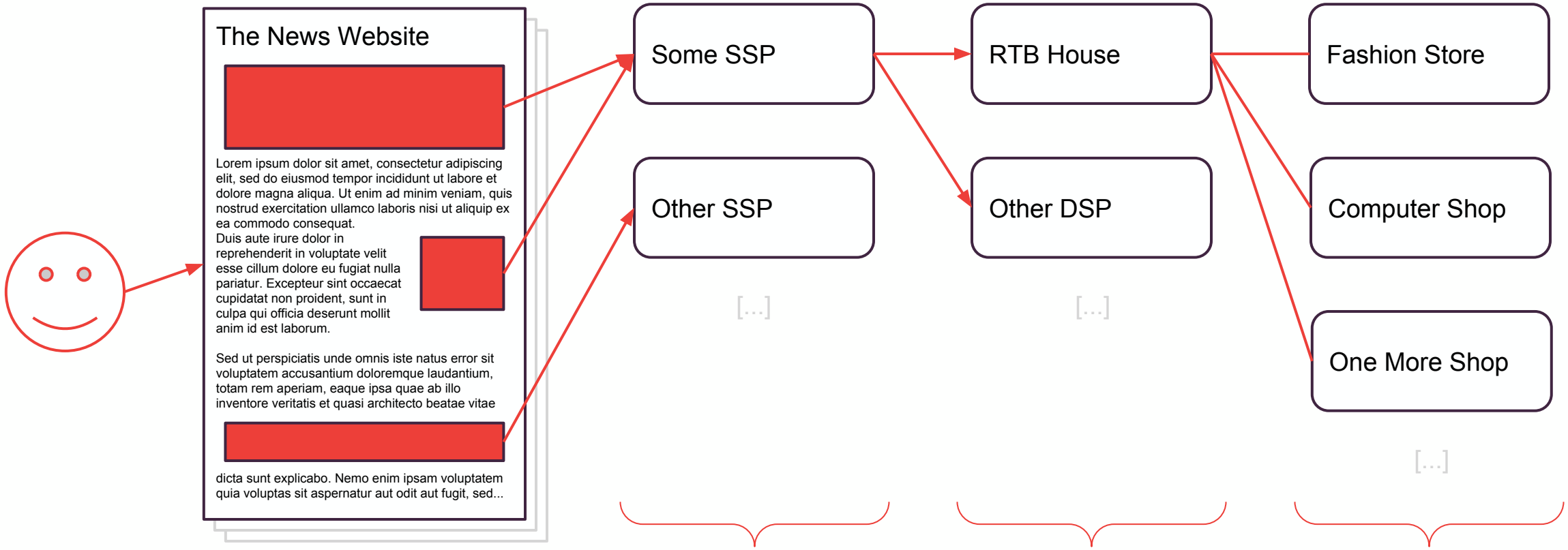
Agenda

- Real-Time Bidding
- Basic model
- Gotchas!

Real-Time Bidding



Retargeting

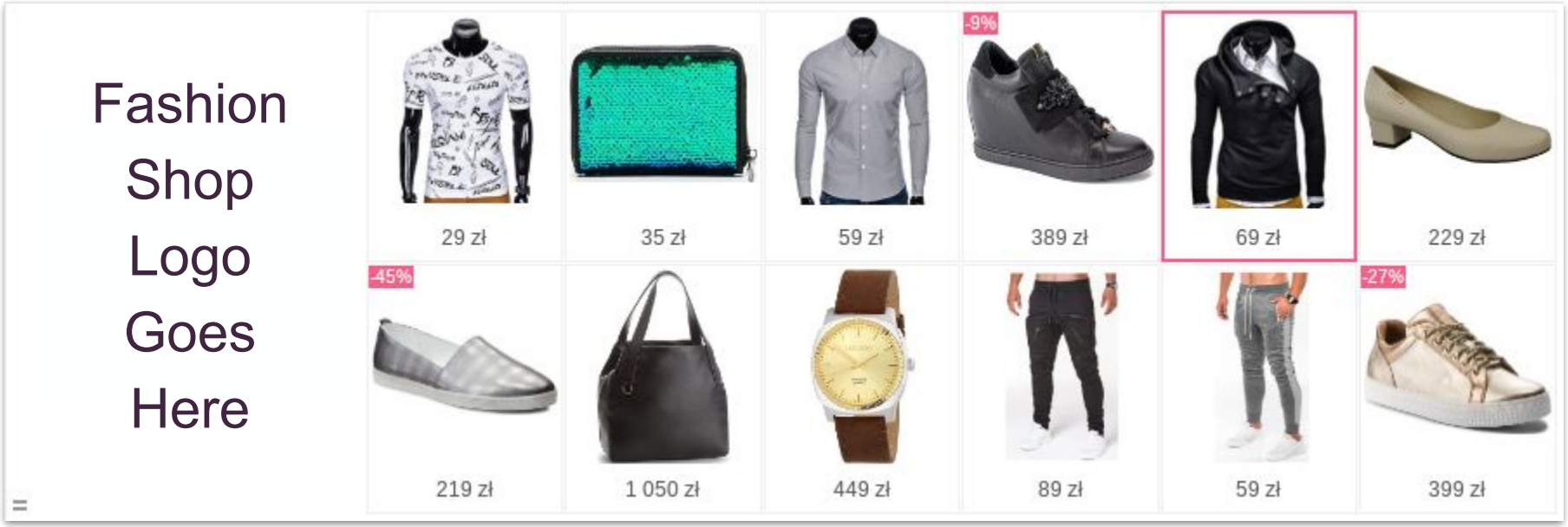
Advertiser

Publisher

Advertiser

Retargeting

Retargeting



Business model

- 5¢ per click
- 5$ per order
- 5% of order value

(And we pay for each impression.)

Data structure

- User’s previous interactions with the advertiser’s website
- Recent impressions and clicks
- Ad/bid context

Event types

Home

Product

Listing

Basket

Order

[..]

Basic model

$$bid = \alpha * CTR * CR * CV * 5\%$$

Basic model

$$bid = \alpha * CTR * CR * CV * 5\%$$

(**C**lick-**T**hrough **R**ate)

Basic model

$$bid = \alpha * CTR * \mathbf{CR} * CV * 5\%$$

(**C**onversion **R**ate)

Basic model

$$bid = \alpha * CTR * CR * \mathbf{CV} * 5\%$$

(**C**onversion **V**alue)

Basic model

$$bid = \alpha * CTR * CR * CV * \mathbf{5\%}$$

(**%** of order value)

Basic model

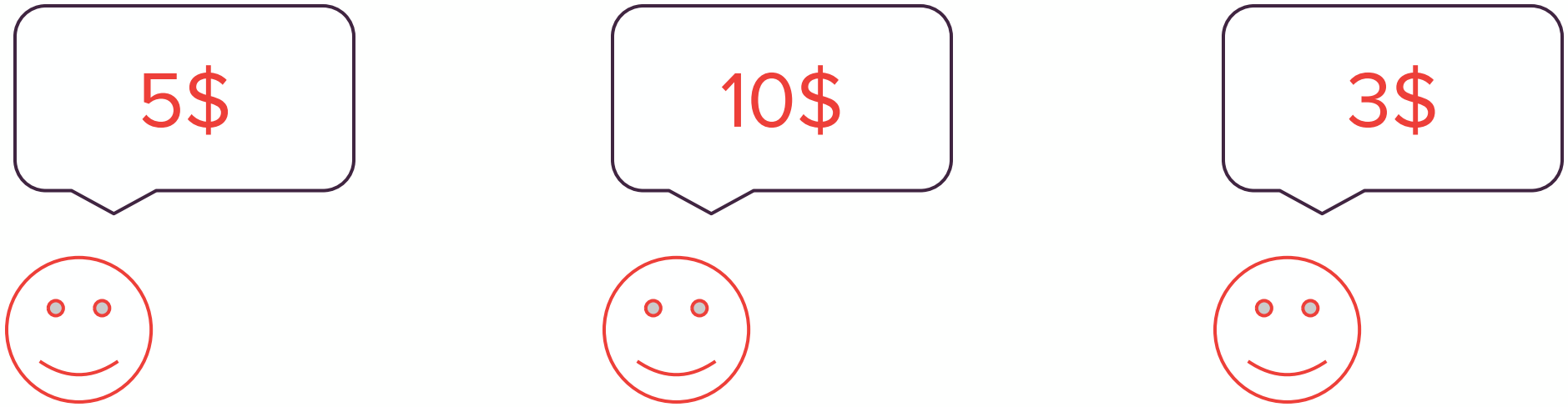
$$bid = \alpha * \underbrace{CTR * CR * CV * 5\%}_{\text{Estimated impression value}}$$

Basic model

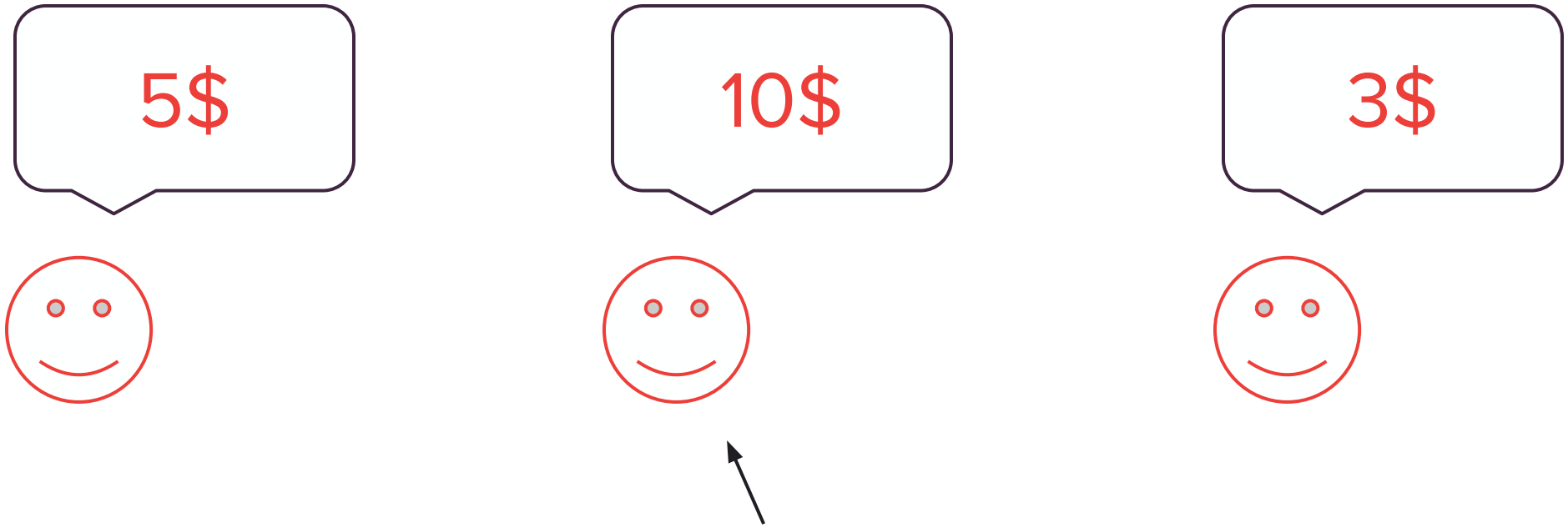
$$bid = \alpha * CTR * CR * CV * 5\%$$

(roughly: 1 - margin)

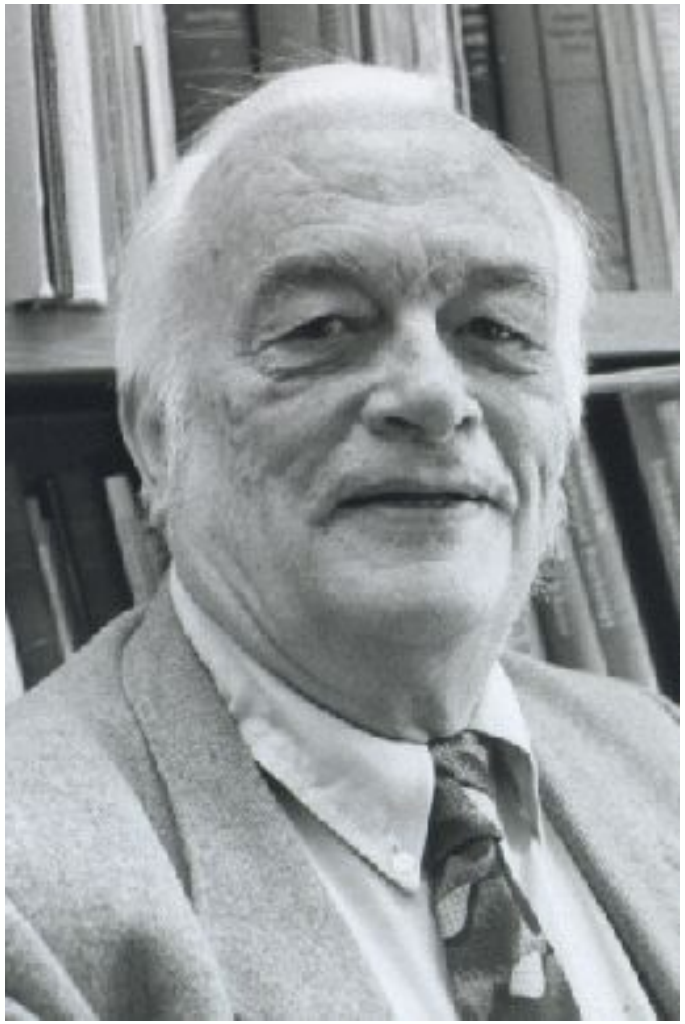
Second-price auctions



Second-price auctions

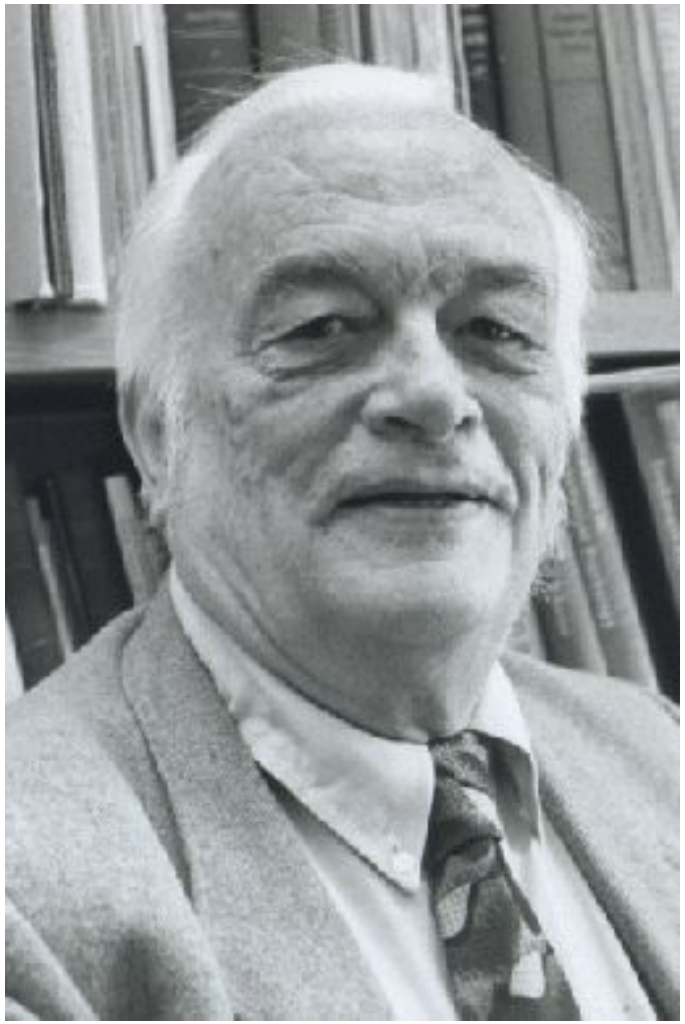


Wins! Pays 5$.



Truthful bidder is the best bidder

(Vickrey's theorem)



But...

1. We never know the real impression value. We just estimate...

news.com

2000 imps
60 clicks
3% CTR

bid = $0.03

sport.news.com

1000 imps
50 clicks
5% CTR

bid = $0.05

moto.news.com

1000 imps
10 clicks
1% CTR

bid = $0.01

sport.news.com

1000 imps
50 clicks
5% CTR

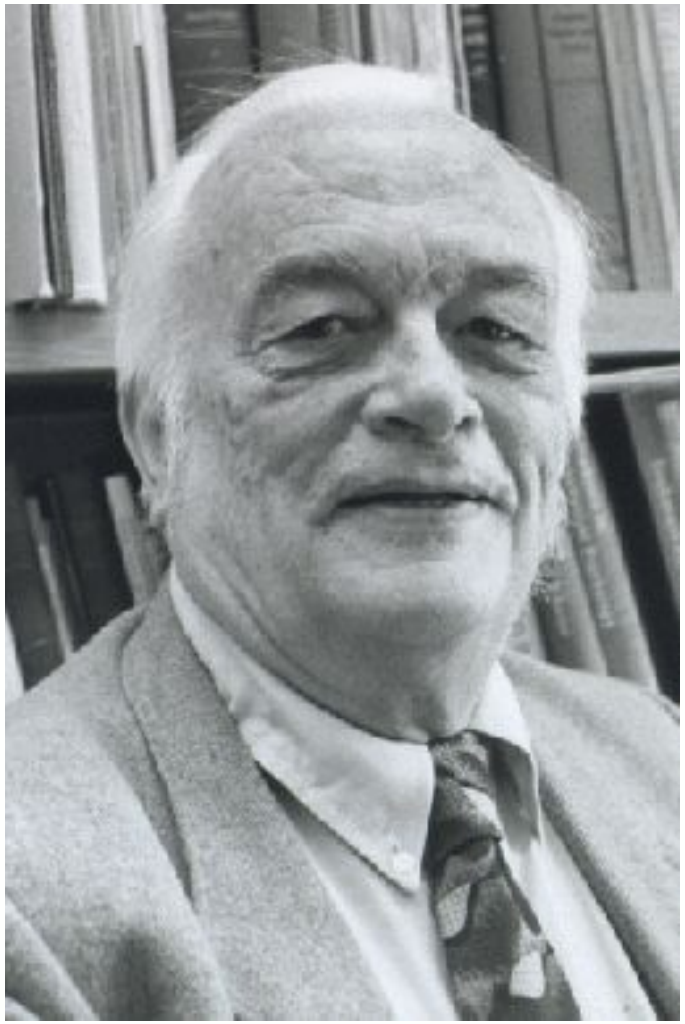
bid = $0.05

moto.news.com

1000 imps
10 clicks
1% CTR

bid = $0.01

(our bid = $0.03)



But...

2. There will be more auctions. We may buy later, cheaper...

Our profit
Our valuation
60
40
20
0
1st Auction
2nd Auction
3rd Auction
4th Auction
5th Auction
Competitor’s bid

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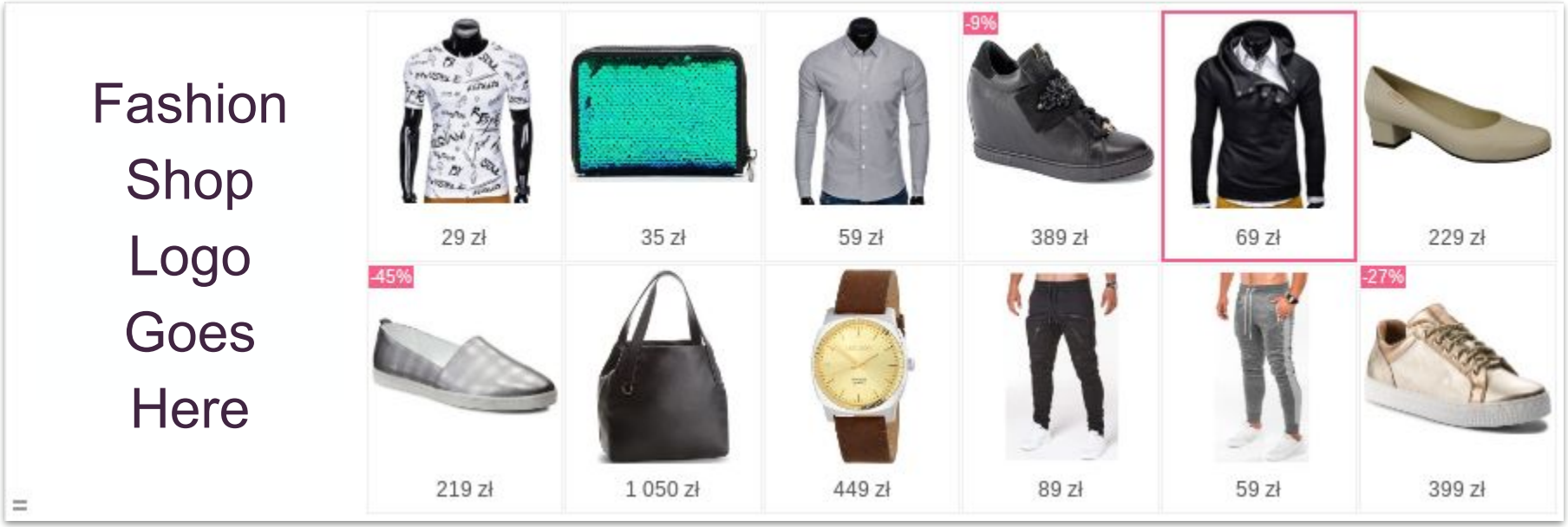
Choosers

Fashion
Shop
Logo
Goes
Here
-27%
-45%
449 zł
549 zł
400 zł
1 050 zł
59 zł
29 zł
-22%
89 zł
97 zł
99 zł
35 zł
59 zł
69 zł

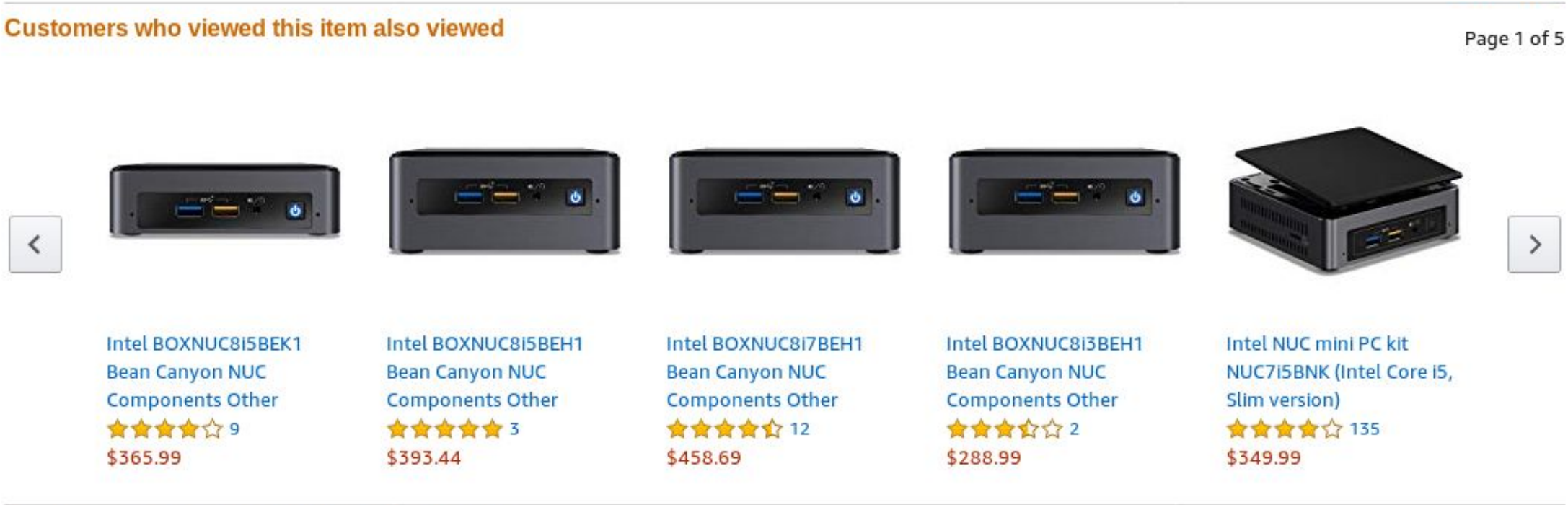
Choosers


Fashion
Shop
Logo
Goes
Here
29 zł
35 zł
59 zł
-9%
389 zł
69 zł
229 zł
-45%
219 zł
1 050 zł
449 zł
89 zł
59 zł
-27%
399 zł

Rule-based

```
TwoLastSeenRestSimilarChooser
```

Item-to-item


Customers who viewed this item also viewed
Page 1 of 5
Intel BOXNUC8i5BEK1 Bean Canyon NUC Components Other
9
$365.99
Intel BOXNUC8i5BEH1 Bean Canyon NUC Components Other
3
$393.44
Intel BOXNUC8i7BEH1 Bean Canyon NUC Components Other
12
$458.69
Intel BOXNUC8i3BEH1 Bean Canyon NUC Components Other
2
$288.99
Intel NUC mini PC kit NUC7i5BNK (Intel Core i5, Slim version)
135
$349.99

	-	42	0	0
	42	-	3	0
	0	3	-	0
	0	0	0	-

Co-occurrence matrix

e.g.: A[x, y] = How many users viewed both items?

Singular Value Decomposition

$$A[x, y] \approx \text{embeddings}[x] * \text{embeddings}[y]$$

And more....

- Metadata
- Word2vec etc...
- Graph convolutions
- [..]

End-to-end

Preselecting → Scoring → Composition

End-to-end

Preselecting → Scoring → Composition

e.g.

Deep Neural Networks for YouTube Recommendations

Paul Covington, Jay Adams, Emre Sargin

It’s all about targets!

Too implicit: what item user will **view** next?

Too explicit: how will user **rank** this item?

Pretty good: will user **buy** this item?

Typical: will user **click** this item?

Click-baits

How do you sell a wood splitter on ebay?

UNACCEPTABLE!

Story

Item has high CTR

Model thinks it’s good

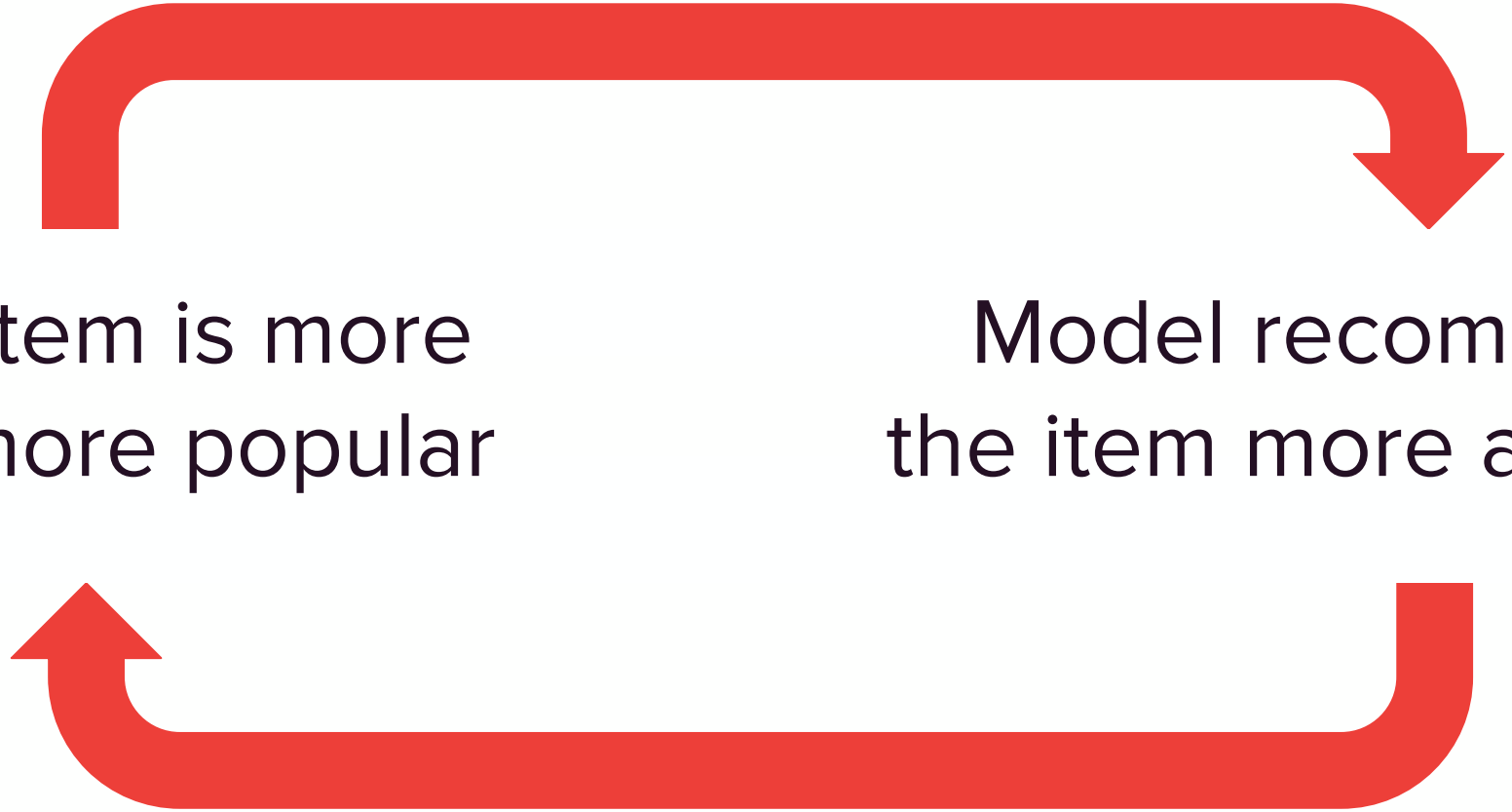
Item becomes more popular

Model thinks it’s very good

Item makes it to the top 10

Model thinks it’s great

Items is now No. 1


The item is more
and more popular
Model recommends
the item more and more

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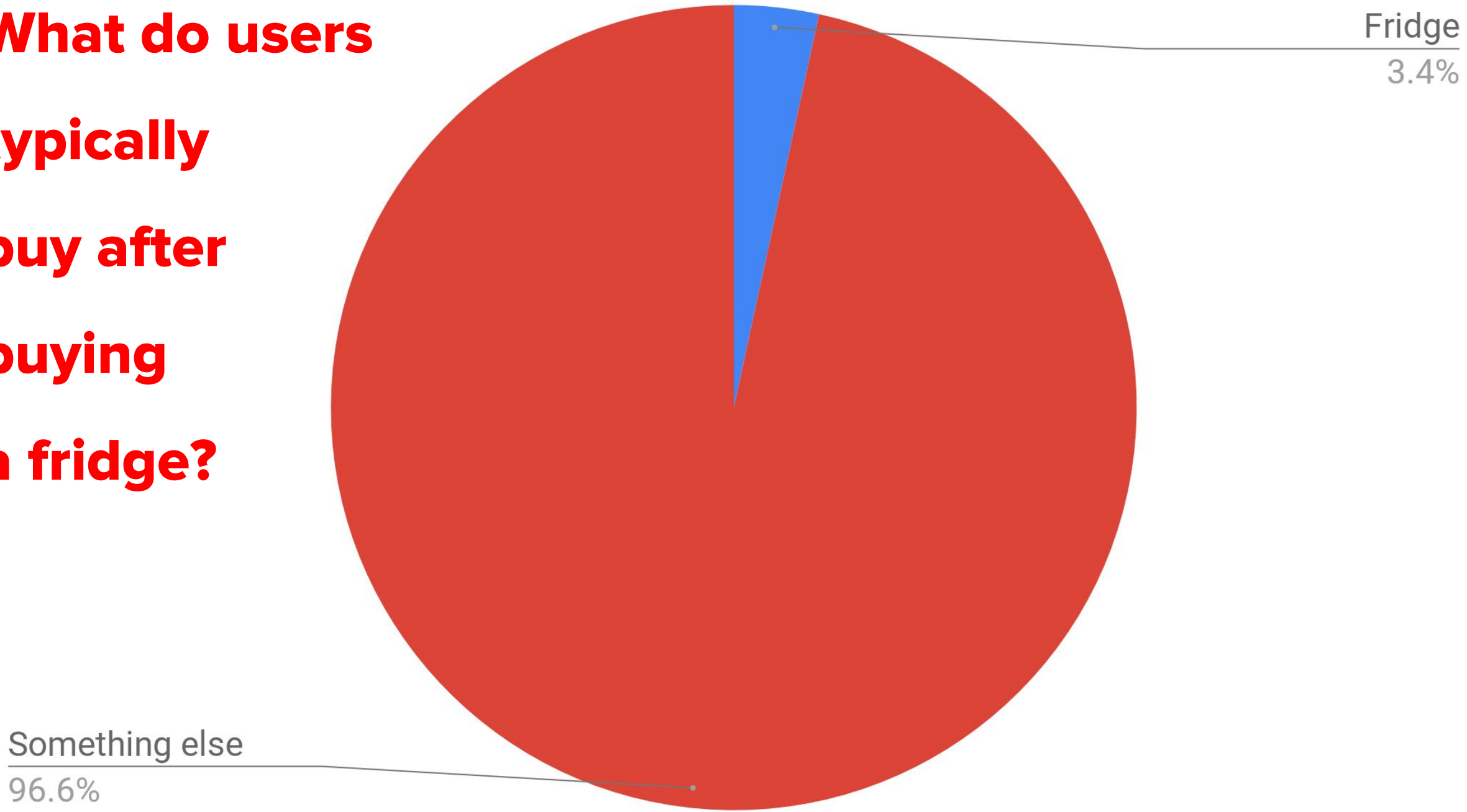
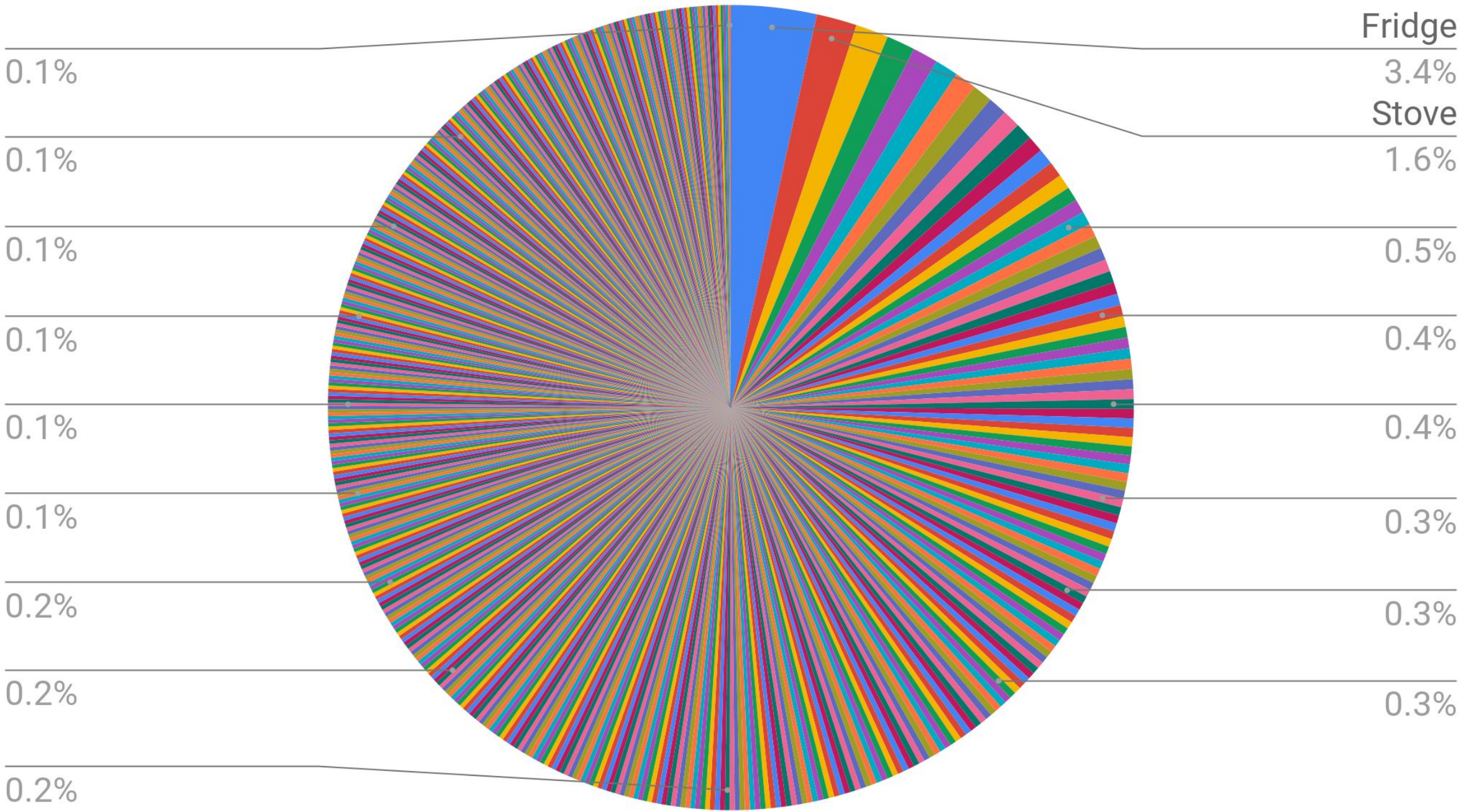
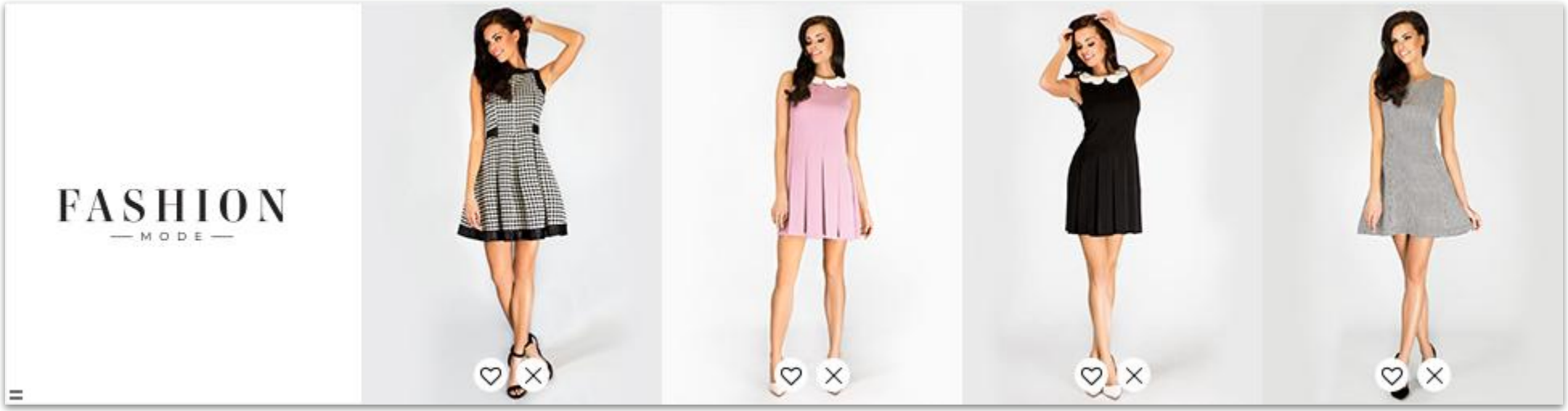
So, I’ve just bought this fridge...

What do users typically buy after buying a fridge?

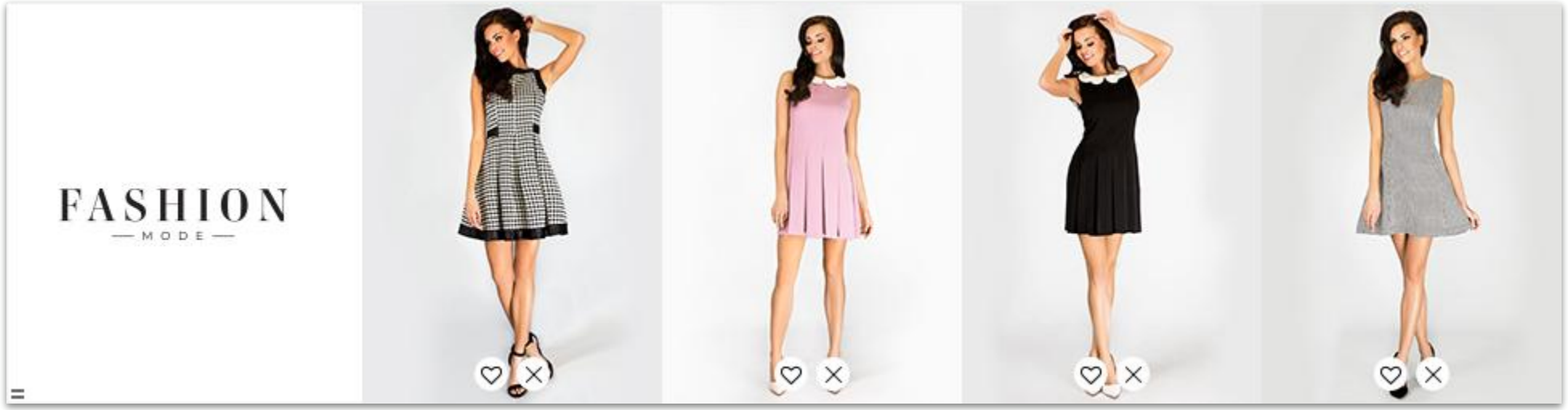



Fridge
3.4%
Stove
1.6%
0.5%
0.4%
0.4%
0.3%
0.3%
0.3%
0.2%
0.2%
0.2%
0.1%
0.1%
0.1%
0.1%
0.1%

Pst!



Pst!



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