User Experience and Data
Bridging the Gap

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RecTour, RecSys 2018 - Vancouver
Largest Accommodation Marketplace

- 130,000+ global destinations
- 28 million listings
- 43 languages
- Terabytes of data every day
- 100+ Machine Learning Models Deployed
- 50+ Recommender Systems Deployed
Three problems...

**Multi-dimensional Item space**
- Destination
- Dates
- Properties
- Rooms
- Policies

**High Stakes**
- No “undo” option
- Trips are expensive
- Maximize Trust

**Zero query**
- Optimal shopping experience with minimal info
...Three more problems

- Rich Content
  - Photos
  - Descriptions
  - Reviews
  - Destination endorsements
  - Etc

- Continuous Cold Start
  - Guests
  - Properties

- Supply Constraint
  - Availability
    - Finite
    - Dynamic
  - Price
    - Dynamic
What kind of recs?
Recommender Systems

Destinations
Plain Recommendations
Autocomplete
Similar Destinations
Multi-city Trip Destinations
Nearby Destinations

Vancouver
Top reasons to visit: scenery, sightseeing, nature

Have you thought about staying further away?

Richmond
13.5 km from Vancouver
101 properties available

North Vancouver
5.5 km from Vancouver
14 properties available *23% cheaper

Burnaby
11.6 km from Vancouver
28 properties available *34% cheaper
Recommender Systems.

Accommodations
Default Ranking
Click History
Personalized Ranking
Similar/Different
Low availability

We found hotels similar to JW Marriott Parq Vancouver that other travelers liked:

The Fairmont Waterfront
-six stars
Wonderful
8,1
821 reviews
Total price from:
€ 724
Book now

Hyatt Regency Vancouver
-six stars
Excellent
8,6
1,080 reviews
Total price from:
€ 503
Book now

Sandman Hotel Vancouver City Centre
-three stars
Good
7,3
4,470 reviews
Total price from:
€ 275
Book now

Check out these 58 other properties outside Amsterdam:

ibis budget Amsterdam City South
-two stars
Very Good
8,0
7,352 reviews
Booked 7 times in the last 6 hours
Recommended for 4 adults
2 x Twin Room
In high demand – only 7 rooms left on our site!
Price for 4 adults for 2 nights: € 576
+ € 13.76 taxes and charges

EXchange Hotel Vancouver
-five stars
Excellent
8,7
82 reviews
Booked 20 times in the last 24 hours
Recommended for 4 adults
2 x Double Room
FREE cancellation – no prepayment needed
Risk Free: You can cancel later, so lock in this great price today!
Price for 4 adults for 1 night: € 312
includes taxes and charges
Recommender Systems.
Recommender Systems are Complex.

<table>
<thead>
<tr>
<th>Target Item</th>
<th>Audience</th>
<th>Framing</th>
<th>KPI</th>
<th>Data</th>
<th>Feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>What do we want to recommend?</td>
<td>Who are we recommending for? When?</td>
<td>What is the role of the recs?</td>
<td>How do we measure effectiveness?</td>
<td>What data are we going to use?</td>
<td>How do we define user satisfaction?</td>
</tr>
</tbody>
</table>
other ML?
Travel Preference
Travel Preference

- Price
- Quality
- Location
Travel Context

Traveling With Kids?
Add your kids to find the perfect property!

Search
Destination/hotel name: Pefkohori
Are you travelling for work? Yes No
Check-in: Thursday 15 June 2017
Check-out: Friday 23 June 2017
8-night stay
Rooms: 1
Adults: 3
Children: 0
Search
Semantic Layer

Enables EVERYONE to introduce
- new features
- personalisation
- persuasion
User Interface Optimization
User Interface Optimization

Whatever accommodations you’re looking for, we’ve got you covered.

- **Apartments**: 652,111 apartments
- **Resorts**: 21,210 resorts
- **Villas**: 332,918 villas

Get inspired for your next trip

- **5 of the most romantic ski vacations**: Enjoy some apres-ski and curl up by the fire at one of these very romantic skiing spots.
- **Top 10 destinations to see the Northern Lights**: The best destinations to see the Northern Lights, according to global travellers.
- **8 Christmas markets you’ll want to visit**: Europe’s most magical lesser-known markets, found in mountaintops and medieval towns.

More than just hotels...discover pure comfort with homes & apartments

- **Annsleys Luxury Suites** - Interisal
  - Starting from € 337.50
  - Exceptional - 6 reviews
- **Casa Portuguesa Prata** - Lisbon
  - Starting from € 242.50
  - Excellent - 78 reviews
- **London Lifestyle Apartments** - London
  - Starting from € 341
  - Good - 16 reviews
- **MY CASA - 131 PROMENADE** - Nice
  - Starting from € 190
  - Very Good - 10 reviews
- **Vancouver**
  - Top reasons to visit: scenery, sightseeing, nature
  - Still interested in your previous searches for Vancouver?
  - Nov 23 - Nov 24
  - 2 rooms, 4 adults
- **Amsterdam**
  - Top reasons to visit: museums, city walks, sightseeing
  - Still interested in your previous searches for Amsterdam?
  - Oct 19 - Oct 20
  - 1 room, 2 adults
- **Victoria**
  - Still interested in your previous searches for Victoria?
  - Nov 23 - Nov 24
  - 1 room, 1 adult
- **Banff**
  - Still interested in your previous searches for Banff?
  - 1 room, 1 adult

Booking.com
What about Supply?
Content Curation

Guests Love...

- "beautiful hotel" 6 related reviews
- "helpful staff" 4 related reviews
- "absolutely loved" 2 related reviews

Vancouver

Top reasons to visit: scenery, sightseeing, nature

What Travelers Love About This Location

9.5 “excellent location. Friendly staff, great property”
S Somnath United States of America

9.5 “The ambiance, location, newness, view from the upper floors and gym. They are all great!”
K Keshmahinder Malaysia

8.7 “Great location to and from town.”
D Daniel Canada
Content Augmentation

Delta Hotels by Marriott Vancouver Downtown Suites

★★★★★

Vancouver - Show on map (700 m from center) - Subway Access

Last booked: 11 hours ago

Recommended for 4 adults

An outstanding value on these dates.

2 x King Suite with Sofa Bed

FREE cancellation – no prepayment

Risk Free: You can cancel later, great price today!

Recommended Destinations for You:

Richmond

Prices in Richmond for your dates have been going up over the past 2 days.

Seattle

Prices in Seattle for your dates are the lowest we've seen in 40 days!
Modelling

ML problem → Ground Truth Data

Feature & Model Selection → Algorithm Design
ML Problem Construction.

Idea → ML problem → Ground Truth Data

Feature & Model Selection → Algorithm Design
Model Construction Challenges.

- **User Base Impact**
  - class proportion of binary classifiers

- **Learning Difficulty**
  - Bayes error rate
  - Ranking VS random/popular
Model Construction Challenges

- Data to Concept Matching
  - e.g. “Multi-leg” destinations
  - e.g. “nearby” destinations

Have you thought about staying further away?

<table>
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<th>Location</th>
<th>Distance from Vancouver</th>
<th>Properties Available</th>
<th>Price Difference</th>
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Offline VS Business
Selection Bias
Offline VS Business

Selection Bias - Family Trip

Predict → SEARCH → CLICK → BOOK → STAY → REVIEW

Labels → X → Family Trip ? y

Booking.com
Offline VS Business.

Selection Bias

PROBLEM: high variance in the region of the feature space where labels are missing
Offline VS Business

Selection Bias

**PROBLEM:** high variance in the region of the feature space where *labels* are *missing*

**SOLUTIONS:**
- more *data* reduces the production sample variance
Offline VS Business

Selection Bias

PROBLEM: high variance in the region of the feature space where labels are missing

SOLUTIONS:
- more data reduces the production sample variance
- propensity modelled feature selection
Modelling for product development.

1. Idea
2. ML problem
3. Ground Truth Data
4. Experiment
5. Monitoring
6. Feature & Model Selection
7. Algorithm Design

- Idea
- ML problem: Classification, Regression
- Ground Truth Data
- Experiment
- Monitoring
- Feature & Model Selection
- Algorithm Design: High Bias, High Variance
- Model Complexity: Validation Error, Training Error
Correlated Models.
Correlated Models.
Correlated Models.

- Larger Outer Spaces (e.g. multiclass / ranking)
- Observation space (experiment per user - prediction per search)
- Per-prediction impact (same model in different features)
Latency is Critical.

A very Important Commercial Metric

Another very Important Commercial Metric
Performance Impact

Blocked experimentation

S0

base

variant one
data

variant two
data + visual change

S1

start stage

start stage

your change
Offline metrics are just a Health Check.
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- **Evaluate Systems as a whole**
  - Including the model, the UI, and the audience
- **Expose wrong intuitions**
  - More clicks is better, is it?
- **Show Improvement Direction**
  - Analysing experiment results we can get concrete ideas about what to do next
- **Discover Causal Effects**
  - Experiments are the ultimate piece of evidence for causality
What Matters?

89% of properties are reserved in Amsterdam
There is also availability in these nearby destinations

- Hoofddorp
- Schiphol
- Badhoevedorp

Amsterdam is 88% unavailable for your dates on our site. Have you considered staying nearby?

- **Schiphol**
  - 43% cheaper
  - 11.4 km away, 8 properties

- **Lijnden**
  - 60% cheaper
  - 9.3 km away, 1 property

- **Badhoevedorp**
  - 64% cheaper
  - 8.3 km away, 4 properties

- **Amstelveen**
  - 53% cheaper
  - 8.1 km away, 5 properties

- **Hoofddorp**
  - 57% cheaper
  - 17.2 km away, 13 properties

- **Zaandam**
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Impact

Time

Booking.com
Not only ML Matters.

Work closely with User Researchers, Designers and Copywriters

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**Impact**

- Hoofddorp
- Schiphol
- Badhoevedorp

**Time**

- Typewriter
- Desktop computer
- Robot
- Robot
- Robot
- Typewriter
- People icon
ML & Experimentation can help bridge the gap between UX and Data.
Thank you!

Questions?

booking.ai

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