Availability of Cloud AI in planning and conducting tourism measure for regional revitalization

How to utilize cloud AI：Masahiro Okuma

The government promotes regional revitalization, particularly, although tourism promotion is an important measure, it is necessary to grasp tourism trends for tourism promotion.

However, the statistical methods conventionally used for grasping tourism trends have some problems.

In this paper, we will consider the solution for problems to grasp tourism trends by performing analysis combining image analysis and natural language processing using AI services provided by cloud companies and it was confirmed that the solution had certain effects.

Key Words & Phrases ：Tourism, cloud AI, image analysis, NLP, clustering

１． Introduction

In recent years, Japan is facing a social problem of population decline and super-aging. Since this tendency is more pronounced in the rural areas, in 2014, the government decided on a "town, person, work creation comprehensive strategy" [1] to promote local creation together with the local government, aiming for regional activation. Above all, tourism promotion is considered as one of the important policies, coupled with the increase of foreign tourists due to coming Tokyo Olympics. In "The Tourism Vision Conception Conference to Support Japan of Tomorrow" [2], a policy meeting in Japan, "polishing pride Japan's abundant and diverse tourism resources and communicating the value to both Japanese and non-Japanese people in an easy-to-understand manner" is cited as an issue.

For realizing these, grasping tourism trend is necessary. In many cases, statistical methods are used, but there are some problems such as time and cost.

In recent years, AI has attracted attention as a mean of solving problems related to such measures. However, the use of AI requires a high level of expertise, and there is a shortage of human resources. But recently, cloud operator companies provide cloud AI that can be easily used. Therefore, we use Cloud AI and examine the method of problem solution for grasping the tourism trend in the planning and implementation of tourism measures.

Note that in this paper, cloud AI is defined as an AI service provided by a cloud provider.

２． Problem to affect tourism measure

2.1 Utilization of statistics and problems

Statistics are used for tourism planning in each area. Currently, in Japan Tourism Agency in order to make use of the tourism measures, it takes about one year to tabulate the statistics of tourists entering each prefecture [3] (hereinafter referred to as "Tourism Agency Statistics") in each prefecture, and strives to grasp the current situation.

However, there are two problems in using statistics.

First problem is that statistics are time-consuming and costly. In fact, in Tourism Agency Statistics, some are in the process of tallying even in the statistics three years ago.

In addition, according to the "2016 Japan Tourism Agency budget summary" [4], a budget of over 600 million yen is spent on development of statistics.

Second problem is that qualitative and detailed information for statistics will be missed. Generally, in statistics, qualitative and specific information is not expressed because information is aggregated as numbers for defined attribute items.

2.2 Examination of methods that can solve problems

Based on the above, method that can classify and summarize data timely and at low cost, or a method that can acquire qualitative and high-resolution information for grasping tourism trends is necessary.

Therefore, in this paper, we discuss some methods to obtain useful knowledge by analyzing travel images obtained from SNS with Cloud AI as a mean to realize such methods, and discuss the results of verification.

According to DAC's survey “Self-interested

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member asking“ SNS utilization of travel destination “fact-finding”[5], more than half of people use SNS for sightseeing, and travel images posted on SNS is considered to be a useful material for planning and implementing tourism measures.

Chapter 3 describes the results of examining whether image analysis can substitute Tourism Agency Statistics for purpose of grasping tendency as a tourist spot in each area.

Chapter 4 describes the results of examining whether it is possible to excavate tourism resources buried from image analysis results as a method of utilizing information that cannot be expressed as statistics.

Finally, this chapter is summarized in Chapter 5.

３. Grasping trend about tourism using image analysis

In this chapter, we verified if it is possible to grasp tendency that can be grasped from the number of customers entering for each tourist spot indicated by the Tourism Agency Statistics from image analysis with Cloud AI.

If this is possible, it is possible to substitute statistics and reduce time and cost involved in grasping tourism trends using statistics.

3.1 Hypothesis

Cloud AI, which aims at image analysis has a function to identify an object and output the name of object.

If it is possible to analyze travel images of each prefecture by image analysis AI, and judge which of the tourist spot classifications in the tourism statistics apply to the image, it is possible to classify images according to the tourist spot classification ("Common criteria for tourism entry statistics" [6] P.10-P.11)

3.2 Method

The judgment of which tourist spot classification an image corresponds to is implemented by measuring degree of similarity between object name obtained from image analysis by Cloud AI and "Tourism point classification code" that detailed tourist spot classification ("Common Criteria Survey Guidelines for Tourism Entry Statistics" [7] Table 2).

Since both object names and tourist spot subcategory are sets of words, we used natural language processing method to measure the degree of similarity between sets of words.

In this verification, we compared the image classification results with the tabulated values of “Tourist spots per year, festivals, and number of tourists entering by sightseeing according to events (total)[7]” in 2017. The target prefectures were "Tokyo," "Fukuoka," and "Kanagawa," which are the top three prefectures for the number of customers in the same year.

3.2.1 Cloud AI we chose

We compared image analysis AI of 4 major cloud companies (Amazon Web Service (AWS), Microsoft, IBM, Google), and we chose “Amazon Rekognition” of AWS.

In natural language procedure, infrequent words can be OOV (Out Of Vocabulary) and it needs some solution. Reason why we chose AWS is that the abstraction level of the object name is appropriate and the number of low frequency words is small comparing to 4 other services

3.2.2 Specific classification procedure of images

(1) We acquire 400 images of each prefecture (photographed in 2017) from the image sharing SNS called “Flickr”. Number of samples that fully reflects the trends of the population comes to be 385 (sample error 5%, confidence interval 95%), and in order to allow for the occurrence of analysis errors, we set the number to 400. Reason for choosing Flickr is that the API is rich and the image acquisition is easy.

(2) Analyzing images by Amazon Rekognition.

(3) Extracting object name from analysis result. Note that only object names with 80% or more confidence in the analysis result were extracted.

(4) Measuring the similarity between the set of extracted object names and the classification code of tourist spot.

   a. Calculating the average of feature vectors for each object name included in the analysis result of one photo (A) and average feature vector for each word in the tourist spot subcategory (B) using Word2Vec. Since the object name is output in English, the classification code for tourist spots is also translated into English (see Table 1). We also use fastText's trained model [9] as the model needed to calculate feature vectors.

b. Calculating cosine similarity of the above A and B.

c. Tourist site classification with the highest similarity is regarded as the classification to which images belong. In addition, an image whose similarity is less than 50% in any tourist spot classification is classified as "Other".

(5) If OOV occurs, manually correct the object name to a similar word and measure the similarity again.

Table 1. Tourist spot subcategory

Tourism spot classification	Subcategory
①Nature	Mountain, Plateau, Wetland, Wilderness, Lake, River, Canyon, Waterfall, Coast, Sand, Cape, Underwater, Island
②History・Culture	Historic, Tombs, Castle, Ruins, Shrines, Temples, Gardens, Museum, Art, Zoo, Botanical, Aquarium, Brewery
③Hot spring・Health	Spa, Hot-spring, Health, Bath
④Sports・Recreation	Sports, Recreation, Golf, Ski, Campground, Fishing, Beach, Marina, Park, Leisure, Amusement
⑤Urban Tourism	Commercial, Mall, Shopping, District, Street, Food, Gourmet
⑥Other	-

3.3 Result

At first, we indicate image classification result according to tourist spots in each prefecture on table 2.

Table 2. Image classification result according to tourist spots in each prefecture

Unit : number of images

	①	②	③	④	⑤	⑥
Tokyo	65	31	1	36	218	43
Fukuoka	100	43	1	32	174	46
Kanagawa	168	26	0	28	126	40

※The total is not 400 because there were images that became analysis errors.

Next, we compare Tourism Agency Statistics and image classification result. To indicate difference of two visually, we indicate radar chart that compares two on figure 1. The scale of the chart is the composition ratio for each tourist spot classification.

3.4 Evaluation

As shown in figure 1, in any of Tokyo, Fukuoka, and Kanagawa, there are one or two matches of trend between Tourism Agency Statistics and image classification results. If tourism statistics is true, it is hard to say this method can grasp features as tourist spot.

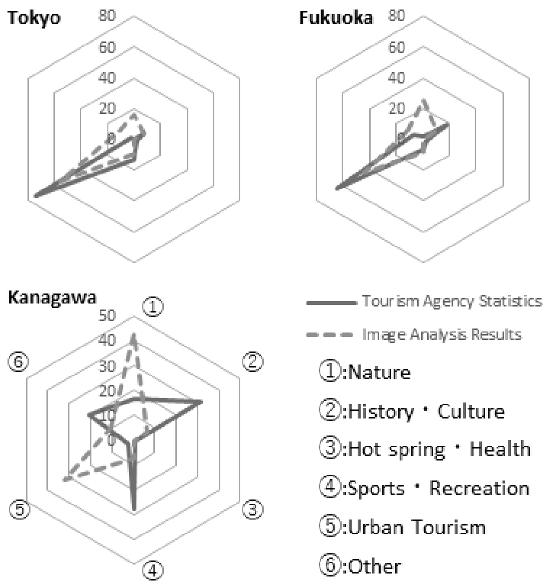

Figure 1. Comparison between Tourism Agency Statistics and classification results

On the other hand, classifying images by word groups to be defined is succeeded.

Figure 2 is the image classification result of Kanagawa Prefecture, where the difference with tourism statistics was the largest, visualized by a tool called Graphviz. As an example, top images "Nature" and "Urban Tourism" are shown, but they could be classified with high accuracy.

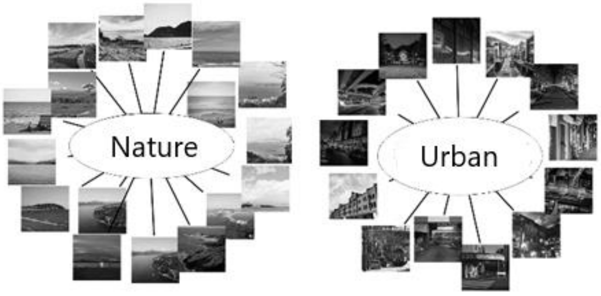

Figure 2. Images of nature and urban tourism of Kanagawa Prefecture

The following can be considered as the reason for difference between the image classification result and the tourist statistics.

(1) Bias of input images
It is not deniable that there is bias; such as it is difficult to upload hot spring images to SNS due to privacy issues.

(2) Matching of image analysis results with tourist spot subcategory is difficult
For example, in the case of an image of trees in park, it should be classified as "sports / recreation" from the definition of classification, but focusing on only trees, it may be classified as "nature".

４. Excavation of tourism resources by clustering of image sets

In this chapter, we verified if it is possible to excavate tourism resources with information not expressed in statistics by clustering using image analysis results of Cloud AI.

4.1 Hypothesis

Analyzing travel images of a specific prefecture with image analysis AI and use the results to cluster image groups. And finding features of the obtained group and set as a hypothesis that buried tourism resources not found in the tourism policy will be excavated.

4.2 Method

Defining a vector using the object names and their confidence contained in image, and cluster by cosine similarity of vectors.

As a clustering method of image sets, there is a method of using the similarity of images themselves. However, in order to directly calculate the similarity between images, it is necessary to collect a large number of images in advance, manually create teacher data, and construct a similarity determiner using a method such as Deep Learning. We didn't adopt this method because it needs advanced AI technology and knowledge and it is different from the purpose of this paper.

In previous researches [9] using object results of cloud AI for travel images, a method of clustering object names by vectorizing object names included in each image with certainty is used.

In this paper, we applied this method and devised and adopted a method of clustering images by vectorizing images instead of object names with certainty.

Tottori prefecture was chosen as the verification target. In Tottori prefecture, in the tourism statistics, the number of customers entered was low, and it is considerable that there is room for improvement in the method of policy planning.

Tottori prefecture published "Tottori Prefecture Tourism Promotion Guidelines" in 2015(planning period: 2015 to 2018)[10] (hereinafter referred to as "tourism promotion guidelines") This is guideline developed by Tottori Prefecture with reference to various statistical materials and compiled as a guideline.

It could be said that the hypothesis could be proved if the tourism resources not included in the "tourism promotion guidelines" could be found.

4.2.1 Cloud AI we chose

We compared services of major cloud operators and chose Google's "Google Cloud Vision API".

For excavating and utilizing information that has disappeared, it is desirable to extract more specific information as object names included in the analysis results. Why we chose this service is that there was a web search option that could detect specific object names using Google image search, and it obtained the most specific information of 4 companies.

4.2.2 Clustering procedure

In the following, the number of images to be analyzed is n, each image is Pi ($1 \le i \le n$), and the total number of object names extracted from each image (counting the same object name appearing in different images as one) is m.

(1) For m numbers of object names, define each

object name as vector elements W1 to Wm.

(2) For the i-th image Pi, when the confidence level c_{ij} of the object name Wj ($1 \leq j \leq m$) is defined, the following is defined by c_{ij}.

$$\vec{P}_i = (c_{i1}, c_{i2}, \cdot \cdot \cdot c_{im})$$

Note that $c_{ij} = 0$ if the certainty factor for Wj is undefined in Pi, or is below the threshold value α (set to 0.3 considering the reliability as data).

(3) Calculating the similarity of any two images Px, Py ($1 \leq x, y \leq n$) based on the cosine similarity of the vector defined above.

(4) Creating an undirected graph with all images as nodes. Each node represents a graph connected with other nodes that have degree of similarity exceeding the threshold β (β is set so that the number of edges is 200 for improved visibility.) with edges. This groups the nodes (images).

4.2.3 How to find features

For some groups, we regard object name included in analysis result of each node (images) belonging to it, which frequently appears the most as object name characterizes the group.

4.3 Result

The same as chapter 3, get 500 travel images from Flickr, and implemented clustering with method we mentioned before. Figure 3 is visualized result of clustering with Graphviz, and it indicates that we obtained group A~H.

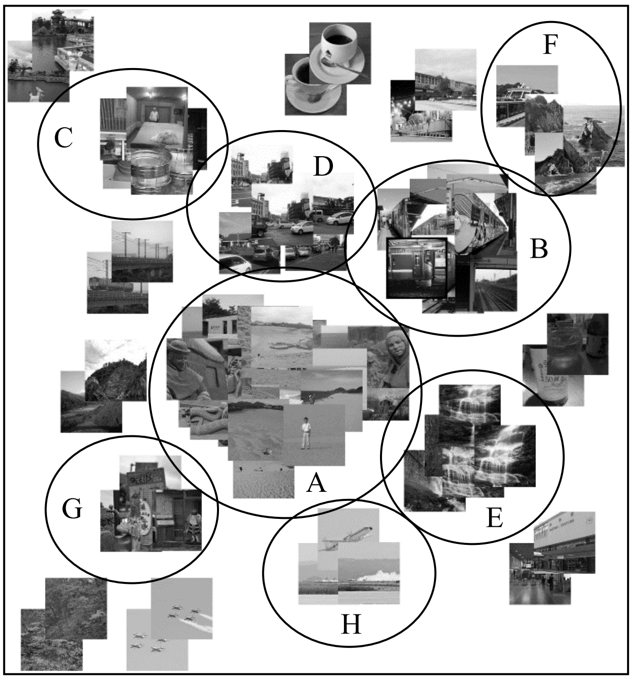

Figure 3. Clustering result of group of images

Note that nodes that are not connected to any other nodes are removed from graph.

Table 3 indicates that object name that characterizes each group.

Table 3. Object name that characterizes each node.

Group	Object name that characterizes
A	Tottori Sand Dunes,Uradome Coast,秋吉台
B	Rail transport, Train, Railroad car
C	Chiyomusubi Okasora ,Honten, Sake, Soju
D	Luxury vehicle,Compact car,Mid-size car
E	Waterfall,Nature reserve,Water resources
F	Uradome Coast,Ginzan, San'in region
G	GeGeGe no Kitaro, Mizuki Shigeru Road,Yokai Shrine
H	Narrow-body aircraft,Aviation, Aircraft

4.4 Evaluation

"Tourism promotion guidelines" mentions that they are going to disseminate following tourism resources actively.

①Tottori Sand Dune, ②San-in Coast Geo-park, ③Mt.Daisen, ④crab・food, ⑤manga

Table 4 is correspondence table which combines each group A~H and tourism resources from ①~⑤

Table 4. Relationship between each group and tourism resources

Group	Tourism resources	Explanation
A	①	Image group that indicates Tottori Sand Dune
B		Train images that is not travel images
C		At Tottori Liquor-making Association, they focus on PR activities as tourism resources like holding a competition as selecting sake.
D		Car images that is not travel images
E	③	Although general word

		"taki" that means water fall is chosen as object name, images are about "Daisen-taki", a famous tourism spot of Tottori.
F	②	Uratomi coast is included in San-in Coast Geo-park, and it is famous tourism spot of Tottori.
G	⑤	Famous tourism spot originate from manga like Mizuki Shigeru road.
H		State of air show in Miho base of air self-defense force

Group C and H are not in tourism promotion guidelines, but it is considerable that they are tourism resources that attract traveler. This can be said that this is an excavation of buried tourism resources tourism promotion guidelines could not find.

Also, it is found that there are four tourism resources that match tourism promotion guidelines from table 4. This indicates that there are many visitors in tourism resources shown in tourism promotion.

In addition, it is found that tourism resource ④ doesn't correspond to any groups. This means that people are not attracted as planned in "tourism promotion guidelines",

５. Summary

5.1 Overall review of verification result

In chapter 3, we verified if we could grasp tendency in each prefecture that could be found from Tourism Agency Statistics from analysis of travel images with cloud AI. As a result, it was hard to say the tendency obtained from image analysis has high tendency and the degree of agreement obtained from statistics, so it could not substitute part of statistics. However, we succeeded in classifying travel images with combination of image analysis and natural language processing. We can say that it is possible to obtain kind of knowledge related to tourism trends from classification results.

In chapter 4, we verified if it is possible to excavate buried tourism resources for Tottori prefecture from the analysis of travel images using Cloud AI. As a result, we could find two tourism resources that could not be found in the prefecture's tourism policy. In addition, we succeeded in confirming the effects of the measures and outlining the measures that have not penetrated travelers.

As a general comment, it has been confirmed that the use of Cloud AI has a certain usefulness for grasping tourism trends, and useful for planning and implementing tourism measures.

5.2 Cost benefits of cloud AI

Although cloud Al cannot substitute a part of statistics and reduce cost of grasping tourism trend, it has cost benefits.

Cloud AI needs no programming and can be used in low fee. Amazon Rekognition requires 1.3USD per 1000 images, and Cloud Vision API requires no fee if the number of images to read is less than 1000.

In addition, the man-hours required to construct the whole verification mechanism are about one man-month. We programmed image acquisition, natural language processing, and clustering, by using Python, Node.js, and SQL, but with a simple mechanism, man-hour is small. We could program with a simple mechanism because we could use not image itself but analysis results of cloud AI (word or value) as inputs of classification and clustering.

5.3 Future tasks

As we mentioned on chapter 3, images that can be obtained from SNS has bias.

Establishing a method to collect images without bias is a task to make method we verified in this paper practical.

In addition, as a substitute for statistics, it is necessary to consider new methods such as combining image analysis results with other information and introducing more advanced natural language processing.

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Attachment: Member list
(alphabetical order of company name)

Attachment：Member list(alphabetical order of company name)

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