Designing a Conversational Travel Recommender System Based on Data-Driven Destination Characterization

Linus W. Dietz, Saadi Myftija, and Wolfgang Wörndl
Technical University of Munich
Department of Informatics
Chair of Connected Mobility
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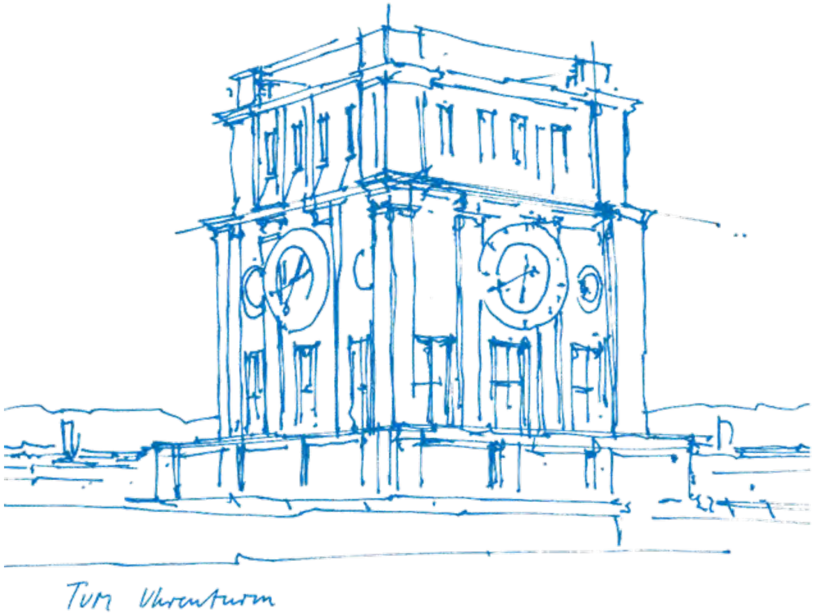

Problem

Recommend global cities for traveling

Challenges

- Large item space
- Intangible items
- No ratings available
- Expert-based characterization of items is very costly
- High-stakes recommendation
- Complex decision making

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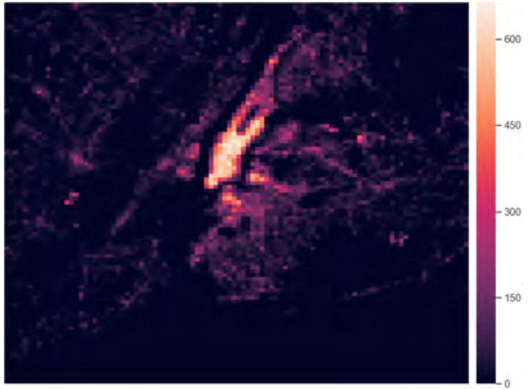
Destination Characterization

Collect City Data

- From Foursquare, via official API
- 180 cities on all continents
- Download of all venues in the city
- Analyze distribution
- Enrich cities with cost and climate data



Heatmap of New York City Venues

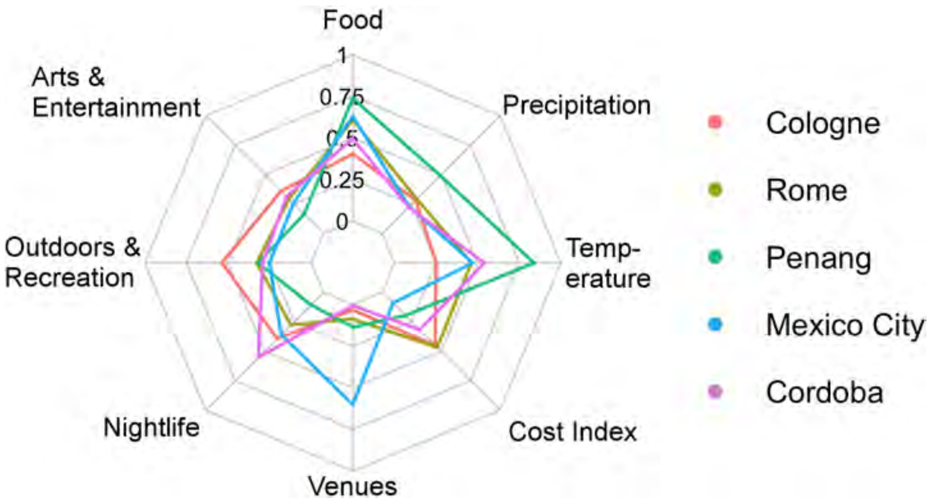
Table 1: Raw values of exemplary cities

City	Venues	Arts	Food	Nightlife	Outdoors	Cost Index	Temperature	Precipitation
Rome	36,848	1,995	12,264	2,063	3,482	69.03	15.7°C	798mm
Mexico City	213,612	12,158	83,225	16,780	19,330	34.18	15.9°C	625mm
Cologne	16,163	966	4,107	1,144	2,127	67.36	10.1°C	774mm
Penang	50,647	2,193	21,389	1,686	5,273	43.98	25.7°C	1,329mm
Cordoba	3,636	246	1,282	427	379	55.11	17.8°C	612mm

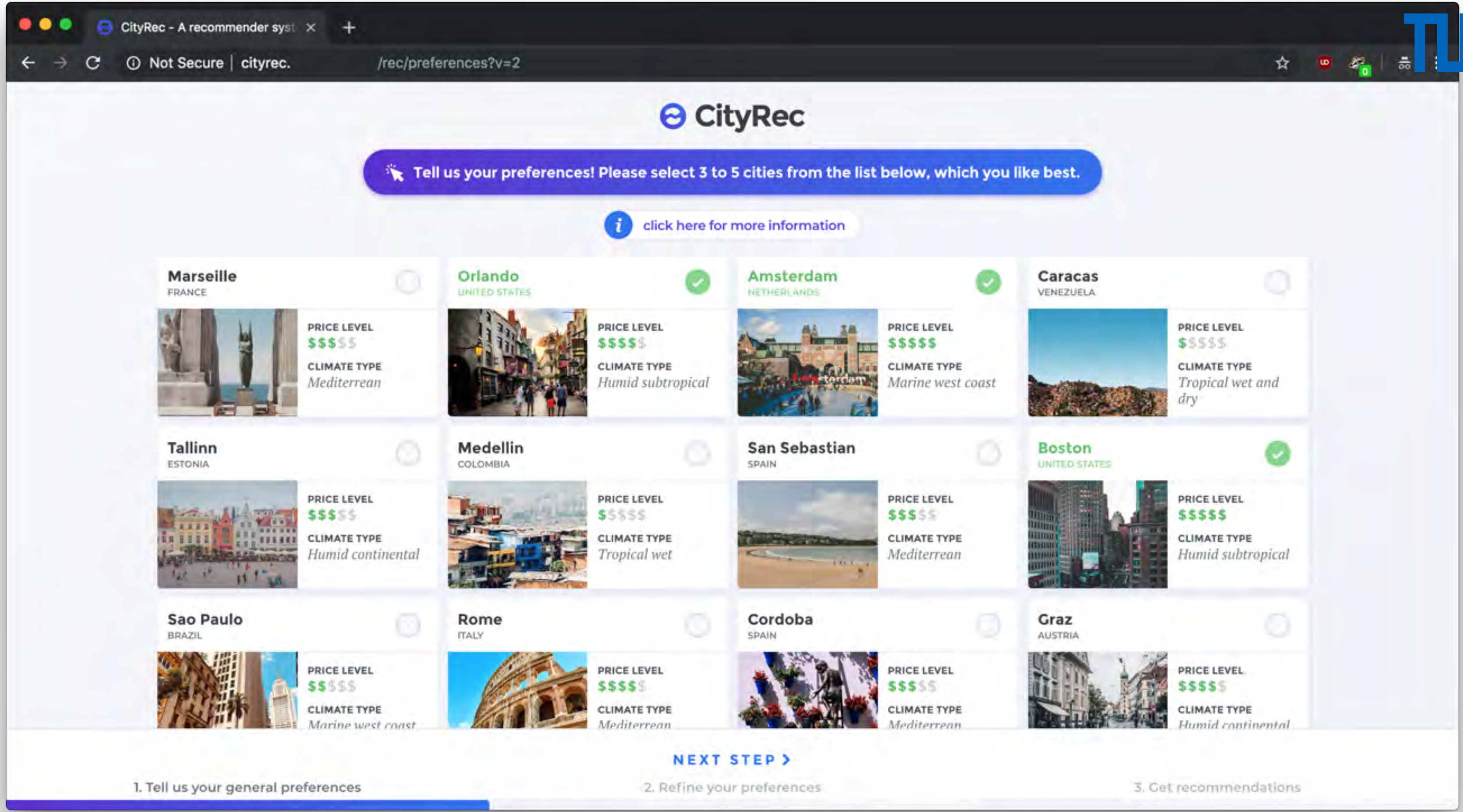
Destination Characterization

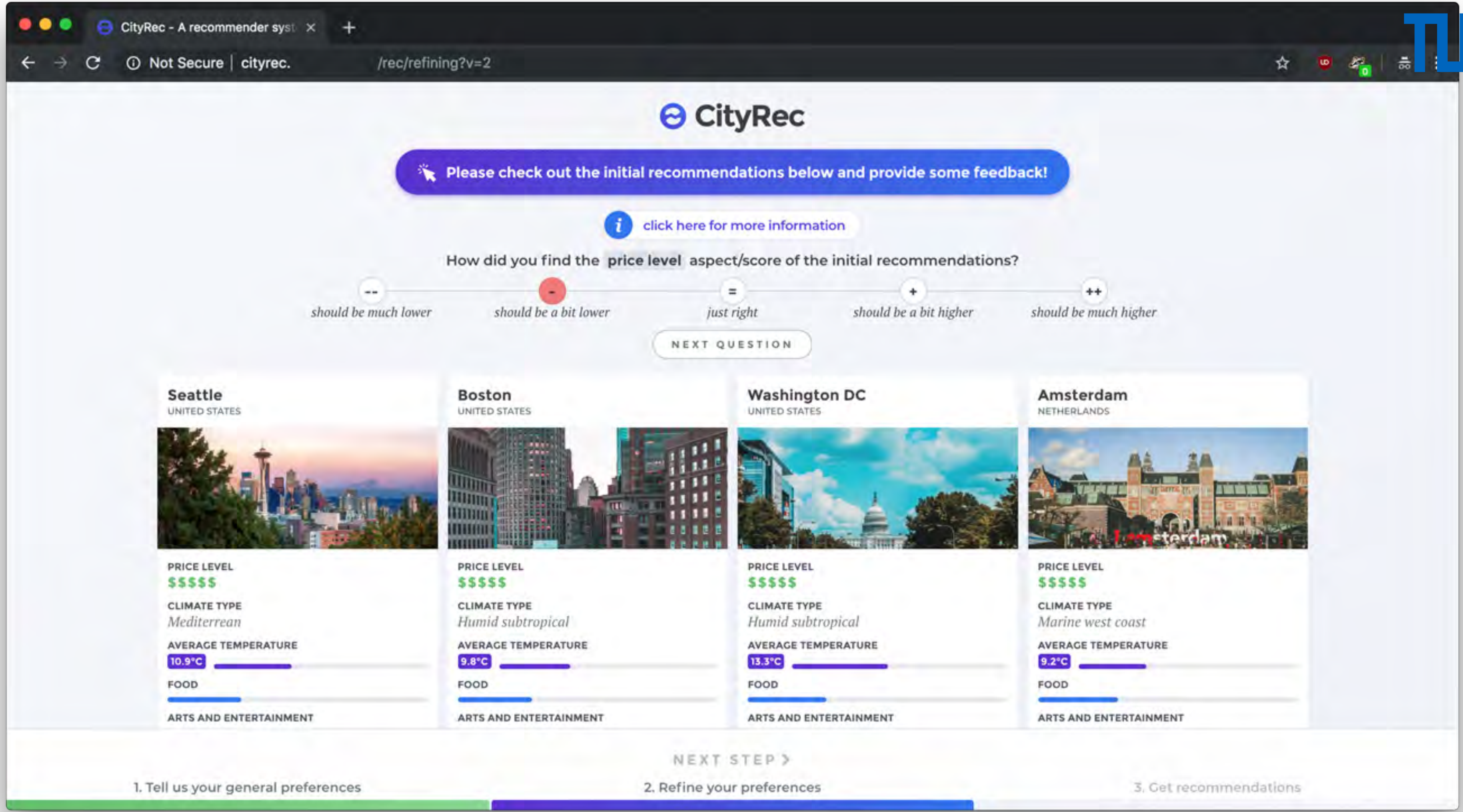
Cluster Analysis

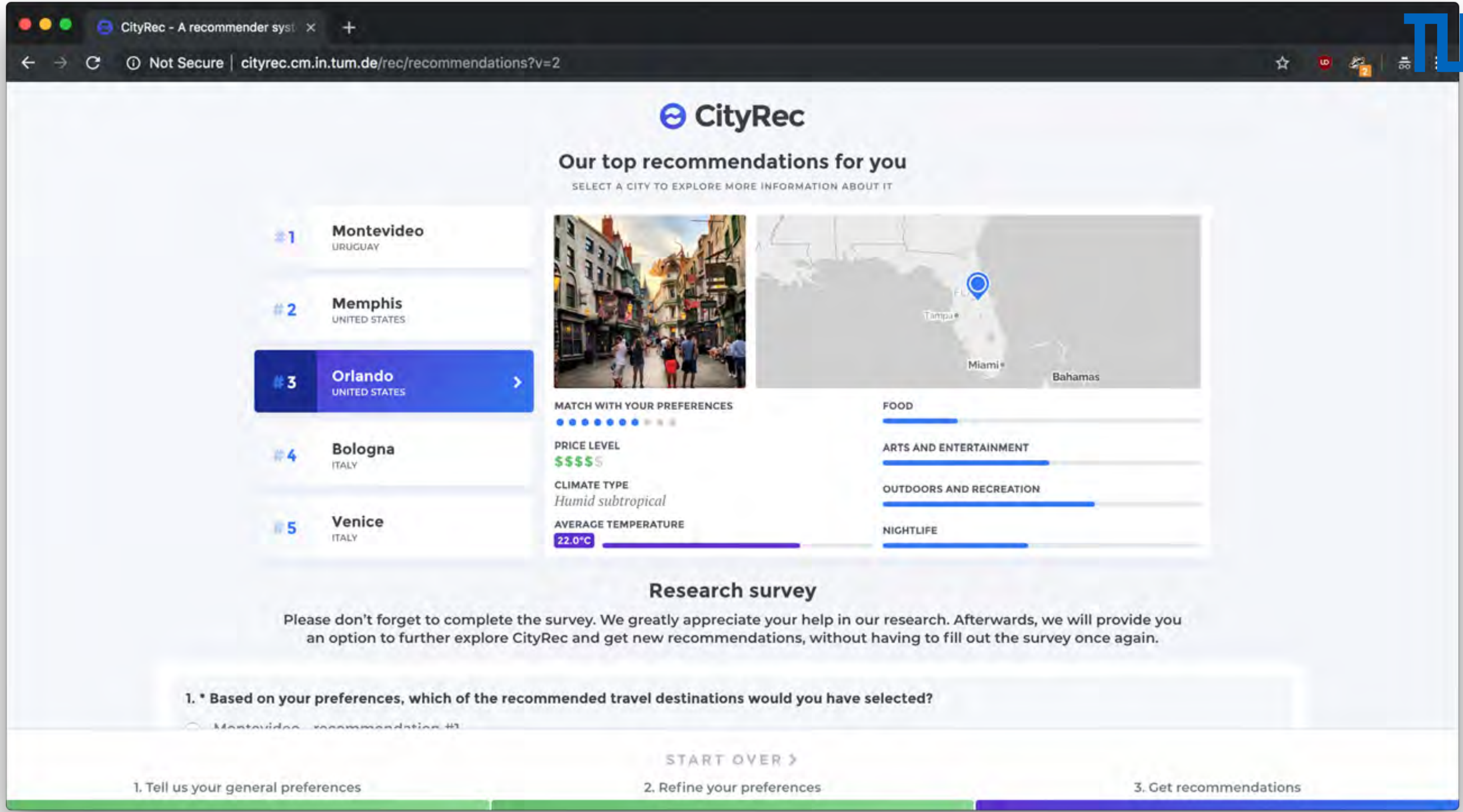
- Normalize raw data by number of venues
- Normalize feature values using min-max
- Compare k-mean, k-medoids, hierarchical clustering
- Determine cluster quality using silhouette width
- **Best result:** Hierarchical clustering with 5 clusters



Normalized Values of Centroid Cities


CityRec - A recommender syst
Not Secure | cityrec.
/rec/preferences?v=2
CityRec
Tell us your preferences! Please select 3 to 5 cities from the list below, which you like best.
click here for more information
Marseille
FRANCE
PRICE LEVEL
$$$$$
CLIMATE TYPE
Mediterrean
Orlando
UNITED STATES
PRICE LEVEL
$$$$$
CLIMATE TYPE
Humid subtropical
Amsterdam
NETHERLANDS
PRICE LEVEL
$$$$$
CLIMATE TYPE
Marine west coast
Caracas
VENEZUELA
PRICE LEVEL
$$$$$
CLIMATE TYPE
Tropical wet and dry
Tallinn
ESTONIA
PRICE LEVEL
$$$$$
CLIMATE TYPE
Humid continental
Medellin
COLOMBIA
PRICE LEVEL
$$$$$
CLIMATE TYPE
Tropical wet
San Sebastian
SPAIN
PRICE LEVEL
$$$$$
CLIMATE TYPE
Mediterrean
Boston
UNITED STATES
PRICE LEVEL
$$$$$
CLIMATE TYPE
Humid subtropical
Sao Paulo
BRAZIL
PRICE LEVEL
$$$$$
CLIMATE TYPE
Marine west coast
Rome
ITALY
PRICE LEVEL
$$$$$
CLIMATE TYPE
Mediterrean
Cordoba
SPAIN
PRICE LEVEL
$$$$$
CLIMATE TYPE
Mediterrean
Graz
AUSTRIA
PRICE LEVEL
$$$$$
CLIMATE TYPE
Humid continental
NEXT STEP >
1. Tell us your general preferences
2. Refine your preferences
3. Get recommendations


CityRec - A recommender syst
Not Secure | cityrec.
/rec/refining?v=2
CityRec
Please check out the initial recommendations below and provide some feedback!
click here for more information
How did you find the price level aspect/score of the initial recommendations?
--
should be much lower
-
should be a bit lower
=
just right
+
should be a bit higher
++
should be much higher
NEXT QUESTION
Seattle
UNITED STATES
PRICE LEVEL
$$$$$
CLIMATE TYPE
Mediterrean
AVERAGE TEMPERATURE
10.9°C
FOOD
ARTS AND ENTERTAINMENT
Boston
UNITED STATES
PRICE LEVEL
$$$$$
CLIMATE TYPE
Humid subtropical
AVERAGE TEMPERATURE
9.8°C
FOOD
ARTS AND ENTERTAINMENT
Washington DC
UNITED STATES
PRICE LEVEL
$$$$$
CLIMATE TYPE
Humid subtropical
AVERAGE TEMPERATURE
13.3°C
FOOD
ARTS AND ENTERTAINMENT
Amsterdam
NETHERLANDS
PRICE LEVEL
$$$$$
CLIMATE TYPE
Marine west coast
AVERAGE TEMPERATURE
9.2°C
FOOD
ARTS AND ENTERTAINMENT
NEXT STEP
1. Tell us your general preferences
2. Refine your preferences
3. Get recommendations


CityRec - A recommender syst
Not Secure | cityrec.cm.in.tum.de/rec/recommendations?v=2
CityRec
Our top recommendations for you
SELECT A CITY TO EXPLORE MORE INFORMATION ABOUT IT
#1 Montevideo URUGUAY
#2 Memphis UNITED STATES
#3 Orlando UNITED STATES
#4 Bologna ITALY
#5 Venice ITALY
Tampa
Miami
Bahamas
MATCH WITH YOUR PREFERENCES
PRICE LEVEL
$$$$$
CLIMATE TYPE
Humid subtropical
AVERAGE TEMPERATURE
22.0°C
FOOD
ARTS AND ENTERTAINMENT
OUTDOORS AND RECREATION
NIGHTLIFE
Research survey
Please don't forget to complete the survey. We greatly appreciate your help in our research. Afterwards, we will provide you an option to further explore CityRec and get new recommendations, without having to fill out the survey once again.
1. * Based on your preferences, which of the recommended travel destinations would you have selected?
START OVER
1. Tell us your general preferences
2. Refine your preferences
3. Get recommendations

Evaluation

Independent variable: Critiquing vs. non-critiquing baseline

Dependent variables:

- Time to result
- Clicks
- Self assessment of the importance of Food, Arts & Entertainment, Outdoors, and Nightlife
- ResQue Questionaire
  1. The travel destinations recommended to me by CityRec **matched my interests**
  2. The recommender system helped me **discover new travel destinations**
  3. **I understood** why the travel destinations were recommended to me
  4. I found it **easy to tell the system what my preferences** are
  5. I found it **easy to modify my taste profile** in this recommender system
  6. The layout and labels of the recommender **interface are adequate**
  7. Overall, I am **satisfied** with this recommender system
  8. **I would use this recommender system again**, when looking for travel destinations

Results

Variable	Baseline	Critiquing	p	W	Significance
(Q1) Interest match	3.58	**3.88**	**0.043**	645	$*$
(Q2) Novelty	3.44	3.75	0.118	705	ns
(Q3) Understanding	3.46	3.77	0.073	673.5	ns
(Q4) Tell prefs.	3.73	3.90	0.328	775	ns
(Q5) Modify profile	3.24	3.48	0.17	723.5	ns
(Q6) Interface	**4.15**	3.62	**0.009**	1,044	$**$
(Q7) Satisfaction	3.66	**3.92**	**0.037**	649	$*$
(Q8) Future use	3.49	3.67	0.166	724	ns
Time to results	60.92s	**184.07s**	**<0.001**		$***$
Clicks	6.32	**21.35**	**<0.001**		$***$
PCC Food	-0.11	-0.01	0.341		ns
PCC Arts	0.05	0.38	0.066		ns
PCC Outdoors	0.02	**0.45**	**0.024**		$*$
PCC Nightlife	0.2	**0.57**	**0.028**		$*$

Significance levels: $*\ p < 0.05$; $**\ p < 0.01$; $***\ p < 0.001$

Conclusions

Recommendation accuracy > User effort

Critiquing system did better in capturing user preferences

Future work

Evaluate destination characterization

Compare different user interaction paradigms

Sources available https://github.com/divino5/cityrec-prototype

Try out CityRec http://cityrec.cm.in.tum.de/