

The Continuous Cold Start Problem in e-Commerce Recommender Systems

Lucas Bernardi, **Melanie Mueller**

Booking.com, Amsterdam

Jaap Kamps, Julia Kiseleva

Amsterdam & Eindhoven University



Cold Start in Travel



Cold Start in Travel

Booking.com



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e.g. city, region, district or specific hotel

Check-in Date

Day Month

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I don't have specific dates yet

Traveling for: Work Leisure



Guests 2 adults, 0 children

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New York City
560 properties



277 people looking at this destination

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Dubai
735 properties



319 people looking at this destination



FREE cancellation on most rooms!

Instant confirmation when you reserve

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Travel recommendations

- User-to-user collaborative filtering:

Customers who viewed Hotel Sacher Wien also viewed:

[Grand Hotel Wien](#)

★★★★★



Only a 3-minute walk from the Vienna State Opera and the famous Kärntner Straße shopping street, the 5-star Grand Hotel Wien offers you luxurious rooms and 2 gourmet restaurants, as well as a large...

[Hotel de France Wien](#)

★★★★★



Centrally located on Vienna's elegant Ringstraße boulevard, Hotel de France Wien offers a restaurant, a bar with piano music, free 24-hour gym access, and free WiFi in all areas. The Schottentor...

[Le Meridien Vienna](#)

★★★★★



Offering free access to its luxurious spa, indoor pool, and 24-hour fitness centre, free WiFi access, and free minibar use with a daily refill, Le Meridien Vienna is located right at the Ringstraße...

- Content-based item-to-item recommendation:

Destinations related to Vienna:

Prague



1037 properties available



Budapest



1019 properties available

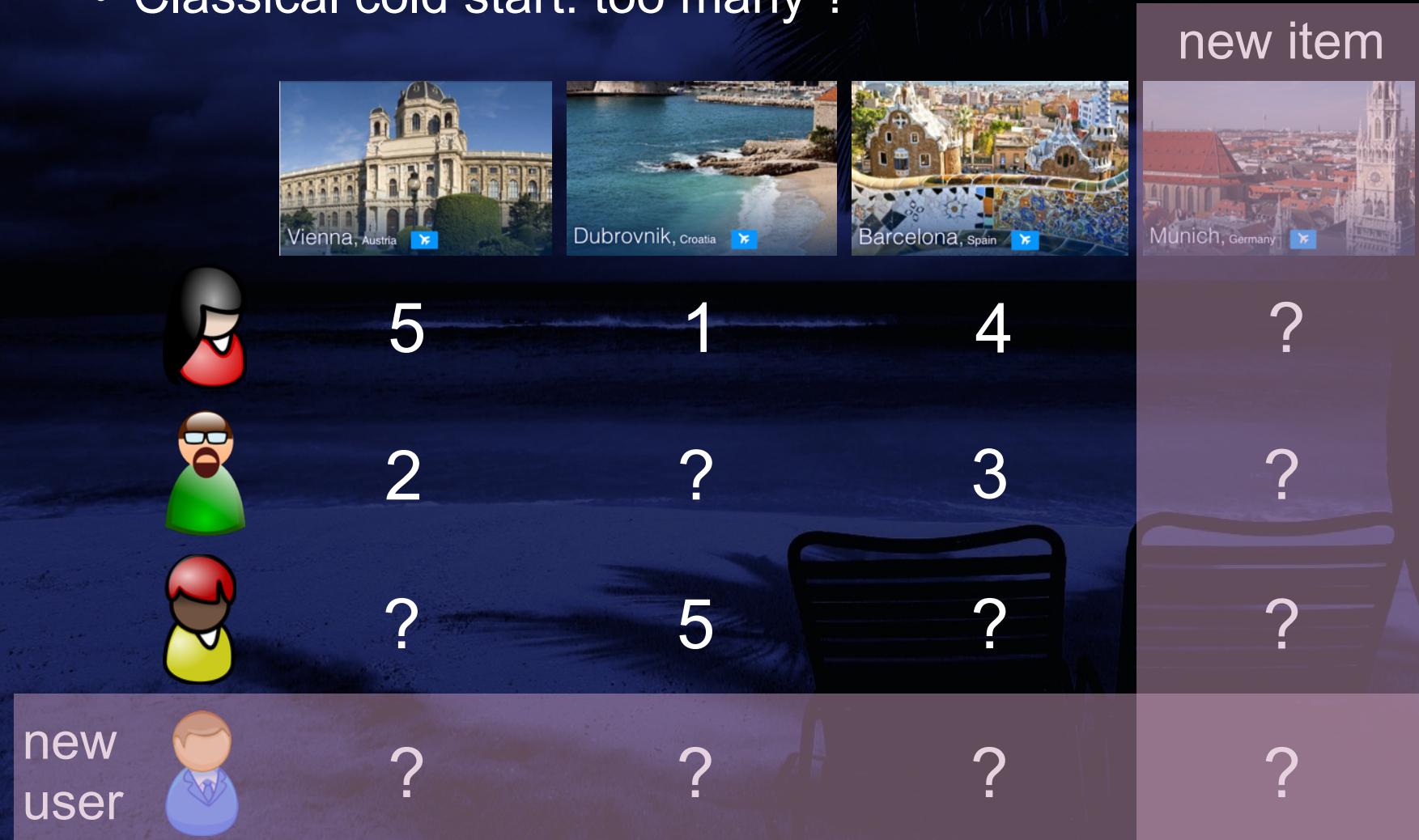


Outline

- Characteristics of the Continuous Cold Start Problem
- Addressing the Continuous Cold Start Problem

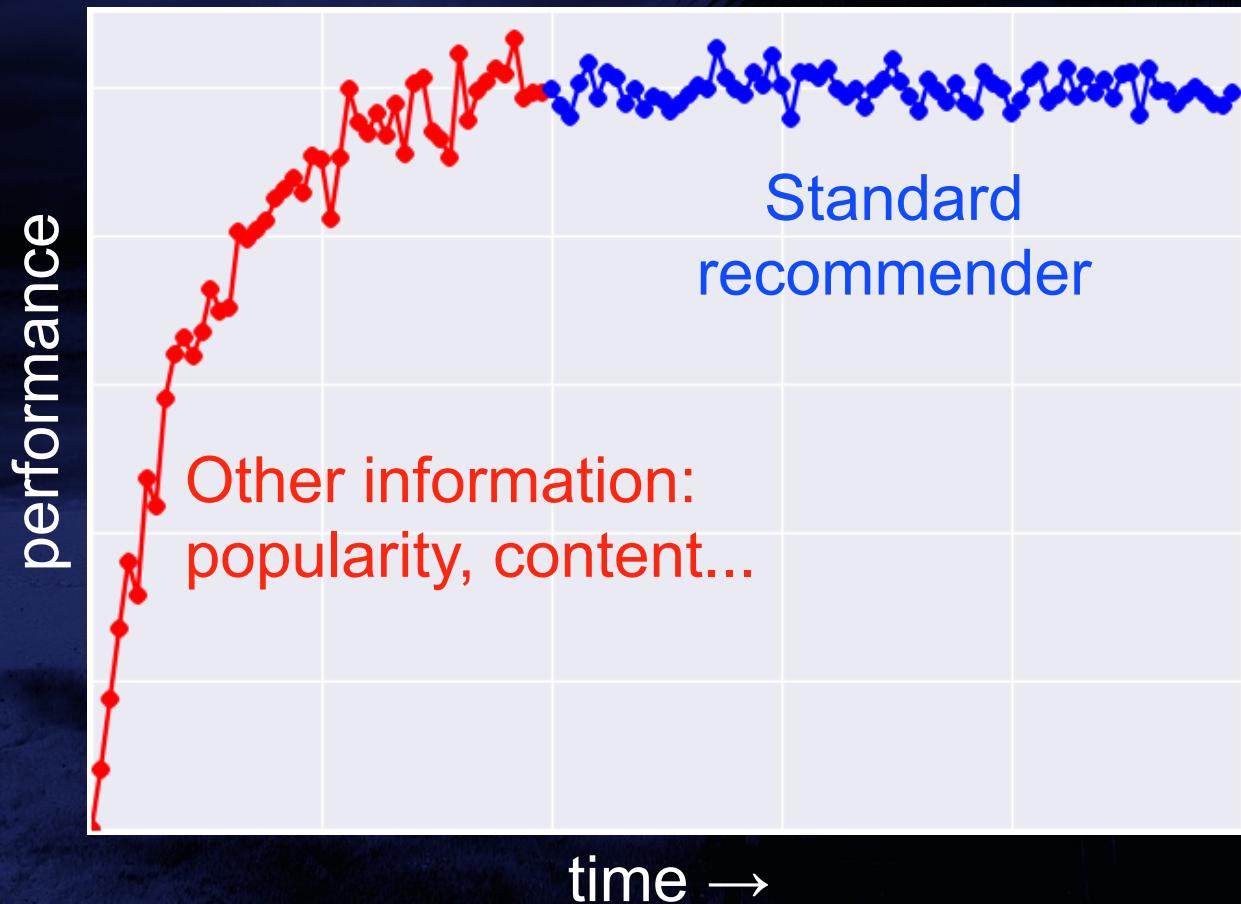
Recommender Systems

- Task: predict rating of new item
- Classical cold start: too many ?



Classical Cold Start

- Cold start = not enough information (yet)
→ Bridge period until warmed up

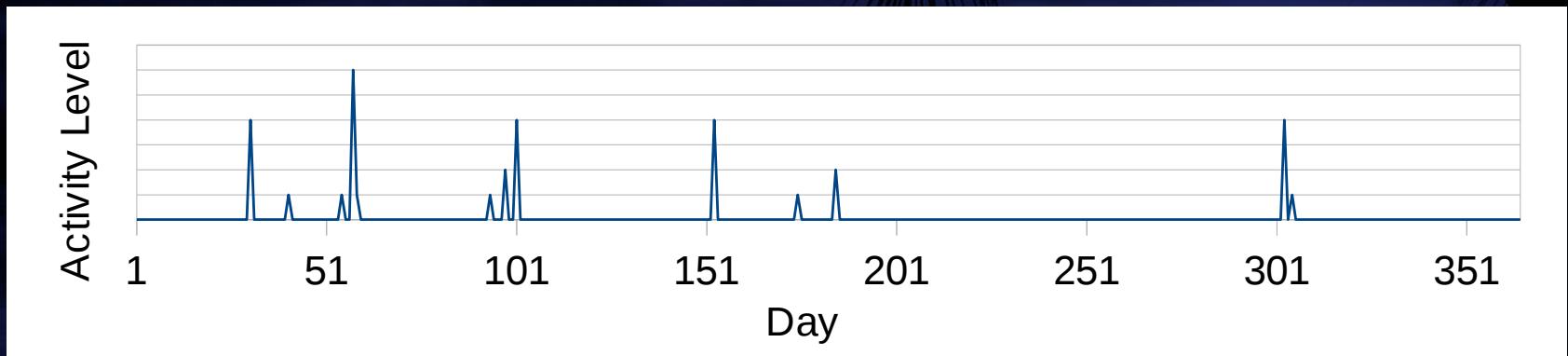


User Continuous Cold Start

- Classical cold-start / sparsity
new / rare users
- Volatility
- Personas
- Identity

Cold Users

- New users:
 - Millions unique users/day, growing
 - Most not logged-in, no cookie
- Sparse users: holidays are rare events!



User Continuous Cold Start

- Classical cold-start / sparsity
new / rare users
- Volatility
user interest changes over time
- Personas
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User Volatility

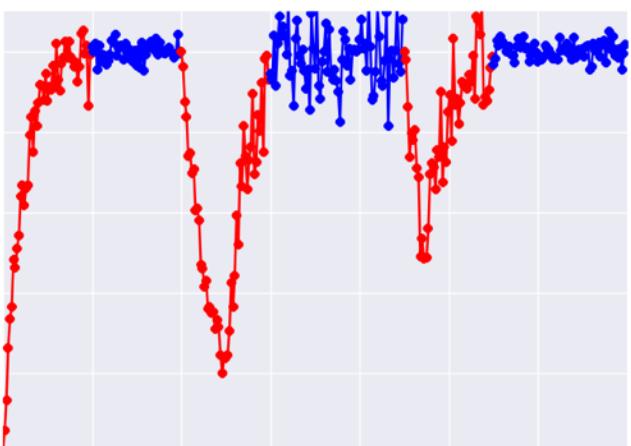
Backpacker hostel



Family hotel



Wellness hotel



User Continuous Cold Start

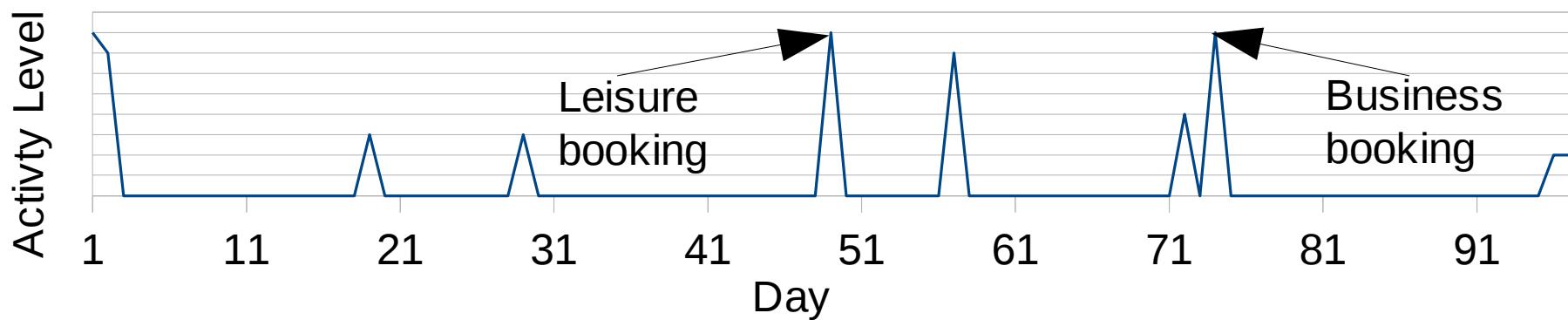
- Classical cold-start / sparsity
new / rare users
- Volatility
user interest changes over time

- Personas
different interest at close-by points in time

- Identity

User Personas

- Leisure versus business:



- Weekend city trip versus long holiday
- Browsing on a sunny versus rainy day

User Continuous Cold Start

- Classical cold-start / sparsity
new / rare users
- Volatility
user interest changes over time
- Personas
different interest at close-by points in time
- Identity
failure to match data from same user

User Identity Problem

- Not logged in
- Different devices



Item Continuous Cold Start

- **Classical cold-start / sparsity**
new / rare items
- **Volatility**
item properties/values change over time
- **Personas**
item appeals to different types of users
- **Identity**
failure to match data from same item

Outline

- Characteristics of the Continuous Cold Start Problem
- Addressing the Continuous Cold Start Problem

Addressing Continuous Cold Start

- Continuous cold start = information continuously missing
 - Need more/other information:
 - Ask user

Ask the User

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Addressing Continuous Cold Start

- Continuous cold start = information continuously missing
 - Need more/other information:
 - Ask user → can add friction
 - **Implicit ratings:**
buys, clicks, views...

Implicit Ratings

Customers who **viewed Hotel Sacher Wien** also **viewed:**

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★★★★★



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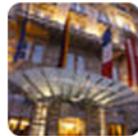
Score from 745 reviews

Superb 9/10

[Book now](#)

[Hotel de France Wien](#)

★★★★★



Centrally located on Vienna's elegant Ringstraße boulevard, Hotel de France Wien offers a restaurant, a bar with piano music, free 24-hour gym access, and free WiFi in all areas. The Schottentor...

Score from 2873 reviews

Very good 8.5/10

[Book now](#)

[Le Meridien Vienna](#)

★★★★★



Offering free access to its luxurious spa, indoor pool, and 24-hour fitness centre, free WiFi access, and free minibar use with a daily refill, Le Meridien Vienna is located right at the Ringstraße...

Score from 1577 reviews

Very good 8.3/10

[Book now](#)

Addressing Continuous Cold Start

- Continuous cold start = information continuously missing
 - Need more/other information:
 - Ask user → can add friction
 - Implicit ratings:
buys, clicks, views... → weak signal
 - Popularity

Destination Finder

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Not sure where to go?

Add your interests and let us do the rest

Try adding countries, regions, continents or specific travel interests

Check-in date

Check-out date

Guests

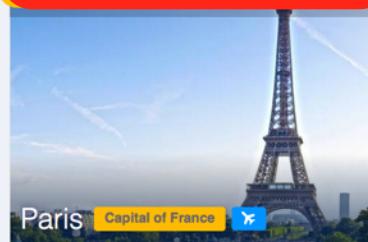
Search

✓ FREE cancellation on most rooms!

Show me: Destinations ▾

View map

Popular with travellers from the Netherlands



Paris

Capital of France



Popular with travellers from the Netherlands



Antwerp, Belgium



Popular with travellers from the Netherlands



London

Capital of United Kingdom



Popular with travellers from the Netherlands



Barcelona, Spain



Popular with travellers from the Netherlands



Brussels

Capital of Belgium



Popular with travellers from the Netherlands



Berlin

Capital of Germany



Booking.com

Addressing Continuous Cold Start

- Continuous cold start = information continuously missing
 - Need more/other information:
 - Ask user → can add friction
 - Implicit ratings: buys, clicks, views... → weak signal
 - Popularity → surprisingly hard to beat!
 - **Content**
 - item descriptions
 - user profiles
 - context

Destination Finder

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Sign In

Not sure where to go?

Add your interests and let us do the rest

Opera coff



Coffee
87 destinations



Coffs Harbour, New South Wales, Australia



Coffee Triangle, Colombia



Coffee Bay, Eastern Cape, South Africa



Coffeyville, Kansas, USA

What's being searched right now

Searched 1 second ago

Italy

Searched 5 seconds ago

Blumenau

Searched 8 seconds ago

Disneyland Paris

Searched 10 seconds ago

Italy

Searched 10 seconds ago

Latvia

Searched 12 seconds ago

Italian Alps

Searched 13 seconds ago

Germany

Searched 18 seconds ago

Exeter

Paris

Capital of France



Antwerp, Belgium



London

Capital of United Kingdom



Popular with travellers from the Netherlands



Barcelona, Spain



Popular with travellers from the Netherlands



Brussels

Capital of Belgium



Popular with travellers from the Netherlands



Berlin

Capital of Germany



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Sign in

Not sure where to go?

Add your interests and let us do the rest

 Opera Coffee Add more
 Check-in date Check-out date Guests Search
✓ FREE cancellation on most rooms!

Sort by: Relevance ▾

Show me: Destinations ▾

View map

3,709 recommendations for "Opera" and 1,034 for "Coffee"

Vienna, Austria Y

579 recommendations for "Opera" and 340 for "Coffee"

Paris Capital of France Y

334 recommendations for "Opera" and 88 for "Coffee"

New York, USA Y

667 recommendations for "Opera" and 125 for "Coffee"

Budapest Capital of Hungary Y

€ 133
Double Room

Meriton Serviced Apartments

820 recommendations for "Coffee" and 164 for "Opera"

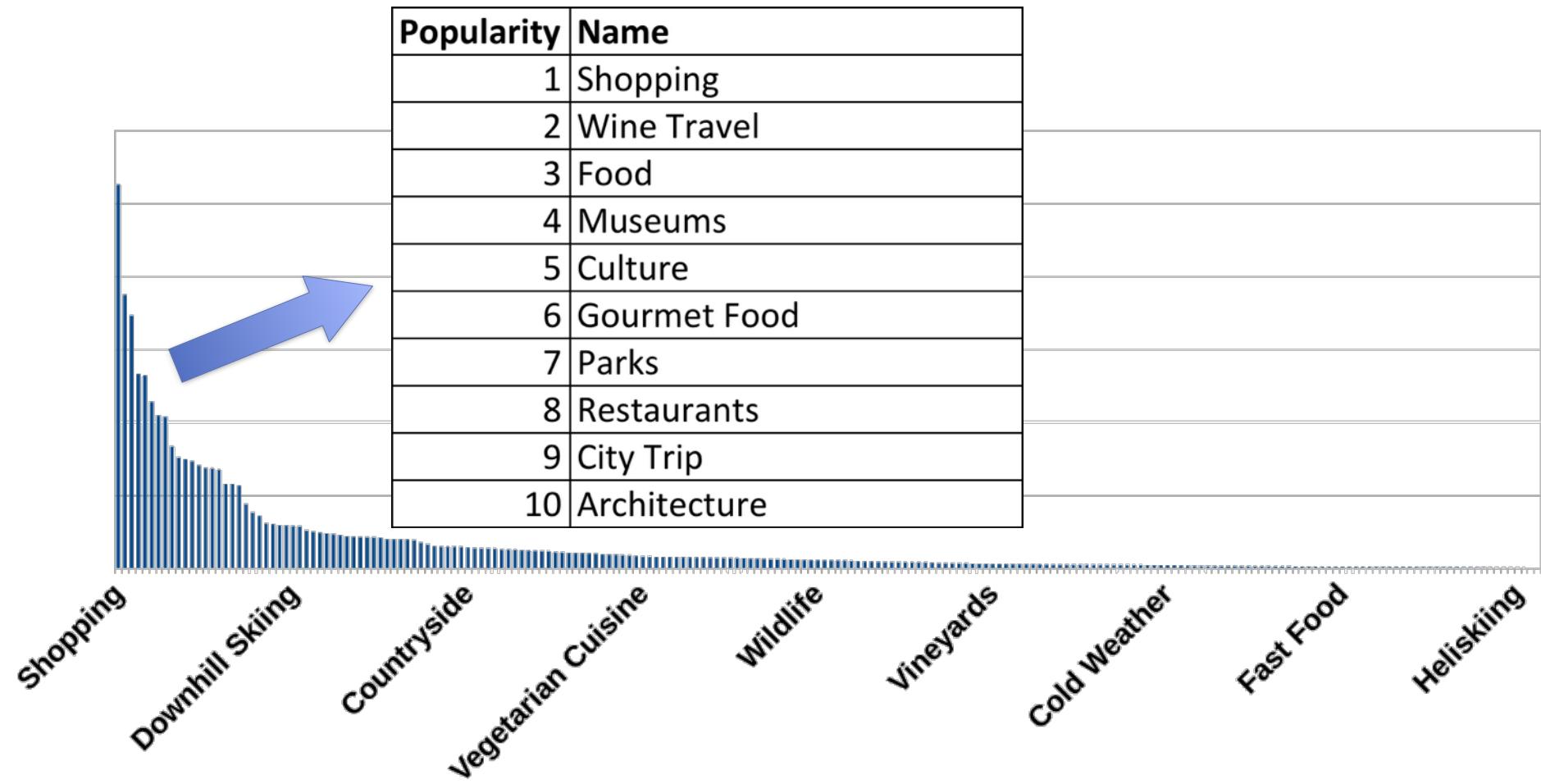
Rome Capital of Italy Y

Booking.com

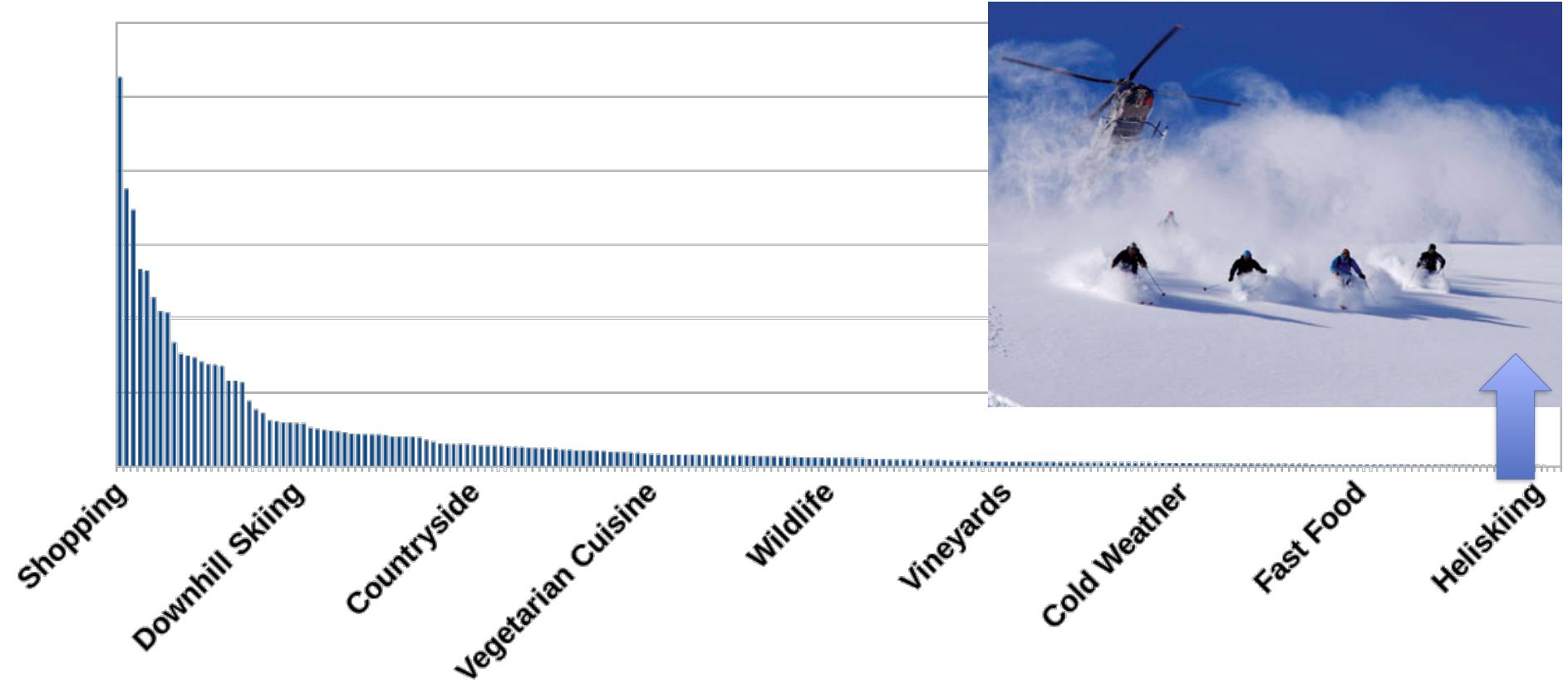
Endorsements

- From users who stayed at hotel in destination
- Free text endorsements since 2013
- 2014: used NLP techniques to extract 256 tags
- 13 000 unique endorsements
- 60 000 destinations

Endorsements



Endorsements



Destination Finder Cold Start

- Upper funnel: almost no information about user (very cold)
- Construct MIXED profile:

Features:

- user: operating system, browser
 - context: weekday
 - item rating: endorsement
- <Ubuntu, Firefox, Tuesday, opera>
- <0,1,0,0,0,1,0,0,0,0,0,0,0,1,0...>

- Clustering → mixed content profiles
- Train recommender for each profile
- New user + query: find closest profile

A/B testing

Recommender	Users	Click-Through-Rate
No mixed profiles	13,306	$18.5 \pm 0.4\%$
With mixed profiles	13,562	$22.2 \pm 0.4\%$

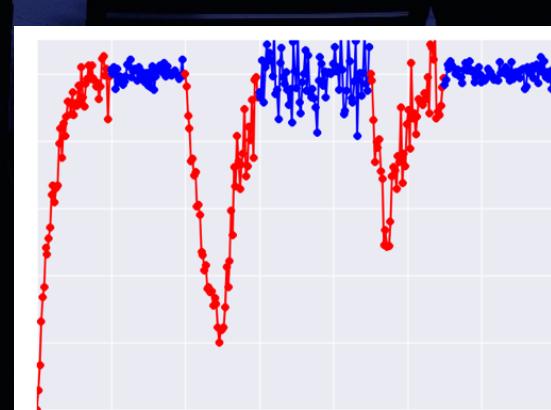
Improved by 20%

Addressing Continuous Cold Start

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 - Ask user → can add friction
 - Implicit ratings: buys, clicks, views... → weak signal
 - Popularity → surprisingly hard to beat!
 - **Content**
 - item descriptions
 - user profiles
 - context

→ mix 'em up!

Not only bridge warm-up period,
but deal with continuous cold start



Summary: Continuous Cold Start

- **Classical cold-start**
new & rare users / items
- **Volatility**
users/items change over time
- **Personas**
different interest at close-by times
- **Identity**
failure to match data from same user/item

Timely Personalized Recommendation: Don't do lunch cold start

