Designing Content-driven Intelligent Notification Mechanisms for Mobile Applications

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Key Benefits of Mobile Notifications

• For a **recipient**, it provides an effortless way to be aware of newly available information in real-time.

• For a **sender**, it provides a mechanism to initiate a remote communication.
Issues with Mobile Notifications

Notifications cause disruption on arriving at inopportune moments.

Notifications can be ignored if they do not arrive at the right moments.

Goal: delivering the right information (notification content) at the right moment (context).
Limitations of Previous Approaches

• Interruptibility is inferred from the sensed context, assuming that a user reaction is the same irrespective of the content and sender.

  **Missing:** Use of notification content and sender information.

• Interruptibility models are trained with experience sampling method (ESM) and artificial notifications sent by the system.

  **Missing:** Models built on real-world notifications received in the wild.

Bridging the Gap

First *in-the-wild* study for predicting interruptibility by using:

- *information type*
- *recipient-sender relationship*
- *context data*
Data Collection

1. User’s interaction with notifications:
   - Contextual information.
   - Notification data.

2. User preferences:
   - Where would you like to receive notifications with similar content?
   - When would you like to receive notifications with similar content?
NotifyMe Dataset

Participants: 35

Study duration: 3 weeks

Notification samples: 70,000 (approx.)

Questionnaire responses: 4,069
Extracting “Information Type” and “Recipient-Sender Relationship”

**Information type:** manual classification of application name.

**Recipient-sender relationship:** users classified their notification titles in 4 categories, namely *Family, Friend, Work, Other.*
Types of Notifications

Chat and Email notifications.
Types of Notifications

Chat and Email notifications are divided into 8 sub-types.
Understanding Interruptibility
Note: the average response time of a notification does not vary with other context modalities including location and presence of the surrounding sound.
Impact of Content on Notification Acceptance: Click Count Percentage

Notification click count refers to the percentage of notifications that are clicked out of total notifications of a specific category.
Predicting an Opportune Moment To Deliver a Notification
What Defines an Opportune Moment?

It is a moment in which a user **quickly** and **favorably** reacts to a notification.

*How quick should it be?*
Constructing Predictors

Four predictors using different features:
1. User-defined rules and context data.
2. Context data.
3. Information type and context data.
4. Social circle, information type and context data.

Three ML algorithms:
1. Naïve Bayes
2. AdaBoost
3. Random forest
By using information type and social circle we were able to predict the acceptance of a notification within 10 minutes from its arrival time with an average sensitivity of 70% and a specificity of 80%.
Generic vs Personal Behavioural Model

All predictors are trained with social circle, information type and context data.
The inference of a user’s interruptibility can be performed locally in an online fashion, achieving more than **60% precision** after **nine days** of training.
Summary

• First *in-the-wild* study that uses **content** (information type, recipient-sender relationship) and **context** to model interruptibility.

• The acceptance of a notification within 10 minutes from its arrival time can be predicted with an **average sensitivity of 70%** and a **specificity of 80%**.

• An online predictor can start making stable predictions after **nine days** of training.
Open Issues

• How to infer the user’s willingness to receive a notification?

• How to capture the level of user’s engagement with the current task, difficulty of the interrupting task, and similar factors that might influence interruptibility?

• How does the user react when notifications are stacked by applications?
Thank You!

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