Intelligent Notification Systems

Synthesis Lectures on Mobile and Pervasive Computing

Editor

Mahadev Satyanarayanan, *Carnegie Mellon University*

Synthesis Lectures on Mobile and Pervasive Computing is edited by Mahadev Satyanarayanan of Carnegie Mellon University. Mobile computing and pervasive computing represent major evolutionary steps in distributed systems, a line of research and development that dates back to the mid-1970s. Although many basic principles of distributed system design continue to apply, four key constraints of mobility have forced the development of specialized techniques. These include: unpredictable variation in network quality, lowered trust and robustness of mobile elements, limitations on local resources imposed by weight and size constraints, and concern for battery power consumption. Beyond mobile computing lies pervasive (or ubiquitous) computing, whose essence is the creation of environments saturated with computing and communication, yet gracefully integrated with human users. A rich collection of topics lies at the intersections of mobile and pervasive computing with many other areas of computer science.

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Abhinav Mehrotra and Mirco Musolesi
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Intelligent Notification Systems

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ABSTRACT

Notifications provide a unique mechanism for increasing the effectiveness of real-time information delivery systems. However, notifications that demand users' attention at inopportune moments are more likely to have adverse effects and might become a cause of potential disruption rather than proving beneficial to users. In order to address these challenges a variety of intelligent notification mechanisms based on monitoring and learning users' behavior have been proposed. The goal of such mechanisms is maximizing users' receptivity to the delivered information by automatically inferring the right time and the right context for sending a certain type of information. This book presents an overview of the current state of the art in the area of intelligent notification mechanisms that rely on the awareness of users' context and preferences. We first present a survey of studies focusing on understanding and modeling users' interruptibility and receptivity to notifications from desktops and mobile devices. Then, we discuss the existing challenges and opportunities in developing mechanisms for intelligent notification systems in a variety of application scenarios.

KEYWORDS

notification systems, interruptibility, context-aware computing, anticipatory computing, intelligent mobile systems, intelligent user interfaces

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Preface

Intelligent notification systems are the key building blocks of modern computing systems. Indeed, from mobile phones to desktop computers and from personal assistants to wearable devices, notifications are becoming a key part of our interactions with interactive systems. With the continuous integration of machine learning and artificial intelligence algorithms in digital systems, the underlying components for deciding what, when, and where to send notifications are becoming more and more intelligent. This book provides an in-depth introduction to the state of the art of this fascinating field. It is aimed at both researchers and practitioners working in this area or interested in exploring this highly cross-disciplinary topic.

The book only assumes a very basic knowledge of human-computer interaction and ubiquitous computing concepts. In general, several definitions are provided and extensive bibliography can be found at the end of book. The structure and contents of this book can be summarized as follows.

- In Chapter 1 (*Introduction*), we introduce the scope of the book and its aims, outlining the key issues in designing intelligent notification systems.

- In Chapter 2 (*Understanding Users' Interaction with Notifications*), we frame the problem by examining possible definitions of *interruptions* based on past and current theories, give an overview of their types and discuss human response to such interruptions.

- In Chapter 3 (*Costs Associated to Interruptions*), we present the findings of various studies that examined the cost associated with the arrival of interruptions at inopportune moments. More specifically, we discuss the detrimental effects of interruptions on users' memory, emotional and affective states, and ongoing task execution.

- In Chapter 4 (*Personalization of Interruptibility Strategies*), we provide an overview of the findings of studies concerning personalization of interruptibility strategies. We focus in particular on the effectiveness of personalization strategies with respect to time allocation in a multitasking environment. Moreover, we report the findings of studies demonstrating that the performance in carrying out an interrupted task is affected by users' anxiety and arousal levels.

- In Chapter 5 (*Design Principles for Interruptibility Management Systems*), we analyze the design of interruption management systems and discuss the difference between users' attentiveness and receptivity to interruptions.

- In Chapter 6 (*Interruptibility Management Systems for Desktop Environments*), we first introduce the characteristics of interruptions in desktop environment as they arrive in a constant context (i.e., desktops are not taken around with users). We then discuss the studies in the area of interruptibility management for desktop environment that were conducted by using a Wizard of Oz approach, by exploiting task phases and through on-the-fly inference of interruptibility.

- In Chapter 7 (*Interruptibility Management Systems for Mobile Environments*), we first discuss how the advent of mobile phones has provided opportunities for users to connect to different information channels and receive updates in real time about a variety of events. We then discuss the studies in the area of interruptibility management for mobile environment based on the analysis of current activity, the transition between activities, contextual data, and those concerning filtering of irrelevant information.

- In Chapter 8 (*Open Challenges and Outlook*), we first provide an overview of the limitations of existing studies that focus on understanding and learning users' behavior in terms of interactions with notifications. We then summarize the key elements of this lecture outlining the open challenges in the field.

We hope that this book will stimulate further developments in this field. In the end, the acceptance of Artificial Intelligence technologies also depends on the design of efficient and effective intelligent solutions for the delivery of information to the end-users. Notifications are an essential class of interaction modality for intelligent technologies. For this reason, we believe a strong foundation in this area is important for everyone involved in the design of such systems.

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