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Overnight Pleasure Travellers' Activities in Canada: Using Association Rule Mining to Discover Relationships

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Abstract

The study attempted to find out the association among travel activities participated in by international overnight pleasure travellers through association discovery mining, using the 2004 International Travel Survey (ITS) by Statistics Canada, and to identify some applicability of the technique in travel and tourism research. As a result, the study identified the strengths of the travel activity combinations, and meaningful association rules in activities participated in are discovered.

Introduction

In travel and tourism literature, many variables have been suggested as useful tools to understand tourists' behaviour and help marketers implement strategies, including tourists' sociodemographic, psychographic, geographic, behavioural characteristics and product related items, and so on (Pearce, 2005). In particular, the choice of attractions or activities at destinations by travellers is determined by differences in the characteristics of the destinations visited, the travel elements that can be purchased prior to departure, as well as the characteristics of travellers to those destinations (Hyde, 2004). However, travel activities in and of themselves are known as useful indices to understand tourists' behaviour (Backman & Uysal, 1987; McIntosh & Goeldner, 1990) and to identify their experiences at the destination (Ryan, 2002).

The tourism industry has paid attention to travellers' needs, wants and preferences by supplying a much greater inventory of facilities, packages and services. Certain travellers may prefer sightseeing, visiting landmarks or visiting historic places, while others may focus on different activities such as swimming, water sports or sunbathing (Hsieh, O'Leary, & Morrison, 1992). From a broader view, the different types of preferred activities participated in can be considered subgroups of the total travel market. For the travel industry, it can improve industry profitability by enhancing appeal to target markets, attracting new markets and/or increasing customer volume in off-peak periods. For the travellers, activity 'packages' can give them more convenient vacation planning, more economic travel, and greater desire for specialized activities and experiences. Morrison (1989) suggested that the application of 'activity types' can provide advantages to both the travel industry and the travellers. Investigating the interrelationship

among travel activities undertaken on holidays or pleasure trips provides useful insights for the destination (Prentice, 1992).

Therefore, it is important to determine whether travellers who participate in travel activity “A” are also involved in activity “B”, and whether these items should be in close proximity to each other (Chena, Tang, Shena, & Hua, 2005; SAS Institute, Inc., 2003, 2004; Zhang & Zhang, 2002). Tourism marketers at destinations want to examine their tourist base and to understand which of their travel activities (or products and services) tend to be participated in (purchased) together.

On the basis of this brief discussion of the issues for tourism marketers or destinations, the following research questions are addressed: (1) what proportion of the travellers who participated in travel activities A and B also participated in activity C? (2) can the frequency of the combination of travel activities participated in by travellers be identified? (3) if so, can the strength of the combination of travel activities participated in by travellers also be examined?

The purposes of the study are to identify the association rule among international overnight pleasure travellers’ activities in Canada and to explore some applicability of association rule mining technique from the top three countries selected.

Association Rule Mining

Association rule is one of the most powerful data mining techniques because it provides relationships among product items purchased by customers. The goal of this method is to find interesting associations and correlation relationships amongst large sets of data items where the presence of one set of items in a transaction implies the presence of other items (Agrawal, Imielinski, & Swami, 1993). Association discovery is the identification of items that occur together in a given event or record (SAS Institute, Inc., 2004). This technique is also known as market basket analysis. Market basket analysis was originally devised for use in grocery stores (Berry & Linoff, 1997). In data mining techniques, association rule analysis generally involves the process of a particular event given the occurrence of other events for market basket analysis (SAS Institute, Inc., 2003).

For instance, what is the probability or percentage occurrence that a consumer will purchase product A if they also buy product B. This technique incorporates the use of frequency and probability functions to estimate the percentage chance of occurrences (Kudyba & Hoptroff, 2001). The purpose of association analysis is to count the number of times items occur alone or in the same shopping cart together (combination) to construct statistics to tell the tale of the strength and reliability of the item-to-item affinities detected (Adriaans & Zantinge, 1996). Market basket analysis counts the number of times every item occurs with every other item (in pairs, triplets, quadruplets, etc.).

Noticeably, the confidence factor, level of support, and lift are three important evaluation criteria of association discovery (Chena, Tang, Shena, & Hua, 2005; SAS Institute, Inc., 2003, 2004; Zhang & Zhang, 2002). The strength of an association is defined by its confidence factor, which is the percentage of cases in which a consequent appears given that the antecedent has occurred. The level of support is how frequently the combination occurs in the market basket (database). Lift is equal to the confidence factor divided by the expected confidence. Lift is a factor by which the likelihood of consequent increases given an antecedent. And expected confidence is equal to the number of consequent transactions divided by the total number of transactions. Consider the rule “travel activity (item) A \Rightarrow B” in which A and B each represent one travel activity, and then observe the following:

Support (%) for $A \Rightarrow B$ is the percentage of all travellers who participated in both A and B. Support is a measure of how frequently the rule occurs in the database. Therefore, the formula is:

$$\text{Support (\%)} = \frac{\text{Number of both Travel Activities "A" and "B" Participated}}{\text{Total Number of Occurrences (Transactions)}} = \frac{\text{count}(A \cup B)}{m} = P(A \cap B)$$

where $\text{count}(A \cup B)$ represents the number of transactions (occurrences) which contains all items (activities) in A or B, m is the number of transactions in the database., and p denotes probability.

Confidence (%) for $A \Rightarrow B$ is the percentage of all travellers who participated in both A and B, divided by the number of travellers who participated A. Often confidence is understood as the conditional probability $P(B|A)$, where the definition below is seen as an estimate for this probability (Hipp, Guntzer, & Nakhaeizadeh, 2000). Thus, the formula can be expressed:

$$\text{Confidence (\%)} = \frac{\text{Number of both Travel Activities "A" and "B" Participated}}{\text{Number of Occurrences including Travel Activity "A"}} = \frac{P(A \cap B)}{P(A)} = P(B | A)$$

Lift of $A \Rightarrow B$ is a measure of strength of the association. If Lift = 2 for the rule $A \Rightarrow B$, then a traveller participating in travel activity "A" is twice as likely to involve in activity "B" as a traveller chosen at random. The formula for Lift can be calculated:

$$\begin{aligned} \text{Lift} &= \frac{\text{Number of both Travel Activities "A" and "B" Participated} \times \text{Total Number of Occurrences}}{\text{Number of Occurrences including Travel Activity "A"} \times \text{Number of Occurrences including "B"}} \\ &= \frac{P(A \cap B)}{P(A)P(B)} = \frac{P(A|B)}{P(B)} = \frac{\text{Confidence}}{P(B)} \end{aligned}$$

Therefore, association rule mining in this study identified groupings of travel activities that tended to be participated or involved in at the same time or at different times by the same overnight pleasure travellers selected. This association discovery analysis answered the questions as follows: what proportion of overnight pleasure travellers who participated in travel activity A and B also participated in activity C? This technique has contributed to a number of benefits such as impulse buying, customer satisfaction, actionable promotions, product bundling, stock inventory, etc. (Fernandez, 2003).

Despite these benefits, Berry and Linoff (1997) have provided some limitations of association rule mining as follows. First, it is necessary to have a large number of real transactions to get meaningful data, but the accuracy of the data is compromised if all of the products and services do not occur with similar frequency. Second, association rule mining can sometimes present results that are actually due to the success of previous marketing campaigns. Third, they sometimes can be trivial and inexplicable and may not always be useful. The result may not be obvious to anyone without some familiarity with the industry at hand or business acumen, and therefore does not necessarily lend itself to immediate use for cross selling.

Methodology

Data source. Canada's International Travel Survey (ITS) data was used for this study. It contains four main parts: Canadian resident trips abroad, Canadian resident trips to United States, overseas resident trips to Canada, and United States resident trips to Canada (Statistics Canada, 2004a, 2004b). Of the four main categories, the two data sets of overseas resident trips to Canada and U.S. resident trips to Canada in 2004 were used.

Samples. As shown in Table 1, a total of 2,265 samples of British travellers, 701 of Japanese travellers, and 41,639 of US travellers to Canada were collected in 2004. Of these, 1,025 of British, 311 of Japanese, and 10,097 of US were overnight pleasure travellers. However, final samples used were re-generated on the basis of the respondents' travel activities. The total possible number of samples was calculated using the raw data of overnight pleasure trips in each country \times 12 (number of travel activities used in this study). Thus, the final number of samples is a function of how many travel activities were selected by each respondent.

Table 1. Total Number of Data collected and Samples used

Country	Total Number of Samples	Overnight Trips	Overnight Pleasure Trips	
			Raw Data	Samples created*
England	2,265	2,199	1,025	3,919
Japan	701	641	311	619
U.S.A.	41,639	18,894	10,097	23,770

Note: * indicates new data sets used in this study.

Travel activity measures. Travellers report all activities in which they have taken part during the trip rather than during their visit. However, the ITS consists of 19 specific activity variables, including (1) visiting friends or relatives, (2) attending a festival or fair, (3) attending a cultural performance (a play, a concert, etc), (4) visiting a museum or art gallery, (5) visiting a historic site, (6) visiting a zoo, aquarium or botanical garden, (7) attending a sports event, (8) shopping, (9) sightseeing, (10) going to a bar or night club, (11) going to a casino, (12) visiting a theme or amusement park, (13) visiting a national or provincial nature park, (14) participating in sports or outdoor activities, (15) boating (motor boat, sail boat, kayak, canoe or other), (16) golfing, (17) downhill skiing or snow boarding, (18) hunting, and (19) fishing. All activities were originally coded by using each activity's ID number above.

Table 2. Descriptive Statistics for the Travel Activities used in the Study

Travel Activity	England		Japan		U.S.A.	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
TA1. Visiting friends or relatives	399	10.2	59	9.5	1,721	7.2
TA2. Attending a festival or fair	132	3.4	13	2.1	1,083	4.6
TA3. Attending a cultural performance	171	4.4	13	2.1	1,451	6.1
TA4. Visiting a museum or art gallery	472	12.0	68	11.0	3,054	12.8
TA5. Visiting a historic site	524	13.4	61	9.9	3,980	16.7
TA6. Visiting a zoo, aquarium or botanical garden	331	8.4	43	6.9	1,554	6.5
TA7. Attending a sports event	115	2.9	10	1.6	460	1.9
TA8. Going to a bar or night club	486	12.4	35	5.7	2,309	9.7
TA9. Going to a casino	75	1.9	31	5.0	815	3.4
TA10. Visiting a theme or amusement park	79	2.0	26	4.2	393	1.7
TA11. Visiting a national or provincial nature park	681	17.4	185	29.9	3,300	13.9
TA12. Participating in sports or outdoor activities	454	11.6	75	12.1	3,650	15.4
Total	3,919		619		23,770	

In this study, seven activity items (“shopping”, “sightseeing”, “boating (motor boat, sail boat, kayak, canoe or other)”, “golfing”, “downhill skiing or snow boarding”, “hunting”, and “fishing”) were eliminated from analysis because the percentage of their frequencies was relatively too high (or too low) compared to other activities and some of them are specific seasonal activities. Table 2 presents descriptive statistics for the travel activities used in this study.

Findings

British travellers’ activities. The results with the most significant rules in the British travellers’ activities are presented in Table 3. According to the lift value for Rule 14, a traveller who participated in TA12 (participating in sports or outdoor activities), TA6 (visiting a zoo, aquarium or botanical garden), and TA5 (Visiting a historic site) is about twice as likely to visit a national or provincial nature park (TA11), go to a bar or night club (TA8), and visit a museum or art gallery (TA4) as a traveller taken at random. However, of the British travellers who participated in TA12, TA6, and TA5, 44.05% (confidence) took part in TA11, TA8, and TA4. The support (%) for this rule, unfortunately, is very low (3.68%), indicating that the event in which both travel activities are related (occurred) together is relatively rare ($n = 37$).

39.4% (Support) of all British overnight pleasure travellers participated in TA5 (visiting a historic site) and TA11 (visiting a national or provincial nature park) (Rule 2). Of the British travellers who participated in TA5, 75.57% (confidence) involved in TA11. However, the lift for this Rule 2 indicates that a traveller who visited a historic site (TA5) is only about 1.12 times as likely to visit a national or provincial nature park (TA11) as a traveller taken at random.

Table 3. Summary of the Most Significant Association Rules for Activities for British Overnight Pleasure Travellers to Canada

Relation Set Size	Confidence (%)	Support (%)	Lift	Count (n)	Rule	Rule ID
2	34.09	4.48	2.00	45	2 \Rightarrow 3	1
2	75.57	39.40	1.12	396	5 \Rightarrow 11	2
2	78.25	25.77	1.15	259	6 \Rightarrow 11	3
3	37.39	4.28	1.98	43	7 \Rightarrow 8 & 1	4
3	73.91	8.46	1.57	85	5 & 3 \Rightarrow 4	5
3	69.19	27.26	1.47	274	11 & 5 \Rightarrow 4	6
3	87.22	15.62	1.29	157	12 & 4 \Rightarrow 11	7
4	45.00	3.58	2.27	36	4 & 2 \Rightarrow 5 & 1	8
4	81.76	13.83	1.57	139	11 & 8 & 4 \Rightarrow 5	9
4	93.33	6.97	1.38	70	12 & 6 & 4 \Rightarrow 11	10
5	50.60	4.18	2.28	42	12 & 5 & 1 \Rightarrow 8 & 4	11
5	69.30	7.86	1.76	79	12 & 8 & 4 \Rightarrow 11 & 5	12
5	93.88	4.58	1.39	46	12 & 8 & 6 & 5 \Rightarrow 11	13
6	44.05	3.68	2.60	37	12 & 6 & 5 \Rightarrow 11 & 8 & 4	14
6	78.72	3.68	2.00	37	12 & 8 & 6 & 4 \Rightarrow 11 & 5	15
6	97.37	3.68	1.44	37	12 & 8 & 6 & 5 & 4 \Rightarrow 11	16

Note: Numbers in column of the “Rule” indicate travel activity (TA) items’ ID number in Table 2.

Expressed in another way, British overnight pleasure travellers who participated in sports or outdoor activities (TA12), went to a bar or night club (TA8), visited a zoo, aquarium or botanical garden (TA6), visited a historic site (TA5), and visited a museum or art gallery (TA4), 97.37% (confidence) visited a national or provincial nature park (TA11) (Rule 16). However, the lift and support for Rule 16 indicates that a traveller who took part in activities like TA12, TA8, TA6, TA5, and TA4 is only about 1.44 times and 3.68% ($n = 37$) as likely to be involved in TA11 (visiting a national or provincial nature park) as other travellers taken at random.

Japanese travellers' activities. The results with the most significant rules for Japanese travellers' activities are presented in Table 4. According to the lift value for Rule 3, a traveller who visited a national or provincial nature park (TA11) and a theme or amusement park (TA10) is about 2.95 times as likely to visit a historic site (TA5) as a traveller taken at random. Of the Japanese travellers who participated in TA11 and TA10, 64.29% (confidence) participated in TA5. However, the support (%) for this rule 3, unfortunately, is very low (3.21%), indicating that the event in which both travel activities are related (occurred) together is relatively rare ($n = 9$).

18.21% (Support) of all Japanese overnight pleasure travellers participated in visiting a historic site (TA5) and visiting a national or provincial nature park (TA11) (Rule 2). Of the Japanese travellers who participated in TA5, 83.61% (confidence) took part in TA11. However, the lift for this Rule 2 indicates that a traveller who visited a historic site (TA5) is only about 1.27 times as likely to visit a national or provincial nature park (TA11) as a traveller taken at random.

Expressed in another way, the Japanese overnight pleasure travellers who participated in visiting a theme or amusement park (TA10) and a historic site (TA5), 90% (Confidence) visited a national or provincial nature park (TA11) (Rule 5). However, the lift and support for Rule 5 were low, indicating that a traveller who engaged in activities like TA10 and TA5 is only about 1.36 times and 3.21% ($n = 9$) as likely to be involved in TA11 (visiting a national or provincial nature park) as a traveller taken at random.

Table 4. Summary of the Most Significant Association Rules for Activities for Japanese Overnight Pleasure Travellers to Canada

Relation Set Size	Confidence (%)	Support (%)	Lift	Count (n)	Rule	Rule ID
2	38.46	3.57	2.50	10	10 \Rightarrow 6	1
2	83.61	18.21	1.27	51	5 \Rightarrow 11	2
3	64.29	3.21	2.95	9	11 & 10 \Rightarrow 5	3
3	45.24	6.79	2.08	19	11 & 4 \Rightarrow 5	4
3	90.00	3.21	1.36	9	10 & 5 \Rightarrow 11	5

Note: Numbers in column of the "Rule" indicate travel activity (TA) items' ID number in Table 2.

US travellers' activities. The results with the most significant rules in the US travellers' activities are presented in Table 5. According to the lift value for Rule 4, a traveller who visited a museum or art gallery (TA4) and attended a festival or fair (TA2) is about 2.97 times as likely to attend a cultural performance (TA3) as a traveller taken at random. Of the US travellers who participated in TA4 and TA2, 46.34% (confidence) were involved in TA3. The support (%) for this rule, unfortunately, is very low (2.25%), indicating that the event in which both travel activities are related (occurred) together is relatively rare ($n = 209$ of the total).

23.66% (Support) of all US overnight pleasure travellers participated in TA11 (visiting a national or provincial nature park) and TA5 (visiting a historic site) (Rule 2). Of the US travellers who participated in TA11, 66.54% (confidence) were involved in TA5. However, the lift for this Rule 2 indicates that a traveller who visited a national or provincial nature park (TA11) is only about 1.56 times as likely to visit a historic site (TA5) as a traveller taken at random.

Furthermore, of those US overnight pleasure travellers who visited a national or provincial nature park (TA11), a museum or art gallery (TA4), and attended a cultural performance (TA3), 86.27% (Confidence) visited a historic site (TA5) (Rule 9). In addition, the lift for this Rule 9 indicates that a traveller who participated in TA11, TA4, and TA3 is about 2.01 times as likely to visit a historic site (TA5) as a traveller taken at random. However, only 3.11% (Support) of the total US overnight pleasure travellers participated in four activities together ($n = 289$).

Table 5. Summary of the Most Significant Association Rules for Activities for US Overnight Pleasure Travellers to Canada

Relation Set Size	Confidence (%)	Support (%)	Lift	Count (n)	Rule	Rule ID
2	35.83	4.17	2.29	388	2 \Rightarrow 3	1
2	66.64	23.66	1.56	2,199	11 \Rightarrow 5	2
2	61.65	10.31	1.44	958	6 \Rightarrow 5	3
3	46.34	2.25	2.97	209	4 & 2 \Rightarrow 3	4
3	83.59	2.36	1.95	219	9 & 4 \Rightarrow 5	5
3	82.94	14.22	1.94	1,322	11 & 4 \Rightarrow 5	6
4	44.47	4.58	2.59	426	6 & 5 \Rightarrow 11 & 4	7
4	54.20	4.58	2.30	426	11 & 6 \Rightarrow 5 & 4	8
4	86.27	3.11	2.01	289	11 & 4 & 3 \Rightarrow 5	9

Note: Numbers in column of the “Rule” indicate travel activity (TA) items’ ID number in Table 2.

Conclusions

In this study, association rules examined the strengths of the travel activity combinations of the selected three countries’ overnight pleasure travellers to Canada. As a result, the study shows that the most significant association rules in overnight pleasure travellers’ activities participated in can be determined by mining the data.

In summary, British travellers were more likely to engage in diverse activity combinations such as participating in sports or outdoor activities, visiting a zoo, aquarium or botanical garden, a historic site, and a national or provincial nature park, going to a bar or night club, and visiting a museum or art gallery, while Japanese travellers tended to participate in the activity combinations such as visiting a national or provincial nature park, a theme or amusement park, and a historic site. Some of the US travellers were more likely to be involved in cultural activity combinations such as visiting a museum or art gallery, attending a festival or fair and a cultural performance, while some of them tended to engage in a mix of cultural activities and visiting a national or provincial nature park and a historic site.

On the basis of these results, tourism marketers need to emphasize diverse activities including sports and outdoor activities, culture, nature, parks, and evening entertainment for British travellers, nature, parks and history for Japanese travellers, and cultural activities for US travellers. Thus, the results imply that tourism marketers can use the travel activity association

rules for specific markets when they promote or develop activity-based travel products and services or travel packages.

Generating association rules can be a useful starting point for exploring unfamiliar data. Rules can help uncover interesting patterns that merit further examination. However, this study is exploratory rather than explanatory as an attempt to identify some applicability of the technique in travel and tourism research, meaning that much further research is needed using advanced research techniques.

It is expected that more knowledge discovery and advanced data analysis tools will be adopted in travel and tourism to help marketing practices and research. This study will contribute to stimulating interest in this subject among academics and practitioners. Understanding tourism, research, and IT together are the skills that are imperative to be successful in pulling together the knowledge discovery process in destinations (Jeffrey, 1996; Palmquist & Ketola, 1999; Pyo, 2005a, 2005b) and to understand the meaning of the data and apply it to the real world of tourism.

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