

Extraction algorithm of relationship between smartphone applications for recommendation

Kohei Terazono Akira Karasudani Satoshi Iwata Tatsuro Matsumoto

HUMAN CENTRIC COMPUTING LABORATORIES, FUJITSU LABORATORIES LTD.

4-1-1 Kamikodanaka, Nakahara-ku, Kawasaki, Kanagawa 211-8588, Japan

{terazono, karasudani.akir, iwata.satoshi, tatsuro}@jp.fujitsu.com

Abstract

Users employing smartphones typically combine multiple applications to perform their tasks. It would be possible to be recommended the appropriate applications by acquiring the contexts of users who perform such tasks. And the contexts are composed by the relationship of applications used in the tasks. We present an algorithm that extracts the relationship between applications that the user intentionally uses in combination. At the end of the paper, we report the results of verification tests conducted on this algorithm.

1. Introduction

Users are annoyed with searching the large number of applications installed in their smartphone. It is useful to recommend the suitable application which matched the user's context. Previous studies on the usage history of smartphone applications have revealed that the frequency of the use of an application of a specific genre tends to be relatively high in specific places and at specific times.^[1]

Smartphone users tend to use multiple applications in a given situation. We think it is possible to recommend the applications depended on their context with higher accuracy by using the combinations of multiple applications used in each situation.

2. The characteristic of the operation

We focused on the user operation characteristic that users switch between applications when using them in combination. We hypothesized that the shorter the switching time, the more likely it is that the operation involves the use of application in combination before and after switching.

In order to verify of the above hypothesis, we analyzed the dataset which logged the application usage for one month by a smartphone user and divided into two groups by our subjectivity. Figure 1 shows how the switching time about relevant and irrelevant pairs of applications. This result confirms that the switching time affect the relevance.

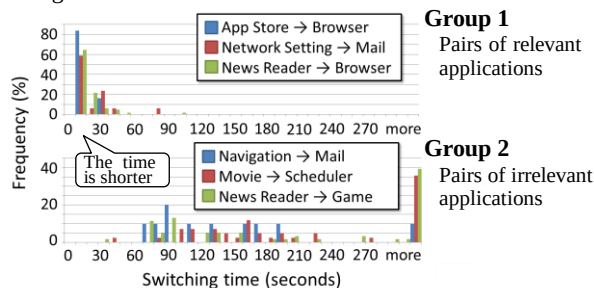


Fig1. Frequency histograms of the time for switching operation

3. Algorithm

Based on the above verified hypothesis, we defined the

relationship between a pair of applications as a unit of application combination, using the operation of switching between them and the representation of the situation. In order to acquire this relationship, we present the algorithm that shows the degree of the relation between application x and y by the score based on the switching time ($T(x,y)$). We represent the relationship score (E_c) based on the switching time in the following equation:

$$E_c(x,y) = (1 - \min(M, T(x,y) / M)) / N,$$

where N is the total number of times application x is used, and M is the threshold period.

We modify the above relationship score using scores for the probability of consistency of usage situations. The score for the location relationship (E_p) is the probability of consistency of usage locations, and the score for the time relationship (E_t) is the closeness in usage time of day.

$$E(x,y) = E_c(x,y) + \alpha \times E_p(x,y) + \beta \times E_t(x,y),$$

where α and β are location and time dependence coefficients, respectively, for application y .

4. Evaluation

We evaluated how well the score $E(x,y)$ represents the users' context using the foregoing dataset. Table 1 shows the probabilities of corresponding the application expected to be used by the user next time with the actual application used by the user next time in the assuming usage cases in which smartphones are used at home in the evening or when driving. We compared the prediction result based on the ranking of the score derived by our algorithm with it based on the frequency of the neighboring use of applications (conventional algorithm). Our results confirm that using the relationship between applications extracted by our algorithm is effective to acquire the users' context with higher accuracy.

Table1. Comparison of prediction accuracy in the assuming use cases

Case	Prediction accuracy	
	Our algorithm	Conventional algorithm
At home in the evening	91%	72%
Driving	69%	58%

5. Conclusion

We proposed an algorithm to extract the relationship between a pair of applications, and verified its effectiveness in cases of actual use. We think the proposed method could be a primary technique to categorize multiple applications, and recommend the suitable applications which matched users' context.

6. References

[1] Q. Xu, J. Erman, A. Gerber, Z. Mao, J. Pang, S. Venkataraman. Identifying Diverse Usage Behaviors of Smartphone Apps. In IMC'11 pp. 329–344, 2011