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Analysis of Opinions from Questionnaire Surveys of Farming Candidates using Cross Tabulation System

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Abstract.

In Japan, agricultural activation poses a big problem and the increase in new-entrants-to-agriculture persons is expected. This paper analyzes questionnaire surveys of those who want to start working in agriculture to figure out the difficulties and anxiety they have. The questionnaires consist of the categorical data, such as status of their willingness to be a farmer, their age and sex and the free texts that are written by person who answered several sets of questions. Categories and free text question items are considered as viewpoints in this paper. Two viewpoints are selected to construct a cross tabulation of a search result. The number of the questionnaires that matches the two conditions is displayed in the cell of the cross table. All possible cross tables can be shown as a result. A specified cross table is shown if the user determines a pair of viewpoints. This paper reports case studies which are hard to achieve by simple keyword search.

Keywords. questionnaire, opinion extraction, opinion visualization, cross tabulation, new-entrants-to-agriculture

1. Introduction

There are various kinds of questionnaires are being collected in many situations and for many purposes, by private firms, by the government, by the governmental agencies and by the educational organizations. Questionnaire replies contain useful information which should be analyzed and should be fully utilized for decision making of the organization side of the questionnaires.

The amount of the questionnaire data is not always the key issue of the analysis. By the questionnaire in a specific field, it is an important issue to acquire as many knowledge as possible from a little data. This paper proposes a system and shows case studies where many hypothesis candidates can be generated efficiently through interaction by user and the system. In conventional data mining approaches, the quality of extracted knowledges matters. The system proposed in this paper considers the quantity and efficiency as well as the quality of the extracted knowledge.

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When a questionnaire contains several segments and several attributes, the correlation analysis of two viewpoints is one of the most fundamental techniques. Cross tabulation is an intuitive method to discover some correlation between two attributes or between two viewpoints. Such visualization is particularly useful for experts.

Typical questionnaire consists of two types of questions – categorical questions and free text questions. In a categorical question, the respondent to the questionnaire is asked to choose from a several choices that describe some degree of attributes, such as age, occupation or degree of satisfaction. In a free text question, the respondent is asked to write some sentences for the question.

About a categorical question, it is easy to conduct total and numerical analysis based on them. After the questionnaires are collected, and they are shown as a graph or statistical information in many cases. On the other hand, the compilation of statistical information from the textual response is hard and time consuming. Even if opinions among free description sentences are extracted, analysis of them takes a long time. There might be several cases where intermediate data are left without being analyzed. One of the reason is that such analysis only can be performed by experts of the field with background knowledge who can think of a hypothesis that will clarify the questionnaire responses. Automation of such intelligent process with high quality is a hard task.

But, many feelings and opinions are included in the free description sentence. Collecting with the formalized categorical question is difficult for them. Since a respondent's raw opinion can be referred to, the importance is also high. If there is automatic extraction of these opinions or an assistive method of an evaluator's check, they will be the big profits to a questionnaire organizer.

In the field of opinion extraction, various researches, such as extraction of the opinion from the review report on a web [3,4], are made. However, many of them concern only on the opinion extraction in a free description sentence. The technique of referring to complexly categorical information which is often seen to a questionnaire, and the information in a free description sentence is seldom seen.

Extraction of opinions from a large-scale data is a hot issue in research area of information retrieval. However, these techniques cannot be used for a small-scale questionnaire result in many cases. Moreover, there are many cases where a questionnaire of the small-scale data about hundreds to thousands replies is only available. Techniques to analyze those small data is required as well.

The authors proposed an analysis method "cross tabulation" which uses multiple viewpoints [1,2]. The present paper applies the method to analyze questionnaires. Case studies are conducted to verify that many useful viewpoints can be given by an analyzer by carrying out the simultaneous display of the cross tabulations in various viewpoints.

2. Related Work

2.1. Faceted Search

Hearst [15] compared the clustering and faceted category hierarchy as analysis tool of the search results. She confirmed that the well designed hierarchical category is much more effective than clustering. [16] proposed a dynamic hierarchical classification of search result using the link structures and categories in Wikipedia and showed effectiveness of

the method. [17] conducted evaluation experiments by many users to analyze 67,000 documents from U.S. Bureau of Labor Statistics. Participants are asked to use three types of interfaces – simple search, hierarchical category search and faceted search. They are assigned three types of search tasks with different level of difficulty – simple lookup, complex lookup and exploratory. They gave a quantitative evaluation of effectiveness of faceted search for complex lookup. In [18], 11 users' video search action for four weeks was analyzed. They reported that the clicks to the facet displayed was used 5 times more frequently than the complicated search with combined keywords. In [19], hierarchical facet display was used as a search result of OPAC data. They observed the user's viewpoint length of stay in the query, the words in categories and the search result. It turned out that the users paid attention less than quarter at facet display. From this, it can be said that greater importance is attached than to a facet to the individual search results at the time of search. The facet is not necessarily attached to general text data. There is research how to give a facet when an obvious facet is not inherent in the target document data. In [20], a method is proposed to extract the phrase which expresses a facet from external resources, such as Wikipedia and WordNet. They used the phrases to give facet for a general text data.

In these researches, two or more facets are used for search condition specification, or for hierarchical display of search results. However, it is not used for the display as shown in a cross-tabulation table like this paper.

2.2. Cross Tabulation

The cross tabulation of patent documents is known as a patent map. However, it does not switch a viewpoint flexibly like this paper. There is a system [21] which visualizes search results by a cross tabulation, where vertical axis and a horizontal axis express the cluster for each viewpoint, and the cluster should be interpreted using the feature words of the cluster. Selection of the clustering method and the feature word sampling process has diversity, and there is no telling what is optimal. Moreover, since the feature words of the axis are not decided in advance, it may be difficult to interpret the meaning of axis. On the other hand, each line and each column of a table are represented by one word. Therefore, the meaning of the lines, columns and cells are clear. Moreover, a word in the comment section and a word in the difficulty section are distinguished with the different tags even if they are the same word. We can capture the different interpretation of the word depending on where the word appears.

2.3. Visualization with Keywords

Concept graph [11] is another approach that the authors are trying to analyze the same data. A concept graph of a query [12,13,14] is a directed graph of words that appear in the search result with respect to the query. The edges of a concept graph represent the co-occurrence relation and the frequency of words. When an infrequent word v co-occurred with a frequent word u , an edge from u to v is drawn. The co-occurrence ration, which is the ratio of the number of documents that contain both u and v compared with that of documents containing v , should be greater than a threshold α . The threshold α determining the strength of the relation. The shape of the concept graph varies according to the threshold α .

Figure 1 displays the concept graph of a query “start farming”. The graph is constructed from top 10 frequent keywords that appear in the 131 search result documents, i.e., questionnaires. The graph is obtained with the threshold $\alpha = 0.4$. We can interpret the graph that the respondents ask for consultation when they are collecting information and that they want support when they start farming. The concept graph is based on the words and relationship of them. So we can easily figure out tightly related group of words. However, there is no way to find relationship between viewpoints.

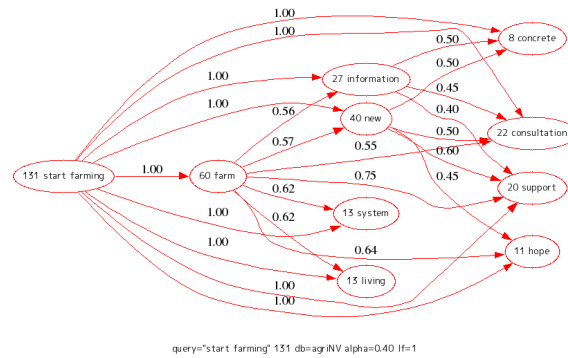


Figure 1. Concept Graph of “start farming”

3. Questionnaire Surveys for New Farming Applicants

3.1. Original Questionnaire Data

This section explains the data we analyze in this paper. They are the questionnaire surveys to the new-entrants-to-agriculture candidates.

We use the questionnaires that were conducted by the National Chamber of Agriculture Japan in 2011 and 2012.

National Chamber of Agriculture is a public representation organization of agriculture and a farmer and form a nationwide body of the Agriculture Committee. It carries out various measures concerning agriculture.

Among such activities, “new farmer fair” is an event for new farming applicants. They provide consultations in each local government, support internship to farmers and run the farmer related job information site “AGUNAVI”. The questionnaire survey was conducted by cooperation of National Chamber of Agriculture for the participants of those events and activities. The respondents were chosen from the participants of the previous year. They are categorized according to the events and experiences they had. The organizer of questionnaire prepared the common and separate questionnaire items corresponding to the status of person who answers the question.

The common questionnaires are the following four categorical questions – age, sex, current condition of employment as a farmer and the prefecture where they live.

The people who became a farmer are asked the following three questions.

- the date they become a farmer
- the past occupation before start farming
- free description of any hardships they met when becoming a farmer

The people who experienced farming events are asked the following.

- What event did you experience? Does the experience give influence to your hope of farming?
- The current occupation
- When you experienced?
- How long the event you experienced?
- Describe any of your comments and opinions

For the people who are under training of farming

- The past occupation before training
- When did you start the training?
- What training do you receive? Does the training give influence to your hope of farming?
- Where do you receive the training?
- Describe any of your comments and opinions

For the people who correct information about farming

- The current occupation
- How did you obtain information? Does the information give influence to your hope of farming?
- Describe any of your comments and opinions

For others

- The current occupation
- What kind of difficulty for farming did you feel? What problems did you face?
- Describe any of your comments and opinions

3.2. *Structuring Questionnaire with Tagged Words*

We converted the questionnaire data into semi-structured data by introducing tagged words that represent occurrences of a word in different free text segments of the questionnaires.

The questionnaire consists of categorical questions and free text description. There are 3 kinds of categorical questions – age, back ground and current status. The current status is represented with the 5 symbols of g:start-farming, g:training, g:experience, g:information and g:other. Table 1 shows the number of respondents with respect to their current status.

The back ground is chosen from 7 events and activities for which the corespondent participated. They are fairs, consultation window and internship organized by national and local government. We used the tagged words, such as b:fair, b:consultation and b:internship, that describe those activities instead of the symbolics as indexes.

There are 2 segments to be filled as free text – comments and difficulties.

The keywords which appear in each segment are distinguished with tag “c:” and “d:” and are analyzed as different word. The original word itself is indexed to be ana-

tag	status	2011	2010
g:"start farming"	Start Agricultural Job	114	17
g:training	In Training for Farming	143	51
g:experience	Enrolling Agricultural Experiment Events	151	54
g:information	Collecting Information	381	181
g:other	Others	325	22
Total		1117	325

Table 1. Status of Respondents

viewpoints	top 5 keywords
difficulty	d:"start farming" d:agriculture d:fund d:people d:income
comment	c:"start farming" c:agriculture c:training c:thought c:information
word	agriculture "start farming" people information new
sex	s:male s:female
age	a:30~39 a:20~29 a:40~49 a:50~59 a:over 60
status	g:"information gathering" g:other g:experience g:training g:"start farming"
background	b:agriculture b:fair b:participate b:people b:consult

Table 2. Frequent Words of Each Viewpoint

lyzed independent to the segments. As a result, the word "agriculture" is indexed as 3 different words of the word itself, "c:agriculture" that appears in the comment segment and "d:agriculture" that appears in the difficulty segment.

Table 2 displays top 5 frequent words of each viewpoints. The first 3 lines represent "textual" viewpoints and the lower 4 lines represent "categorical" viewpoints.

The questionnaire in 2010 and 2011 have different items. However, some of the categorical data and free descriptions are the same. In the present paper, we analyzed the data of 2011.

4. Cross Tabulation System

Figure 2 is a snapshot of the system of the crossing table with the query "g:start-farming z:20-29". The system has 4 areas of keyword input frame, a region to display the feature words of each segment, a cross table and the detail of questionnaires. The original data and queries are written in Japanese as shown in the frame of "detailed questionnaires". English words in the table are the authors' manual translation for the exposition of the present paper.

By clicking the check box "detailMenu", a detailed control list of parameters appear by which the axes of viewpoints can be changed. The number of feature words of each segments determines the size of the table. They can be adjusted as well.

There are 7 viewpoints that can be choose as an axis. They are (1) tagged words in difficulty, (2) tagged words in comment, (3) words in comment or in difficulty, (4) tagged words in background, (5) sex, (6) age and (7) current status (displayed as genre)

A combination of two viewpoints gives a table. There are 42 cross tables for the same query. The system can display only one of the tables according to the choice of viewpoints pair as Figure 2. We constructed another system that displays all of 42 cross

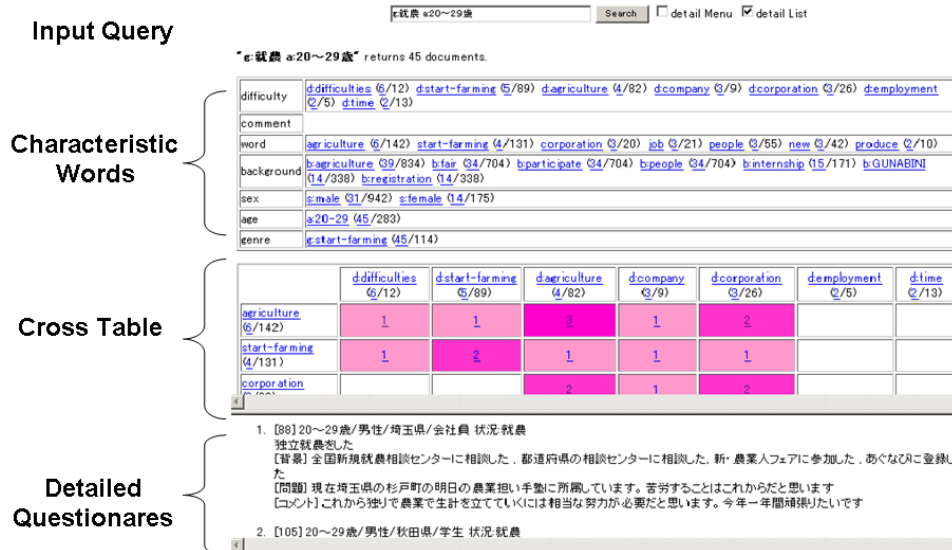


Figure 2. Cross Tabulation System

tables at the same time as in Figure 3. We can glance all the combinations of viewpoints easily. So, we can focus on interesting combination of viewpoints at the next step.



Figure 3. Table of Cross Tabulations

5. Case Studies with Cross Tabulation

Figure 4 is a cross table of the whole 1117 data displayed with the viewpoints of background and difficulty as horizontal and vertical axes. Top 10 frequent words are choose as axis of the difficulties. We notice a characteristic pattern of the table where there are no elements are shown except for the columns of g:start-farm and g:other. This is because that the question of difficulties were not asked for the respondents whose current status were g:gathering-information, g:experience and g:training who do not actu-

ally started working as farmer. Many answers from the people of g:other said that they gave up to be a farmer. The feature words in vertical axis, i.e., in difficulty are d:fund, d:income, d:farm-land and d:life. We expect that obtaining farm land and the change of income would be common difficulty between those who started farming and who gave up agriculture.

What would be a difference among those description the whole item between the candidates who actually found a job as a farmer, and the candidates who gave up? It will become useful information for the organizer if we can extract such key words.

	g:information-collection (381/381)	g:other (325/325)	g:experience (154/154)	g:training (143/143)	g:start-farming (114/114)
d:start-farming (89/89)		70			19
d:agriculture (82/82)		70			12
d:fund (41/41)		34			7
d:people (34/34)		32			2
d:income (31/31)		29			2
d:farm-land (30/30)		22			8
d:life (26/26)		22			4
d:corporation (26/26)		22			4
d:farmer (26/26)		19			7
d:necessary (25/25)		22			3

Figure 4. Cross Table by Status and Difficulty

Next, we analyzed what kind of difference there is according to the age of the people who actually found a job as a farmer. Figure 5 is the cross table obtained from a keyword g:start-farming with “age” as the horizontal axis and “difficulty” as the vertical axis. People in 30-39 consider d:farm-land, d:farmer, d:fund and d:training. Those words tell that they are determined to perform farm management by themselves. On the other hand, the words in a:20-29 are d:difficulty and d:time. They only describe the difficulty in the training and internship but do not mention how to manage a farm by themselves.

	a:20-29 (45/283)	a:30-39 (33/330)	a:40-49 (19/262)	a:50-59 (9/162)	a:60- (5/55)
d:start-farming (19/89)	5	9	4	1	
d:agriculture (12/82)	4	5	2		1
d:difficulties (11/12)	6	2	2	1	
d:farm-land (8/30)	1	2	3	1	1
d:farmer (7/26)	1	3	1		1
d:fund (7/41)		4	3		
d:time (6/13)	2	2	2		
d:training (6/25)	1	4		1	
d:very-much (5/10)	1	1		1	1
d:work (5/9)	1		2	1	1

Figure 5. Cross Table by Age and Difficulty

To analyze the opinion of young people, we added a keyword a:20-29 and obtained 45 documents. Figure 6 displays the result with the axis of difficulty and word. The first column of d:difficulty says that there are 6 young person who responded with d:difficulty. But there are no cell except for the first and the second line of agriculture and of start-

	d:difficulties (6/12)	d:start-farming (5/88)	d:agriculture (4/82)	d:company (3/9)	d:corporation (3/26)	d:employment (2/5)	d:time (2/13)	d:house (2/9)	d:physical-strength (2/6)	d:salaary (2/4)
agriculture (6/142)	1	1	3	1	2				1	1
start-farming (4/131)	1	2	1	1	1			1	1	1
corporation (3/20)			2	1	2					1
job (3/21)			2	1	2					1
people (3/55)			1		1					
new (3/42)			2	1	2					1
produce (2/10)			1	1	1					1
company (2/9)			2	1	2					1
grasp (2/3)			2	1	2					1
participate (2/29)			1		1					

Figure 6. Cross Table by Difficulty and Word

farming, both of which are query words. This means that they wrote no description in the segment of comment and difficulty as free text.

If we change the vertical axis to background, as Figure 7, we see the co-occurred words of b:agriculture, b:fair, b:participation and b:people with the word d:difficulty. The keyword d:difficulty in the search result of “g:start-farming a:20-29” indicates the difficulties they had experienced when they participated in agriculture fairs. The plain words of “fair” and “participation” did not appear in the cross table of difficulty and word, because those words are indexed as tagged words but not as simple words.

	d:difficulties (6/12)	d:start-farming (5/88)	d:agriculture (4/82)	d:company (3/9)	d:corporation (3/26)	d:employment (2/5)	d:time (2/13)	d:house (2/9)	d:physical-strength (2/6)	d:salaary (2/4)
b:agriculture (39/834)	4	4	4	3	3	2	2	1	2	2
b:fair (34/704)	4	4	4	3	3	2	1	1	2	2
b:participate (34/704)	4	4	4	3	3	2	1	1	2	2
b:people (34/704)	4	4	4	3	3	2	1	1	2	2
b:internship (15/171)	1	1	1	1	1		1			2
b:GUNAEBINI (14/338)	3	4	4	2	3	1		1	1	1
b:registration (14/338)	3	4	4	2	3	1		1	1	1
b:consultation (13/408)	3	3	2	1	1			1	1	2
b:center (13/408)	3	3	2	1	1			1	1	2
b:new (10/271)	2	2	2	1	1				1	2

Figure 7. Cross Table by Difficulty and Background

6. Conclusion and Further Work

The present paper analyzed 1171 questionnaire surveys of participants who are new farming applicants. The aim of the analysis is extract the difficulties they have. The au-

thors constructed a cross tabulation system in which two axes can be chosen from the categorical views of age, sex and background and the keywords in free description in comments and difficulty they had when they participated events related to agriculture. Case studies were conducted to figure out the difference between those who proceeded to be a farmer and those who gave up. The difference according to the generation were analyzed as well.

The data used this time was the reply of the questionnaire which National Chamber of Agriculture performed. The objects were the people who participated in the events or used a consultations organized by National Chamber of Agriculture. According to the event which participated, the forms of the questionnaire differed delicately. Therefore, unification of data needed to be pretreated. For example, seven kinds of events etc. serve as a background, and it was described by 60-100 characters, respectively. Those sentences were dealt with as tagged words but not as a categorical data. However, since it was not the language which the user itself described, it was not used as a general word. Thus, a portion with an index has various problems and it is thought that there is greatly room for improvement.

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Response Letter

The authors would like to thank the reviewers for their time and valuable comments.

We rewrote the introduction to clarify our proposal and result, where the main contribution of the paper is in the application of the interactive cross tabulation method and the analysis result of a "not a huge number" of big data, but a relatively small number of real data which we need to analyze in detail. We added the original questionnaire items which essentially determines the the purpose of the analysis and at the same time the "view points" of the analysis. We appreciate the reviewers advizce.

Response to comments of reviewers

1. In general, data mining methods using big data is useful especially for analytical objectives using ends free data. On the other hand, you deal with a questionnaire result that is constructed from the viewpoint of some kinds of ends. I'm wondering if the two different methods should be compared from the formal viewpoint without any contexts.

response: Thank you very much for the interesting and crucial research subject. We agree with the reviewers' idea. Our results would be a very tiny step compared with this big goal. However, we believe it is worth while. So, we added this point in the section of further work.

2. You mentioned the feature words of the axis are not decided in advance, it may be difficult to interpret the meaning of axis. I agree, it is the common problem in the field of machine learning. On the other hand, there are several methods to support attributes discovery that contributes to make cluster in the pattern recognition fields. It prompts users to discover axis to make clear clusters, thus it is better to survey such research.
3. It might be better that you illustrate the original questionnaire items so that readers can read and understand the contents of cross tables. I could not understand the meaningfulness of your methods without understanding the meaning of contents.
4. What is your definition of the concept of ?Viewpoint?. In general, the term viewpoint is used in the context where the one object can be captured as plural other objects, e.g., a human is recognized as a selection manager from ?the viewpoint of professional roles? in a company whereas father form ?the viewpoint of family roles? in a family.

6. In the early part of this paper, you described the survey results from technical viewpoints. However, the later part of your paper shows case example of cross table with something data. What are the main proposal or results of this paper? The question might be occurred from the item 3.

response: Most of the comments concern with the the word "viewpoint" and "feature" we used in the paper. Thank you very much for pointing out the unclearness of the paper. The data we analyzed in this paper is questionnaires, where aims are clearly stated in the original questionnaires. The each questions determines a viewpoint. We added the list of original questions, as the reviewer advised. And, we rewrote the abstract to clarify the meaning of "viewpoints" of the paper.

5. Regarding Fig. 2, you mentioned that those words in the table are written in English. The original data are written in Japanese. However, it is described in Japanese. It should be written in English or give explanation that helps to understand the contents for English speaking persons.

response: We replaced Fig.2 which displays "English" words.

7. In p. 7, there exists Figure ??... It seems Fig. 6.

response: We fixed them.