

Are the States United? An analysis of US hotels' offers through TripAdvisor's eyes

ABSTRACT

This empirical data-driven research aims to unveil thought-provoking insights on the United States (US) hotel offer across its 50 states. Information of more than thirty thousand hotels was collected through web scraping from TripAdvisor. Using such data, 50 support vector machine (SVM) models were trained to model the TripAdvisor score, one per state, to assess the convergent and divergent factors in customer satisfaction across all the US states.

A conceptual model is proposed and validated through the data-driven SVM models developed for each state to identify convergent features across the states to explain customer satisfaction (here represented by TripAdvisor score). Hotel size, price, and stars are not moderated by the location, expressed by the corresponding state, although these highly influence satisfaction, whereas both hotel number of published photos and the amenities are affected by the location. Thus, adaptation issues were found regarding amenities and published photos within each state's offer.

KEYWORDS

Hotel offer; customer satisfaction; customer feedback; TripAdvisor; United States.

1. INTRODUCTION

Tourism analytics is a novel research trend that emerged from data analytics to leverage tourism knowledge based on available Big Data sources, from which social media is one of the most prominent (Aluri et al., 2018; Marine-Roig & Clavé, 2015; Moro et al., 2018b). Social media includes any online platform developed under the Web 2.0 paradigm, where the user is the major content contributor (Kaplan & Haenlein, 2010). Tourism is among the pioneer industries to implement a popular format of social media on a worldwide scale: online review platforms (Moro & Rita, 2018). One of the most recognized is TripAdvisor, where users are encouraged to write their opinions about the hotels where they stayed (Moro et al., 2019). Therefore, it is one of the information richest online review platforms where relevant information about hotels can be found.

The United States (US) is one of the largest and most populated countries in the world and with both Atlantic and Pacific coasts. The regional asymmetries across its 50 states are widely known (Voulgaris et al., 2017), with coastal states being the most densely populated and wealthier ones (e.g., California, New York, Florida). The US government has recently adopted a public data policy, providing free access to government data, including travel and tourism information (Zuiderwijk & Janssen, 2014). Travel and tourism researchers have taken advantage of such data in studying problems such as modeling air travel passenger flows (Mao et al., 2015). However, such data is limited to factual information, not accounting for the traveler experience which enables understanding the customers' perspective. Alternatively, scholars have designed surveys to obtain customer feedback (e.g., Yuan et al., 2008). Nevertheless, this is a method limited to a reduced number of responses in comparison to retrieving data from social media platforms. The present study addresses such limitation by modeling the

TripAdvisor hotel score, which can be considered a proxy for customer satisfaction (Moro et al., 2017).

Customer satisfaction based on social media data has been widely investigated in tourism (Calheiros et al., 2017). Current literature acknowledges the influence of several dimensions to tourist satisfaction, including hotel stars, price, and the amenities (Moro et al., 2018b). Additionally, hotel location is regarded as an important construct to tourist satisfaction (Gao et al., 2018). Both scholars and practitioners agree that selecting a place for a new hotel unit is a difficult task (Yang et al., 2014). Thus, this study contributes to the existing body of knowledge by assessing how the location affects the influence of well-known dimensions from the guests' perspective. The findings from the undertaken analysis can help hoteliers to invest more in some dimensions in detriment of others, depending on the unit's location. Yet, most of these dimensions have been analyzed separately. We propose to address such gap in the existing body of knowledge by bringing together a coherent set of relevant features to customer satisfaction, with a specific emphasis on the moderating effect of region through 50 data-driven models, one per each US state. Each model is then scrutinized to assess the most meaningful hotel features contributing to traveler satisfaction. This study aims to include previously identified features in the literature that influence hotel guest's satisfaction (e.g., price and amenities), under a unique data-driven model that enables to highlight the regional symmetries and asymmetries of US states. Thus, the study is guided by two research questions: (RQ1) which hotel features influence most customer satisfaction? And (RQ2) is customer satisfaction moderated by the location (i.e., state) in the US?

2. LITERATURE REVIEW AND PROPOSED MODEL

2.1. The Importance of Regional Asymmetries on Accommodation

Regional asymmetries play a key role in the accommodation offer (Andraz et al., 2015). These can result from several factors, such as local competition and weather (Barros & Mascarenhas, 2005). The recent body of knowledge on the subject acknowledges regional asymmetries' influence on price, amenities (Moro et al., 2018b), and hotel size (Tundis et al., 2017). Additionally, there is evidence that the star level of a location's offer is also affected by competition (Radojevic et al., 2015).

The highly mature US tourism market, with most of the hotels present in TripAdvisor, and with a vast territory covering from desert to tundra and including tropical regions, was scrutinized. Cultural country-level constraints exist that support an analysis of the US market, even when compared to other English-speaking countries such as the UK (Voss et al., 2004). The vastness of the US also encompasses regional contexts that need to be isolated under a state level analysis (Alonso et al., 2013). The large volume of information justifies a data-driven approach, while the localized phenomenon associated with tourism across the US (Baker et al., 2013) advocates a cross-state analysis.

2.2. The moderating effect of location

A hotel's location can have a key influence on its performance in many ways. Regional clusters enhance individual units' productivity (Peiró-Signes et al., 2015), and competition may lead to a convergent service relevance within the same region (Frochot & Gyimóthy, 2001). Thus, hotels that start offering a specific amenity that is aligned with tourists' needs (e.g., refrigerator in rooms for warmer regions), have an advantage over the remaining ones, emphasizing the importance of that service to tourists' choices (Stringam, 2008). Nonetheless, Abrate and Viglia (2016) found that although amenities

have an influence on customer satisfaction, the reputational dimension translated by the hotel stars holds a stronger impact in comparison. Additionally, since the destination image highly influences accommodation offer, the impact of travelers' photos is considerably higher for less known destinations (Deng & Li, 2018). The importance of hotel location is perceived differently by guests depending on the hotel number of stars (Rhee & Yang, 2015). This suggests that location moderates how hotel stars influence customer satisfaction. Likewise, guests are willing to pay more per hotel rooms in more attractive locations. Sánchez-Pérez et al. (2019) confirmed the influence of the city where the hotel is located on prices in four European countries, and its subsequent impact on customer satisfaction. Therefore, location also has a moderating effect on guests' perceived relevance of room price. Thus, we hypothesize that these (i.e., amenities, price, size, stars, number of photos) are features that are moderated by US regional asymmetries to influence tourists on their stays and that may be translated into a higher or lower granted quantitative score along with their written opinion.

2.3. The Importance of Consumer's Satisfaction on Tourism

Tourism is an industry driven by the human nature of exploring and living different experiences (Chang, 2008). Thus, consumer satisfaction is of chief importance to attract visitors, who may choose to stay on a certain hotel based on its number of stars, amenities, or on what they read and see online (Moro et al., 2018a). Additionally, recent literature has added more features to such body-of-knowledge, including gamification awards (Moro et al., 2019) and consumers' published photos (Ma et al., 2018). Yet, literature is scarce in adopting a holistic view that encompasses all those features as inputs of a unique model able to understand which of those features contribute the most to guests' perceptions and subsequent evaluation of units. Achieving such task requires non-linear complex techniques that enable to compute each feature's contribution to the

defined target (Cortez & Embrechts, 2013). One of these techniques is based on support vector machines (SVM) and was used by Moro et al. (2017) to study guests' feedback about Las Vegas hotels at the user granularity level. The present study takes a different approach by focusing instead on the hotel granularity level.

2.4. Conceptual Model

Sainaghi (2011) proposed a model for explaining revenue per available room (RevPAR) based on two dimensions: (1) "what", including features such as size and stars; and (2) "where", based on the location. His results show that both dimensions influence RevPAR. The present study is framed by those two dimensions to propose a novel model supported by known features from previous studies to understand how each of them influences customer satisfaction (Figure 1). Those features are unfolded into the ones available in TripAdvisor. Notably, individual amenities encompass many features. The proposed model guides the research questions raised in the previous section, particularly, the "what" question regarding RQ1, and the "where" question regarding RQ2.

3. METHODOLOGY

3.1. Web Scraping and Knowledge Extraction Procedure

An experimental approach was implemented using two of the most popular data analysis scripting languages, Python and R, to achieve a fully automated procedure. It consisted of extracting all the required data through a specifically developed web scraping script, and in modeling the TripAdvisor's score for each registered hotel using a support vector machine (SVM). This enabled knowledge extraction from the model

using data-based sensitivity analysis (DSA) (Figure 2). DSA uses a randomly selected sample of the data to train the model and to assess its sensitivity by simultaneously varying the input features used for training the model through their range of possible values (Cortez & Embrechts, 2013), thus unveiling the most influential features in building each hotel's reputation in TripAdvisor. Although recent, both web scraping and DSA for knowledge extraction are not a novelty in tourism (see Johnson et al., 2012, for the former, and Moro et al., 2018b, for the latter). However, the combined use of both for a fully automated analysis of customer satisfaction of a large country across its regions has no precedent in previous literature. The major advantage of the proposed approach based on both methods is scalability. First, the model can be trained with any amount of collected reviews. Second, the model can be fed with any number of input features. The only limitation to the abovementioned advantages is computational capability. Third, DSA is independent of the modeling technique, thus it can be applied to any type of model, including other advanced machine learning techniques such as neural networks (Barraza et al., 2019).

3.2. Data Collection

The information concerning a total of 37,059 registered hotels was collected on July 27-30, 2017, from which 17 features that characterize each hotel were derived. Figure 3 depicts the information gathered per hotel (the names of the features displayed are used henceforth). From the initial dataset, 6,475 hotels were found to have missing values in features such as price and the number of rooms, denoting lack of investment in TripAdvisor. Hence, those hotels were removed, leaving a total of 30,584 for all the 50 US states. A few distinct features concealed similar hotel amenities (i.e., Figure 3: highlights; top.amenities; amenities; room.amenities; things.to.do). Thus, the individual amenities were computed based on those features, with each extracted amenity

constituting a new added feature. As a result, the final tuned dataset consisted of 30,584 hotels, each one characterized by 46 features, hence a volume of information requiring an automated analysis procedure such as the one proposed.

3.3. Data Analysis

The score on TripAdvisor to model was a numerical discrete value between 1 and 5 with an interval of 0.5 (overall statistics and per state are shown in Table 1). Therefore, the SVM became a support vector regressor.

A 10-fold cross-validation scheme was followed to achieve a robust model validation, similarly to experiments conducted by Moro et al. (2017). Such scheme consists in training the SVM with 9/10 of the hotels and then testing the built model with the remaining 1/10, iteratively shifting the fold used for testing, thus ensuring all data was used for both training and testing (Refaeilzadeh et al., 2009). To assess SVM's accuracy, two metrics were computed: the mean absolute error (MAE), which measures the deviation of the modeled score to the real one; and the mean absolute percentage error (MAPE), which is the ratio between MAE and the real score (Hyndman & Koehler, 2006), one of the most popular measures for forecasting error.

4. RESULTS AND DISCUSSION

4.1. Accommodation Offer per State

Figure 4 highlights the divergences in hotel offer across the states. In a mature hotel market as the US, the offer is adjusted to the regional market size. As such, the larger and more populous is the state, the higher is the number of hotel units and rooms available. In that sense, the largest states like California and Texas tend to offer larger

units (i.e., with more rooms per unit). The state of Nevada is a notable exception: its capital, Las Vegas, the notorious city of gambling and entertainment is driven by tourism (Moro et al., 2017) and offers the largest hotels in the US - the 18 largest hotels from the collected set, with more than 3 thousand rooms per unit, are all located in Las Vegas. When comparing the average number of stars per state with the average TripAdvisor score (Figure 5), it is possible to observe that customer satisfaction registered in TripAdvisor is clearly above the number of stars, although both encompassing a 1 to 5 scale. In addition, there is not a full convergence on both averages. Some states with a score above 4 have an average number of stars around 2.5 (e.g., Maine), while others have a number of stars clearly above 3 (e.g., Hawaii). This result is consistent with current literature since traditional rating systems are associated with the offered conditions and amenities, not reflecting the overall quality of the service (Stringam et al., 2010). The performance results for the 50 models were considered valid for knowledge extraction: MAPE ranged from 4.8% (Florida) to 14.7% (Rhode Island). Such results are consistent with current machine learning literature: a larger dataset (as it is the case for Florida, the state with more hotels) is likely to achieve a more robust model when compared to smaller datasets (e.g., Chen et al., 2012). Nevertheless, all the models achieved a good modeling performance when compared to similar studies (e.g., Moro et al., 2017, achieved a MAPE of 27%), validating them for knowledge extraction.

4.2. Customer Satisfaction Model

We have also modeled the TripAdvisor score for each one of the states using the previous feature set, composed of 46 features. The relative importance (i.e., contribution) of each one of the features to the score was obtained for each state, again using DSA. Figure 6 shows the resulting heat matrix, where each column represents a

state, identified by its abbreviation (see Figure 5). Thus, the sum of the rows for each state is 100%. Marked cells correspond to the top 30% values, while the darkest cells correspond to the top 10% values (14.2% is the highest value within the matrix). The features were collected through the process mentioned in Section 2. There is an apparent convergence of the high relevance of the top seven features highlighted in Figure 6. Nonetheless, there are some lighter spots across the darker frame observed in those seven rows. Notably, the number of photos hotels show on TripAdvisor is clearly less relevant in the most mature destinations, namely California, Florida, and New York (Tasci et al., 2018). One hypothesis for such finding derives from the strong brand image associated with these states, where there is no need to show the magnificent landscapes (Pan, 2010).

While looking at the features corresponding to amenities and observing the darker and whiter spots within the heat matrix, other findings emerge. Free parking tends to be more relevant in highly populated states (e.g., Florida, New Jersey) when compared to sparsely populated ones such as Delaware and Montana. Since most rooms in New York hotels are small, those that still have room for a refrigerator are appreciated by families¹, which is supported by Figure 6 when comparing NY to other states such as LA and NC. Being a non-smoking hotel is highly relevant in Nevada, likely due to the dichotomy between stressed gambling tourists unloading the pressure to win on cigars and the families in leisure trips annoyed with the load of smoke within hotels that allow smoking (York & Lee, 2010).

Another interesting result emerging from Figure 6 is the power of TripAdvisor as an influential tourism platform: the TripAdvisor Excellence award (“tripadvisor.excel”) emerges as a relevant feature for all states. According to TripAdvisor, the Excellence

¹ <http://www.nyctrip.com/pages/Index.aspx?PageID=1466>

award² is computed based on customers' reviews. However, the specific criteria used are not disclosed. Not even the algorithm for computing hotel's score is disclosed, strengthening TripAdvisor's influence over hotels (see a forum thread on the subject, answered by an identified TripAdvisor staff³). Furthermore, there is not a direct relationship between the score and the abovementioned award, as there are several hotels scoring 5 without the Excellence award, while some hotels with lower scores such as 3.5 still hold that award.

The moderating effect of location is observed by comparing the features shades in each column in Figure 6. Such effect is noticeable for some features. For example, in NY state, the great relevance of the features *family rooms*, *breakfast included*, and *refrigerator in room*, is evidence of a tourist segment visiting NY. Such result is aligned with the study by Ahn et al. (2017), who found that food is a great concern for families staying in NY hotels. A closer look at Figure 6 enables to uncover a type of amenity that seems to have always some influence on customer satisfaction: food-related amenities. In fact, *refrigerator in room*, *microwave*, and *kitchenette* are amenities that appear with relevance for many US states, thus appealing for basic food preparation and storing needs. Still related to food, *breakfast* is the most important meal in hotels, since people usually need a good meal for fresh-starting the day. Thus, in several states, breakfast available or included is valued, although there is little overlap (i.e., states where both appear in darker shades in Figure 6), showing evidence of the moderating effect of regions. Also, *smoking* patterns appear moderated by each state, considering there are nine states for which being a non-smoking hotel has relevance, while six give

² <http://www.tripadvisor.com/TripAdvisorInsights/n2290/frequently-asked-questions-about-certificate-excellence>

³ https://www.tripadvisor.com/ShowTopic-g1-i12104-k2230746-How_does_TA_calculate_hotel_ratings-Help_us_make_TripAdvisor_better.html

importance to non-smoking rooms, with only one state overlapping the importance of both features.

Recent studies in tourism concur on TripAdvisor's influence on tourism electronic word-of-mouth. As a result, empirical research is often conducted using TripAdvisor's data (e.g., Nicely & Ghazali, 2014; Calheiros et al., 2017). Recent research also shows that hotel managers are generally aware of the power of TripAdvisor (Ayeh et al., 2013). Yet, other online platforms are becoming increasingly important, and currently many sales-based platforms provide customer feedback tools, such as Booking.com (Moro et al., 2018b). Thus, online platforms are contributing to an information overload, to add to existing survey-based governmental databases and scholarly collected primary data. Such information richness is often explored by researchers to study a small list of specific feature's influence over a phenomenon. However, non-linear complex techniques such as SVMs can be fed with a large number of features. Furthermore, data can be combined to have an enriched dataset including several distinct sources and platforms (Moro et al., 2018b). National tourist offices can benefit from similar approaches to mine insightful knowledge that can enrich current governmental databases (Moro et al., 2018a). Nevertheless, both regional, national tourist offices and destination marketing organizations are still not fully exploring social media to understand what drives customer satisfaction (Tussyadiah et al., 2011).

The proposed model can be validated through the heat matrix presented in Figure 6. In general, the amenities are highly influenced by the location. This is an expected result, considering the appreciation of many amenities is dependent on context factors such as the weather (e.g., air conditioning). Yet, overall, amenities are less relevant than the remaining four features (price, stars, size, number of published photos). Conversely, price, stars, and hotel size are less subjected to location influence, but have a high

impact on customer satisfaction. This has direct managerial implications for global chains operating different segment-brands across the US, suggesting a globalization effect on the US. The “number of photos” feature also highly influences customer satisfaction, but on a different scale. Specifically, the TripAdvisor Excellence award appears to have a homogeneous effect, while having an own website or even having published photos is moderated by the location. Thus, the two research questions can be answered as follows: (RQ1) customer satisfaction is highly influenced by the hotel number of photos, size, stars, and price, and also by the offered amenities, although at a smaller scale; and (RQ2) the amenities and the hotel number of photos are moderated by the location (i.e., state) when explaining customer satisfaction, although price, size, and stars are not.

5. CONCLUSIONS

This study highlights the convergent and divergent factors contributing to TripAdvisor score in each of the 50 US states. Features such as the number of rooms, price, and the number of stars contribute highly to hotels’ score in all states, although at different levels. Likewise, the amenities’ observed relevance showed that each state has adapted its respective offer to meet regional demand. For example, in the hot dry weather of Arizona, it is crucial that hoteliers keep their air conditioning units in proper operation. Our study also unveiled that guests visiting Nevada are highly sensitive to the non-smoking issue, but on a unit level. Thus, it is not enough that units offer non-smoking rooms, since guests are demanding non-smoking lobbies and common spaces. Additionally, the results revealed that a huge and mature tourism market such as the US where the large majority of the population has access to the Internet and uses social

media is highly influenced by TripAdvisor's awards. The validated model provides evidence of the influence of five major hotel features on customer satisfaction: hotel price, stars, size, number of photos, and amenities. The two latter were found to be highly moderated by the location, while the former three were not. Some major contributions emerge, related to the moderating effect of regions on amenities. First, the same segments of visitors in a region can leverage the relevance of some amenities valued by these visitors (e.g., families appreciate more *refrigerator in room* when visiting NY in comparison to other states). Second, at least one food-related amenity is accountable for some relevance in customer satisfaction, although which amenity depends on the state. Hoteliers should pay special attention to food and analyze competition to understand if competitors are offering the amenity that is most valued by their region's visitors.

However, there are some limitations that should be noted. The analysis is limited to TripAdvisor as the single source and, although it provides a large amount of information, a richer dataset might be compiled by aggregating other sources such as governmental databases, and survey responses, as well as other online platforms. Also, the results are restricted to the large US market. Finally, the hotel-granularity level analysis prevents an evaluation of individual features influencing guests, such as the cultural origins. Thus, it would be interesting in future research to extend the proposed approach to other distinct markets to assess if those awards also play such a significant role as observed for the US. Furthermore, it would be also of interest to build in the future a model that could mimic hotel scores based on individual user reviews, helping to add transparency to this widely used platform. Such research could be developed using the same tools presented in this study. The information and sources' overload also suggest enriching data collected from TripAdvisor with external governmental

databases and/or primary collected data from surveys. Given the SVM is able to include a large number of input features, a model could be trained to validate if the US national tourist office's perception is aligned with customer satisfaction.

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Table 1 - Statistics on TripAdvisor's score for the 30,584 hotels.

State	Nr. hotels	Nr. Rooms (k)	Mean	SD
Alabama	728	63	3.63	0.84
Alaska	162	15	3.70	0.67
Arizona	824	97	3.91	0.56
Arkansas	535	40	3.71	0.75
California	1045	166	4.27	0.34
Colorado	810	82	4.11	0.44
Connecticut	309	36	3.64	0.72
Delaware	121	11	3.72	0.76
Florida	1082	209	4.31	0.33
Georgia	973	109	4.04	0.42
Hawaii	186	53	4.08	0.49
Idaho	238	20	3.90	0.70
Illinois	925	131	4.02	0.43
Indiana	778	74	3.64	0.76
Iowa	592	45	3.76	0.70
Kansas	491	39	3.73	0.69
Kentucky	608	55	3.72	0.72
Louisiana	741	86	3.68	0.79
Maine	357	24	4.02	0.62
Maryland	587	73	3.69	0.67
Massachusetts	650	74	3.80	0.70
Michigan	790	81	4.00	0.45
Minnesota	697	69	3.85	0.69
Mississippi	517	49	3.54	0.81
Missouri	858	90	3.80	0.67
Montana	352	25	3.89	0.64
Nebraska	335	28	3.79	0.73
Nevada	410	195	3.68	0.66
New Hampshire	254	19	3.92	0.62
New Jersey	774	90	3.62	0.70
New Mexico	520	43	3.71	0.69
New York	967	147	4.21	0.39
North Carolina	917	98	4.15	0.40
North Dakota	245	21	3.96	0.64
Ohio	935	99	4.04	0.45
Oklahoma	634	56	3.68	0.78
Oregon	752	59	3.77	0.69
Pennsylvania	943	107	4.09	0.46
Rhode Island	106	10	3.72	0.76
South Carolina	859	97	3.66	0.75
South Dakota	299	21	3.84	0.62
Tennessee	877	92	3.94	0.51
Texas	1045	155	4.28	0.36
Utah	510	46	3.82	0.69
Vermont	161	12	3.84	0.64
Virginia	959	118	4.03	0.45
Washington	817	84	3.82	0.65

West Virginia	248	24	3.76	0.76
Wisconsin	753	66	3.96	0.52
Wyoming	308	23	3.76	0.74
ALL	30584	3523	3.91	0.64

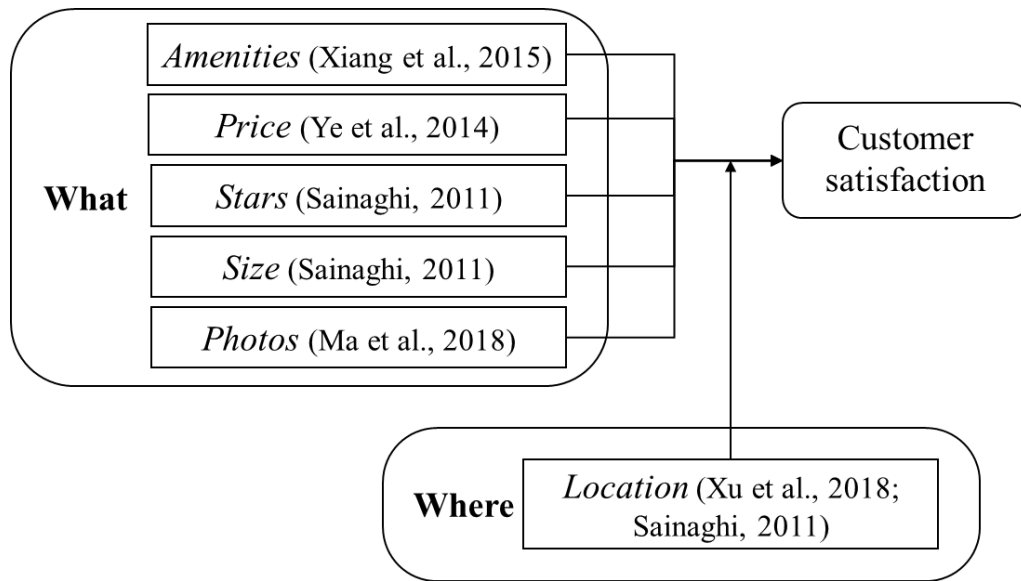


Figure 1 - Proposed conceptual model.

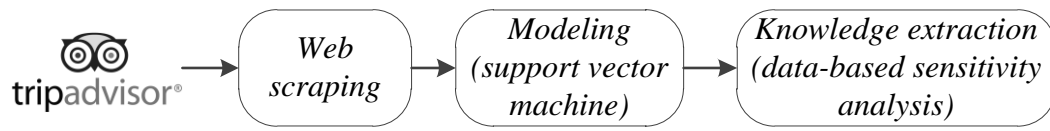


Figure 2 - Experimental approach.

Auberge du Soleil

704 Reviews | #1 of 2 Hotels in Rutherford | **has.website**
 180 Rutherford Hill Rd., Rutherford, CA 94573 | 00 1 707-310-8561 | **Hotel website**

score | **nr.reviews** | **state**

Best prices for your stay
 8/20/2017 - 8/21/2017
 1 room | 2 adults | 0 children

Expedia	\$1,174	View Deal
Booking.com	\$1,175	View Deal
agoda	\$1,175	View Deal

nr.photos

Free Wifi | **Free Parking** | **Breakfast included** | **Air Conditioning** | **Pool**

5.0 Star Hotel
 All hotel details
stars

highlights

Awards & Recognition

eco.level
 GreenLeaders Gold level
 Certificate of Excellence

trav.choice
 Travelers' Choice 2017 Winner

tripadvisor.excel

Details

price.min | **price.max**
 PRICE RANGE: \$883 - \$4,506 (Based on Average Rates for a Standard Room)

price.min | **price.max**
 HOTEL CLASS: ★★★★★

ROOM TYPES: Suites, Non-Smoking Rooms

nr.rooms
 NUMBER OF ROOMS: 50

Amenities

TOP AMENITIES	HOTEL AMENITIES	ROOM AMENITIES	THINGS TO DO
Pool	Room Service	Air Conditioning	Pool
Restaurant	Free Parking	Refrigerator in room	Restaurant
Fitness Center with Gym / Workout Room	Dry Cleaning	Minibar	Fitness Center with Gym / Workout Room
Room Service	Meeting Rooms		Bar/Lounge
Bar/Lounge	Business Center with Internet Access		Spa

top.amenities | **amenities** | **room.amenities** | **things.to.do**

Figure 3 - Features extracted (example for the case of Auberge du Soleil, California).

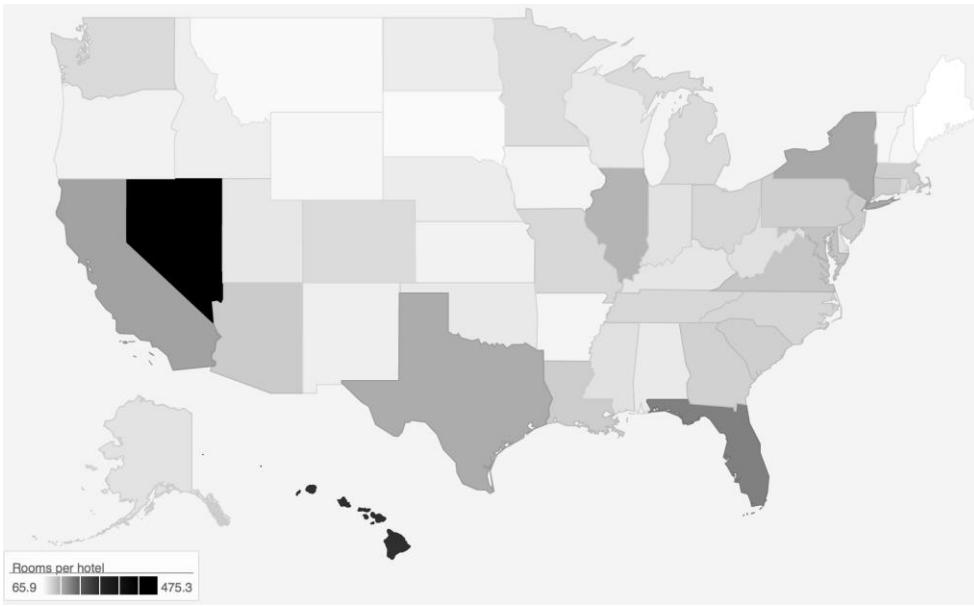


Figure 4 – Average number of rooms per hotel.

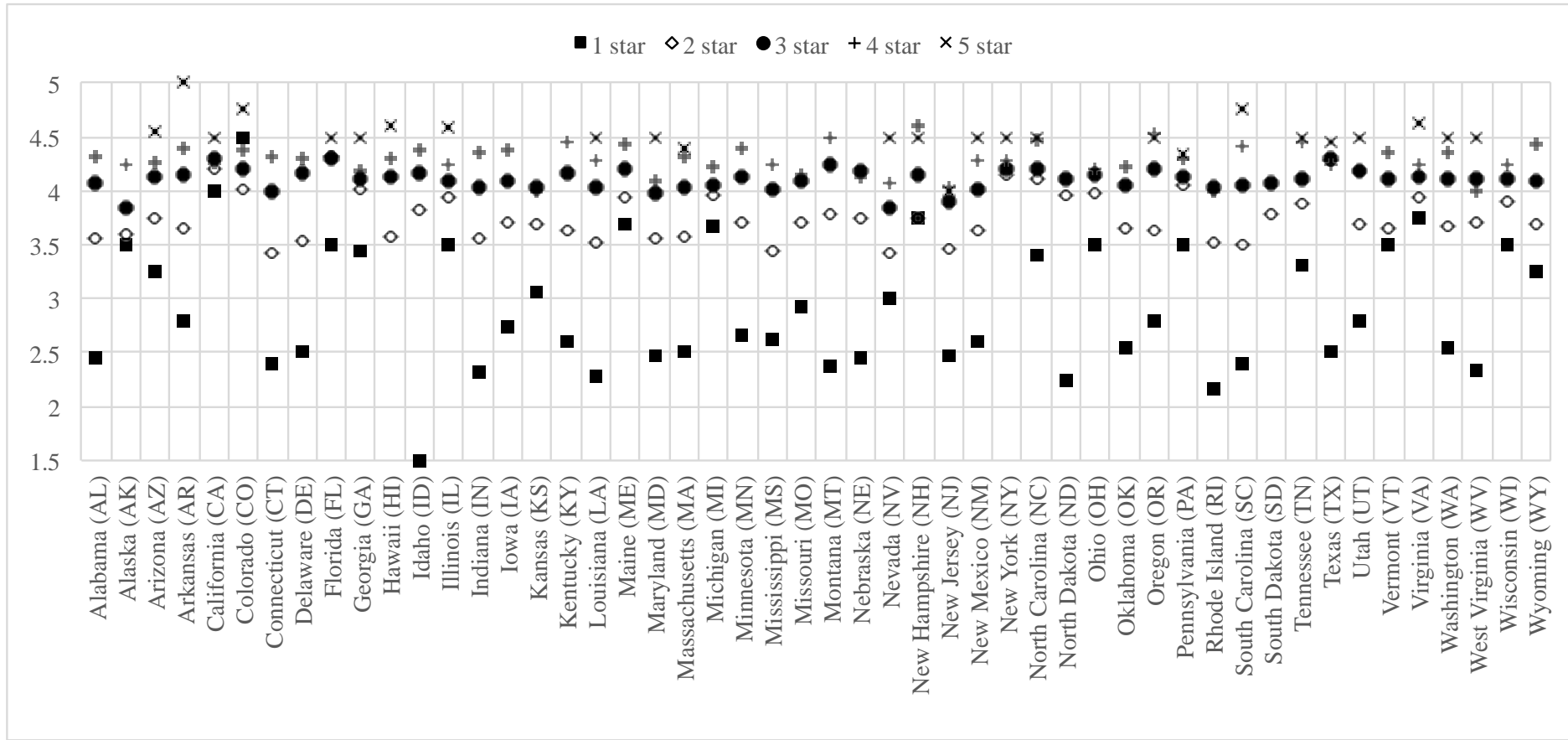


Figure 5 - TripAdvisor score by hotel stars and US state.

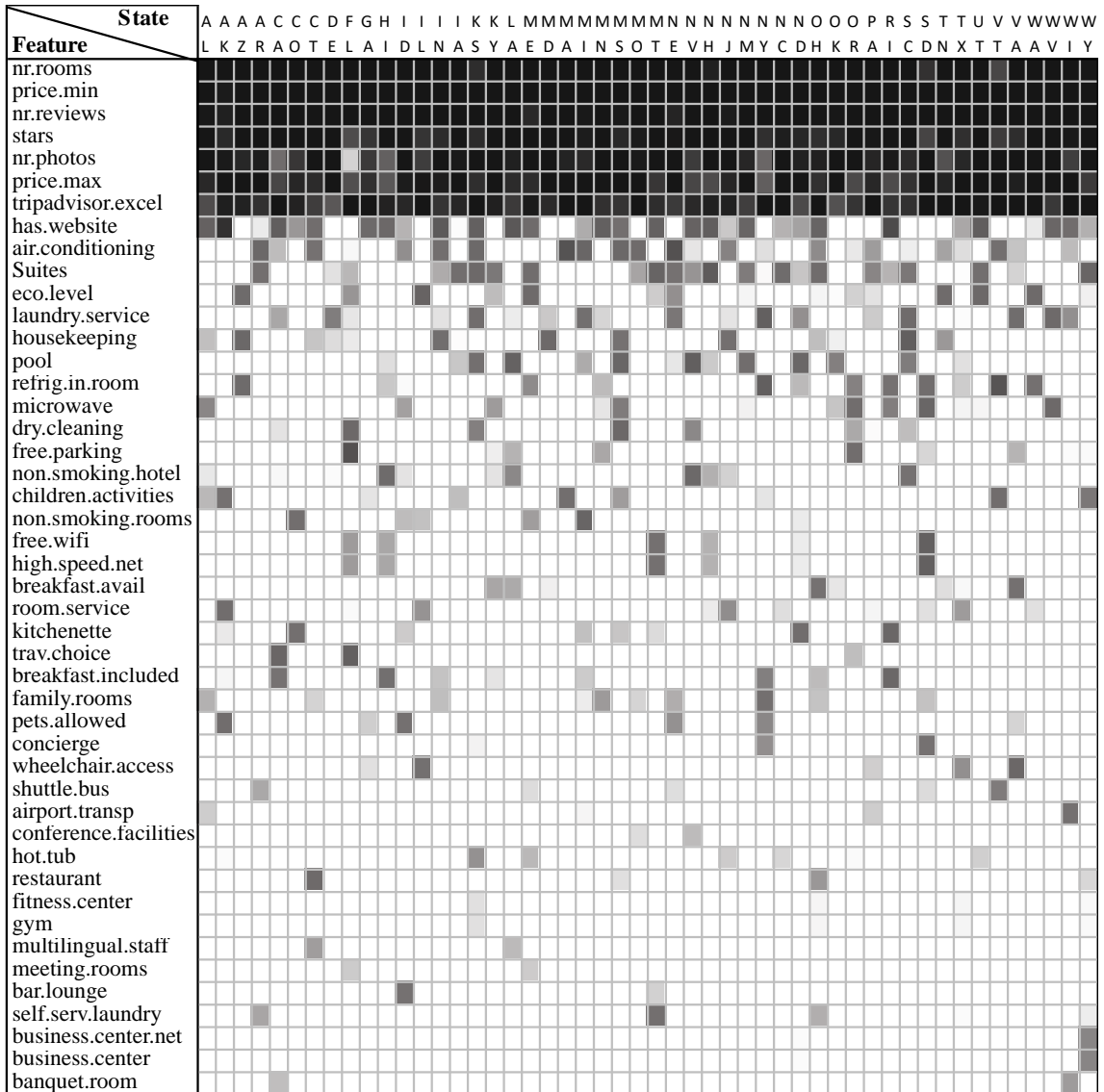


Figure 6 - Heat matrix.