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Building a Smartphone Push Notification Management System

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Abstract: The number of mobile applications that utilize push notifications is extremely high, and smartphone users who use multiple applications receive large amounts of push notifications each day. The amount of notifications that users see all at once is high, and not only could this be a nuisance, it creates the possibility of users missing important notifications. You can restrict unnecessary notifications by changing the notification settings, but changing the settings takes time. The purpose of this research is to improve user experience by saving the time required for these settings through the automatic classification of push notifications and the assessment of the importance thereof. We have assessed the importance of standard notifications, and implemented a notification simulator with an assessment database into iOS.

Keywords: *Notification system, Importance categorization, Application development*

1. INTRODUCTION

Due to the fact that push notifications send information in real time, they are a powerful tool to reach users. Because of this, the majority of mobile applications send push notifications to their users for marketing purposes. Countless smartphone users currently receive large amounts of notifications every day, with many users who look at them all at once [1]. However, as the number received increases, they become a nuisance, which increases the possibility that users could miss important notifications.

One method to solve this would be to use the push notifications settings. Most OS's include a settings function, including Android OS and iOS, which allow you to change settings for notification permissions, sounds, and vibration. This makes it possible to restrict unneeded notifications. However, you need to change the settings for each application, resulting in many users not changing the settings [1]. Further, as of version 8.0, Android OS added a function called Notification Channel, which categorizes notifications within applications, and allows you to change notification settings by category. However, because the setting options have become further fragmented, it actually increases the time needed to change the settings. The fact that many users feel that changing the notification settings are a pain, and that the settings are becoming more complex, and take more time, are problems. To solve these issues, we propose decreasing the time it takes to change these settings by automatically categorizing and assessing the importance of push notifications.

For this research, we built a push notification

management system for smartphones. Additionally, we examined the display methods for the categorized notifications. Highly accurate assessments are necessary to implement such a system, meaning that the importance of the notifications must be assessed with accuracy. we conducted comprehensive assessments of standard pre-existing notifications before we began assessing automatically generated ones.

2. Push Notifications in the Mobile Environment

2.1 Issues with Notification Channel

We conducted a survey with 29 people to investigate their impressions and usage of Notification Channel.

Because some of the users were not using Android 8.0, we first explained Notification Channel to all participants before asking about their impressions of the system (Figures 1 and 2). With only 13.6% of participants answering that changing the settings was hard or slightly hard, it appears that the settings are not generally seen as difficult; however, 75.7% of participants answered that the settings were inconvenient or slightly inconvenient. With these results, we found that the issue with Notification Channel is that it takes a lot of effort, much the same as traditional notification settings. Therefore, in this research, we focused on solving the issue of reducing the effort required in setting notifications.

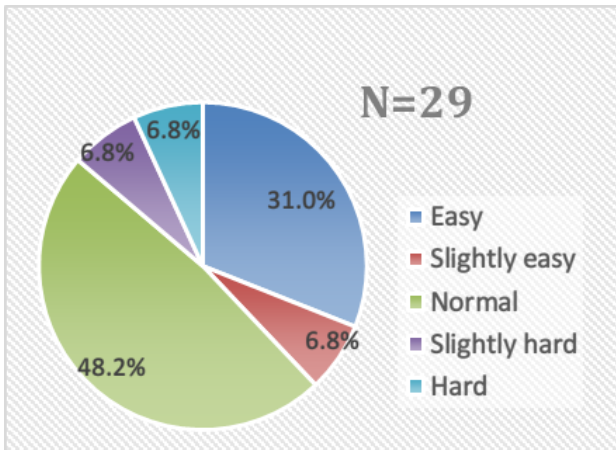


Figure1: Comprehensibility

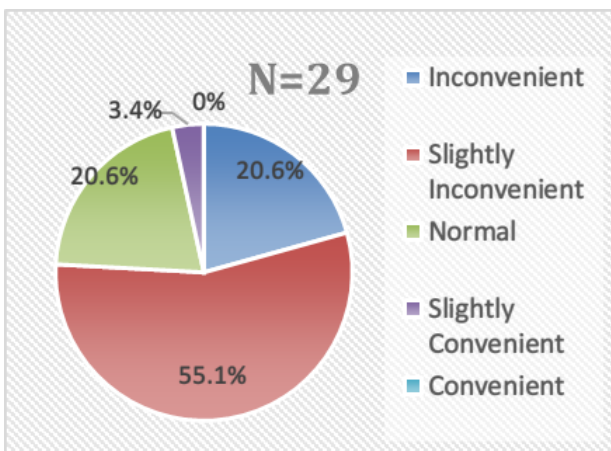


Figure2: Effort required

2.2 Previous Research

Previous research regarding the assessment of importance can be found in the research of Maruya et al. [2] regarding the detection of lesions in medical imagery, where they proposed the detection of important images by using activity history taken during browsing to determine the importance of the images.

Okoshi et al. [3] conducted research to reduce the annoyance of push notifications. They gathered data from input information from smartphones, and analyzed it with machine AI. Using this data to predict the times push notifications were opened, they proposed times of the day that receiving push notifications do not feel annoying.

Kuromiya et al.[4] limited the users' time on their devices, and calculated the probability of user recognition based on data obtained through usage histories and sensors, with which they created a prototype push style information notification system that conducts communication control. The possibility of notifications of new information sent during browsing sessions guiding users toward a specific topic has been reported, and it is believed that sending important notifications at such timing reduces the possibility of it being overlooked.

Yamanaka et al.[5] proposed a system to receive information on the conditions in areas managed in facility management and disaster prevention fields through the use of the massive quantities of text data (relatively short

messages) that accompanies spatial temporal information. This system had a function to automatically categorize the messages based on a pre-determined designations, and proved that on-site conditions are more easily understandable when categorized.

Okoshi et al.[3] and Kuromiya et al.[4] proposed sending notices and specific timing to decrease the annoyance felt at push notifications, and prevent users overlooking important ones. This research takes a different approach in that it focuses on the ability of the users to choose what time they check their notifications at. Further, Kuromiya et al.[4] and Yamanaka et al.[5] proved the efficacy of automating the assessment of importance through the usage histories of users, and that categorizing messages makes it easier to get a handle on on-site circumstances. This research is similar in the assessment of the importance of notices and the categorization thereof, and so will apply their approach.

3. Assessment of Pre-existing Standard Notices

3.1 Assessment by Type

When selecting which push notifications to assess, we conducted an importance assessment experiment for notification types to determine which notices are important to users, and which are not. The experiment gathered elements related to 24 notifications on paper, and had 30 users assess them based on a five level scale (1 "Important" through 5 "Unimportant"). We conducted a t-test on the assessment points for each element to make the selection of push notifications easier, and categorized the elements, which allowed us to sort them into seven categories of importance (table 1).

Table 1: Notification elements (in order

A:Emergency/Teacher/Boss/Work
B:Family/Alarm/School
C:Friend/Schedule/Email/System
D:Relative/Update/SNS
E:Daily Activity/Game/Discount/ Online Purchase/Automated
F:Video/Acquaintance/URL/Music/Cuisine
G:Celebrity/Ad

3.2 Assessment of Content

We made our selection of the content of the pre-existing notifications based on 60 total notifications, split into six groups of ten, where the appearance ratio of each of the seven categories are relatively even. Next, we had 30 student users arrange ten notifications randomly selected from each group on paper in order of importance (table 2).

Table2: An example group

Email: From professor; request for confirmation
SNS: The latest highlights
System: New updates
Online shopping: Your order has been shipped
SNS: Your friend made a post – This video is funny!
Video app: (Celebrity) posted a video
Game: Your number of remaining tries has been restored
SNS : From friend – Wanna hang out tomorrow?
Email: From Online store – On sale now!
Reminder: You're meeting someone shortly

To reorganize all of the notifications by order of importance, we used the arrangement from the results of the assessment to allocate points to each notification. We utilized the method of allocating higher points to notifications the faster they were selected, with the first notification selected getting ten points, the one following it getting nine, and so on, slowly reducing the number of points, with the last notification getting one point. Using this method, we gave all of the push notifications points, and made a temporary order of importance based on a list of the notifications sorted by order of average points given to all 60 notifications. Four of the 60 notifications had similar contents, and had almost identical averages, so we combined them into two notifications, which made for a final notification quantity of 58 (table 3).

Table 3: A comparison of the points of the combined notifications

No.	Content	Score
15	System: Battery power is low	7.10
46	System: Battery power is low	7.10
19	App: A handy notification from (Business)!	3.31
47	App: A discount notification from (Business)!	3.31

4. Verification Experiment

4.1 Experiment overview

We conducted an assessment of the importance of notifications on smartphones, and examined whether or not we could see common trends with the paper assessment. Using a simulator installed on Android OS, we had 30 student users assess the importance of each notification. We displayed the importance of the contents shown through this assessment on the simulator with numbering on the simulator, in order of importance (Figure3). By sliding the screen, it allows you to scroll through the notifications in a similar way to the actual environment notifications are received in.

The subjects looked at the screen of the simulator, and had them select up to five notifications that they felt did not have the proper level of importance from the list in descending order, and assess the importance of the notifications based on four choices: Higher, A little higher,

A little lower, Lower.

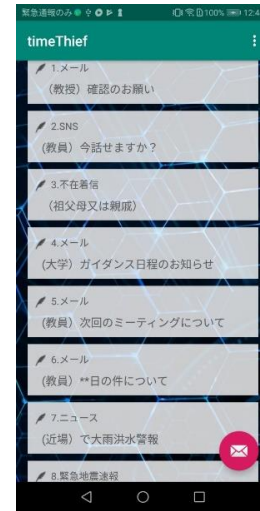


Figure3: A portion of the simulator screen

4.2 Results

The number of selections for each number the notifications were given are shown in figure 4. The x-axis show the notification number, and the y-axis shows the number of selections each received; notifications that received no selections have been abbreviated. It shows that notifications that were rated high in importance in the paper assessment have received most of the selections. By contrast, notifications assessed as unimportant are were either selected at low rates, or not selected at all.

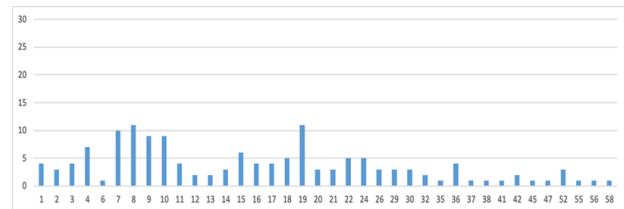


Figure4: Amounts that each notification was selected

Next, we analyzed the trends in the four-choice assessment. We considered the possibility that notifications that have not been selected a sufficient number of times might not yield a clear assessment trend, and limited it to notifications selected ten times or more, which accounts for over a third of all selections made. Diagram 6 shows the results of the four-choice assessment for numbers 7, 8, and 19, all of which were selected over ten times. 7 and 8 are notifications regarding natural disasters, and trend toward being selected as "A little lower". 19 is regarding battery usages, and received contradicting results, with the same number of "A little higher" and "A little lower" selections.

Table4: Four-choice assessment for notifications selected

No. Content	Lower	A little Lower	A little Higher	Higher	Total
7.Flood warning in (nearby)	6	1	3	0	10
8.Seismic intensity 4 earthquake in (nearby)	4	3	3	1	11
19.Battery power is running low	3	4	1	3	11

4.3 Observations

There were no notifications that were particularly over represented in diagram 4. The smaller the number of times the notifications were selected, the more varied they become; their level of importance was appropriate, showing similar trends as the assessment of their contents.

The push notifications assessed as low in importance in the content assessment experiment received hardly any selections, which means their importance here matches the results of said experiment. The lower the importance of the notification, the less attention grabbing its contents, which may mean that users do not attempt to proactively change their order.

The "Battery power is running low" notification from table 4 was assessed to be "Low" and "High" by three people each. There are people who run out of batteries quickly, and those who do not, depending on how they usually use their phones, which means the frequency they see these push notifications is different. Therefore, it is likely this is the result of individual variance in importance. This hints at the necessity of taking individual usage into consideration due to the level of importance of each notification varying per person.

5. Summary and Future Developments

This report generated pre-existing standard notifications and assessed their importance both on paper and on smartphones. We totaled the number of times each notification was selected, and found that the assessments share commonalities with the results of the content importance assessments. We found evidence to suggest the necessity of implementing learning functionality to cover the individual differences in importance placed on different types of notifications by users. By contrast, we found that notifications that are on average low in importance trend toward being common between users, meaning there is no need to customize these notifications to each user. Future issues include examining how many important notifications we make it learn, and introduce learning functionality with a base in the common points between users to deal with the elements that effect individual differences in importance, including generation and profession.

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