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Method for Classifying Wake-up Alarms Using Machine Learning (ML)

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Abstract:

This publication describes an operating system (OS) of a user equipment (UE), such as a smartphone, that can classify a wake-up alarm from other types of alarms. The importance of such classification stems from the fact that when a user sets a wake-up alarm on the smartphone, they may or may not turn on a do-not-disturb (DND) feature. In addition, the UE's DND feature may differ, such that it may silence calls and alerts, but keep the luminosity of the UE's screen the same, it may silence calls and alerts and lower the luminosity, or a combination thereof. To aid the user in classifying a wake-up alarm from other types of alarms, the UE's OS autonomously analyzes the user's behavior using a machine-learned model. The machine-learned model analyzes several inputs, such as location, day of the week, week, time of day, date, time duration until alarm, time elapsed since last alarm, alarm ringtone, barometer data, accelerometer data, recent user activity, user identity, and so forth. Then, the machine-learned model determines what is the probability of this alarm being a wake-up alarm to determine when and how the DND feature functions.

Keywords:

User equipment, UE, smartphone, tablet, dim, reduce luminosity, decrease brightness, display screen, text message, call, video call, ringtone, do-not-disturb, DND, alarm, wake-up alarm, sleep alarm, heuristic, neural network, artificial intelligence, AI, machine learning, machine-learned model, support vector machine, recurrent neural network, RNN, convolutional neural network, CNN, dense neural network, DNN.

Background:

Software developers and user equipment (UE) manufacturers increasingly offer a user more product features. A widely used UE, such as a smartphone, enables the user to call, video conference, text, email, bank, shop, search for information, consume several types of media, participate in social networking, and use a plethora of other application software. In addition, the UE manufacturers often integrate accelerometers, barometers, global-positioning system (GPS) technology, radar technology, cameras, microphones, and various other sensors in or on the UE, which enhance the user experience and often play a role on various application software.

Many people use the smartphone to set up an alarm, such as a wake-up alarm, an alarm to take medication, a cook-time alarm, and other task-reminder alarms. As described herein, a wake-up alarm refers to an alarm that also turns on a do-not-disturb (DND) feature that may silence all calls and alerts and may lower the luminosity of the UE's screen display. The user may set a wake-up alarm before their sleep time, study time, religious activity, classroom setting, meditation, and so forth.

In modern times, sleep deprivation is a major concern for many people. Because of that, many people pay special attention to the quality, the duration, and the consistency of sleep. Among other factors, sleep-deprivation research has concluded that UE "blue light" (light from UE screens) and UE sounds disrupt the ability of many people to fall and remain asleep. Many people, however, use a smartphone to set wake-up alarms. Often, users set the smartphone next to their bed, such as on a nightstand, as illustrated in Figure 1.

Figure 1

Assume Jane works as a production manager in a manufacturing facility. Besides her demanding career, Jane is also a mother of two young children. She uses her smartphone to help organize her demanding career and her busy personal life. For Jane to function optimally and remain healthy, she needs to have good-quality sleep. Most days, Jane heads to bed around 11:00 PM. Using her smartphone, she sets a wake-up alarm for 7:00 AM, turns on the do-not-disturb (DND) feature, and places the smartphone on her nightstand, as illustrated in Figure 1.

The DND feature on Jane's smartphone dims the lock screen, silences calls and alerts, and routes incoming notifications directly to her smartphone's history. This way, Jane's smartphone does not disrupt her sleep until the wake-up alarm sounds the alarm. Jane, however, does not always go to bed at 11:00 PM, and she does not always wake up at 7:00 AM. Most Fridays and Saturdays she may stay up late. Most Saturdays and Sundays she may sleep past 7:00 AM. In addition, every-other week Jane is "on-call," and her manufacturing facility may call her in case there are problems with a production line. Furthermore, Jane often drives her partner to the airport to catch an early-morning flight.

Like most users, Jane acts in "auto-pilot" on routine tasks throughout her day. Sometimes, she sets a wake-up alarm, but mistakenly turns on the DND feature, which prevents her from receiving calls when she is "on-call." At other times, she sets a wake-up alarm, but forgets to turn on the DND feature of the smartphone, which may result in her receiving calls or alerts during sleep. Jane may also set a wake-up alarm when she is focusing to meet a work-related deadline, taking a "power nap," attending a conference, taking part in a religious activity, attending a parent-teacher meeting, meditating, and so forth.

It is desirable for Jane to use a smartphone that can classify a wake-up alarm from other types of alarms and help determine when the DND feature is to be turned on or off and act accordingly.

Description:

This publication describes an operating system (OS) of a user equipment (UE), such as a smartphone, that can classify a wake-up alarm from other types of alarms. The importance of such classification stems from the fact that when a user sets a wake-up alarm on the smartphone, they may or may not turn on a do-not-disturb (DND) feature. When the user turns on the DND feature, the smartphone may silence calls and alerts, may lower the screen luminosity, and route any incoming notifications directly to the smartphone's history. As described herein, luminosity refers to the perceived brightness of an object by a user. Modifying the luminosity may include modifying luminance (*e.g.*, brightness, contrast, or opaqueness). A low luminosity may refer to a luminosity level that is less than a predefined threshold level, such as approximately 50%, 40%, 25%, 15%, and so on. This predefined threshold may be set by a manufacturer or defined by a setting selected by a user. A high luminosity may refer to a luminosity level that is greater than a predefined threshold level, such as approximately 50%, 60%, 75%, 85%, 95%, or 100%.

To aid the user in classifying a wake-up alarm from other types of alarms, the UE's OS can autonomously analyze the user's behavior using a machine-learned model, such as a neural network, a support vector machine, a recurrent neural network (RNN), a convolutional neural network (CNN), a dense neural network (DNN), heuristics, or a combination thereof.

Figure 3 illustrates an example of how the UE's OS may use the machine-learned model to determine whether the user is setting a wake-up alarm.

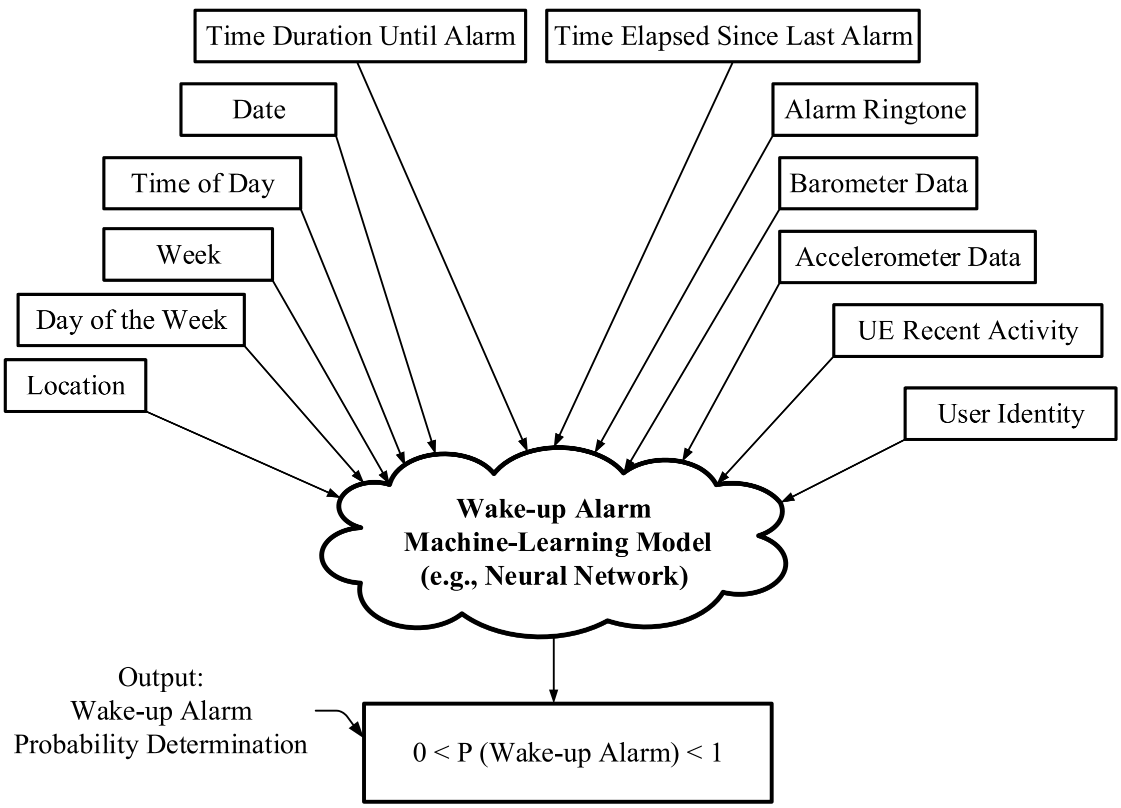

Figure 3

As illustrated in Figure 3, the UE's OS feeds several inputs to the machine-learned model. As the user sets an alarm, the OS's UE analyzes several inputs, such as location, day of the week,

week, time of day, date, time duration until alarm, time elapsed since last alarm, alarm ringtone, barometer data, accelerometer data, recent user activity, user identity, and so forth. The machine-learned model determines the probability of this alarm being a wake-up alarm. The output of the machine-learned model is 0 < P (wake-up alarm) < 1, where "0" represents zero percent, "1" represents 100%, and "P (wake-up alarm)" refers to the probability of an alarm being a wake-up alarm.

Examples of how each input helps the machine-learned model decide what is the probability of an alarm being a wake-up alarm are:

Location — The location of the UE may show whether the user is at home, at work, at church, instate, out of state, out of the country, and so forth. For example, the machine-learned model may find that at home the user sets a variety of alarms, but at church the user always sets a wake-up alarm.

Day of the week — The user may go to sleep at different times depending on the day of the week. This may depend on the user's work schedule, school schedule, religious activity (*e.g.*, early Sunday Mass for some Christians), sport or exercise schedule (*e.g.*, early-morning aerobics class), and other activities.

Week — The user may go to sleep at a different time depending on the week. The user may practice a profession that requires them to work varying schedules or shifts, not work at all, or may be "on-call" depending on the week. For example, the user may be a firefighter, a nurse, an emergency room medical doctor, a manufacturing technician, an oilfield worker, or some other professional with changing weekly schedule. Aside from the user's profession, other factors may contribute to the user's week-to-week routine change, such as the user may share physical custody of a child, and they may go to bed earlier and wake up earlier when the child stays with the user.

Time of day — The user may set different types of alarms depending on the time of the day. For example, around 6:30 PM the user may set an alarm (not a wake-up alarm) for when to take their dinner out of the oven, around 8:00 PM the user may set a wake-up alarm to meditate, around 11:00 PM the user may set another wake-up alarm before going to bed, and so forth.

Date — The user may go to sleep at a different time depending on the date. For example, the user may stay up late on their birthday, their friend's birthday, a holiday (*e.g.*, New Year's Eve), an event (*e.g.*, a festival), and so forth.

Time duration until alarm — The time of day until alarm can suggest whether the user may be preparing to go to sleep (*e.g.*, nine hours, eight hours, seven hours), take something out of the oven (*e.g.*, two hours, 45 minutes, 30 minutes, 20 minutes), celebrate Mass (*e.g.*, one hour), and so forth.

Time elapsed since last alarm — The user may set wake-up alarms at regular intervals. Therefore, this input can suggest whether the alarm follows the same pattern.

Alarm ringtone — The user may set a specific alarm ringtone for a reminder alarm (*e.g.*, a loud constant beeping, a single beep) and another specific alarm ringtone for a wake-up alarm (*e.g.*, a progressive increase in alarm sound volume, light music, radio station).

Barometer data — Some UE's have built-in barometers or altimeters that may help determine whether the user placed the phone in their shirt pocket, front pocket, floor, table, nightstand, or so forth. This data may help determine whether the user is going to sleep and placed the smartphone on the nightstand, cooking and placed the smartphone on the kitchen counter, walking and put the smartphone in their front pocket, and so forth.

Accelerometer data — The user may have a predictable movement behavior before they set a wake-up alarm. For example, as the user gets ready for sleep, they may set the smartphone on the nightstand, brush their teeth, take a bath, and then set a wake-up alarm. The smartphone may experience no movement for 30 or 40 minutes as the user gets ready to sleep.

UE recent activity — The user's recent interaction with the UE may also predict the user's intent as they set an alarm. For example, the user may read before bedtime, while playing light music using a music application or browser. As another example, the user may check emails before their bedtime.

User identity — Users who cohabitate may share one or many UE that support alarm setting. Users may share a smartphone, a laptop, a voice-assistant device, and so forth, which may use several ways to authenticate which user is interacting with the UE. The inputs of these users to the machine-learned model may differ.

In addition to analyzing each input separately, the machine-learned model analyzes each input in relation to other inputs. Combining and analyzing all inputs enhances the capability of the machine-learned model to better-predict the outcome.

During the first stages of model training, the UE's OS may ask for user input. As the user sets an alarm, the OS may ask "Do you want to turn on the DND feature?" or "Is this a wake-up alarm?" Depending on the type of UE the user is using, the UE may ask these questions differently, such as a toast or a small popup on the bottom of the screen (*e.g.*, a smartphone's screen), an audible question (*e.g.*, a voice-assistant device), a popup graphical user interface (*e.g.*, a notebook's screen), and so forth. The UE's OS may also ask questions on the DND feature itself, such as "Do you want to allow calls, but silence all other alerts?" "Do you want to silence calls and alerts, but keep the luminosity level the same?" and other possible combinations. Referring to the example of Figure 1, when Jane is "on-call" she may want to silence alerts, lower the UE's luminosity level, but allow calls in case someone from her manufacturing facility needs her help.

The various UE inputs and user feedback are used to train the model. It may not be possible for the model to predict whether an alarm is a wake-up alarm with 100% accuracy, but it may do so with a high degree of confidence, such as approximately 99%, 98%, 95%, or 90% accuracy, and may not ask for a user input if the degree of confidence is higher than a predefined threshold level. Given the large computational power that machine learning uses to train a model to analyze so many inputs, the model training may be performed on a cloud, server, or other capable computing device or system.

Additionally, a user may be provided with controls allowing the user to make an election as to both if and when systems, programs, or features described herein may enable collection of user information (*e.g.*, information about a user's social network, social actions or activities, profession, a user's preferences, or a user's current location), and if and when the user is sent content or communications from a server. In addition, certain data may be treated in one or more ways before it is stored or used, so that personally identifiable information is removed. For example, a user's identity may be treated so that no personally identifiable information can be determined for the user, or a user's geographic location may be generalized where location information is obtained (such as to a city, ZIP code, or state level), so that a particular location of a user cannot be determined. Thus, the user may have control over what information is collected about the user, how that information is used, and what information is provided to the user. The user may also select that the UE's OS perform the model training on a personal device instead of a cloud or a server.

In summary, the machine-learned model may help classify wake-up alarms and determine when and how the do-not-disturb feature functions, which may enhance the user's quality of sleep, concentration, or overall well-being.

References:

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