

Multi-funnel Recommender System for Cold Item Boosting

Ahmed Khaili, Adva Hadrian,
Kostia Kofman, Edgar Cano, Andrew Mende

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Booking.com

Agenda

- Introduction

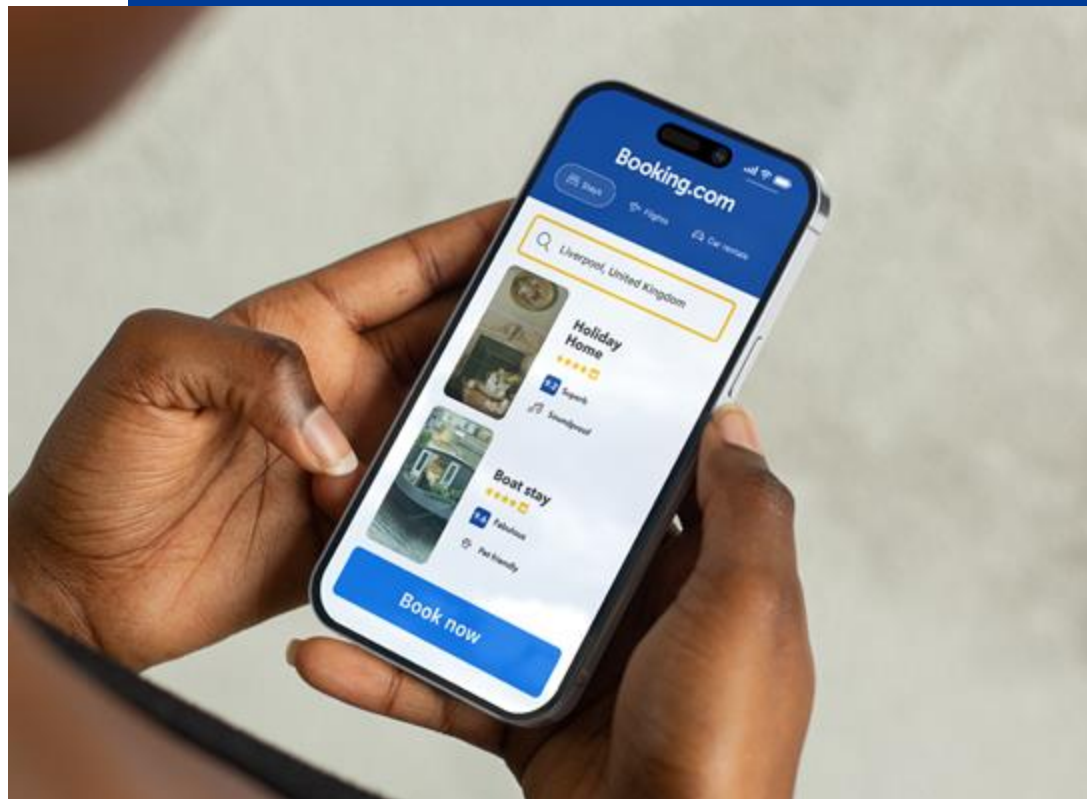
- Background- Ranking System

- Method - Personalized Cold Start Properties Boosting

Experiment Design

- Results

Next Steps





Flights to
4,500+
destinations
worldwide

347M+
verified guest
reviews and
24/7
customer service
in **45**
languages and
dialects

Since 2010,
Booking.com has
welcomed
4.5B+
guest arrivals

29M
total reported
listings
worldwide

7.8M
options in homes,
apartments and
other unique places
to stay

140 offices in **70** countries over
5,000 employees in Amsterdam

175,000
destinations around the world

Car hire available in **145+**
countries and pre-booked taxis in
over **600+** cities across
130+ countries

30
different types of
places to stay,
including homes,
apartments, B&Bs,
hostels, farm stays,
bungalows, even
boats, igloos and
treehouses

Curated bookable
attractions and
experiences in over
1,800 cities

01 Introduction

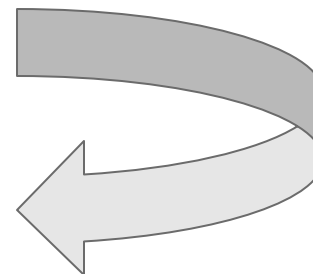
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Problem Formulation

- **Growth of e-commerce** shift the way customers discover and engage with products and services.
- Recommender systems **provide personalized suggestions.**
- Tend to rely on **historical data.**

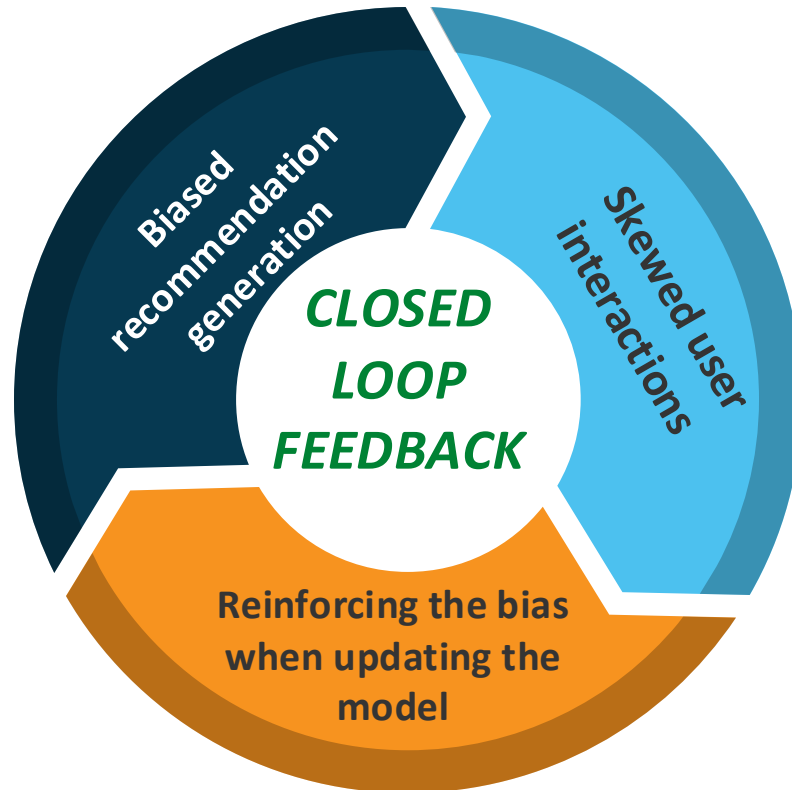
Hence

- Struggle with **new customers and items** due to a lack of data.
- Leads to suboptimal recommendations



Focus on **cold start problem in items only** → in our case is the properties we suggest.

The Closed Loop Feedback



Two Sided Marketplace



Travelers

Looking for the perfect accommodation

New properties may **lack reviews**



Property Owners

Gain listing **visibility**

Offer better discounts, optimize listings, increase room availability

OUR GOAL

Address the property cold start problem by balancing two objectives:

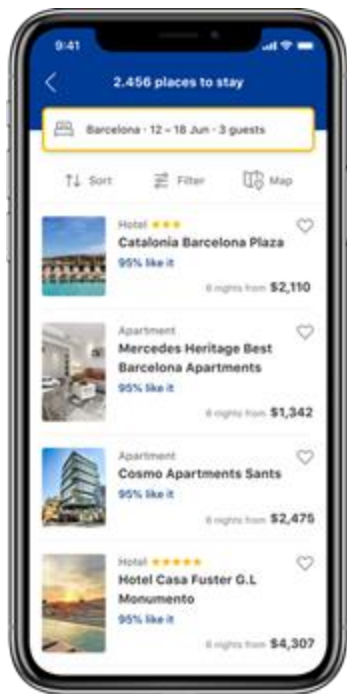
- Increasing exposure for cold properties to enable them to compete with existing listings.
- Ensuring customers see the most relevant properties based on their specific search criteria.



Background on the Overall Ranking System

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Ranking System



- Deep Cross Networks - **DCN** for modeling complex interactions
- Embedding handling **high-cardinality** features in large-scale systems

Relevant Features:

- **ItemID**: unique id of the property
- **ItemID CVR**: conversion rate from impression to book of item (for different time intervals)
- **Customer Context**: search context of the customer: length of stay, destination, device type etc.

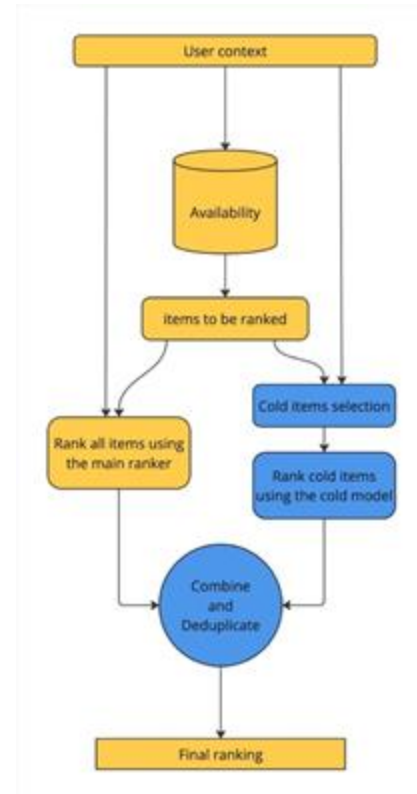
Personalized Cold Start Properties Boosting

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Multi-Funnel RS Architecture

Main funnel : Before cold introducing start pipeline.

Cold start funnel : Focus of this presentation.



Cold Item & Cold Model

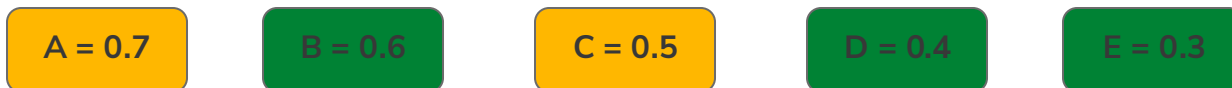
- **Cold item definition:**
 - Properties in their first 30 days after joining the platform
- **Cold Model:**
 - Similar features and architecture to the main model while omitting *itemID* embedding
 - *itemID CVR* features are kept during training, and replaced with an estimate based on warm items during inference.

Cold Model Against Baselines

Evaluation data	NDCG@10	NDCG@10
	Cold Model	Cold Model
	Relative to Main model	Relative to least expensive
Cold reservations - Cold supply	0.8% ± 1.04%	25% ± 1.6%
All reservations - full supply	-0.9% ± 0.03%	-

Deduplication Logic

- Main ranking

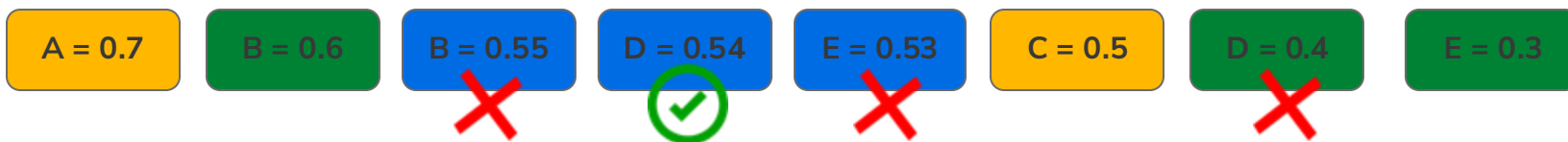


- Cold item ranking



- Warm item
- Cold item - Main model
- Cold item - Cold model

- Maximum of boosted items = 1



04 Experiment Design

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Experiment Design

First - Traveler Facing Experiment

- **A/B Experiment:** Half of travelers exposed to boosting, half are not.
- **Hypothesis:** Negative short-term impact on conversion rates expected.

Second - Supply Facing Experiment

- **A/B Experiment:** Half of **cold** properties are boosted, the other half are not.
- **Hypothesis:** This will increase long-term retention, outweighing the negative conversion impact.

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Results

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Online Results – Traveler Experiment

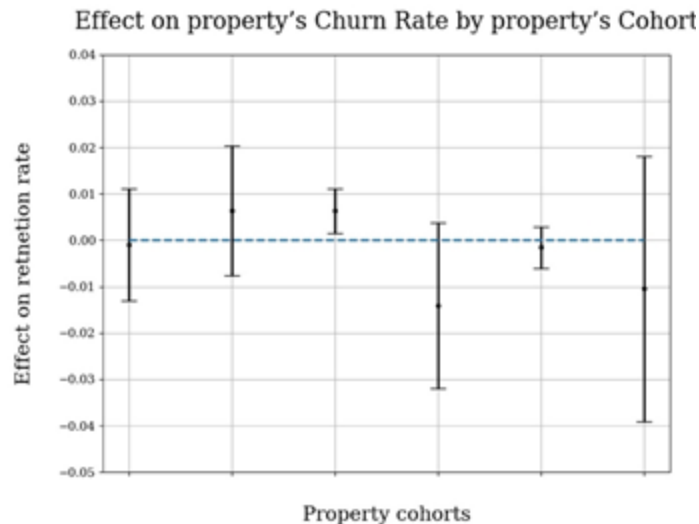
Experiments	Metrics	Value
Traveler facing	Conversion rate	-0.09% ± 0.07%
Supply facing	Cold properties with at least one booking	Positive
	Retention rate	Inconclusive

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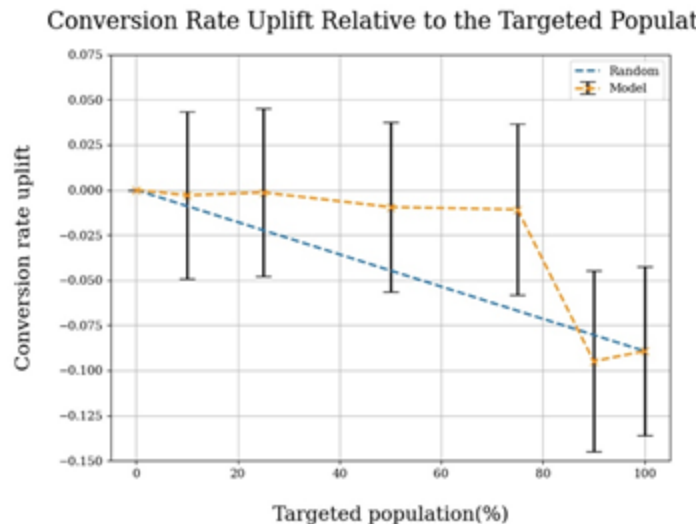
Next Steps

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Next Steps



Not all of our partner's cohorts respond the same to this treatment.



Limiting this boosting mechanism to less sensitive customers can potentially reduce boosting costs.

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Conclusion

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Conclusion

- **Problem:**
 - Balancing between traveller and property owners interests in a two sided marketplace.
- **Approach:**
 - A multi-funnel Recommender System boosting personalized properties while controlling the rate of this boost.
- **Results and next steps:**
 - A move in the right direction but a desired balance is still not achieved yet
 - A room for improvement by :
 - Focusing on properties that respond positively to increased exposure.
 - Targeting customers who are less sensitive to properties without reviews.

Thank you

Ahmed Khaili

ahmed.khaili@booking.com

Adva Hadrian

adva.hadrian@booking.com

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